

### **Industrial Automation Headquarters**

Delta Electronics, Inc. Taoyuan Technology Center No.18, Xinglong Rd., Taoyuan District, Taoyuan City 33068, Taiwan TEL: +886-3-362-6301 / FAX: +886-3-371-6301

### Asia

Delta Electronics (Shanghai) Co., Ltd. No.182 Minyu Rd., Pudong Shanghai, P.R.C. Post code : 201209 TEL: +86-21-6872-3988 / FAX: +86-21-6872-3996 Customer Service: 400-820-9595

Delta Electronics (Japan), Inc. Industrial Automation Sales Department 2-1-14 Shibadaimon, Minato-ku Tokyo, Japan 105-0012 TEL: +81-3-5733-1155 / FAX: +81-3-5733-1255

Delta Electronics (Korea), Inc. 1511, 219, Gasan Digital 1-Ro., Geumcheon-gu, Seoul, 08501 South Korea TEL: +82-2-515-5305 / FAX: +82-2-515-5302

Delta Energy Systems (Singapore) Pte Ltd. 4 Kaki Bukit Avenue 1, #05-04, Singapore 417939 TEL: +65-6747-5155 / FAX: +65-6744-9228

Delta Electronics (India) Pvt. Ltd. Plot No.43, Sector 35, HSIIDC Gurgaon, PIN 122001, Haryana, India TEL: +91-124-4874900 / FAX: +91-124-4874945

Delta Electronics (Thailand) PCL. 909 Soi 9, Moo 4, Bangpoo Industrial Estate (E.P.Z), Pattana 1 Rd., T.Phraksa, A.Muang, Samutprakarn 10280, Thailand TEL: +66-2709-2800 / FAX: +66-2709-2827

Delta Electronics (Australia) Pty Ltd. Unit 2, Building A, 18-24 Ricketts Road, Mount Waverley, Victoria 3149 Australia Mail: IA.au@deltaww.com TEL: +61-1300-335-823 / +61-3-9543-3720

### Americas

TEL: +52-55-3603-9200

Delta Electronics (Americas) Ltd. 5101 Davis Drive, Research Triangle Park, NC 27709, U.S.A. TEL: +1-919-767-3813 / FAX: +1-919-767-3969

Delta Electronics Brazil Ltd. Estrada Velha Rio-São Paulo, 5300 Eugênio de Melo - São José dos Campos CEP: 12247-004 - SP - Brazil TEL: +55-12-3932-2300 / FAX: +55-12-3932-237

Delta Electronics International Mexico S.A. de C.V. Gustavo Baz No. 309 Edificio E PB 103 Colonia La Loma, CP 54060 Tlalnepantla, Estado de México

### EMEA

Delta Electronics (Netherlands) B.V. Sales: Sales.IA.EMEA@deltaww.com Marketing: Marketing.IA.EMEA@deltaww.com Technical Support: iatechnicalsupport@deltaww.com Customer Support: Customer-Support@deltaww.com Service: Service.IA.emea@deltaww.com TEL: +31(0)40 800 3900

Delta Electronics (Netherlands) B.V. Automotive Campus 260, 5708 JZ Helmond, The Netherlands Mail: Sales.IA.Benelux@deltaww.com TEL: +31(0)40 800 3900

Delta Electronics (Netherlands) B.V. Coesterweg 45, D-59494 Soest, Germany Mail: Sales.IA.DACH@deltaww.com TEL: +49 2921 987 238

Delta Electronics (France) S.A. ZI du bois Challand 2,15 rue des Pyrénées, Lisses, 91090 Evry Cedex, France Mail: Sales.IA.FR@deltaww.com TEL: +33(0)1 69 77 82 60

Delta Electronics Solutions (Spain) S.L.U Ctra. De Villaverde a Vallecas, 265 1º Dcha Ed. Hormigueras – P.I. de Vallecas 28031 Madrid TEL: +34(0)91 223 74 20 Carrer Llacuna 166, 08018 Barcelona, Spain Mail: Sales.IA.Iberia@deltaww.com

Delta Electronics (Italy) S.r.l. Via Meda 2-22060 Novedrate(CO) Piazza Grazioli 18 00186 Roma Italy Mail: Sales.IA.Italy@deltaww.com TEL: +39 039 8900365

Delta Energy System LLC Vereyskaya Plaza II, office 112 Vereyskaya str. 17 121357 Moscow Russia Mail: Sales.IA.RU@deltaww.com TEL: +7 495 644 3240

### Delta Greentech Elektronik San. Ltd. Sti. (Turkey)

Şerifali Mah. Hendem Cad. Kule Sok. No:16-A 34775 Ümraniye – İstanbul Mail: Sales.IA.Turkey@deltaww.com TEL: + 90 216 499 9910

Eltek Dubai (Eltek MEA DMCC)

OFFICE 2504, 25th Floor, Saba Tower 1, Jumeirah Lakes Towers, Dubai, UAE Mail: Sales.IA.MEA@deltaww.com TEL: +971(0)4 2690148



**Digitized Automation for a Changing World** 

# **AX-3 Series Operation Manual**

\*We reserve the right to change the information in this manual without prior notice.



# **AX-3 Series Operation Manual**

# **Revision History**

Version	Revision	Date
1 <sup>st</sup>	The first version was published.	2020/10/30
2 <sup>nd</sup>	<ol> <li>Chapter 1 &amp; 2: added information for new products, AX-300NA0PA1, AX-324NA0PA1P and AX-308EA0MA1P.</li> <li>Chapter 4: Updated images of new version DIADesigner-AX software. Added descriptions for new setting page System Setting in section 4.2.1.11. Added Added LocalIIO Fresh Task Delay Time table in section 4.2.2. Added Timing for the Variable to be Cleared to Zero in section 4.3.2.5. Added three new motion control function blocks in the list of Synchronization axes in section 4.4.1.4.</li> <li>Chapter 7: Added velocity axis description in section 7.4.2. Added information of Servo Gear Ratio Setting in section 7.4.2.1. Updated step information and corrected the wording Trapezoid in section 7.4.3. Added new variables for axis group in section 7.5.2.</li> <li>Chapter 8: Updated software images in section 8.2. Deleted information about Matrikon ® FLEX<sup>™</sup> OPC UA. Added Setting up an Encrypted Connection with the "UaExpert".</li> <li>Chapter 9: Added information about Startup Checking and Timeouts in section 9.1.3. Added notes in section 9.3.1.2.</li> </ol>	2021/04/26
3 <sup>rd</sup>	1. Chapter 2: Product name correction in section 2.2.1.	2021/05/12
4 <sup>th</sup>	<ol> <li>Chapter 1 &amp; 2: Added information for new products: AX-304ELA0PA1T, AX-304ELA0PA1P, AX-316EA0MA1T, AS02PU-A, AS04PU-A, AS02HC-A,</li> <li>Chapter 4: Updated the table in section 4.3.2.5. Added section 4.3.2.6: Timing for the Default Value to be Valid. Update the table in section 4.4.1.4. Added 4.5 Recipe Manager.</li> <li>Updated the content of step 9 in section 8.3.4.</li> <li>Added section 9.4 EtherNet/IP in chapter 9.</li> <li>Appendix A: Updated the content of troubleshooting error code 16#1807 in section A.4.2.2 and added information for new products: AS02HC-A, AS02PU-A and AS04PU-A.</li> </ol>	2021/9/31
5 <sup>th</sup>	<ol> <li>Added description of AX-332 and AS02ADH-A module to section 1.1.2.</li> <li>Added information of flammability rating and AX-332 model to chapter 2. Add wiring configuration of new model types to section 2.2.5.</li> <li>Added related information of model AX-332 to chapter 3.</li> <li>Added description of project ID and AX-332 model to</li> </ol>	2022/8/11

Version	Revision	Date
	<ul> <li>section 4.2.1.11.</li> <li>5. Added information of settings related to Delta servo system in section 7.4.2.1. Add version information to section 7.6.3.5. Update the software display and relating information in section 7.7.7.6. Add description of axis group limit in section 7.7.8.2.</li> <li>6. Added section 9.1.4 Backup Parameters for EtherCAT Slaves to chapter 9. Update information of values when instance=1. Add section 9.6 FTP Functions.</li> </ul>	
6 <sup>th</sup>	<ol> <li>Chapter 1: Updated information of program capacity and data capacity in section 1.1.2. Updated the conversion time for analog I/O modules. Added a new type of sensor for AS06RTD-A. Added new product information for AS00SCM-A and AS04SIL-A. Updated the model names of ECAT cables for motion controller from UC-EMCXXX-02A to UC-EMCXXX-02C. Added a table of firmware interoperability in section 1.1.3. Added a table of operating modes supported by AX-3 Motion Controllers in section 1.1.4.</li> <li>Chapter 2: Updated the information of ambient air temperature-barometric pressure-altitude in section 2.1. Added information of Ethernet port as well as PROFINET. Updated information of RS485 port, EtherNet/IP and the specification of AX-332EP in section 2.2.1.</li> <li>Chapter 4: Added Licensed Software Metrics in section 4.2.1.8. Added options of Apply IP Settings While Download and Retain Settings for System Setting in section 4.2.1.10. Added a table of firmware interoperability in section 4.2.1.10.1. Updated information of Symbol Rights in section 4.2.2.1.03. Updated the timing for the variable to be cleared to zero in section 4.3.2.5. Updated the timing for the default value to be effective in section 4.3.2.6.</li> <li>Chapter 7: Added a new code 1031 for Synchronous axis in section 7.5.1. Added a new function "PlanningPriority" in section 7.7.6.1. Updated DIADesigner-AX operating images. Updated the input range for hardware filter in section 7.7.7.2. Added a description of connecting interfaces for SSI encoders and updated the function of Clock Frequency under General in section 7.7.7.3. Added a description of connecting interfaces for pulse encoders in section 7.7.7.4. Added operating description of pulse output functions in section 7.7.7.6.</li> </ol>	2023/5/24

Version	Revision	Date
	<ol> <li>Chapter 9: Added a compatibility table of firmware version of AX-3 Series PLC CPU and the version of the</li> </ol>	
	EtherCAT function library in section 9.1. Added a new section for introducing PROFINET IO in section 9.3.5; removed section 9.6 FTP Functions.	
	<ol> <li>Added Chapter 10 Convenience Functions.</li> </ol>	
	<ol> <li>Appendix A: Added error LED codes 16#7, 16#8 and 16#D in sections A.2.3 and A.5.1. Changed the name of</li> </ol>	
	DL_BuiltInIO_AX3 to DL_BuiltInIO in section A.3.1.	

# **AX-3 Series Operation Manual**

# **Table of Contents**

# Chapter 1 Product Introduction

1.1 C	0verview
1.1.1	Related Manuals1-2
1.1.2	Models Descriptions1-3
1.1.3	Firmware Interoperability1-10
1.1.4	Operating Modes Supported by AX-3 Series Motion Controllers1-11
1.2 D	IADesigner-AX Software Overview1-12
1.2.1	Features1-12

# Chapter 2 Specifications and System Configurations

2.1	General Specifications2-2
2.2	CPU Module Specifications
2.2.	1 Functional specifications
2.2.	2 Electrical specifications 2-12
2.2.	3 CPU Module Profiles 2-14
2.2.	4 CPU Module Input/Output Terminals 2-20
2.2.	5 Wiring Configuration 2-22
2.3	Power Supply Module Specifications2-29
2.3.	1 General Specifications
2.3.	2 Power Supply Module Profiles 2-29
2.3.	3 Power Supply Module Terminals 2-30
2.4	Extension Modules 2-32

# Chapter 3 Installing Hardware and Getting Started

	Installing Hardware	3.1
	.1.1 Installing and Removing a	3.1.
ery 3-3	.1.2 Installing and Replacing a	3.1.

3.1.3	Installing the AX-3 Series PLC in the Control Cabinet	3-5
3.2 Ins	stalling and Uninstalling DIADesigner-AX	3-7
3.2.1	Installing DIADesign-AX	3-8
3.2.2	Uninstalling DIADesigner-AX	3-14
3.3 Get	tting Started and Setting up Communication	3-15
3.3.1	Getting Started	3-15
3.3.2	Setting up Communication	3-16

# Chapter 4 Basic Operation

4.1 Intro	oduction on DIADesigner-AX	
4.1.1	Creating a New Project	
4.2 Setti	ng Items on the Device Page	
4.2.1	CPU Parameter Settings	
4.2.2	Extension Module Parameter Settings	4-31
4.3 Data	Type and Variables	
4.3.1	Data Type	4-32
4.3.2	Variables	4-33
4.4 Task		
4.4.1	Task Configuration	4-44
4.5 Recip	pe Manager	
4.5.1	Recipe Manager	4-51
4.5.2	Recipe Definition	4-53
4.5.3	RecipeManCommand	4-55

# Chapter 5 Hardware Configuration

5.1 Environment of Hardware Configuration	5-2
5.2. Add a Module	5-5
5.3 Remove a Module	5-7
5.4 Copy and Paste a Module	5-9
5.4.1 Copy a Module	5-9
5.4.2 Paste a Module	5-10

5.5 Cut and Paste a Module	5-11
5.5.1 Cut a Module	5-11
5.5.2 Paste a Module	5-12

# Chapter 6 Network Configuration

6.1	Network Configuration	6-2
6.1.	.1 Introduction	
6.1.	.2 Basic Knowledge	
6.1.	.3 Creating a Network Topology	

# Chapter 7 Motion Control Basic Settings and Operation

7.1 Int	roduction on Motion Control Instructions7-5
7.1.1	Motion Control Instructions
7.1.2	Application Notes on Motion Control Instructions
7.1.3	Categories of Motion Control Instructions
7.2 Cre	eating Motion Control Project7-7
7.2.1	Process Flowchart
7.2.2	Process for Creating a Project
7.3 Co	mmissioning7-14
7.3.1	Procedure for Commissioning7-14
7.3.2	Example of Axis Parameter Settings
7.3.3	Perform Axes Commissioning7-16
7.4 Mo	tion Control Device
<b>7.4 Mo</b> 7.4.1	tion Control Device7-19Overview7-19
7.4.1	Overview
7.4.1 7.4.2	Overview
7.4.1 7.4.2 7.4.3 7.4.4	Overview7-19Introduction to Axis7-19Procedure for Single-axis Configuration7-29
7.4.1 7.4.2 7.4.3 7.4.4	Overview7-19Introduction to Axis7-19Procedure for Single-axis Configuration7-29Axis Group Settings7-36
7.4.1 7.4.2 7.4.3 7.4.4 7.5 Mo	Overview7-19Introduction to Axis7-19Procedure for Single-axis Configuration7-29Axis Group Settings7-36Ation Axis Variables7-44
7.4.1 7.4.2 7.4.3 7.4.4 <b>7.5 Mo</b> 7.5.1 7.5.2	Overview7-19Introduction to Axis7-19Procedure for Single-axis Configuration7-29Axis Group Settings7-36Ation Axis Variables7-44Variables for Single Axis7-44
7.4.1 7.4.2 7.4.3 7.4.4 <b>7.5 Mo</b> 7.5.1 7.5.2	Overview7-19Introduction to Axis7-19Procedure for Single-axis Configuration7-29Axis Group Settings7-36Otion Axis Variables7-44Variables for Single Axis7-44Variables for Axis Group7-47

Execution and Status Indication for Motion Control Instructions7-5	7.6.3	
4 Position7-6	7.6.4	
5 CAM Tables and Framework7-6	7.6.5	
Motion Control Functions7-7	7.7 M	7.
1 System Structure7-7	7.7.1	
2 Single-axis Control7-7	7.7.2	
3 Velocity Control7-9	7.7.3	
4 Torque control7-9	7.7.4	
5 Common Functions for Single-axis Control7-9	7.7.5	
6 Axis Group Control7-10	7.7.6	
7 High-speed IO7-10	7.7.7	
Other Features	7.7.8	
Programming Example7-14	7.8 Pi	7.
1 Device Framework7-14	7.8.1	
2 Examples	7.8.2	

# Chapter 8 OPC UA Server

8.1	OPC UA Server	
8.1	1.1 Creating a Project for OPC UA Access	8-2
8.2	Setting up a Connection with the "UaExpert" Client	8-4
8.3	Setting up an Encrypted Connection	8-8
8.3	3.1 Setting up User Account and Password	8-8
8.3	3.2 CODESYS Security Agent	8-9
8.3	3.3 Setting up an Encrypted Connection with the "Prosys OPC UA Client"	8-12
8.3	3.4 Setting up an Encrypted Connection with the "UaExpert"	8-15

# **Chapter 9 Communication**

9.1 Introduction to EtherCAT Communication	9-3
9.1.1 Features of EtherCAT Fieldbux	
9.1.2 Settings up EtherCAT Master	
9.1.3 Setting up the EtherCAT Slave	9-6
9.1.4 Backup Parameters for EtherCAT Slaves	
9.2 Introduction to Modbus Serial Communication	9-16

9.2.1 Modbus Serial Port	
9.2.2 Modbus Serial Master	
9.2.3 Modbus Serial Slave	9-29
9.3 Introduction to Ethernet Communication	
9.3.1 Network Security	9-32
9.3.2 Ethernet	
9.3.3 Modbus TCP Master (Client)	9-37
9.3.4 Modbus TCP Slave (Server)	
9.3.5 PROFINET IO	9-51
9.4 EtherNet/IP	9-58
9.4.1 Introduction to EtherNet/IP	9-58
9.4.2 EtherNet/IP Scanner Function	9-61
9.4.3 EtherNet/IP Adapter Function	9-83
9.4.4 CIP Object	9-95
9.4.5 Delta EIP Product List	9-105

# Chapter 10 Convenience Functions

10.1	SD (	Card Functions	10-2
10.1.	.1	Instructions for Reading/Writing from/to an SD Card	10-2
10.1.	.2	Startup Command	10-6
10.1.	.3	Backup and Restore EtherCAT Slave Parameters	0-14

# Appendix A Troubleshooting

A.1 T	roubleshotting	A-2
A.1.1	Basic Troubleshooting Steps	A-2
A.1.2	Clear the Error States	A-2
A.1.3	Troubleshooting SOP	A-3
A.1.4	Viewing Log	A-3
A.2 T	roubleshooting of CPU Modules	A-6
A.2.1	ERROR LED Indicators Blinking Every 0.5 Seconds	A-6
A.2.2	ERROR LED Indicators Blinking Rapidly Every 0.2 Seconds	A-8
A.2.3	ERROR LED Indicators Slow Blinking Every 3 Seconds and Light	ing up
	for 1 Second	A-8
A.2.4	BAT. LOW LED Indicators Are ON	A-8

A.2.5	BAT. LOW LED Indicators Blinking Every 0.5 Seconds A-9
A.2.6	Others
A.3 Tro	ubleshooting of the Funciton BlocksA-10
A.3.1	DL_BuiltInIO_AX3 A-10
A.3.2	Motion Control Related Instructions A-13
A.4 Tro	ubleshooting of I/O ModulesA-14
A.4.1	Troubleshooting of Analog Modules (AD/DA/XA) and Temperature Modules
	(RTD/TC) A-14
A.4.2	Troubleshooting of Loadcell Modules AS02LC A-16
A.5 Err	or Codes and LED Indicators for CPU ModulesA-17
A.5.1	Error Codes and LED Indicators for CPU Modules A-18
A.5.2	Error Codes and LED Indicators for Analog and Temperature Module A-20

# Chapter 1 Product Introduction

# Table of Contents

1.1 0	verview
1.1.1	Related Manuals1-2
1.1.2	Models Descriptions1-3
1.1.3	Firmware Interoperability 1-10
1.1.4	Operating Modes Supported by AX-3 Series Motion Controllers 1-11
1.2 D	IADesigner-AX Software Overview1-12
1.2.1	Features 1-12

# 1.1 Overview

This manual introduces the AX-3 Series CPU functions, devices, module tables, troubleshooting, and so forth.

## 1.1.1 Related Manuals

The related manuals for AX-3 Series programmable logic controllers are listed below.

- AX-3 Series Operation Manual This manual introduces CPU functions, devices, module tables, electrical specifications, appearances and dimension, basic concept of motion control, basic configurations, troubleshooting, and so forth.
- AX-3 Series Quick Start
   This quick start helps you create and use the system in a short time. Besides presenting you with basic system framework, this quick start uses example to demonstrate how to design, write programs, use variables as well as function blocks (FB) and download the PLC program to the PLC. Refer to Appendix A Troubleshooting of AX-3 Series Operation Manual, if any error occurs.
- AX Series Motion Controller Manual This introduces single-axis and multi-axes instructions for programming the AX Series Motion Controllers.
- AX Series Standard Instructions Manual This introduces standard instructions for programming the AX Series Controllers.
- AS Series Hardware and Operation Manual This manual introduces electrical specifications, wirings of CPU modules and modules, appearances, dimensions, and so forth.
- AS Series Module Manual This manual introduces special I/O modules such as network modules, analog I/O modules, temperature measurement modules, and so forth.
- DIADesigner-AX User Manual This manual introduces the use of the software, programming languages, including Ladder Diagram (LD), Sequential Function Chart (SFC), Structured Text (ST), and Function Block Diagram (FBD), as well as Program Organization Unit (POU), tasks and editing techniques for motion control programs.

# 1.1.2 Models Descriptions

Classification	Model Name	Description
	AS 0502	Input: 100-240 VAC, 50/60 Hz
Power Supply	AS-PS02	Output: 24VDC/2A, 48W (for PLC internal use)
Module		Input: 100-240 VAC, 50/60 Hz
Module	AS-PS02A	Output: 24VDC/1.5A, 36W (for PLC internal use)
		Output: 24VDC/0.5A, 12W (for external use)
		CPU module, built-in with 2x Ethernet port switches, 1x RS-485,
	AX-300NA0PA1	1x RS-232, 1 USB, Micro SD interface. Program capacity: 8 MB;
AX-3 Logic		removable terminal blocks
Controller CPU		CPU module, PNP output, built-in with 16DI (200KHz), 8 DO
Module	AX-324NA0PA1P	(200KHz), 2x Ethernet port switches, 1x RS-485, 1x RS-232, 1
	AA-324NAUFATF	USB, Micro SD interface. Program capacity: 8 MB; removable
		terminal blocks
		4-axis motion controller CPU module, NPN output, 16 DI
	AX-304ELA0PA1T	(200KHz), 8 DO (200KHz NPN), 2x Ethernet port switches, 1x
	AX-304ELA0FATT	EtherCAT, 1x RS-485, 1x RS-232, 1 USB, Micro SD interface.
		Program capacity: 8 MB; removable terminal blocks
		4-axis motion controller CPU module, PNP output, 16 DI
		(200KHz), 8 DO (200KHz NPN), 2x Ethernet port switches, 1x
	AX-304ELA0PA1P	EtherCAT, 1x RS-485, 1x RS-232, 1 USB, Micro SD interface.
		Program capacity: 8 MB; removable terminal blocks
		8-axis motion controller CPU module, NPN output, 2 X built-in
	AX-308EA0MA1T	Incremental encoders, 1 X SSI, 16 DI (200KHz), 8 DO (200KHz
AX-3 Motion		NPN), 2x Ethernet port switches, 1x EtherCAT, 1x RS-485, 1x
Controller CPU		RS-232, 1 USB, Micro SD interface. Program capacity: 8 MB;
Module		removable terminal blocks
		8-axis motion controller CPU module, PNP output, 2x built-in
		Incremental encoders, 1x SSI, 16 DI (200KHz), 8 DO (200KHz),
	AX-308EA0MA1P	2x Ethernet port switches, 1x EtherCAT, 1x RS-485, 1x RS-232,
		1 USB, Micro SD interface. Program capacity: 8 MB; removable
		terminal blocks
		16-axis motion controller CPU module, NPN output, 2 X built-in
	AX-316EA0MA1T	Incremental encoders, 1 X SSI, 16 DI (200KHz), 8 DO (200KHz
		NPN), 2x Ethernet port switches, 1x EtherCAT, 1x RS-485,
		1x RS-232, 1 USB, Micro SD interface. Program capacity: 8 MB;
		removable terminal blocks

Classification	Model Name	Description
		32-axis motion controller CPU module, NPN output, 2x built-in
		Incremental encoders, 1x SSI, 16 DI (200KHz), 6 DO (200KHz
	AX-332EP0MB1T	NPN), 2x Ethernet port switches, 1x EtherCAT, 1x RS-485,
		1x RS-232, 1 USB, Micro SD interface. Program capacity: 128
		MB; removable terminal blocks.
		64-axis motion controller CPU module, NPN output, 2x built-in
		Incremental encoders, 1x SSI, 16 DI (200KHz), 8 DO (200KHz
	AX-364ELA0MA1T	NPN), 2x Ethernet port switches, 1x EtherCAT, 1x RS-485,
		1x RS-232, 1 USB, Micro SD interface. Program capacity: 8 MB;
		removable terminal blocks
		24VDC
	AS08AM10N-A	5mA
	ASOCAWION-A	8 inputs
		Spring-clamp terminal block
		5 - 30VDC
		0.5A/output, 4A/COM
	AS08AN01P-A	8 outputs
		Sourcing output
		Spring-clamp terminal block
		240VAC/24VDC
		2A/output, 8A/COM
Digital	AS08AN01R-A	8 outputs
Digital		Relay
input/output module		Spring-clamp terminal block
module		5 - 30VDC
	AS08AN01T-A	0.5A/output, 4A/COM
		8 outputs
		Sinking output
		Spring-clamp terminal block
		24VDC
	AS16AM10N-A	5mA
	AS IGAIVITUN-A	16 inputs
		Spring-clamp terminal block
		5 - 30VDC
	AS16AN01P-A	0.5A/output, 4A/COM
		16 outputs

Classification	Model Name	Description
		Sourcing output
		Spring-clamp terminal block
		240VAC/24VDC
		2A/output, 8A/COM
	AS16AN01R-A	16 outputs
		Relay
		Spring-clamp terminal block
		5 - 30VDC
		0.5A/output, 4A/COM
	AS16AN01T-A	16 outputs
		Sinking output
		Spring-clamp terminal block
		24VDC
		5mA
		8 inputs
		5 - 30VDC
	AS16AP11P-A	0.5A/output, 4A/COM
		8 outputs
		Sourcing output
		Spring-clamp terminal block
		24VDC
		5mA
	AS16AP11R-A	8 inputs
		240VAC/24VDC
		2A/output, 8A/COM
		8 outputs
		Relay
		Spring-clamp terminal block
		24VDC
		5mA
	AS16AP11T-A	8 inputs
		5 - 30VDC
		0.5A/output, 4A/COM
		8 outputs
		Sinking output
		Spring-clamp terminal block

Classification	Model Name	Description
		24VDC
		3.2mA
	AS32AM10N-A	32 inputs
		MIL connector
		5 - 30VDC
		0.1A/output, 3.2A/COM
	AS32AN02T-A	32 outputs
		Sinking output
		MIL connector
		24VDC
	AS64AM10N-A	3.2mA
	AS64AMTUN-A	64 inputs
		MIL connector
		5 - 30VDC
		0.1A/output, 3.2A/COM
	AS64AN02T-A	64 outputs
		Sinking output
		MIL connector
		4-channel analog input module
		Hardware resolution: 16 bits
	AS04AD-A	0–10V, 0/1–5V, -5 to +5V, -10 to +10V, 0/4–20mA, -20–+20mA
		Conversion time: 2 ms/channel (upgraded for FW V1.02 or later:
		1 ms/channel)
		8-channel analog input module
		Hardware resolution: 16 bits
Analog	AS08AD-B	0 to +10V, 0/1–5V, -5V to +5V, -10V to +10V
input/output		Conversion time: 2 ms/channel (upgraded for FW V1.02 or later:
module		1 ms/channel)
module		8-channel analog input module
	AS08AD-C	Hardware resolution: 16 bits
		0/4–20mA, -20mA–+20mA
		Conversion time: 2 ms/channel (upgraded for FW V1.02 or later:
		1 ms/channel)
	AS04DA-A	4-channel analog output module
		Hardware resolution: 12 bits
		-10 to +10V, 0–20mA, 4–20mA

Classification	Model Name	Description
		Conversion time: 2 ms/channel
		4-channel analog input
		Hardware resolution: 16 bits
		0–10V, 0/1–5V, -5 to +5V, -10 to +10V, 0/4–20mA, -20 to +20mA
		Conversion time: 2 ms/channel
	AS06XA-A	2-channel analog output
		Hardware resolution: 12 bits
		-10 to +10V, 0–20mA, 4–20mA
		Conversion time: 2 ms/channel (upgraded for FW V1.02 or later:
		1 ms/channel)
		2-channel analog input
		Hardware resolution: 16 bits
		0–10V, 0/1–5V, -5 to +5V, -10 to +10V, 0/4–20mA, -20 to +20mA
	AS02ADH-A	High-speed conversion time: 20us max
		Full isolation, including channel-to-channel isolation
		A max of 2000 records with peak values and triggering records
		FIR lowpass and bandpass filter
	AS04RTD-A	4-channe, 2-wire/3-wire RTD
		Sensor type: Pt100 / Ni100 / Pt1000 / Ni1000 / JPt100 / LG-
		Ni1000 / Cu50 / Cu100 / 0-300Ω / 0-3000Ω
		Resolution: 0.1°C/0.1°F (16 bits)
		Conversion time: 200ms/channel
		6-channe, 2-wire/3-wire RTD
		Sensor type: Pt100 / Ni100 / Pt1000 / Ni1000 / JPt100 / LG-
Temperature	AS06RTD-A	Ni1000 / Cu50 / Cu100 / 0-300 $\Omega$ / 0-3000 $\Omega$ / Ni120 (FW V1.06 or
measurement		later); Resolution: 0.1°C/0.1°F (16 bits)
module		Conversion time: 200ms/channel
module		4-channel thermocouple
	AS04TC-A	Sensor type: J, K, R, S, T, E, N, B and -100 to +100 mV
	700+10-X	Resolution: 0.1°C/0.1°F (24 bits)
		Conversion time: 200ms/channel
		8-channel thermocouple
	AS08TC-A	Sensor type: J, K, R, S, T, E, N, B and -100 to +100 mV
	100010-A	Resolution: 0.1°C/0.1°F (24 bits)
		Conversion time: 200ms/channel
Positioning	AS02PU-A	2-axis motion control

Classification	Model Name	Description
module		5~24VDC, one differential input (A/B/Z phase) with a maximum
		bandwidth of 200KHz.
		24VDC, 5mA, 5 inputs with a maximum bandwidth of 1KHz.
		5VDC, 2-axis (4 points) differential input with a maximum
		bandwidth of 200KHz.
		4-axis motion control
	AS04PU-A	24VDC, 5mA, 6 inputs with a maximum bandwidth of 1KHz.
	A304F 0-A	5~30VDC, 0.1A, 4-axis (8 points) NPN output with a maximum
		bandwidth of 100KHz.
		2 channels high speed counter module
Counter		Two counting methods available - pulse input (up to 200Hz) and
module	AS02HC-A	SSI input (up to 1.25Hz).
module		Open collector 4 - point output, 5~30VDC, 0.1A, compatible with
		high speed comparators.
		2-channel, 4-wire/6-wire load cell sensor
Load cell	AS02LC-A	Eigenvalue applicable to a load cell: 1, 2, 4, 6, 20, 40, 80 mV/V
module		Highest accuracy: 0.04% of full-scale
module		ADC Resolution : 24 bits
		Conversion time: 2.5–400 ms (nine options to choose from)
Network	AS00SCM-A	Serial communication module, 2x communication ports for
module	ASOUSCIM-A	communication cards, supporting Modbus protocols
module	AS04SIL-A	IO-Link module, built-in with 4 IO-Link communication ports
	UC-PRG015-01A	Used for the connection between a PLC and a PC via a mini
	(1.5M)	USB port, use for AS Series CPU modules
Drogramming	UC-PRG030-01A	Use for the connection between a PLC and a PC with a mini
Programming cable	(3M)	USB port, use for AS Series CPU modules
cable		Use for the connection between a PLC and a PC with a RJ45
	UC-PRG030-20A	port, use for AS Series CPU modules and AS-FEN02 function
	(3M)	card
	UC-ET010-24B	
	(1M)	
1/0 ovtonoior	UC-ET020-24B	MIL connector, 40Pin $\leftrightarrow$ 40Pin, shielded, use for AS32AM10N-A,
I/O extension	(2M)	AS32AN02T-A, AS64AM10N-A and AS64AN02T-A
cable	UC-ET030-24B	
	(3M)	
	UC-ET010-24D	MIL connector, 40Pin $\leftrightarrow$ 2x 20Pin, shielded, use for AS332T-A,

Classification	Model Name	Description
	(1M)	AS332P-A, AS324MT-A, AS32AM10N-A, AS32AN02T-A,
	UC-ET020-24D	AS64AM10N-A, and AS64AN02T-A
	(2M)	
	UC-ET030-24D	
	(3M)	
		16 inputs/outputs, 20-Pin MIL connector, use for AS332T-A,
	UB-10-ID16A	AS332P-A, AS324MT-A, AS32AM10N-A, AS32AN02T-A,
		AS64AM10N-A and AS64AN02T-A
	UB-10-ID32A	32 inputs, 40-Pin MIL connector, use for AS32AM10N-A and
	00-10-1032A	AS64AM10N-A
External		Terminal block (spring clamp/MIL connector), MIL connector to
terminal	UB-10-IO32D	40-Pin spring clamp terminal block, use for AS332T-A, AS332P-
module		A, AS324MT-A, AS32AM10N-A, AS32AN02T-A
	UB-10-OR16A	16 relay outputs, 20-Pin MIL connector, NPN, use for AS332T-A,
		AS32AN02T-A and AS64AN02T-A
	UB-10-OR16B	16 relay outputs, 20-Pin MIL connector, PNP, use for AS332P-A
	UB-10-OT32A	32 transistor outputs, 40-Pin MIL connector, NPN, use for
		AS32AN02T-A and AS64AN02T-A
	UC-EMC003-02C	Ethernet communication cable, 0.3M
	UC-EMC005-02C	Ethernet communication cable, 0.5M
	UC-EMC010-02C	Ethernet communication cable, 1M
	UC-EMC020-02C	Ethernet communication cable, 2M
	UC-EMC050-02C	Ethernet communication cable, 5M
	UC-EMC100-02C	Ethernet communication cable, 10M
ECAT cables	UC-EMC200-02C	Ethernet communication cable, 20M
for motion	UC-EMC003-02B	Ethernet communication cable, 0.3M
controller	UC-EMC005-02B	Ethernet communication cable, 0.5M
	UC-EMC010-02B	Ethernet communication cable, 1M
	UC-EMC020-02B	Ethernet communication cable, 2M
	UC-EMC030-02B	Ethernet communication cable, 3M
	UC-EMC050-02B	Ethernet communication cable, 5M
	UC-EMC100-02B	Ethernet communication cable, 10M

# 1.1.3 Firmware Interoperability

The firmware version has been validated to work with the devices listed in the table below.

AX-3 Series PLC CPU Firmware Version	Module Type	Module Name	Module Firmware Version	
Filliware version		AS08AM10N-A	Filliware version	
		AS08AN10N-A	_	
		AS08AN01P-A	_	
		AS08AN01R-A		
		AS16AM10N-A		
		AS16AN01P-A	_	
		AS16AN01R-A	_	
V1.00.00 and later	Digital I/O Module	AS16AN01T-A		
		AS16AP11P-A		
		AS16AP11R-A	_	
		AS16AP111T-A	_	
		AS10ALTITA AS32AM10N-A	_	
		AS32AN10N-A	_	
		AS64AM10N-A	_	
		AS64AN02T-A	_	
		AS04AD-A		
		AS08AD-B	_	
V1.00.00 and later		AS08AD-C	V1.00.00 and later	
	Analog I/O Module	AS04DA-A		
		AS06XA-A		
V1.00.03 and later		AS02ADH-A	V1.00.00 and later	
		AS04RTD-A		
	Temperature	AS06RTD-A	_	
V1.00.00 and later	Measurement Module	AS04TC-A	V1.00.00 and later	
		AS08TC-A	_	
V1.00.00 and later	Load Cell Module	AS02LC-A	V1.06.00 and later	
		AS02EU-A		
V1.00.01 and later	Positioning Module	AS02PU-A	V1.00.00 and later	
V1.00.01 and later	Counter Module	AS02HC-A	V1.00.00 and later	
V1.00.05 and later	Network Module	AS00SCM-A	V2.00.00 and later	

# 1.1.4 Operating Modes Supported by AX-3 Series Motion Controllers

CiA 402 is the device profile for applications of drives and motion controls. The operating modes including Profile Position Mode, Profile Velocity Mode, Cyclic Synchronous Position Mode, Cyclic Synchronous Velocity Mode, and Cyclic Synchronous Position Mode are defined in CiA 402.

Mode	Description	Supported FB
P2P	Design the motions between points to points for slaves. Available CiA 402 operating modes include Profile Position Mode and Profile Velocity Mode.	DL_MotionControlLight
P2P & Synchronized	Design the motions between points to points for slaves and Electronic CAM. Available CiA 402 operating modes include Cyclic Synchronous Position Mode and Cyclic Synchronous Velocity Mode.	SM3_Basic DL_MotionControl
Group	Multi-axes interpolation motions; Available CiA 402 operating modes include Cyclic Synchronous Position Mode.	DL_MotionControl

Model Model	P2P	P2P & Synchronized	Group
AX-304ELA0PA1T/P	Y	Ν	Ν
AX-308EA0MA1T/P	Y	Y	Y
AX-316EA0MA1T	Y	Y	Y
AX-332EP0MB1T	Y	Y	Y
AX-364ELA0MA1T	Y	Y	Y

Y = supported

N = not supported

# 1.2 DIADesigner-AX Software Overview

Conformed to IEC61131-3, DIADesigner-AX is a new programming tool for a new generation Delta PLC. With the abundant applied instructions and an adequate motion function library, DIADesigner-AX provides a friendly and multilingual programming interface for a more convenient and efficient development environment.

### 1.2.1 Features

DIADesigner-AX is applicable to AX-8 and AX-3 series.

- Support all the programming languages that IEC 61131-3 defines, including LD, SFC, ST, and FBD, as well as POU, tasks and other programming language standard.
- Powerful and proven function library for various applications.
- Input assistance for the input and configuration.
- User-friendly programming with mouse and keyboard in IEC 61131-3 supported programming languages.
- Extensive debugging and online features for the fast optimization of the application code and to speed up testing and commissioning.
- Numerous security features for the protection of the source code and for safeguarding the operation of the controller.
- Programmable devices from different manufacturers.
- The user interface is extendible and adaptable without leaving the framework.
- Transparent internal structures of the development tool and the available components.
- Many seamlessly integrated tools for different kinds of automation tasks.

Two built-in configuration tools:

- Hardware Configuration: the hardware configurations and parameter managements for the system.
- Network Configuration: the network configurations and data exchange management for the system.

Providing various solutions for motion control including PLCopen, MC function block, G-code editor, E-CAM editor, positioning planning chart tool and many more.

- Support PLCopen POUs for single and multi-axis motions
- Support PLCopen POUs for add-on functions, including diagnostics, stop, and CAM controller
- Additional POUs for different tasks including monitoring dynamic data, following error, operating CAMs and CAM controllers
- Integrated graphical CAM editor with loads of configuration options
- Virtual and logical axes are supported.
- Integrated drivers for numerous Modbus and EtherCAT protocols
- Configuration of the drives as standard field devices.

# Chapter 2 Specifications and System Configurations

# **Table of Contents**

2.1	Gen	eral Specifications	2-2
2.2	CPU	Module Specifications	2-4
2.2	.1	Functional specifications	
2.2	.2	Electrical specifications	2-12
2.2	.3	CPU Module Profiles	
2.2	.4	CPU Module Input/Output Terminals	2-20
2.2	.5	Wiring Configuration	
2.3	Pow	ver Supply Module Specifications	2-29
2.3	.1	General Specifications	2-29
2.3	.2	Power Supply Module Profiles	2-29
2.3	.3	Power Supply Module Terminals	
2.4	Exte	ension Modules	2-32

# 2.1 General Specifications

ltem	Specifications
Operating temperature	-20 to 55°C*1; -20~50°C <sup>(AX-332)</sup>
Storage temperature	-40 to 80°C
Operating humidity	5–95% No condensation
Storage humidity	5–95% No condensation
Work environment	No corrosive gas exists.
Installation location	In a control box
Pollution degree	2
Ingress protection (IP ratings)	IP20
EMC Standard (electromagnetic compatibility)	Refer to tables of EMI, EMS and conducted immunity test below.
Vibration resistance	Tested with: $5 \text{ Hz} \leq f \leq 8.4 \text{ Hz}$ , constant amplitude 3.5 mm; $8.4 \text{ Hz} \leq f \leq 150 \text{ Hz}$ , constant acceleration 1g Duration of oscillation: 10 sweep cycles per axis on each direction of the three mutually perpendicular axes International Standard IEC 61131-2 & IEC 60068-2-6 (TEST Fc)
Shock resistance	Tested with: Half-sine wave: Strength of shock 15 g peak value, 11 ms duration; Shock direction: The shocks in each in direction per axis, on three mutually perpendicular axes (total of 18 shocks) International Standard IEC 61131-2 & IEC 60068-2-27 (TEST Ea)
Safety	Conforms to IEC 61131-2, UL508
Ambient air temperature-barometric pressure-altitude	Operating: 1013 ~ 795hPa (0 ~ 2000 m) Storage:1013 ~ 660hPa (0 ~ 3500 m)
Silicone Flammability Rating	UL94V-0

\*1: Leave the AX-3 Series PLC in an environment within the operating temperature for at least one hour to ensure the AX-3 Series PLC temperature is within the operating temperature.

### • EMI

Port	Frequency range	Level (Normative)	Reference standard
Enclosure port (radiated)	30-230 MHz	40 dB (µV/m) quasi-peak	IEC 61000-6-4
(measured at a distance of 10 meters)	230-1000 MHz	47 dB (μV/m) quasi-peak	
		79 dB (µV) quasi-peak	
AC power port	0.15-0.5 MHz	66 dB (μV) average	
(conducted)		73 dB (µV) quasi-peak	IEC 61000-6-4
	0.5-30 MHz	60 dB (µV) average	

### • EMS

Environmental phenomenon	Reference standard	Test		Test level
Electrostatic		Contact		± 4 kV
discharge	IEC 61000-4-2	Air		± 8 kV
Radio frequency	IEC 61000-4-3	80% AM, 1 kHz sinusoidal	2.0-2.7 GHz	1 V/m
electromagnetic field Amplitude modulated			1.4-2.0 GHz	3 V/m
			80-1000 MHz	10 V/m
Power frequency		60 Hz		30 A/m
magnetic field	IEC 61000-4-8	50 Hz		30 A/m

# Conducted immunity test

Environmental phenomenon		Fast transient burst	High energy surge	Radio frequency interference
Reference	e standard	IEC 61000-4-4	IEC 61000-4-5	IEC 61000-4-6
Interface/Port	Interface/Port Specific interface/port		Test level	Test level
Data	Shielded cable	1 kV	1 kV CM	10 V
communication	Unshielded cable	1 kV	1 kV CM	10 V
	AC I/O (unshielded)	2 kV	2 kV CM 1 kV DM	10 V
Digital and analog I/O	Analog or DC I/O(unshielded)	1 kV	1 kV CM	10 V
	All shielded lines (to the earth)	1 kV	1 kV CM	10 V
	AC power	2 kV	2 kV CM 1 kV DM	10 V
Equipment power	DC power	2 kV	0.5 kV CM 0.5 kV DM	10 V
I/O power and	AC I/O and AC auxiliary power	2 kV	2 kV CM 1 kV DM	10 V
auxiliary power output	DC I/O and DC auxiliary power	2 kV	0.5 kV CM 0.5 kV DM	10 V

# 2.2 CPU Module Specifications

# 2.2.1 Functional specifications

• Logic Controller CPU Module

Туре			AX-300NA*1	<b>AX-324NA</b> *2		
		LD instru	uction	5 nanosec	onds (ns)	
Process time	Execution time	Arithmetic in (LREAL da		36 nanose	conds (ns)	
	Program capacity	Capad	city	8 N	ЛВ	
	Variable	Retaintive	Retain			
Program	memory		Persist	128	КВ	
		Non-retaintive		16	МВ	
	Device memory (%M)	Siz	Size ts ts tg teed Ca	512	КВ	
	N	umber of ports		2		
	Phys	sical media type	S			
Ethernet port		Тороlоду			Star, linear	
	Trai	Transmission speed		10, 100, 1	000 Mbps	
	Cable			Category 5e or later	, 100 meters (Max.)	
	Comm	Cable				
	N	umber of ports		1		
USB port		Туре		Image: Second	USB	
	Ν	umber of ports		1		
RS232		Retaintive     Persist       Non-retaintive     Persist       Non-retaintive     Persist       Number of ports     Size       Number of ports     Topology       Topology     Transmission speed       Cable     Cable       mmunication protocol     Number of ports       Number of ports     Type       Number of ports     Baud rate       Baud rate     Number of ports       Baud rate     Size       Number of ports     Size				
port	Serial co	ommumication fo	ormat	• • • •	•	
	Comm	umication proto	col	Modbus A	SCII/RTU	
	N	umber of ports		1		
RS485		Baud rate				
port	Serial co	Serial commumication format			Stop bit: 1, 2; Parity bit: None, Odd, Even; Data bit: 7, 8	
	Comm	umication proto	col	Modbus ASCII/RTU		

	Туре			AX-324NA*2
	Modbus TCP Maximum number of the connections			
705	SOCKET	32 (Server + Client) TCP connections		r + Client)
TCP	Modbus TCP	Maximum data length per connection	100 words	
	SOCKET	Maximum data length per instruction	8 KB	

	Тур	AX-300NA <sup>*1</sup>	AX-324NA*2		
		Maximum number of the Scanner connections	1:	2	
		Maximum number of the Adapter connections	1		
	CIP IO	Requested Packet Interval (RPI)	20 ~ 1,000 ms	s (unit: 1 ms)	
	Connection	Maximum Transmission Speed	2,200	) pps	
EtherNet/IP		Maximum data length per connection	Input: 509 bytes (T $\rightarrow$ O) Output: 505 bytes (O $\rightarrow$ T) O: Originator T: Target		
	CIP Explicit Message	Number of Connections	12		
		UCMM	Yes		
		Class 3 / UCMM	Get_Attribute Get_Attribut Set_Attribute Set_Attribute	es_All (FB) _Single (FB)	
		CIP objects supported	Identity, Message Router, Assembly, Connection, Manager, Port, TCP/IP interface, Ethernet link, Vendor specifi		
	Supporte	Supported profiles and models		Foundation: OPC UA I for IEC 61131-3	
OPC UA	Endpoints	Endpoints and connecting ports		configurable via ation file)	
server	Maximum nu	mber of sessions (Client)	5	;	
	Maximum nun	nber ofmonitored items per server	1000		
	Sampling rate	of the monitored items (ms)	100, 300, 500, 10	000, 2500, 5000	

	Тур	e		AX-300NA*1	AX-324NA*2	
	Maximum nu		of subscriptions per rver	1	00	
			r of variables that published	10,	000	
			of value attributes e published	10,	000	
			structure definitions	1	00	
OPC UA server	Conditions that can not be published for each network- published variable			<ul> <li>More than three dimensional arrays</li> <li>Array of Array</li> <li>The OPC UA Stack will limit messages to about 300 kB. This is the maximum for values too.</li> <li>Pointer variables, Interface variables</li> <li>Structures containing pointers and interfaces</li> </ul>		
	Security mode and policy			None Sign - Basic256Sha256 SignAndEncrypt - Basic256Sha2566		
	Application Nun authentication		Authentication	X.509		
			ber of certificates that can be stored	Trusted applications: 32 Issuer certificiates: 32 Rejected applications: 32		
	User authentication		Method of user authentication	User name / password / Anonymous		
	Max.	IO Slo	t Supported	64		
PROFINET	Minimum Time f	or Dat	a Exchange to Operate	1	ms	
	Maximum Data	a Leng	th/Per Transmission	Input: 1440 bytes Output: 1440 bytes		
	Number of IO er	ntensi	on modules supported	3	32	
IO configuration		I/O ca	pacity		92byte 192byte	
Sonngulation	Built-in IO		High speed counter	-	6 (200 KHz)	
	Built-in IO PWM		-	8 (200 KHz)		
Memory card	SD card type		Micro SD (SDHC, 32GB max.)			
Real-time clock	Year, Month, Date, Hour, Minute, Second, Week		One CR1620 ba	attery is required.		

\*1 : AX-300NA represents model AX-300NA0PA1

\*2 : AX-324NA represents model AX-324NA0PA1P

	Туре			AX-304 EL*1	AX-308 EA* <sup>2</sup>	AX-316 EA* <sup>3</sup>	AX-364 EL*4	AX-332E P *5
		LD ins	struction	5 nanoseconds (ns)				1.6 ns
Process time	Execution time	Arithmetic instructions (LREAL data type)			36 nanoseconds (ns)			1.6 ns
	Program capacity	Cap	oacity		8	MB		128 MB
Program	Variable memory	Retain tive			768 KB (device memory (%M) is counted in)			1.5 MB (device memory included %M)
			Persist		128	8 KB		512 KB
		Non-re	etaintive		16	MB		256 MB
	Device memory (%M)	Size		512 KB				
		num	imum ber of lled axes	4 axes	16 axes	32 axes	64 axes	32 axes
	F Number of	EtherCAT axes		4 axes	8 axes	16 axes	4 axes	32 axes
		Pulse Out axes		-	4 axes		1 axes	
		numbe for interp	Maximum number of axes for linear interpolation axis control		6 axes			
Motion control	num fo inte		Maximum number of axes for circular interpolation axis control		2 axes			
	Maximum number of axes groups		-	8 groups 16 grou		16 groups		
	Motion co	ntrol per	riod			I period as		
	САМ	Numb er of CAM data points	Max. points per CAM table	-		256 pc	bints	32,767 points

### • Motion Controller CPU Module

		Ma poir for CA tabl Maximum number of C tables	ts all VI es	-	20,480 points 80	655,340 points 160
	Numbe	r of ports			2	
Physical media types Ethernet		10BASE-T, 100BASE-TX,		IEEE 802.3/802 .3u/802.3 ab 1G bps (Intel I210IT)		
port	Тор	ology			Star, linear	
	Transmis	sion speed		1	0, 100, 1000 Mbps	
	Cable			Category 5	5e or later, 100 meters (	(Max.)
	Commumication Protocols			ARP, IP, TCP, UDP, Modbus TCP, EtherNet/IP, OPC UA, PROFINET		
	Numbe	r of ports		1		
USB port	Ţ	уре		Mini USB		USB 2.0 (0.5A)
	Numbe	r of ports		1		
RS232	Baud rate			00 / 38,400 / 57,600 / / 115,200 bps		
port	Serial commumication format			- Parity bit: None, Odd, Data bit: 7, 8		
	Commumica	ation protocol		Modbu	s ASCII/RTU	
	Numbe	r of ports			1	
RS485	Bau	d rate		9,600 / 19,200 / 38,400 / 57,600 / 76,800 / 115,200 bps		
port	Serial commu	mication form	at	Stop bit: 1, 2; Par	ity bit: None, Odd, Ever 8	n; Data bit: 7,
	Commumica	ation protocol		r	Modbus ASCII/RTU	
	EtherCA	AT Master			Class B	
EtherCAT port	Physical r	nedia types		100	BASE-TX	IEEE 802.3/802 .3u/802.3 ab 1G bps (Intel I210IT)

	Transmis	sion speed			100 Mbp	S	
	Тор	ology	Line, daisy chain, and branching				g
	C	able	Category 5e or later, 100 meters (Max.)				Max.)
	Maximum number of Slaves Transmission cycle		16	64	64	96	256
			(or		00µs ~ 32, can set the	000µs e unit to 25	0 µs)
	Modbus TCP	Maximum number of the connections					
ТСР	SOCKET	Maximum number of the TCP connections		32	(Server + (	Client)	
	Modbus TCP	Maximum data length per connection	100 words				
	SOCKET	Maximum data length per instruction	8 KB				
		Number of adapter to be connected	8				
	CIP IO	Maximum number of the CIP connections (Scanner)	12				
		Maximum number of the CIP connections (Adapter)	1				
EtherNet/IP	Connection	Requested Packet Interval (RPI)	20~1,000ms (unit: 1 ms)				
		Maximum Transmission Speed	2,200 pps				
		Maximum data length per connection		Output	509 bytes : 505 bytes O: Origina T: Targe	s (O $\rightarrow$ T) tor	
	CIP Explicit	Number of Connections			12		
	Message	UCMM	Yes				

		Class 3 / UCMM	Get_Attribute_Single (FB) Get_Attributes_All (FB) Set_Attribute_Single (FB) Set_Attributes_All (FB)	
		CIP objects supported	Identity, Message Router, Assembly, Connection Manager, Port, TCP/IP interface, Ethernet link, Vendor specific	
	Supported pro	files and models	PLCopen and OPC Foundation: OPC UA Information Model for IEC 61131-3	
	Endpoints and	connecting ports	TCP: 4840 (Reconfigurable via configuration file)	
		nber of sessions ient)	5	
		ber ofmonitored er server	1000	
	Sampling rate of the monitored items (ms)		100, 300, 500, 1000, 2500, 5000	
	Maximum number of subscriptions per server		100	
	Maximum number of variables that can be published		10,000	
OPC UA	Maximum number of value attributes that can be published		10,000	
server	Maximum number of structure definitions that can be published		100	
	Conditions that can not be published for each network- published variable		<ul> <li>More than three dimensional arrays</li> <li>Array of Array</li> <li>The OPC UA Stack will limit messages to about 300 kB. This is the maximum for values too.</li> <li>Pointer variables, Interface variables</li> <li>Structures containing pointers and interfaces</li> </ul>	
	Security mode and policy		None Sign - Basic256Sha256 SignAndEncrypt - Basic256Sha2566	
		Authentication	X.509	
	Application authentication	Number of certificates that can be stored	Trusted applications: 32 Issuer certificiates: 32 Rejected applications: 32	
	User authentication	Method of user authentication	User name / password / Anonymous	
	Max. IO Slo	ot Supported	64	
PROFINET		ime for Data to Operate	1 ms	

	Maximum Data Length/Per Transmission		Input: 1440 bytes Output: 1440 bytes			
	Number of IO entension modules supported			32		
	I/O capacity			Input: 8,192byte Output: 8,192byte		
		Encoder	-	2	1	
IO configuration Built-in l		SSI		- 1		
	Built-in IO	High speed counter	6 (200 KHz)			
		Pulse out	-	4 (200 KHz)	1 (200 KHz)	
		PWM	8 (200 KHz)		4 (200 KHz)	
Memory card	SD card type		Micro SD (SDHC, 32GB max.)		Micro SD (SD3.0/S DR50/ SDXC)	
Real-time clock		n, Date, Hour, econd, Week	One CR1620 battery is required.			

\*1: AX-304EL includes model AX-304ELA0PA1T and AX-304ELA0PA1P.

\*2: AX-308EA includes model AX-308EA0MA1T and AX-308EA0MA1P.

\*3: AX-316EA represents model AX-316EA0MA1T.

\*4: AX-364EL represents model AX-364ELA0MA1T.

\*5: AX-332EP represents model AX-332EP0MB1T.

\*6: Except for AX-332, other AX series models are only applicable to a commercially available CR1620 3V battery. For model AX-332EP, please contact your local agents for batteries and accessories.

EtherCAT axes include positioning axes and synchronization axes. The maximum number of the axes are listed below.

Item Model	Maximum number of positioning axes	Maximum number of synchronization axes	Maximum number of positioning and synchronization axes
AX-304EL*1	4	-	4
AX-308EA*2	8	8	8
AX-316EA* <sup>3</sup>	16	16	16
AX-364EL*4	64	8	64
AX-332EP *5	32	32	32

\*1: AX-304EL includes model AX-304ELA0PA1T and AX-304ELA0PA1P.

\*2: AX-308EA includes model AX-308EA0MA1T and AX-308EA0MA1P.

\*3: AX-316EA represents model AX-316EA0MA1T.

\*4: AX-364EL represents model AX-364ELA0MA1T.

\*5: AX-332EP represents model AX-332EP0MB1T.

# 2.2.2 Electrical specifications

Model	AX-300NA0PA1	AX-304ELA0PA1T/P AX-324NA0PA1P	AX-308EA0MA1T/P AX-316EA0MA1T AX-364ELA0MA1T	AX-332EP0MB1T
Supply voltage	24	VDC ( 20.4 VDC~28.	8 VDC ) ( -15%~+209	%)
Power consumption (W)	4	5	11	24
Weight (g)	240	300	380	390

• Electrical specifications for the inputs on digital input/output module. The signals passing through the inputs are 24 VDC signals.

Model Item		AX-304ELA0PA1T/P, AX-308EA0MA1T/P, AX-316EA0MA1T, AX-324NA0PA1P, AX-364ELA0MA1T	AX-332EP0MB1T	
Number of	inputs	16	6	
Connector	type	Removable ter	minal blocks	
Input type		Digital	input	
Input form		Direct current (sinking or sourcing)		
Input volta	ige/ current	24 VDC, 5 mA		
Action	OFF→ON	>15 V	/DC	
level	ON→OFF	<5 VDC		
Response	OFF→ON	2.5	us	
time	ON→OFF	5 μ	S	
Maximum input frequency		200KHz		
Input impedance		5.6 kΩ		
Input electrical isolation		optocoupler		
Input display		When the optocoupler is driven, the input LED indicator is ON.		

Item	Model	AX-304ELA0PA1T AX-308EA0MA1T AX-316EA0MA1T AX-364ELA0MA1T	AX-304ELA0PA1P AX-308EA0MA1P AX-324NA0PA1P	AX-332EP0MB1T	
Number of	outputs	8		6	
Connector	type	Re	movable terminal blocks		
Output forn	า	NPN (Sinking)	PNP (Sourcing)	N-MOS	
Voltage		5~30\	24 VDC (-15% ~ +20%)		
	Resistance	0.1A/output			
Maximum Ioad	Inductance		-		
	Bulb		-		
Maximum output frequency <sup>*1</sup>		200 KHz			
Maximum Response time	OFF→ON		2.5 µs		

• Electrical specifications for the outputs on digital input/output module.

# 2.2.3 CPU Module Profiles

# • AX-300NA0PA1





Unit: mm
• AX-304ELA0PA1T / AX-304ELA0PA1P









#### • AX-308EA0MA1T / AX-308EA0MA1P/ AX-316EA0MA1T / AX-364ELA0MA1T

• AX-324NA0PA1P

(3)

0

2

• []

þ





### • AX-332EP0MB1T



Number	Name	Description		
1	Battery holder	A case for holding a battary (not enclosed) for the real-time clock fuction		
2	Power supply	For power supply		
3	Label	Nameplate		
4	External module port	Connects the modules		
5	Grounding clip For grounding			
	Power LED indicator	Indicates the power status of the CPU module		
	Run LED indicator	Operating status of the CPU module		
		ON: the module is running.		
		OFF: the module is stopped.		
6		Blinking: the module is detecting an error.		
	Error LED indicator	Error status of the module		
		ON: a serious error occurs in the module.		
		OFF: the module is normal.		
		Blinking: a minor error occurs in the module.		

Number	Name	Description	
	BAT.LOW LED indicator	Indicates the battery status of the CPU module.	
	COM1 LED COM2 LED	Indicates the communication status of the COM port. OFF: no communication over the COM port Blinking: communication over the COM port	
	FB1 LED FB2 LED	Indicates the communication status of the FB port. FB1 OFF: no communication over ECAT. FB1 blinking: normal communication over ECAT. FB2 OFF: no communication over CAN bus. FB2 blinking: normal communication over CAN bus.	
7	Run/Stop	RUN: execute the programs STOP: stop the programs	
8	COM Port	Provides an interface for RS-485 and RS-232 communication	
9	Input/Output LED indicator	If there is an input signal, the input LED indicator is ON. If there is an output signal, the output LED indicator is ON.	
10	Model name Shows the model name of the CPU module.		
11	USB Port	AX-3 Series (except for AX-332): Mini USB communication port AX-332: USB 2.0 port	
12	SSI Port	SSI Encoder communication port	
13	Input Terminals	For input wiring	
14	Ethernet Port	<ul> <li>Ethernet Switch communication port</li> <li>LINK indicator (Green):</li> <li>LED ON: The network connection is established.</li> <li>LED OFF: The network connection is NOT established.</li> <li>ACT indicator (Orange):</li> <li>LED blinking: Data transmission (sending/receiving)</li> <li>LED OFF: No data transmission</li> </ul>	
15	EtherCAT Port	<ul> <li>EtherCAT communication port</li> <li>LINK indicator (Green):</li> <li>LED ON: The network connection is established.</li> <li>LED OFF: The network connection is NOT established.</li> <li>ACT indicator (Orange):</li> <li>LED blinking: Data transmission (sending/receiving)</li> <li>LED OFF: No data transmission</li> </ul>	
16	SD Card Slot	Provides an interface for an SD card	
17	Encoder Port	Incremental encoder communication port	
18	Output Terminals For output wiring		

AX-304ELA0PA1T / AX-304ELA0PA1P				
	I	N		
	0	8		
	1	9		
	2	10		
	3	11		
	4	12		
	5	13		
	6	14		
550 <b>(C)</b> 551	7	15		
	S/S0	S/S1		
	0	JT		
	0	4		
	1	5		
	2	6		
	3	7		
	C0	CO		

# 2.2.4 CPU Module Input/Output Terminals

AX-308EA0MA1T / AX-308EA0MA1P / AX-316EA0MA1T / AX-364ELA0MA1T								
	)		SSI		ENCNDOR		IN	
		L	1	DATA+	1	A1+	X0.0	X0.8
	SSI	IM	2	DATA-	2	A1-	X0.1	X0.9
O ERROR RUN O BAT. LOW			6	CLK+	10	B1+	X0.2	X0.10
RS-232     RS-485     STOP			14	CLK-	11	B1-	X0.3	X0.11
MicroSD	0,00		8	GND	4	Z1+	X0.4	X0.12
	5 6 6 13 6 6 6 14 7 6 6 6 15 5/50 6 6 951	5 8 8 13 6 8 14 7 8 8 15	15	5V	5	Z1-	X0.5	X0.13
					15	+5V1	X0.6	X0.14
				3	A2+	X0.7	X0.15	
		0 <b>0 0</b> 4 1 <b>0 0</b> 5			9	A2-	S/S0	S/S1
	80000000000000000000000000000000000000				6	B2+	0	ŪΤ
		2 8 8 6 3 8 8 7 C0 8 6 C0			12	B2-	Y0.0	Y0.4
					13	Z2+	Y0.1	Y0.5
07 01507	Encoder	Ū			14	Z2-	Y0.2	Y0.6
	)				7	+5V2	Y0.3	Y0.7
					8	0V	C0	C0

AX-324NA0P	A1P	
	11	N
	0	8
	1	9
	2	10
	3	11
	4	12
	5	13
	6	14
	7	15
	S/S0	S/S1
	Ol	Л
	0	4
	1	5
	2	6
	3	7
	C0	C0

AX-332EP0MB1T						
		ENCODER				
		1	TX+	2	TX-	
		3	SG	4	SG	
		5	RX+	6	RX-	
- (()) 🖉 Nelta Ax332e	SG O B SG RX O B RX-	7	A+	8	A-	
		9	B+	10	B-	
		11	Z+	12	Z-	
		13	IN 0	14	OUT 0	
		15	IN 1	16	OUT 1	
		17	IN 2	18	OUT 2	
		19	IN 3	20	OUT 3	
		21	IN 4	22	OUT 4	
		23	IN 5	24	OUT 5	
		25	S/S	26	C0	

# 2.2.5 Wiring Configuration

#### Attentions for wiring:

- When connect high-speed inputs of AX series PLCs with (NPN / PNP) open connector outputs, we would suggest to add (pull-up/ pull-down) parallel resistors between the specified Input point and S/S. For resistors, we suggest you to use 3W/470ohm or 2W/1Kohm resistors.
- 2. If using push-pull outputs to connect high-speed inputs of AX series PLCs, parallel resistors would not be required.



### 2.2.5.1 AX-304ELA0PA1T Wiring

Input Type	Direct current (Sinking or Sourcing)
Input voltage/Current	24VDC, 5mA
Output Type	Sinking transistors
Output voltage/Current	5~30VDC, 0.1A

• Please find section 2.2.5.3 for wiring specification of high-speed counters.

Normal I/O Wiring



Input Type Direct current (Sinking or Sourcing)	
Input voltage/Current	24VDC, 5mA
Output Type	Sourcing transistors
Output voltage/Current	5~30VDC, 0.1A

#### 2.2.5.2 AX-304ELA0PA1P Wiring

- Please find section 2.2.5.3 for wiring specification of high-speed counters.
- General I/O Wiring



### 2.2.5.3 AX-308EA0MA1T / AX-316EAMA1T / AX-364ELA0MA1T Wiring

Input Type	IN0~IN15: Direct current (Sinking or Sourcing)
Input voltage/Current IN0~IN15: 24VDC, 5mA	
Output Type	Out0~Out7: Sinking transistors
Output voltage/Current	Out0~Out7 : 5~30VDC, 0.1A

• SSI Wiring



\*Note: A 5V power supply is provided to SSI interface.

When VCC = 5V, SSI encoder power supply voltage(VCC) can be connected to pin 15 on the SSI interface as well as connecting encoder 0V terminal to Pin8 on the SSI interface. If VCC  $\ddagger$  5V, please supply power to the SSI encoder separately based on the actual power voltage of the encoder.

#### • Encoder Wiring



Encoder interface			Encoder
			6)
Pin	Function		Function
1	A1+		A
2	A1-		Ā
10	B1+		в
11	B1-		B
4	Z1+	·	Z
5	Z1- ·		Ī
15	5V		VCC
8	GND		0V

\*Note: A 5V power supply is provided to Encoder interface.

When VCC = 5V, encoder power supply voltage(VCC) can be connected to pin 15 on the SSI interface as well as connecting encoder 0V terminal to Pin8 on the SSI interface. If VCC  $\pm$  5V, please supply power to the SSI encoder separately based on the actual power voltage of the encoder.

General Wiring



• High-speed Counter Wiring (PNP)



High-speed Output Wiring



#### 2.2.5.4 AX-308EA0M1P Wiring

Input Type	IN0~IN15: Direct current (Sinking or Sourcing)
Input voltage/Current	IN0~IN15: 24VDC, 5mA
Output Type	Out0~Out7: Sourcing transistors
Output voltage/Current	Out0~Out7 : 5~30VDC, 0.1A

- Please find section 2.2.5.3 for SSI, Encoder and high-speed counter wiring specification.
- General I/O Wiring



• High-speed Output Wiring



	<u> </u>
Input Type Direct current (Sinking or Sourcing)	
Input voltage/Current	24VDC, 5mA
Output Type	Sourcing transistors
Output voltage/Current	5~30VDC, 0.1A

2.2.5.5 AX-324NA0PA1P Wiring

General I/O Wiring



### 2.2.5.6 AX-332EPOMB1T Wiring

Input Type	Direct current (Sinking or Sourcing)
Input voltage/Current	24VDC, 5mA
Output Type	Sinking transistors
Output voltage/Current	5~30VDC, 0.1A

General I/O Wiring



• RS-422 / RS-485 Wiring



Encoder Wiring



\*Note: The encoder interface is with 5V DC only.

# 2.3 Power Supply Module Specifications

# 2.3.1 General Specifications

### • AS-PS02/AS-PS02A

lte	m	Specifications			
Supply vo	oltage	100–240 VAC (-15% to +10%) 50/60 Hz±5%			
Action specifications		If the input power supply is larger than 85 VAC, the power supply module can function normally.			
Allowable instantan power fail	eous	If the instantaneous power failure time is less than ten milliseconds, the power supply module keeps running.			
Fuse		2.5A/250 VAC			
Inrush cu	rrent	< 70A@115 VAC			
24 VDC or	utput	AS-PS02: 2 A for internal use: the CPU and the modules. AS-PS02A: 1.5 A for internal use: the CPU and the modules; 0.5 A for external use.			
Power pro	otection	The 24 VDC output is equipped with the short circuit protection and the overcurrent protection.			
Electrical	isolaiton	1,500 VAC (Primary-secondary), 1,500 VAC (Primary-PE), 500 VAC (Secondary-PE)			
Insulation voltage		Above 5 M $\Omega$ The voltage between all inputs/outputs and the ground is 500 VDC.			
Ground		The diameter of the ground should not be less than the diameters of the cables connected to the terminals L and N.			
	AS-PS02	270 g			
Weight	AS-PS02A	310 g			

# 2.3.2 Power Supply Module Profiles

### • AS-PS02



• AS-PS02A



Unit: mm

Number	Name	Description
1	POWER LED indicator (green)	Indicates the status of the power supply
2	Model name	Model name of the power supply module
3	Arrangement of the output terminals (only for AS-PS02A)	+24V: current output 24VDC, 500mA 24G: current output groud referenced
4	Arrangement of the input terminals	L: AC power input Line N: AC power input Neutral LG: Line ground
5	Power output (connect to CPU module)	

### 2.3.3 Power Supply Module Terminals

• AS-PS02



#### AS-PS02A



# 2.4 Extension Modules

You can connect the AS Series modules to AX-3 Series CPU. Refer to AS Series Module Manual for more information.



# Chapter 3 Installing Hardware and Getting Started

# **Table of Contents**

3.1 Ins	talling Hardware	
3.1.1	Installing and Removing a Memory Card	3-2
3.1.2	Installing and Replacing a Button Cell Battery	3-3
3.1.3	Installing the AX-3 Series PLC in the Control Cabinet	
3.2 Ins	talling and Uninstalling DIADesigner-AX	
3.2.1	Installing DIADesign-AX	3-8
3.2.2	Uninstalling DIADesigner-AX	3-14
3.3 Get	tting Started and Setting up Communication	3-15
3.3.1	Getting Started	3-15
3.3.2	Setting up Communication	3-16

### 3.1 Installing Hardware

### 3.1.1 Installing and Removing a Memory Card

#### • Memory Card Slot of the CPU Module

The memory card slot is on the front side of the AX Series PLC.



#### • Installing a Memory Card

Insert a memory card into the CPU module memory card slot and push it to the end of the slot until it clicks. Be sure the memory card is fixed firmly in the slot; if the memory card is loose, it is not installed correctly. With a fool-proofing design, the memory card can only be inserted in one direction. Do not force to push the memory card into the slot or you may damage the CPU module. See the instructions in the figures below for reference.



#### • Removing a Memory Card

You can remove a memory card by pushing it further into the slot. And then the card springs from the slot.



### 3.1.2 Installing and Replacing a Button Cell Battery

#### Installation

**▲** Warning

The real-time clock (RTC) cannot work unless the battery power is properly supplied. The AX-3 Series PLC does NOT include the battery when it leaves the factory. You need to purchase and install the CR1620 3V battery beforehand. And before installing the battery, you must get rid of the static electricity in the body by touching the grounded metal or you can wear antistatic gloves to avoid the static electricity.

The first-time battery installation can be done whether the AX-3 Series PLC is powered on or off. After installation, you can set the RTC through DIADesigner-AX. Follow the steps below for installing a battery.

1. Pull out the battery holder from the AX-3 Series PLC with the tip of a screwdriver at the concave part of the battery compartment as shown below.



2. Put the CR1620 3V battery in the battery holder in the direction indicated by the arrow below.



3. After putting the battery in the battery holder, push the battery holder back into the AX-3 Series PLC as shown below.



#### Replacement

# ▲ Warning

When the BAT LOW indicator of the AX-3 Series PLC is red, it indicates there is no battery installed or the battery voltage is low and you need to install or replace the battery of the AX-3 Series PLC. It is suggested to replace the battery while the AX-3 Series PLC is powered on. If you replace the batter while the PLC is powered off, the realtime clock data will be lost. Before replacing the battery, you must get rid of the static electricity in the body by touching the grounded metal or you can wear antistatic gloves to avoid the static electricity.

Follow the steps below for replacing a battery.

1. Pull out the battery holder from the AX-3 Series PLC with the tip of a screwdriver at the concave part of the battery compartment as shown below.



2. Take the CR1620 3V battery out of the battery holder in the direction indicated by the arrow below.



3. After the battery is removed, put in a new one and push the battery holder back into the AX-3 Series PLC as shown below.



### 3.1.3 Installing the AX-3 Series PLC in the Control Cabinet

#### • Environmental Temperature Requirement for the Control Cabinet

### ▲ Warning

- The ambient temperature of the control cabinet should be -20 ~ 55°C and the humidity 5 ~ 95%.
- DO NOT install the control cabinet near flammable material or high-temperature equipment.
- Keep enough space for air ventilation.
- Install fans or air conditioning system if the environment temperature exceeds 55°C.
- The equipment is for indoor use only.
- Install the control cabinet around 1.0m~2.0m in height for easier installation and operation.
- Keep the installation away from the high-voltage equipment or power equipment.
- Cut off the power supply of the control cabinet before installation.

#### • Actions for Anti-interference

# ▲ Warning

- Do not install the AX-3 Series PLC in the control cabinet with high-voltage equipment.
- Keep at least 200mm away from the power wire.
- The control cabinet should be grounded.
- Use the AX-3 Series PLC according to the instructions on the manual. If operating the AX-3 Series PLC in a manner not specified by the manufacturer, it may weaken the protection provided.

#### • Dimension Requirement for the Control Cabinet

The AX-3 Series PLC has to be installed in an enclosure. In order to ensure that the AX-3 Series PLC radiates heat normally, the space between the AX-3 Series PLC and the enclosure should be larger than 50 millimeters. (D > 50mm)



#### • Installing the AX-3 Series PLC on DIN rail

Pull out the fixing clips at the rear of the AX-3 Series PLC. Then edge in the horizontal slots which are at the rear of the AX-3 Series PLC on the DIN rail. And then push and lock the fixing clips to have the AX-3 Series PLC securely installed in the control cabinet. (The image below is for illustration purposes only; refer to AS500E Series Motion Controller Operation Manual for more information.)



• The installation inside the control cabinet (The image below is for illustration purposes only; refer to AS500E Series Motion Controller Operation Manual for more information.)



# 3.2 Installing and Uninstalling DIADesigner-AX

### • System requirements

Project	System Requirement			
Runtime System	DIADesigner-AX V1.00 or later			
Operating System	Windows 7 / 8.1 / 10 (32/64 bits)			
CPU	Intel Celeron 540 1.8 GHz (min.), Intel Core i5 M520 2.4 GHz (min.)			
Memory	2GB or above (recommend to use 4GB or more)			
Hard Disk Drive	10GB or more			
Monitor	Resolution 1920 x 1080 Pixels recommend			
Keyboard/Mouse	General Keyboard Mouse or Windows compatible device			
PC interface	Ethernet, USB, Serial port (depends on product interface)			
Software	Need to install .Net Framework 4.6.2			

### 3.2.1 Installing DIADesign-AX

Before installation begins, make sure the computer used for installing DIADesigner-AX meets the minimum system requirements listed in section 3.2.

The **DIAInstaller** is a software installer which assists you to download and install **DIAStudio** software applications. You can download, install, and update products such as **DIASelector**, **DIADesigner**, **DIAScreen**, and **COMMGR**. Go to <u>https://diastudio.deltaww.com/home/downloads</u> to download the **DIAStudio** for **DIAInstaller**.

Before entering the download page, you need to sign in or sign up.

0	<b>NELTA</b>
Sign in with	your existing account
Email Address	
Password	
Password	Forgot your password?
	Sign in

After logging-in, click DIAStudio download button to download **DIAInstaller** as the image shown below.

Software

Software Name	Description	OS	Issue Date	File
DIASelector App V0.4 (Early Access!)	DIASelector Mobile App	Android Lollipop (5.0) and above	2020/05/06	
DIAStudio V0,4 (Early Access!)	DIAStudio Software download and Installation Tool	Windows 7 / 8.1 / 10 / Server 2012 R2 32/64 bit	2020/05/06	

Follow the steps below for installing DIADesigner-AX.

1. Double-click DIAInstaller icon to see the latest version of DIADesigner-AX.

#### 2. Click **Download**.

DIAInstalle	r						- 🗆 🗙
						English	Sign Ir
oftware List	DIA	Studio					
<i>4</i> 8		Product Name	Version	Size	Download/Update Installation	Progress Ir	nstall/Uninstall
Option	i	DIADesigner	0.4	1.0 GB	↓ Download		🛃 Install
	i	DIASelector	0.4	767.4 MB	↓ Download		Anstall
	i	DIAScreen	0.4	1.6 GB	▲ Download		🛃 Install
	i	COMMGR	1.3	224.0 MB	▲ Download		Anstall
	i	DIADesigner-AX	0.5.0	1.3 GB	↓ Download		S Install
						Check for	Download
Åbout						Updates	Ali

3. After that, you can see DIADesigner-AX is downloaded and grayed out. Click Install.

are List		tudio					English ( 🗋 Ray w
rare List		tudio					
ŝ							
303	F	Product Name	Version	Size	Download/Update Installation	Progress	Install/Uninstall
ption	<b>i</b> (	DIADesigner	0.4	1.0 GB	↓ Download		🔄 Install
	i	DIASelector	0.4	767.4 MB	↓ Download		S Install
	i	DIAScreen	0.4	1.6 GB	🕁 Download		🛃 İnstall
	i	COMMGR	1.3	224.0 MB	↓ Download		Install
	i	DIADesigner-AX	0.5.0	1.3 GB	Downloaded		🛃 Install
							Check for Updates All

4. An InstallShied Wizard shows up and starts installing. Click Next.



5. The window of License Agreement shows up. Select "I accept the terms in the license agreement" and then click **Next**.

< Back

Next >

Cancel

📸 DIADesigner-AX 64 0.5.1 - InstallShield Wizard	×
License Agreement	4
Please read the following license agreement carefully.	
License Agreement	^
for the usage of a CODESYS Software or CODES Software Package	SYS
General Terms of License (End User License Agreemen supplied Software. Please read this Software User Agre carefully before using the supplied Software. Downloadi installation of the Software constitutes recognition by the the conditions of this Agreement.	ement ng or
The following conditions are agreed between you as the	e software 🗸 🗸
I accept the terms in the license agreement	Print
InstallShield	en Source Licenses
< Back Next >	Cancel

6. Click **Change...** to change the download path. Or leave the default path unchanged. Click **Next**.

estination Folder Click Next to install to this folder, or click Change to install to a different folder. Install DIADesigner-AX 64 0.5.1 to: C:\Program Files\Delta Industrial Automation\DIADesigner-AX V0.5.1\ IIShield Change DIADesigner-AX 64 0.5.1 - InstallShield Wizard hange Current Destination Folder Browse to the destination folder. Look in: © DIADesigner-AX V0.5.1 Colder name: DiADesigner-AX V0.5.1		gner-AX 64 0.5.1 - In	stallShield	Wizard		
C:\Program Files\Delta Industrial Automation\DIADesigner-AX V0.5.1\ IIShield IIShield IIShield IIShield IIShield IIShield IIShield IIShield IIShield IIShield IIIShield IIIIShield IIIShield II			, or click Ch	ange to install t	o a different folder	3
C:\Program Files\Delta Industrial Automation\DIADesigner-AX V0.5.1\ IIShield IIShield IIShield IIShield IIShield IIShield IIShield IIShield IIShield IIShield IIIShield IIIIShield IIIShield II	~	Install DIADesigner-A	X 64 0.5.1 t	:		
< Back	D	C:\Program Files\Delt			ADesigner-AX	Change
< Back						
< Back						
DIADesigner-AX 64 0.5.1 - InstallShield Wizard hange Current Destination Folder Browse to the destination folder. Look in: P DIADesigner-AX V0.5.1 E P P P P P P P P P P P P P P P P P P P	allShield -					
hange Current Destination Folder Browse to the destination folder. Look in:				< Back	Next >	Cancel
Eolder name: D:\Program Hies\Delta Industrial Automation\DIADesigner-AX V0.5.1\						3
Eolder name: D:\Program Hies\Delta Industrial Automation\DIADesigner-AX V0.5.1\						
D:\Program Files\Delta Industrial Automation\DIADesigner-AX V0.5.1\	Look in:					
D:\Program Files\Delta Industrial Automation\DIADesigner-AX V0.5.1\	-	Designer-AX V0.5.1				
D:\Program Files\Delta Industrial Automation\DIADesigner-AX V0.5.1\	-	Designer-AX V0.5.1				
D:\Program Files\Delta Industrial Automation\DIADesigner-AX V0.5.1\	-	Designer-AX V0.5.1				× •
D:\Program Files\Delta Industrial Automation\DIADesigner-AX V0.5.1\	-	Designer-AX V0.5.1				
	-	Designer-AX V0.5.1				
IIShield	Eolder na	ame:				
	Eolder na	ame:	aí Automatic	n\DIADesigner	-AX V0.5.1)	

7. The window of Setup Type shows up as the image shown below. Select the one you need and then click Next.



8. The window of Ready to Install the Program appears as below and then click Install.

🐻 DIADesigner-AX 64 0.5.1 - InstallShi	eld Wizard		×
Ready to Install the Program			14
The wizard is ready to begin installation.			9
Click Install to begin the installation.			
If you want to review or change any of yo the wizard.	our installation sett	ings, click Back. Click C	Cancel to exit
InstallShield			
	< Back	Install	Cancel

It may take some time to install.

13	Please wait while the InstallShield Wizard installs DIADesigner-AX 64 0.5.1. This may take several minutes.							
	Status:							
	Validating install							
		_						

9. After installation, the window of InstallShield Wizard Completed appears. Click **Finish** to complete the installation.



### 3.2.2 Uninstalling DIADesigner-AX

Follow the steps below for uninstalling DIADesigner-AX.

1. Double-click DIAInstaller icon to open and then click Uninstall.

er						- 🗆 🗙
						English ( 🕄 Ray w
DIA	Studio					
	Product Name	Version	Size	Download/Update Installation	Progress	Install/Uninstall
i	DIADesigner	0.4	1.0 GB	↓ Download		🛃 Install
i	DIASelector	0.4	767.4 MB	↓ Download		S Install
i	DIAScreen	0.4	1.6 GB	↓ Download		S Install
i	COMMGR	1.3	224.0 MB	↓ Download		C Install
i	DIADesigner-AX	0.5.0	1.3 GB	installed		📤 Uninstall
						Check for Download
						Updates All
	DIA i i i i	DIAStudio Product Name i DIADesigner i DIASelector i DIAScreen i COMMGR	Product Name       Version         I       DIADesigner       0.4         I       DIASelector       0.4         I       DIAScreen       0.4         I       COMMGR       1.3	DIAStudioProduct NameVersionSize1DIADesigner0.41.0 GB1DIASelector0.4767.4 MB1DIAScreen0.41.6 GB1COMMGR1.3224.0 MB	DIAStudio         Product Name       Version       Size       Download/Update Installation         i       DIADesigner       0.4       1.0 GB       ★ Download         i       DIASelector       0.4       767.4 MB       ★ Download         i       DIAScreen       0.4       1.6 GB       ★ Download         i       COMMGR       1.3       224.0 MB       ★ Download	DIAStudio         Product Name       Version       Size       Download/Update Installation       Progress         i       DIADesigner       0.4       1.0 GB       ★ Download         i       DIASelector       0.4       767.4 MB       ★ Download         i       DIASereen       0.4       1.6 GB       ★ Download         i       COMMGR       1.3       224.0 MB       ★ Download

2. The system will remove DIADesigner-AX from your computer in the background.

# 3.3 Getting Started and Setting up Communication

### 3.3.1 Getting Started

After DIADesigner-AX is successfully installed, click Start **L**, you can find it under the folder of Delta Industrial

Automation and you can also find its short cut on the desktop. Double-click either one to start the software. You can open more than one DIADesigner-AX software to achieve multitasking.



After the loading is done, you can see the start page as below. Refer to Chapter 4 for more details on operation.



#### 3.3.2 **Setting up Communication**

After DIADesigner-AX is successfully installed, the system creates the execution file CODESYS Gateway V3 under the folder of Delta Industrial Automation and GatewaySysTray.exe in the Program Files folder. Double-click either one to start the Gateway. After that, the system starts Gateway automatically whenever you turn your computer on. And its

icon

will appear on the taskbar. If not, go to the execution file CODESYS Gateway V3 under the folder of Delta Industrial Automation or GatewaySysTray.exe in the Program Files folder to start the Gateway manually.



Click Stop Gateway if you need to stop gateway working.



3

If you need to discontinue the execution of GatewaySysTray completely, you can click **Exit Gateway Control** and the icon will disappear on the taskbar.

	Start Gateway Stop Gateway
	Exit Gateway Control
	About
٠	📰 🗇

Open the software DIADesigner-AX and open/create your project to see the project-setting page. Double-click Device (Product Name) to open the device-setting page. You can find the Gateway status under the Communication Settings tab. If the Gateway is started, its light is green. If the Gateway is stopped, its light is red.

Devices • • • ×	Device ×					
Outitled1     Ovice (AX-308EA0MA1T)	Communication Settings	Scan Network Gateway	Device *			
di Hardware Configuration	Applications Backup and Restore				_	1
W PLC Logic     Mpplication     Wiltin_IO (BuiltIn_IO)	Files					COTON
<ul> <li>DIO (DIO)</li> <li>Delta_LocalBus_Master (Delta LocalBus Master)</li> </ul>	Log		100	Gateway		
EtherCAT_Master_SoftMotion (EtherCAT Master SoftMot:     SoftMotion General Axis Pool	PLC Settings		Gateway-1	<	~	TWTY3NB1364
<ul> <li>Sutrouur General Aus Pour</li> </ul>	PLC Shell		IP-Address: localhost			Press ENTER to set active path
	Users and Groups		Port: 1217			
	Access Rights					
	Symbol Rights					
	System Parameters					
	Task Deployment					
	Status					
	Information					

You can configure the Local Gateway. Click **Gateway** and click the option **Configure the Local Gateway** to open the setting page.


You can find two interfaces under Local Gateway, including UDP interface and TCP interface. You can also create a different port. Click **Add** and select **Add top level interface** and then use the drop-down list to select the port you needed to add. Here we use adding COM Port as an example.

Gateway Configuration		×	Gateway Configuration		×
Interface = UDP interface Name = Shared Memory = TCP interface Port	Setting Default UDPimerface 11743	¢	Interface WDP interface Name Shared Memory WTCP interface UDP interface Interface	Setting Default UDPInterface	
To display additional informa keys. Add top level interfac Add sub level interfar Add configuration se	ce		Add Delete		OK Cancel

After adding COM Port, you can set up the COM port name, its corresponding port and the baudrate. Once the setting is done, click **OK**. You need to Stop/Start GatewaySysTray again to ensure the following action, such as Scan Network to work properly. Refer to the previous steps to run GatewaySysTray again.

	P. 40	
nterface	Setting	
UDP interface		
Name	Default UDP interface	
Shared Memory		
TCP interface	in the second second second second second second second second second second second second second second second	
Port	11743	
COM Port	14 Mar 1997	
Name	Com<1>	
Port	1	
Baudrate	57600	
his setting defines the pl	nysical serial port used for this interface (e.g. COM 5 on a V	Mindows PC).

You can add configuration settings under COM Port. Right-click the COM Port icon **COM** Port , select Add configuration setting..... to add the setting items. After that you can further define the setting values. Once the setting is done, click OK.

			= COM Port Name Port Bandrate	Com<1> 1 57600
			Enable auto addressing	~
= COM Port Name Port	Add top lev	vel interface vel interface	Enable auto addressing Local address Parity Storbuts	
Baudrate	Add config	uration setting	Enable half-duplex auto n Enable RTS toggle hands Timeout	iegotiate haking

After the configurations of Local Gateway are set, you can select the **Scan Network** tab to bring out network scanned results on the **Select Device** setting page. Select **AX-308EA0MA1T** and then click **OK**.

Communication Settings	Scan Network Gateway * Device *	
Applications		
Backup and Restore		10 July 10 Jul
Files	•	
Log	Gateway	
PLC Settings	Select Device	
PLC Shell	Select the network path to the controller:	Device Name: A Scan Network
Jsers and Groups	AX-308EA0MA1T [0005]	AX-308EA0MA1T
sers and Groups		Wink Device Address:
ccess Rights		0005
ymbol Rights		Block driver:
ystem Parameters		UDP
ask Deployment		Number of
аж рерюушенс		channels:
tatus		4
nformation		Serial number:
		RTS- 8237ab589fbe5aa4
		Target ID: 16F7 0313

If the connection is established successfully, you can find that the status light is green and the detailed device information under the device image.

Communication Settings Scan I	Network Gateway • Device •	
Applications		(
Backup and Restore	1000	- <u>+</u>
Files		
Log	Gateway	
PLC Settings	Gateway-1	~ [0005] (active) ~
PLC Shell	IP-Address: localhost	Device Name: AX-308EA0MA1T
Users and Groups	Port: 1217	Device Address: 0005
Access Rights		Target ID: 16F7 0313
Symbol Rights		Target Type: 4102
System Parameters		Target Vendor: Delta Electronics
Task Deployment		Target Version:
Status		3.5.15.11
Information		

3

MEMO

# 4

# Chapter 4 Basic Operation

# Table of Contents

4.1 Introduction on DIADesigner-AX4-2
4.1.1 Creating a New Project
4.2 Setting Items on the Device Page4-4
4.2.1       CPU Parameter Settings       4-4         4.2.1.1       Communication Settings       4-4         4.2.1.2       Applications       4-7         4.2.1.3       Backup and Restore       4-8         4.2.1.4       Files       4-9         4.2.1.5       Log       4-9         4.2.1.6       PLC Settings       4-11         4.2.1.7       PLC Shell       4-12         4.2.1.8       Licensed Software Metrics       4-13         4.2.1.9       System Settings       4-14         4.2.1.10       Right Settings       4-14         4.2.1.10       System Setting       4-14         4.2.1.10       System Settings       4-16         4.2.1.10       Licensed Groups       4-17         4.2.1.10.1       Users and Groups       4-16         4.2.1.10.2       Access Rights       4-21         4.2.1.10.3       Symbol Rights       4-26         4.2.1.11       System Parameters       4-28         4.2.1.12       Task Deployment       4-30         4.2.1.14       Information       4-30
4.2.2Extension Module Parameter Settings4-314.3 Data Type and Variables4-32
4.3.1Data Type4-324.3.2Variables4-334.3.2.1Declaration of Variables4-334.3.2.2Address Assignments4-344.3.2.3Variables4-354.3.2.4User-defined Data Types4-394.3.2.5Timing for the Variable to be Cleared to Zero4-424.3.2.6Timing for the Default Value to be Effective4-434.4 Task4-44
4.4.1       Task Configuration
4.5 Recipe Manager4-49
4.5.1       Recipe Manager

# 4.1 Introduction on DIADesigner-AX

DIADesigner-AX is an open platform for PLC development system and industrial automation. The adaptable DIADesigner-AX provides an easy way to create professional engineering of IEC 61131-3 automation projects. Based on the IEC 61131-3 data structure and the high-level language programming, DIADesigner-AX is strong in functionality, easy to develop, reliable, extendable and open for development. Integrated with components such as visualization and Safety solution, DIADesigner-AX offers a variety of user-friendly engineering functions for your professional applications in controller development system sectors including PLC and motion control.

In DIADesigner-AX, you can customize the user interface by arranging the window layout and the appearance of menus, toolbars and commands according to your requirements.

# 4.1.1 Creating a New Project

Double-click the DIADesigner-AX icon to open DIADesigner-AX. Click **New Project** on the Start Page or select *File > New Project (Ctrl+N)* to create a new project.



Next you will see a window with two sections, Categories and Templates. Click **Projects** in the Categories section and click **Standard project** in the Templates section. After that create a Name and specify a location for the project and then click **OK**.

Categories		Templates
a libraries a Prolects		Project Project AX-308E AX-8xxE
A project o Jame	ontaining one device, on Untitled1	e application, and an empty implementation for PLC_PRG

And a Standard Project dialog appears. You can select the device and the programming language from the drop-down list. Click **OK**, the system generates a cyclic task with a default PLC\_PRG.

DIADesigner-AX Version V1.0.0		DIA	ADesigner-AX Version V1.1.0 o	or later	
Standard	I Project		× Standard Project		×
57	objects with - One progra - A program - A cyclic tas - A reference	ut to create a new standard project. This wizard will create t in this project: mmmable device as specified below PLC_PRG in the language specified below is which calls PLC_PRG to the newest version of the Standard library currently inst AX-308EA0MA1T (Delta Electronics, Inc.)		You are about to create a new standard project. This wiza following objects within this project: - One programmable device as specified below - Two programs PLC_PRG and Motion_PRG in the langue - One cyclic task which calls PLC_PRG and one cyclic ta Motion_PRG - A reference to the newest version of the Standard library	age specified below ask which calls
	Device PLC_PRG In	Inconservering (LD) Index Electronics, Inc.) Index Electronics, Inc.) OK	Information Name Cancel Vendor	AX-308EA0MA1T Delta Electronics. Inc.	
	er Logic Diag		→ Description	AX-308EA0MATT motion controller with 16 points Built-in IO (digital output type: NPN), It can supports up to 8 EtherCAT axes and 4 pulse out axes.	
		ion Chart (CFC) ion Chart (CFC) - page-oriented	Device	AX-308EA0MA1T (Delta Electronics, Inc.)	*
Funct	ion Block Di	agram (FBD)	Version	1.0.1.0	~
	iction List (I er Logic Diac		PLC_PRG in	Structured Text (ST)	~
Seque		on Chart (SFC)		Continuous Function Chart (CFC) Continuous Function Chart (CFC) - page-oriented Function Block Diagram (RBD) Ladder Logic Diagram (LD) Sequential Function Chart (SFC)	

After a new project is successfully created, you can see a project management area in the left side of the window. All the options are listed in nodes. Click *View -> Devices (Alt+0)* on the toolbar, if nothing appears in the project management area.

Untitled1.project - DIADesigner-AX						×
File Edit View Project Build Online Debug Tools	Window Help	and so the second second second				1
19日本日本のお町に入業は1月1	🕯 🦄 👘 🛅 🛗 Application	[Device: PLC Logic] 👻 👒 👘 🔳 🖞		際(字)や		
Devices	×			ToolBox	<b>~</b> #	×
Current Configuration     Configuration	offMotor)					
inconden inconvenuitation energiation						
		Last build: 🤤	0 🕐 0 Precompile 🧹 🧣	Project user	: (nobody) 🛛 🖗	

# 4.2 Setting I tems on the Device Page

This section introduces all the setting items on the Device Page.



# 4.2.1 CPU Parameter Settings

# 4.2.1.1 Communication Settings

On the Communication Settings page, you can define the communication method for DIADesigner-AX and controller. Use the drop-down list of the Gateway tab to add new gateways or manage existing gateways or configure local gateways. You can simply specify an IP address or DNS address for the gateway while adding new gateways. This is useful if you want to connect to a remote gateway running on another PC or device. If you use DNS the address must begin with "dns". For the setting of PLC, you can enter its IP address (e.g. 192.168.1.5) or its device name (e.g. AX-308EA0MA1T) in the field under the controller image. After that DIADesigner-AX scans to search for the PLC in the network of the gateway.

Communication Settings	Scan Network Gateway	Device					
Applications							
ackup and Restore			•				
Files							
		-	Gateway			-	•
og		Gateway-1		~	0005		_
LC Settings		IP-Address: localhost			Press ENTER	to set active path	
PLC Shell		Port					
icensed Software Metrics		1217					
System Settings							

4



The dots under the images of gateway and controller indicate the connection status.

Red: Not be able to establish a connection

Green: A connection is established.

Black: Unknown connection status

Tab	Description
Scan Network	Click <b>Scan Network</b> to open the Select Device page. This page lists all configured gateways with the associated devices. You can select one target device from this list.
Gateway	<ul> <li>This menu includes the following setting items:</li> <li>Add New Gateway: You can add and define a new gateway channel here.</li> <li>Manage Gateways: This page is with an overview of all gateways. You can add or delete entries here or change their order.</li> <li>Configure the Local Gateway: Select this setting item to open the Gateway Configuration page. You can configure the block drivers for the local gateway.</li> </ul>
Device	<ul> <li>This menu includes the following setting items:</li> <li>Options: <ul> <li>Add Current Device to Favorites: Adds the currently set device to the list of favorite devices.</li> <li>Manage Favorite Devices: Click this option to open a list of all preferred devices. You can add or delete entries or change their order. The top device is the default.</li> <li>✓: Filter Network Scans by Target ID: The display is limited on the devices that have the same target ID as the current device configured in the project. </li> <li>✓: Confirm Online Mode: DIADesigner-AX requires you to confirm the followings when calling the following online commands (for safety purposes): Force values, Write values, Multiple loading, Remove force list, Single cycle, Start, and Stop. </li> <li>Store Communication Settings in Project: <ul> <li>✓: DIADesigner-AX saves the communication settings in the project for reuse on the same computer. Note: If you use the project on another computer, you need to reset the active path.</li> <li>□: DIADesigner-AX saves the communication settings in the options of the local installation for reuse on the same computer.</li> <li>Note: When using DIADesigner-AX SVN, the option should be cleared in order to prevent blocking the device object.</li> </ul> </li> </ul></li></ul>

4

	Description			
	evice: Click this setting item to open the Change Device Name page. ice: Devices that support this function illuminate a flashing signal.			
test the network co packets and then w communication buf	<b>e:</b> DIADesigner-AX sends five echo services to the PLC. These are used to nnection, similar to the ping function. The services are sent first without data vith data packets. The scope of the data packets depends on the fer of the PLC. A message box opens with information about the average echo he scope of the sent data packets.			
Encrypted Comm	unication:			
EX: The communication to this controller is encrypted. A certificate of the controller in order to log in to the controller. If the certificate is not available, message shows up prompting whether or not the certificate should be displainstalled.				
	force Encrypted Communication option is selected as Security level in the Screen view, then the Encrypted Communication is disabled here.			
<b>Change Communication Policy:</b> Click this setting item to open the Change Commu Policypage for changing the device setting for the encryption of communication. If a new communication policy is selected in this dialog, then the configuration on the changed.				
	Communication			
Current policy	The currently selected policy for the encryption of communication			
New policy	<ul> <li>Drop-down list for the new policy for encryption</li> <li>No encryption: The controller does not support encrypted communication.</li> <li>Optional encryption: The controller supports encrypted and unencrypted communication.</li> <li>Enforced encryption: The controller supports encrypted communication only.</li> </ul>			
	Device User Management			
Current policy	The currently selected policy for user management			
	Drop-down list for the new policy for user management • Optional user management: It is the responsibility of the			

# 4.2.1.2 Applications

Here you can check and manage the applications on the PLC.

Device X		
Communication Settings	Applications on the PLC	
Applications	Application_1 Application_2	Remove Remove All
Backup and Restore		Details
Synchronized Files		Content
Files		
Log		
PLC Settings		
PLC Shell		

Button	Description
Remove / Remove All	Remove: Deletes the application selected in the list.
Remove / Remove All	Remove All: Deletes all listed applications on the PLC.
Click <b>Details</b> button to see information defined for the application on the Info	
Details	of the dialog box Properties.
	Requirement: Go to Application > Proprieties > Application Generation Options to
	activate the Download the application info option. This causes information about the
	contents of the application to be additionally loaded to the PLC.
Content	
	Click Content button to see additional information about the differences between the
	latest generated code and the application code that exists on the controller. The different
	modules are displayed in a comparison view.
	Click <b>Refresh List</b> button to have the controller scanned for applications and the list is
Refresh List	refreshed accordingly.

## 4.2.1.3 Backup and Restore

You can backup and restore the application-specific file on the PLC by saving and reading a zip archive.

Communication Settings	Backup • Restore •		
Applications	Target Information		
Backup and Restore	ID Type Version	1	
Files	Backup Information		
Log	File name Size of active files	0 bytes	
PLC Settings	Mode	No information	9
PLC Shell	Comment		
Licensed Software Metrics			
System Settings	Active Component	File Size Requires STOP	

Tab Description Click Backup tab to see the followings • Read Backup Information from Device: Use this function to search for applicationspecific files from the \$PIcLogic\$ directory of the PLC and lists them on the Backup tab page. Backup • Create Backup File and Save to Disk: Use this function to compress the files in into a backup zip file. The file extension is tbf (="Target Backup File"). Save Backup File to Device: Use this function to save the backup file to the TBF directory of the PLC. Load Backup File from Disk: After clicking this button, the system generates a list of all backup files found on the disk. Select one of these files to view its contents. Load Backup File from Device: After clicking this button, the system generates a list Restore of all backup files found on the PLC. Select one of these files to view its contents. Restore on Device: This function is available if at least one component of the backup file that is currently loaded in the tabbed page is set to active. It prompts for restoring the application status on the device.

#### • Target Information

ID	ID of the PLC
Туре	Device type
Version	Device version

#### • Backup Information

File name	Storage path of the backup file.		
Size of active files	Total size of the files set as active in the table		
Mode         Defines the scope of the backup: Application. The application-related files are added to archive.			
Comment	Optional entry for comments to be saved in the meta.info file of the backup and reading when the files are restored.		

# 4.2.1.4 Files

You can transfer files between the computer and the PLC on this page through DIADesigner-AX. .

B Device X						
Communication Settings	Host Location		• I 🖿 🗙 🔶 I	Runtime		- 🖻 🔶 🛠
Applications	Name	Size	Modified	Name <click icon="" list="" on="" refresh="" the="" to="" update=""></click>	Size	Modified
Backup and Restore	D:\					
Files						
Log						
PLC Settings						
PLC Shell						

Item	Description
Location	Path in the file system of the computer. Subdirectories and files are shown in the lower part of the view with name, size, and change date.
<b>`</b>	Click this button to create a new file folder
×	Deletes the selected files or folders
÷\$	Updates the list of files and folders for the set path (location)
>>	Write File to the PLC
<<	Write File from the PLC

# 4.2.1.5 Log

You can view the PLC log here. It lists the events that were recorded on the target system, including

- Events during the startup and shutdown of the system (components loaded, with version)
- Application download and loading of the boot application
- Custom entries
- Log entries from I/O drivers
- Log entries from data sources

Severity	Time Stamp	Description	Component
o	01.01.1970 08:07:17	Channel 58628 connected	
0	01.01.1970 08:07:17	Channel 41740 dosed by request, 0	CmpChannelServer
0	01.01.1970 08:05:42	Channel 41/40 dosed by request, 0 Channel 41740 connected	CmpChannelServer
0	01.01.1970 08:05:16	Channel 141/40 connected Channel 144 closed by request, 0	CmpChannelServer CmpChannelServer
0	01.01.1970 08:05:13	Channel 144 connected	CmpChannelServer
0	01.01.1970 08:00:21	Warning unexpected working counters: number of slaves has changed or is different to the configuration!	IoDryEtherCAT
ő	01.01.1970 08:00:21	Startup finished: All slaves in operational !	IoDrvetherCAT
0	01.01.1970 08:00:15	All slaves operational	IoDrvEtherCAT
0	01.01.1970 08:00:15	All slaves operational Set operational mode	IoDrvetherCAT
0	01.01.1970 08:00:15	All slaves safe-operational	IoDrvEtherCAT
ŏ	01.01.1970 08:00:15	All slaves sale-operational	IoDrvEtherCAT
0	01.01.1970 08:00:15	Svnchronize Slaves	IoDrvEtherCAT
ő	01.01.1970 08:00:15	Configure distributed clock settings	IoDrvEtherCAT
ő	01.01.1970 08:00:15	All slaves pre-operational	IoDrvEtherCAT
ő	01.01.1970 08:00:15	prepare slaves	IoDryEtherCAT
ă	01.01.1970 08:00:15	All slaves init mode	IoDrvEtherCAT
ő	01.01.1970 08:00:15	Set physical addresses	IoDryEtherCAT
ŏ	01.01.1970 08:00:15	[CAN]IoDrvGetModuleDiagnosis set bIOErrSet[3]	IoDryDelta
ŏ	01.01.1970 08:00:15	[CAN]IoDrvGetModuleDiagnosis set bIOErrSet[1]	IoDryDelta
ŏ	01.01.1970 08:00:15	[CAN]EVT StartDone!!	IoDryDelta
ŏ	01.01.1970 08:00:15	[MTCPSlave]EVT StartDone!!	IODrvDeltaModbusTCPS
ŏ	01.01.1970 08:00:15	[CAN]IoDrvGetModuleDiagnosis dear bIOErrSet[3]	IoDrvDelta
ŏ	01.01.1970 08:00:15	[CAN]IoDrvGetModuleDiagnosis dear bIOErrSet[1]	IoDryDelta
0	01.01.1970 08:00:15	[CAN]EVT PrepareStart!	IoDrvDelta
ŏ	01.01.1970 08:00:15	[MTCPSlave]EVT PrepareStart!!	IODryDeltaModbusTCPS
ō	01.01.1970 08:00:15	Read slave informations	IoDryEtherCAT
0	01.01.1970 08:00:14	Preparation successful	IoDrvEtherCAT
0	01.01.1970 08:00:14	Networkadapter opened	IoDrvEtherCAT
0	01.01.1970 08:00:14	CODESYS Control ready	CM
0	01.01.1970 08:00:14	CH INIT FINISHED	CmpDeltaConnHandler
0	01.01.1970 08:00:14	Segment[0]: Tag=TAG_RETAIN_FREE, Size=393192, Guid=00000000-0000-0000-0000-00000000000	CmpRetain
0	01.01.1970 08:00:14	SRAM layout: Address=0x23036000	CmpRetain
0	01.01.1970 08:00:14	Segment[0]: Tag=TAG_RETAIN_FREE, Size=393192, Guid=00000000-0000-0000-0000-00000000000	CmpRetain

# AX-3 Series Operation Manual

ltem	Description				
	E Default settings				
Offline logging	E: The PLC also records actions that are not related to the connection with the controller.				
	However, this is currently available only for the safety version of CODESYS.				
	: Standard setting; the time stamp is converted to the local time on the computer as				
UTC time	indicated by the time zone of the operating system.				
	☑: The time stamp of the runtime system is displayed.				
	Four categories for the severity of the event:				
	• 0 : Message				
	• 🤨 : Warning				
Severity	• O : Error				
	• Debugging				
	You can show or hide each category by clicking corresponding buttons in the bar. Each button				
	shows the number of log entries of the category concerned.				
Time stamp	Date and time (example: 08-01-2020 09:48)				
Description	Description of the event				
Component	Name of the runtime system component concerned, e.g. CmpApp				
Drop-down list with	The log list displays only events that concern the selected component				
component names					
	Drop-down list with all available logs. The standard setting is the <default logger=""> specified</default>				
Logger	by the target system; now it is identical to 'StdLogger for DIADesigner-AX runtime system.				
	Refreshes the log list				
	Exports the list contents to an xml file.				
	Imports a log list from an xml file.				
	Deletes the displayed log list. All entries are deleted.				

# 4.2.1.6 PLC Settings

You can make the basic settings for the configuration of the PLC here, for example the handling of inputs and outputs and the bus cycle task.

PLC Settings			
Update IO while in stop			
Behaviour for outputs in stop	Keep current values 🛛 🗸		
Always update variables	Disabled (update only if used in a task)	~	
Bus Cycle Options			
Bus cycle task	<unspecified></unspecified>	~	
Additonal Settings			
Generate force variables for	IO mapping Enable Diagnosis for device	es	
Show I/O warnings as errors			

# ① Application for I/O handling

ltem	Description
Application for I/O handling	Application that is for the I/O handling.

# **② PLC Settings**

Item	Description		
Update IO while in stop	<ul> <li>DIADesigner-AX does not refresh the values of the input and output channels when the PLC is in the stop state.</li> <li>DIADesigner-AX refreshes the values of the input and output channels even if the PLC is in the stop state. If the watchdog detects a malfunction, the outputs are set to the predefined default values.</li> </ul>		
Behavior of the outputs in stop	<ul> <li>Handling of the output channels when the controller enters the stop state:</li> <li>Keep current values: The current values are retained.</li> <li>Set all outputs to default: The default values resulting from the I/O mapping are assigned.</li> <li>Execute program: You can control the handling of the output values via a program contained in the project, which DIADesigner-AX executes at "STOP". Enter the name of the program in the field on the right.</li> </ul>		
Always update variables	<ul> <li>Global setting that defines whether or not DIADesigner-AX updates the I/O variables in the bus cycle task. This setting is effective for I/O variables of the slaves and modules only if 'disabled' is defined in their update settings.</li> <li>Disabled (update only if used in a task): DIADesigner-AX updates the I/O variables only if they are used in a task.</li> <li>Enabled 1 (use bus cycle task if not used in another task): DIADesigner-AX updates the I/O variables in the bus cycle task if they are not used in any other task.</li> <li>Enabled 2 (always in bus cycle task): DIADesigner-AX updates all variables in each cycle of the bus cycle task, regardless of whether they are used and whether they are mapped to an input or output channel.</li> </ul>		

### **③ Bus Cycle Options**

ltem	Description
Bus cycle task <sup>∗1</sup>	Task that controls the bus cycle. By default the task defined by the device description is entered.

Note 1: Before you select the <unspecified> setting for the bus cycle task, you should be aware that "<unspecified>" means that the default setting given in the device description goes into effects. You should therefore check this description. Use of the task with the shortest cycle time may be defined as the default there, but use of the task with the longest cycle time could equally well be defined!

#### ④ Additional Settings

Item	Description	
Generate Force variables for	The device does not support this function.	
I/O mapping		
Enable Diagnostics for devices	DIADesigner-AX automatically integrates the library CAA Device Diagnosis in the project and creates an implicit function block for each device. If there is already a function block for the device, then either an extended FB is used (for example with EtherCAT) or a further FB instance is added. This then contains a general implementation of the device diagnostics.	
Show I/O warnings as errors	Warnings concerning the I/O configuration are displayed as errors.	

# 4.2.1.7 PLC Shell

You can use this text-based control monitor for querying specific information from the controller. You can specify devicedependent commands for this and receive the response from the controller in a result window.

Device A		
Communication Settings		
Applications		
Backup and Restore		
Files		
Log		
PLC Settings		
PLC Shell		
Licensed Software Metrics		
System Settings		
Right Settings		

# 4.2.1.8 Licensed Software Metrics

Here you can find the code sizes of the applications of the open project. The data is updated when clicking *Build -> Generate Code* or Online -> Login. If the compile information is deleted, the data of the corresponding application shown here is reset.

Communication Settings	Read current metrics from device				
Applications	Metric = O Size of User Code	Value in Project 0 Byte	Max. allowed by License	Value on Device 0	Usage on Device
Backup and Restore	Application	n/a			
	😑 👙 Number of Tasks	2	n/a	0	
Files	Application	2			
	Variables used in visual	0 Variables	not yet supported	not yet supported	
Log	Application	n/a		not yet supported	

# 4.2.1.9 System Setting

Here you can set up the system settings for the AX-3 Series PLC. Before setting up, make sure that DIADesigner-AX is successfully connected to AX-3 Series PLC. Refer to section 4.2.1.1 for establishing the connection between DIADesigner-AX and AX-3 Series PLC.

Note: the name of this setting page was "Runtime Clock Configuration" in DIADesigner-AX V1.0.0. Now in DIADesigner-AX V1.1.0, this page is named "System Settings", given that Network Settings are included here.

	Runtime Clock		
Communication Settings	1 PLC Time:	1/2/2000 1:54:18 PM	Read PLC Time
Applications	2 Date:	2023年 3月17日	Write PLC Time
Backup and Restore	3 Time:	下午 07:51:08	Sync with Local Time
	Time Zone		
Files	4 PLC Timezone:	(UTC+08:00) 亚洲/台北	Read Timezone
Log	5 Timezone:	(UTC+08:00) 亚洲/台北	Write Timezone
PLC Settings	10 Network		
PLC Shell	Apply IP sett	ings while download	
Licensed Software Metrics			
System Settings	<ul> <li>IP Address Mod</li> <li>IP address:</li> </ul>	e: Static ~	
Right Settings	Subnet mask:	255 . 255 . 255 . 0	
System Parameters	Default gateway	0.0.0.0	
Task Deployment	Obtain DNS	server address automatically	
Status	8 Ouse the follow	owing DNS server addresses:	
Status	Preferred DNS s	erver: 0 . 0 . 0 . 0	
Information	Alternate DNS s	erver: 0 . 0 . 0 . 0	
			Read from PLC
	(9) Project ID		
	Project ID statu	s: Inactive	Set Project ID
	11 Retain Settings		
	Retain Mode:	Original mode	• %M mode
	Start Memory	Address (%MB) 0	
	End Memory A	Address (%MB) 524287	
	Clear all %M a	ddresses	Clear

# Runtime Clock

- ① PLC Time: Use the button Read PLC Time to read the PLC current date and time and the result will be updated here.
- ② Date: Use the button Write PLC Time to write the date on DIADesigner-AX (PC) into PLC and the result will be updated here.
- ③ **Time**: Use the button **Sync with Local Time** to write the time on DIADesigner-AX (PC) into PLC and the result will be updated here.

## • Time Zone

- ④ PLC Timezone: Use the button Read Timezone to read the PLC current timezone and the result will be updated here.
- (5) **Timezone:** Use the button **Write Timezone** to write the timezone on DIADesigner-AX (PC) into PLC and the result will be updated here.

#### • Network (available for DIADesigner-AX V1.1.0 or later)

- 6 IP Address Mode: Static.
- ⑦ IP address: You can input your own IP address, Subnet mask and Default gateway.
- (8) DNS settings: You can obtain DNS server address automatically or define your own DNS server addresses.
- (1) Apply IP settings while download<sup>\*4</sup>: The IP address setting is effective once the parameters are downloaded.

(9) Set Project ID: After enabling Project ID feature, this setting must be complete before downloading projects.

# Retain Settings

# 1 Retain Settings\*4

Retain Mode for the variables:

- Original mode: Determined by the retainability of the variable type.
  - %M mode: If the variable is in the section of %M, it is retainable.
    - Start Memory Address: If the variable is in the starting address of the %M section (not user-defined).
    - End Memory Address: If the variable is in the ending address of the %M section (not user-defined).
      - Clear all %M addresses: Clear the values in the %M section.

#### \*Note:

- 1. Diamond directive files of AX series PLCs must be V1.0.1.0 and above so as to configure the network parameter settings on this page.
- 2. Model AX-332 PLCs support dual LAN ports and the network settings are shown in the figure below. If the checkbox of Enable Gateway and DNS Setting is checked, you would only be able to configure the setting values of PLC Gateway and DNS configuration on the tab page (GLAN1) as shown in the figure below. If the checkbox is unchecked, the fields of setting values would be grey and not editable.
- 3. With firmware version 1.0.4.0 and above, the operation of Project ID feature is detailed in chapter 8.2 in DIADesigner-AX user manual.

LAN1 GLAN2		
		Enable Gateway and DNS Setting
IP Address Mode:	Static $\checkmark$	
IP address:	192 . 168 . 0	. 10
Subnet mask:	255 . 255 . 255	. 0
Default gateway:	0.0.0	. 0
Obtain DNS server a	ddress automatically	
Ose the following D	VS server addresses:	
Preferred DNS server:	0.0.0	. 0
Alternate DNS server:	0.0.0	. 0

4. This functionality is only available for AX-3 Series PLC with firmware version 1.0.5.0 or later which can be found in in the DDF file.

4

# 4.2.1.10 Right Settings

Settings here are only available for DIADesigner-AX V1.3.0 or later. The settings include Users and Groups, Access Rights and Symbol Rights.

Communication Settings	🔹 Users and Groups 🔹 🖻 🔯 Device user: Anonymous	
Applications	Offline mode is not supported by the device, switch to synchronized mode to edit the user management.	
Backup and Restore		O Add
iles		C Import
og		🛃 Edit
		© Delete
LC Settings		
LC Shell		
icensed Software Metrics		
lystem Settings		
Right Settings		
System Parameters	- Groupe	
ask Deployment		O Add
tatus		C Import
nformation		edit
		© Delete

# Toolbar of the tab

Item	Description
Synchronization	<ol> <li>Switches on and off the synchronization between the editor and the user management on the device.</li> <li>If the button is not pressed, then the editor is blank or it contains a configuration that you loaded from the hard disk.</li> <li>If the button is pressed, then DIADesigner-AX synchronizes the display in the editor continuously with the current user management on the connected device.</li> <li>If you activate the synchronization while the editor contains a user configuration that is not synchronized with the device yet, then you are prompted what should happen to the editor contents. Options:</li> <li>Upload from the device and overwrite the editor content: The configuration on the device is loaded into the editor, overwriting the current contents. Download the editor content to the device and overwrite the user management there: The configuration in the editor is transferred to the device and applied</li> </ol>
E Import from disk	there. Click this button and then to select and import a user management configuration from the file.
Export to disk	Click this button and then to save the current user management configuration as an XML file.
Export all to disk	Click this button and then to save all the user management configurations as an XML file.
Device user	User name of the user currently logged in on the device

# 4.2.1.10.1 Users and Groups

It is important that the firmware version of AX-3 Series PLC should work with specific software version of DIADesigner-AX. If not, this functionality cannot be used. You can upgrade either the firmware or the software to make them compatible with each other.

## **Firmware Interoperability**

Group	Firmware version of AX-3	Software version of DIADesigner-AX
1	V1.0.4 or previous versions	V1.3.0
2	V1.0.5 or later versions	V1.4.0

#### • For Group 1:

You can edit the device user management of the controller, define user accounts and user groups. In combination with the configuration on the Access Rights tab, you can control access to control objects and files at runtime. For the first time use, use default settings "Administrator" as the user name and password. After logging-in, for security reasons, change the defaults of the username and password.

_		
	not authorized to perform this operation on an user account which has got the sufficient	
Device Name	Device (AX-308EA0MA1T)	
DeviceAddress		
User Name	Administrator	
Password	•••••	
Operation: Object:	View "Device"	
		OK Cancel

# • For Group 2:

You will need to set up the user account and password for the first time use.

DIADesigner-AX	< :×.	
Would	ntly, the user management is not activated on the device. d you like to activate it now? a note: When activating the user management you will be asked to a new admin user. Then you will be asked to login as this user.	
	是(N) 否(N)	
dd Device User		
Name Default group	Administrator	
Password Confirm password		<
Password strength	Very weak           Very weak           Password can be changed by user           Password must be changed at first login	
	OK Can	cel

# • Account management setting images:

Communication Settings	Users and Groups • 😤 🖲 🔯 Device user: admin Synchronized mode: All changes are immediately downloaded to the device. This mode does not support ur	ndoing actions.
Applications	Users	
Backup and Restore	* 💈 admin	O Add
Files		O Import
		🖉 Edit
Log		o Delete
PLC Settings		
PLC Shell		
Licensed Software Metrics		
System Settings		
Right Settings	Groups	
System Parameters	* Si Administrator	O Add
Task Deployment	- 199 Service	O Import
	Si Watch	🛃 Edita.
Status		O Delete
Information		

#### • Toolbar of the tab

4

Item	Description
Synchronization	<ol> <li>Switches on and off the synchronization between the editor and the user management on the device.</li> <li>If the button is not pressed, then the editor is blank or it contains a configuration that you loaded from the hard disk.</li> <li>If the button is pressed, then DIADesigner-AX synchronizes the display in the editor continuously with the current user management on the connected device.</li> <li>If you activate the synchronization while the editor contains a user configuration that is not synchronized with the device yet, then you are prompted what should happen to the editor contents. Options:</li> <li>Upload from the device and overwrite the editor content: The configuration on the device is loaded into the editor, overwriting the current contents.</li> <li>Download the editor content to the device and overwrite the user management there: The configuration in the editor is transferred to the device and applied there.</li> </ol>
🖹 Import from disk	Click this button and then to select and import a user management configuration from the file.
Export to disk	Click this button and then to save the user management configuration as an XML file.
Device user	User name of the user currently logged in on the device

# • Users

Item	Description
Add	Click this button to create a new user account.*1
Import	Click this button to select the desired entries to import users into the device user management.*2
🗹 Edit	Click this button to change the settings of the selected user account.
Delete	Click this button to delete the account of the selected user.

•	Groups	
	ltem	Description
	Add	Click this button to create a new user group.*3
	Import	Click this button to select the desired entries to import groups into the device user
-		management.*4
	🗹 Edit	Click this button to change the settings of the selected group.
	🗢 Delete	Click this button to delete the selected group.

# Note 1: The Add User setting page

Name	PLC_test1	
Default group	Administrator	
Password		-
Confirm password	••••••	
Passwordstrength	Better 6 Hidepassword	
	Password can be changed by user	
	8 🔲 Password must be changed at first login	

	Item	Description
1	Name	User name
2	Default group	Use the drop-down list to select the default group
3	Password	Password
4	Confirm password	Confirm password
5	Password strength	Levels from Very weak to Very good
6	Hide password	E: The password is shown only with asterisks "*" when it is typed in.
0	Password can be changed by user	Password can be changed by the user
8	Password must be changed at first login	Password must be changed at first login

# Note 2: The Import User setting page

After selected the user from the list, click **OK** to import.

mport Users		×
Project Users		
defined in th	Il find a list of all users cun e project user management which you want to import in ment.	. Select
enter the pas	hat for security reasons yo sword for each selected us rd will be used for the corre account.	ser account.
S Owner		
		Cancel

# Note 3: The Add Group setting page

Type in the new group name and select the to-be-added group members for this new group and then click OK.



# Note 4: The Import Group setting page

After selected the group from the list, click **OK** to import.

mport Groups		>
Project Groups		
defined in the p	ind a list of all groups currently roject user management. Select hich you want to import into the ragement.	
Se Everyone		
Se Owner		
	OK Canc	el

# 4.2.1.10.2 Access Rights

Here you can define the device access rights of device users to objects on AX-3 Series PLC. As in the project user management, users must be members of at least one user group and only user groups can be granted certain access rights.

Requirements for the Access Rights tab to be displayed:

• In the DIADesigner-AX options, in the Device editor category, the Show access rights page option must be selected. Note that this DIADesigner-AX option can be overwritten by the device description.

Requirements for the access rights to be granted to user groups

- A component for the user management has to be available on AX-3 Series PLC. That is the primary requirement.
- Users and user groups have to be configured on the Users and Groups tab.



#### Toolbar of the tab

Item	Description
Synchronization	<ol> <li>Switches on and off the synchronization between the editor and the user management on the device.</li> <li>If the button is not pressed, then the editor is blank or it contains a configuration that you loaded from the hard disk.</li> <li>If the button is pressed, then DIADesigner-AX synchronizes the display in the editor continuously with the current user management on the connected device.</li> <li>If you activate the synchronization while the editor contains a user configuration that is not synchronized with the device yet, then you are prompted what should happen to the editor contents. Options:         <ul> <li>Upload from the device and overwrite the editor content: The configuration on the device is loaded into the editor, overwriting the current contents.</li> <li>Download the editor content to the device and overwrite the user management there: The configuration in the editor is transferred to the device and applied there.</li> </ul> </li> </ol>
🖼 Import from disk	Click this button and then to select and import a user management configuration

Item	Description
	from the file.
Export to disk	Click this button and then to save the user management configuration as an XML file.
Device user	User name of the user currently logged in on the device

#### Objects

#### Description

In the tree structure, the objects are listed to which actions can be executed at runtime. The objects are each assigned by their object source and partially sorted in object groups. In the Rights view, you can configure the access options for a user group to a selected object.

Object source (root node)

- File system objects ► Device: In these objects, the rights can be granted to folders of the current execution directory of the AX-3 Series PLC.
- Runtime objects ► /: In these objects, all objects are managed that have online access in the AX-3 Series PLC and therefore have to control the access rights.

A description of the objects is located in the table. Overview of the objects

Object groups and objects (indented)

Example: Device with child nodes Logger, PlcLogic, Settings, UserManagement.

#### Rights

#### Description

In general, the access rights are inherited from the root object (also Device or /) to the sub-objects. This means that if a permission of a user group is denied or explicitly granted to a parent object, then this first affects all child objects. The table applies for the object that is currently selected in the tree. For every user group, it shows the rights currently configured for the possible actions on this object.

bjects	Rights				
Runtime objects		Add/Remove	Modify	View	Execute
Device     Coger     Plc.ogic     Application	Administrator	+	+	+	+
	Developer	+	-	+	-
	Everyone		-	+	-
	Service	+	-	+	
	test_group	×	22	25	× .
Backup&Restore	Watch	-	-	+	-

Possible actions on the object:

- Add/Remove
- Modify
- View
- Execute

When an object is clicked, a table on the right side shows the access rights of the available user groups for the selected object.

This allows you to quickly see:

- Which access rights are evaluated by an object
- Which user group has which effective rights to which object

Meanings of the symbols

- + Access right granted explicitly
- -: Access right denied explicitly
- +: Access right granted through inheritance
- —: Access right denied through inheritance
- X: The access right was not granted or denied explicitly and also not inherited by the parent object. Access is not possible.
- No symbol: Multiple objects are selected that have different access rights.

Change the permission by clicking the symbol.

#### • Overview

Runtime objects > Device

Runtime objects	1
Device	
- Iogger	
😑 🔿 PlcLogic	
😑 🔿 Application	
- 🔿C-ModuleI	Integration
Backup&Resto	

#### Device > Logger

The Logger object on the Access Rights tab was created by the "Logger" component and controls its access rights. The possible access rights for this object can be granted only for the View action.

Runtim	e objects	
De	vice	
	Logger	
<b>₽</b> ^ <b>₽</b>	PlcLogic	
	Application	
	C-ModuleIntegration	
	→Backup&Restore	

#### Device > PlcLogic

RL RL	intime objects	
<u>ė.</u> –	Device	
	🔿 Logger	
.0	PlcLogic	
	= = Application	
	Backup&Restore	

All IEC applications are inserted here automatically as child objects during download. When an application is deleted, it is removed automatically. This allows specific control of online access to the application. Access rights can be assigned centrally over all applications in the PlcLogic. The Administrator and Developer user groups have full access to the IEC applications. The Service and Watch user groups only have read access (for example for read-only monitoring of values).

PlcLogic > Application

RI	untime objects	
<u>e</u>	Device	
	🔿 Logger	
(G	PlcLogic	
	🖃 🔿 Application	
	⇒Backup&Restore	

The following table shows which action is affected in particular when a specific access right is granted for an IEC application.

**x**: The right has to be set explicitly.

-: The right is not relevant.

	Oneration	Access rights				
	Operation	Add/Remove	Execute	Modify	View	
	Login	•	•	•	x	
	Create	х	•	•	•	
	Create child object	х	•	•	•	
	Delete	х	•	•	•	
Application	Download / online change	x	•	•	•	
	Create boot application	x	•	•	•	
	Read variable	•	•	•	x	
	Write variable	•	•	х	x	
	Force variable	•	•	х	x	
	Set and delete breakpoint	•	x	х	•	
	Set next statement	•	x	х	•	
	Read call stack	•	•	•	x	
	Single cycle	•	х	•	•	
	Switch on flow control	•	х	х	•	
	Start / Stop	•	х	•	•	
	Reset	•	x	•	•	
	Restore retain variables	•	x	•	•	
	Save retain variables	•	•	•	x	

# PicShell

Only the Modify permission is evaluated at this time. This means that only when the Modify permission has been granted to a user group can PLC shell commands also be evaluated.

Ru	ntime objects
(a) -	Device
-	I Logger
-	PlcLogic
	C-ModuleIntegration
	Backup&Restore
	PlcShell

#### RemoteConnections

Additional external connections to the AX-3 Series PLC can be configured below this node. Currently, access to the OPC UA server can be configured here.

	RemoteConnections
dan	OPCUAServer
	Settings
	UserManagement
÷	X509

## Settings

This is the online access to the configuration settings of the AX-3 Series PLC. By default, access to Modify is granted only to the administrator.

	RemoteConnections
-	⇒ Settings
	🗇 UserManagement
:	⇒ X509

#### UserManagement

This is the online access to the user management of AX-3 Series PLC. By default, read/write access is granted only to the administrator.

	RemoteConnections	
· 学	OPCUAServer     Settings	
¢	UserManagement	
- 4	X509	

#### > X509

This controls the online access to the X.509 certificates. Two types of access are distinguished here: Read (View)

Write (Modify)

Every operation is assigned to one of these two access rights. Each operation is inserted as a child object below X509. Therefore, access per operation can now be fine-tuned even more.



## ♦ File system objects > /

All folders from the execution path of the AX-3 Series PLC are inserted below the "/" file system object. This allows you to grant specific rights to each folder of the file system.

= File system objects	
📫 Boot	
😑 🔿 cert	
🔿 export	
🔿 import	
🖶 🔿 Prj	
😑 🧼 PlcLogic	
=b trend	
📫 _cnc	
System Volume Information	

# 4.2.1.10.3 Symbol Rights

Here you can define the access rights of different user groups to the individual symbol sets available on the AX-3 Series PLC. Before that you need to enable the Symbol set under Symbol Configuration and then download the project to the controller. See the following examples for reference.

Symbol Configu	uration X	
View - 🔛 Build	🕞 Settings 🔹 Tools 👻	
Change bor config Symbo - V Constants - V D IoConfig_Gl + V PLC_PRG	Include Col ts in XML     Include Node Flags in XML	Members Comment
	Use empty namespaces by default (V2 compatibility) Enable direct I/O Access Include call information in XML Enable Symbol Sets	

Use the icons 2 or 2 for synchronization. Upload the controller current parameters to the DIADesigner-AX3 and then you can set up the access right. You can find the user groups in the column of Rights. And when you select the Application under Symbol Sets you can see the corresponding access right for different user groups in the column of Rights.  $\clubsuit$ : Access granted;  $\eqqcolon$ : Access not granted. You can change the access rights by double-clicking the symbol. Click the  $\fbox{2}$  button to save the current access configuration to an XML file. The file type is Device symbol management files (\*.dsm). Click the  $\Huge{2}$  button to read a file like this from the computer.



4

# 4.2.1.11 System Parameters

Here you can set up the various parameters for the AX-3 Series PLC. Note that settings on this page do NOT support on-line editing.

Commy Sication Settings	Parameter	Туре	Value	Default Value	Unit	Description
Applications	I/O module CONFIG by Manual/Max when Power On	Enumeration of BOOL	Manual	Manual		
	<ul> <li>PCPU module Stop when I/O Module No Response</li> </ul>	Enumeration of BOOL	Stop	Stop		
Backup and Restore	PCPU module Stop when I/O Module Occurred Error	Enumeration of BOOL	Keep Run	Keep Run		
	Select Action when 24V dc Input unstable	Enumeration of BOOL	Continue Running when power stable	Continue Running when power stable		
Files	Show Battery Low Voltage Error	Enumeration of BOOL	Enable	Enable		
	Execute Startup Command when Power On	Enumeration of BOOL	Enable	Enable		
2 C Shell						
PLC Shell Licensed Software Metrics System Settings						
Licensed Software Metrics						
Licensed Software Metrics System Settings						

4

#### • I/O module CONFIG by Manual/Max when Power On

You can set the number of I/O modules here.

- Manual (default): The actual module placement should be based on the configuration set in HWCONFIG. If the settings are matched, the PLC can run normally.
- Max: Sets a maximum number for the module placement. An alarm shows if your actual I/O module placement is larger than the maximum setting.

#### • CPU module Stop when I/O Module No Response

The parameter sets whether the CPU and other normal modules can operate constantly when there is an extension module, which does not response during offline period.

- > Stop (default): The CPU module stops running and then shows errors.
- > Keep Run: The CPU module and other normal modules keep running.

#### CPU module Stop when I/O Module Occurred Error

The parameter sets the method to deal with a minor error in the extension modules.

- > Stop: The CPU stops running and sends an error.
- > Keep Run (default): The CPU keeps running but records the warning message.

#### • Select Action When 24Vdc Input Unstable

What to do when the 24Vdc power is unstable

- Continue Running when power stable (default): The CPU stops and waits till the power is stable and then the CPU begins to run.
- Into Error Status: The CPU stops and ERROR LED blinks; even after the power is stable again, the CPU still stays stop.

#### • Show Battery Low Voltage Error

The parameter sets whether the alarm is shown when the lithium battery for the real-time clock is of low voltage or is not installed.

- Disable: The function is closed.
- > Enable (default): An alarm shows when the lithium battery is of low voltage or not installed.

# 4.2.1.12 Task Deployment

Here displays a table of inputs and outputs and their assignments to the defined tasks and bus cycle task. You can search for the relevant information here. The information is refreshed after the project is compiled and downloaded to the CPU. If the search result is not as expected, you can use the information to troubleshoot.

Communication Settings	1/0 Deployment for Tasks				
	I/O channels	Channel	EtherCAT_Task (0)	MainTask (1)	
Applications					
Backup and Restore	😑 🦇 %IB0	IN:0-7	<b>S</b>		
Dackup and Restore	** %IX0.0	INO	OX		
Files	* %IX0.1	IN1	<u> </u>		
	* %IX0.2	IN2	<u> </u>		
Loc	🍫 %IX0.3	IN3	<b>9</b> ×		
	* %IX0.4	IN4	<u> </u>		
PLC Settings	* %IX0.5	IN5	<b>9</b> ×		
	* %IX0.6	IN6	<u> 9 x</u>		
PLC Shell	- %IX0.7	IN7	<b>9</b> ×		
	= 🍫 %IB1	IN:8-15	<b>9</b> ×		
Licensed Software Metrics	* %IX1.0	IN8	<b>O</b> 🗙		
	* %IX1.1	IN9	<b>9</b> ×		
System Settings	🍫 %IX1.2	IN 10	<u> </u>		
and a second second second second second second second second second second second second second second second	🍫 %IX1.3	IN11	<b>S</b> X		
Right Settings	🍫 %IX1.4	IN12	<u> 9 x</u>		
System Parameters	*> %IX1.5	IN 13	<b>9</b> ×		
System Parameters	* %IX1.6	IN14	9 🗙		
Task Deployment	* %IX1.7	IN15	<u>9 x</u>		
	= 🐝 %IB2	Encoder	<u>9 x</u>		
Status	* %IX2.0	A1	<u> 9 x</u>		
	* %IX2.1	B1	<u>9</u> ×		
Information	- %IX2.2	Z1	<u> </u>		
	* %IX2.3	Reserve	<b>O</b> 🗙		
	🍫 %IX2.4	A2	<u> </u>		
	* %IX2.5	B2	<u> 9 x</u>		
	🍫 %IX2.6	Z2	<b>9</b> 🗙		
	%IX2.7	Reserve	OX		
	= ** %Q80	OUT:0-7	• • •		
	** %QX0.0	OUTO	<b>S</b> X		
	- %QX0.1	OUT1	<u> 9 x</u>		
	** %QX0.2	OUT2	<u> 9 x</u>		
	G = Bus Cycle Task	10.000	0.00	-	

0	The task defined as a Bus cycle task in the PLC Settings of the device
×	For inputs and outputs that are written or read by a task.

Δ

#### 4.2.1.13 Status

Here you can find the device status information, for example 'Running' or 'Stopped', and specific diagnostic messages from the respective device, also information about the card used and the internal bus system.

Communication Settings	BuiltIn_IO :	n/a
Applications	AX-308EA0MA1T :	n/a
Backup and Restore		
Files		
Log		
PLC Settings		
PLC Shell		
Licensed Software Metrics		
System Settings		
Right Settings		
System Parameters		
Task Deployment		
Status		
Information		

# 4.2.1.14 Information

Here you can find general information that originates from the device description file: name, vendor, categories, version, order number, description, and other relevant information.

Sector and sector and	General
Communication Settings	Name: AX-308EA0MA1T
Applications	Vendor: Delta Electronics, Inc. Categories: SoftWotion PLCs Type: 4102
Backup and Restore	ID: 16f7 0314 Version: 1.0.5.8
Files	Description: AX-308EA0MA1T motion controller with 16 points Bult-in IO (digital output type: NPN). It can supports up to 8 EtherCAT axes and 4 pulse out axes
Log	
PLC Settings	
PLC Shell	
Licensed Software Metrics	
System Settings	
Right Settings	
System Parameters	
Task Deployment	
Status	
Information	

# 4.2.2 Extension Module Parameter Settings

You can set up the extension settings, including IO update task time, command task priority and task delay time in this setting page.

evices 👻 🕈 🗙	Delta_LocalBus_Master	×					
Untitled2     Image: State of the state	Delta-Bus Parameters	Parameter	Туре	Value	Default Value	Unit	Description
E I PLC Logic		LocalIO Fresh Task Priority	WORD(031)	4	4		
😑 🔘 Application	Status	LocalIO Cmd Task Priority	WORD(031)	4	4		
Library Manager	Information	LocalIO Fresh Task Delay Time	DINT(1255)	10	10	ms	
EtherCAT_Task							

# • LocallO Fresh Task Priority :

It is the priority of the data exchange tasks between the CPU module and the extension modules. Set the priority level from 0 to  $31.^{1}$ 

# • LocalIO Cmd Task Priority :

It is the priority of the extension module tasks, including module Run/Stop, module parameter read/write, module instruction From/To and so forth. Set the priority level from 0 to 31.<sup>\*1</sup>

# • LocallO Fresh Task Delay Time :

This is used for editing the importing/exporting cycle time of the extension modules. You can set the task delay time according to the module types. Below is the data exchange time table for the AS Series modules. Refer to section 4.4.1.2 for more information on Bus Cycle Task.

Module	Time (ms)	Module	Time (ms)
AS02HC	*2	AS08AM	0.6
AS02PU	1.5	AS08AN	0.6
AS04PU	2.1	AS06RTD	0.9
AS02LC	0.6	AS16AP11R	1.2
AS02ADH	0.6	AS16AN01T	0.6
AS04AD	0.9	AS16AM10N	0.6
AS04DA	0.9	AS06XA	1.5
AS08AD	1.2	AS32AM	0.6
AS04RTD	0.9	AS32AN	0.6
AS04TC	0.9	AS64AM	0.9
AS08TC	1.2	AS64AN	0.9

Note 1: It is suggested not to change the task priority or it might affect the communication of module or EtheCAT functions. Note 2: The duration for the module to perform data exchange varies according to the instructions used in the program.

# 4.3 Data Type and Variables 4.3.1 Data Type

Data Type	Minimum Value	Maximum Value	Data Width	
BOOL	FALSE	TRUE	1 bit	
BYTE	0	255	8 bit	
WORD	0	65535	16 bit	
DWORD	0	4294967295	32 bit	
LWORD	0	2 <sup>64</sup> -1	64 bit	
SINT	-128	127	8bit	
USINT	0	255	8 bit	
INT	-32768	32767	16 bit	
UINT	0	65565	16 bit	
DINT	-2147483648	2147483647	32 bit	
UDINT	0	4294967295	32 bit	
LINT	-2 <sup>63</sup>	2 <sup>63</sup> -1	64 bit	
ULINT	0	2 <sup>64</sup> -1	64 bit	
REAL	-3.402823E+38	3.402823E+38	32 bit	
LREAL	-1.7976931348623157E+308	1.7976931348623157E+308	64 bit	
TIME	T#0ms	T#49d17h2m47s295ms	32 bit	
LTIME	LTIME#0ns	LTIME#213503d23h34n33s 709ms551us615ns	64 bit	
TIME_OF_DAY ( TOD )	TOD#00:00:00.000	TOD#23:59:59.999	32 bit	
DATE	D#1970-1-1 (01/01/70)	DATE#2106-2-7 (February 07, 2106)	32 bit	
DATE_AND_TIME	DT#1979-1-1-00:00:00 (01/01/1970 00:00:00)	DT#2106-2-7-6:28:15 (February 07, 2106 6:28:15)	32 bit	
STRING	ASCII format (8 bit): up to 255 characters			
WSTRING	Unicode format (16 bit): no limit on the length			
# 4.3.2 Variables

## Rules for identifiers of variables:

- No spaces or special characters
- Not case sensitive (For example, Var0 and VAR0 are seen as the same variable)
- No multiple consecutive underscores (For example, b\_Var0 is not permitted)

## Rules for multiple use of identifiers

- Local variable cannot be declared more than one time.
- If a local variable and a global variable share the same name, the local variable has priority within the POU.
- Variables with the same name can be declared in different global variables list.

(For example, globe\_list1.bvar and globe\_list2.bvar can co-exist in two different global variables lists.)

## Comments

- Single comment: the symbol // indicates a single comment, for example: // Variable Define
- Multiple comments: the symbol (\* XX : XX \*) indicates multiples comments from XX to XX, for example (\* Variable Define : Variable Define\*)

## 4.3.2.1 Declaration of Variables

In DIADesigner-AX projects you can declare variables in the following methods.

Syntax: <Variable Name> : <Data Type> := <Initialization> ; Example:

```
VAR

bVar : BOOL ;

byVar : BYTE := 1 ;

wVar : WORD := 16#0001 ;

todVar : TOD := TOD#02:30:15.100;

END_VAR
```

Array

Syntax : <Variable Name> : ARRAY[0..N] OF <Data Type>

Example:

```
VAR
byVar_Array : ARRAY[0..10] OF BYTE ;
wVar_Array : ARRAY[0..30] OF WORD ;
rVar_Array : ARRAY[0..50] OF REAL ;
END_VAR
```

4-33

## 4.3.2.2 Address Assignments

In AX-3 Series, there are three ranges in the memory area, including I (input memory range), Q (output memory range) and M (flag memory range). You can use specific character strings to express memory position and size. For the M flag memory range in AX-3 Series PLC, you cannot manually use the bit operation when in online mode.

Syntax: %<Memory Area Prefix><Size Prefix><Memory Position>

Memory Area	Description	Range
I	Input Memory Range	8 KB
Q	Output Memory Range	8 KB
М	Flag Memory Range	512 KB

Size Prefix	Data Type	Data Width
Х		1 bit
В	Byte	8 bit
W	Word	16 bit
D	DWord	32 bit
L	LWord	64 bit

\*Note1: For flag memory (M) in AX-3 series PLCs, bits cannot be used while in online mode. %MX would only be supported by devices equipped with firmware version V1.0.3.0 and above.

## Memory Area

The numbering that you use for addressing the memory position depends on the target system. Before specifying the address value in the memory area, you need to know the mapping corresponding relationship of devices to prevent the overlapping memory ranges. See the table below for reference.

Memory Area							
X0.63~X0.56	X0.55~X0.48	X0.47~X0.40	X0.39~X0.32	X0.31~X0.17	X0.23~X0.16	X0.15~X0.8	X0.7~X0.0
X7.7~X7.0	X6.7~X6.0	X5.7~X5.0	X4.7~X4.0	X3.7~X3.0	X2.7~X2.0	X1.7~X1.0	X0.7~X0.0
B7	B6	B5	B4	B3	B2	B1	B0
W3		W	/2	W	/1	١	W0
	D1 D0						
LO							

4

## • Example

Address	Description		
%QX7.5	Single bit address of the output bit 7.5		
%IW215	Word address of the input word 215		
%QB7	Byte address of the output byte 7		
%MD48	Address of a double word at memory position 48 in flag memory		
VAR wVar0 AT %IW0 : WORD; END_VAR	Variable declaration with address information of an input word		
VAR bVar0 AT IX7.5 : BOOL; END_VAR	Boolean variable declaration with address information of an input bit X7.5.		

## 4.3.2.3 Variables

## Global Variables

If a variable that is declared in the POU, it is a local variable and it can only be used in the same POU. If a variable that is declared in the global variable list, it is a global variable and it can used in any POU.

File Edit View Project Build O	nline Debug Tools Window Help 🎍 🏠   🎚 🤋 🦄 🎘   📾   🐯 🤇 🧐	
	PLC_PRG ×       1     PROGRAM PLC_PRG       2     VAR       3     END_VAR         & Cut       © Copy       Paste       ×     Delete       Refactoring       Properties       Add Object	
		Visualization Manager



#### Constant Variables

You can declare a variable as a constant variable. Constant variables can be accessed as read-only and without assigning an initialization value.

#### **Declaration of Constant Variables**

```
VAR CONSTANT
pi : REAL := 3.14159 ;
END_VAR
```

## Retain Variables

You can declare a variable as retentive or use retain / persistent variable directly. Refer to the table below for differences among variable, retain variable and persistent variable.

	Initialize						
	Reboot PLC	Reboot PLC         Reset warm         Reset cold         Download         Reset Origin					
Variable	0	0	0	0	0		
Retain Variable	х	х	0	0	0		
Persistent Variable	Х	Х	Х	Х	0		

## **Declaration of Retain Variables**



You can declare the Persistent Variable / Retain Persistent Variable / Persistent Retain Variable in the Persistent Variable Object and the results are the same.

## Persistent Variable List:

File Edit View Project Build O	nline Debug Tools Window Help 🖄 🛀   📕 🧐 🦏 🆄 🔚 🎬 - 🔓 🕮 💖 🔍	ğ ► = ≪  [≡ ?= č≡ t= Ş   ¢   ∰   ₹/
Devices • • • • • • • • • • • • • • • • • • •	PIC_PRG X  PROGRAM PLC_PRG VAR B CUt Copy Paste X Delete Refactoring Properties Add Object Add Folder Add Folder	<ul> <li>Alarm Configuration</li> <li>Application</li> <li>Application</li> <li>Axis Group</li> <li>Cam table</li> <li>ChC program</li> <li>CNC program</li> <li>CNC settings</li> <li>Data Sources Manager</li> <li>DUT</li> <li>External File</li> <li>Global Variable List</li> <li>Image Pool</li> <li>Network Variable List</li> <li>Interface</li> <li>Network Variable List (sender)</li> <li>POU</li> <li>POU</li> <li>POU</li> <li>POU</li> <li>POU</li> <li>Action Pool</li> <li>Network Variable List (sender)</li> <li>Network Variable List (sender)</li> <li>Recipe Manager</li> <li>Recipe Manager</li> <li>Recundancy Configuration</li> </ul>
		<ul> <li>Keedindarky comiguration</li> <li>Symbol Configuration</li> <li>Text List</li> <li>Trace</li> <li>Trend Recording Manager</li> <li>Unit Conversion</li> <li>Visualization</li> <li>Visualization</li> <li>Visualization Manager</li> </ul>



If you need to declare a local variable as persistent, you need to add the variable instance path in the persistent variable list.



4-38

## 4.3.2.4 User-defined Data Types

You can create your own data type, DUT (Data Type Unit) or UDT (User-defined Data Type), by clicking ADD Object and selecting DUT. Four data types can be created, including Structure, Enumeration, Alias and Union.

## DUT:



## • Structure :

A structure is a compound data type used for grouping simple data types or other compound data types.

## Syntax:

TYPE <Structure Name>:

## STRUCT

<Variable Declaration 1>

```
...
```

<Variable Declaration n>

END\_STRUCT

END\_TYPE

Example:

```
TYPE DUT :
STRUCT
    bVar
                 BOOL
            ÷
                         ;
    wVar
                 WORD
            1
                         ;
    iVar Array
                     ARRAY[0..2]OF INT
                .
                                           ;
END STRUCT
END TYPE
```

Applications:

```
PLC_PRG ×
     1
        PROGRAM PLC PRG
    2
B
    3
        VAR
    4
            byVar2 AT %QX7.5
                                      BOOL ;
                                  .
    5
             DUT Var :DUT
                             :=
                                  (bVar:=TRUE,wVar:=12,iVar_Array:=[1,2,3]);
        END VAR
    6
    7
        DUT_Var.bVar:=FALSE;
    1
    2
        DUT_Var.iVar_Array[1]:=123;
```

## • Enumeration :

An enumeration is used to map a set of names to numeric values. Enumerated data types help make the code more selfdocumenting and make program listing more readable.

Syntax:

```
TYPE <Enumeration Name> :
```

(

```
<First Component Declaration>:= Component Declaration,
```

...,

< Last Component Declaration >:= Component Declaration

```
) <Basic Data Type> := Default Variable Initialization;
```

END\_TYPE

Example:

```
TYPE Enumeration_0 :
(
    GREEN := 0,
    YELLOW:=3,
    RED:=8
) INT:=YELLOW;
END TYPE
```

```
• Alias :
```

Alias is a scalar data type for a variable that can save a single value and self-define the data type.

Example:

TYPE <Alias Name> : STRING(20); END\_TYPE

• Union :

Union is a data structure that contains different data types. All components have the same amount of memory.

Syntax: TYPE <Union Name>: UNION <Variable Declaration 1> ... <Variable Declaration n> END\_UNION

END\_TYPE

Example:

TYPE DUT\_Union :
UNION
 unVar0:WORD;
 unVar1:DWORD;
END\_UNION
END\_TYPE

Z

## 4.3.2.5 Timing for the Variable to be Cleared to Zero

For different types of variables, the timing to clear the variables to zero is various. Find the various timings below for the variables to be cleared to zero under different occasions.

## Retain Mode : Original mode

Action	VAR	VAR Retain	VAR Retain Persistent
Online Change	•	•	•
Reboot PLC	0	•	•
Reset Warm	0	•	•
Reset Cold	0	0	•
Download	0	0	•
Reset Origin	0	0	0

## Retain Mode : %M mode

Action	VAR	VAR Retain	VAR Retain Persistent	
Action	The variable address is in the retainable area.			
Online Change	•	•	•	
Reboot PLC	•	•	•	
Reset Warm	•	•	•	
Reset Cold	•	•	•	
Download	•	•	•	
Reset Origin	0	0	0	

Action	VAR	VAR Retain	VAR Retain Persistent	
Action	The variable address is out of the retainable area.			
Online Change	•	•	•	
Reboot PLC	0	•	•	
Reset Warm	0	•	•	
Reset Cold	0	0	•	
Download	0	0	•	
Reset Origin	0	0	0	

• = Value retained

 $\circ$  = Clear to zero

\*Note: If there's no function of retained values, default values would be effective.

## 4.3.2.6 Timing for the Default Value to be Effective

## • Retain Mode : Original mode

Action	VAR	VAR Retain	VAR Retain Persistent
Online Change	•	•	•
Reboot PLC	0	•	•
Reset Warm	0	•	•
Reset Cold	0	0	•
Download	0	0	•
Reset Origin	0	0	0

## • Retain Mode : %M mode

Action	VAR	VAR Retain	VAR Retain Persistent
	The variable address is in the retainable area.		
Online Change	•	•	•
Reboot PLC	•	•	•
Reset Warm	•	•	•
Reset Cold	•	•	•
Download	•	•	•
Reset Origin	0	0	0

Action	VAR	VAR Retain	VAR Retain Persistent				
Action	The variable address is out of the retainable area.						
Online Change	•	•	•				
Reboot PLC	0	•	•				
Reset Warm	0	•	•				
Reset Cold	0	0	•				
Download	0	0	•				
Reset Origin	0	0	0				

• = Invalid

 $\circ$  = Valid

# 4.4 Task

# 4.4.1 Task Configuration

You define one or more tasks for controlling and executing the program blocks (POUs) in the PLC. 0You define a task with a name, a priority, and a type, which determines which condition triggers the start of the task. You can define this condition either by time (cyclic-interval, freewheeling) or by the occurrence of an internal or external event to process the task.

A task calls one or more program blocks (POUs). With the combination of priority and condition, you define the order in which the tasks are processed. You can configure a watchdog for each task.

Rules for the processing order of the defined tasks:

- If the task condition is satisfied, then the system processes the task.
- If several tasks satisfy the condition for processing at the same time, then the system processes the tasks with the highest priority first.
- If several tasks with the same priority level satisfy the condition for processing at the same time, then the system processes the longest waiting task first.
- The program calls are processed in the order they appear in the configuration dialog of the task.
- If a called program has the same name in the device tree of the application and in a library or project-global in the POU window, then the application program is used.

Note: Set the priority level from 0 to 31. If the set number is closer to 0, it has higher priority.

## 4.4.1.1 Task Types

There are five types of task types:

## • Cyclic Task :

The system processes the task in cycles. The cycle time of the task is defined in the input field Interval.

## Event Task :

The system starts processing the Event Task as soon as the global variable defined in the input field Event contains a rising edge.

## • Freewheeling Task :

The system starts processing the Freewheeling Task again automatically in a continuous loop at program start and at the end of a complete pass.

## • Status Task :

The system starts Status Task processing as soon as the variable defined in the Event input field yields the Boolean value TRUE.

## 4.4.1.2 Bus Cycle Task

If the task condition is satisfied, then the system processes the task. Set the priority level from 0 to 31. If the set number is closer to 0, it has higher priority. The system processes the task in the order of Task Group in Task Configuration.

## Behavior of the bus cycle



1 Bus cycle

Task 1: Priority = 1, Bus cycle Task, Cyclic Task

Task 2: Priority = 3, Event Task

Task 3: Priority = 5, Freewheeling Task

1 The condition for starting Task 1 is met; Task 1 starts.

- 2 Task 1 completes and the I/O data from buffer is exchanged with the I/O channel (physical hardware.) Task 3 starts.
- 3 The condition for starting Task 2 is met and Task 2 has higher priority than Task 3 does. Thus Task 2 starts and Task 3 halts.
- The condition for starting Task 1 is met and Task 1 has higher priority than Task 2 does. Thus Task 3 starts and Task 4 halts.
- Task 1 completes and the I/O data from buffer is exchanged with the I/O channel (physical hardware.) Task 2 starts again.
- 6 Task 2 completes and the Task 3 starts again.

Note ①: The messages are normally sent on the bus in this task. Other tasks copy only the I/O data from an internal buffer that is exchanged only with the physical hardware in the bus cycle task.

## 4.4.1.3 Watchdog

If the task exceeds the time set for the watchdog, then the task is halted with an error status.

File Edit View Project Build Onl	line Debug Tools Window Help
🎦 🛩 🖬 🕼 🗠 🗠 🐇 🗈 🛍 🗙 🕼 🌿 📥	🌜 📕 웹 웹 🍓 🛍 🕯 🖀 🧐 🧐 🖌 🗉 😤 🕼 역 열 열 열 왕 🕨 🛒 🐼 👘
Devices 👻 🕈 🗙	📋 PLC_PRG 🕺 Device 🖉 MainTask 🗙
Christed1	Configuration
Device (AX-308EA0MA1T)	
Hardware Configuration	Priority ( 031 ): 1
A Network Configuration	Time
PLC Logic	Туре
Application	Cyclic      Interval (e.g. t#200ms) 20
👘 Library Manager	
PLC PRG (PRG)	*1
	Watchdog
EtherCAT Task	C Enable
🗏 🖉 MainTask	Time (e.e. +#200me) 500
PLC_PRG 2	
🗉 🗊 BuiltIn_IO (BuiltIn_IO)	Sensitivity 1
Delta_LocalBus_Master (Delta Local	
EtherCAT_Master_SoftMotion (Ethe	
SoftMotion General Axis Pool	
MainTask     PLC_PRG     Delta_LocalBus_Master (Delta_Localf     EtherCAT_Master_SoftMotion (Ethe	Watchdog  Enable  Time (e.g. t#200ms)

- Several consecutive timeouts:
   Sensitivity: 0, watchdog timeout = time \*1
   Sensitivity: n, watchdog timeout = time \*n
- 4

# 4.4.1.4 Motion Instructions for Types of Tasks

Here is the table of motion instructions for different task types. "V" means the motion instruction can be executed for the task type.

	Instruction Name	Task Type				
Classification	Instruction Name	Cyclic	Freewheeling	Bus Cycle EtherCAT		
	MC_Home			V		
	MC_Stop			V		
	MC_Halt			V		
	MC_MoveAbsolute			V		
	MC_MoveRelative			V		
	MC_MoveAdditive			V		
	MC_MoveSuperImposed			V		
	MC_CamIn			V		
	MC_CamOut			V		
	MC_MoveVelocity			V		
	MC_PositionProfile			V		
	MC_VelocityProfile			V		
	MC_AccelerationProfile			V		
Motion	MC_Jog			V		
Control	MC_GearIn			V		
Function	MC_GearOut			V		
Blocks	MC_GearInPos			V		
	MC_Phasing			V		
	DMC_TorqueControl			V		
	DMC_VelocityControl			V		
	DMC_MoveLinearAbsolute			V		
	DMC_MoveLinearRelative			V		
	DMC_MoveCircularAbsolute			V		
	DMC_MoveCircularRelative			V		
	DMC_GroupStop			V		
	DMC_GroupHalt			V		
	DMC_Home_P			V		
	DMC_GroupInterrupt			V		
	DMC_GroupContinue			V		
	DMC_ImmediateStop_P			V		
	MC_Power	V	V	V		
	MC_SetPosition	V	V	V		
	MC_ReadParameter	V	V	V		
Instructions	MC_WriteParameter	V	V	V		
for Management	MC_ReadBoolParameter	V	V	V		
Management	MC_WriteBoolParameter	V	V	V		
	MC_ReadActualPosition	V	V	V		
	MC_ReadActualVelocity	V	V	V		
	MC_ReadActualTorque	V	V	V		

• Synchronization axes

# AX-3 Series Operation Manual

		Task Type			
Classification	Instruction Name	Cyclic	Freewheeling	Bus Cycle EtherCAT	
	MC_Reset	V	V	V	
	MC_ReadStatus	V	V	V	
	MC_ReadAxisError	V	V	V	
	MC_CamTableSelect	V	V	V	
	MC_TouchProbe	V	V	V	
	MC_AbortTrigger	V	V	V	
	MC_DigitalCamSwitch	V	V	V	
	DMC_GroupEnable	V	V	V	
	DMC_GroupDisable	V	V	V	
	DMC_GroupReadStatus	V	V	V	
	DMC_GroupReadError	V	V	V	
	DMC_GroupReset	V	V	V	
	DMC_CamReadTappetStatus	V	V	V	
	DMC_CamReadTappetValue	V	V	V	
	DMC_CamWriteTappetValue	V	V	V	
	DMC_CamAddTappet	V	V	V	
	DMC_CamDeleteTappet	V	V	V	
	DMC_CamReadPoint	V	V	V	
	DMC_CamWritePoint	V	V	V	
	DMC_ChangeMechanismGearRation	V	V	V	
	DMC_ReadMotionState	V	V	V	
	DMC_GroupReadParameter	V	V	V	
	DMC_GroupWriteParameter	V	V	V	

Note: it is suggested a motion function block should be created within a bus cycle EtherCAT to avoid inconsistent movement.

## • Positioning axes

Classification	Instruction Name	Task Type				
Classification	Instruction Name	Cyclic	Freewheeling	Bus Cycle EtherCAT		
	MC_Halt_DML	V	V	V		
Motion	MC_Home_DML	V	V	V		
Control	MC_MoveAbsolute_DML	V	V	V		
Function	MC_MoveRelative_DML	V	V	V		
Blocks	MC_MoveVelocity_DML	V	V	V		
	MC_Stop_DML	V	V	V		
	MC_Power_DML	V	V	V		
	MC_ReadBoolParameter_DML	V	V	V		
	MC_ReadParameter_DML	V	V	V		
	MC_ReadStatus_DML	V	V	V		
Instructions	MC_Reset_DML	V	V	V		
for Management	MC_WriteBoolParameter_DML	V	V	V		
Management	MC_WriteBoolParameter_DML	V	V	V		
	MC_ChangeAxisConfig_DML	V	V	V		
	MC_ReinitDrive_DML	V	V	V		
	MC_SetOpmode_DML	V	V	V		
	MC_StartupDrive_DML	V	V	V		

# 4.5 Recipe Manager

With Recipe Manager, you are allowed to import recipe files and export specific parameters to recipe files by using "RecipeManCommands" from "Recipe\_Management.library" function block.

Add recipe manager



Add recipe definition



Add Recipe Definition	×					
0			Devices	-	ą	×
Create a new Recipe Definition	Cancel	¢	A Network     A Network	ware Configuration	on ) per PRG G) ger ation ) er (D ftMo	n Velta

# 4.5.1 Recipe Manager

Recipe Ma				
torage General				
Storage type	e Textual			~
File path				
File extensio	,txtrecip	e		
Separator				
() Tab		O Semicolon	🔘 Comma	
O Space		• :=	01	
Available Colu	umns	>	Selected Columns	
👈 Туре		>>	Variable	
Name			Current Value	
Minimal Va		<	1	
Maximal V		<<		
Save as Defa			Up	Down

Selection	Description
Storage type	The file format to save recipe files. You can choose between Textual and Binary.
File path	The path to save recipe files. Example: If choosing to save files in AllRecipes, the path would be PIcLogic/AllRecipes.
File extension	The extension of the file <file extension=""> The naming format of extension files <recipe>.<recipe definition="">.<file extension="">.</file></recipe></recipe></file>
Separator	Separators between each values in recipe files.
Available Columns Selected Columns	Define contents and order of recipe files.
Save as Default	Apply the setting to all the recipe managers in the project.

/ 🔒 🖪	Recipe Manager 🗙
Storage	General
Recip	pe Management in the PLC
Sa	ve Recipe
	Save recipe changes to recipe files automatically
Loa	ad Recipe
۲	Load only by exact match of variable list
0	Load matching variables by variablename
Write F	Recipe
● Lim	nit the variable to min/max when recipe value is out of the range
O Do	not write to a variable when the recipe value is out of the min/max range $% \left( {{{\mathbf{x}}_{i}}} \right)$
Read F	Recipe
Che	eck recipe for changes

Selection	Description
Recipe management in the PLC	After this item has been selected, Recipe Manager would be activated.
Save Recipe	
Save recipe changes to recipe files automatically	After this item has been selected, recipe files would be updated automatically while downloading projects. In case that Recipe changes, it would be auto-saved to the recipe file.
Load Recipe	
Load only by exact match variable list	Select this item to load recipe files to the variables in the controller. The variables in the file must be in the same order as in the variable list while loading the recipe. Otherwise, the recipe cannot be loaded. (Additional entries at the end are ignored.)
Load matching variables by variable name	Select this item to load only variables with matching variable names from the recipe file, even though the order of variables or the contents in Name column do not match to the setting in the variable list.
Write Recipe	
Limit the variable to min/max when recipe value is out of the range	In case that the recipe value is out of the min/max range, the maximum or minimum value would be written to the corresponding variables in the controller.
Do not write to a variable when the recipe value is out of the min/max range	Prevent a value from being written to the controller if the recipe contains a value that is beyond the value range.

# 4.5.2 Recipe Definition

Devices + 4 >	Recipes	_01 X						
Recipe     Device (AX-308EA0MA1T)	Variable	Type WORD	Name MW3 Variable	Comment	Minimal Value	Maximal Value	Current Value	Case1 350
Hardware Configuration	PLC_PRG.iVar	INT	int Variable					800
<ul> <li>A Network Configuration</li> <li>II PLC Logic</li> </ul>	PLC_PRG dwVar	DWORD	dword Variable		100	800		250
Library Manager Motion_PRG (PRG) PLC_PRG (PRG) Recipe Manager Recipes_01 Recipes_02 Task Configuration Builtin_IO (Builtin_IO) DIO (DIO)								

Parameter	Description
Variable	In the table, you can specify any variable including variables defined in a POU.
Туре	This column would automatically display the relevant data type of the specified variable.
Name	You can define names of variables for inspection and comparison of Load Recipe.
Comment	Additional information.
Minimal Value Maximal Value	You can optionally specify the maximum and minimum value for values which should be permissible for being written on this variable. When the recipe value is out of the min/max range, the controller would determine whether to write the value on the variable according to the recipe manager.
Current Value	The current value would be displayed in online mode.

## • Add a new variable

You can directly enter the name of variable or double click on the blank cell to open "Input Assistant" to choose the target variable.

ariable	Туре	Name	Comment	Minimal Value	Maximal Value	Current Value	Case
MW3	WORD	MW3 Variable		10	500		350
C_PRG.iVar	INT	int Variable					800
C_PRG.dwVar	DWORD	dword Variable		100	800		250
OR	2	Recipe	s_01 X				
OR		Recipe		e Name	Ce		
OR	2		s_01 X				
OR		Variable	Тур				

## • Add a new recipe

Right click on the page and select "Add a New Recipe".

ariable		Туре	Name	Comment	Minimal Valu	e Maximal Value	Current Value	Case
W3		WORD	MW3 Variable		10	500		350
PRG.i	/ar	INT	int Variable					800
_PRG.d	lwVar	DWORD	dword Variable		100	800		250
			E E	$\bigcirc$				
	Сору			•				
1	Paste							
$\times$	Delete			Rev Recipe				
	Select All			+ New I	vecipe			×
-19	Insert Variable			Name	Ca	Case 2		
-19	Add Child			Conv fro	m existing	<create empty=""></create>		
-10	Add Sibling					a core empty >		~
C,	Update Structured	Variables				OK	Cance	el
2	Add a New Recipe							-
Q.	Remove Recipe							
e7	Load Recipe	0						
16C								

## Recipe files generated from the controller



# 4.5.3 RecipeManCommand

Function block "RecipeManCommands" from "Recipe\_Management.library" gives you different methods to load recipe files or export recipe files from the controller.

RecipeManCommands	Description			
LoadAndWriteRecipe	Load the default recipe file and write the recipe to variables in the controller.			
LoadFromAndWriteRecipe	Load the specified recipe file and write the recipe to variables in the controller.			
ReadAndSaveAS	Save the variables of the controller in the target file.			
ReadAndSaveRecipe	Read the current PLC values into the default recipe.			
ReadAndSaveRecipeAS	Read the current PLC values into the default recipe and save the recipe to a specified recipe file.			

## • Example 1p

In this example, we add "StartDone" event by using "Add Event Handler" with "LoadAndWriteRecipe" method. So the recipe "Case 1" from the recipe definition "Recipes\_01" would be loaded automatically to the corresponding variables in the controller when the PLC state changes from "STOP" to "RUN".

<b>→</b> ∓ X	Task Configuration 🗙		
-	Monitor Variable Usage System	Events Properties	
	Add Event Handler 🔀 Re	move Event Handler   🛛 Event Info 📄 C	pen Event Function
nfiguration tion (STRUCT)	Name	Description	
on_PRG (PRG)	Add Event Handler		×
pe Manager	Even	StartDone	~
	Function to ca	Start_Done	
	Scop	Application OPOUs	
and the second second second second second second second second second second second second second second second	Implementation languag	Structured Text (ST)	~
Seneral Axis Pool	Descriptio	Called after application starts. Context=Comm Debugging=Disabled	unication task.
		OK	Cancel
		AOMA IT) AOMA IT) onfiguration nfiguration ation r (STRUCT) ary Manager ion_PRG (PRG) _PRG (PRG) _PRG (PRG) _PRG (PRG) ipe Manager k Configuration SultIn_IO) O) Sus_Master (Delta LocalBus taster_SoftMotion (AX-3 Sc Consert Avic Pool	Monitor Variable Usage System Events Properties  Add Event Handler Remove Event Handler Sevent Info.  Add Event Handler  Event StartDone  Function to call Start_Done  Scope Application  Function to call Start_One  Scope Application  Function to call after application starts. Context=Commu Debugging=Disabled



## • Example 2

4

In this example, we use methods "ReadAndSaveRecipe" and "ReadAndSaveAS" to read the current PLC values into the default recipe as well as the specified recipe file.



# 5

# Chapter 5 Hardware Configuration

# **Table of Contents**

5.1 Environment of Hardware Configuration	5-2
5.2. Add a Module	5-5
5.3 Remove a Module	5-7
5.4 Copy and Paste a Module	5-9
5.4.1 Copy a Module	
5.4.2 Paste a Module	5-10
5.5 Cut and Paste a Module	5-11
5.5.1 Cut a Module	5-11
5.5.2 Paste a Module	5-12

Hardware Configuration is the tools in DIADesign-AX for hardware configuration. Its functions include setting parameters for CPU and modules. This chapter will introduce the abovementioned funcitons.

# 5.1 Environment of Hardware Configuration

Double-click **a** Hardware Configuration on the Device section to open the Hardware Configuration (Device) window as the image shown below.



Hardware Configuration (Device): This is the main work area for system configuration and settings.

Product List Editor: Here listed out all supported modules for the selected CPU.

Click to see all the supported modules on the right window (Product List Editor).

Click to unfold the list. Click the module name to see a short module description.



Click on the upper-left corner to see the current configurations. For example, the width of the total connected module, the current consumption and power current output.



experience and easier operation.

한 🖄 EtherCAT	~				
					150 💭 + +
- prosen - pasa - pasa - part Low - coart - coart					
· COM colar		04	08	+	
- 99 day - 0- 9 - 9 - 1 - 0 - 1 - 2 - 10 - 2 - 2 - 10 - 2			AN		
4 8 4 4 8 4 8 4 8 1 7 8 1	Dens U	<b>.</b>			
<sup>8</sup> Hardware Confi	guration [Device]	×			
🛃 EtherCAT	~				50 C - 1 +

Enter a key word in the **Search Toolbox** on the right-side window and press "Enter" button on your keyboard to search for the matched modules.



# 5.2. Add a Module

## Method 1

With AX-3 Series PLC backplaneless design, the extension module can install on the right-side of AX-3 Series PLC directly. Double-click or drag and drop the extension module that you'd like to add from the Product List. Newly added extension modules will apper on the right-side of the AX-3 Series PLC. And the device names will also show up on the left-side under Delta\_LocalBus\_Master.



## • Method 2

If the AX-3 Series PLC and its connected extension module are powered on and the gateway is correctly set,

you can use the icon to scan and add the modules in. Newly added extension modules will apper on the right-side of the AX-3 Series PLC. And the device names will also show up on the left-side under Delta\_LocalBus\_Master.



# 5.3 Remove a Module

You cannot remove a CPU. You can only delete extension modules.

#### Method 1

Right-click the module image that you'd like to remove to open the context menu and click the option Delete or

use the Delete Button on your keyboard to remove the module.



After you click **Delete**, a confirmation shows up. Click **Yes** to delete the module.

Delete					
4	It will ren this mode	nove this mode ule?	ule in this rac	ik, Are you su	re to remove

And the device names will also be removed from the left-side under Delta\_LocalBus\_Master.



## • Method 2

Right-click the device name under Delta\_LocalBus\_Master that you'd like to remove to open the context menu and click the option **Delete** or use the Delete Button on your keyboard to remove the module. After that the device image will also be removed from the editing area.



# 5.4 Copy and Paste a Module

You cannot use copy and paste on a CPU. You can only use copy and paste on extension modules.

# 5.4.1 Copy a Module

### Method 1

Right-click the module image that you'd like to copy to open the context menu and click the option **Copy** to duplicate the module.

8 Har	dware Config	uration [De	evice] ×		
2	EtherCAT	~			
		A 🔳			
			08 AM	08 AN	+
			ut Ctrl+1	x	_
			opy Ctrl		
		📋 Ra	iste Ctri	+V	
		💿 De	elete De	el	

#### Method 2

Right-click the device name under Delta\_LocalBus\_Master that you'd like to copy to open the context menu and click the option **Copy** to copy the module.



## 5.4.2 Paste a Module

## Method 1

You can place the module between modules. Right-click where you'd like to paste the module to open the context menu and click the option **Paste** to place the module on the left of the module you had clicked. Or you can place the module at the end by right-clicking the + to paste the copied module there.



And the device names will also be updated on the left-side under Delta\_LocalBus\_Master.



## Method 2

You can place the module between modules. Right-click where you'd like to paste the module under Delta\_LocalBus\_Master to open the context menu and click the option **Paste** to place the module above the module you had clicked. Or you can place the module at the end by right-clicking Delta\_LocalBus\_Master to paste the copied module.



And the module image will also be updated on the editing area.



# 5.5 Cut and Paste a Module

You cannot use cut and paste on a CPU. You can only use cut and paste on extension modules.

# 5.5.1 Cut a Module

## Method 1

Right-click the module image that you'd like to cut to open the context menu and click the option **Cut** to take out the module.



## • Method 2

Right-click the device name under Delta\_LocalBus\_Master that you'd like to cut to open the context menu and click the option **Cut** to take out the module.

🛯 🔟 DIO (DIO)			
🖷 🗊 Delta_LocalBus_Master (Delta L	*	Cut	
🗐 AS08AM10N_A_1 (AS08AM10		Сору	
AS08AN01T_A_1 (AS08AN01	Ē	Paste	
EtherCAT_Master_SoftMotion (E	×	Delete	

## 5.5.2 Paste a Module

## Method 1

You can place the module between modules. Right-click where you'd like to paste the module to open the context menu and click the option **Paste** to place the module on the left of the module you had clicked. Or you can place the module at the end by right-clicking the + to paste the copied module there.



And the device names will also be updated on the left-side under Delta\_LocalBus\_Master.



#### Method 2

You can place the module between modules. Right-click where you'd like to paste the module under Delta\_LocalBus\_Master to open the context menu and click the option **Paste** to place the module above the module you had clicked. Or you can place the module at the end by right-clicking Delta\_LocalBus\_Master to paste the copied module.



And the module image will also be updated on the editing area.




## Chapter 6 Network Configuration

## **Table of Contents**

6.1	Net	work Configuration	6-2
		Introduction	
6.1.	2	Basic Knowledge	6-3
6.1.	3	Creating a Network Topology	6-5

## 6.1 Network Configuration

DIADesigner-AX provides a Network Configuration tool for users to configure the network in a project. Detailed network setting information will be covered in the following sections.

## 6.1.1 Introduction

You can use Network Configuration to:

- (a) create networks such as EtherCAT, Modbus, Ethernet, CANOpen in a project and set up file sending paths
- (b) set up EtherCAT Master
- (c) set up Modbus COM port
- (d) set up Ethernet IP settings

Network Configuration is under the Device tree. You can double-click A Network Configuration to open its setting page and start planning a network framework for the project.





- **O** Device: Here shows all the configured devices in a tree view.
- Working area: Here is the main working area for you to create a network framework.
- Device list: Here lists all the available devices in a tree view.
- **O** Message display area: Here displays operational messages.

## 6.1.2 Basic Knowledge

Before creating networks, you need to have some basic knowledge. Here we provide some basic knowledge in the following sections for you.



#### • Device and Network

A device is the most basic element in a network. It can be a PLC, a servo, a drive or any device that you defined. Here a network is a collection of devices which are interconnected. Every communication port should be assigned with a network type, such as Modbus, Ethernet, EtherCAT or CANOpen. A physical interface that a device uses to connect to a network is a communication port of the device. If there are more than two ports on a device, the device can connect to different networks.

#### Device Name

A device name is the identity of the device. You can identify a device in the Device Tree by its name. However it bears little significance on operation.

#### • Network Type and Communication Port

#### EtherCAT

The orange yellow line indicates the EtherCAT communication. Double-click the Master station node to open the EtherCAT setting page of the Master. The number of Master Station is 0 and that cannot be changed. Double-click the connection of Slave to open the EtherCAT setting page of the Slave. The last digit appeared in the EtherCAT address 1001 is used as an indicator of this connection on the Network Configuration Editor page.

ASD_A2_EEEE X A	Network Configuration Editor	Device	
General	Address		ASD-A2-E
Process Data	AutoInc address	0 Enable expert settings	ASD-A2-E
	EtherCAT address	1001 🗘 Optional	
Startup Parameters	Distributed Clock		
EtherCAT I/O Mapping	Select DC	DC-Synchronous	
EtherCAT IEC Objects	🖂 Enable	4000 Sync unit cycle (µs)	ASD AS LEFE
Status	Sync0:	Y	ON
	Enable Sync 0		Par
Information	Sync unit cycle	x 1 V 4000 Cycle time (µs)	

#### Modbus TCP/EtherNETIP

The blue line indicates the Modbus TCP/EtherNetIP communication. Double-click this line to open its setting page to edit IP addresses. The last digit appeared in the last section of the IP address is used as an indicator of this connection on the Network Configuration Editor page.

General	Interface sw0					
Log	IP address	192 . 168 .	1.5			Device
Status	Subnet mask	255 . 255 .	255 . 0		AX-305EADMA1T	
Ethernet Device I/O Mapping	Default gateway	0.0.			Device	
Ethernet Device IEC Objects						
Information				<b>–</b>		

#### Modbus

The blue line indicates the Modbus communication (RS-232 / RS-485). Double-click this line to open the Modbus communication port setting page.

tatus	Serial Port Configuration	on	
	And the second second		
nformation	COM Port	RS-232	*
nrormation	Baudrate	9600	14
	Parity	Even	¥
	Data Bits	7	14
	Stop Bits	1	*
	Transmission Mode	O RTU 💿	ASCII

## 6.1.3 Creating a Network Topology

#### 6.1.3.1 Station Nodes

When you open the Network Configuration for the first time, the system creates a graphical representation automatically.



You can use the following methods to add devices including PLCs, servo motors, and drives in the network topology.

#### Method 1

Double-click the device that you want to add from the **Product List** on the right. After that you can see the added device is updated in the graphical representation and also on the Device Tree.



#### Method 2

Right-click the project name on the Device Tree to bring out the context menu. Double-click **Add Device** on the context menu to open a setting page for adding devices. Double-click the device you'd like to add or click **Add Device** to add the device in.



#### • Method 3

Right-click the device to bring out the context menu and click **Network Scan** or click the icon scan to automatically scan and then add the connected configured devices and network in the project.



#### 6.1.3.2 Creating a Connection

After creating the station nodes, you can start to crate connections. The network types include Modbus, Ethernet, EtherCAT and CANOpen. Refer to 6.1.2 for more information.

You can use the following methods to add created network connections.

#### Method 1

Drag and drop the communication port to the corresponding network type shown in line to create a connection between devices.



#### • Method 2

Hold the communication port and drag it to the unused dotted line to create a network connection that is the same as the selected network communication type and then a new gray unused dotted line will also be created.



MEMO



# Chapter 7 Motion Control Setup & Operation

## **Table of Contents**

7.1	Introduction on Motion Control Instructions
7.1.1	Motion Control Instructions7-5
7.1.2	Application Notes on Motion Control Instructions
7.1.3	Categories of Motion Control Instructions7-6
7.2	Creating Motion Control Project7-7
7.2.1	Process Flowchart7-7
7.2.2	Process for Creating a Project7-8
7.3	Commissioning7-14
7.3.1	Procedure for Commissioning7-14
7.3.2	Example of Axis Parameter Settings
7.3.3	Perform Axes Commissioning7-16
7.4	Motion Control Device7-19
7.4.1	Overview
7.4.2	Introduction to Axis
7.4.	2.1 About Axis Parameters
7.4.	2.2 Axis Application in Program7-28
7.4.3	Procedure for Single-axis Configuration7-29
7.4.4	Axis Group Settings7-36
7.4.	4.1 Prameters for Axis Group7-36
7.4.	4.2 Using Axis Groups in Program
7.4.5	Procedure for Axis Group Configuration7-39
7.5	Motion Axis Variables7-44
7.5.1	Variables for Single Axis
7.5.2	Variables for Axis Group
7.6	Motion Control Programming7-50
7.6.1	Motion Control Program 7-50
7.6.	1.1 Program Architecture and Types in DIADesigner-AX7-50

7.6.1.2	POU in DIADesigner-AX7	-51
7.6.1.3	Adding POU in DIADesigner-AX7	-51
7.6.1.4	PDO Mapping7	-53
7.6.2	Axis State Transitions	-54
7.6.2.1	Axis State7	-54
7.6.2.2	Axis Group State	-56
7.6.3	Execution and Status Indication for Motion Control Instructions	-57
7.6.3.1	Basic Rules of Executing Instructions7	-58
7.6.3.2	Timing Diagram for Input/Outputs7	-60
7.6.3.3	Repeated Execution Behavior of Single Axis Motion Instructions7	-60
7.6.3.4	Multi-execution of Motion Control Instructions7	-61
7.6.3.5	Synchronous Execution Eehavior of Motion Instructions7	-61
7.6.4 Po	osition	-67
7.6.4.1	Types of Positions	-67
7.6.5 CA	M Tables and Framework	-67
7.6.5.1	E-CAM Framework7	-67
7.6.5.2	Creating E-CAM7	-68
7.7 Mc	otion Control Functions7-	72
	Otion Control Functions       7-         System Structure       7-	
7.7.1		-72
7.7.1	System Structure	-72 -72
7.7.1 7.7.2	System Structure	-72 -72 -72
7.7.1 7.7.2 7.7.2.1	System Structure    7-      Single-axis Control    7-      Cyclic Synchronous Position Mode    7-      Profile Position Mode    7-	-72 -72 -72 -73
7.7.1 7.7.2 7.7.2.1 7.7.2.2	System Structure    7-      Single-axis Control    7-      Cyclic Synchronous Position Mode    7-      Profile Position Mode    7-	-72 -72 -72 -73 -73
7.7.1 7.7.2 7.7.2.1 7.7.2.2 7.7.2.2 7.7.2.3	System Structure    7-      Single-axis Control    7-      Cyclic Synchronous Position Mode    7-      Profile Position Mode    7-      Positioning    7-	-72 -72 -72 -73 -73 -73
7.7.1 7.7.2 7.7.2.1 7.7.2.2 7.7.2.3 7.7.2.4	System Structure       7-         Single-axis Control       7-         Cyclic Synchronous Position Mode       7-         Profile Position Mode       7-         Profile Position Mode       7-         Stop Method       7-	-72 -72 -73 -73 -73 -74 -77
7.7.1 7.7.2 7.7.2.1 7.7.2.2 7.7.2.3 7.7.2.4 7.7.2.5	System Structure       7-         Single-axis Control       7-         Cyclic Synchronous Position Mode       7-         Profile Position Mode       7-         Profile Position Mode       7-         Stop Method       7-         MC_GearIn       7-	-72 -72 -73 -73 -73 -74 -77
7.7.1 7.7.2 7.7.2.1 7.7.2.2 7.7.2.3 7.7.2.4 7.7.2.5 7.7.2.6 7.7.2.7	System Structure7-Single-axis Control7-Cyclic Synchronous Position Mode7-Profile Position Mode7-Positioning7-Stop Method7-MC_GearIn7-MC_GearInPos7-	-72 -72 -72 -73 -73 -74 -77 -79 -80
7.7.1 7.7.2 7.7.2.1 7.7.2.2 7.7.2.3 7.7.2.4 7.7.2.5 7.7.2.6 7.7.2.7	System Structure7-Single-axis Control7-Cyclic Synchronous Position Mode7-Profile Position Mode7-Positioning7-Stop Method7-MC_GearIn7-MC_GamIn7-MC_CamIn7-	-72 -72 -72 -73 -73 -74 -77 -77 -80 -90
7.7.1 7.7.2 7.7.2.1 7.7.2.2 7.7.2.3 7.7.2.4 7.7.2.5 7.7.2.6 7.7.2.7 7.7.3	System Structure       7-         Single-axis Control       7-         Cyclic Synchronous Position Mode       7-         Profile Position Mode       7-         Positioning       7-         Stop Method       7-         MC_GearIn       7-         MC_CamIn       7-         Velocity Control       7-	-72 -72 -73 -73 -73 -74 -77 -79 -80 -90 -90
7.7.1       3         7.7.2       3         7.7.2.1       7.7.2.1         7.7.2.2       7.7.2.3         7.7.2.4       7.7.2.5         7.7.2.5       7.7.2.6         7.7.2.7       7.7.3         7.7.3       7.7.3.1	System Structure       7-         Single-axis Control       7-         Cyclic Synchronous Position Mode       7-         Profile Position Mode       7-         Positioning       7-         Stop Method       7-         MC_GearIn       7-         MC_CamIn       7-         Velocity Control       7-         CSP Mode       7-	-72 -72 -73 -73 -73 -74 -77 -79 -80 -90 -90 -91
7.7.1 7.7.2 7.7.2.1 7.7.2.2 7.7.2.3 7.7.2.4 7.7.2.5 7.7.2.6 7.7.2.7 7.7.3 7.7.3.1 7.7.3.1 7.7.3.2 7.7.3.3	System Structure       7-         Single-axis Control       7-         Cyclic Synchronous Position Mode       7-         Profile Position Mode       7-         Positioning       7-         Stop Method       7-         MC_GearIn       7-         MC_CamIn       7-         Velocity Control       7-         CSP Mode       7-         CSV Mode       7-	-72 -72 -73 -73 -73 -74 -77 -79 -80 -90 -90 -91 -91
7.7.1 7.7.2 7.7.2.1 7.7.2.2 7.7.2.3 7.7.2.4 7.7.2.5 7.7.2.6 7.7.2.7 7.7.3 7.7.3.1 7.7.3.1 7.7.3.2 7.7.3.3 7.7.3.3 7.7.4	System Structure.       7         Single-axis Control.       7         Cyclic Synchronous Position Mode       7         Profile Position Mode       7         Positioning       7         Stop Method       7         MC_GearIn       7         MC_CamIn       7         Velocity Control       7         CSV Mode       7         Profile Velocity Mode       7	-72 -72 -73 -73 -74 -77 -77 -80 -90 -90 -91 -91 -91 -92 -93

7

7.7.5.2	Velocity Command	7-95
7.7.5.3	Acceleration and Deceleration Command	7-96
7.7.5.4	Jerk Command	7-97
7.7.5.5	Axis Direction	7-98
7.7.6	Axis Group Control	7-100
7.7.6.1	Linear Interpolation	7-100
7.7.6.2	Circular Interpolation	7-102
7.7.6.3	Group Stop Command	7-104
7.7.7	High-speed IO	7-105
7.7.7.1	IO Configurations	7-105
7.7.7.2	DIO Settings	7-107
7.7.7.3	SSI Encoder Settings	7-111
7.7.7.4	Pulse Encoder Settings	7-119
7.7.7.5	Capture/Compare Function Settings	7-133
7.7.7.6	Pulse Output Function Settings	7-139
7.7.7.7	Confirm High-Speed IO Errors	7-144
7.7.8	Other Features	7-145
7.7.8.1	Change Current Position	7-145
7.7.8.2	Software Limit	7-145
7.7.8.3	Position Lag Settings	7-146
7.7.8.4	Cam Switch Functions	7-147
7.7.8.5	Position Capture	7-147
7.8 Pr	ogramming Example	7-149
7.8.1	Device Framework	7-149
7.8.1.1	Utilization	7-149
7.8.1.2	Configurations	7-149
7.8.2	Examples	7-149
7.8.2.1	Servo On	7-151
7.8.2.2	Reset and Control Single-axis Error	7-152
7.8.2.3	Control on Instruction Errors	7-155
7.8.2.4	Quick Stop for Single Axes	7-157
7.8.2.5	Home Positioning	7-159
7.8.2.6	Absolute Positioning	7-162
7.8.2.7	Switch CAM Table during CAM Operation	7-163

7.8.2.8	Perform Master PhaseOffset for CAM7-172
7.8.2.9	Change Current Position in Movement7-179
7.8.2.10	Perform Superimposed during Gear Engagment

## 7.1 Introduction on Motion Control Instructions

## 7.1.1 Motion Control Instructions

This manual introduces the elements for motion control programming including devices, symbols and motion control instructions.

Motion control instructions are defined as function blocks (FB) and are used in the program for performing a variety of motion control purposes. The motion control (MC) instructions are developed based on the specifications of PLCopen\* motion control function blocks.

This section gives an overview of the motion control instructions for both PLCopen-based function blocks and Deltadefined function blocks. PLCopen defines the program and function block interfaces so as to achieve a standardized motion control programming environment for the languages specified in IEC61131-3. Using PLCopen-based instructions together with Delta-defined instructions reduces the costs for training and support.

Before using the instructions, please be sure that you understand the devices, symbols and the function of instructions sufficiently.

You can also refer to the Appendices for a quick reference of the motion control instruction list and error codes.

#### \*Note:

**PLCopen** is an organization promoting industrial control based on IEC61131-3, which is an international standard widely adopted for PLC programming. For more information regarding PLCopen, check the official website at: <a href="http://www.plcopen.org/">http://www.plcopen.org/</a>

## 7.1.2 Application Notes on Motion Control Instructions

This section explains important specifications and limitations when applying motion control instructions. For detailed information of each instruction in this manual, refer to section 7.6.3 Motion Control Programming.

#### Programming languages for motion control instructions

You can use all programming languages provided by DIADesigner-AX to create, edit, or maintain the program. The supported languages include Ladder Diagram (LD), Sequential Function Chart (SFC), Continuous Function Chart (CFC), Structured Text (ST) and Function Block Diagram (FBD).

For detailed information about the programming languages, refer to **DIADesigner-AX Software Manual**.

## 7.1.3 Categories of Motion Control Instructions

This section explains the catogeries of motion control instructions. The relating instructions can be found in the libraries of SM3\_Basic, DL\_MotionControl and DL\_MotionControlLight, which the details are set out in **AX Series Motion Controller Manual**.

Categories	Туре	Function Group	Description
		Single axis positioning	"SMC": Motion instructions
		Velocity control on single axis	"MC_": PLCopen motion
Single-axis motion	Motion	Torque control on single axis	control instructions "DMC_": Delta motion control
control instructions		Synchronized control on single axis	instructions "MC_XXX_DML": Delta motion
	Administrative	Administrative functions on single axis	control instructions, used with positioning axis.
Multiple-axis motion	Motion	Axis group movement functions	Multiple-axes motion
control instructions	Administrative	Administrative functions on mutiple axes	Multiple-axes configuration, monitoring and reset function.

## 7.2 Creating Motion Control Project

## 7.2.1 Process Flowchart

The following flowchart shows the process of creating motion control project and positioning axis.



## 7.2.2 Process for Creating a Project

- Create a new project
- Double ckick on the DIADesign-AX icon to open the software.



Click File.

#### ■ Choose New Project



Type in the fields of Name and Location in the New Project window, select the desired project and then click OK. Model AX-308E is taken as an example to illustrate the process, which the project name is shown as "Project AX-308EA0MA1T".

Categories	<u>(</u>	Templates			
	varies ojects	Project AX-308EA0	Project SxxE	Standard project	
Name	Untitled 1 C: (Users \admin \D	, one application, two em	pty implementat	ions for PLC_PRG and	Motion_
Location	er poer a pointin p	ocumenta.			-

Double-click on "Network Configuration" to continue with EtherCAT settings.



 "Network Configuration Editor" window will pop up after double-click. Find the target slave devices from "Product List Editor" on the right.



■ Choose "Servo Device" → "ASD-A2" → "ASD-A2-E" from the product list. Then, the device will be automatically added to "Network Configuration Editor" after a double-click

A Network Configuration Editor X	
CRUSPE AX-STREAMANT Device	80 C+ Search Toolbox Product List P Controller ASD-A2 ASD-A2-E ASD-A2-E ASD-A2-E ASD-A2-E ASD-A2-E ASD-A2-E ASD-A2-E ASD-A2-E ASD-A2-E ASD-A2-E
EtherCAT_1	► II ASD-B3 ► E Drive & Active Front End

Click and hold the left mouse button on the yellow box of slave device and drag it towards the EtherCAT main line to complete the configuration of master-slave connection.



Double-click on the yellow box of master device to continue on parameter settings for EtherCAT master device.



EtherCAT distributed clock can be configured within master device settings.

General	Autoconfig Master/Slaves	EtherCAT
Sync Unit Assignment	EtherCAT NIC Setting	
Log	Destination address (MAC) FF-FF-FF-FF-FF	-FF Broadcast Enable redundancy
EtherCAT I/O Mapping	Source address (MAC) 00-00-00-00	Browse
EtherCAT IEC Objects	Network Name O Select network by MAC	ct network by name
Status	Jistributed Clock	D Options
Information	Cycle time 2000 🖨 µs 🖛	
	Sync offset 50 🔦 %	
	Sync window monitoring	
	Sync window 1 🌲 µs	



Double-click on the slave device to continue on EtherCAT slave device settings.

Tabs relating to slave device configuration will be displayed after double-clicking, such as Station address setting, "Process Data" and "Startup Parameters".

General	Address	-		Additional		EtherCAT.
Process Data	AutoIncaddress EtherCAT address	0	+	Enable     Option	expert settings al	Luicienti
Startup Parameters	Distributed Clock					
EtherCAT I/O Mapping	Select DC	DC-Synchr	onous		~	
EtherCAT IEC Objects	🕑 Enable	4000	Sync ut	nit cycle (µs)		
Status	Sync0:					
Information	Sync unit cycle	× 1		4000 🗘	Cycle time (µs)	
	User-defined			0 ‡	Shift time (µs)	
	Sync1:					
	Enable Sync 1					
	<ul> <li>Sync unit cycle</li> </ul>	¥ 1		4000 🗘	Cycle time (µs)	
	O User-defined			0 🔹	Shift time (µs)	

Afterwards, you can start writing programs with motion function blocks in POUs, which should be placed under "EtherCAT+Task", to ensure normal operation of function blocks.



## 7.3 Commissioning

## 7.3.1 Procedure for Commissioning

The chart below shows the steps to build a commissioning process:



## 7.3.2 Example of Axis Parameter Settings

Before using software to perform commissioning, axis parameters must be set first. The figure below illustrates the setting method.



• Axis configuration screen

Axis Type and Li	mits	Motion Parameter			
Virtual mode		Error Reaction			
O Linear Axis     Rotary Axis	Linear Axis Software Limits  Activated	Quick Stop	Deceleration [u/s <sup>2</sup> ]: 100	A V	
(2	Negative [u]: -10000	Velocity Ramp Type			
	Positive [u]: 10000	Trapezoid O	Sin <sup>2</sup> O Quadratic O Quad	ratic(smooth)	
	Rotary Axis Modulo Setting	Position Lag Supervi	sion	S 10 17 14	
	Modulo value [u]: 360	Position Lag Reaction	n Deactivated 🗸	Lag Limit [u]: 1	A V
Mechanism Type	Ball Screw v	<ul> <li>Mechanism Setting</li> <li>(1) Command pulse</li> <li>(4) Pitch: 1</li> </ul>	per motor rotation: 10000	🛔 [ Pulse ]	
+		Gear Box			
V	(3)	Gear Ratio =	(2) Gear ratio numerator	1	
		Gear Ratio =	(3) Gear ratio denominator	1	

#### • Parameters setting

Name	Setting
Axis Type①	Linear Axis
Command pulse per motor rotation 3	10,000
Pitch <sup>③</sup> [Unit]	1*1
Gear ratio denominator	128*2
Gear ratio numerator	1*2
Software limit_Posotive@	10,000
Software limit_Negative@	-10,000

#### \*Note:

- 1. In case of the Unit [mm], the input parameter should be 0.001 for moving 1um.
- 2. It's a must to set P1-44 and P1-45 of the servo drive.

#### 7.3.3 Perform Axes Commissioning

• Select "EtherCAT\_Master\_SoftMotion" and double-click on it.



Left click on the "Online Config Mode" icon.



After entering online commissioning, double-click on "SM\_Drive\_ETC\_Delta\_ASDA\_A2"



• Open "Commissioning" tab after entering the setting screen of axis parameters.

Devices 👻 🕈	X Me SM_Drive_ETC_Delta_AS	DA_A2 X	
Chelded J     Device (AX-30EEA0MAIT)     de Tardware Configuration     A tetwork Configuration     A tetwork Configuration     A tetwork Configuration     A tetwork Configuration     Device (Logic     Devi	General Setting Homing Setting Commissioning SM Once, EFC Deta, ASDA, A2: IEC Objects Status	Axis Type and Limits Urtual mode Concerned and Stream Limits Activated Negative [u]: 0 Positive [u]: 1000 Rotary Axis Modulo Setting Modulo value [u]: 350	Motion Parameter Error Reaction Quick Stop Deceleration [u/s <sup>2</sup> ]; 100 Velocity Ramp Type Postion Lag Supervision Postion Lag Supervision Postion Lag Reaction Deactivated  Lag Limit [u]; 1
Image: Barrier and State and Sta	2)	Transmission Mechanism Mechanism Type Ball Screw	Mechanism Setting (1) Command public per motor rotations: 131072 (2) [Pulse] (4) Pitch: 1 (2) [Unit ] Gear Box Gear Ratio = (2) Gear ratio numerator 1 (2) (3) Gear ratio denominator 1 (2)

Introduction of commissioning screen

Online		(	2	
variable	set value	actual value	Status:	SMC_AXIS_STATE.power_off
Position [u]	0.00	0.00	Communicatio	on operational (100)
Velocity [u/s]	0.00	0.00	Errors	
Acceleration [u/s <sup>2</sup> ]		0.00	Axis Error:	
Torque [Nm]	0.00	0.00	0 [16#00000	[000]
			FB Error:	
			SMC_ERROR	.SMC_NO_ERROR
			uiDriveInterf	aceError:
			0	
			strDriveInter	faceError:
CO Power	0	Reset		Start
Inch				Read&Write
	Distance:	1		Parameter:
-	Velocity:	1		Value:
(<)	Acceleration:	10		Prepared Value:
	Deceleration:	10		
	Jerk:	0		

① Information of axis commands

Name	Function
Position[u]	Command position and actual position
Velocity[u/s]	Command value and actual value of velocity
Acceleration[u/s <sup>2</sup> ]	Command value and actual value of acceleration
Torque[Nm]	Command value and actual value of torque

© Axis status and communication status					
Name	Function				
Status	Axis status				
Communication	Communication status				

- 3 Axis power: Set power ON/ OFF.
- Error reset: Clear error messages of servo axis.
- S Homing: Make the axis back to the start position.
- Inch

Name	Function
Distance	Moving distance
Velocity	Moving velocity
Acceleration	Acceleration rate
Deceleration	Deceleration rate
Jerk	Command value of jerk

- Read&Write: Read-write parameters of upper axes. If need be, you can read and modify Object Dictionary by inputting as follows.
  - Read and write the parameter 0x6098 in object dictionary



1 = fixed number

6098 =the parameter to be read and written

00 = sub of the parameter

- 1. Convert 0x1609800 to demical number as 23,107,584
- 2. Change 23,107,584 to -23,107,584
- 3. Enter -23,107,584 in the "Parameter" field to read the parameter "0x6098".

## 7.4 Motion Control Device

## 7.4.1 Overview

Motion control devices are mainly used for configuring parameters for motion axis. In most applications, you can set up axis parameters in DIADesigner-AX software, a convenient environment for you, where axis parameters required for configuring motion control on axis are defined as Structure. A Structure is a data type applicable to group the data elements together.

## 7.4.2 Introduction to Axis

The axis is used to perform motion control in the system and includes real servo drives, encoders and virtual servo drives. The following table shows the axis types:

Туре	Description
Positioning axis <sup>*1</sup>	Achieve basic positioning control via EtherCAT, such as functions of absolute positioning, relative positioning, and etc.
Velocity axis <sup>*1</sup>	Achieve velocity control and torque control. (as seen in CIA 402 Velocity Mode)
Synchronous axis*2	Achieve servo motor control and basic positioning control via EtherCAT, as well as synchronous motion control like electronic cam function.
Pulse-type axis	Achieve real servo motor control with pulses.
Virtual axis	Execute motion control commands without using real servo motor.
Encoder axis	Use real encoder (SSI or incremental encoder) as feedback signals.
Virtual encoder axis	Can only be used in the program without encoders.

\*Note 1:

- Positioning and velocity axes must match the function library of DL\_MotionControlLight.
- When AX-364EL uses Ethercat with the number of axes exceeding 64 and the Soft Motion version is below V4.7.0.0, the parameters of MAX\_MAILBOX\_CHANNELS and MAX\_SDO\_Channels in the Library (IODrvEtherCat → ETC\_Parameter) must be changed to 128.

\*Note 2: Synchronous axes must match DL\_MotionControl and the function library of SM3\_Basic.

#### 7.4.2.1 About Axis Parameters

After creating a servo axis, the corresponding axis parameters will be generated as well. The following table details the relating description.

• Synchronous Axis

General Setting	1 Axis Type and Lin	nits		4	Motion Parameter				
oming Setting	Virtual mode	2		4	Error Reaction				
	Linear Axis     Rotary Axis	Linear Axis Soft	ware Limits		Quick Stop	eceleration [u/s <sup>2</sup> ]: 100	A Y		
commissioning	O Rotary Pais	Negative [u]:	)	6	Velocity Ramp Type				
M_Drive_ETC_Delta_ASDA_A2: EC Objects			1000			in² 🔿 Quadratic 🔿 Quad	fratic(smooth)		
	3	Rotary Axis Mod		6					
atus		Modulo value [u			Position Lag Supervis Position Lag Reaction		Lag Limit [u]:	1	1
formation	8				Position Lag Reaction	Disable Drive	Lag Linni (u).	1	-
	Transmission Me	chanism							
	Mechanism Typ	e Ball Screw	¥		Mechanism Setting		101		
			(4)			per motor rotation: 131072	🕈 [ Pulse	e]	
		(2)			(4) Pitch: 1	🗣 [ Unit ]			
		10		ZO					
	<b>4</b> 1			r .	Gear Box				
	V		2)			(2) Gear ratio numerator	1	*	
	V		3)		Gear Ratio =			*	
	V		3)			(2) Gear ratio numerator (3) Gear ratio denominator	1	•	
	J		3)						
	J		3)						
		Positive Com	3) mand Negal	ive Comr	Gear Ratio =				
	0	Positive Com	a) mand Negal	ive Comr	Gear Ratio =				
	0	Positive Com	and Negal	ive Comr	Gear Ratio =				
	<ul> <li>Reverse OFF</li> </ul>	Positive Com	mand Negat	ive Comr	Gear Ratio =				
	<ul> <li>Reverse OFF</li> </ul>	G	a) mand Negat	G	Gear Ratio =				
	<ul> <li>Reverse OFF</li> </ul>	Positive Com	a) mand Negat	ive Comr	Gear Ratio =				
	<ul> <li>Reverse OFF</li> </ul>	G	a) mand Negat	G	Gear Ratio =				
		G	a) mand Negal	G	Gear Ratio =				
	<ul> <li>Reverse OFF</li> <li>Reverse On</li> </ul>	G	a) mand Negal	G	Gear Ratio =				

#### ① Axis Type and Limits

Name	Function
Virtual	Activate virtual axes.
Linear Axis / Rotary Axis	Set to be linear axis or rotary axis.

#### 2 Linear Axis Software Limits

Name	Function
Activated	Activate software limits (only supports Linear axis)
Negative[u]	Reverse software limit.
Positive[u]	Forward software limit.

#### ③ Rotary Axis Modulo Setting

Name	Function
Modulo Value[u]	Set the area of rotation for a turn. (only supports rotary axes)

#### ④ Error Reaction

Name	Function
Quick Stop	Emergency stop for axes
Deceleration[u/s2]	Deceleration stop for axes (effective when Quick Stop is inactive)

#### S Velocity Ramp Type

Name	Function
Trapezoid/Sin2/Quadratic/ Quadratic(Smooth)	Motion curves setting for axes

#### Position Lag Supervision

Name	Function	
Positon Lag Reaction	Set the reaction for position lag.	
Lag Limit [u]	Set the value of lag limit.	

#### ⑦ Positive / Negative Command

Name	Function
Reverse OFF / ON	Enable or disable reverse function for positive/negative command setting.

#### ⑧ Transmission Mechanism

Servo Gear Ratio Setting

Name Function		
Unit Numerator	Numerator factor of the electronic gear unit	
Unit Denominator	Denominator factor of the electronic gear unit	

#### Descriptions of different machanism types are as follows:

l)	Ball Screw	*	(1) Command pu (4) Pitch: 1	ng ulse per motor rotation: 1 [ Unit ]	ŧ	] [ Pulse ]
	- C()		Gear Box			
v	(3)			(2) Gear ratio numerator	1	4
			Gear Ratio =	(3) Gear ratio denominator	1	4

## AX-3 Series Operation Manual

Name	Function
(1) Command Pulse per motor rotation	The command pulse value for per motor rotation
(4) Pitch	The distance between screw threads
(2) Gear ratio numerator	Numerator of gear ratio
(3) Gear ratio denominator	Denominator of gear ratio

#### Round Table

Mechanism Type Round	Table (4	0	ulse per motor rotation: 1 istance per motor rotation: 1	♥ [Pulse]
		Gear Box	(2) Gear ratio numerator	1
V	(3)	Gear Ratio =	(3) Gear ratio denominator	1

Name	Function
(1) Command Pulse per motor rotation	The command pulse value for per motor rotation
(4) Movement distance per motor rotation	Movement distance for one full motor retation
(2) Gear ratio numerator	Numerator of gear ratio
(3) Gear ratio denominator	Denominator of gear ratio

## Belt Pully

Mechanism Type Belt Pully		¥	Mechanism Settin (1) Command pu	ulse per motor rota	ation: 1	*	[ Pulse ]
		(4)	(4) Diameter: 1 Movement distan	nce per motor rota	[ Unit ] ition: Diamete	r*n	
		Gear Box					
	(3)		Cons Ballio	(2) Gear ratio n	umerator	1	÷
			Gear Ratio =	(3) Gear ratio d	enominator	1	4

Name	Function
(1) Command Pulse per motor rotation	The command pulse value for per motor rotation
<ul> <li>(4) Diameter*</li> <li>(Movement distance per motor rotation: Diameter X π)</li> </ul>	Diameter (Movement distance per motor rotation: Diameter X $\boldsymbol{\pi}$ )
(2) Gear ratio numerator	Numerator of gear ratio
(3) Gear ratio denominator	Denominator of gear ratio

Note:

For DIADesigner-AX V1.3 or previous versions, the measured disameter should multiply  $\pi$ . For DIADesigner-AX V1.4 or later versions, the result of diameter is already multiplied  $\pi$  automatically.

#### 9 Homing Setting

General Setting	Homing Mode 35 *
Commissioning	Homing speed during search for switch 100
Homing Setting	Homing speed during search for z phase pulse 20 🛊 [ 0.1 rpm ] Homing Acceleration 100 🌲 [ ms ]
SM_Drive_ETC_Delta_ASDA_A2: IEC Objects	Description
Status	Mode 35 : Depending on the current position
Information	In mode 35, The homing instruction is executed, the axis does not move and its current position is regarded as the home position.

Name	Function
Homing Mode	Configure homing mode setting.
Homing Speed during search for switch	Set the homing speed during search for switch.
Homing Speed during search for z phase pulse	Set the homing speed during search for Z phase pulse.
Homing Acceleration	Set the homing acceleration rate.

#### • Positioning Axis

eneral Setting	Axis Type and Limits	Motion Parameter
oming Setting ML_Drive_ETC_Delta_ASDA_A2: arameters ML_Drive_ETC_Delta_ASDA_A2: iC Objects	Linear Axis     Rotary Axis     Rotary Axis     Activated     Negative [u]:     1000     100	(4) Velocity Ramp Type Trapezoid v
tatus		
formation	6 Transmission Mechanism Mechanism Type Ball Screw ~ (1)	Mechanism Setting (1) Command pulse per motor rotation: 1280000 [Pulse] (4) Pitch: 10000 [ Unit ]
		Gear Box Gear Ratio = (2) Gear ratio numerator 1 *
		Gear Ratio = (3) Gear ratio denominator 1 *
	Servo Gear Ratio Setting	Gear Raud = (3) Gear ratio denominator 1
		e Command
	Positive Command Negative     Reverse OFF     Reverse OFF	(3) Gear ratio denominator

#### ① Axis Type and Limits

7

Name	Function
Linear Axis / Rotary Axis	Set to be linear axis or rotary axis.

#### ② Linear Axis Software Limits

Name	Function
Activated	Activate software limits (only supports Linear axis)
Negative[u]	Reverse software limit.
Positive[u]	Forward software limit.

## 3 Rotary Axis Modulo Setting

Name	Function
Modulo Value[u]	Set the area of rotation for a turn. (only supports rotary axes)

④ Velocity Ramp Type

Name	Function
Trapezoid/Sin2	Motion curves setting for axes

#### S Positive / Negative Command

Name	Function
Reverse OFF / On	Enable or disable reverse function for positive/negative command setting.

#### © Transmission Mechanism

	-	-		
•	Servo	Gear	Ratio	Setting

Name	Function
Unit Numerator	Numerator factor of the electronic gear unit
Unit Denominator	Denominator factor of the electronic gear unit

#### Descriptions of different machanism types are as follows:

(1) (2) (4) (4) (4) (4) (4) (4) (4) (4) (4) (4	*	Mechanism Setting (1) Command pulse per motor rotation: 1 (4) Pitch: 1 (4) Pitch: 1 (5)		
	Gear Box Gear Ratio =	(2) Gear ratio numerator	1	<b>(</b>
	Name	(3) Gear ratio denominator	1	Functio

Name	Function	
(4) Command Pulse per motor rotation	The command pulse value for per motor rotation	
(4) Pitch	The distance between screw threads	
(5) Gear ratio numerator	Numerator of gear ratio	
(6) Gear ratio denominator	Denominator of gear ratio	

#### Round Table

Mechanism Type	Round Table	~	Mechanism Setting (1) Command pulse per motor rotation: 1 I Pulse		Pulse ]	
	°C		(4) Movement d	istance per motor rotation: 1		[ Unit ]
•			Gedi box			1.1
		-	Gear Ratio =	(2) Gear ratio numerator	1	-
	(Th)					

Name	Function
(1) Command Pulse per motor rotation	The command pulse value for per motor rotation
(4) Movement distance per motor rotation	Movement distance for one full motor retation
(5) Gear ratio numerator	Numerator of gear ratio
(6) Gear ratio denominator	Denominator of gear ratio

#### Belt Pully

lechanism Type	Belt Pully	*	Mechanism Setti (1) Command p	ng ulse per motor rotation: 1		[ Pulse ]
		(4)	(4) Diameter: 1 Movement dista	[ Unit ] nce per motor rotation: Diamete	er*n	
	<b>~ ()</b>		Gear Box			
	(3)		Gear Box Gear Ratio =	(2) Gear ratio numerator	1	

Name	Function
(4) Command Pulse per motor rotation	The command pulse value for per motor rotation
<ul><li>(4) Diameter</li><li>(Movement distance motor rotation : Diameter X π)</li></ul>	Diameter (Movement distance per motor rotation: Diameter X $\boldsymbol{\pi})$
(5) Gear ratio numerator	Numerator of gear ratio
(6) Gear ratio denominator	Denominator of gear ratio

#### Note:

For DIADesigner-AX V1.3 or previous versions, the measured disameter should multiply  $\boldsymbol{\pi}.$ 

For DIADesigner-AX V1.4 or later versions, the result of diameter is already multiplied  $\pi$  automatically.

## ⑦ Homing Setting

General Setting	Homing Mode 35 °
Homing Setting	Homing speed during search for switch 100
DML_Drive_ETC_Delta_ASDA_A2: Parameters	Homing speed during search for z phase pulse 20 🛊 [ 0.1 rpm ] Homing Acceleration 100 🛊 [ ms ]
DML_Drive_ETC_Delta_ASDA_A2: IEC Objects	Description
Status	Mode 35 : Depending on the current position
Information	In mode 35, The homing instruction is executed, the axis does not move and its current position is regarded as
	the home position.

Name	Function
Homing Mode	Configure homing mode setting.
Homing Speed during search for switch	Set the homing speed during search for switch.
Homing Speed during search for z phase pulse	Set the homing speed during search for Z phase pulse.
Homing Acceleration	Set the homing acceleration rate.

#### 7.4.2.2 Axis Application in Program

After a servo axis is newly added in the project, the name of servo axis will be generated automatically (you are allowed to change the name) and input to the function block.

• Synchronous Axis



#### Positioning Axis


# 7.4.3 Procedure for Single-axis Configuration

The procedure for axis settings is shown as follows. For more details of creating new projects, please find section 7.2.



Configure EtherCAT settings after opening the project. First, click "Network Configuration".



Click "Delta ASDA-A2-E EtherCAT(CoE) Drive Rev4\_SM" \*1 after entering Network Configuration page and connect to the line above.



Note 1: \*1 Delta ASDA-A2-E EtherCAT(CoE) Drive Rev4\_SM is a synchronous axis. If a positioning axis is what you need, select Delta ASDA-A2-E EtherCAT(CoE) Drive Rev4\_DML instead. After that, the operational procedures are the same for the synchronous axis and positioning axis.

Double-click on the slave device after finishing the connection.

Å Network	onfiguration Editor 🗙			
a 🖻 🕼			100 0	++++
			EtherCAT	
			ModbusTCP/EtherNetIP Modbus	
	0	evice	CANOpen	
	Device			
	Device	# 🍳 👖		
		0 1		
	1	1 1 0		
EtherCAT	1			
			$\gamma=\gamma+\gamma=\gamma+\gamma=\gamma$	
		*******		
	Delta ASDA-A2-E	5.7 m		
	Delta ASDA-A2-E EtherCAT(CoE) Drive Rev4_SM	-		
	Delta ASDA-A2-E	N P		
	EtherCAT (CoE) Drive			
		And a second		
		22		
		SDADING		
	1	St.		

Switch to "Procesas Data" page to configure mapping groups of PDO. The default setting for ASDA-A2 is second group, which can operate normally with most function blocks. If additional groups or parameters of PDO need to be selected and added, please refer to content concerning fuction blocks description in AX Series Motion Controller Manual.

Select the Outputs			Select the Inputs		
Name	Туре	Index	Name	Type	Index
Control Word	UINT	16#6040:00	Status Word	UINT	15#5041:00
					16#6054:00
					16#6060:00
					16#6077:00
	51/01	16#6080;00		2th/1	16#6051:00
	UINT	15#6040-00		UNT	16#6041:00
					16#6064:00
	0.11				
Control Word	UINT	16=6040100	Status Word	UINT	16#6041:00
TargetVelocity	DINT	16#60FF:00	ActualPosition	DINT	16=6064:00
16#1603 4th RxPDO Happing (exclu			Velocity actual value	DINT	16#6060:00
Control Word	LINT	16=6040.00	16#1A03 4th TxPDO Happing (e		
TergetTorque	THE	16=6071100	Status Word	UINT	16#6041:00
			ActualPosition	DINT	16#6064:00
			ActualTorque	INT	16#6077:00
	Name I Ga 1600 1st RxPDO Mapping (excla Control Word TargetPosition TargetPosition TargetPosition TargetTorique ModeOfOperation I Ga 1601 2nd RxPDO Mapping Control Word TargetPosition I Ga 1602 3rd RXPDO Mapping (exclu Control Word TargetVelocity I Ga 1603 4th RxPDO Mapping (exclu Control Word	Name         Type           16#16001st RxPDO Happing (exclustion)         UINT           Control Word         UINT           TargetPosition         DINT           TargetVelocity         DINT           TargetVelocity         DINT           TargetTorique         INT           ModeDfOperation         SINT           V         16#16012nd RxPDO Mapping           Control Word         UINT           TargetPosition         DINT           10#1002.3rd RXPDO Mapping (exclust Control Word         UINT           Control Word         UINT           TargetPosition         DINT           16#1603.4th RxPDO Mapping (exclust Control Word         UINT           Control Word         UINT           16#1603.4th RxPDO Mapping (exclust Control Word         UINT	Name         Type         Index           16#1600 1st RxPDO Mapping (excla	Name         Type         Index           16#1600 1st RxPD0 Mapping (exclu         16#1600 1st RxPD0 Mapping (exclu         16#1600 1st TxPD0 Mapping (e           Control Word         UINT         16#6076:00         ActualPosition           TargetPosition         DINT         16#6071:00         ActualPosition           TargetPosition         DINT         16#6071:00         ActualPosition           TargetPosition         DINT         16#6070:00         ActualPosition           TargetPosition         SINT         16#6040:00         ActualPosition           ModeOfOperation         SINT         16#6040:00         ModeOfOperationDisplay           V         16#1601 2nd RxPDO Mapping         Status Word         ActualPosition           Control Word         UINT         16#6040:00         Status Word           TargetPosition         DINT         16#6040:00         Status Word           Control Word         UINT         16#6040:00         Status Word           TargetVelocity         DINT         15#60F1:00         ActualPosition           Control Word         UINT         16#6040:00         Status Word           TargetVelocity         DINT         15#60F1:00         ActualPosition           Control Word         UINT	Name         Type         Index           16#1600 1st RXPD0 Mapping (exclu         16#1600 1st RXPD0 Mapping (exclu         16#1600 1st RXPD0 Mapping (e           Control Word         UINT         16#6078:00         ActualPosition         DINT           TargetPosition         DINT         16#6078:00         ActualPosition         DINT           TargetVelocity         DINT         16#6078:00         ActualPosition         DINT           TargetVelocity         DINT         16#6070:00         ActualPosition         DINT           ModeOfOperation         SINT         16#6040:00         ModeOfOperationDisplay         SINT           V 16#1601 2nd RXPDO Happing         Control Word         UINT         16#6040:00         Status Word         UINT           Control Word         UINT         16#6040:00         Status Word         UINT         ActualPosition         DINT           Control Word         UINT         16#6040:00         Status Word         UINT         ActualPosition         DINT           Control Word         UINT         16#6040:00         Status Word         UINT         NotualPosition         DINT           Control Word         UINT         16#6040:00         Status Word         UINT         NotualPosition         DINT

#### Initialize EtherCAT communication

After initialization is completed, you need to input fixed values for the required Object Dictionary which can be configured on "Startup Parameters" page.

General	Add	Edit X Delete	🕆 Move Up 🐥 Move Dow	n					
Process Data	Line	Index:Subindex	Name	Value	Bitlength	Abort if error	Jump to line if error	Next line	Comment
	- 1	16#6060:16#00	Op mode	8	8			0	Op mode
Startup Parameters	- 2	16#60C2:16#01	Interpolation time period	4	8			0	Interpolation time p
	- 3	16#60C2:16#02	Interpolation time index	-3	8			0	Interpolation time in
therCAT I/O Mapping									
therCAT IEC Objects									
Ratus									
Information									

■ After finishing the settings of axis communication, double-click on "SM\_Drive\_ETC\_Delta\_ASDA\_A2".



Axis settings page

Options of axis type: "Rotary Axis" and "Linear Axis"

eneral Setting	Axis Type and Limits	Motion Parameter Error Reaction
loming Setting	Linear Axis Software Limits     Rotary Axis     Activated	Quick Stop Deceleration [u/s <sup>2</sup> ]: 100
ommissioning	Negative [u]: 0	Velocity Ramp Type  Trapezoid Sin <sup>2</sup> Quadratic Quadratic(smooth)
M_Drive_ETC_Delta_ASDA_A2: EC Objects	Positive [u]: 1000	
tatus	Modulo value [u]: 360	Position Lag Supervision Position Lag Reaction Deactivated Lag Limit [u]:
formation	Transmission Mechanism	2
	Mechanism Type Ball Screw ~	Mechanism Setting (1) Command pulse per motor rotation: 131072
		(4) Pitch: 1 🗣 [ Unit ]
	1 60	Gear Box
		Gear Ratio =
		(3) Gear ratio denominator 1

Setup Software Limits for linear axis. Click Activated to start software limit that contains negative limits ("Negative") and positive limits ("Positive").

General Setting	Axis Type and Limits	Motion Parameter
Homing Setting	Virtual mode     Unear Axis     Linear Axis Software Limits     Rotary Axis     Virtual Mode	Error Reaction Quick Stop Deceleration [u/s <sup>2</sup> ]: 1000
Commissioning SM_Drive_ETC_Delta_ASDA_A2:	Negative [u]:         0         ♦           Positive [u]:         10000         ♦	Velocity Ramp Type Trapezoid Sin <sup>2</sup> Quadratic Quadratic(smooth)
IEC Objects Status	Rotary Axis Modulo Setting Modulo value [u]: 360	Position Lag Supervision Position Lag Reaction Stay Enabled V Lag Limit [u]: 100

The rotation range must be defined after finishing rotary axis settings. Please setup "Modulo value" IN "Modulo settings".

n) [u]

#### Scaling/ Mapping page

Set the pulse value for "Command pulse per motor rotation". Set the movement distance within one full motor retation for "Pitch".

General Setting	Axis Type and Limits	Motion Parameter Error Reaction
Homing Setting	Linear Axis     Linear Axis Software Limits     Rotary Axis     Activated	Quick Stop Deceleration [u/s <sup>2</sup> ]: 100
Commissioning	Negative [u]: 0	Velocity Ramp Type Trapezoid Sin <sup>2</sup> Quadratic Quadratic(smooth)
SM_Drive_ETC_Delta_ASDA_A2: EC Objects	Positive [u]: 1000	
Itatus	Modulo value [u]: 360	Position Lag Supervision           Position Lag Reaction         Deactivated
nformation	Transmission Mechanism	Mechanism Setting
	Mechanism Type Ball Screw ~ (4)	(1) Command pulse per motor rotation: 131072
		(4) Pitch: 1 [ Unit ]
	1	Gear Box
		Gear Ratio = (2) Gear ratio numerator
	1	Gear Box

To configure the communication cycle time of Ethernet, click "EtherCAT\_Master\_SoftMotion", then set the value of "Cycle time" as 2000 and "Sync offset" as 50.



#### Scan PLC controller

evices	* # X	ASDA_A2_E_COE_Drive	M SM_Drive_ETC_Delta_ASDA	A2 EtherCAT	Master_SoftMotion	PLC_PRG	Device x	
United1     Device (CODESYS SoftMotion	on Win V3w64)	Communication Settings	Scan network Gateway -	Device +				
= S MainTask ( ∰ PLC_P = ∭ EtherCAT_Master_Soft = ∭ ASDA_A2_E_CoE_J	) tion Task (IEC-Tasks) IEC-Tasks) RG Motion (EtherCAT Master Soft Drive (Deita ASDA-A24 EtherC C. Deita_ASDA_A2 (SM_Drive,	Applications Backup and Restore Files Log PLC Settings PLC Shell Users and Groups Access Rights Symbol Rights Task Deployment Status Information		Gateway Gateway PAddreas: localhost 1227	• • •	NVT1380436 (active perior Name: VTT1380436 (active VTT1380436 ) revice Address: 0003.0690.4000 0004 arget Type: 102 grapt Vendor: S - Smart Software Arget Venion: S, S13.10	ve) 🤟	
Devices Devices	>							

Add the newly scanned PLC controller and click "OK".

	ASDA_AZ_E_COE_Drive M/ SM_Drive_ETC_Delta_ASDA_A	12 EtherCAT_Master_SoftMotion	*
Consend      Consend      Application     Application     Proceeding     Pr	A2-E Ether(	Device Name: TVTV:340468 Device Address: Dool.0650.4001 Biock drives: LP Encrysted Communication: TJ: Supported Communication: TJ: Supported Communication: Commun	

- Ble Edt View Broject Build Online Debug Tools Window Help \* 10 m m m 2 1 m 1 m 1 m 1 m • 4 × ASDA\_A2\_E\_CoE\_Drive Drive\_ETC\_Delta\_ASDA\_A2 PLC\_PRG Device: 1 Communication Settings Gateway . Device . Applications -. ..... Backup and Restore ----\*\* . Files Gateway Log PLC Settings IP-Addres Device Name: TWTY3NB0436 PLC Shell Port: 1217 Device Address: 0003.0690.A001 Users and Groups Target ID: 0000 0004 Access Rights Target Type: 4102 Symbol Rights Target Vendor: 35 - Smart Software Solutions GmbH Task Deploy Target Version: 3.5.13.10 Status Information 4 S Devices Devices Last build: 🥥 0 🕐 0 Precomple: 🗸 🖓 0 Project user: (nobody)
- A green light icon will be shown if the connection is successful, then click "Login".

A prompt box will pop out to remind you if you want to perform a download, click "Yes" to continue.

Devices	• # X 🖉	🗃 ASDA_AZ_E_COE_Drive 🔹 SM_Drive_ETC_Delta_ASDA_A2 📑 EtherCAT_Master_SoftMotion 📵 PLC_PRG 📑 Device 🗙	
=	o r Task (EC-Tasks) IEC-Tasks) IEC-Tasks) RG offMotion (Effert CAT Master S E,Drive (Delta ASDA A.22 EM ETC / Delta ASDA A.22 (SM_Dr) Axos Pool	Communication Settings     Sam network	

# 7.4.4 Axis Group Settings

Axis group movement will be functioned when executes linear interpolation and circular interpolation with multiple axes. DIADesigner-AX is required for grouping axes.

Movimum controll o	Linear interpolation	6 axes	
Maximum controll a	Circular interpolation	6 axes (3 follower axes)	

# 7.4.4.1 Prameters for Axis Group

The parameters used for axis group movement are as follows.



Name	Function
Axis X <sup>*1</sup>	X axis in axis group
Axis Y <sup>*1</sup>	Y axis in axis group
Axis Z <sup>*1</sup>	Z axis in axis group
Axis A <sup>*1</sup>	A axis in axis group
Axis B <sup>*1</sup>	B axis in axis group
Axis C <sup>*1</sup>	C axis in axis group

## ① Kinematic

#### **2** Motion Parameter

Name	Function
Ramp Type*2	Velocity ramp type
Max Velocity Limit*3	The max velocity of axis group
Max Acceleration Limit*3	The max acceleration of axis group
Max Deceleration Limit*3	The max deceleration of axis group
Max Jerk Limit(Reserved)*3	The max jerk rate of axis group (Reserved)

## ③ Tasks

Name	Function
Bus Task	Configure the updating task for axis groups.

#### Note 1: Axis X ~ Axis C: Enter the names of axes individually.



#### Note 2: There are two Ramp Type: Trapezoid and S-curve type, which are shown in the following figures.

#### Trapezoid



S Curve



Note 3:

- Max Velocity Limit : An error occurs when the velocity exceeds the setting value.
- Max Acceleration Limit : An error occurs when the acceleration exceeds the setting value.
- Max Deceleration Limit : An error occurs when the deceleration exceeds the setting value.

## 7.4.4.2 Using Axis Groups in Program

To follow the procedure, you must add the node of axis group to the project tree and names the required axis in the group individually before using the AxisGroup function block. After finishes the settings, please connect the node of axis group to AxisGroup input of each function block.



# 7.4.5 Procedure for Axis Group Configuration

To use the axis group movement function, you must name the axis group and set the corresponding individual axes with DIADesigner-AX. The process flowchart of creating axis groups is shown below.



#### Procedure of creating axis groups in program

(1) Add single axes. The following example starts from creating two virtual axes.



7-39



(2) After finish creating axes, select "Application" and right click "Add Object" → "Delta Axis Group"

(3) Set the name for axis group on the "Add Delta Axis Group" page, then click "Add"



- Devices φ x = 🗿 AxisGroup Device (AX-308EA0MA1T) Bardware Configuration A Network Configuration & EtherCAT Filter PLC Logic ÷. O Application DeltaAxisGroup Library Manager PLC\_PRG (PRG) Task Configuration EtherCAT\_Task PLC\_PRG MainTask BuiltIn\_IO (BuiltIn\_IO) Delta\_LocalBus\_Master (Delta LocalBus Master) AX\_308\_Series\_EtherCAT\_Master\_SoftMotion (AX-308 SoftMotion General Axis Pool SM\_Drive\_Virtual (SM\_Drive\_Virtual) SM\_Drive\_Virtual\_1 (SM\_Drive\_Virtual)
- (4) Afterwards, "DMC\_Axis\_Group" will be shown on the Project tree.

(5) Click "DeltaAxisGroup", then enter the names of two virtual axes into the fields of "Axis X" and "Axis Y".



(6) Click "Bus Task" to enter "Input Assistant", then choose "EtherCAT\_Task" on the screen and click "OK" with "EtherCAT\_Task" shown in the Tasks field afterwards.

		100 State (100 State)			
Axis Zi Please Enter an Axis	Mapping	Input Assistant			
kes X		Fext Search Categories	1 Marca	14	Address
Round Ans Protowing Ratio Ans At Please Enter an Aug Ans Bt Please Enter an Aug	Mapping		Nome EtherCAT_Task HoleTask	Type	Address
Are C Please Enter an Are	(Mapping a)		4		
Following Ratio = Target Position of Following Axis Target Position of Axis Group		Documentation		Sheet with arguments	Emerit with correspondences
stoo Presenter JamoType S Curve - Max Velocit Max Acceler	ation Limit 2000000 🗘 (user unit)/s <sup>2</sup> ration Limit 2000000 🔹 (user unit)/s <sup>2</sup>				
Max Decele Max Jerk La	nit (Reserved) 0 🙀 (user unit)/s <sup>3</sup>				C X
	nt (Reserved) (0 (see unit)/s*				CX
Nav Jerk La	d Tasks				X

(7) Add "DMC\_GroupEnable" function block below PLC\_PRG and connect the name of axis group to the AxisGroup input.



(8) After the program writing is completed, click the Compile button to confirm the validity.



(9) After compilation, click Online Monitoring button to download the program.



# 7.5 Motion Axis Variables

# 7.5.1 Variables for Single Axis

After creating axes in the Project tree with DIADesigner\_AX, the corresponding axis parameters (read-only) will be generated automatically. Axes are categorized into two types: synchronous axis (Axis\_REF\_SM3) and positioning axis (Axis\_REF\_DML), which are set out in the following table

## • Synchronous axis (Axis\_REF\_SM3)

Numbering	Name	Data type	Default value	Description
1000	nAxisState	SMC_AXIS_ STATE(INT)	Standstill (3)	Operating state of the current axis according to MC_ReadStatus
1012	bCommunication	BOOL	FALSE	When communication is normal (refer as True), if disconnected (refer as False)
1014	uiDriveInterfaceError	UINT	0	When Driver Interface detects an error, Error Handling occurs
1021	wDriveld	WORD	Driver	The number in driver nodes on the Field bus
1025	fTaskCycle	LREAL	Driver	EtherCAT cycle time of task
1031	dwErrorID	DWORD	0	Error code of Slave (Add the parameter 0x603F in PDO and use the function block MC_ReadAxisError to read the error code.)
1035	fbeFBError	ARRAY [0g_SMC_ NUMBER_F B_ERRORS ] OF SMC_FBER ROR	0	Axis-related error table
1040	bVirtual	BOOL	FALSE	True: virtual axis ; false: real axis
1051	iRatioTechUnitsNum	DINT	1	Change gear ratio in axis setting (denominator)
1052	dwRatioTechUnits Denom	DWORD	1	Change gear ratio in axis setting (numerator)
1060	iMovementType	INT	1	0 = Modulo 1 = Finite

Numbering	Name	Data type	Default value	Description
1061	fPositionPeriod	LREAL	1000	Max movement distance of rotary axis
1062	eRampType	SMC_RAMP TYPE	Trapez	Velocity ramp type: Trapezoid sin^2 Quadtatic Quadtatic(smooth)
1100/1	fSetPosition	LREAL	0	Commanded position (User-defined unit)
1101	fActPosition	LREAL	0	Feedback position (User-defined unit)
1110,11	fSetVelocity	LREAL	0	Commanded velocity (User-defined unit /s)
1111,10	fActVelocity	LREAL	0	Feedback velocity (User-defined unit /s)
1115	bConstantVelocity	BOOL	FALSE	True: the axis is driving with constant velocity
1120	fSetAcceleration	LREAL	0	Commanded acceleration (Unit: User- defined unit /s^2)
1125	bAccelerating	BOOL	FALSE	True when Axis is accelerating
1135	bDecelerating	BOOL	FALSE	True when Axis is decelerating
1140	fSetJerk	LREAL	0	Commanded jerk value
1160	fSetTorque	LREAL	0	Commanded torque (Nm)
1161	fActTorque	LREAL	0	Actual torque (Nm)
1200,2	fSWLimitPositive	LREAL	0	Setting the range of positive software limit
1201,3	fSWLimitNegative	LREAL	0	Setting the range of positive software limit
1204	bSWEndSwitchActive	BOOL	FALSE	True when software limit switch activated State machine changes to ErrorStop
1205	bSWLimitEnable	BOOL	FALSE	Software limit end switches: True (Enable) /False(Disable)
-	strDriveInterfaceError	STRING	63	Axis error
	1	1		1

Numbering	Name	Data Type	Default value	Descripyion
1000	nAxisState	SML_AXIS_STATE	SML_AS_PowerO ff(0)	Operating state of the current axis according to MC_ReadStatus
1012	bCommuni cation	BOOL	FALSE	When communication is normal (refer as True), if disconnected (refer as False)
1014	uiDriveInter faceError	UINT	0	When Driver Interface detects an error, Error Handling occurs
1051	iRatioTech UnitsNum	DINT	1	Change gear ratio in axis setting (denominator)
1052	dwRatioTec hUnits Denom	DWORD	1	Change gear ratio in axis setting (numerator)
1060	iMovement Type	SML_MovementTy pe	SML_MT_MODUL O	Axis types SML_MT_MODULO = Rotary axis SML_MT_FINITE = Linear axis
1062	eRampTyp e <sup>*1</sup>	SMC_RAMPTYPE	Trapez	Setting Ramp type: Trapezoid sin^2
1101	fActPosition	LREAL	0	Feedback position (User-defined unit)
-	strDriveInte rfaceError	STRING	Ø	Axis error

# • Positioning Axis (Axis\_REF\_DML)

\*Note 1: Only support Trapezoid and sin^2

7

# 7.5.2 Variables for Axis Group

After creating axis groups in project tree with DIADesigner-AX, the corresponding axis variables will be generated automatically, which are set out in the following table.

Name	Data Type	Setting Value (Default Value)	Function
GroupState	DMC_ GROUP_ STATE	GroupDisabled / GroupStandby / GroupMoving / GroupHoming / GroupStopping / GroupErrorstop (GroupDisabled)	Commands for axis group status.
bError	BOOL	TRUE / FALSE (FALSE)	TRUE when an error occurs in the axis group
dwErrorld	DMC_ ERROR	DMC_ERROR (DMC_GM_NO_ ERROR)	Detailed error description
IrVelocity	LREAL	0~1.798E+308 (0)	Current velocity of axis group
IrAcceleration	LREAL	Positive number, negative number or zero (0)	Current acceleration of axis group
IrJerk	LREAL	Positive number, negative number or zero (0)	Current jerk of axis group
bAccelerating	BOOL	TRUE / FALSE (FALSE)	TRUE when accelerating
bDecelerating	BOOL	TRUE / FALSE (FALSE)	TRUE when decelerating
bConstantVelocity	BOOL	TRUE / FALSE (FALSE)	TRUE when moving at a constant velocity (including zero velocity)
bInPosition	BOOL	TRUE / FALSE (FALSE)	TRUE when positioning is done.
bContinueDataWriten	BOOL	TRUE / FALSE (FALSE)	TRUE when axis group is forced to stop and the relevant data can be used by DMC_GroupContinue.
ContinuePos	ARRAY [05] OF LREAL	[0,0,0,0,0,0]	When the execution of DMC_GroupInterrupt is done, the position of the current axis group is recorded.
AxisX_Name*	String		Display the Axis_X name for current axis group
AxisY_Name*	String		Display the Axis_Y name for current axis group
AxisZ_Name*	String		Display the Axis_Z name for current axis group
AxisA_Name*	String		Display the Axis_A name for current axis group
AxisB_Name*	String		Display the Axis_B name for current

Name	Data Type	Setting Value (Default Value)	Function
			axis group
AxisC_Name*1	String		Display the Axis_C name for current axis group
RampType	DMC_GROUP_ RAMP_TYPE	Trapezoid / S Curve (S Curve)	Ramp type of current S-curve
IrMaxVelocityLimit	LREAL	Positive number or zero (1000000)	The maximum velocity of axis group
IrMaxAcceleration Limit	LREAL	Positive number or zero (2000000)	The maximum acceleration of axis group
IrMaxDecelerationLimit	LREAL	Positive number or zero (2000000)	The maximum deceleration of axis group
IrMaxJerkLimit (Reserved)	LREAL	Positive number or zero (0)	The maximum jerk of axis group (Reserved)
			Planning the path:
PlanningPriority <sup>*2</sup>	DMC_GROUP_ PLANNING_PRI ORITY	Velocity / Acceleration (Velocity)	Velocity: Acceleration or deceleration can be ignored in order to meet the condition of velocity. Acceleration: Velocity can be ignored in order to meet the condition of acceleration / deceleration.
bVelocityWarning	BOOL	TRUE / FALSE (FALSE)	When the velocity of axis group exceeds the proportionality, the state is TRUE.
bAccelerationWarning	BOOL	TRUE / FALSE (FALSE)	When the acceleration of axis group exceeds the proportionality, the state is TRUE.
bDecelerationWarning	BOOL	TRUE / FALSE (FALSE)	When the deceleration of axis group exceeds the proportionality, the state is TRUE.
bJerkWarning (Reserved)	BOOL	TRUE / FALSE (FALSE)	When the jerk of axis group exceeds the proportionality, the state is TRUE.
StopMethod	Enum of BYTE	Immediate Stop / MaxGroupDecStop / MaxAxisDecStop (Immediate Stop)	Set the stop method when an error occurs to the axis group or in the middle of motions
IrVelocityWarning Percentage	LREAL	0 ~ 1 (0)	Set the proportionality of the maximum velocity of axis group for the warning to start. Once the set persontage is reached, the warning starts. Set the value to 0 to stop the warning.
IrAccelerationWarning Percentage	LREAL	0 ~ 1 (0)	Set the proportionality of the maximum acceleration of axis group for the warning to start. Once the set persontage is reached, the warning starts. Set the value to 0 to stop the warning.

Name	Data Type	Setting Value (Default Value)	Function
IrDecelerationWarning Percentage	LREAL	0 ~ 1 (0)	Set the proportionality of the maximum deceleration of axis group for the warning to start. Once the set persontage is reached, the warning starts. Set the value to 0 to stop the warning.
IrJerkWarning Percentage (Reserved)	LREAL	0 ~ 1 (0)	Set the proportionality of the maximum jerk of axis group for the warning to start. Once the set persontage is reached, the warning starts. Set the value to 0 to stop the warning.
Radius Correction	LREAL	0 ~ 100 (0, 1)	This is to set the tolerance for setting the radius when circular interpolation is seclected in the function block of DMC_MoveCircularRelative.AuxPoint. Tolerance % = the distance between the center point and the bisection of the starting and ending points to be divided by the radius.
bVelocityWarning	BOOL	TRUE / FALSE (FALSE)	TRUE when the velocity of axis group exceeds the value set in the IrVelocityWarning Percentage.
bAccelerationWarning	BOOL	TRUE / FALSE (FALSE)	TRUE when the acceleration of axis group exceeds the value set in the IrAccelerationWarningPercentage.
bDecelerationWarning	BOOL	TRUE / FALSE (FALSE)	TRUE when the deceleration of axis group exceeds the value set in the IrDecelerationWarningPercentage.
bJerkWarning (Reserved)	BOOL	TRUE / FALSE (FALSE)	TRUE when the jerk of axis group exceeds the value set in the IrDecelerationWarningPercentage.
StopMethod	Enum of BYTE	Immediate Stop / MaxGroupDecStop / MaxAxisDecStop (Immediate Stop)	Set the stop method for the axis group when errors occur or when it is time to stop the movement.

Note:

- 1. When the rotary type of axis is selected, the range of motion can NOT exceed the value set in modulo, otherwise, an error message "Axis limit violated" will occur." appears.
- 2. For the DL\_MotionControl library of V1.3.3.0 or later versions, the display of PlanningPriority is supported.

# 7.6 Motion Control Programming

# 7.6.1 Motion Control Program

Before programming in DIADesigner-AX, please take the following descriptions as reference.

# 7.6.1.1 Program Architecture and Types in DIADesigner-AX

In the classic architecture, a source code for a PLC is composed of procedures including subroutines. When the size of a program becomes larger, maintenance and debugging also becomes a huge burden. Under the IEC 61131-3 architecture, a program is divided into several units according to the functions or characteristics which makes developing and maintaining much easier. Since POU are modularized, different POU can be developed by different designers to enhance distribution of professional manpower and project execution

There are three types of POUs: program (PROG), function block (FB) and function (FC).

### Program (PROG):

The program type plays a major process role in a PLC program. The execution is assigned by Task which includes specific scan cycle or interrupt subroutines and provides scan order arrangement for programs in the Task list. Besides, a POU of the program type can call a function block (FB).

Function block (FB):

A static symbol can be declared in a function block (FB). As a result, the value of the symbol after an operation can be retained. Owing to the fact that the operation is performed on the value memorized in the function block and an input value, the output values may be different even if the input values are the same.

Besides, a function block can call another function block. The function block (FB) type is similar to subroutines. The FB process requires suitable parameters and can only execute once called by a program.

Function (FC):

Function (FC) is used to return back operation results. Contrary to FBs, it have no memory and can only return a single value. Since an FC does not have any memory of its own, it cannot call a function block but a function.

Tasks

Each program POU needs to assign a Task that determines the order for program execution or start.

The programming structure characteristic of IEC 61131-3 is that a program can be divided into several independent POUs. When POUs are compiled, they are rearranged and combined into an execution code for scanning. The new combination order of POUs are based on the assigned Tasks.

Below are types of tasks:

- Cyclic: Assigned POU sets interval time for per scan.
- Event: When Bool variable is set from False to True, a scan execution is performed.
- External: When external triggers to send a signal, a corresponding POU is executed.
- Freewheeling: Assigned POU performs scan automatically in a continuous loop when the previous scan has been completed.
- Status: When Bool variable is set from False to True, a scan cycle is executed.

Please refer to section 4.4.1 for the details of task operating process.

# 7.6.1.2 POU in DIADesigner-AX

All POUs created by you are listed in the project management area with programs and function blocks been managed separately. In addition, the icon of POU may vary based on different program and function block programming languages which also includes information beside the POU name.

Double-click the POU in the project management area for editing. The POU editing section is composed of two parts. The upper part of the editing section is the symbol table of local variables, while the lower part is the main part of the program. Also, the editing environment at the lower part of the editing section is different when using different programming languages. For more information on symbol tables and programming, please refer to the following sections.

· · · · · ·	PROGRAM PLC_PRG	
" Scope Name Add	dress Data type Initialization Comment Attributes	5 
4	Program	3

# 7.6.1.3 Adding POU in DIADesigner-AX

Open the existed projects in DIADesigner-AX and right-click "Application" to select "Add Object", then choose "POU".



Type in POU name. For Implementation language, select a programming language then click "Add"



■ The POU appears in the left column. Double-click on "EtherCAT\_Task" and choose "Add Call".

Devices	- # X	H POU SEtherCAT_Task X	
Untitled1     Device (AX-308EA0MAIT)     Ardware Configuration     A Network Configuration	•	Configuration Priority ( 0.31 ): 1	
DIC Logic     Orgin Control Contr		Type	ms ∨
With the second se	ta LocalBus Master)	Time (e.g. t#200ms) Sensitivity	
SoftMoton General Axis Po		POU Comment Comment	

■ Select the created POU and click "OK".

Text savd). Catopoles
Structured view

Choose POU in EtherCAT\_Task item to compile a program.

Devices - 9 ×	🖶 POU 🗙 🍪 EtherCAT_Task	
Unsted:     Derice (AX-SDBEA0MAIT)     Hardware Configuration     Anetwork Configuration     Derice (Configuration     Derice (Configuration     Derice (Re()     Derice (R	L PROGRAM FOU C VAR 3 END_VAR 4	
<ul> <li> <sup>(1)</sup> POU         <sup>(2)</sup> PAINTABK         <sup>(2)</sup> PLCPRG         <sup>(2)</sup> PL</li></ul>		100 %

# 7.6.1.4 PDO Mapping

Before using motion control instructions, the communication of PDO (Process Data Objects) Mapping between the software DIADesigner-AX and AX motion CPU must be setup first.

Setting values for PDO Mapping

RxPDO(1600 hex)	Control Word(6040 hex) · TargetPosition(607A hex)
TxPDO(1A00 hex)	Status Word(6041 hex) · ActualPosition(6064 hex)

The table above is the pre-determined PDO Mapping parameters for ASDA-A2-E.

Please refer to **AX Series Motion Controller Manual** for the PDO parameters required by the related motion function blocks.

# 7.6.2 Axis State Transitions

This section introduces single axis state transitions and multi-axis state transitions in axis groups for multiple function block use. The transition rules fulfills PLCopen motion control standard.

#### 7.6.2.1 Axis State

Synchronous Axis



Note 1: Regardless of the state. An error in the axis has occured.

Note 2: Regardless of the state. MC\_Power.Enable = FALSE. There is no error in the axis.

Note 3: MC\_Reset and MC\_Power.Status = FALSE

Note 4: MC\_Reset and MC\_Power.Status = TRUE and MC\_Power.Enable = TRUE

Note 5: MC\_Power.Enable = TRUE and MC\_Power.Status = TRUE

Note 6: MC\_Stop.Done = TRUE and MC\_Stop.Execute = FALSE

State	Meaning
Disabled	Axis during servo OFF, standstill, ready to execute
Standstill	Axis during servo ON, standstill
Discrete Motion	The state would be Discrete Motion while executing single-axis motion instructions.
Continuous Motion	The state would be Continuous Motion while executing continuous motion instructions of single-axis.
Synchronized	Achieves state of synchronized motion via instructions for synchronized control.
	Includes synchronous waiting state.
Stopping	When Execute is True via MC_Stop instructions
	Cannot execute axis instructions during this state
	When CommandAborted is TRUE, the instruction is executed
ErrorStop	Axis during servo ON or axis errors
	Cannot execute axis motion instructions under this state and all instructions are in CommandAborted = 1 state.
Homing	The state would be Homing while executing MC_Home or MC_HomeWithParameter instructions for single axis.

#### Positioning Axis



7

State	Meaning	
Disabled	Axis during servo OFF, standstill, ready to execute	
Standstill	Axis during servo ON, standstill	
Discrete Motion	The state would be Discrete Motion while executing single-axis motion instructions.	
Continuous Motion	The state would be Continuous Motion while executing continuous motion instructions of single-axis.	
Stopping	When Execute is True via MC_Stop instructionsCannot execute axis instructions during this state	
ErrorStop	When an error occurs in the single axis.Cannot execute axis motion instructions for single axis under this state.	
Homing	The state would be Homing while executing MC_Home or MC_HomeWithParameter instructions for single axis.	

# 7.6.2.2 Axis Group State



Note 1: Applicable to all function blocks of group moving, non-administrative.

Note 2: All motion function blocks are able to be executed when the state is GroupErrorStop or GroupStopping Note 3: When DMC\_GroupStop is Done or MC\_GroupStop is not Execute.

Note 4: The state of GroupDisabled can only be changed under	GroupStandby state, o	or an error will occur.
--	-----------------------	-------------------------

Status	Definition	
GroupDisabled	Execute MC_GroupDisable and switch axis to GroupDisabled.	
GroupStandby	No motion instructions has been executed and the state of axis group is GroupStandby.	
GroupMoving	A group positioning instruction is being executed, the state of axis group is GroupMoving.Moving $^{\circ}$	
GroupStopping	When Active of MC_GroupSto is True, the state of axis group is GroupStopping. No motion instructions can be executed under this state.	
GroupErrorStop	The axis group will enter GroupErrorStop state, once an error occurs.	

- Interaction between single-axis state and axis group state
  - (1) If one of the axes in the group is in ErrorStop and the axis group is not in GroupDisabled, the group would be in GroupErrorStop status.
  - (2) When state GroupMoving/GroupStopping/GroupHoming disconnect the power of an axis, the axis group would be in GroupErrorStop state.
  - (3) If all axes are in Standstill, the axis group can be in state GroupStandby, GroupDisabled or GroupErrorStop.
  - (4) If the motion of a single-axis interrupts the motion of axis group, the other axes in the group should be stopped and enter state Stopping, while the state of the axis group entering state GroupStandby.
  - (5) In case that the axis group is in GroupStandby, there's no need for all the single axes being in state SynchronizedMotion.
  - (6) For axis group motion instructions (including MC\_GroupStop), all single axes in the axis group should be in state SynchronizedMotion.
  - (7) When an error occurs during the movement of axis group, all axis in the group should stop immediately till the axis group entering state GroupErrorStop. Those single axes with no errors will enter state Standstill.
  - (8) When the state of axis group is GroupErrorStop, the state of single axes will not be affected.

# 7.6.3 Execution and Status Indication for Motion Control Instructions

The motion function blocks are grouped under two main categories with AX series motion controllers:

Category	Description
MC_	PLCopen motion control function blocks
DMC_	Delta self-defined function blocks*

\*Note: Delta self-defined function blocks (DMC) include motion control type and other administrative/ nonadministrative type applicable for AX series motion CPU. Please find AX

General pins for motion control function blocks include input, output and in-out. The section explains the meanings and behaviors of these pins. For more details concerning motion function blocks, please refer to **AX** Series Motion Controller Manual.

# 7.6.3.1 Basic Rules of Executing Instructions

• Defining input and output pins

Common inputs and outputs in motion control function blocks are listed below. Usually, a function block consists of at least one or a part of the input/output pins listed below. For example, a function block contains either Execute or Enable input pin based on the properties of the motion control function block.

Inputs			
Name	Description	Date Type	Setting value (Default)
En	Receiving the logic status in front of the instruction	BOOL	True/False (False)
Enable	Enabling motion control function block	BOOL	True/False (False)
Execute	Executing motion control function block	BOOL	True/False (False)
	Outputs		
Name	Description	Date Type	Setting value(Default)
Eno	Transfering the input logic state of the <i>En</i> to the next serial instruction	BOOL	True/False (False)
Done	The execution of the function block is completed	BOOL	True/False (False)
Valid	The output pin value is valid	BOOL	True/False (False)
Busy	The motion control function block is listed for execution	BOOL	True/False (False)
Active	Axes are been controlled by function blocks	BOOL	True/False (False)
CommandAbort ed(Aborted)	Aborts execution for motion control function blocks	BOOL	True/False (False)
Error	Error occurs in function blocks	BOOL	True/False (False)

A motion control function block usually consists of Execute or Enable input pin and is used to either execute or enable a motion control function block. In addition, a motion control function block has Busy and Done output pins. The Busy and Done outputs refer to the status of motion control function blocks. When execution of motion control function blocks can be aborted by another motion control function block, the CommandAborted/Aborted output pin appears in the function block. Nevertheless, when Error output pin is True, this indicates error during function block execution.

A motion control function block not only has Execute/Enable input, but also include the input value/state. The characteristics are described below.

Use input value

When a function block contains Execute input, each input value is used once Execute input signal changes from False to True. However, when Execute is re-triggered, input values are not updated as a result.

When a function block contains Enable input, each input value is used once Enable input signal changes from False to True. Compare to Execute input, function blocks of Enable input usually have more input values which need to be continuously updated. (Refer to each function block for more detail).

7-58

#### Input value exceeds range

When a motion control function block is enabled, the system restricts you to input values that exceeds the permitted range. Nevertheless, error occurs during execution of motion control function blocks and results in motion axes errors. You should avoid input incorrect values in programs.

- Output pins are mutually exclusive.

When a function block contains Execute input, Busy output, Done output, CommandAborted output or Error output, only one state is set to True during the same time. When Execute input is set True, one output (Busy, Done, CommandAborted or Error) must set True.

When a function block contains Enable input, while Valid output and Error output are mutually exclusive, this indicates only one output is set True.

Valid time for output data/status value

When a function block contains Execute input and the input signal changes from True to False, the current Done output, Error output, CommandAborted output of current True and output pin data are reset or cleared. However, when a function block is Busy, despite that the Execute input signal changes from True to False, execution of the function block will not stop. The expected output state (Done output, Error output, CommandAborted output) will generate to True and retain for one week.

When a function block contains Enable input and input signal changes from True to False, Valid output, Busy output and Error output are reset. (For input and output description not mentioned, please refer to MC\_Power instruction for more details.)

Characteristic of Done output

When execution of a motion control function block is completed, Done output is set to True.

Characteristic of Busy output

When a function block contains Execute input and uses Buy output to indicate incomplete execution, new output state (value) is to be generated. When Execute input signal changes from False to True, then Busy output is set to True. When Done output, CommandAborted output or Error output is set to True, then Busy output is reset.

When a function block contains Enable input and uses Buy output to indicate incomplete execution, new output state (value) is to be generated. When Enable input signal changes from False to True and as long as Busy output is set True, changes in input state (value) can be expected.

- Characteristic of CommandAborted/Aborted output

When execution of a motion control function block is aborted, CommandAborted/Aborted output is set True.

Relation between Enable input and Valid output

A function block contains Enable input and uses Valid output to indicate validity of output data/status. Only when Enable input is set True and output data/status is valid, then Valid output is set True; when errors occur in function blocks, then output data/status is invalid and Valid output is set to False; when errors are cleared in motion control function blocks and output data/status changes to valid, then Valid output is set to True.



# 7.6.3.2 Timing Diagram for Input/Outputs

Situation 1: The execution of motion control function block is aborted.

Situation 2: Errors occur in motion control function blocks.

Situation 3: The execution of motion control function block is completed.



Situation 1: The execution of motion control function block is normal.

Situation 2: An error occurs in a motion control function block.

#### 7.6.3.3 Repeated Execution Behavior of Single Axis Motion Instructions

When single axis motion function blocks are executing (Busy state), variables for input pins can be modified and function block pins can be re-triggered on the rising. Meanwhile, the state of function block output pins remain the same (remain Busy), while the system is executing which means it is aborting the previous rising edge-trigger instruction under buffer mode. For similar mode of behavior, refer to section 7.6.3.5 Single Axis Buffer Mode (Aborting) for more details.

# 7.6.3.4 Multi-execution of Motion Control Instructions

This section describes executing multiple motion control instructions for the same axis or axis group within the same scan period.

- In the following programming, instruction instances Move1 and Move2 start in the same task period when contact A turns ON.
- According to the ladder logic, instructions in a program are executed from the top. Therefore Motion1 starts first, and then Motion 2 will be executed once Motion 1 is finished.
- This is considered multi-execution of motion control instructions. Since the motion combination is dertermined by input variables of BufferMode, BufferMode setting in Motion 2 is used to execute Motion 2 in relation to Motion 1.



# 7.6.3.5 Synchronous Execution Eehavior of Motion Instructions

#### Single Axis Buffer Mode

You can execute another motion control instruction while an axis is moving. A total of six types of BufferMode can be chosen to proceed multi-execution of two instructions, which you can set the BufferMode input variables to the later motion control instruction to select one of the six Buffer Modes.

The meanings of terms relating to BufferMode shown as follows:

- 1. Current instruction: The motion control instruction that was in operation just before executing the multiexecution instruction.
- 2. Buffered instruction: A motion control instruction that was executed during an axis motion and is waiting to be executed
- 3. Transit velocity: The velocity to use by the current instruction to trasfer to the buffered instruction.
- 4. Target Velocity: The Velocity parameters of the instruction.
- 5. Target position: the Positon or Distance parameters of relating move instructions.

BufferMode	Description of Operation
0 : mcAborting (Aborting)	The current instruction is aborted and the multi-executed instruction is executed.
1 : mcBuffered (Buffered)	The buffered instruction is executed after the operation for the current instruction is normally finished.
2 : mcBlendingLow (Low velocity)	The buffered instruction is executed after the target position of the current instruction is reached. The transit velocity is set to the target velocity of the current instruction or the buffered instruction, whichever is lowest.
3 : mcBlendingPrevious (Previous velocity)	The buffered instruction is executed after the target position of the current instruction is reached. The target velocity of the current instruction is used as the transit velocity
4:mcBlendingNext (Next velocity)	The buffered instruction is executed after the target position of the current instruction is reached. The target velocity of the buffered instruction is used as the transit velocity.

BufferMode	Description of Operation
5:mcBlendingHigh (High velocity)	The buffered instruction is executed after the target position of the current instruction is reached. The transit velocity is set to the target velocity of the current instructionor the buffered instruction, whichever is highest.

#### • Example: Brefly explain with two MoveRelative instructons

The max velocity and the displacement of the first and second instruction are respectively  $V_1$ ,  $S_1$  and  $V_2$ ,  $S_2$ .

Different types of BufferModes set for the second instruction result in various transitting situation shown as follows.



#### Buffermode=mcAborting



### Buffermode=mcBuffered

#### Buffermode=mcBlendingLow





#### Buffermode=mcBlendingPrevious


### Buffermode=mcBlendingNext



\*Note: Single-axis motion instructions MC support only Buffermode=mcAborting while motion instructions for axis group support all of the above BufferMode.

# 7.6.4 Position

This section describes the position processes of motion control programming.

# 7.6.4.1 Types of Positions

MC function blocks are formed by the following two types of positions.

- Command position: MC function block provides command position.
- Actual position: The actual feedback position from servo drives.

The following figure indicates the relationship between the command position and the actual position.



The following item of command position and actual position is the same.

Position Type	Description
Command position	This is the position that motion controller outputs to servo drive
Actual (feedback) position	This is the position feedback from servo drive or encoder

\*Note: For axes configured as Virtual, the actual position is equal to the command.

# 7.6.5 CAM Tables and Framework

This section introduces electronic cam (E-CAM) operation and using DIADesigner-AX to generate CAM table settings as well as E-CAM applications. For details regarding insturctions, please refer to **AX Series Motion Controller Manual**.

# 7.6.5.1 E-CAM Framework

Adopt CAM Editor function from software DIADesigner-AX for planning CAM curves and download to PLC via communication protocols so that MC function blocks can be used to control CAM.



# 7.6.5.2 Creating E-CAM

The data that defines the relationship between master/slave (CAM axis) is called E-CAM data.

When using CAM Editor of DIADesigner-AX, it is crucial to know the relationship between master and slave axis position through the two methods described below:

Method 1: Obtains the relationship between master and slave axis position based on E-CAM data setting.

Method 2: Measures the corresponding relationship between master and slave axis position through real task.

When the CAM master and slave relationship is confirmed, the slave position can be obtained based on the master axis position.

#### Create DIADesigner-AX CAM tables

- Devices џ x PLC\_PRG X = 🗿 Untitled6 PROGRAM PLC\_PRG VAR Device (AX-308EA0MA1T) END VAR Hardware Configuration A Network Configuration A EtherCAT Filter PLC Logic = () Applica Cut PLC Сору 1 Task Paste SE X Delete De M Alarm Configuration .... Refactoring ₫ . 2 🗄 📑 BuiltIn\_IO (Bu 🕞 Application... Properties ... Delta\_LocalBu 8 Axis Group... Add Object EtherCAT\_Ma Cam table.. Add Folder... MASD\_A2\_ 8 Ø CNC program... BA SM. D Edit Object 6 CNC settings ... SoftMotion Get Edit Object with ... Data Sources Manager... C Login 4 DUT ... Delete application from device External File... ۲ Global Variable List ... Image Pool ... -O Interface... 66 Network Variable List (Receiver) .... 6 Network Variable List (Sender).... T Persistent Variables... POU... POU for implicit checks... Recipe Manager. Redundancy Configuration.... Symbol Configuration... Text List... G<sup>9</sup> Trace. Trend Recording Manager... < Sevices POUs 53 Unit Conversion... < (B) Visualization.. Messages - Total 0 error(s), 0 warning(s), 0 message(s) -Visualization Manager...
- (1) Right-click "Application", choose "Add Object" and then select "CAM Table".

(2) Type the name of the CAM table.

Add Cam table	×	
Name:	•	
	Add	

(3) After clicking "Add", CAM icon is shown on the left item box.



(4) Click "Cam Table" on the CAM page.

Devices 👻 🕈 🗙	P	LC_PRG	🙆 Cam	×							
🔄 Unbiled6 🔹	Cam	Cam table	Tappets Ta	ppet table							
Device (AX-308EA0MA1T)		X		v	A	J	Segment Type	min(Position)	max(Position)	max([Velocity])	max( Acceleration )
- 🔏 Hardware Configuration		0		0	0	0					
A Network Configuration	0						Poly5	0	120	1.5120000000000007	0.032835282941414162
A EtherCAT Filter		120	120	1	0	0					
CLOGIC	0						Poly5	120	240	1	0
= () Application		240	240	1	0	0					
Cam	•						Poly5	240	360	1.512	0.032835282941414141
PLC_PRG (PRG)		360	360	0	0	0					
Gild Configuration     Gild Configuratio											

- (5) Add or delete CAM data on the CAM Table screen
- Click I to add new CAM data
- Click 👼 to delete CAM data
- X: Position data of master axis
- Y: Position data of slave axis
- A: Acceleration of slave axis
- J: Jerk of slave axis
- Segment Type: Curve type

🖲 Cam 🗙 Cam table Cam Tappets Tappet table × Y v A J Segment Type min(Position) max(Position) max(|Velocity|) max(|Acceleration|) 0 0 0 0 0 0 Poly5 0 120 1.5120000000000007 0.032835282941414162 Ŵ 120 120 1 0 0 0 Poly5 120 240 0 1 Ŵ 240 240 0 1 0 0 240 360 1.512 0.032835282941414141 Poly5 360 360 0 0 0

(6) You can configur multiple tappets on "Tappets" page and several tappets can be set for each tappet ID. After finishing setting "Tappet table", a diagram which illustrates the relation between tappets and master axes would be shown on "Tappets " page. While moving the points on Tappets page, the setting parameters on Tappet table page would be changed simultaneously.



- (7) You can configure tappets on "Tappet table" page and read the status of tappets with SMC\_GetTappetValue, which can also be modified according to the settings in "Tappet table" and the direction when CAM master passing the tappets.
  - Click 🔹 to add new Track ID.
  - Click 🖤 to delete TrackID.
  - Track ID: Tappet ID
  - X: Master position
  - Positive pass: Axis passes tappets in positive direction, which the setting is as below:
    - None: No action
    - Switch to ON: TRUE
    - Switch to OFF: FALSE
    - Invert: Opposite direction
  - Negative pass: Axis passes tappets in negative direction, which the setting is as below:
    - None: No action
    - Switch to ON: TRUE
    - Switch to OFF: FALSE
    - Invert: Opposite direction

Cam Ca	am table Tappe	ets Ta	ppet table		
•	Track ID	×	positive pass	negative pass	
1		180	switch ON	switch OFF	
1		360	switch OFF	none	
•	2				
1		90	switch ON	none	
W		200	invert	switch OFF	
0					

# 7.7 Motion Control Functions

# 7.7.1 System Structure

The single axis motion instructions of MC function blocks can generate specified motion path for axis based on user-defined parameters under three control modes including position control, velocity control, and torque control.

The CANopen over EtherCAT (CoE) protocol is based on standard CiA402 which includes Cyclic Synchronous Position Mode, Cyclic Synchronous Velocity Mode and Cyclic Synchronous Torque Mode (explained in the following sections).

# 7.7.2 Single-axis Control

### 7.7.2.1 Cyclic Synchronous Position Mode

The synchrinization between AX series controllers and servo drives is implemented via sync signal transmission sent by controllers. These incoming data would not be valid until the Distributed Clocks (DC)\* in each servo drives are synchronized. In the following figure, four servo drives receive control data at different timing (t1, t2, t3, t4) within a synchronous cyclic time (T). However, the data is valid after all servo drives are synchronized with the SYNC event of the distributed clock system.



\*Note: Cyclic synchronous position mode is used only for synchronous axes.

# 7.7.2.2 Profile Position Mode

After the servo drive receives position demands from the master device, the drive controls the motor to reach the target position. Under profile position mode\*, at first the master device only inform the drive about configuration relating to target position, velocity command, acceleration, and deceleration. All motion plannings are executed by the trajectory generator inside servo drive, from triggering demand to reaching target position.



\* Profile position mode is only used for positioning axes.

# 7.7.2.3 Positioning

### Absolute positioning

The curves for motion planning allows axis to move to the absolute coordinates of the target position in relation to home. In addition, the absolute positioning range for modulo axis is limited to the range of its cyclic rotation. Please refer to MC\_MoveAbsolute function block for more information.

The following figure shows the motion trajectory for absolute positioning.



### Rotary axes setting

After choosing "Rotary Axis" for axis type, set the angle of rotation for rotary axis in "Modulo value" area.

General Setting	Axis Type and Limits	Motion Parameter
Homing Setting	Virtual mode	Error Reaction
Commissioning	Rotary Axis     Activated	Quick Stop Deceleration [u/s <sup>2</sup> ]: 100
SM_Drive_ETC_Delta_ASDA_A2: IEC Objects	Negative [u]: 0	Velocity Ramp Type Trapezoid Sin <sup>2</sup> Quadratic Quadratic(smooth)
Status	Rotary Axis Modulo Setting Modulo value [u]: 360	Distion Lag Supervision
Information		Usable Drive Lag Linit [u]. 1
	Transmission Mechanism Mechanism Type Ball Screw	Mechanism Setting (1) Command pulse per motor rotation: 131072 (4) Pitch: 1 (1) Unit ]
		Gear Box (2) Gear ratio numerator
		Gear Katio = (3) Gear ratio denominator 1
		Gear Ratio = (3) Gear ratio denominator 1

Relative positioning

The curves for motion planning allos axis to move to the relative coordinates of the target position in relation to the actual position. Please refer to MC\_MoveRelative function block for more information.

The following figure shows the motion trajectory for relative positioning.



# 7.7.2.4 Stop Method

The stopping state includes using motion instructions or enabled limit input as well as error stop input to stop axis operation. The stop behavior regarding clear error and limit input differs depending on the servo drives.

### Using motion instructions to stop

To stop single-axis movement, use MC\_Stop or MC\_Halt instruction.

### MC\_Stop

- MC\_Stop stops an axis in motion based on specified method and changes the state to "Stopping".

- The instruction aborts any instructions in execution. When the axis state is "Stopping", no instructions can be executed.

- The state of "Stopping" continues until velocity reaches 0 or Execute becomes False. When velocity is 0, Done changes to True.
- When Done becomes True and Execute is False, the axis changes to "Standstill" state.

The following diagram shows MC\_Stop motion trajectory.

Velocity is determined by specified deceleration (DT).



Vt : Velocity before the deceleration slope starts Dt : The specified deceleration rate

### MC\_Halt

- MC\_Halt temporarily stops an axis in motion and changes axis state to "DsicreteMotion" until axis velocity reaches 0. When the axis stops, the axis state changes to "Standstill".
- During axis deceleration, other motion instructions can be executed to immediately abort MC\_Halt operation.

#### Limit input stop

**Software limit:** You can activate/ inactivate software limit and configure its parameter settings on axis parameter setting page. When the axis is close to software limit during the movement, it will start the deceleration stop based on the axis parameters and stop under the software limit.

The example is shown as below:

- The positive and negative limit are respectively set as 10000 and 0 with "Activated" being selected. Then set 1000 for Deceleration.

General Setting	Axis Type and Limits	Motion Parameter
Homing Setting Commissioning SM_Drive_ETC_Delta_ASDA_A2: IEC Objects Status	↓ Virtual mode         ● Linear Axis         ○ Rotary Axis         ✓ Activated         Negative [u]:         0 Positive [u]:         10000         Rotary Axis Modulo Setting         Modulo value [u]:         560	Trapezoid Sin <sup>2</sup> Quadratic Quadratic(smooth)      Position Lag Supervision
Information	Transmission Mechanism Mechanism Type Ball Screw (4) (1)	Position Lag Reaction     Deactivated     Lag Limit [u]:     1       Mechanism Setting     (1) Command pulse per motor rotation:     10000     [Pulse]       (4) Pitch:     10000     [Unit]
		Gear Box Gear Ratio = (2) Gear ratio numerator 1 (3) Gear ratio denominator 1 (4)

- Use function block MC\_MoveRelative and activate the function block when the position reaches 11,000. After the axis moving to about 8,000, Busy of the function block will shift from TRUE to FALSE, while CommandAborted shifts from FALSE to TRUE. The axis then starts to decelerate and stop at the position inside software limit



**Hardware limit:** Since the EtherCAT servo wires carry the hardware limit signals, the stop method for hardware limit may be different between companies and brands. The following description takes Delta ASDA-A2-E servo drive as example:

 Use MC\_Jog function block to perform axis rotating in positive direction. Once the hardware limit is reached during the rotation, ASDA-A2-E servo drive will be stopped and report error messages via communication.



After using MC\_Reset to clear errors for reaching software/ hardware limit, the system synchronizes the command positon with the values of return position automatically and move away from the direction of limit so as to operate properly.

# 7.7.2.5 MC\_GearIn

Use MC\_GearIn instruction to control gear movement and cancel synchronization via MC\_Gear Out instruction



In MC\_GearIn, the master and slave axes, gear ratio numerator and gear ratio denominator, acceleration, deceleration as well as jerk are specified.

The following diagram shows the execution steps of instructions for electronic gears:



- When executing MC\_GearIn, the slave axis enters the state of synchronized motion, while for MC\_GearOut execution, the slave axis shifts awaya from sync state and maintains instant velocity to continue the movement and enters the state of continuous motion.
- During synchronized motion, when executing MC\_Stop on the slave axis, MC\_GearIn is aborted while master axis maintains the state of continuous motion and the slave axis enters to stopping state that will return to standstill once MC\_Stop is Done.
- When slave axis is in synchronized motion state, its velocity may alter according to the master axis velocity and gear ratio.
- When both master and slave axes enters state of synchronization, use MC\_SetPosition to prevent motors from generating accidents due to high speed operation.

Using RatioNumerator, RatioDenominator in MC\_GearIn to setup the gear ratio between master and slave axes.

- When gear ratio is positive, the master and slave axes are moving in the same direction.



- Ratio Numerator: Ratio Denominator = 2:1
- When gear ratio is negative, the master and slave axes are moving in the opposite direction.



- Synchronization of master and slave axes is completed once slave velocity reaches the setting in the instruction.



- 1. When MC\_GearIn is enabled, the slave starts to engage with the master axis and the slave velocity is twice the speed of the master velocity (RatioNumerator : RatioDenominator = 2:1).
- 2. When InGear is True, synchronization of master and slave axes are completed and slave axis is in synchronized motion state.
- 3. When MC\_Stop is enabled, the master axis starts decelerating and the slave axis in sync also decelerates based on the gear ratio.
- 4. When MC\_Stop is operating, MC\_GearOut is enabled, the sync between master and slave axes is aborted but maintains that velocity and is in continous motion state.

# 7.7.2.6 MC\_GearInPos

You can adopt MC\_GearInPos to assign the synchronous starting positions of master and slave axis.

### MC\_GearInPos sequence

The assigned master and slave, gear ratio numerator and denominator, synchronous starting positions of master and slave axis in MC\_GearInPos executes the master start distance in sync as well as whether or not to permit reversal. The function block engages both master and slave axis in the assigned position based on the curve of the slave axis.



- The master axis starts to execute sync position as MasterSyncPosition(180) MasterStartDistance(50); When the axis reaches to that position, StartSync is True.
- The slave axis generates a motion curve based on other parameters; When the master reaches MasterSyncPosition(180) and the slave axis also reaches SlaveSyncPosition(90), the StartSync is False and InSync is True.
- When MasterStartDistance ≤ 0, the function block executes and synchronization is completed; Meanwhile, the slave axis position will move up and down to the assigned sync position.
- When slave reversal is not permitted, you need to set AvoidReversal to True.

# 7.7.2.7 MC\_CamIn

The slave axis follows the master axis for synchronized motion based on CAM table. The master and slave axes are assigned via the pre-assigned CAM table (MC\_CamTableSelect). Use MC\_CamIn for CAM engagement, and MC\_CamOut to remove gear engagement.



After the engagement, synchronization between master and slave axis is completed successfully and the state of slave axis is Synchronized Motion. The following is the information about creating E-CAM:

### Initial setting

Create E-CAM data

The following two methods can create E-CAM curve data:

Method 1: Master and slave positions are determined base on standard functions.

Method 2: The corresponding relationship between master and slave base on actual measurement.

### • E-CAM master and slave setting and operation

By using MC\_CamIn and MC\_CamTableSelect, E-CAM slave and master as well as basic operation setups can be completed.

- Master and slave source setting

In MC\_CamTableSelect and MC\_CamIn function blocks, the master input pins determines the master source while slave input pin determines the slave source.

MC_CamTa	ableSelect
— Master AXIS_REF_SM3	BOOL Done-
—Slave AXIS_REF_SM3	BOOL Busy-
CamTable MC_CAM_REF	BOOL Error -
Execute BOOL	SMC_ERROR ErrorID
-Periodic BOOL	MC CAM ID CamTableID

MC_C	amIn
- Master AXIS_REF_SM3	BOOL InSync-
	BOOL Busy-
- Execute BOOL	BOOL CommandAborted
<ul> <li>MasterOffset LREAL</li> </ul>	BOOL Error -
	SMC_ERROR ErrorID
- MasterScaling LREAL	BOOL EndOfProfile
	SMC_TappetData Tappets -
— StartMode MC_StartMode	
CamTableID MC_CAM_ID	
- Acceleration LREAL	
- Deceleration LREAL	
-Jerk LREAL	
- TappetHysteresis LREAL	

\*Note: For more details of pins definition, please refer to AX Series Motion Controller Manual.

- Master as external pulse counter

The sources of E-CAM master include actual and virtual axes as well as the counter. When using the external counter as master's source, use DMC\_HCnt function block.

System structure and DMC\_HCnt



DMC_HCnt	
	BOOL Valid
Enable BOOL	BOOL Busy
	BOOL Error
	DMC_HSIO_ERROR ErrorID
	DINT CounterValue

- Relationship between master and slave positions

By using the software to pre-plane the relationship between CAM master and slave positions, the positions in the CAM table rather than actual axis positions define the phase of the master and slave axes. When the pre-planned CAM mechanism defined as CAM function, the input is the CAM master phase and the output is the CAM slave phase. For example:

x: CAM master phase ; y: CAM slave phase

$$y = CAM(x)$$

The CAM phase derives from the axis position and conversion may take place. The conversion between axis position and CAM phase is related to parameters including MasterAbsolute, SlaveAbsolute, MasterOffset, SlaveOffset, MasterScaling and SlaveScaling. The slave follows the master axis to perform synchronized motion under MC\_CamIn instruction. The relationship between master and slave positions should be based on the pre-planned CAM relationship (relation curve or CAM table). The process of calculating slave position from the master position is shown below:



The above diagram resulted in the following calculation method:

Position\_Slave = SlaveScaling×CAM (MasterScaling×MasterPosition + MasterOffset) + SlaveOffset

When master is in absolute mode, the current master position is the arithmetic result of the rotating axis; when in relative mode, the master position is the starting point (usually 0) in corresponse to CAM.

- Relationship between Startmode and MasterAbsolute, SlaveAbsolute in CamTableSelect
  - Absolute mode (StartMode=0): When E-CAM synchronization starts, the CAM calculation and current slave position is irrelevant. When current slave position is different from the starting position that is calculated, then Jump is generated.
  - Relative mode (StartMode=1): CAM changes based on current slave positions; the slave positions are added from its current position. When the engaging position of the slave is different from the starting position plus the current position that is calculated, then Jump is generated.
  - Ramp mode (StartMode = 2, 3, 4): Add a curve of motion compensation based on VelocityDiff, Acceleration, Deceleration, Jerk to prevent the Jump during CAM engagement.

MC_CamTableSelect.MasterAbsolute	Master mode
absolute	Absolute mode
relative	Relative mode

MC_CamIn.StartMode	MC_CamTableSelect.SlaveAbsolute	Slave mode
absolute	True	Absolute mode
absolute	False	Relative mode
relative	True	Relative mode
relative	False	Relative mode
ramp_in	True	Ramp in absolute mode
ramp_in	False	Ramp in relative mode
ramp_in_pos	True	Positive ramp in absolute mode
ramp_in_pos	False	Positive ramp in relative mode
ramp_in_neg	True	Negative ramp in absolute mode
ramp_in_neg	False	Negative ramp in relative mode

- Offset and scaling (MasterOffset/MasterScaling/SlaveOffset/Slavescaling)

Since the CAM mechanism between master and slave are pre-planned, when executing CAM, you can adopt Offset and Scaling parameters to pre-plane position offset or scaling. For example, the processing product has different dimensions, but only one CAM mechanism is required for programming, therefore, by changing offset and scaling parameters, the switching of processing products amongst different dimensions can be adjusted. You can input specific scaling values for master scaling of CAM and slave offset. The master and slave can setup offset and scaling values accordingly.

The master and slave offset and scaling both determine the actual CAM in relation to the effect that is described in the following example. The diagram below demonstrates pre-planned CAM mechanism:



When master and slave are both in absolute mode and executes engagement, both master and slave positions are 0; when not using offset and scaling (default value), the following diagram shows the actual corresponding relationship between master and slave during the process of executing CAM:



When position offset or scaling is not in default value, the following diagrams show the effects of the corresponding relationship between master and slave actual positions during CAM execution:

For master and slave offset as 0, the effects from scaling of master and slave for actual CAM execution



- Situation 1: When scaling ratio for master and slave is 1, offset is 0, the actual CAM mechanism is the same as pre-planned.
- Situation 2: When master scaling ratio is 1, slave scaling ratio is 2 and offset for both axes is 0, the slave position that corresponds to the master position is twice the amount of pre-planned measurement.
- Situation 3: When master scaling ratio is 1, slave scaling ratio is 0.5 and offset for both axes is 0, the slave position that corresponds to the master position is half the amount of pre-planned measurement.
- Situation 4: When master scaling ratio is 2, slave scaling ratio is 1 and offset for both axes is 0, the master position that corresponds to the slave position is twice the amount of pre-planned measurement. From CAM phase perspective, the Master CAM is twice the amount of pre-planned measurement, meaning the Master CAM changes from 360 to 180, while Slave CAM phase remains the same.

Situation 5: When master scaling ratio is 0.5, slave scaling ratio is 1 and offset for both axes is 0, the master position that corresponds to the slave position is half the amount of pre-planned measurement. From CAM phase perspective, the Master CAM is half the amount of pre-planned measurement, meaning the Master CAM changes from 360 to 720, while Slave CAM phase remains the same.

The scaling ratio for master and slave is 1 and the CAM effect when executing actual master and slave offset. The master offset means that the position curve of actual axis position moves horizontally during CAM execution; the slave offset means that the position curve moves vertically during CAM execution.

Situations:



- Situation 1: When the scaling ratio of master and slave is 1, the master offset is 0 and the slave offset is 60, the slave position that corresponds to the master position need to add 60 based on the pre-planned measurement. For instance, the master position is 180 and corresponds to the slave position that is 180 in CAM mechanism, but the slave position is 240 (240=180+60) during actual execution.
- Situation 2: When the scaling ratio of master and slave is 1, the master offset is 90 and the slave offset is 0, the master position that corresponds to the slave position offsets by 90 (adding offset value) based on the pre-planned measurement. For instance, the master position is 180 and corresponds to the slave position that is 180 in CAM mechanism. However, during actual execution, the master position is 90 and corresponds to the slave position of 180, meaning the slave position corresponds to the master position that is 180 (180=90+90) in pre-planned CAM mechanism.

### CAM table

By selecting CAM in **DIADesigner-AX** project tree, you can edit the CAM curve that determines the operating characteristics of CAM.



### - Features of CAM table

- Direct observation on the changes of CAM curves in corresponds to the slave motion range, velocity, acceleration, and jerk at any time.
- The master starting coordinate by default begins from 0 and ends at 360. You can make modifications based on real physical range

### - Editing method for CAM curves

#### • Graph editing on DIADesigner-AX



You adopt graphs to edit CAM table, horizontal coordinates as master position and master axis length to determine CAM operating range. The four kinds of curves shown in the page (see below) represents position, speed, acceleration and jerk. When designing CAM, postion and speed curve can be used to make motion range adjustment, while adjusting acceleration curve allows stabilization in movement.

#### • CAM table editing on DIADesigner-AX

Besides using graphs for editing, the CAM table is also used to modify any increase or decrease on critical points and positions directly on the CAM table page

🔏 Cam 🗴													
Cam	Car	m table Ta	appets	Тарр	et table								
		×	(	Y		V	А	J	Segm	min(P	max(P	max( V	max( A
			D	0		0	0	0					
6									Poly5	0	120	1.5120	0.0328
W	1	12	D	120		1	0	0					
6									Poly5	120	240	1	0
W	1	24	D	240		1	0	0					
6									Poly5	240	360	1.512	0.0328
		36	D	360		0	0	0					

### • Programming editing

You can also adopt programming to make modifications regarding critical points on the CAM table. To modify a program (see below), the starting position (master, slave) of CAM table moves from (0,0) to (0, 30), but image displayed in the software will not be changed.

For using DMC\_CamWritePoint function block to modify CAM table in programming, descriptions are as follows:

OAssigned CAM table

①Execute function blocks

Ochoose the CAM point number to read

③Position of the CAM master axis

④ Position of the CAM slave axis

SVelocity of the CAM slave axis

GAcceleration of the CAM slave axis



\*Note: For more details of function blocks, please refer to AX Series Motion Controller Manual.

#### • CAM table properties:

In Properties window, you can adjust the properties regarding CAM table. For example, the starting and ending position of master and slave, periodic parameters setups, required curve continuation and editing formats.

### • Steps on using E-CAM:

- 1. CAM table configuration: setup master range, slave range, create starting point, ending point and other critical points as well as curve type adjustments.
- 2. Use instruction MC\_CamTableSelect to connect configured CAM table with the actual one and receive CAM ID to be used for later instructions.
- 3. After receiving CAM ID, use instruction MC\_CamIn to execute engagement for assigned master and slave.
- Use instruction MC\_Camout for the master and slave relationship disengagement. For synchronous movement, use instruction MC\_Stop and MC\_Halt on slave axis for disengaging synchronous relation between master and slave.

### • Switching of CAM tables:

When CAM table is operating, please refer to MC\_CAM\_REF for switching the CAM table of MC\_CamTableSelect.

• Declaring variables

	0		
P : MO	CAM_REF;	//CamTable	reference
CamTak	oleID : INT;	//CamTable	Switch

Switching of CAM tables
 CASE CamTableID OF

CASE Camiableid OF
0: P:=Cam;
<pre>l: P:=Cam_1;</pre>
END_CASE

In the programming examples shown above, use the switching of CamTableID to change MC\_CAM\_REF to achieve switching of multiple CAM tables. Below are the two CAM tables:





300-	slave positio																	
200-							,											
100-																		
d	2	0 4	10	60 8	30 10	0 12	0 14	0 16	60 11	30 21	0 22	20 2	40 21	50 2	80 3	00 33	mas 20 34	ter position [u]

Timing diagram for switching of Cam table



When switching Cam tables, the slave moves along the motion path based on the first CAM table until the master position reaches to the next critical point and then start to follow th motion path based on the second.

#### 7.7.3 **Velocity Control**

There are three kinds of motion control modes, the Cyclic Synchronous Position (CSP), the Cyclic Synchronous Velocity mode (CSV), and Profile Velocity mode (PV).

# 7.7.3.1 CSP Mode

The CSP mode is described as cyclic synchronous position in section 7.7.2.1. Under this mode, the controller can calculate the position of a command per cycle based on assigned velocity (including acceleration, deceleration and jerk) then send this command to the servo for execution.

In CSP mode, when external interference causes the current servo position to lag behind the position command of the controller, vibrations may appear as a result to compensate these position errors.

The use of motion instruction MC\_MoveVelocity can execute velocity and motion control in CSP mode. When executing, the axis state enters continuous\_motion state. The assigned acceleration, deceleration and jerk can be set during velocity adjustment (before reaching assigned velocity or during buffering). MC\_Stop and MC\_Halt or other motion instructions can be used to stop the control mode when needed.

The following diagram uses MC\_MoveVelocity to proceed velocity and motion control, as well as MC\_Halt for discontinue in the timing diagram:



Assign velocity to 0, though the current movement is static but the system will be in continuous\_motion status.

In AX series, use instruction MC\_MoveVelocity to execute velocity control for single axis in CSP mode. Please refer to AX Series Motion Controller Manual for more function block details.

# 7.7.3.2 CSV Mode

The CSV mode is the cyclic synchronous velocity mode (CSV). Under this mode, the controller can calculate the velocity for per cycle based on the assigned velocity (including acceleration, deceleration and jerk) then send this command to the servo for execution.



Despite external interference, cyclic velocity commands in CSV mode are send to servos that are unlikely to cause vibrations due to compensating positions found in CSP mode.

In AX series, use instruction MC\_ VelocityControl to execute velocity control for single axis in CSV mode. Please refer to **AX Series Motion Controller Manual** for more function block details.

### 7.7.3.3 Profile Velocity Mode

Under this mode, velocity trajectory generator performs motion path planning based on conditions assigned by master devices, such as velocity command and acceleration as well as deceleration.



\*Note: Profile Velocity mode is used for positioning axes.

# 7.7.4 Torque control

Torque control can be categorized into Cyclic Synchronous Torque mode (CST) and Profile Torque mode (PT).

- Profile Torque mode\* (PT)
- Use DMC\_TorqueControl to generate assigned torque output continuously through single axes.
- Notification
  - When using DMC\_TorqueControl, switch the control mode to cyclic synchronous torque mode.
  - When using MC\_TorqueControl, the control mode switches to torque mode and cannot use function blocks regarding shifts or velocity. Use MC\_TorqueControl Enable instead of MC\_Stop to stop motors.
  - Do not set Torque to 0, when setting is 0, MC\_TorqueControl is reported as error.
  - Use the velocity of DMC\_TorqueControl to set the maximum velocity limit for servo motors which avoids high speed rotation as motor load declines in torque mode.
  - Adopt TorqueRamp to achieve the target torque value.
  - When Torque is bigger than 0 (Torque > 0), the motor operates in positive direction.



• When Torque is smaller than 0 (Torque < 0), the motor operates in negative direction.



Note:

\*1: ASDA-A3-E Series V1.1165 or later supports Profile Torque Mode.

\*2: ASDA-B3-E Series V1.0665 or later supports Profile Torque Mode.

# 7.7.5 Common Functions for Single-axis Control

The common functions for single-axis control are described in the following section.

# 7.7.5.1 Command Position

### • Types of positions

The axis motion function modules adopt the following two types of positions.

Type of position	Meaning
Command position	The position that MC function modules outputs to control an axis.
Actual position	The position as feedback from the servo drive*

\*Note: For virtual axis, there is no position feedback from the servo drive, so the command position will replaces the actual position.

### The following figure shows the relationship between the command position and actual position:



A comparison between the command position and actual position:

ltem	Command position	Actual position
Count mode	Linear axis / rotary axis	The same count mode setting as in command position
Command unit	Length unit (m, mm, inch…) / angle unit (degree) / …	The same unit setting as in command position
Software limits	Set the range limit for MC function modules	The same range limit setting as in command positoin
Positioning	Change to any desire position within the range limit	The same position setting as in command position, but position lag may appear*

\*Note: Due to the settings of servomechanism, the so-called position lag may be generated between command and actual positions. As motion velocity increases, position lag also increases slightly. When limiting the lag, you can adjust axis setting to monitor the position lag and set operation for position lag being too large. For virtual axis, actual position equals to command position and position lag does not exist. Descriptions for the relevant parameters are as follows:

### • Position unit

The unit refers to "command unit".

# Position lag

Setting	Value	Meaning
	Deactivated	Position lag not checked
Position lag	Disable drive	When position lag exceeds the limit, the axis is in servo off.
supervision	Do quick stop	When position lag exceeds the limit, the axis is in quick stop.
	Stay enabled	When position lag exceeds the limit, the axis maintains servo on.
Lag limit [u]	LREAL	Allowable lag limit

Besides deactivated setting value, when other settings exceeds lag limits, the axis reports error as in SMC\_ERROR.SMC\_DI\_POSITIONLAGERROR.

### • Software limits

Setting	Value	Meaning
Software limits Activated	Checked / Unchecked	Whether or not software limits is activated.
Negative [u]	LREAL	Negative software limit
Positive [u]	LREAL	Positive software limit

### • Description of positions in MC function modules

Please take note of the following input variables with two different interpretations that are related to positions in MC function modules:

ltem	Meaning
Position	Target position (absolute position)
Distance	Moving distance (relative position)

### • Monitoring positions

To observe change in position, you can focus on the following two axis variables (AXIS\_REF\_SM3 type) for monitoring:

Variable name	Position type	Data type
.fSetPosition	Command position	LREAL
.fActPosition	Actual position	LREAL

# 7.7.5.2 Velocity Command

### • Types of velocity

The following two types of velocity are used in MC function modules.

Position type	Meaning
Command velocity	The velocity in which MC function module ouputs for axis control
Actual velocity	The velocity based on the actual feedback position of servo drives at each point in time*

\*Note: For virtual axis, there is no position feedback from the servo drive, so the command position will replaces the actual position.

### • Velocity unit

The velocity unit is "command unit/s".

# • Velocity ramp type

Setting	Value	Meaning	
Velocity ramp type	Trapezoid	A trapezoidal velocity ramp (Each section is constant acceleration)	
	Sin <sup>2</sup>	The velocity ramp equals to sin <sup>2</sup> function (acceleration ramp is fixed)	
	Quadratic	Acceleration ramp with trapezoidal profile (jerk limited)	
	Quadratic (smooth)	Adopts the same meaning as in Quadratic, but with continuous S-curve velocity (jerk limited).	

#### • Description of velocity in MC function modules

The following input variable that is related to velocity in MC function modules:

Item	Meaning
Velocity	Target velocity*

\***Note:** Due to inadequate trajectory length, small acceleration and jerk as well as other factors, it is not possible to obtain the target velocity.

### • Monitoring velocity

To observe change in velocity, you can focus on the following two axis variables (AXIS\_REF\_SM3 type) for monitoring:

Variable name	Position type	Data type	
.fSetVelocity	Command velocity	LREAL	
.fActVelocity	Actual velocity	LREAL	

# 7.7.5.3 Acceleration and Deceleration Command

#### • Types of acceleration

The following two types of acceleration are used in the MC function modules.

Position type	Meaning
Acceleration command	The outputs of MC function modules to control axis acceleration
Actual acceleration	The acceleration calculated based on actual velocity

#### • Acceleration unit

The acceleration rates are in "command units/ s<sup>2</sup>".

#### • Axis settings related to acceleration

(1) Types of acceleration waveform

Please refer to "7.7.5.2 Velocity Command- Velocity ramp type" for more information.

#### • Description of acceleration in MC function modules

The following input variables that are related to acceleration/deceleration in MC function modules:

Item	Meaning		
Acceleration	Target acceleration*		
Deceleration	Target deceleration*		

\*Note: Due to inadequate trajectory length, small jerk and other factors, it is not possible to obtain target acceleration or target deceleration.

According to standard acceleration and deceleration rates, if demand for absolute value of current velocity decreases, deceleration rate is performed; if the demand for absolute value of current velocity increases, acceleration rate is performed.

For instance, when the current axis velocity is 500, the motion control instructions during execution is in reverse direction (Velocity = 1000, Acceleration = 1200, Deceleration = 600). The following diagram shows the velocity and acceleration waveform:

Targ	ger Velocity = -1000
	Acceleration = Decceleration = 600

#### • Monitoring acceleration

To observe change in acceleration, you can focus on the following two axis variables (AXIS\_REF\_SM3 type) for monitoring:

Variable name	Position type	Data type	
.fSetAcceleration	Command acceleration	LREAL	
.fActAcceleration	Actual acceleration	LREAL	

# 7.7.5.4 Jerk Command

The jerk assigns the changes in acceleration or deceleration rate. When the jerk is specified, the velocity waveform is in S-curve (the ramp of acceleration increases or decreases, no jerk) can reduce the shock on machines.

### • Types of jerk

The following two types of jerk are used in the MC function modules.

Position type	Meaning	
Command jerk	The outputs of MC function modules to control axis	
Actual jerk	The jerk that is calculated based on actual acceleration	

### • Jerk unit

The jerk is in "command units/s<sup>3</sup>".

### • Axis settings related to jerk

(1) Types of jerk waveform

Please refer to "7.7.5.2 Velocity Command- Velocity ramp type" for more information.

#### • Description of jerk in MC function modules

The following input variable that is related to jerk in MC function modules:

Item	Meaning
Jerk	Target jerk*

\***Note:** When velocity ramp type is trapezoid or in Sin<sup>2</sup>, the setting values of jerk are not applied in the movement; when velocity ramp type is quadratic or quadratic (smooth), the jerk does affect the velocity ramp.



### • Monitoring jerk

To observe change in jerk, you can focus on the following two axis variables (AXIS\_REF\_SM3 type) for monitoring:

Variable name	Position type	Data type
.fSetJerk	Command jerk	LREAL
.fActJerk	Actual jerk	LREAL

# 7.7.5.5 Axis Direction

The following situation requires specified operation directions:

- When input value of absolute during contant velocity, specified direction is required.
- When setting rotation axis, movement towards either postivie or negative direction can reach the target position, therefore, operation direction is required.
- Description of directions in MC function modules

The following input variable that is related to direction in MC function modules:

Item	Setting	Meaning				
	negative	Motion operates in a negative direction				
	shortest	Motion operates the shortest way (Only for rotation axis)*				
Direction	positive	Motion operates in a positive direction				
	current	Motion operates based on the current direction (Only for rotation axis)				
	fastest	Motion operates in the fastest way (Only for rotation axis)*				

\*Note: The concept of shortest (moving distance) and fastest (moving time) are similar but not completely the same, please refer to the following example:

• Setup:

Set axis as rotation axis, range 360

Set velocity ramp type of axis as Trapezoid.

Procedure:

Use MC\_MoveVelocity to execute constant velocity motion. (Velocity=1000)

When motor reaches 350 and velocity reaches 1000, execute MC\_MoveAbsolute with 2 different direction settings

(1) Execute MC\_MoveAbsolute (Position=180, Velocity = Acceleration = Deceleration = 1000, Direction = fatest)



When MC\_MoveAbsolute.Execute triggers, the system determines the shortest way to reach position 180 is to move in positive direction and decrease velocity to 0. The process takes about 1 sec.

- Velocity Position MC\_MoveAbsolute Execute
- (2) Execute MC\_MoveAbsolute (Position = 180, Velocity = Acceleration = Deceleration = 1000, Direction = shortest)

When MC\_MoveAbsolute.Execute triggers, the system determines the shortest way to reach position 180 is to move in negative direction (350 - 180 = 170). However, since the process requires velocity to be in reverse, therefore, more turns are included. The process takes about 2.5 sec.

# 7.7.6 Axis Group Control

An axis group must consists of at least one axis configured via DIADesigner-AX. Up to six axes can be supported for linear axes, while three axes are supported by rotary type with three extra axes as the follow axes.

# 7.7.6.1 Linear Interpolation

TransitionMode: The resulting noises and vibration of machines may occur if the trajectory of interpolation changes while in motion. By using the input variable "TransitionMode", the chances of the above situation will be minimized.

### Available transition modes

Mode	Description
None	No effects (default)
Overlap	Continued by combining the deceleration of the previous motion and the acceleration of the current motion.
SingleAxis	Continues according to the settings in Blending Mode, specifically for the single axis in a group

### Supported buffer modes

Mode	Aborting	Buffered	Blending Low	Blending Previous	Blending Next	Blending High
None	А	A	N	N	N	Ν
Overlap	А	A	D	D	D	D
SingleAxis	А	A	А	A	А	A

A = Supported

N = Not supported

D = Continued but different from the effects of settings set in Blending Mode for the single axis in a group


**TransitionMode:** For the below situation, set the mode to be None or Overlap, then choose buffered.

• **TransitionMode:** For the below situation, set the mode to be Overlap, then choose Blending. Plan with reference to acceleration and deceleration given to the motion function block of each axis group.



• TransitionMode: For the below situation, set the mode to SingleAxis, then choose Blending.



# 7.7.6.2 Circular Interpolation

Circular movements can be run in the three main planes of the spatial coordinate system, only using X, Y, Z axis and three additional follower axes.



### Concept of follower axes:

Follower axes A, B, C move in a propotional and synchronized motion as axes X, Y, Z moving.

The axis group moves to position (30, 40, 0) with the start point of 0, which the combined moving distance is 50, while follower axes moving to position (100, 200, 300). The synchronized movement between aixs group and follower axes is shown as following figures.



\*Note: When the axis group is not in motion, the input velocity given to axis group function block is used for the follower axis whichever the distance is the longest. At the same time, other follower axes move in synchronized motion based on the proportion of distances.

# 7.7.6.3 Group Stop Command

There're two different ways to stop axis group motion:

Programming stop

Use DMC\_GroupStop in the programming to decelerate the moving axis group to a stop. Then the group state switches to GroupStopping, which no motion instruction can be executed under this status.

The velocity for a deceleration stop must be set to the IrDeceleration pin.

Error stop

As soon as an error occurs in group motion, the axis group stops operating.

For example, Hardware Limit is reached while the axis group is moving. The velocity drops to zero as a result of the output CommandAborted.



# 7.7.7 High-speed IO

The chapter contains information regarding CPU with IOs for configuration and parameter settings.

# 7.7.7.1 IO Configurations

For all AX-3 Series PLC CPU (except AX-332E)



For AX-332E Series PLC CPU

are IO Configuration	Status	1	Configuration	
IO I/O Mapping	Status	L.	Counter	SSI
stion	TX+ SG RX+ A+ B+ Z+ IN 0 1 2 3 4 IN 5 5/5	TX- 5G RX- A- B- Z- 0 OUT 1 2 3 4 5 OUT C0	Mode: MODE_UD **	SSI Encoder Capture Capture 0 Compare Compare 0
		ECAT		

**DIO:** Set functions including interrupt, filter and polarity. Refer to section 7.7.7.2 for more information.

**SSI Encoder**: Set functions such as SSI coding type, clock frequency and SSI data length. Refer to section 7.7.7.3 for more information.

**Pulse Encoder:** Set functions including high speed counter variables, count modes, enable or disable Z phase signal as well as declare high speed timer variables. Refer to section 7.7.7.4 for more information.

**Capture/ Compare:** Declares variables regarding high speed capture and compare. Refer to section 7.7.7.5 for more information.

**Pulse Output:** Set functions including pulse output, direction and homing mode. Refer to section 7.7.7.6 for more information.

## 7.7.7.2 DIO Settings

The section describes setting funcitons including interrupt, filter and polarity of IOs in DIO device.

Double-click on "DIO" to enter the configuration page.

#### For all AX-3 Series PLC CPU (except AX-332E)



For AX-332E Series PLC CPU



### Configuration

Function	Description	
	Default value	
	Activate external interrupt	
External Interrupt     Setting*	When external interrupt is activated, set input signals as rising edge.	
Setting*	When external interrupt is activated, set input signals as falling edge.	
	When external interrupt is activated, set input signals as rising and falling edge.	
@ Port	Port number	
③ Filter	Set filter time (us), setting range is from 0 to 100000000. The default is 100us.	
	E Set input polarity. The default is contact A .	
④ Polarity	Set input polarity, The default is contact B.	

Note: External Interrupt Setting is not available for AX-332E Series PLC CPU.

#### IO interrupt mode setting

After activate the interrupt function on DIO setting page, click on "Task" tp proceed.



Enter Task configuration page and choose "External" from the drop down list for Type.

Devices - 4 X	Stask 🗙
Untitled1 Device (AX-308EA0MA1T) Hardware Configuration A Network Configuration A Network Configuration PIC Logic PIC Logic PIC Logic POU (PRG) POU (PRG) EtherCAT_Task PIC_PRG EtherCAT_Task PIC_PRG EtherCAT_Task PIC_PRG EtherCAT_Task PIC_PRG EtherCAT_Task PIC_PRG EtherCAT_Task PIC_PRG EtherCAT_Task PIC_PRG EtherCAT_Task PIC_PRG EtherCAT_Task PIC_PRG EtherCAT_Task PIC_PRG POU POU POU POU POU POU POU POU POU POU POU POU POU POU POU POU	Configuration Priority (0.31): Type OCOLOR Value
<ul> <li>EtherCAT_Master_SoftMotion (EtherCAT Master SoftMotion)</li> <li>Builtin_IO (Builtin_IO)</li> <li>DIO (DIO)</li> <li>&lt; <empty></empty></li> <li>Motion Pulse_Encoder (Pulse_Encoder)</li> <li> Pulse_Encoder (Capture_Compare)     <li> Pulse_Output (Pulse_Output)     <li>SoftMotion General Axis Pool</li> </li></li></ul>	POU Comment ④ POU

■ Then choose the corresponding interrupt contact from the drop down list of External event.

Devices 🗸 🕈 🗙	Task X
<ul> <li>Untitled1</li> <li>Device (AX-308EA0MA 1T)</li> <li>Hardware Configuration</li> <li>Ketwork Configuration</li> <li>Ketwork Configuration</li> <li>EtherCAT Filter</li> <li>PLC Logic</li> <li>Application</li> <li>Lbrary Manager</li> <li>PLC_PRG (PRG)</li> <li>POU (PRG)</li> <li>Task Configuration</li> <li>EtherCAT_Task</li> <li>POU (PRG)</li> <li>Task</li> <li>POU</li> <li>Delta_LocaBus_Master (Delta LocaBus Master)</li> <li>EtherCAT_Master_SoftMotion (EtherCAT Master SoftMotion)</li> <li>Builtin_IO (Builtin_IO)</li> <li>Builtin_IO (Builtin_IO)</li> <li>Builtin_IO (Builtin_IO)</li> <li>Capture_Compare (Capture_Compare)</li> <li>Puise_Encoder (Puise_Encoder)</li> <li>SoftMotion General Axis Pool</li> </ul>	Configuration         Priority (031 ):         Image: Starmal with the starmal starmatic starmati starmati starmatic starmatic starmati starmati starm

• The setting value for hardware filter time is smaller than IN input duty on time as shown below:



- For AX-3 Series PLC CPU: The input range for hardawre filter is from 1 to 50,000,000, unit as 0.1 μs (except for AX-332E).
- For AX-332E: The input range for hardawre filter is from 1 to 50,000,000, unit as 0.1 µs.

Input range	Effective value
$0 \leq input value < 1000$	0 µs
$1000 \leq input value < 5000$	100 µs
5000 $\leq$ input value < 10000	500 µs
10000 ≦ input value	1000 µs

Four ranges are as shown below.

Example 1: Input a value of 900, the effective value will be 0  $\mu$ s.

Example 2: Input a value of 12000, the effective value will be 1000 µs.

The relation between filter frequency and filter time:

Filter frequency<sup>\*1</sup> (Hz): Filter frequency=  $1 / (2^*t)$ ; t is the filter time setting value (unit: 0.01µs). When input frequency is higher than the filter frequency range, signals are filtered.

The function focuses on the X input point used in DFB\_Capture, DFB\_Hcnt, DFB\_HTmr, DFB\_Compare and IO interrupt.

# 7.7.7.3 SSI Encoder Settings

For AX-3 Series PLC CPU (except AX-332E): Through connecting D-SUB port and PLC, the port provides 5V encoder power output.

For AX-332E: Connects through European style terminal block

You can click and enable SSI encoder function to setup the required parameters as well as receive data via hardware configuration channels.

• SSI encoder structure



- Enable SSI encoder
  - Click SSI Encoder and choose SSI Encoder Configuration on BuiltIn\_IO page.

For all AX-3 Series PLC CPU (except AX-332E)

Configuration		
Configuration		Counter 551
		Counter 0 SSI Encoder
		Z Phase use OC
	IN IN	Counter 1
	0 8	2 Phase use oc
SSI Data	1 9	Counter 2. Capture 1
SSI	2 10	Counter 3 Capture 2
	3 11	Counter 4 Capture 3
SSI Clack		Counter S Capture 4
	4 12	Counter 6 Capture 5
	5 13	Counter 7
	6 14	Timer 0 Capture 7
	7 15	Timer 1
	5/50 5/51	Timer 2 Compar
		Timer 3 Compare 0
	ουτ ουτ	Timer 4 Compare 1
AI		Timer 5 Compare 2
81	0 4	
Z1	1 5	Timer 7
A2		Axis Compare 4
82	2 6	Pulse Output Axis 0 Compare 5
22	3 7	Pulse Output Axis 1 Compare 6
	co co	Pulse Output Axis 2 Compare 7
Encoder		Pulse Output Axis 3

### For AX-332E



7

The SSI related configuration can be set on the SSI Encoder Configuration page. Refer to below descriptions for settings respectively.

Hardware 10 Configuration	General			
SSI Encoder Configuration	Clock Frequency		Clock Pause Time	
IEC Objects	Cleck			1.0.0
Status				
Information	Data X			
	Multi-Turn Da	ta Single-Tu	n Deta	
		M		
	Encoder Type: Gray Code 🗠			
	Clock Frequency: 500	kHZ Clock Paus	e Time: 80	🔹 us
	Single Turn Setting: 13	Multiple Tu	rns Setting: 12	•
		10		
	(2) Axis Standard	~		
	Y	4	Positive Command	Negative Command
	Encoder Type: SSI Encoder		Co.	(An
	3 Axis Type	Reverse OFF	(507.	(50)
	Linear Axis     Rotary Axis			- /
	Modulo: 360 4 [ Unit ]		cw	CCW
			(An	(An
		O Reverse On	USON.	USOJ.
			cow	CW
	5 Transmission Mechanism		ccw	CW
	Mechanism Type Ball Screw V	Mechanism Setti	ng	
	(4)	(1) Command p	ulse per motor rotation: 1	Pulse ]
		(4) Pitch: 1	🗣 [ Unit ]	
		Gear Box		
			(2) Gear ratio numerator	1
		Gear Ratio =	(3) Gear ratio denominator	1

For all AX-3 Series PLC CPU (except AX-332E)

```
1) General
```

ltem	Function	Setting value (Default value)
EncoderType	Set SSI encoder type	Gray code / Binary code (Gray code)
Clock Frequency	Set SSI clock frequencies (Need SSI encoder datasheet as reference) AX-3 Series PLC CPU (except AX-332E): you can input any value in the range of 0-10000; AX-332E: 5 available options to choose from, 100, 200, 500, 1000 and 2000	(500)

# AX-3 Series Operation Manual

ltem	Function	Setting value (Default value)
MultiTurnsSetup	Set SSI encoder multiturn setup (Need SSI encoder datasheet as reference)	(12)
SingleTurnsSetup	Set SSI encoder singleturn setup (Need SSI encoder datasheet as reference)	(13)
Clock Pause Time	After the last falling edge of clock, the data line keeps at a low level for a while before the line rises. (Need SSI encoder datasheet as reference)	(80)

# 2 Axis Standard

ltem	Function	Setting value (Default value)
Encoder Type	Display encoder type	-

# ③ Axis Type

Item	Function	Setting value (Default value)
Linear Axis / Rotary Axis	Set the axis type to be Linear Axis or Rotary Axis.	Linear Axis Rotary Axis (Linear Axis)
Modulo	Choose the axis type to be rotary axis first and set the value for the rotation area for a turn.	(360)

# ④ Positive / Negative Command

Item	Function
Reverse OFF / ON	Decide on the rotation direction for positive and negative commands.

# © Transmission Mechanism

Different structures are presenred in the following descriptions:

# Ball Screw

lechanism Type	Ball Screw	¥	(1) Command pu	ng ulse per motor rotation: 1	-	[ Pulse ]
		2	(4) Pitch: 1			
			Gear Box			
	(3)		Gear Ratio =	(2) Gear ratio numerator	1	4
			Gear Ratio =	(3) Gear ratio denominator	1	4

Item	Description
(1) Command Pulse per motor rotation	Amount of pulses that the encoder counts per revolution of the motor
(4) Pitch	Pitch of screw
(2) Gear ratio numerator	The numerator of gear ratio
(3) Gear ratio denominator	The denominator of gear ratio

Mechanism Type	Round Table	× (4)		Ise per motor rotation: 1 stance per motor rotation: 1		[Pulse ] [Unit]
Å	ÊC I		Gear Box			
	ÊC <sub>0</sub>		Gear Box Gear Ratio =	(2) Gear ratio numerator	1	•

Item	Description
(1) Command Pulse per motor rotation	Amount of pulses that the encoder counts per revolution of the motor
(4) Movement distance per motor rotation	Distance of movement per revolution of the motor.
(2) Gear ratio numerator	The numerator of gear ratio
(3) Gear ratio denominator	The denominator of gear ratio

#### Belt Pully

lechanism Type	Belt Pully	*	Mechanism Settin (1) Command pu	ng ulse per motor rotation: 1	1 V	[ Pulse ]
		(4)	(4) Diameter: 1 Movement distan	[ Unit ]	er * n	
			Gear Box			
	(3)		Gear Ratio =	(2) Gear ratio numerator	1	\$
			Gedi Kalio =	(3) Gear ratio denominator		4

Item	Description
(1) Command Pulse per motor rotation	Amount of pulses that the encoder counts per revolution of the motor
(4) Diameter (Movement distance motor rotation : Diameter $*\pi$ )	Distance of movement per revolution of the motor. (Movement distance per rotation : Diameter $*\pi$ )
(2) Gear ratio numerator	The numerator of gear ratio
(3) Gear ratio denominator	The denominator of gear ratio

#### SSI Encoder mapping variable setting

The actual position and ErrorID can be read by SSI Encoder via the following parameters.

Description
Actual position of SSI Encoder
Status of SSI Encoder Communication.
0 : No Error
1 : Error Communication
2 : Wrong Parameter Setting

## \*Note:

ErrorID:

- 1. When SSI encoder is not connected or SSI encoder and CPU is disconnected, then ErrorID=1.
- 2. When MultiTurns + SingleTurns is bigger than 32, then ErrorID=2.

The error situations mentioned above allows BusCycle to stop updating EncoderPosition and the EncoderPosition will keep the last value, the purpose is to avoid jump from other slave axis when main axis encoder is in synchronized motion.

#### ErrorID Clear:

1. When SSI encoder is not connected or SSI encoder and CPU is disconnected, then Status Data=1, the BusCycle stops to update and the EncoderPosition keeps the last value, the purpose is to avoid jump from other slave axis when main axis encoder is in synchronized motion.

Ans: Check the connection between SSI encoder and CPU. The modified firmware will make sure the communication channel is properly connected to restore EncoderPosition updates of BusCycle. There are many reasons for cause of errors, for example: SSI encoder not properly connected, broken SSI encoder and abnormal drive board.

2. When MultiTurns + SingleTurns is bigger than 32, then Status Data =2:

Ans: When the parameter setting value of MultiTurns + SingleTurns does not exceed 32, then download again.

#### • Use SSI Encoder in program

The SSI encoder device contains variables of axis encoder that can be used for MC function blocks in POU. (Ex. MC\_CamIn).

ler Configuration		Counter	SSI
	IN IN	Counter 0 Z Phase use OC	SSI Encoder Capture
	0 8	Z Phase use OC	Capture 0
on		Counter 2	Capture 1
551 Data	1 9	Counter 3	Capture 2
SSI	2 10	Counter 4	Capture 3
SSI Clock	3 11	Counter 5	Capture 4
	4 12	Counter 6	Capture 5
U	5 13 6 14	Counter 7 Timer	Capture 6
		Timer 0	Capture 7
	7 15 5/50 5/51	Timer 1	Compare
$\cap$		Timer 3	Compare 0
AI	ουτ ουτ	Timer 4	Compare 1
B1	0 4	Timer 5	Compare 2
21		Timer 6	Compare 3
A2	1 5	Timer 7 Axis	Compare 4
B2	2 6	Pulse Output Axis 0	Compare 5
22	3 7	Pulse Output Axis 1	Compare 6
	c0 c0	Pulse Output Axis 2	Compare 7
Encoder		Pulse Output Axis 3	

■ Click "IEC Objects" on BuiltIn\_IO page.

#### Example of variable reading

Variable	Туре	Configuration Function
Encoder_Axis_1	DFB_SSI_ENCODER_REF DMC_ENCODER_AXIS_REF	SSI Encoder SSI Encoder/FreeEncoder_Axis
	SSI_Encoder	SSI_Encoder DFB_SSI_ENCODER_REF

The actual position and ErrorID can be accessed via the variable with red border, such as "SSI\_Encoder. EncoderPosition" and "SSI\_Encoder.ErrorID".

The column marked ① on the IEC Objects tab is the configuration function for each variable. For the axis used in POU, the axis name should be set as Encoder\_Axis.

Hardware IO Configuration	Variable	Туре	Configuration Function
	SSI_Encoder	DFB_SSI_ENCODER_REF	SSI Encoder
SSI Encoder Configuration	Encoder_Axis	DMC_ENCODER_AXIS_REF	SSI Encoder/FreeEncoder_Axis
IEC Objects			
Status			
Information			
Information			
Information			

For MC\_CamIn function block in POU, SSI can be used for master source, while the input name of Master axis is Encoder\_Axis.



# 7.7.7.4 Pulse Encoder Settings

- AX-3 Series PLC CPU (except AX332E) provides two connecting interfaces for the pulse encoder
  - AX-3 Series PLC CPU supports two differential inputs: Connecting through D-SUB15 port, up to 2 sets of high speed counters / timers can be used to count or time the pulse values or the frequencies of the encorder.
  - AX-3 Series PLC CPU supports six sets of open collector typed pulse inputs: Connecting through the euroblock installed on the IO board; up to 6 sets of high speed counters / timers can be used to count or time the pulse values or the frequencies of the encorder.
- AX332E Series PLC CPU (except AX332E) provides two connecting interfaces for the pulse encoder
  - AX332E supports one differential input: Connecting through differential input as designed from the euroblock installed on the IO board, one set of high speed counter / timer can be used to count or time the pulse values or the frequencies of the encorder.
  - AX332E supports six sets of open collector typed pulse inputs: Connecting through the open connector typed pulse inputs as designed from the euroblock installed on the IO board; up to 6 sets of high speed counters / timers can be used to count or time the pulse values or the frequencies of the encorder.

You need to seclet to enable pulse-type encoder function and set up the required parameters and then through the configured hardawre channel to receive the encoder data.

This section below describes the pulse-type encoder (see below), the maximum amount of high speed counters and high speed timers supported for AS308E is 8 sets. While for AS332E, it supports 7 sets of of high speed counter, but no high speed timers.

## • High speed counter (Cnt)

When selecting Cnt function in Hardware IO Configuration, you can also setup the high speed counter and encoder sections.



# • Enable hign speed IO function AX-3 Series PLC CPU (except AX-332E)

A number of 8 counters are displayed on BuiltIn\_IO page. Select Counter 0, then click "Counter Configuration" tag.



• On Counter Configuration page, choose Counter.

Hardware IO Configuration	Counter 0 Counter Mode					
Counter Configuration	Counter Mode Description		Description			
IEC Objects			Cladowice Public			
Status	0	UD	Counter-clockwise Pulse			

rdware IO Configuration	Coun	ter 0						
unter Configuration		unter M	lode					
Objects			Counter Mode			Description		
tus				Clockwise Pulse	<u></u>			_
	3	0	UD	Counter-clockwise Pulse	ockwize Pulse.			
rmation		+						
		0	PD	Pulse				_
				Direction Clockwise		Cou	nter-clockwise	
				A-Phase Pulse		гъг	-	
		۲	AB	B-Phase Pulse			1	
	-	-		37.987.99	,			
		0	4AB	A-Phase Pulse			<u> </u>	
		2	TAD	8-Ffuice Pulse			t	
		-	External Trigge	r				
	(2) <sub>A</sub>	xis Star	ndard		0			
	E	ncoder	Type: Incre	mental Encoder	4	Positive Command	Negative C	ommand
	1.1					(An	((c	m
	3 A	xis Typ	e		Reverse OFF	Cor.	0	1
	۲	Linea	r Axis	Rotary Axis		cw	cc	w
	P	todulo:	360	¥ [Unit]		$\cap$	m	
					C Reverse On	((da))	((C	20
					O Reverse On	07	C	1
	(5)					cow	0	N
		ansmiss	ion Mechanism					
	м	lechani	sm Type Ball S	icrew +	Mechanism Setti (1) Command p	ulse per motor rotation: 1		[ Pulse ]
			(2)		(4) Pitch: 1	🖨 [ Unit ]		
	(1	Λ	60	111 3	0			
			CO		Gear Box			
				(3)		(2) Gear ratio numerator	1	
					Gear Ratio =	Test e constant de la constant	1	
						(3) Gear ratio denominator	1	\$

Configure Counter-related settings on Counter Configuration page. Descriptions are as follows.

### ① Counter Mode

Pulse Counter Mode	Description
UD	Forward rotation pulse train and reverse rotation pulse train
PD	Pulse and direction
AB	A-phase and B-phase pulse
4AB	A-phase and B-phase pulse (4x)
External Trigger*	Activate Z-phase signals

Note: Refer to section 3.5 DFB Preset Value from AX Series Standard Instruction Manual for more information on function blocks.

Refer to section 7.7.7.3 SSI Encoder Setting for 2 3 4 5 on configuration page.

# • AX332E

A number of 7 counters are displayed on BuiltIn\_IO page. Counter 0 is fixed to correspond to difficiential inputs A, B, Z. For the rest counters, you can set to other modes. Here are explanaitons for Counter 0, and Counter 1 to 7.

### Counter 0:

A number of 7 counters, counter 0 to 6, are displayed on BuiltIn\_IO page. Select Counter 0, then click "Counter Configuration" tag.



• On Counter Configuration page, choose Counter.

Hardware IO Configuration	Counter		
Counter Configuration	Counter	Mode	
counter configuration	_	Counter Mode	Description
IEC Objects			Clockwise Pulke
Status	0	UD	Counter-clockwise Pulse
Information			

unter Configuration	Counter	Mode				
C Objects		Counter Mode			Description	
iltIn_IO I/O Mapping	۲	UD	Clockwise Pulse Counter-clockwise Pulse			
prmation	0	4AB	A-Phase Pulse			- <u>1</u>
		andard er Type: Incre	mental Encoder	4	Positive Command	Negative Command
	• Fin	Axis Type Finite ( Modulo: 360	O Modulo	Reverse OFF	(Go).	Cory.
	1000		[ one ]	O Reverse On	Gog.	(G).
	(5)Transm	ission Mechanism				
	Mecha (1)	(2)	icrew ~	Mechanism Sett (1) Command p (4) Pitch: 1	ngs ulse per motor rotation: 1 [ Unit ]	🛓 [ Pulse ]
	Ĵ	CO	0	Gear Box	(2) Gear ratio numerator	1
			10)	Gear Ratio =	(3) Gear ratio denominator	1

Configure Counter-related settings on Counter Configuration page. Descriptions are as follows.

① Counter Mode

Pulse Counter Mode	Description
UD	Forward rotation pulse train and reverse rotation pulse train
4AB	A-phase and B-phase pulse (4x)

Refer to section 7.7.7.3 SSI Encoder Setting for 2 3 4 5 on configuration page.

7

### Counter 1 to 7:

Counter 0 to 6 are displayed on BuiltIn\_IO page. You can select various modes from the drop-down list. Different mode corresponds to its specific counters.



### • Descriptions for modes and their corresponding counters

Mode	Corresponding Counter	Description
		1. Use the pins of UP or DOWN for input
MODE_UD	Counter1~Counter6	siganls and the counter can count up or
		count down.
		1. Use the pins of UP or DOWN for input
MODE_UDR	Counter1/Counter3/Counter5	siganls and the counter can count up or count down.
		2. Use the pin of RESET to clear the counter.
	Counter1/Counter4	1. Use the pins of UP or DOWN for input
		siganls and the counter can count up or
MODE UDRE		count down.
		2. Use the pin of RESET to clear the counter.
		3. Use the pin of ENABLE to activate the
		counter.
		1. Use the pin of UP for input siganls and the
		counter can count up.
		2. Use the pin of DOWN for input siganls and
MODE_UDRE2	Counter1	the countes can cout down.
		3. Use the pin of RESET to clear the counter.
		4. Use the pin of ENABLE to activate the
		counter.

Mode	Corresponding Counter	Description
MODE_PAB	Counter1	<ol> <li>Use the pin of PA (pulse A phase) for input signals and Phase A signal is single-wired (counter).</li> <li>Use the pin of PB (pulse B phase) for input signals and Phase B signal is single-wired (counter).</li> <li>Use the pin of RESET to clear the counter.</li> <li>Use the pin of ENABLE to activate the counter.</li> </ol>

• Different hardware layouts are designed for variou modes. DIADesigner-AX shows the corresponding counters and their pins.



7-125





	0				
IEC Objects	(2) Axis Standard		4	Positive Command	Negative Comma
BuiltIn_IO I/O Mapping	Encoder Type:	Incremental Encoder		(A.	A.
Status	3 Axis Type		Reverse OFF	USOJ.	US0-
Information	Finite	O Modulo		cw	CCW
	Modulo: 360	[ Unit ]		$\cap$	$\cap$
			O Reverse On	(507.	(So
				ccw	cw
	5 ransmission Mech		Markening Collin		
	(1) (2) (4) (4)		Mechanism Settings (1) Command pulse per motor rotation:          (4) Pitch:       1       [ Unit ]		
	(1)				E L Pul
					E [ Pul
			(4) Pitch: 1		T

Configure Counter-related settings on Counter Configuration page. Descriptions are as follows.

Refer to section 7.7.7.3 SSI Encoder Setting for @ 3 @ \$ on configuration page.

### • Use Counter in program

The high speed counter contains variables of axis encoder that can be used for MC function blocks in POU.

■ Click on "IEC Objects" tab on BuiltIn\_IO page.

Configuration	L	Counter	SSI
		Counter 0 Z Phase use OC	SSI Encoder Capture
	0 8	Z Phase use OC	Capture 0
	1 9	Counter 2	Capture 1
		Counter 3	Capture 2
SSI	2 10	Counter 4	Capture 3
	3 11	Counter 5	Capture 4
	4 12	Counter 6	Capture 5
	<u> </u>	Counter 7 Timer	Capture 6
		Timer 0	Capture 7
	7 15 5/50 5/51	Timer 1	Compare
		Timer 3	Compare 0
AL	ουτ ουτ	Timer 4	Compare 1
B1	0 4	Timer 5	Compare 2
21		Timer 6	Compare 3
A2	1 5	Timer 7 Axis	Compare 4
B2	2 6	Pulse Output Axis 0	Compare 5
22	3 7	Pulse Output Axis 1	Compare 6
	C0 C0	Pulse Output Axis 2	Compare 7
Encoder		Pulse Output Axis 3	

The column marked ① on the IEC Objects tab is the configuration function of each variable. To enable counter function, the variavle Counter\_0 needs to be input to the Counter pin of DFB\_HCnt.

Hardware IO Configuration	Variable	Туре	Configuratio	DFB_H	Cnt_0
	Counter_0	DFB_COUNTER_REF	Counter 0	DFB	HCnt
Counter Configuration	Encoder_Axis	DMC_ENCODER_AXIS_REF	Counter 0/Freezncoder_Axis	EN	ENO
EC Objects				Counter_0 - Counter	bValid -
tatus				-bEnable	bBusy -
					bError -
nformation					ErrorID -
				di	CounterValue -

For MC\_CamIn function block in POU, the input variable corresponding to Master should be Encoder\_Axis while using variable Counter\_0 SSI as the source of the master axis.

Hardware 10 Configuration	Variable	Туре	Configuration Function	1	MC_GearIn_0
	Counter_0	DF6_COUNTER_REF	Counter 0	TRUE	MC_GearIn
Counter Configuration	Encoder_Axis	DMC_ENCODER_AXIS_REF	Counter 0/FreeEncoder_Axis	E	N ENO-
IEC Objects				Encoder_Axis - Ma	
	-			SM_Drive_Virtual - SI	
tatus				- E3	xecute CommandAborted
nformation					atioNumerator Error
				- R.	atioDenominator ErrorID
				- Ac	cceleration
	-			- De	eceleration
				- 34	erk

### • High speed timer (Tmr)



#### Enable high speed timer function

### For AX-3 Series PLC CPU:

When selecting Tmr function in Hardware IO Configuration, the high speed timer in AX series is set as 0.1µs. To enable timer function, select Timer 0 to 7 on BuiltIn\_IO page to activate.

#### For AX332E:

This functionality is not supported.



- Timer mapping variable setting
  - Right click "BuiltIn\_IO" and choose Edit IO Mapping.



Click	to add new variables on Edit IO Mapping page.

Edit IO mapping ×	Filter S	show all			Add FB for IO Channel.
Variable	Channel	Address	Туре	Description	
🖻 - 🛐 DIO					
1 · · · · · · · · · · · · · · · · · · ·	IN:0-7	%IB0	BYTE	8-CH Open Collector In	put
🛞 - 🍫	IN:8-15	%IB1	BYTE	8-CH Open Collector In	nput
۰. ۲	Encoder	%IB2	BYTE	2-CH of Incremental Er	ncoder Input
· 😧	OUT:0-7	%QB0	BYTE	8-CH Open Collector O	utput
= Pulse_Encoder					
🖻 🛤 Timer_0					
L 30	Timer Value	%ID1	DWORD	HSIO Timer Value	

### • Use Timer in program

The Timer variables can be used for MC function blocks in POU.





The column marked ① on the IEC Objects tab is the configuration function of each variable. For the axis used in POU, the axis name should be set as Timer\_0.

Hardware IO Configuration	Variable	Туре	Configuration Function
IEC Objects	Timer_0	DFB_TIMER_REF	Timer 0
Status			
Information			

To enable Timer function, DFB\_HTmr\_0 is required to use. For DFB\_HTmr\_0 function block in POU, enter Timer\_0 as the axis name.



# 7.7.7.5 Capture/Compare Function Settings

This section introduces the Capture and Compare function modules with built-in high-speed counters. A maximum of 8 groups of high-speed captures and compares can be supported by AX series motion controllers.

# Capture





## Enable Capture function



Select one of the 8 Capture groups to activate on the BuiltIn\_IO page.

Then choose the external trigger input from the drop-down list after activating Capture.



### Use Capture in program

BuiltIn IO ¥

The Capture variables can be used for MC function blocks in POU.

■ Click "IEC Objects" on BuiltIn\_IO page.

Status		Ln .	-
		Counter	SSI
0		Z Phase use OC	SSI Encoder
	IN IN	Counter 1	Capture
	Cap ExternalTrigger 0 1 8	Z Phase use OC	Capture 0 IN 0
	1 9	Counter 2	Capture 1
		Counter 3	Capture 2
SSI	2 10	Counter 4	Capture 3
	3 11	Counter 5	Capture 4
	4 12	Counter 6	Capture 5
	5 13	Counter 7	Capture 6
	6 14	Timer	Capture 7
	7 15	Timer 0	
	5/50 5/51	Timer 1	Compare
		Timer 2	Compare 0
	τυο τυο	Timer 3	Compare 1
AL		Timer 5	
81	0 4	Timer 6	Compare 2
Z1	1 5	Timer 7	Compare 3
A2		Axis	Compare 4
B2	2 6	Pulse Output Axis 0	Compare 5
22	3 7	Pulse Output Axis 1	Compare 6
	C0 C0	Pulse Output Axis 2	Compare 7
Encoder		Pulse Output Axis 3	

■ The column marked ① on the IEC Objects tab is the configuration function of each variable. For the axis used in POU, the axis name should be set as Capture \_0.

Hardware IO Configuration	Variable	Туре	Configuration Function
IEC Objects	Capture_0	DFB_CAPTURE_REF	Capture 0
Status			
Information			

For DFB\_Capture function block in POU, enter Capture \_0 as the axis name.



### Compare



#### • Enable Compare function

Select one of the 8 Compare groups to activate on the BuiltIn\_IO page.




Then choose the external trigger output from the drop-down list after activating Compare.

# Use Compare in program

The Compare variables can be used for MC function blocks in POU.

Status			-Un			
				Counter	S	51
				Z Phase use OC	SSI Encoder	
	IN	IN	5	Counter 1	Cap	ture
$\cap$		8	2	Z Phase use OC	Capture 0	
		- C - C - T	_ 2	Counter 2	Capture 1	
		9	_	Counter 3	Capture 2	
SSI	2	10	- 1	Counter 4	Capture 3	
	3	11	- 1	Counter 5	Capture 4	
5 2		12	_	Counter 6	Capture 5	-
U	5	13	- 1	Counter 7 Timer	Capture 6	-
	6	14	- 1	Timer 0	Capture 7	
	7	15	- 1	Timer 1		
	5/50	5/51		Timer 2	Com	
$\cap$				Timer 3	Compare 0	OUT 0
	OUT	OUT		Timer 4	Compare 1	
81	Cmp CoincidentOutput	4	_	Timer 5	Compare 2	
21				Timer 6	Compare 3	
A2		5	_	Timer 7 Axis	Compare 4	
B2	2	6		Pulse Output Axis 0	Compare 5	
22		7	_	Pulse Output Axis 1	Compare 6	
	C0	co	-	Pulse Output Axis 2	Compare 7	
Encoder				Pulse Output Axis 3		

Click "IEC Objects" on BuiltIn\_IO page.

■ The column marked ① on the IEC Objects tab is the configuration function of each variable. For the axis used in POU, the axis name should be set as Compare \_0.

Hardware IO Configuration	Variable	Туре	Configuration Function
IEC Objects	Compare_0	DFB_COMPARE_REF	Compare 0
Status			

■ For DFB\_Compare function block in POU, enter Compare \_0 as the axis name.

POU X			
1		DFB_Co	mpare_0
	TRUE	DFB_C	ompare ENO-
	Compare_0 -	Compare	bValid -
		Counter	bBusy-
		bEnable	bError
		Mode	ErrorID
		wRefreshCycl	e
		diCmpValue	

# 7.7.7.6 Pulse Output Function Settings

This section introduces pulse output function modules with built in IO shown as follows

For AX-3 Series PLC CPU: A maximum of 4 groups pulse-output units can be used with AX-308E series motion controllers.

For AX332E: Only one group of pulse-output unit can be used with AX332E.

#### Activate axis function

Choose one of the four pulse output axes to activate on BuiltIn\_IO page.



Click "PoAxis Configuration" after activating Axis.



7

Mode A/B	¥		Axis Type and L     Virtual mode     Uinear Axis		re Limits
Reverse OFF	Positive Command	Negative Command	Cinear Axis     Rotary Axis	Activated Negative [u]: 0 Positive [u]: 100 Rotary Axis Modulo Modulo value [u]:	0 Setting
) Reverse On	Cw cw	CCW CCW	Velocity Ramp	Deceleration [u/s	a]: 1000
ansmission Mec Mechanism Typ		Mechanism (1) Comm (4) Pitch:	and pulse per motor	rotation: 10000 Unit ]	A [Pulse]
		Gear Box			

Click to enter Axis 0 tab on PoAxis Configuration page.

7

lode Setting	ting	(	Axis Type and Limits		
Mode A/B	v		Virtual mode		
inter line	Positive Command	Negative Command	Linear Axis 3 Linear Axis Software Limits		
	Positive command	Continuity Continuity	Rotary Axis     Activated		
	( PO	( PO	Negative [u]:		
	1 don	(0)	Positive [u]: 1000		
Reverse OFF	1007	1007	4 Rotary Axis Modulo Setting		
	10	CW	Modulo value [u]: 360		
	CCW	CW	Motion Parameter		
	( 60)	( 6)	5 Error Reaction		
Reverse On	(0)	(0)	Quick Stop Deceleration [u/s²]: 1000		
	1	1	6) Velocity Ramp Type		
	cw	CCW	Trapezoid      Sin <sup>2</sup> Quadratic      Quadratic(smooth)		
Insmission Med	chanism				
lechanism Type	e Ball Screw V	Mechanism	Setting		
and an and a short		(1) Comma	nd pulse per motor rotation: 10000 🛉 [ Pulse ]		
	(2) (4)	(4) Pitch:			
(1)		(4) Pitch:			
(1)	- UIII	20			
4		Gear Box			
1			(2) Gear ratio numerator 1		
V	(3)	Gear F	(2) Gear ratio numerator 1		
			(3) Gear ratio denominator 1		
ming Setting					
	Mode 35 V				
loming Mode	Mode 35 v during search for switch 100	🗘 [ Unit/s ]			
loming Mode					
loming Mode	during search for switch 100 during search for z phase puls	se 50 🛔 [ Unit/s ]			
loming Mode	during search for switch 100 during search for z phase puls	se 50 🛔 [ Unit/s ]			
loming Mode loming speed o loming speed o loming Acceler escription	during search for switch 100 during search for z phase puls ration 1000	se 50 🛉 [ Unit/s ] nit/s² ]			
loming Mode loming speed o loming speed o loming Acceler escription	during search for switch 100 during search for z phase puls	se 50 🛉 [ Unit/s ] nit/s² ]			
loming Mode loming speed o loming speed o loming Acceler escription	during search for switch 100 during search for z phase puls ration 1000	se 50 🛉 [ Unit/s ] nit/s² ]			
loming Mode loming speed o loming speed o loming Acceler escription	during search for switch 100 during search for z phase puls ration 1000 (Ur : Depending on the	it [ Unit/s ]	the axis does not move and its current position is regarded as		

• Axis-related settings can be configured on Pulse Output Setting page, which is described in the following information.

# 1 Mode setting

ltem	Funtion	Setting Value (Default)
Mode	Set the type of pulse output.	CW/CCW Pulse and Direction (A/B)
Reverse ONn / Reverse OFF	Set the pulse axis to rotate in positive or negative direction.	Reverse ONn Reverse OFF (Reverse OFF)

### ② Axis Type and Limits

ltem	Funtion	Setting Value (Default)
Virtual	Activate virtual axes.	TRUE FALSE (FALSE)
Linear Axis / Rotary Axis	Set the axis type to be linear axis or rotary axis.	Linear Axis Rotary Axis (Linear Axis)

### ③ Linear Axis Software Limits

Item	Funtion	Setting Value (Default)
Activated	Activate software limit (only supports linear axis)	TRUE/FALSE (FALSE)
Negative[u]	Set the negative software limit.	(0)
Positive[u]	Set the positive software limit.	(10000)

### ④ Rotary Axis Modulo Setting

Item	Funtion	Setting Value (Default)
Modulo Value[u]	Set the area of rotation for a turn. (only supports rotary axes)	(360)

### (5) Error Reaction

Item	Funtion	Setting Value (Default)
Quick Stop	Stop the axis immediately.	(360)
Deceleration[u/s2]	The axis will perform a deceleration stop. (functional only when Quick Stop is not activated)	(10000)

### 6 Velocity Ramp Type

Item	Funtion	Setting Value (Default)
Trapezoid/Sin²/Quadratic/ Quadratic (Smooth)	Set the ramp type for axis motion.	(Trapezoid)

### O Software Configuration Page: Please refer to 7.7.7.3 SSI Encoder Setting

### ⑧ Homing Setting

Item	Funtion	Setting Value (Default)
Homing Mode	Set the homing mode.	(Mode 351)
Homing speed during search for switch	Set the homing speed during search for switch.	(1000)
Homing speed during search for z phase pulse	Set the homing speed during search for z phase pulse.	(50)
Homing Acceleration	Set the homing acceleration.	(10000)

### Use Pulse Axis in program

To use Pulse Axis in POU, Pulse Output Axis variables are required for MC function blocks in POU.

Status		Counter	
		Counter	SSI
		Z Phase use OC	SSI Encoder
	IN IN	Counter 1	Capture
	Po Axis CHO LSP 0 8	Z Phase use OC	Capture 0
	Po Axis CHO LSN 1 9	Counter 2	Capture 1
	Po Axis CH0 Z	Counter 3	Capture 2
SSI	Po Axis CH0 Home Switch	Counter 4	Capture 3
	3 11	Counter 5	Capture 4
	4 12	Counter 6	Capture 5
	5 13		Capture 6
	6 14	Timer	
	7 15	Timer 0	Capture 7
	5/50 5/5	Timer 1	Compare
		L Timer 2	
	τυο τυο	Timer 3	Compare 0
A1 \			Compare 1
81	Po Axis CH0 A 0 4	Timer 5	Compare 2
21	Fo Axis CH0 B	Timer 6	Compare 3
A2	13	Timer 7	Compare 4
82	2 6	Pulse Output Axis 0	Compare 5
22	3 7	Pulse Output Axis 1	Compare 6
	co co		Compare 7
Encoder	co co	Pulse Output Axis 3	

Click "IEC Objects" on BuiltIn\_IO page.

The column marked ① on the IEC Objects tab is the configuration function of each variable. For the axis used in POU, the axis name should be set as Pulse\_Output\_Axis\_0.

Hardware IO Configuration	Variable	Туре	Configuration Function
PoAxis Configuration	Pulse_Output_Axis_0	DMC_PULSE_AXIS_REF	Pulse Output Axis 0
IEC Objects			
Status			

■ For MC\_Power function block in POU, enter Pulse\_Output\_Axis\_0 as the axis name.

C_Power_0	ŀ	
MC Power		TRUE
ENC	EN	
Status	Axis	Pulse_Output_Axis_0-
bRegulatorRealState	Enable	
bDriveStartRealState	bRegulatorOn	
Busy	bDriveStart	
Error		
ErrorID		

# 7.7.7.7 Confirm High-Speed IO Errors

Errors in Pulse Output Axis are displayed on Status tab under BuiltIn\_IO page with messages notifying you of which pulse axis has error.

vices 🗸 🗸 🗸	Device 👔 Library Ma	anager DLC_PRG DIO BuiltIn_10	×	
Unsted1     Unsted1     Device [connected] (AX-308EA0M4     A Hardware Configuration     A Network Configuration	Hardware IO Configuration	Pulse_Output : Last Diagnostic Message	Bus failure	Acknowledge
B) P.C. Logic     Application [run]     Bory Manager     B. C. PRG (PRG)     Static Configuration     Static Configuration     Soft Task     G) P.C. PRG	IEC Objects Status Information	Dagnoos Message: "Pulse axis channel () has error'		
A      Builth 10 (Builtin 10)     DIO (DIO)     SoftMotion General Axis Pool	2			

You can continue to check and monitor the error information on PoAxis Configuration tab page.

= 😏 🕤 Device [connected] (AX-308EA0MA	Hardware IO Configuration	Axis 0				
A Network Configuration	PoAxis Configuration	Online Status: SMC_AXIS_STATE	errorstop		Communication: operational (100)	
CLoge     Correction [run]     Application [run]     Dray Manager     PLC_PRG (PRG)     Stat Configuration     PLC_PRG     Stat Configuration     PLC_PRG     Did (PRG)     Did (PRG)     SoftMotion General Ass Pool	IEC Objects Status Information	variable Position [u] Velocity [u/s] Acceleration [u/s <sup>2</sup> ] Torque [Nm]	set value 0,004 0 0 0	actual value 0.004 0 0 0	Errors Axis Error: 0 (16#00000000) FB Error: SNC_ERROR.SMC_FB_WASNT_CALLES_DURING_MOTION uDriveInterfaceError: 0 strDriveInterfaceError:	
		Reverse OFF	e Command	Negative Command	Axis Type and Limits Virtual mode Uinaar Axis Rotary Axis Negative [u]: Positive [u]: Rotary Axis Nodulo Setting Modulo value [u]: Solo	
		O Reverse On	~~ ( ~~ (	cw CCW	Motion Parameter Error Reaction Quick Stop Deceleration [u/s4]: 1000 Velocity Ramp Type Trapezoid Sin <sup>2</sup> Quadratic Quadratic(smooth)	

# 7.7.8 Other Features

# 7.7.8.1 Change Current Position

### MC\_SetPosition

This function block is to change the current position by shifting the coordinate system of an axis.

The changing of the coordinate system is made by modifying both the current position of the instruction (command position) and the actual position from the feedback signals with the same value.

The following error between command position and actual position remains the same value.

The function block is used to change the coordinate system and does not lead to servo drive and motor movement. And the current position of the encoder axis can be edited by this function block.

#### Timing diagram



# 7.7.8.2 Software Limit

In addition to hardware limit, the range of axis motion can also be limited by software limit.

Values for forward and reverse limit range need to be set before activating software limit. Software limit is set to be not activated as defult so as to prevent any damage to the device when an operator error occurs.



Note: Refer to section 7.7.2.4 for example on Stop Method.

### Software display

Can be configured via DIADesigner-AX software.

General Setting	Axis Type and Li		Motion Parameter
Homing Setting Commissioning SM_Drive_ETC_Delta_ASDA_A2: IEC Objects	<ul> <li>Virtual mode</li> <li>Linear Axis</li> <li>Rotary Axis</li> </ul>	Linear Axis Software Limits Activated Negative [u]: 0  Positive [u]: 1000	Error Reaction Quick Stop Deceleration [u/s <sup>2</sup> ]: 100 Velocity Ramp Type Trapezoid Sin <sup>2</sup> Quadratic Quadratic(smooth)
Status		Rotary Axis Modulo Setting Modulo value [u]: 360	Position Lag Supervision Position Lag Reaction Deactivated * Lag Limit [u]:
Information	Transmission Mer Mechanism Typ (1)		Mechanism Setting (1) Command pulse per motor rotation: 131072 (4) Pitch: 1 Unit ]
			-
			Gear Box (2) Gear ratio numerator 1

The positive and negative position are able to be resized on the configuration page:

Item	Data Type	Default Setting
Negative	LREAL	0.0
Position	LREAL	10000.0

# 7.7.8.3 Position Lag Setting

The command position as well as feedback position are located at zero while the axis is in motion. If there's a greart difference between command position and feedback position, an error will be reported.

The position lag reaction is set to be "Stay Enabled" as default.

Setting mode	Function
Deactivated	Not activated.
Disable drive	When position lag exceeds limit setting, axis will shift to servo off.
Do quickstop	When position lag exceeds limit setting, axis will shift to quick stop.
Stay enabled	When position lag exceeds limit setting, axis will remain as servo on.
8# SM_Drive_ETC_Delta_ASDA_A2 X	

General Setting	Axis Type and Lin		Motion Parameter Error Reaction
Homing Setting	Linear Axis     Rotary Axis	Linear Axis Software Limits	Quick Stop Deceleration [u/s <sup>2</sup> ]: 1000
Commissioning	0 1000 700	Negative [u]: 0	Velocity Ramp Type
SM_Drive_ETC_Delta_ASDA_A2: IEC Objects		Positive [u]: 10000	Trapezoid Sin <sup>2</sup> Quadratic Quadratic(smooth)
Status		Rotary Axis Modulo Setting Modulo value [u]: 360	Position Lag Supervision Position Lag Reaction Stay Enabled Y Lag Limit [u]: 100
Information	Transmission Mec	hanism	
	Mechanism Type	Ball Screw	Mechanism Setting
			(1) Command pulse per motor rotation: 10000
		Com 2	Gear Box
	V V		(2) Gear ratio numerator
V		Gear Ratio =	

# 7.7.8.4 Cam Switch Function

### MC\_DigitalCamSwitch

Specify the tappet position. True when the moving axis reaches the specified position, then turn to False when passing it. The following example regards to configuration settings.

- Example: Use two switches in the same track with MC\_DigitalCamSwitch instruction.
  - Parameter setting

Parameter	Туре	Switch1	Switch2
TrackNumber	INT	1	1
FirstOnPosition [u]	REAL	200	400
LastOnPosition [u]	REAL	300	-
AxisDirection	INT	0=Both	0=Both
CamSwitchMode	INT	0=Position	1=TIME
Duration	TIME	-	2500ms

Trigger and timing

Position 400 200	 		
MC_DigitalCamSwitch			
Enable			
Track1			2.5sec

- Switch 1 on Track 1 is ON when the position reaches 200 and turns to OFF once the axis position reaches 300.
- When the position reaches 400, Switch 1 turns to ON again for 2500ms and then shifts to OFF.

# 7.7.8.5 Position Capture

MC\_TorchProbe captures and records an axis position when a trigger event occurs.

A total of two trigger signals can be configures for each axis. MC\_AbortTrigger is used to abort capture function.

Function description:

- The touch probe operation activates for only one time for recording the very first trigger signal after Execute is set as True. When a valid position is captured and recorded, the following trigger signals will be ignored.
- One function block instance should relate to only one MC\_TouchProbe instruction.
- If there were multiple function block instances on the same capture and axis, the members of MC\_TRIGGER\_REF should be added with TouchProbeID, which identifies different TouchProbe actions. The definition of TouchProbeID can be associated to MC\_AbortTrigger.
- The operation of MC\_TouhcProbe with window mask function is demonstrated as below:



- At the first activation of the trigger input signal, the signal is not accepted because the axis position hasn't reach the specified window mask section.
- When the axis position enters the window mask section, the second activation of the trigger input signal is accepted, and after a period Done chnages to True.

# 7.8 Programming Example

The following section explains on the basis of the programming example.

# 7.8.1 Device Framework

The following devices are used in the example.

Device	Model Name	
CPU	AX-308E	
Power	DVP-PS02	
Servo driver	Delta ASDA-A2-E	
Servo motor	Delta ECMA-C	

# 7.8.1.1 Utilization

Please refer to the following manuals for information regarding device configuration and wiring.

Device	Reference	
CPU and Power	Chapter 2 in this manual	
Servo driver	Related configuration description in Delta servo drive user manuals	
Wiring for EtherCAT slave device	Delat ASDA A2-E EtherCAT Interface Servo Drive User Manual	

# 7.8.1.2 Configurations

The following configuration is applied in the example in the next section.

Device	Configuration setting
Controller	Chapter 2 in this manual
Motion control settings	Chapter 7 in this manual
Servo parameters	Use the default settings of ASDA-A2-E slave, gear ratio=10000 : 10000

# 7.8.2 Examples

The following example uses the same POU in EtherCAT task to explain. Also, the required variables will be declared and used in this POU Task. (The POU naming in LD and ST languages will be different for illustration purpose.)



The Interval time for ECAT synchronization is set to be 4 ms.

EtherCAT_Task X		
nfiguration		
Priority ( 031 ): 1		
Туре		
🕑 Cyclic 🗸 🗸	Interval (e.g. t#200ms): 4000	µs ~
Watchdog		
Enable		
Time (e.g. t#200ms):		ms
Sensitivity:		
🕂 Add Call 🗙 Remove Ca	I 📝 Change Call   🔮 Move Up 👙 Move Down   + 🖥 Open POU	
POU	Comment	
EcatMotion		

Set the gear ratio as 10000:10000 for mechanism setting.

General Setting	Axis Type and Limits	Motion Parameter
Homing Setting	Virtual mode     Uinear Axis     Rotary Axis     Axis     Activated	Error Reaction Quick Stop Deceleration [u/s <sup>2</sup> ]: 1000
Commissioning SM_Drive_ETC_Delta_ASDA_A2:	Negative [u]: 0	Velocity Ramp Type Trapezoid Sin <sup>a</sup> Quadratic Quadratic(smooth)
IEC Objects	Rotary Axis Modulo Setting	Position Lag Supervision
Status	Modulo value [u]: 360	Position Lag Reaction Stay Enabled Y Lag Limit [u]: 100
	Province of the second s	Mechanism Setting
	Mechanism Type Ball Screw (4)	Mechanism Setting (1) Command pulse per motor rotation: 10000 Pulse ] (4) Pitch: 10000 P [ Unit ]
		(1) Command pulse per motor rotation: 10000 🔮 [ Pulse ]

# 7.8.2.1 Servo On

Execute MC\_Power (Servo on) instruction to activate the servo driver after the EtherCAT communication is built in the following example with LD and ST programming languages supported.

Main variables used in programming	
------------------------------------	--

Variable	Data Type	Default	Note
SM_Drive_Virtual	AXIS_REF_SM3	-	Virtual axis variable
Start	BOOL	FALSE	Shift to True when start the server and enable Servo On

### LD language

Check for the successful EtherCAT communication when Start is True so as to enable MC\_Power via ServoOn output, which the status should be True.



#### ST language

Check for the successful EtherCAT communication when Start is True so as to enable MC\_Power via ServoOn output, which the status should be True.

Monitoring window can also be used to observe the variable output status with no need for naming the output variables.

```
IF Start THEN
```

ServoOn :=TRUE; ELSE ServoOn :=FALSE;

```
END_IF
```

```
//MC_Power
```

MC\_Power\_0(

```
Axis:= SM_Drive_Virtual,
Enable:= ServoOn,
bRegulatorOn:= TRUE,
bDriveStart:= TRUE,
Status=> ,
bRegulatorRealState=> ,
bDriveStartRealState=> ,
Busy=> ,
Error=> ,
ErrorID=> );
```

# 7.8.2.2 Reset and Control Single-axis Error

You can view the error information of variable status through Watch table. Take MC\_MoveVelocity input as example, when acceleration value is set as 0 and Execute is True, an error will occur in the fuction block and the ErrorID displays Row Data 301. You can find the complete error message in the Watch table, which is SMC\_MV\_INVALID\_ACCDEC\_VALUES. After troubleshooting with manual's help, MC\_MoveVelocity can function normally by shifting the Execute status from False to True. As for MC\_Reset, it is used for clearing servo errors.

The following example supports with LD and ST programming languages.

#### • Main variables used in programming

Variable	Data Type	Default	Note
SM_Drive_Virtual	AXIS_REF_SM3	-	Virtual axis variables
ServoOn	BOOL	FALSE	To enable MC_Power
MC_MoveVelocity0_Execute	BOOL	FALSE	Execute input of velocity instruction
MC_MoveVelocity0_Acceleration	LREAL	0	Acceleration input of velocity instruction, for setting acceleration.
MC_DIRECTION.positive	MC_Direction	-	Assigned moving direction-positive
FBErrorOccured	MC_ReadStatus	FALSE	True when an error occurs in the function block
ClearErr	BOOL	FALSE	When FBErrorOccured is True, FB errors can beclear by triggering SMC_ClearFBError

# Timing Diagram



### LD Language

	MC Power 0	MC MoveVelocity 0
	MC_Power	MC_MoveVelocity
BM_Drive_Virtual Axis Servoln TRUE Fasble IRUE bRegulato TRUE bDriveSta		SM_Drive_Virtual Axis Invesced 7702 MC_NoveVelocity0_Execute 7702 Execute Susy F7152 MC_NoveVelocity0_Execute 7702 Execute Susy F7152 10000 Velocity CommandAported 77152 MC_NoveVelocity0_Acceleration Acceleration ErrorID - 57152 10000 Deceleration ErrorID - 57052 10000 Jerk MC_DIRECTION.positive C1 Direction
SM Drive_Virtus1 — MC_Reset_0_Excute ZAMSE		HC ReadStatus_0 NC ReadStatus_0 NC ReadStatus Drive_Virtual — Axia Valid TRUE Enable Rusy TRUE Eraor PRASE RerorTD - SRC_NO_ERA Disabled - PRASE RerorTD - SRC_NO_ERA Stopping 73155 Stopping 731555 Stopping 731555 Stopping 731555 Stopping 731
		SynchronizedMotion = 72552 Hobing = 72552 ConstantyLocity = 72552

Via function SMC\_ClearFBError that error can be deleted and output FBErrorOccured of MC\_ReadStatus would shift to Fulse, once an error occurs in the function block. In addition, since input of SMC\_ClearFBError need to be tranferred via pointers, ADR(input) must be fed and use bool to clear FB error flag.

	Reset Reset Busy Rusy ErrorID RerorID (MC NO			Stopping - StandStill - DiscreteMotion - ContinuousMotion -	Teles Teles FALSE (SC) 303 CB2 FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE	ADR (SM	Drive_Virtual	SMC_ClearFError
Watch 1								
Watch 1	Application	Туре	Value		Prepared y	Executionpoint	Address	Comment
Expression	Application	Туре	Value		Prepared v	Executionpoint	Address	Comment Error identification
				D_ACCDEC_VALUES		Executionpoint Cyclic Monitoring	Address	Comment Error identification

#### Disable Execute input of MC\_MoveVelocity to update the status of Error output.

	MC_Power_0			MC_M	oveVelocity_0
10 m	MC_Power			MC_1	NoveVelocity
SM Drive Virtual Axis		Status - TRUE	53	Drive Virtual Axis	InVelocity - FALS
Servoon TRUE Enable	bRegulator	RealState - TRUE		Execute Execute	Busy - FALS
TRUE DRegul	atorOn bDriveStart	RealState - TRUE	the second second second second second second second second second second second second second second second se	10000 - Velocity	CommandAborted - 9748
IRUE DDrive	Start	Busy - TRUE	MC_MoveVelocity0_Accelerat	ion 0 Acceleratio	
		Error - FALSE		10000 - Deceleratio	n ErrorID - 59C
		EFFORID - SMC_NO_ERS	1	10000 Jerk	

Set acceleration of MC\_MoveVelocity to be 10000 and restart (Execute is True). The output of MC\_MoveVelocity would be Busy with values of fSetVelocity and fSetPosition shown on the Watch table under normal operation.



#### ST Language

MC\_MoveVelocity\_0(

Axis:= SM\_Drive\_Virtual,

Execute:= MC\_MoveVelocity0\_Execute,

Velocity:= 10000,

Acceleration:= MC\_MoveVelocity0\_Acceleration,

Deceleration:= 10000,

Jerk:= 10000, Direction:= MC\_DIRECTION.positive,

InVelocity=> ,

Busy=>,

CommandAborted=>,

Error=> ,

ErrorID=>);

MC\_ReadStatus\_0( Axis:= SM\_Drive\_Virtual, Enable:= TRUE);

Set acceleration of MC\_MoveVelocity to be 10000 and restart (Execute is True). The output of MC\_MoveVelocity would be Busy with values of fSetVelocity and fSetPosition shown on the Watch table under normal operation.

MC\_MoveVelocity\_0( Axis:= SM\_Drive\_Virtual, Execute:= MC\_MoveVelocity0\_Execute, Velocity:= 10000, Acceleration:= MC\_MoveVelocity0\_Acceleration := 10000, Deceleration:= 10000, Jerk:= 10000, Direction:= MC\_DIRECTION.positive,

```
InVelocity=> ,
Busy=> ,
CommandAborted=> ,
Error=> ,
ErrorID=> );
MC_ReadStatus_0(
Axis:= SM_Drive_Virtual,
Enable:= TRUE );
```

# 7.8.2.3 Control on Instruction Errors

If an error occurs while executing instruction MC\_Power (Servo On), no further action will be taken, while ProgNext indicates whether execution can be moved on. The following example supports with LD and ST programming languages.

Variable	Data Type	Default	Note
SM_Drive_Virtual	AXIS_REF_SM3	-	Virtual axis variables
ServoOn	BOOL	FALSE	To enable MC_Power
ProgNext	BOOL	FALSE	ProgNext indicator shows whether to take further action
MC_Power_0.Status	BOOL	FALSE	Axis is ready to move when the status is True.
MC_Power_0.Busy	BOOL	FALSE	Execution of FB has not been completed when the status is True.

#### • Main variables used in programming

#### Timing Diagram



### • LD Language

Check if any errors have occurred in MC\_Power before moving onto the next step.

1	Start 	ServoOn (
2	MC_Power_0     MC_MoveVelocity_0       28     RMC_Power     RMC_MoveVelocity_0       SM_Drive_Virtual     Axis     Status     TMORE       IRUE     DRegulatorOn     bDriveStartRealState     TMORE     10000     Velocity     CommandAborted       TRUE     DDriveStart     Busy     TMORE     10000     Deceleration     Error ID     FMASE       TRUE     DDriveStart     Busy     TMORE     10000     Deceleration     Error ID     FMASE       INC_NO_ERR     10000     Jeceleration     Error ID     MC_DIRECTION.positive C1     Direction	
3	MC_Power_0.Status MC_Power_0.Busy	ProgNext —(

### • ST Language

ErrorID=> );

```
IF Start THEN
     ServoOn :=TRUE;
     ELSE
     ServoOn :=FALSE;
END_IF
IF (MC_Power_0.Status=TRUE) OR (MC_Power_0.Busy=TRUE) THEN
     ProgNext :=TRUE;
     ELSE
     ProgNext :=FALSE;
END_IF
//MC_Power
MC_Power_0(
     Axis:= SM_Drive_Virtual,
     Enable:= ServoOn,
     bRegulatorOn:= TRUE,
     bDriveStart:= TRUE,
     Status=>,
     bRegulatorRealState=>,
     bDriveStartRealState=> ,
     Busy=>,
     Error=>,
```

# 7.8.2.4 Quick Stop for Single Axes

MC\_Stop can be used to stop the moving axis when an error occurs during execution of MC\_MoveAbsolute instruction. The following example supports with LD and ST programming languages.

### • Main variables used in programming

Variable	Data Type	Default	Note
SM_Drive_Virtual	AXIS_REF_SM3	-	Virtual axis variables
ServoOn	BOOL	FALSE	To enable MC_Power
MC_MoveAbsolute0_Execute	BOOL	FALSE	Execute input of MC_MoveAbsolute
MC_DIRECTION.positive	MC_Direction	-	Assigned moving direction-positive (valid for rotary axes)
StopOn	BOOL	FALSE	Activate MC_Stop when the status is True
MC_Stop_0.Done	BOOL	FALSE	Execution of MC_Stop is done when the status is True

### Timing Diagram

MC_MoveAbsolute Execute	
MC_MoveAbsolute Busy	
MC_MoveAbsolute Done	
MC_MoveAbsolute Error	
MC_Stop Execute	
MC_Stop Done	
SetVelocity	
SavePosition	

#### LD Language

Execute homing under normal output status of MC\_Power. Once homing is completed, execute MC\_MoveAbsolute. At the same time, MC\_Stop can be excuted for a quick stop if needed, which would abort MC\_MoveAbsolute with state True of CommandAborted output so as to command a deceleration stop for axis based on the setting of deceleration, then the Done output of MC\_Stop shifts to True after the stop command completed.



#### ST Language

The process is same as LD. After MC\_Home is done, the state would be Standstill.

```
//MC_Power
```

```
MC_Power_0(
Axis:= SM_Drive_Virtual,
Enable:= ServoOn,
bRegulatorOn:= TRUE,
bDriveStart:= TRUE,
Status=>,
bRegulatorRealState=>,
bDriveStartRealState=>,
Busy=>,
Error=>,
ErrorID=>);
```

```
//MC_Home
```

IF MC\_Power\_0.Status THEN MC\_Home\_0( Axis:= SM\_Drive\_Virtual, Execute:= MC\_Home\_0\_Execute, Position:= 0, Done=>, Busy=>, CommandAborted=>, ErrorID=>); END\_IF If a quick stop is performed by MC\_Stop during execution of MC\_MoveAbsolute, MC\_MoveAbsolute would be aborted and be in Stopping state.

//MC\_MoveAbsolute & MC\_Stop MC\_MoveAbsolute\_0( Axis:= SM\_Drive\_Virtual, Execute:= MC\_MoveAbsolute0\_Execute, Position:= 10000.0, Velocity:= 500.0, Acceleration:= 500.0, Deceleration:= 500.0, Jerk:=, Direction:= MC\_DIRECTION.positive, Done=>, Busy=>, CommandAborted=>, Error=>, ErrorID=>); MC\_Stop\_0( Axis:= SM\_Drive\_Virtual, Execute:= StopOn, Deceleration:= 5000.0, Jerk:=, Done=>, Busy=>, Error=>, ErrorID=>);

#### 7.8.2.5 Home Positioning

Use homing instruction in the the following example to let you understand how to perform the homing operation. Currently, a total of 36 homing modes (0~35) are supported and the OD is 6098(Homing method) /6099sub1(Speed during search for switch) /6099sub2(Speed during search for zero). For more details, please refer to Delta High Resolution AC Servo Drive ASDA-A2 Series User Manual.

For the following example, specify the parameters of OD as mentioned above after adding A2-E sevo in EtherCAT Slave.

Choose mode 33 for Homing Method (Perform homing operation once meet the first Z pulse.)

Speed during search for switch =1000 (Unit: 0.1rpm) (Search for limit switch at the speed of 100rmp.)

Speed during search for zero =100 (Unit: 0.1rpm) (Search for zero at the speed of 10rmp.)

After settings are completed, the homing method for executing MC\_Home with LD/ ST language would be corresponding to the one specified as above.

neral Setting	Homing Mode 33	
ming Setting	Homing speed during search for switch 1000 🗳 [0.1 rpm ] Homing speed during search for 2 phase pulse 100 🗳 [0.1 rpm ]	
nmissioning	Homing Acceleration 100 🔮 [ms]	
Drive_ETC_Delta_ASDA_A2: Dbjects	Mode 33 : Depending on Z pulse in the negative direction	
	wode 55 . Depending on 2 pulse in the negative direction	
ation	In mode 33, The homing instruction is executed and the axis moves at the sec	cond-phase speed ( Homing speed
	during search for Z phase pulse ) in the negative direction. And the place where t	he axis stands is the home position
	once the first Z pulse is met.	and the second second second
	Stop point Start point	
	Stop point Start point	

# • Main variables used in programming

Variable	Data Type	Default	Note
Axis_1	AXIS_REF_SM3	-	Real axis variables
ServoOn	BOOL	FALSE	To enable MC_Power

# • Timing diagram

MC_Home Execute	
MC_Home Done	
MC_ReadStatus Disabled	
MC_ReadStatus StandStill	
MC_ReadStatus - Homing	

### LD language

The state would be Standstill when the outputs of MC\_Power are under normal status. Shift to state Homing when execute MC\_Home, then back toStandstill after home positioning is completed.



#### ST language

Process is same as LD. The state is Standstill after execution of MC\_Home is completed, which the output status can be checked via variables and Watch tables.

#### MC\_Home\_0(

Axis:= Axis\_1, Execute:= , Position:= 0, Done=> , Busy=> , CommandAborted=> , Error=> , ErrorID=> );

MC\_ReadStatus\_0(

```
Axis:=Axis_1,
Enable:= TRUE,
Valid=> ,
Busy=>,
Error=>,
ErrorID=>,
Disabled=>,
Errorstop=>,
Stopping=>,
StandStill=>,
DiscreteMotion=>,
ContinuousMotion=>,
SynchronizedMotion=>,
Homing=>,
ConstantVelocity=>,
Accelerating=>,
Decelerating=>,
FBErrorOccured=>);
```

# 7.8.2.6 Absolute Positioning

Via MC\_MoveAbsolute instruction used in the following example that you are able to understand how to perform displacement at one speed. The following example supports with LD and ST programming languages.

#### • Main variables used in programming

Variable	Data Type	Default	Note
Axis_1	AXIS_REF_SM3	-	Real axis variables
ServoOn	BOOL	FALSE	To enable MC_Power
MC_MoveAbsolute0_Execute	BOOL	FALSE	Execute input of MC_MoveAbsolute
MC_DIRECTION.positive	MC_Direction	-	Assigned moving direction- positive (valid for rotary axes)

### Timing diagram

Servo On	
MC_MoveAbsolute Execute	
MC_MoveAbsolute Busy	
MC_MoveAbsolute Done	
MC_MoveAbsolute Error	
SetVelocity	
SavePosition	

### • LD language

Check if the outputs of MC\_Power is under normal status, then execute MC\_MoveAbsolute to move from the start position 0 to the assigned position 50000.

	MC_Power_0	MC_MoveAbsolv	te_0
1.1	MC_POWER	MC_MoveAbsol	ute
Axis_1 - Axis	Status - TRUE	Axis_1 - Axis	Done
ServoOn TRUE Enable	bRegulatorRealState TRVE	MC_MoveAbsolute0_ExecuteExecute	Busy
TRUE bRegulator(	n hDriveStartRealState TRUE	50000 - Position Com	andAborted
TRUE - bDriveStart	Busy - TRUE	10000 - Velocity	Error
	Error - FALSE	100000 - Acceleration	ErrorID
	ErrorID - SMC NO ERE	100000 - Deceleration	
L		100000000 Jerk	
		MC_DIRECTION.positive C 1 Direction	

### ST language

```
MC_Home_0(
     Axis:= Axis_1,
     Execute:=,
     Position:= 0,
     Done=>,
     Busy=>,
     CommandAborted=>,
     Error=>,
     ErrorID=> );
MC_MoveAbsolute_0(
     Axis:= Axis_1,
     Execute:= MC_MoveAbsolute0_Execute,
     Position:= 50000,
     Velocity:= 10000,
     Acceleration:= 100000,
     Deceleration:= 100000,
     Jerk:= 100000,
     Direction:= SM3_Basic.MC_DIRECTION.positive,
     Done=>,
     Busy=>,
     CommandAborted=> ,
     Error=>,
     ErrorID=> );
```

# 7.8.2.7 Switch CAM Table during CAM Operation

The following example illustrates that CAM table can be switched while executing MC\_CamIn.

Perform switching between two CAM tables configured with different output parameters by adding master and slave axes as well as using two MC\_CamIn instructions. Use CamTable 1 when the instruction position of master axis is below 3000. Once the position is over 3000, it will switch to CamTable 2.

- Default Variable Data Type Note Axis\_Master AXIS\_REF\_VIRTUAL\_SM3 \_ Master-related axis variables Axis\_Slave AXIS\_REF\_VIRTUAL\_SM3 \_ Slave-related axis variables CamTable1 MC\_CAM\_REF -Relating variables for Cam table1 CamTable2 MC\_CAM\_REF Relating variables for Cam table2 If this variable is TRUE and the communication with axes is normal, Servo StartFlag BOOL FALSE ON will be activated and continue on further actions. Status output variables of MC\_Power for MC\_Power0\_Status BOOL FALSE master, TRUE when Servo On Status output variables of MC\_Power for FALSE MC\_Power1\_Status BOOL slave, TRUE when Servo On
- Main variables used in programming

Variable	Data Type	Default	Note
MC_Home0_Done	BOOL	FALSE	Output Done variables of MC_Home for master, TRUE when homing completed.
MC_Home1_Done	BOOL	FALSE	Output Done variables of MC_Home for slave, TRUE when homing completed.
MC_MoveAbs_Busy	BOOL	FALSE	Output Bust variables of MC_MoveAbsolute for master, TRUE when the FB is executed.
CamTableSelect	MC_CAM_REF	-	Specify the corresponding Cam table.
CamTable1_En	BOOL	FALSE	TRUE when CamTable1 is chosen to be used.
CamTable2_En	BOOL	FALSE	TRUE when CamTable2 is chosen to be used.
CamTableID	MC_CAM_ID	-	The internal data structure of the selectedCam table, which is from MC_CamTableSelect and used as input of MC_CamIn.
MC_CamIn1_InSync	BOOL	FALSE	Output InSync variables of CamTable1, TRUE when master and slave axis are synchronized with cam.
MC_CamIn2_InSync	BOOL	FALSE	Output InSync variables of CamTable2, TRUE when master and slave axis are synchronized with cam.

# CamTable1 :

300.0				 					
200	 	 				 			
. S 100도			 	 	 				
			 		 	 	m	aster posi	tion [u]

# CamTable2 :

30	slave				 	•	 				
20	- positi	 					 				
10	임 아드	 		 			 				
			 						 m	aster <u>pos</u> iti	on [u]

# • Timing diagram

StartFlag		
MC_Power0_Status		
MC_Power1_Status		
MC_MoveAbs_Busy		
CamTable1_En		
CamTable2_En		
MC_Camin1_InSync		_
MC_Camin2_InSync		
Axis_Master. 6000		
Axis_Slave. fSetPosition		-
	1 · · · · · · · · · · · · · · · · · · ·	

# • LD language

Set StartFlag to be TRUE, then the normal operation of communications for both master and slave axis would be checked respectively

	StartFlag	Axis_Master.bCommunication	 MC_Power0_Enable
2	StartFlag	Axis_Slave.bCommunication	MC_Power1_Enable ([]) MC_Power1_RegulatorOn ([]) MC_Power1_DriveStart ([])

	1	1C_Power_0	
		MC_Power	
	EN	ENO	
Axis_Master-	⇔ Axis	Status	- MC_Power0_Status FALS
MC_Power0_Enable FALSE	Enable	bRegulatorRealState	FALSE
MC_Power0_RegulatorOn FALSE	bRegulatorOn	bDriveStartRealState	FALSE
MC_Power0_DriveStart FALSE	bDriveStart	Busy	FALSE
		Error	FALSE
		ErrorID	SMC_NO_ERR
	P	1C_Power_1	
		MC_Power	
	EN		
Axis_Slave -	<b>EN</b> ⇔Axis	MC_Power ENO Status	- MC_Power1_Status FALS
Axis_Slave - MC_Power1_Enable FALSE -	<b>EN</b> ⇔Axis	MC_Power ENO	
	EN Axis Enable	MC_Power ENO Status	FALSE
MC_Power1_Enable FALSE	EN Axis Enable bRegulatorOn	MC_Power ENO Status bRegulatorRealState	FALSE FALSE
MC_Power1_Enable FALSE MC_Power1_RegulatorOn FALSE	EN Axis Enable bRegulatorOn	MC_Power ENO Status bRegulatorRealState bDriveStartRealState	FALSE FALSE FALSE
MC_Power1_Enable FALSE MC_Power1_RegulatorOn FALSE	EN Axis Enable bRegulatorOn	MC_Power ENO Status bRegulatorRealState bDriveStartRealState Busy	FALSE FALSE FALSE

Under normal condition, Servo ON state will be set to master and slave axis.

Under Servo On state and unsure of the start position, home positioning will be operated first.



After the homing operation of master axis is completed, execute MC\_MoveAbsolute instruction.



7

When the instruction position of master axis is below 3000, use CamTable1 (CamTable1\_En=True, CamTable2\_En=False). Conversely, when position is over 3000, use CamTable2 (CamTable1\_En=False, CamTable2\_En=True). Under both conditions, set the corresponding Cam table with MC\_CamTableSelect instruction.



When absolute positioning is operated for master axis and CamTable1\_En is True, execute with CamTable1.



When absolute positioning is operated for master axis and CamTable2\_En is True, execute with CamTable2.



#### • ST language

// Set StartFlag to be TRUE, then the normal operation of communications for both master and slave axis would be //checked respectively

```
IF StartFlag = TRUE THEN

IF Axis_Master.bCommunication = TRUE THEN

MC_Power0_Enable := TRUE;

MC_Power0_RegulatorOn := TRUE;

MC_Power0_DriveStart := TRUE;

END_IF

IF Axis_Slave.bCommunication = TRUE THEN

MC_Power1_Enable := TRUE;

MC_Power1_RegulatorOn := TRUE;

MC_Power1_DriveStart := TRUE;

END_IF
```

END\_IF

//Under normal condition, Servo ON state will be set to master and slave axis.

#### MC\_Power\_0(

```
Axis:= Axis_Master,
Enable:= MC_Power0_Enable,
bRegulatorOn:= MC_Power0_RegulatorOn,
bDriveStart:= MC_Power0_DriveStart,
Status=> MC_Power0_Status,
bRegulatorRealState=> ,
bDriveStartRealState=> ,
Busy=> ,
Error=> ,
ErrorID=> );
```

MC\_Power\_1(

```
Axis:= Axis_Slave,
Enable:= MC_Power1_Enable,
bRegulatorOn:= MC_Power1_RegulatorOn,
bDriveStart:= MC_Power1_DriveStart,
Status=> MC_Power1_Status,
bRegulatorRealState=> ,
bDriveStartRealState=> ,
Busy=> ,
Error=> ,
ErrorID=> );
```

// Under Servo On state and unsure of the start position, home positioning will be operated first.

```
IF MC_Power0_Status = TRUE THEN
MC_Home0_Execute := TRUE;
END_IF
IF MC_Power1_Status = TRUE THEN
MC_Home1_Execute := TRUE;
END_IF
MC_Home_0(
```

Axis:= Axis\_Master,

Execute:= MC\_Home0\_Execute, Position:= 0, Done=> MC\_Home0\_Done, Busy=> , CommandAborted=> , Error=> , ErrorID=>);

MC\_Home\_1(

Axis:= Axis\_Slave, Execute:= MC\_Home1\_Execute, Position:= 0, Done=> MC\_Home1\_Done, Busy=> , CommandAborted=> , Error=> , ErrorID=> );

// After the homing operation of master axis is completed, execute MC\_MoveAbsolute instruction.

//MC\_MoveAbsolute(

Axis:= Axis\_Master, Execute:= MC\_Home1\_Done, Position:= 6000, Velocity:= 500, Acceleration:= 1000, Deceleration:= 1000, Jerk:= , Direction:= positive, Done=> MC\_MoveAbs\_Done, Busy=> MC\_MoveAbs\_Busy, CommandAborted=> , Error=> , ErrorID=> );

// When the instruction position of master axis is below 3000, use CamTable1 (CamTable1\_En=True, //CamTable2\_En=False).

//When position is over 3000, use CamTable2 (CamTable1\_En=False, CamTable2\_En=True).

//Under both conditions, set the corresponding Cam table with MC\_CamTableSelect instruction.

```
IF Axis_Master.fSetPosition > 3000 THEN
CamTableSelect := CamTable2;
CamTable1_En := FALSE;
CamTable2_En := TRUE;
ELSE
CamTableSelect := CamTable1;
CamTable1_En := TRUE;
CamTable2_En := FALSE;
END_IF
IF (CamTable1_En = TRUE) OR (CamTable2_En = TRUE) THEN
CamTable_En := TRUE;
END_IF
```

MC\_CamTableSelect( Master:= Axis\_Master, Slave:= Axis\_Slave, CamTable:= CamTableSelect, Execute:= CamTable\_En, Periodic:= TRUE, MasterAbsolute:= FALSE, SlaveAbsolute:= FALSE, Done=> MC\_CamTableSelect\_Done, Busy=> , Error=> , ErrorID=> , CamTableID=> CamTableID);

// When absolute positioning is operated for master axis and CamTable1\_En is True, execute with //CamTable1.

IF (MC\_MoveAbs\_Busy = TRUE) AND (CamTable1\_En = TRUE) THEN

MC\_CamIn\_1( Master:= Axis\_Master, Slave:= Axis\_Slave, Execute:= TRUE, MasterOffset:= 0, SlaveOffset:= 0. MasterScaling:= 1, SlaveScaling:= 1, StartMode:= relative, CamTableID:= CamTableID, VelocityDiff:= 1000, Acceleration:= 1000, Deceleration:= 1000, Jerk:= . TappetHysteresis:=, InSync=> MC\_CamIn1\_Insync, Busy=>, CommandAborted=>, Error=>, ErrorID=>, EndOfProfile=>, Tappets=>);

END\_IF

// When absolute positioning is operated for master axis and CamTable2\_En is True, execute with //CamTable2

IF (MC\_MoveAbs\_Busy = TRUE) AND (CamTable2\_En = TRUE) THEN MC\_CamIn\_2(

Master:= Axis\_Master, Slave:= Axis\_Slave, Execute:= TRUE, MasterOffset:= 0, SlaveOffset:= 0, MasterScaling:= 1, SlaveScaling:= 1, StartMode:= relative, CamTableID:= CamTableID, VelocityDiff:= 1000, Acceleration:= 1000, Deceleration:= 1000, Jerk:= , TappetHysteresis:= , InSync=> MC\_CamIn2\_Insync, Busy=> , CommandAborted=> , ErrorID=> , ErrorID=> , EndOfProfile=> , Tappets=> ); END\_IF

Based on the above settings to perform switching Cam tables. Switch the table when the position of master axis is over 3000.



7

# 7.8.2.8 Perform Master PhaseOffset for CAM

After the motion of slave axis being aborted during original CAM operation, it starts to sychronize with the controlled master axis. Phase offset of the master axis is operated by executing MC\_Phasing when PhasingActive is TRUE.and the slave axis synchronizes with the phase after offset completed. The following example supports with LD and ST programming languages.

#### • Main variables used in programming

Variable	Data Type	Default	Note					
Axis_Master	AXIS_REF_ VIRTUAL_SM3	-	Master-related axis variables.					
Axis_Slave	AXIS_REF_ VIRTUAL_SM3	-	Slave-related axis variables.					
CamTable	MC_CAM_REF	-	Variables relating to Cam table.					
StartFlag	BOOL	FALSE	If this variable is TRUE and the communication with axes is normal, Servo ON will be activated and continue on further actions.					
MC_Power0_Status	BOOL	FALSE	Status output variables of MC_Power for master, TRUE when Servo On.					
MC_Power1_Status	BOOL	FALSE	Status output variables of MC_Power for slave, TRUE when Servo On.					
MC_Home0_Done	BOOL	FALSE	Output Done variables of MC_Home for master, TRUE when homing completed.					
MC_Home1_Done	BOOL	FALSE	Output Done variables of MC_Home for slave, TRUE when homing completed.					
MC_MoveVelocity_ Velocity	LREAL	500	The target velocity for master axis to move in constant velocity motion.					
MC_MoveVelocity_ InVelocity	BOOL	FALSE	The InVelocity output variables of MC_MoveVelocity, TRUE when the target velocity is reached.					
CamTableID	MC_CAM_ID	-	The internal data structure of the selectedCam table, which is from MC_CamTableSelect and used as input of MC_CamIn.					
MC_CamIn1_InSync	BOOL	FALSE	Output InSync variables of CamTable1, TRUE when master and slave axis are synchronized with cam.					
PhasingActive	BOOL	FALSE	If the variable is TRUE and Cam is InSync, MC_Phasing will starts to be executed.					
MC_Phasing_PhaseShift	LREAL	500	Specify the phaseshift values for the master and slave axis.					
MC_Phasing_Velocity	LREAL	300	Specify the relative velocity for phasing operating between the master and slave axis.					
MC_Phasing_Done	BOOL	FALSE	The Done output variables of MC_Phasing. TRUE when phase offset is completed.					

CamTable :

700	Slave		 	 	 	•		 	 	 	
500			 	 	 			 	 	 	
300	j j		 				       			 	
100	) 	 								aster position	[u]
#### • Timing diagram

				I
StartFlag				
MC_Power0_Status				
MC_Power1_Status				
MC_MoveVelocity_InVelocity				
MC_CamIn1_InSync				         
PhasingActive				
MC_Phasing_Done				
Axis_Master. fSetPosition				
Axis_Master. fSetVelocity	/			
Axis_Slave. fSetPosition		~~~~~		
Axis_Slave. fSetVelocity			$\sim$	

#### • LD language

Set StartFlag to be TRUE, then the normal operation of communications for both master and slave axis would be checked respectively.



	MC Power 0	
	MC Power	
EN	ENO	
Axis_Master ── Axis	Status - MC_Power0_St	atus FALSE
MC_Power0_Enable FALSE Enable	bRegulatorRealState - FALSE	
MC_Power0_RegulatorOn FALSE bRegulatorOn	bDriveStartRealState - FALSE	
MC_Power0_DriveStart FALSEbDriveStart	Busy - FALSE	
	Error - FALSE	
	ErrorID - SMC_NO_ERR	
	MC_Power_1	
EN	MC_Power	
Axis_Slave — Axis	Status - MC_Power1_St	atus FALSE
MC_Power1_Enable FALSEEnable	bRegulatorRealState - FALSE	_
MC_Power1_RegulatorOn <b>FALSE</b> bRegulatorOn	bDriveStartRealState - FALSE	
MC_Power1_DriveStart FALSEbDriveStart	Busy - FALSE	
	Error - FALSE	

Under normal condition, Servo ON state will be set to master and slave axis.

Under Servo On state and unsure of the start position, home positioning will be operated first.

MC_Home_0	MC Home0 Dor
MC_Home	No Noneo Doi
Axis_Master — Axis Done	
Busy - PALSE	
MC_Power0_Status CommandAborted - FALSE	
Execute Error - PALSE	
0 Position ErrorID SMC_NO_ERR	
MC Home 1	
MC_Home_1	MC Homel Don
MC_Home	MC_Home1_Don
Axis_SlaveAxis Done	MC_Home1_Don {[])
Axis_slave	MC_Homel_Don ([])
Axis_SlaveAxis Done Busy MC_Powerl_Status CommandAborted RC_Powerl_Status	MC_Home1_Don ([])
Axis_slave	MC_Homel_Dor ([])

After the homing operation of master axis is completed, execute MC\_MoveVelocity.

	-	elocity_0	
		Velocity	MC_MoveVelocity_InVelocity
Axis_Ma	ter - Axis	InVelocity	(0)
		Busy - FALSE	
MC_Home0_Done		CommandAborted - FALSE	
	Execute	Error - PALSE	
MC_MoveVelocity_Velocity 500		ErrorID - SMC_NO_ERR	
MC_MoveVelocity_Acc 500	-Acceleration		
MC MoveVelocity Dec 500	Deceleration		
0	-Jerk		
current C 2	- Direction		

8		MC CamTable	Select 0					
		MC CamTable						
	Axis Master 🗕		Done	TRUE				
	Axis Slave -			FALSE				
	CamTable —			FALSE				
				SMC_NO_ERR				
	TRUE		CamTableID					
		Execute						
	TRUE							
		Periodic						
	FALSE							
		MasterAbsolute						
	FALSE							
		SlaveAbsolute						
9								
			М	C_CamIn_1				
				MC CamIn				MC_CamIn1_InSync
		Axis_Master	Master	-	InSync			——(I)
		Axis_Slave 🕂	Slave			FALSE		
				Commandi	Aborted			
	MC_MoveVeloci					FALSE		
	l		Execute			SMC_NO_ERR		
			MasterOffset		Profile	FALSE		
			SlaveOffset		Tappets			
			MasterScaling	l .				
			SlaveScaling					
	relativ	re C 1	StartMode					
			VelocityDiff					
			Acceleration					
			Deceleration					
			Jerk					
			TappetHystere	sis				

After the master axis reaches the target velocity, execute MC\_CamIn with the Cam table specified by MC\_CamTableSelect.

If PhasingActive is TRUE and the slave axis is in synchronized with the master axis based on the setting of MC\_Phasing, master and slave axis start performing phase offset, which breaks the original master-slave relationship in Cam.



According to above setting to perform phase offset of the master axis, the slave axis synchronizes with the phase after offset completed and the PhaseShift would be fixed, which the PhaseShift between master and slave would be 500, taking the cursor timing 3500-3000 as example, and the velocity of slave axis would be 200 while performing phase offset (velocity of master axis 500 minus velocity 300).



#### • ST language

//Set StartFlag to be TRUE, then the normal operation of communication for both master and slave axis //would be checked respectively.

```
IF StartFlag = TRUE THEN

IF Axis_Master.bCommunication = TRUE THEN

MC_Power0_Enable := TRUE;

MC_Power0_RegulatorOn := TRUE;

MC_Power0_DriveStart := TRUE;

END_IF

IF Axis_Slave.bCommunication = TRUE THEN

MC_Power1_Enable := TRUE;

MC_Power1_RegulatorOn := TRUE;

MC_Power1_DriveStart := TRUE;

END_IF

END_IF
```

//Under normal condition, Servo ON state will be set to master and slave axis.

MC\_Power\_0( Axis:= Axis\_Master, Enable:= MC\_Power0\_Enable, bRegulatorOn:= MC\_Power0\_RegulatorOn, bDriveStart:= MC\_Power0\_DriveStart, Status=> MC\_Power0\_Status, bRegulatorRealState=> , bDriveStartRealState=> , Busy=> , Error=> , ErrorID=> );

MC\_Power\_1( Axis:= Axis\_Slave, Enable:= MC\_Power1\_Enable, bRegulatorOn:= MC\_Power1\_RegulatorOn, bDriveStart:= MC\_Power1\_DriveStart, Status=> MC\_Power1\_Status, bRegulatorRealState=> , bDriveStartRealState=> , Busy=> , Error=> , ErrorID=> );

//Under Servo On state and unsure of the start position, home positioning will be operated first IF MC\_Power0\_Status = TRUE THEN MC\_Home0\_Execute := TRUE; END\_IF

IF MC\_Power1\_Status = TRUE THEN MC\_Home1\_Execute := TRUE; END\_IF

MC\_Home\_0( Axis:= Axis\_Master, Execute:= MC\_Home0\_Execute, Position:= 0, Done=> MC\_Home0\_Done, Busy=> , CommandAborted=> , Error=> , ErrorID=> );

MC\_Home\_1( Axis:= Axis\_Slave, Execute:= MC\_Home1\_Execute, Position:= 0, Done=> MC\_Home1\_Done, Busy=> , CommandAborted=> , Error=> , ErrorID=> );

//After the homing operation of master axis is completed, execute MC\_MoveVelocity.

MC\_MoveVelocity(

Axis:= Axis\_Master, Execute:= MC\_Home0\_Done, Velocity:= MC\_MoveVelocity\_Velocity, Acceleration:= MC\_MoveVelocity\_Acc, Deceleration:= MC\_MoveVelocity\_Dec, Jerk:= , Direction:= current, InVelocity=> MC\_MoveVelocity\_InVelocity, Busy=> , CommandAborted=> , Error=> , ErrorID=> );

// After the master axis reaches the target velocity, execute MC\_CamIn with the Cam table specified by
//MC\_CamTableSelect.

MC\_CamTableSelect(

Master:= Axis\_Master, Slave:= Axis\_Slave, CamTable:= CamTable, Execute:= TRUE, Periodic:= TRUE, MasterAbsolute:= FALSE, SlaveAbsolute:= FALSE, Done=> MC\_CamTableSelect\_Done, Busy=> , Error=> , ErrorID=> , CamTableID=> CamTableID);

IF MC\_MoveVelocity\_InVelocity = TRUE THEN MC\_CamIn\_1( Master:= Axis\_Master, Slave:= Axis\_Slave, Execute:= TRUE, MasterOffset:= 0, SlaveOffset:= 0, MasterScaling:= 1, SlaveScaling:= 1, StartMode:= relative, CamTableID:= CamTableID, VelocityDiff:= 1000, Acceleration:= 1000, Deceleration:= 1000, Jerk:=, TappetHysteresis:=, InSync=> MC\_CamIn1\_Insync, Busy=>, CommandAborted=>, Error=>, ErrorID=>, EndOfProfile=>,

```
Tappets=> );
END_IF
```

//If PhasingActive is TRUE and the slave axis is in synchronized with the master axis based on the setting of //MC\_Phasing, master and slave axis start performing phase offset, which breaks the original master-slave //relationship in Cam.

```
IF (PhasingActive = TRUE) AND (MC_CamIn1_Insync = TRUE) THEN
MC_Phasing_Execute := TRUE;
END_IF
```

MC\_Phasing( Master:= Axis\_Master, Slave:= Axis\_Slave, Execute:= MC\_Phasing\_Execute, PhaseShift:= MC\_Phasing\_PhaseShift, Velocity:= MC\_Phasing\_Velocity, Acceleration:= MC\_Phasing\_Acc, Deceleration:= MC\_Phasing\_Dec, Jerk:= , Done=> MC\_Phasing\_Done, Busy=> , CommandAborted=> , Error=> , ErrorID=> );

#### 7.8.2.9 Change Current Position in Movement

Change the current position of axis to the target position in the coordinate system with the feedback of the current position. The interacting effects between MC\_MoveRelative and MC\_SetPosition are explained in the below example. The following example supports with LD and ST programming languages.

Variable	Data Type	Default	Note			
Axis_Virtual	AXIS_REF_ VIRTUAL_ SM3	-	Associate variables of axis.			
StartFlag	BOOL	FALSE	If this variable is TRUE and the communication with axes is normal, Servo ON will be activated and continue on further actions.			
MC_Power0_Status	BOOL	FALSE	Status output variables of MC_Power for master, TRUE when Servo On.			
MC_Home0_Done	BOOL	FALSE	Output Done variables of MC_Home for master, TRUE when homing completed.			
MC_MoveRel_Distance	LREAL	8000	The target relative positions of MC_MoveRelative.			
MC_MoveRel_Done	BOOL	FALSE	The output Done variables of MC_MoveRelative. TRUE when the relative positioning is completed.			
MC_MoveRel_Busy	BOOL	FALSE	The output Busy variables of MC_MoveRelative TRUE when the instruction is triggered and executed.			
MC_SetPosition_Execute	BOOL	FALSE	If TRUE, MC_SetPosition starts to be executed.			
MC_SetPosition_Position	LREAL	3000	The absolute position and relative distance changed by MC_SetPosition.			
MC_SetPosition_Mode	BOOL	TRUE	MC_SetPosition is to set the axis position to be absolute position or relative position.			
MC_SetPosition_Done	BOOL	FALSE	The output Done variables of MC_SetPosition TRUE when the position is changed.			

#### • Main variables used in programming

#### • Timing diagram

StartFlag	
MC_Power0_Status	
MC_Hone0_Done	
MC_MoveRel_Done	
MC_MoveRel_Busy	
MC_SetPosition_Execute	
MC_SetPosition_Done	
11000	
fSetPosition 4000	

#### • LD language

Set StartFlag to be TRUE, then the normal operation of communication for axis would be checked.

1	StartFlag Axis_Virtual.bCommunication	MC_Power0_Enable MC_Power0_RegulatorOr MC_Power0_DriveStart
		· · · · · · · · · · · · · · · · · · ·

#### Under normal condition, set the axis to be in state Servo On.



#### Under Servo On state and unsure of the start position, home positioning operation will be required.

3			
		MC_Home_0	
		MC_Home	MC_Home0_Done
	Axis_Virtual 🚢		(I)
		Busy	FALSE
	MC_Power0_Status	CommandAborted	FALSE
	[∎]	Execute Error	FALSE
	0 —	Position ErrorII	- SMC_NO_ERR
	L		

After the homing operation of axis is completed, execute MC\_MoveRelative.

The target position of relative displacement = 8000

4			
		MC_MoveRelative_0	
		MC_MoveRelative	MC_MoveRel_Done
	Axis_Virtual —	Axis Done	(1)
		Busy	MC_MoveRel_Busy FAMSE
	MC_Home0_Done	CommandAborted	FALSE
		Execute Error	PALSE
	MC_MoveRel_Distance 8E+03 ,	Distance ErrorID	SMC_NO_ERR
	MC_MoveRel_Velocity 2E+03 >	Velocity	
	MC_MoveRel_Acc 4E+03 >	Acceleration	
	MC_MoveRel_Dec 4E+03 .	Deceleration	
	0 -	Jerk	

When the current position of axis passes 4000, execute MC\_SetPosition (Mode = Relative  $\cdot$  Distance = 3000) so as to change the current position to be the assigned target position.



Start a relative positioning procedure based on the current set position in coordinate system according to the above settings, which the position would finally reach 11000 (11000 = 4000 + 3000 + (8000 - 4000)) without influencing the displacement of motion body controlled by MC\_MoveRelative. The displacement is 8000 (8000 = (4000 - 0) + (11000 - 7000)) same as the original setting.



The difference between the above and the picture below is that the mode of MC\_SetPoition is changed to Absolute (Position = 3000). The actual position is set to the parameterized absolute target Position value, and the position would finally reach 7000 (7000 = 3000+(8000 - 4000)) without influencing the displacement of motion body controlled by MC\_MoveRelative. The displacement would be 8000 (8000=(4000 - 0)+(7000 - 3000))same as the original setting.



#### • ST language

Set StartFlag to be TRUE, then the normal operation of communication for axis would be checked.

```
IF StartFlag = TRUE THEN
IF Axis_Virtual.bCommunication = TRUE THEN
MC_Power0_Enable := TRUE;
MC_Power0_RegulatorOn := TRUE;
MC_Power0_DriveStart := TRUE;
END_IF
END_IF
```

 $\ensuremath{\textit{//}}$  Under normal condition, set the axis to be in state Servo On.

MC\_Power\_0(
 Axis:= Axis\_Virtual,
 Enable:= MC\_Power0\_Enable,
 bRegulatorOn:= MC\_Power0\_RegulatorOn,
 bDriveStart:= MC\_Power0\_DriveStart,
 Status=> MC\_Power0\_Status,
 bRegulatorRealState=> ,
 bDriveStartRealState=> ,
 Busy=> ,
 Error=> ,
 ErrorlD=> );

//Under Servo On state and unsure of the start position, home positioning operation will be required.

```
IF MC_Power0_Status = TRUE THEN
MC_Home0_Execute := TRUE;
END_IF
```

```
MC_Home_0(
Axis:= Axis_Virtual,
Execute:= MC_Home0_Execute,
Position:= 0,
Done=> MC_Home0_Done,
Busy=> ,
CommandAborted=> ,
Error=> ,
ErrorID=> );
```

//After the homing operation of axis is completed, execute MC\_MoveRelative.

//The target position of relative displacement = 8000

#### MC\_MoveRelative(

Axis:= Axis\_Virtual, Execute:= MC\_Home0\_Done, Distance:= MC\_MoveRel\_Distance, Velocity:= MC\_MoveRel\_Velocity, Acceleration:= MC\_MoveRel\_Acc, Deceleration:= MC\_MoveRel\_Dec, Jerk:= , Done=> MC\_MoveRel\_Done, Busy=> MC\_MoveRel\_Busy, CommandAborted=> , Error=> , ErrorID=> );

//When the current position of axis passes 4000, execute MC\_SetPosition (Mode = Relative , Distance = 3000) so as to //change the current position to be the assigned target position.

```
IF (MC_MoveRel_Busy = TRUE) AND (Axis_Virtual.fSetPosition >= 4000) THEN
MC_SetPosition_Execute := TRUE;
END_IF
```

```
MC_SetPosition(
```

Axis:= Axis\_Virtual, Execute:= MC\_SetPosition\_Execute, Position:= MC\_SetPosition\_Position, Mode:= MC\_SetPosition\_Mode, Done=> MC\_SetPosition\_Done, Busy=> , Error=> , ErrorID=> );

#### 7.8.2.10 Perform Superimposed during Gear Engagment

Perform MC\_MoveSuperImposed on the particular slave axis while the gear has been engaged in the following example. The final position of slave axis would be the displacement of gear ratio relative to master axis and plus the specific distance superimposed in motion. The following example supports with LD and ST programming languages.

#### • Main variables used in programming

Variable	Data Type	Default	Note
Axis_Master	AXIS_REF_ VIRTUAL_SM3	-	Master-related axis variables.
Axis_Slave	AXIS_REF_ VIRTUAL_SM3	-	Slave-related axis variables.
StartFlag	BOOL	FALSE	If this variable is TRUE and the communication with axes is normal, Servo ON will be activated and continue on further actions.
MC_Power0_Status	BOOL	FALSE	Status output variables of MC_Power for master, TRUE when Servo On.
MC_Power1_Status	BOOL	FALSE	Status output variables of MC_Power for slave, TRUE when Servo On.
MC_Home0_Done	BOOL	FALSE	Output Done variables of MC_Home for master, TRUE when homing operation completed.
MC_Home1_Done	BOOL	FALSE	Output Done variables of MC_Home for slave, TRUE when homing operation completed.
MC_GearIn_InGear	BOOL	FALSE	Output InGear variables of MC_GearIn. TRUE when the engage operation is completed.
MC_GearIn_RatioNumer ator	DINT	2	Numerator of the gear ratio between master and slave axis.
MC_GearIn_RatioDeno minator	UDINT	1	Denominator of the gear ratio between master and slave axis.
MC_MoveAbs_Execute	BOOL	FALSE	When the variable is TRUE, MC_MoveAbsolute is executed.
MC_MoveAbs_Position	LREAL	3000	Absolute target position of assigned master axis.
MC_MoveAbs_Velocity	LREAL	1000	Target velocity of assigned master axis.
MC_MoveAbs_Done	BOOL	FALSE	Output Done variables of MC_MoveAbsolute for master, TRUE when absolute positioning completed.
MC_MoveAbs_Busy	BOOL	FALSE	Output Busy variables of MC_MoveAbsolute for master axis. TRUE when the instruction is executed.
MC_MoveSuperImposed _Execute	BOOL	FALSE	When the variable is TRUE, MC_MoveSuperImposed is executed.

Variable	Data Type	Default	Note
MC_MoveSuperImposed _Done	BOOL	FALSE	Output Done variables of MC_Move- SuperImposed for slave axis. TRUE when the superimposed movement is completed.
MC_MoveSuperImposed _Distance	LREAL	1000	Superimposed displacement of the assigned slave axis.
MC_MoveSuperImposed _ VelocityDiff	LREAL	1500	Specify the relative velocity to the master axis while the superimposed movement operating on the slave axis.

## • Timing diagram

		(			1		
StartFlag		1					
MC_Power0_Status	1						
MC_GearIn_InGear							
MC_MoveAbs_Exceute					-		
MC_MoveAbs_Done							
MC_MoveSuperImPosed_Execute					Ì		
MC_MoveSuperImPosed_Done							
3000		<u> </u>			Į.		
Axis_Master.fSetPosition							
Collection and Second							
Axis_Master.fSetVelocity		$\square$		/			
7000		ļ					
Axis_Slave.fSetPosition							
3500 Axis_Slave.fSetVelocity			$\square$				
200						~3000	

#### • LD language

Set StartFlag to be TRUE, then the normal operation of communications for both master and slave axis would be checked respectively.

1	StartFlag Axis_Master.bCommunication	MC_Power0_Enable ([]) MC_Power0_RegulatorOn ([]) MC_Power0_DriveStart ([])
2	2 StartFlag Axis_Slave.bCommunication	MC_Power1_Enable ([]) MC_Power1_RegulatorOn ([]) MC_Power1_DriveStart ([])

MC\_Power\_0 MC\_Power SN EN Axis\_Master-Axis Status - MC\_Power0\_Status FALSE bRegulatorRealState - FALSE MC\_Power0\_Enable FALSE Enable bDriveStartRealState - FALSE MC\_Power0\_RegulatorOn FALSE bRegulatorOn Busy - FALSE Error - FALSE MC\_Power0\_DriveStart FALSE bDriveStart ErrorID \_ SMC\_NO\_ERR MC\_Power\_1 MC Power EN ENC Axis\_Slave → Axis Status - MC\_Power1\_Status FALSE MC\_Power1\_Enable FALSE bRegulatorRealState - FALSE bDriveStartRealState - FALSE Enable MC\_Power1\_RegulatorOn FALSE bRegulatorOn MC\_Power1\_DriveStart FALSE bDriveStart Busy - FALSE Error - FALSE ErrorID - SMC\_NO\_ERR

When the master and slave axis are in Servo On state and unsure of the start position, home positioning operation will be required.

MC_Home_0 MC_Bome	MC_Home0_Don
Done	
Busy - FALSE	50-7
CommandAborted - FALSE	
e Error - PALSE	
on ErrorID SMC_NO_ERR	
MG_Home_1	
MC_Home	MC_Home1_Don
MC_Home	MC_Home1_Don ([])
MC_Home	MC_Home1_Don
MC_Home	MC_Home1_Don ([])
MC_Rome Done Busy - FAMSE	MC_Home1_Don

Under normal condition, Servo ON state will be set to master and slave axis.

1 - I

After the homing operation is completed, execute MC\_GearIn to activate a master-slave coupling (gear coupling).



Right after the engage action completed with output InGear, execute MC\_MoveAbsolute to the master axis.



At the same time, when the slave axis moves to the preset triggering position=2000 based on the coupling relationship, MC\_MoveSuperImposed would be executed which the slave axis would move a superimposed distance of specific displacement on the original preset target position.



According to the above settings, slave axis would move a displacement according to the gear ratio relative to the master axis and also the specific distance superimposed while in motion to reach the final target position.

The moving distance of master axis is 3000 and the original target position of slave axis would be 6000 calculated with the gear ratio 1:2. Therefore, the final target position of slave axis will changes to be 7000 (6000+1000) with an extra superimposed distance=1000. While coupling, the velocities of master and slave axis are respectively 1000 and 2000. Yet the velocity of slave axis changes to 3500 while superimposing (the original velocity 2000+ VelocityDiff 1500).



#### ST language

Set StartFlag to be TRUE, then the normal operation of communications for both master and slave axis would be checked respectively.

IF StartFlag = TRUE THEN

IF Axis\_Master.bCommunication = TRUE THEN

```
MC_Power0_Enable := TRUE;
```

MC\_Power0\_RegulatorOn := TRUE;

```
MC_Power0_DriveStart := TRUE;
```

END\_IF

```
IF Axis_Slave.bCommunication = TRUE THEN
MC_Power1_Enable := TRUE;
MC_Power1_RegulatorOn := TRUE;
MC_Power1_DriveStart := TRUE;
END_IF
```

END\_IF

Under normal condition, Servo ON state will be set to master and slave axis.

MC\_Power\_0(

Axis:= Axis\_Master, Enable:= MC\_Power0\_Enable, bRegulatorOn:= MC\_Power0\_RegulatorOn, bDriveStart:= MC\_Power0\_DriveStart, Status=> MC\_Power0\_Status, bRegulatorRealState=> , bDriveStartRealState=> , Busy=> , Error=> , ErrorID=> ); MC\_Power\_1(

Axis:= Axis\_Slave, Enable:= MC\_Power1\_Enable, bRegulatorOn:= MC\_Power1\_RegulatorOn, bDriveStart:= MC\_Power1\_DriveStart, Status=> MC\_Power1\_Status, bRegulatorRealState=> , bDriveStartRealState=> , Busy=> , Error=> , ErrorID=> );

When the master and slave axis are in Servo On state and unsure of the start position, home positioning operation will be required.

IF MC\_Power0\_Status = TRUE THEN MC\_Home0\_Execute := TRUE; END\_IF

IF MC\_Power1\_Status = TRUE THEN MC\_Home1\_Execute := TRUE; END\_IF

MC\_Home\_0(

Axis:= Axis\_Master, Execute:= MC\_Home0\_Execute, Position:= 0, Done=> MC\_Home0\_Done, Busy=> , CommandAborted=> , Error=> , ErrorID=> );

MC\_Home\_1(

Axis:= Axis\_Slave, Execute:= MC\_Home1\_Execute, Position:= 0, Done=> MC\_Home1\_Done, Busy=> , CommandAborted=> , Error=> , ErrorID=> );

After the homing operation is completed, execute MC\_GearIn to activate a master-slave coupling (gear coupling).

MC\_GearIn(

Master:= Axis\_Master, Slave:= Axis\_Slave, Execute:= MC\_Home0\_Done,

```
RatioNumerator:= MC_GearIn_RatioNumerator,
RatioDenominator:= MC_GearIn_RatioDenominator,
Acceleration:= MC_GearIn_Acc,
Deceleration:= MC_GearIn_Dec,
Jerk:= ,
InGear=> MC_GearIn_InGear,
Busy=> ,
CommandAborted=> ,
Error=> ,
ErrorID=> );
```

```
IF MC_GearIn_InGear = TRUE THEN
MC_MoveAbs_Execute := TRUE;
END_IF
```

Right after the engage action completed with output InGear, execute MC\_MoveAbsolute to the master axis.

#### MC\_MoveAbsolute(

Axis:= Axis\_Master, Execute:= MC\_MoveAbs\_Execute, Position:= MC\_MoveAbs\_Position, Velocity:= MC\_MoveAbs\_Velocity, Acceleration:= MC\_MoveAbs\_Acc, Deceleration:= MC\_MoveAbs\_Dec, Jerk:= , Direction:= Positive, Done=> MC\_MoveAbs\_Done, Busy=> MC\_MoveAbs\_Busy, CommandAborted=> , Error=> , ErrorID=> );

At the same time, when the slave axis moves to the preset triggering position=2000 based on the coupling relationship, MC\_MoveSuperImposed would be executed which the slave axis would move a superimposed distance of specific displacement on the original preset target position.

```
IF MC_MoveAbs_Busy = TRUE THEN
```

```
IF Axis_Slave.fSetPosition >= 2000 THEN
```

```
MC_MoveSuperImposed_Execute := TRUE;
```

```
END_IF
```

END\_IF

MC\_MoveSuperImposed(

Axis:= Axis\_Slave,

Execute:= MC\_MoveSuperImposed\_Execute, Distance:= MC\_MoveSuperImposed\_Distance, VelocityDiff:= MC\_MoveSuperImposed\_VelocityDiff, Acceleration:= MC\_MoveSuperImposed\_Acc, Deceleration:= MC\_MoveSuperImposed\_Dec, Jerk:= , Done=> MC\_MoveSuperImposed\_Done, Busy=> , CommandAborted=> , Error=> , ErrorID=> );



# Chapter 8 OPC UA Server

# Table of Contents

8.1	OPC UA Server	8-2
	Creating a Project for OPC UA Access	
8.2	Setting up a Connection with the "UaExpert" Client	
8.3	Setting up an Encrypted Connection	
8.3.1	Setting up User Account and Password	
8.3.2	CODESYS Security Agent	8-9
8.3.3	Setting up an Encrypted Connection with the "Prosys OPC UA Client"	8-12
8.3.4	Setting up an Encrypted Connection with the "UaExpert"	8-15

## 8.1 OPC UA Server

The standard installation of DIADesigner-AX includes an OPC UA server. You can use it to access the variable interface of the controller via a client. The OPC UA server communicates with connected OPC UA clients over a separate TCP connection. Therefore, these connections have to be examined again separately with regard to security. The OPC UA server can now be safeguarded by using encrypted communication to the client and OPC UA user management. See the following sections for these settings.

- Browsing of data types and variables
- Standard read/write services
- Notification for value changes: subscription and monitored item services
- Encrypted communication according to "OPC UA standard (profile: Basic256SHA256)"

## 8.1.1 Creating a Project for OPC UA Access

You need to create a project for OPC UA access before using OPC UA Server. Follow the steps below.

- 1. Create a new DIADesigner-AX project.
- 2. Declare some variables of different types in the PLC\_PRG program.

wval1		Value	Prepared value	Address	Comment	
A MAGIT	WORD	0				
dwval2	DWORD	0				
bval3	BOOL	FALSE				
aryval4	ARRAY [020] OF B					

3. Go to Application -> Add Object -> Symbol Configuration to add a Symbol Configuration object.



4. Select **Support OPC UA feature** and click **Add** on the setting page of Add Symbol Configuration. After that Symbol Configuration setting page shows up automatically.

Add Symbol Configuration	×
Create a remote access symbol configurat	ion.
Name	
Symbol Configuration	
Include comments in XML	
Support OPC UA features	
Add library placeholder in Device Application (recommended, but may trigger download)	
Client Side Data Layout	
O Compatibility Layout	
Optimized Layout	
Add	Cancel

5. Click Build on the Symbol Configuration setting page. The variables are shown in a tree structure.



6. Select the variables that you want to change with an OPC UA client. Specify the access rights. After setting, click **Build** again.

PLC_PRG Symbol Configuratio				
View - 🕮 Build 🛱 Settings - Tools -		_		
There are 6 configured variables which are not a	referenced by the I	EC code. Reading a	nd writing to them may not have the desired effect(	s). Remove
hanged symbol configuration will be transferred v	with the next downle	oad or online chang	je	
Symbols	Access Rights	Maximal Att	ibute Type	Members
Constants		and a sector of		
CompilerVersion		50	VERSION	
RuntimeVersion	50	50	VERSION	
- 🔲 📄 IoConfig_Globals				
EtherCAT_Diag		-	DL_BuiltInIO_AX3.EtherCAT_Diag	
EtherCAT_ErrorLED_Handle		540	DL_BuiltInIO_AX3.EtherCAT_ErrorLED_Han	dle
- therCAT_Master_SoftMotion		<b>See</b>	IoDrvEthercatLib.IODrvEtherCAT	***
- V Pulse_Output	30	-	DL_BuiltInIO_AX3.DMC_PO_SLOT_REF	
- Pulse_Output_SYNC		-	DL_BuiltInIO_AX3.Po_Sync	
nIoConfigTaskMapCount	-	-	DINT	
→ pIoConfigTaskMap		St.	POINTER TO IoConfigTaskMap	
PLC_PRG				
🔍 🧳 aryval4	-	-	ARRAY [020] OF BYTE	
- 📝 🛷 bval3	-	540	BOOL	
- 👽 🛷 dwval2		540	DWORD	
🗸 🧳 wval1	-	-	WORD	

7. Download the project to the AX-3 Series PLC.

## 8.2 Setting up a Connection with the "UaExpert" Client

The OPC UA client "UaExpert" is freely accessible software. You can download the software here: <u>https://www.unified-automation.com/downloads/opc-ua-clients.html</u> Using this client, you can connect to the OPC UA server. The following description refers to this program. Other OPC UA clients work in a similar way. After download UAExpert, follow the following steps to set up a connection.

- (1) Double-click the UaExpert **Hara** to start the UaExpert.
- (2) Right-click Server and then click Add to open Add Server window.



(3) Go to Custom Discovery -> Double click to Add Server...> and then type in "opc.tcp://192.168.1.5" in the Enter URL dialog.

Add Server	4
onfiguration Name	
Discovery Advanced	
Endpoint Filter: No Filter	•
Local Local Network  Microsoft Terminal Services Microsoft Windows Network  Microsoft Windows Network  Web Client Network  Custom Discovery Custom Discovery  Custom Discover	₹ * × service running:
Authentication Settings Anonymous	
TTT MELLER Burnhall	Store
Anonymous     Usemane	Store
Anonymous     Usemane     Password     Certificate	Concel

(4) After that you can find AX308E under the opc.tcp://192.168.1.5. Select OPCUAServer@AX-308EA0MA1T and click OK to close the window. If the connection type is NOT an encrypted one, the node None-None appears under the added server.

iscovery Advanced			
			_
E Stocal Network			
🖻 😏 Microsoft Terminal Services			
Opc.tcp://tsclient			
🕀 💇 Microsoft Windows Networ	¢		
E DELTA			
<ul> <li>Web Client Network</li> <li>opc.tcp://idelta.deltaww</li> </ul>	0000		
Custom Discovery	comesse		
Custom Discovery	1.5		
🖻 🔍 opc.tcp://192.168.1.5			
	A0MA1T		
OPCUAServer@AX-308			
OPCUAServer@AX-308     None - None     ORecently Used     Unified Automation Demo 9			
None - None			
None - None Recently Used Unified Automation Demo S			
None - None     None - None     None - None     One - Noe     One - Noe     One - None- None     One - Noe     One - Noe			
None - None     None - None - None     None - None - None     None - None - None     None - None - None     None - None - None - None - None     None -			
Authentication Settings		T Stor	De
None - None     None - None - None     None - None - None     None - None - None     None - None - None     None - None - None - None - None     None -	erver	T Stor	Ne .

(5) If you need to edit the server properties, go back to the starting window. Expand the option **Servers** under **Project** and then right-click **AX308** to open a context menu. Click **Properties** to open the Server Settings page.



(6) Change the Endpoint Url from OPCUAServer@AX-308EA0MA1T:4840 to **opc.tcp://192.168.1.5:4840** and click **OK** to close the window.

Endpoint Url	opc.tcp://192.168.1.5:4840
Security Settings	
Security Policy	None
Message Security Mode	None
Username Password	L Store
	ntly not supported by UsExpert
Session Settings	I
Session Name	m:TWTY3PC1346:UnifiedAutomation:UaExpert

(7) Right-click AX308 to open a context menu. Click Connect to AX308E.

Project		8 >
<ul> <li>Project</li> <li>Servers</li> </ul>		
OPCUAServe	Remove	
Documents	Connect	
	Disconnect	
3	Properties	
2	Change User	

8\_

(8) After establishing the connection, you can change the variables in AX308E through the OPC UA client UaExpert. Select and drag the variables you'd like to modify from the left view "Address Space" to the right view "Default DA View" and then double-click the item to be modified to edit.

Project 8	× Default DA View							.0
E D Project	Server	Node id	Display Name	Value	Datatype		Server Timestamp	
Server     Server     Server     Decuments     Default DA View	AX308E AX308E AX308E AX308E	NS4/String (ver) Petra-ARM-VeWorks, NS4/String) ver) Detra-ARM-VeWorks, NS4/String) ver) Detra-ARM-VeWorks, NS4/String) ver) Detra-ARM-VeWorks,	anyval4 bval3 dvval2 vvval1	00.000.000000000000000000000 take 0	Byte Boolean Ulnt32 Ulnt16	08:25:51:428 08:25:52:826 08:25:55:4211 08:25:55:622	08:25:51:428 08:25:52:826 08:25:54:211 08:25:55:622	Good Good Good Good
Adduess Space B	×							
Root     Objects     DeviceSet     DeviceSet     DeviceManual     DeviceNanual     DeviceNanual     DeviceManual     DeviceManual     DeviceManual     DeviceManual     DeviceManual     Objects     Oconstats     Constats     Oconstats     Ococonstats     Oconstats     Oconstats     Oconstats     Oconstats								
SerialNumber								

# 8.3 Setting up an Encrypted Connection

To have a successful encrypted connection, you need to follow the sections below to create certificates for OPC UA server and OPC UA client.

## 8.3.1 Setting up User Account and Password

Setting up an account and password for OPC UA Server is the same as setting up the account for AX-3 Series PLC. Refer to section 4.2.1.8 of AX-3 Series Operation Manual for more information.

Below is an example for setting up a new account as guest. The default account is Administrator. And here you can see two accounts on the example image.

×

Device

oplications	Synchronized mode: All changes are immediately downloaded to the device.	
ackup and Restore	* S Administrator	• Add
nchronized Files	🛞 😫 guest	Import
		2 Edit
es		O Delete
g		
.C Settings		
.C Shell		
ers and Groups		
cess Rights	Groups	
mbol Rights	🚍 🤮 Administrator	O Add
mbol Rights ntime Clock Configuration	😟 😫 derived from 'Developer'	Add     Import
ntime Clock Configuration	served from 'Developer'     served from 'Administrator'     serveloper     Serveloper	
	erved from 'Developer'     s has user member 'Administrator'     S Developer     Everyone     s has user member 'Administrator'	O Import
ntime Clock Configuration stem Parameters	served from 'Developer'     served from 'Administrator'     serveloper     Seveloper     Seveloper     Severyone	<ul> <li>✔ Import</li> <li>✓ Edit</li> </ul>

# 8.3.2 CODESYS Security Agent

(1) Install the add-on **CODESYS Security Agent**. After installing, you need to restart DIADesigner-AX.

Refresh			Sort by	Name	~	Install
Name	Version	Installation date	Update info	License info		umnstall.
AX-8xxEP0 Series	1.0.0.0	2019/12/2		No license required		Détails
CODESYS Security Agent	1.1.0.0	2019/12/11		No license required		and an and a second sec
CODESYS SoftMotion	4.6.0.0	2019/12/11	_	No license required		Updates
Delta_ASD_A2_M_Package	1.0.0.2	2019/12/2		License info not ava	ilable	
Delta_AX-308EA0MA1T_Package	0.30.0.9	2019/12/11		No license required		Search Updates
Delta_VFD_C2000_Package	1.0.0.1	2019/12/2		License info not ava		Download
Delta_VFD_MH300_Package	1.0.0.0	2019/12/2		License info not ava		
Delta_VFD_MS300_Package	1.0.0.2	2019/12/2				CODESYS Store Rebright
Display versions 🔽 Search update					>	Close

(2) Open DIADesigner-AX to create a project. Click View on the toolbar and then click the option Security Screen to open the setting page.



#### (3) Select the **Devices** tab.

User	Φ	Information	2.2	Information	Issued for	Issued by	Valid from	Valid u
Project	创	Click the 'Refresh' button to load the data.	大道	1.00				
Dévices			39					

(4) Click 🔯 to refresh and all services of the controller that require a certificate are displayed in the right view.

Security Screen X	(					
User	Φ	Information	13	Information	Issued for	ls
	何	= Device	×	OPC UA Server (not available)		
Project	( interest of the second secon	Own Certificates	Total I	Encrypted Application (not available)		
Devices		Trusted Certificates	2	Encrypted Communication	AX-308EA0MA1T	A
Devices		Unstrusted Certificates		Web Server	AX-308EA0MA IT	A
		Quarantined Certificates				

(5) Select the service **OPC UA Server** and then click **[**] to open the **Certificate Settings** page for the creation of

a new certificate for the device. After setting up the certificate parameters, click OK. And the certificate is created on the controller.

User	Φ.	Information		Information	Issued for
	54	E Device	X	OPC UA Server (not available)	
Project		Own Certificates	-	Encrypted Application (not available	)
Devices		Trusted Certificates	创	Encrypted Communication	AX-308EA0MA1T
Devices		Unstrusted Certificates		🙀 Web Server	AX-308EA0MA1T
		Quarantined Certificates			
	•	Certificate Settings		×	
		Certificate Settings Key length (bit)	3072	× ~	

(6) Again select the service Encrypted Application and then click **[**] to open the Certificate Settings page for

the creation of a new certificate for the device. After setting up the certificate parameters, click OK. And the certificate is created on the controller.

User	0	Information		Information	Issued for
Project	個	E Device	X	M OPC UA Server	OPCUAServer@AX-308
Hoject		Own Certificates	2	Encrypted Application (not available)	
Devices		Trusted Certificates		Encrypted Communication	AX-308EA0MA1T
		Unstrusted Certificates		🔯 Web Server	AX-308EA0MA1T
		Quarantined Certificates			
		•			
		tificate Settings		×	
		tificate Settings y length (bit)	3072	×	

(7) And you have created two certificates OPC UA Server and Encrypted Application on the controller.\*

Security Screen	8								
User	0	Information	13	Information	Issued for	Issued by	Valid from	Valid until	Thumbprint
	144	= Device	×	P OPC UA Server	OPQUAServer@AX-308EA0MA1T	OPCUAServer@AX-308EA0MA1T	1970/1/2 上千 08:48:15	1971/1/2 上午 08:48:15	5C3F2C0888EC97E0286210688A738
Project	1000	Com Certificates	- Labora	R Encrypted Application	AX-SOSEA0MA 1T	AX-308EA0MA1T	1970/1/2 上午 08:48:55	1971/1/2 上午 08:48:55	53882A26088664F4484EDEA91389A
Devices		Trusted Certificates	23	Encrypted Communication	AX-208EA0MA1T	AX-308EA0MA1T	1970/1/1 上平 08:00:13	1970/1/31 上平 08:00:13	50836809F81A7C5089816707CE675
Venice		Unstrusted Certificates		Web Server	AX-308EA0MA IT	AX-308EA0MA1T	1970/1/1上年 08:00:13	1970/1/31 上午 08:00:13	508368D9F81A7C5D89816707CE675
		Quarantined Certificates							

\* Note: You need to power-on and then power-off the PLC to have the two certificates become effective.

# 8.3.3 Setting up an Encrypted Connection with the "Prosys OPC UA Client"

The OPC UA client "Prosys OPC UA Client" is freely accessible software. You can download the software here: https://downloads.prosysopc.com/opc-ua-client-downloads.php

Using this client, you can connect to the OPC UA server. The following description uses Prosys OPC UA Client V3.2.0 as an example. Other OPC UA clients work in a similar way. After download Prosys OPC UA Client, follow the following steps to set up a connection.

(1) Double-click the Prosys OPC UA Client



to start the Prosys OPC UA Client.

(2) Type in the OPC UA Server IP address "opc.tcp://192.168.1.5:4840" in the field of Disconnected as shown in ①.

Prosys OPC UA Client		- 0	×
Help New Tab +		2 6	
Disconnected opc.tcp://192.16	8.1.5:4840 🔶 🛄 🚺		
Search	Attributes and References +		
-		🔶 🔶 Filters 👬 👬 Browse Direction Porwar	rd -
6		ReferenceType Target	
	n.		
Select server and connect	n		

(3) Click 💼 as shown in (3) to open the Security Settings window. Only the connection type Basic256SHA256 is

supported. Select "Show only modes that are supported by the server". Click OK.

Security Mode	Security Policy	
None	None	OK
Sign	Basic128RSA15	
<ul> <li>Sign &amp; Encrypt</li> </ul>	Basic256	Cancel
the state of the s	Basic256SHA256	

(4) Click 📥 as shown in ④ to open the User Authentication setting window. Set up the username and password

and click **Apply** to apply the settings.

Anonumous	Username and Passy		and Drivata Kay	Apply	Cancel
Anonymous	Usemanie and Passi	word O Certificate	and Flivate Key	Apply	Cancer
Username	Administrator	Password	****		
			-		

(5) If you click is as shown in (2) to connect to the AX-3 Series PLC. You will see a warning, stating the server

does not accept this application's certificate. That is because ProsysOpcUaClient is not a trusted certificate for AX-3Series PLC. You need to go back to DIADesigner-AX to approve this service.

Untrusted	certificate error X
0	The server does not accept this application's certificate. Error=Bad_SecurityChecksFailed (0x80130000) "An error occurred verifying security."
	Close

(6) Go back to DIADesigner-AX. Click View on the toolbar and then click the option Security Screen to open the setting page. Select the Devices tab.

User	Φ	Information	1.	Information	Issued for	Is
	摺	E Device	×	OPC UA Server (not available)		
Project	-	Own Certificates	1011	Encrypted Application (not available)		
Devices		Trusted Certificates	퀸	Encrypted Communication	AX-308EA0MA1T	A
Devices		Unstrusted Certificates		🙀 Web Server	AX-308EA0MA1T	A
		Quarantined Certificates				

(7) Click 💠 to refresh and all services of the controller that require a certificate are displayed in the right view. Find

ProsysOpcUaClient in the folder of Quarantined Certificates. Drag it to the folder of Trusted Certificates.

Security Screen	×					
User Project Devices		Information	X	Infor	Issued for Issued I ProsysOpcUaClient ProsysOp	by Valid f pcUaClient 2020/5/
Security Screen	Φ	Information		Information	Issued for	Issued by
Project	1	Device	×	22	Integration Objects' OPC UA Client	t Integration Obje

**Own** Certificates

Trusted Certificates

Unstrusted Certificates Quarantined Certificates

Devices

ProsysOpcUaClie

ProsysOpcUaClient

(8) Go back to ProsysOpcUaClient. Click is as shown in (2) to connect to the AX-3 Series PLC as an Administrator.

C Prosys OPC UA Clien	t			- 🗆 X
Help				
OPCUAServer@AX-3	08EA0MA1T +			
Running opc.tcp://192.1	68 1.5:4840 um:AX-308EA0MA1T:Delt	a%20Electronics%2C%20Inc.A	-308EA0MA1T:OPCUA:Server	🔹 🗙 🔒 🚢 Administrator
Search	Attributes and References	+		
Objects	0		+ + Filters	Browse Direction Forward
<ul> <li>Types</li> <li>Views</li> </ul>	Attribute	Value	ReferenceType	Target
P VIEWS	► Nodeld	1=85	Organizes	DeviceSet
	NodeClass	Object	Organizes	Server
	BrowseName	Objects	HasTypeDefinition	FolderType
	DisplayName	(en-Us) Objects		
	Description			
	WriteMask	NONE (0)		
	UserWriteMask	NONE (0)		
	EventNotifier	0		

After establishing the connection, you can edit the settings in AX308E through ProsysOpcUaClient

If you connect to the AX-3 Series PLC as a guest. You do not have permission to make any change on the settings.

OPCUAServer@AX-3	08EA0MA1T	+	FI .										-	
Running opercp//192.1	68.1.5.484	- Un	n AX-308EA	0MA1T:Delta9	620Electron	ics%2C%2	Oinc AX-308EA	OMA1T:C	PCUA Server	*	×		÷	gues
Search		Attr	ributes and P	References	Data View	x +								
Objects     DeviceSet     AX-308EA0MA1T     Resources		Sub	scription En	abled 🗸	Publishing	Interval (in i	milliseconds)		1,000 *	Subscrip	ption S	ettings		
		#	Nodeld	DisplayNan	ne Value	DataType	SourceTime	estam	ServerTimestam	StatusCoo	ie Me	onitoringMo	G	raph
		0	ns=4;s=	aaa	false	Boolean	29.05.2020 0	1:29:	29.05.2020 01:29:	GOOD (0x	R	eporting		
1.0		1	ns=4;s=	bbb	false	Boolean	29.05.2020 0	1:29:	29.05.2020 01:29:	GOOD (0x	R	eporting		
	antien.	2	ns=4:s=l	000	false	Boolean	29.05.2020 0	1:29	29.05 2020 01:29	GOOD (0x	Re	aportina		
Error												>	<	
•	Write failed Diagnostic		r=ServiceFa	ult Bad_User	AccessDen	ied (0x801F	0000) "User do	bes not h	ave permission to per	form the req	ueste	d operation. Close		

## 8.3.4 Setting up an Encrypted Connection with the "UaExpert"

The OPC UA client "UaExpert" is freely accessible software. You can download the software here: <u>https://www.unified-automation.com/downloads/opc-ua-clients.html</u> Using this client, you can connect to the OPC UA server. The following description uses UaExpert V1.5 as an example. Other OPC UA clients work in a similar way. After download UAExpert, follow the following steps to set up a connection.

- (1) Double-click the UaExpert **Here** to start the UaExpert.
- (2) Right-click **Server** and then click **Add** to open Add Server window.



(3) Go to Custom Discovery -> Double click to Add Server...> and then type in "opc.tcp://192.168.1.5" in the Enter URL dialog.

Configuration Name	
Discovery Advanced	
Endpoint Filter: No Filter	
<ul> <li>Local</li> <li>Cocal Network</li> <li>Microsoft Terminal Services</li> <li>Microsoft Windows Network</li> <li>Web Client Network</li> <li>Web Client Network</li> <li>Custom Discovery</li> <li>Custom Discovery</li> <li>Custom Discovery</li> <li>Recently Used</li> </ul>	€ ? × service running:
opc tcp #192.168.1.5	
OK R	Store
Authentication Settings Authentication Settings Anonymous Username	Store
OK Authentication Setting: Anonymous      Usemanne      Password      Certificate	

(4) After that you can find opc.tcp://192.168.1.5 under Custom Discovery. Select Basic256SHA256 under the OPCUAServer@AX-308EA0MA1T (opc.tcp) and click OK after inputting the Username and Password in the Authentication Settings to create an encrypted connection.

inigorouon monte or e	UAServer@AX-308EA0MA1T	
Discovery Advanced		
indpoint Filter: No Filte	er	
Microsoft     Web Clier     Web Clier     Reverse Disco     Custom Disco         Custom Disco         Custom Disco         Custom Disco         Custom Disco         OpCLQ://         OpCLQ://	Terminal Services Windows Network It Network wery overy click to Add Server >	sinary
Recently Used	sic256Sha256 - Sign (uatcp-uasc-uabinary)	
	ssic256Sha256 - Sign (uatcp-uasc-uabinary) I	
Q Recently Used Authentication Setting	ssic256Sha256 - Sign (uatcp-uasc-uabinary) I	
Recently User     Authentication Setting     Anonymous     Username	ssic256Sha256 - Sign (uatcp-uasc-uabinary) 1 gs 	

(5) If you need to edit the server properties, go back to the starting window. Expand the option **Servers** under **Project** and then right-click **AX308** to open a context menu. Click **Properties** to open the Server Settings page.

Project	e ×
<ul> <li>✓ D Project</li> <li>✓ D Servers</li> </ul>	
OPCUAServer® = Remove Documents Data Access Vie Connect Disconnect	
Properties	
Change Use	f

(6) Change the Endpoint Url from OPCUAServer@AX-308EA0MA1T:4840 to **opc.tcp://192.168.1.5:4840** and click **OK** to close the window.

Server Settings - OPCU	JAServer@AX-308EA0MA1T	?	×
Configuration			_
Configuration Name	OPCUAServer@AX-308EA0MA1T		
Server Information			
Endpoint Url	opc.tcp://192.168.1.5:4840		
Reverse Connect			
Security Settings			
Security Policy	Basic256Sha256	•	
Message Security Mode	Sign & Encrypt	•	
Authentication Settings			
Username	Administrator	🗹 Store	
Password	••••		
Certificate			
Private Key			
Session Settings			
Session Name	m:TWTY3NB1693:UnifiedAutomatic	on:UaExpert	
	OK	Cancel	

(7) Right-click **AX308** to open a context menu. Click **Connect** to AX308E.

5 ×
2/
(8) After clicking **Connect**, you will see an error. That is because UaExpert is not a trusted certificate for AX-3Series PLC. You need to go back to DIADesigner-AX to approve this service.

₩ 🖯			
Timestamp	Source	Server	Message
1/18/2021 6:25:10.622 PM	Server Node	OPCUAServer@AX-308EA0MA1T	Endpoint: 'opc.tcp://AX-308EA0MA1T:4840'
1/18/2021 6:25:10.622 PM	Server Node	OPCUAServer@AX-308EA0MA1T	Security policy: 'http://opcfoundation.org/UA/SecurityPolicy#Basic256Sha256'
1/18/2021 6:25:10.622 PM	Server Node	OPCUAServer@AX-308EA0MA1T	ApplicationUri: 'urn:AX-308EA0MA1T:Delta%20Electronics%2C%20Inc.:AX-308EA0MA1T:OPCUA:Server
1/18/2021 6:25:10.622 PM	Server Node	OPCUAServer@AX-308EA0MA1T	Used UserTokenType: UserName
1/18/2021 6:25:10.737 PM	Server Node	OPCUAServer@AX-308EA0MA1T	Error 'BadSecurityChecksFailed' was returned during OpenSecureChannel
1/18/2021 6:25:10.737 PM	Server Node	OPCUAServer@AX-308EA0MA1T	Connection status of server 'OPCUAServer@AX-308EA0MA1T' changed to 'Disconnected'.

(9) Go back to DIADesigner-AX. Click **View** on the toolbar and then click the option **Security Screen** to open the setting page. Select the **Devices** tab. Click is to refresh and all services of the controller that require a

certificate are displayed in the right view. Find **UaExpert** in the folder of **Quarantined Certificates**. Drag it to the folder of **Trusted Certificates**.

User Project Devices	•	Information  Device  Own Certificates  Trusted Certificates  Quarantined Certificates	× 文 空	Information	sued for UaExpert	Issued by UaExpert	Va 1/
Vser	<	Information	1	Information	Issued for	Issued by	Va

(10) Repeat step 7 to connect to OPC UA Server again. After the connection is established, you can see the tree node on the left side and you can edit the settings in AX308E through UaExpert.





# **Chapter 9 Communication**

# **Table of Contents**

9.1 Introduction to EtherCAT Communication9-	-3
9.1.1 Features of EtherCAT Fieldbux9	-3
9.1.2 Settings up EtherCAT Master9	-4
9.1.3 Setting up the EtherCAT Slave9	
9.1.4 Backup Parameters for EtherCAT Slaves	
9.1.4.1 Data Backup Procedure	-9
9.1.4.2 Introduction to Backup and Restore9-7	10
9.1.4.2.1 Operation for the Backup Function	
9.1.4.2.2 Operation for the Restore Function	
9.2 Introduction to Modbus Serial Communication9-1	16
9.2.1 Modbus Serial Port9-7	
9.2.1.1 Adding Delta Modbus COM9-7	16
9.2.1.2 Setting up Delta Modbus COM9-7	17
9.2.2 Modbus Serial Master9-7	
9.2.2.1 Adding Delta Modbus Master/Slave COM9-7	19
9.2.2.2 Setting up Delta Modbus Master COM9-2	
9.2.2.3 Setting up Delta Modbus Slave COM9-2	
9.2.3 Modbus Serial Slave9-2	
9.2.3.1 Adding a Modbus Serial Device9-2	
9.2.3.2 Setting up the Modbus Serial Device9-3	
9.3 Introduction to Ethernet Communication9-3	
9.3.1 Network Security9-3	
9.3.2 Ethernet	
9.3.2.1 Adding an Ethernet Adapter Device9-3	
9.3.2.2 Setting up the Ethernet9-3	
9.3.3 Modbus TCP Master (Client)9-3	
9.3.3.1 Adding a Modbus TCP Master/Slave9-3	
9.3.3.2 Setting up the Modbus TCP Master9-4	
9.3.3.3 Setting up the Modbus TCP Slave9-4	
9.3.4 Modbus TCP Slave (Server)9-4	
9.3.4.1 Adding a Modbus TCP Slave Device9-4	
9.3.4.2 Setting up the Modbus TCP Slave Device9-4	
9.3.5 PROFINET IO	
9.3.5.1 PROFINET Device	
9.5.3.1.1 Add a PROFINET Device	
9.3.5.1.2 Settings of PROFINET Device	
9.3.5.1.3 Export GSDML File	57

9.4 EtherNet/IP	
9.4.1 Introduction to EtherNet/IP	9-58
9.4.1.1 EtherNet/IP Overview	9-58
9.4.1.2 Definition	9-58
9.4.1.3 Features of Ethernet	9-59
9.4.1.3.1 Delta EIP Architecture	9-59
9.4.1.3.2 Features of EIP	9-60
9.4.2 EtherNet/IP Scanner Function	9-61
9.4.2.1 Setting up Compact Drive MS300	9-61
9.4.2.1.1 Hardware Configuration	9-61
9.4.2.1.2 Read-Write Setting for Implicit Messages	9-61
9.4.2.1.3 CIP Object Read-Write Setting for Explicit Messages	9-67
9.4.2.2 Read-Write to AS00SCM-A (AS-FEN02 Communication Card)	9-68
9.4.2.2.1 Setup IO modules on AS00SCM-RTU	9-68
9.4.2.2.2 Download the EDS File of AS00SCM-RTU	9-70
9.4.2.2.3 Configure EtherNet/IP Parameters of AS00SCM-RTU	
9.4.2.2.4 Operate IO modules on AS00SCM-RTU	9-80
9.4.2.2.5 Parameter Information of AS00SCM-RTU Module	9-82
9.4.3 EtherNet/IP Adapter Function	9-83
9.4.3.1 EtherNet/IP Adapter	9-83
9.4.3.3.1 Add an EtherNet/IP Adapter	9-83
9.4.3.1.2 Setting up EtherNet/IP Adapter	9-91
9.4.3.1.3 Export an EDS File	9-92
9.4.3.2 Example of Connecting to a Third Party	
(Allen Bradley Controllogix 1756-L71)	9-92
9.4.3.2.1 Structure	9-92
9.4.3.2.2 Create a Project	9-93
9.4.3.2.3 Create a Scanner	9-93
9.4.3.2.4 Create a New Module	9-93
9.4.3.2.5 Import an EDS File	9-93
9.4.3.2.6 Create a New Adapter	9-93
9.4.3.2.7 Projects Download	9-94
9.4.3.2.8 Data Mapping	9-94
9.4.4 CIP Object	9-95
9.4.4.1 Object List	9-95
9.4.4.2 Data Type	9-96
9.4.4.3 Identity Object (Class ID: 01 Hex)	
9.4.4.5 TCP/IP Interface Object (Class ID: F5 Hex)	
9.4.4.6 Ethernet Link Object (Class ID: F6 Hex)	
9.4.5 Delta EIP Product List	
9.4.5.1 Delta EIP Product List (Adapters Supported)	
9.4.5.2 Delta EIP Product List (Scanners Supported)	

# 9.1 Introduction to EtherCAT Communication

Firmware Version	IODrvEtherCAT 3.5.15.30	IODrvEtherCAT 4.4.0.0
V1.0.4.2 or previous	Compatible	Incompatible
V1.0.5.0 or later	Compatible	Compatible

The compatibility of the firmware version of AX-3 Series PLC CPU and the version of the EtherCAT function library:

# 9.1.1 Features of EtherCAT Fieldbux

The EtherCAT bus is the Ethernet-based fieldbus. The communication rate of the EtherCAT network is 100Mbps and the distance between two adjacent nodes is within 50 metres. The EtherCAT network is noticeably very different from the general Ethernet network. One EtherCAT network has just one EtherCAT master and EtherCAT slaves contain ESC chips (EtherCAT Slave Controller) specially used for processing EtherCAT communication data and inserting the data which slaves need to transmit to the master into the EtherCAT frame. The last EtherCAT slave in the network will return the data which have been handled to the master in chronological order. See the illustration of data transmission shown below.

Thanks to the ESC chips in slaves, the master can make a communication with all slaves in an EtherCAT data frame and thus the communication efficiency is enhanced.



#### • EtherCAT Communication between the Controller and Slaves

Since the EtherCAT bus is the EtherNet-based fieldbus, the EtherCAT data frame still adopts the UDP/IP Ethernet data frame structure.

EtherCAT data field includes 2 bytes of EtherCAT data header and 44~1498 bytes of EtherCAT data. EtherCAT Data field consists of one or more EtherCAT datagrams. EtherCAT Data can be defined and analyzed in a protocol as long as the master and slaves comply with the protocol. Currently the mostly used two protocols are COE (CANopen Over EtherCAT) and SOE (Sercos Over EtherCAT). EtherCAT data frame structure is as displayed below.



# 9.1.2 Settings up EtherCAT Master

This section introduces functions in the tab of AX\_308\_Series\_EtherCAT\_Master\_SoftMotion. Refer to Chapter 6 for Network Configuration and how to create an EtherCAT connection.

General	1 Autoconfig	g Master/Slave	s		Ether CAT.
Sync Unit Assignment	2 EtherCAT NIC	Setting —			
Log	Destination a	ddress(MAC)	FF-FF-FF-FF-FF	Broadcast	Enable redundancy
EtherCAT I/O Mapping	Source address (MAC)		00-00-00-00-00-00	Browse	
EtherCAT IEC Objects	Network Nam	e work by MAC	cpsw1 Select netwo	ork by name	
Status	3 Distributed C	Clock —	(4	Options	
Information	Cycle time	2000	ir μs	Use LRW inste	
	Sync offset	50	\$ %	Enable messa	
				Automatic rest	tart slaves
	Sync windo	wmonitoring			

#### General

- ① Autoconfig Master/Slaves: Enable this option to have basic configurations done. Suggested to use this option.
- ② EtherCAT NIC Setting
  - Destination address (MAC): MAC address of the device in the EtherCAT network that is to receive the telegrams.
  - Source address (MAC): MAC address of the controller (Select CPSW1 when you use Broswe... to find Slave)
  - Network Name: Name or MAC of the network, depending on which of the following options is activated:
  - Select Network by MAC: The network is specified by the MAC ID. (default: CPSW<sup>\*1</sup>)
  - Select network by Name: Network is identified by the network name and the project is deviceindependent.
- ③ Distributed Clock
  - Cycle time: Master sends out corresponding data to the Slaves in a cycle time specified here.
  - Sync offset: Parameter for setting the delay time between the Distributed Clock time base of the EtherCAT slave and the cycle start of the PLC. With the default value of 20%, the PLC cycle starts 20% of the bus cycle time after the sync interrupt of the slave. For the controller program, 80% of the cycle is always available. Here the Sync offset determines only when the EtherCAT data of the master is exchanged to and from the slaves relative to the time base of the EtherCAT slave.
  - Sync window monitoring: Enabled to monitor the synchronization of the slaves.
  - Sync window: Time for Sync window monitoring.
- ④ Options
  - Use LRW instead of LWR/LRD: Use combined read/write commands/PDO (LRW) instead of separating read (LRD) and write commands (LWR).
  - Enabled messages per task: Read and write commands, i.e. the handling of the input and output messages, can be controlled with various tasks.
  - Automatic restart slaves: In the case of a communication breakdown, the master immediately attempts to restart the slaves.

#### Log

Here you can view the PLC log. It lists the events that wer recorded on the target system. Refer to section 4.2.1.5 Log for more information.

General	😲 0 warning(s)	0 error(s)	E 0 exception(s)	<ol> <li>0 information(s)</li> </ol>	O debug message(s)	I I
Sync Unit Assignment	UTC time					
-,	Severity	Time Stamp	Descri	ption		
Log						
EtherCAT I/O Mapping						
EtherCAT IEC Objects						
Status						
Information						

#### • EtherCAT I/O Mappting

Here you can select the bus cycle task for EtherCAT communication. The bus cycle task selected will be synchronized with the specified EtherCAT\_Master cycle time.

Bus cycle task: Select a bus cycle task to synchronize with the EtherCAT communication time. When the option "Use parent bus cycle setting is selected", the system use the shortest cycle time as the EtherCAT cycle time.

General	Bus Cycle Options	
	Bus cycle task	EtherCAT_Task ~
Sync Unit Assignment		Use parent bus cycle setting EtherCAT_Task
Log		MainTask
EtherCAT I/O Mapping		
EtherCAT IEC Objects		
Status		
Information		

# 9.1.3 Setting up the EtherCAT Slave

This section introduces functions in the tab of Slaves. You can either scan the network to add the slaves in or add slaves from the Product list. Refer to section 6.1.3 for more information.

General	Address			Additional —		
Expert Process Data	AutoInc address EtherCAT address	0	4 V	🗹 Enable exp	pert settings	EtherCAT
Process Data	Distributed Clock					
Startup Parameters	2 Select DC	DC-Synch	nronous		~	
EtherCAT I/O Mapping	Enable	2000	Sync u	unit cycle (µs)		
EtherCAT IEC Objects	Sync0:					
Status	Sync unit cycle	x 1	~	2000 🧘	Cycle time (µs)	
Information	O User-defined			0	Shift time (µs)	
	Sync1:					
	Enable Sync 1					
	Sync unit cycle	x 1	-	2000 📫	Cycle time (µs)	
	O User-defined			0	Shift time (µs)	
	3 Startup Checking			4 Timeouts		
	Check vendor ID			SDO access	2000	🔺 ms
	Check product ID	her		I -> P	3000	🚔 ms
				P-> S/S-> 0	10000	🖨 ms

#### General

#### Address

① EtherCAT address: Final address of the slaves, assigned by the master during bootup. The address is independent of the position of the slave in the network.

#### Distributed Clocks

② Select DC: Cycle time for the data exchange.

#### 3 Startup Checking

Function	Description
Check vendor ID	Once the system starts, it checks if the vendor ID and product ID are the same
Check product ID	as the configured. If not, the system stops without any further operation.
Check revision number	Once the system starts, it checks if the revision number is the same as the drop- down list showed.

#### ④ Timeouts

Function	Description
SDO access	Once the system starts, the SDO also starts transmitting. Unit: ms
I -> P	Switching form Init mode to Pre operational mode. Unit: ms
P -> S / S -> O	Switching from Pre operational mode to Safe Operational mode. Or switching from Safe-Op mode to Operational modd. Unit: ms

#### • Process Data

The data mapping of the EtherCAT network is a cyclic data exchange between the master and slave through the CoE-based PDO mapping. The data that a slave sends to the master are packed in TxPDO and the data that the slave reads from the master are packed in RxPDO. The inputs and outputs on the pages of Select the Outputs and Select the Inputs contain the lists of PDOs which are available for data exchange and can be edited. For ESI file of a device, the PDOs and PDO contents for option have been defined and some PDO contents are allowed to be edited by users themselves as defined in ESI.

General	Select the Outputs				Select the Inputs				
	Name	Туре	Index	^	Name	Туре	Index	^	
Process Data	16#1600 1st RxPDO Mapping (est 16#1600 1st RxPDO Mapping)	cclu			16#1A00 1st TxPDO Mapping	(e			
	Control Word	UINT	16#6040:00		Status Word	UINT	16#6041:00		
Startup Parameters	Target Position	DINT	16#607A:00		Actual Position	DINT	16#6054:00		
EtherCAT I/O Mapping	Target Velocity	DINT	16#60FF:00		Velocity actual value	DINT	16#606C:00		
and do hopping	Touch Probe Function	UINT	16#60B8:00		Touch Probe Status	UINT	16#6089:00		
therCAT IEC Objects	✓ 16#1601 2nd RxPDO Mapping				Touch Probe Pos1 Pos Value	DINT	16#60BA:00		
	Control Word	UINT	16#6040:00		Digitalinputs	UDINT	16#60FD:00		
Status	Target Position	DINT	16#607A:00		✓ 16#1A01 2nd TxPDO Mapping				
	Target Velocity	DINT	16#60FF:00		Status Word	UINT	16#6041:00		
information	Target Torque	INT	16#6071:00		Actual Position	DINT	16#6064:00		
	Touch Probe Function	UINT	16#60B8:00		Velocity actual value	DINT	16#606C:00		
	16#1602 3rd RxPDO Mapping (e	xclu			Actual Torque	Actual Torque	INT	16#6077:00	
	Control Word	UINT	16#6040:00		Touch Probe Status	UINT	16#60B9:00		
	Target Position	DINT	16#607A:00		Touch Probe Pos1 Pos Value	DINT	16#60BA:00		
	Target Velocity	DINT	16#60FF:00		Digitalinputs	UDINT	16#60FD:00		
	Target Torque	INT	16#6071:00		16#1A02 3rd TxPDO Mapping	(e			
	Mode Of Operation	SINT	16#6060:00		Status Word	UINT	16#6041:00		
	Touch Probe Function	UINT	16#60B8:00		Actual Position	DINT	16#6064:00		
	16#1603 4th RxPDO Mapping (e	xclu			Velocity actual value	DINT	16#606C:00		
	Control Word	UINT	16#6040:00		Actual Torque	INT	16#6077:00		
	Target Position	DINT	16#607A:00		Mode Of Operation Display	SINT	16#6061:00		
	Target Velocity	DINT	16#60FF:00		Touch Probe Status	UINT	16#60B9:00		
	Target Torque	INT	16#6071:00		Touch Probe Pos1 Pos Value	DINT	16#60BA:00		
	Mode Of Operation	SINT	16#6060:00		Digitalinputs	UDINT	16#60FD:00		
	Positive torque limit	UINT	16#60E0:00		16#1A03 4th TxPDO Mapping	(e			
	Nantivatornualimit	ITMT	16#6051.00	~	Statue Mard	LITNIT	16#6041+00	2	

If outputs of the device are activated here (for writing), these outputs can be assigned to project variables in the EtherCAT I/O Mapping window. And if inputs of the device are activated here (for reading), these inputs can be assigned to project variables in the EtherCAT I/O Mapping window. It takes more PLC system resources, if you use more PDOs.

#### • Startup Parameters

The table shows the commands which have been defined by default in ESI file when the master will read and write values to the slave in the specific status of EtherCAT network operation. Users can add or reduce or modify commands in the table.

Funciton Button	Description
Add	By specifying new index/subindex entries, a new object can be added to the SDO that is not yet described in the EDS file. This is useful if only an incomplete object directory or none at all is present.
Edit	In this window you can change the parameters of the SDO before the SDO is added to the configuration.
Move Up	Moves the selected line upwards by one line
Move Down	Moves the selected line downwards by one line

General	- Auu		Move Up 🚯 Move Down						
Process Data	Line	Index:Subindex	Name	Value	Bit Length	Abort on Error	Jump to Line on Error	Next Line	Commen
Process Data	- 1	16#0000:16#00	16#0000:16#00	0	8			0	
Startup Parameters	- 2	16#6060:16#00	Op mode	8	8			0	Op mode
	- 3	16#2119:16#00	DRV's Parameter P1-25	0	16			0	
EtherCAT I/O Mapping	- 4	16#1603:16#00	4th Receive PDO Mapping	0	8			0	
EtherCAT IEC Objects	- 5	16#1A02:16#00	3rd Transmit PDO Mapping	0	8			0	
	- 6	16#2104:16#00	DRV's Parameter P1-04	0	16			0	
Status	- 7	16#2006:16#00	DRV's Parameter P0-06	0	32			0	Interpolat
	8	16#6098:16#00	Homing method	35	32			0	
Information	9	16#60C2:16#01	Interpolation time period	2	8			0	Interpolat
	- 10	16#609A:16#00	Homing acceleration	100	32			0	
	- 11	16#6099:16#01	Speed during search for switch	100	32			0	
	12	16#1C13:16#00	TxPDO assign	0	8			0	
	13	16#6099:16#02	Speed during search for zero	20	32			0	

Click Add button to open the Select Item Object Directory window. And select the parameter that you'd like to add and then click OK to add the item in.

SubIndex: 16#	0	-	0		÷	-	Cancel
Index: 16#	2001	Bit length	16		\$	Г	OK 🗙
Name	DRV's Parameter P0-01						
16#2012:16#0	0 DRV's Parameter	P0-18	RW	UINT			~
16#2011:16#0	0 DRV's Parameter	P0-17	RW	UINT			
16#2007:16#0	0 DRV's Parameter	P0-07	RW	UDINT			
16#2006:16#0	0 DRV's Parameter	P0-06	RW	UDINT			
16#2005:16#0	0 DRV's Parameter	P0-05	RW	UDINT			
16#2004:16#0	0 DRV's Parameter	P0-04	RW	UDINT			
16#2003:16#0	0 DRV's Parameter	P0-03	RW	UINT			
16#2002:16#0	0 DRV's Parameter	P0-02	RW	UINT			
16#2001:16#0	0 DRV's Parameter	P0-01	RW	UINT	1		
± 16#1C33:16#0	0 SM input parameter	er				10	
16#1C32:16#0	0 SM output parame	ter					
* 16#1C13:16#0	0 TxPDO assign						
+ 16#1C12:16#0	0 RxPDO assign						
+ 16#1A03:16#0	0 4th Transmit PDO	Mapping					
+ 16#1A02:16#0	0 3rd Transmit PDO	Mapping					
+ 16#1A01:16#0	0 2nd Transmit PDO	Mapping					
Index:Subindex	Name		Flags	Туре	Default		^

# 9.1.4 Backup Parameters for EtherCAT Slaves

While using EtherCAT communication, we provide custom parameter storage feature for ASDA series servo drives with the backup feature to backup and recover parameters of all slave stations.

#### 9.1.4.1 Data Backup Procedure

Backup procedure



Recover procedure



\*Note: If there's any existing axis error while executing parameter backup or recovery, the corresponding slave station would be skipped in the backup/ recovery procedure. After the backup/ recovery of all the rest of slave stations are completed, all the related messages of axis errors would be dispayed.

#### 9.1.4.2 Introduction to Backup and Restore

- Supported version for backup and recovery
  - AX-3 series firmware version: V1.0.2.0 and above
  - DIADesigner-AX version: V1.2 and above
  - Only models ASDA-A3-E and ASDA-B3-E are supported for parameter backup and recovery.
    - ASDA-A3-E firmware version: V11165 sub 92 and above
    - ASDA-B3-E firmware version: V10665 sub 75 and above
- Data that is backed up

Servo parameters P0~P4 (Not including P0.001 and P4.000), P5.0003, P5.0008~P5.0009, P5.0020~P5.0030 and P6.0000~P6.0001.

- Enter the parameter backup page
  - Method 1



\*Note: By using this method, the option "Current Project" would not able to be chosen for the setting of "Generate Target Device List from".

rg → 
sDA_A3) g ▶
g ▶
st
er
ice
Devices
evice
evice
t
t with
pping
ppings from CSV
ppings to CSV

• Enter the Parameter Backup and Restore page

Parameter Backup and Restore				×
General	Action: Backup to File Generate Target Device List from: Online Device Online Device Device Name: Device Address: Device Address: Device Type: Device ID: Device Version:	Action	Backup 1	
		Action:	васкирт	o rile

Name	Function
Online Device	Select the target device to connect.
Generate Target Device List from	<ul> <li>Select EtherCAT project tree</li> <li>Archive File → EtherCAT topology file</li> <li>Current Project → EtherCAT topology in the current project</li> <li>Online Topology → Online EtherCAT topology</li> </ul>
Action	<ul> <li>Select the target action</li> <li>Backup to File → Backup parameters to files.</li> <li>Backup to SD Card → Backup parameters to external SD cards.</li> <li>Restore from File → Restore parameters from files.</li> <li>Restore from SD Card → Restore parameters from SD cards.</li> </ul>
<b></b>	Save the current EtherCAT topology (Archive File)
$\triangleright$	Execute the backup/ restore feature.

#### • External SD card backup path

External SD card path: /PLC CARD/AX\_/SysDup/ECAT/BackupRestore/ (The "\_" in the path represents model types. For example, model AX-3 would be defined as AX3 here.)

#### 9.1.4.2.1 Operation for the Backup Function

#### Parameter backup

- ① Select Device.
- 2 Configure EtherCAT topology for the curret project.
- ③ Set Action to "Backup to File".
- ④ Execute backup.

General Target Device List	Action:			
✓ 1001 (Delta ASDA-A3-E)	Backup to File ~			
	Generate Target Device List from: 1			
	Current Project			
	Online Device			
	Gateway-1/0005 v			
	Device Name: AX-308EA0MA1T Device Address: 0005			
	Device Type: 4102			
	Device ID: 16F7 0314 Device Version: 1.0.1.4			
	Device version: 1.0.1.4			
				-
	😵 0 Errors 🔥 0 Warnings 🚺 0 Messages 🚔			
	Device Message			-
		Action:	Backup	to

• Change the PLC state to Stop.



• Click "Close" after the parameter backup is complete.

Parameter Backup and Restore		$\times$
General J Target Device List 1001 (Delta ASDA-A3-E)	Action: Backup to File Generate Target Device List from: Current Project Online Device Gateway-1/0005 Device Name: AX-308EA0MA1T Device Adm Device Tyle Backup Device IV: Device Ver Finished	
	O Errors       1 Warnings       1 Messages         Device       Message         1 001 (Delta ASDA-A3-E)       Device "1001" backup destination already has a file named "1001_Delta_A         1 1001 (Delta ASDA-A3-E)       Successfully backup device: 1001 (Delta ASDA-A3-E)          Action: Backup to	>

Backup directory

Parameter Backup and Restore		– 🗆 X
General ✓ Target Device List ✓ 1001 (Detra ASI <sup>C</sup> 3-E)	General Address: 1001 Vendor Id: 1DD Settings	Product Code: 00006010
	File Name: Directory:	1001_Delta_ASDA_A3_E.par
		Clone to Other Devices
	Device	Warnings 🕦 1 Messages
		a ASDA-A3-E) Successfully backup device: 1001 (Delta ASDA-A3-E)
	<	Action: Backup to File

9\_

#### AX-3 Series Operation Manual

Name	Function
File Name	Set the name for parameter backup file.
Directory	Set the backup directory.
Clone to Other Devices	Change all the backup directoryof other devices.

#### 9.1.4.2.2 Operation for the Restore Function

#### • Parameter restoration

- ① Select Device.
- 2 Configure EtherCAT topology for the curret project.
- ③ Set Action to "Backup to File".

Parameter Backup and Restore				×
General ✓ Target Device List ✓ 1001 (Delta ASDA-A3-E)	Action: 3 Restore from File  Generate Target Device List from: Current Project Online Device 1 Gateway-10005 Device Name: AX-308EA0MA1T Device Address: 0005 Device Varsion: 1.0.1.4 0 Message Device Version: 1.0.1.4			
	· · · · · · · · · · · · · · · · · · ·	Action: Re	store fror	m File

• Click on the target device and set the path to the file to restore.

General General	General
✓ Target Device List	Address: 1001
✓ 1001 (Delta ASP ^ 3-E)	Vendor Id: 1DD Product Code: 00006010
	Settings
$\smile$	Path: C\Users\Johnny.xie\Documents\Delta Industrial Automation\ParameterBackupRestore\1001_Del
	😢 0 Errors 🛕 0 Warnings 🌒 0 Messages 🔮
	Device Message

• Activate the restore function.

🖻 Parameter Backup and Restore — 🗆 🗡	×
General       Action:         ▲ I Target Device List       Restore from File ↓         Generate Target Device List from: ●       Generate Target Device List from: ●         Generate Target Device List from: ●       Current Project ↓         Device Variant       Device Cateway-1/0005 ↓         Device Address: 0005       Device Toppe: 4102         Device Version: 1.0.1.4       Device Version: 1.0.1.4	

• Change the PLC state to Stop.

DIADesigner-AX	
Do you want to stop the controller and servo off the slave devices?	

• Click Yes after the restoration is complete, then reboot the device.

General	Action:	
✓ Target Device List ✓ 1001 (Delta ASDA-A3-E)	Restore from File	
	Generate Target Device List from: 1	
	Current Project	
	Online Device	_
	Gateway-1/0005	
	DIADesigner-AX X	
	Please manually reboot the successfully restored devices.	
	Please manually reboot the successfully restored devices.	
	Please manually reboot the successfully restored devices.	

9\_

# 9.2 Introduction to Modbus Serial Communication

# 9.2.1 Modbus Serial Port

DIADesigner-AX supports the following Modbus network types, including one RS-232 and one RS-485. Each Modbus Serial Port allows one master. A maximum of 32 slaves can be attached to a master. But since RS-232 has no multipoint capability, only point-to-point connection is possible. And only the FIRST slave can communicate with the master. Since RS-485 has multipoint capability, RS-485 does NOT have such limitations. Follow the below section to set up the basic settings for communication via the serial port for the Modbus serial port.

#### 9.2.1.1 Adding Delta Modbus COM

1. Right-click the PLC in the tree view to open up a context menu. And click **Add Device...**to open the Add Device setting window.



2. Find **Delta Modbus COM** (Fieldbuses -> Modbus -> Modbus Serial Port -> Delta Modbus COM) and then double-click it or click **Add Device** to add this port in.

ame Delta_Modbus_COM				
Action				
Append device Tinsert device				
tring for a fulltext search	Vendor	<all vendors=""></all>		~
Name	Vendor		Version	Description
Miscellaneous				
Fieldbuses				
CAN CANbus				
Brut EtherCAT				
* Ethernet Adapter				
🛞 👄 EtherNet/IP				
Home&Building Automation				
🚍 💶 🖬 Modbus				
Modbus Serial Port				
Delta Modbus COM	Delta Electroni	ts, Inc.	0.30.1.0	De rial port o
Modbus COM	3S - Smart Sof	tware Solutions Gmb	H 3.5.15.0	A OM Port
🔅 🚟 Profibus				
* Profinet IO				
* S sercos				
c ] Group by category 🔲 Display all ve	rsions (for expert	s only) 🗌 Displa	y outdated versio	ns
Name: Delta Modbus COM			^	
Vendor: Delta Electronics, Inc.				
Categories: Modbus Serial Port				
Version: 0.30.1.0			_	3
Order Number: -			*	-
ppend selected device as last child evice	of			
You can select another target noc	le in the navigato	while this window	is open.)	
		1	Add Device	Close

3. Find the added port **Delta\_Modbus\_COM (Delta Modbus COM)** in the tree view and double-click it to open the setting window to set up.

Devices	• 4 ×	Delta_Modbus_COM X	[]		
DIA+_COM_port  DIA+_COM_port  Device (AX-308EA0MA1T)  Hardware Configuration  A tetherCAT Filter  ModbusCOM Filter  ModbusCOM Filter  PIC Logic  C Application  PIC Logic  C Application  PIC Logic  D PIC_PRG (PRG  D PIC_PRG PRG  D PIC_PR  D PIC_P	r ) tion Task RG (Delta LocalBus Ma Motion (EtherCAT M elta Modbus COM),	General Status Information	Serial Port Configuration COM Port Baudrate Parity Data Bits Stop Bits Transmission Mode	RS-232 9600 Even 7 1 O RTU O ASCII	

#### 9.2.1.2 Setting up Delta Modbus COM

#### General

Here you can configure Serial Port Parameters. Settings include COM Port (RS-232 /RS-485), Baudrate, Parity, Data Bits, Stop Bits and Transmission Mode can be set here.

neral		
itus	- Serial Port Configuration	
	COM Port	RS-232 Y
ormation	Baudrate	9600 ~
	Parity	Even 🗸
	Data Bits	7 ~
	Stop Bits	1 ~
	Transmission Mode	○ RTU

ltem	Description
COM Port	Communication interface: RS-232/RS-485
Baudrate	The communications speed in bits per second (bps): 9600/19200/38400/57600/115200
Parity	None/Odd/Event
Data Bits	7/8 (when the transmission mode is RTU, you need to set the data bits to 8)
Stop Bits	1 bit/2bits
Transmission Mode	RTU/ASCII

#### Status

Here you can find the device status information, for example 'Running' or 'Stopped', and specific diagnostic messages from the respective device, also information about the card used and the internal bus system.

Delta_Modbus_COM 🗙		
General	ModbusSerial :	Running
Status	,	
Information		

ltem	Description
Modbus Serial	The status of Modbus Serial Communication

#### Information

Here you can find general information that originates from the device description file: name, vendor, categories, version, order number, description, and other relevant information.

Delta_Modbus_COM X	
General	General
	Name: Delta Modbus COM
Status	Vendor: Delta Electronics, Inc.
	Categories: Modbus Serial Port
Information	Type: 40001
	ID: 16F7 8702
	Version: 0.30.1.0
	Order Number: -
	<b>Description:</b> Delta serial port of Modbus 

# 9.2.2 Modbus Serial Master

AX-3 Series PLC can act as a Modbus Serial Master, after you have created Modbus Master COM port and Modbus Slave COM port. Follow the below section to set up the Modbus Serial Master.

#### 9.2.2.1 Adding Delta Modbus Master/Slave COM

1. Right-click the created Delta\_Modbus\_COM (Delta Modbus COM) in the tree view to open up a conext menu. And click **Add Device...**to open the Add Device setting window.

Devices	- 7	×
Untitled 1     AX_308EA0MA1T (AX-308EA0MA1T)     AT_308EA0MA1T (AX-308EA0MA1T)     A Hardware Configuration     A Network Configuration     A LitherCAT Filter		^
ModbusCOM Filter     ModbusTCP Filter     ModbusTCP Filter     PLC Logic     Difference     ModbustCP Filter     Difference     ModbustCOM Filter     ModbustCOM Filter		
DIO (DIO) Delta_LocalBus_Master (Delta LocalBus Master AX_308_Series_EtherCAT_Master_SoftMotion Ethernet (Ethernet)		
Delta_Modbus_COM (Delta Modbus COM)  SoftMotion General Axis Pool  AX_308EA0MA 1T_1 (AX-308EA0MA 1T)	ж П	Cut Copy
AX_308EA0MA 1T_2 (AX-308EA0MA 1T)     AT And Ware Configuration     A Network Configuration     A EtherCAT Filter	®× ₽	Paste Delete Properties
A ModbusCOM Filter		Add Object Add Folder Add Device
Library Manager		Insert Device Disable Device

 Find and double-click Delta Modbus Master COM Port (Fieldbuses -> Modbus -> Modbus Serial Master -> Delta Modbus Master COM Port) or click Add Device to add this port in. You can only add one Master COM Port. After you added one master, the other added devices are slave ports: Delta\_Modbus\_Master\_COM\_Port, the Delta\_Modbus\_Slave\_COM\_Port.

Action Append device O Insert device	) Plug device (	) Update device		
String for a fulltext search	Vendo	r <all vendors=""></all>		Ŷ
Name Fieldbuses Modbus Modbus Serial Device	V	endor	Version	Description
Coup by category Display all	versions (for exper	elta Electronics, Inc. ts only) 🔲 Display	0.40.1.0	Delta Serial Port Sel
Delta Modbus Mas     Delta Modbus Mas     Group by category Display all     Name: Delta Modbus Master C     Vendor: Delta Electronics, Inc.     Categories: Modbus Serial Ma     Version: 0.40, 1.0	versions(for exper			,
<ul> <li>Composition of the second state o</li></ul>	versions(for exper DM Port Ster	ts only) 🗌 Display		\$

3. Find the added port **Delta\_Modbus\_Master\_COM\_Port (Delta Modbus Master COM Port)** in the tree view and double-click it to open the setting window to set up.



#### 9.2.2.2 Setting up Delta Modbus Master COM

#### General

Here you can configure the basic settings for Modbus Serial Master.

General	
DeltaModbusSerialMaster I/O Mapping	- General Configuration
DeltaModbusSerialMaster IEC Objects	Retry Count 3
Status	
Information	

ltem	Description
Retry Count	Set up the number of times for the COM port to reconnect if the connection is lost.
Auto-Reconnect	Enable this option to have this port to reconnect automatically if an error occurs or commection timeout occurs.

#### Delta Modbus Serial Master I/O Mapping

Bus cycle task: Select a bus cycle task to synchronize with the Modbus communication time. When the option "Use parent bus cycle setting is selected", the system use the shortest cycle time as the bus cycle time. Refer to section 4.2.1.6 PLC Settings for more information.

General	Bus Cycle Options	
	Bus cycle task	mdbsComTask
DeltaModbusSerialMaster I/O Mapping		Use parent bus cycle setting mdbsComTask
DeltaModbusSerialMaster IEC Objects		
Status		
Information		

#### Delta Modbus Serial Master IEC Objects

Here is the correspondings of the DFB\_ModbusCOMMaster function block. You can check the status of Modbus Serial Master under this tab.



#### Status

Here you can find the device status information, for example 'Running' or 'Stopped', and specific diagnostic messages from the respective device, also information about the card used and the internal bus system.

General	DeltaModbusSerialMaster	nla
DeltaModbusSerialMaster I/O Mapping	1	
DeltaModbusSerialMaster IEC Objects		
Status		
Information		

#### Information

Here you can find general information that originates from the device description file: name, vendor, categories, version, order number, description, and other relevant information.

DeltaModbusSerialMaster I/O	Name: Delta Modbus Master COM Port Vendor: Delta Electronics, Inc.
Mapping	Categories: Modbus Serial Master
DeltaModbusSerialMaster IEC	Type: 40001 ID: 16F7 8705
Objects	Version: 0.40.1.0 Order Number: -
Status	Description: Delta Serial Port Setting of Modbus Master

#### 9.2.2.3 Setting up Delta Modbus Slave COM

In the tree view, find the added port **Delta\_Modbus\_Slave\_COM\_Port (Delta Modbus Slave COM Port).** Double-click it to open the setting window to set up.



#### General

Here you can configure the basic settings for Modbus Serial Slave, such as Slave Address, Response Timeout and Device Type.

General	General Configuration	
Modbus Slave Channel	Slave Address [1247]	1
Modbus Slave Init	Response Timeout [ms]	1000
DeltaModbusSerialSlave I/O Mapping	Device Type	Standard Modbus Devices v
DeltaModbusSerialSlave IEC Objects		
Status		
Information		

ltem	Description
Slave Addres	Address of a serial Modbus device (value between 1 and 247)
Response Timeout	Time interval for the master to wait for the response from the slave. This is especially configured for this slave node and overwrites the general response timeout setting of the respective master.
Device Type	You can select standard Modbus devices or Delta devices. If you select Delta devices, the system converts the protocol used into Modbus protocol automatically so that you do NOT need to refer to the register map for the conversion.

9\_

#### Modbus Slave Channel

Here you can define slave channels. Each channel represents a single Modbus request. You can create up to 10 channels for each slave. AX-3 Series PLC will send out Modbus request packets in chronological order. All channels share the same Modbus connection.

General	0	~	Name Channel 0	Access Type Read Coils	Trigger Cyclic, 100ms	READ Offset 0x0	Length 1	Error Handling Keep last Value
Modbus Slave Channel	1	~	Channel 1	Read Coils	Cyclic, 100ms	0x0	1	Keep last Value
	2		Channel 2	Read Coils	Cyclic, 100ms	0x0	1	Keep last Value
Modbus Slave Init	3	~	Channel 3	Read Coils	Cyclic, 100ms	0x0	1	Keep last Value
DeltaModbusSerialSlave I/0	4		Channel 4	Read Coils	Cyclic, 100ms	0x0	1	Keep last Value
Mapping	5		Channel 6	Read Coils	Cyclic, 100ms	X Coil 0x0	1	Keep last Value
DeltaModbusSerialSlave IEC	6		Channel 7	Read Coils	Cyclic, 100ms	0x0	1	Keep last Value
Objects	7		Channel 8	Read Coils	Cyclic, 100ms	0x0	1	Keep last Value
Status	8		Channel 9	Read Coils	Cyclic, 100ms	X Coil 0x0	1	Keep last Value
Information								
	4							
		Move	11	fove Down		Add Channel	Delete	Edit

Click Add Channel, you can edit the channel before adding it in. The **Device Address** shows the Modbus protocol address whether the device type you selected is **Standard Modbus Device** or **Delta Devices** under the **General** tap. Since the system converts the protocol used into Modbus protocol automatically, you do NOT need to refer to the register map for the conversion.

Modbus Channel ×	Modbus Channel ×
Enable	Enable
Channel	Channel
Name Channel 0	Name Channel 0
Access Type Read Coils	Access Type Read Coils
Trigger Cyclic 🔽 100 ms	Trigger Cyclic 🖌 100 ms
Comment	Comment
Read Register	Read Register
Device Address 0x0	Device Address X Coil 🔽 0x0
Length 1	Length 1
Error Handling Keep last Value	Error Handling Keep last Value
OK Cancel	OK Cancel

#### Device Type : Standard Modbus Device

#### Device Type : Delta AH Series

Item	Desc	ription
Device Type	Standard Modbus Device	Delta Series Device
Enable	Activates t	this channel
Name	Defines this	channel name
Access Type	Modbus function code Read coils (0x01) Read discrete inputs (0x02) Read holding registers (0x03) Read input registers (0x04) Read single coil (0x05) Write single register (0x06) Write multiple coils (0x0F) Write multiple registers (0x10) Read/Write multiple registers (0x17)	Read/Write Registers <ul> <li>Read coils</li> <li>Read registers</li> <li>Write coils</li> <li>Write registers</li> </ul> <li>Note: PLC uses the corresponding Modbus function code according to the read/write register of the device type.</li>
Trigger	<ul> <li>Cyclic: The request occurs periodically.</li> <li>Rising edge: The request occurs as a reaction to a rising edge of the Boolean trigger variables. The trigger variable is defined in the tab I/O Mapping.</li> <li>Application: The Modbus request is triggered by DFB_ModbusComChannel</li> </ul>	<ul> <li>Cyclic: The request occurs periodically.</li> <li>Rising edge: The request occurs as a reaction to a rising edge of the Boolean trigger variables. The trigger variable is defined in the tab I/O Mapping.</li> <li>Application: The Modbus request is triggered by DFB_ModbusComChannel</li> </ul>
Comment	Description	of the channel
Device Address	Modbus protocol address	Delta register address (will be converted into Modbus protocl in the background)
Length	Number of the register to be read/written to. (up to 100 coils and 100 registers)	Number of the register to be read/written to. (up to 256 coils and 100 registers)
Error Handling	<ul> <li>What to do with the data in case of a commun</li> <li>Set To ZERO</li> <li>Keep last value</li> </ul>	ication error:

#### Modbus Slave Init

After the Modbus connection between AX-3 Series PLC and the slaves is established, you can use **Add Channel** button to edit the Initialization Value of the Coil/Register.

General	Line	Access Type Write Single Coil	WRITE Offset 0x0	Default Value	Length 1	Comment		
Modbus Slave Channel	1	Write Single Coil	0x0	0	1			
todbus Slave Init	3	Write Multiple Registers Write Multiple Colls	0x0 0x0	5	1 8			
DeltaModbusSerialSlave1/0 Mapping								
DeltaModbusSerialSlave IEC Objects								
itatus								
Information								
	16	ove Up Nove Down			Ad	id Channel	Delete	Edt

Click **Add Channel**, you can edit the Access Type, Device Address, Length, Initialization Value and Comment. Click OK to confirm the settings.

Access Type	Write Multiple F	legisters	~
Device Address	0x0		
Length	1		
Initialization Value	5		
Comment			

#### Modbus Generic Serial Slave I/O Mapping

After you have added channels under the tab of Modbus Slave Channel, you can find the variables and the set access types under this tab. Here you can define the variables for mapping. The descriptions here reflect what you have set for the **Access Type** in Modbus Slave Channel tab. When the **Trigger type** is set to **Rising edge** in Modbus Slave Channel, the description here adds one more condition, **Trigger variable**.

General	Find		Filter Show all			Add Fl	B for IO Channel * Go to Instanc
Modbus Slave Channel	Variable	Mapping	Channel	Address	Туре	Unit	Description
Houbus slave channel			Channel 0	%QX4.0	BIT		Trigger variable
Modbus Slave Init	+ *		Channel 0	%IW5	ARRAY [00] OF WORD		Read/Write Multiple Registers
	666 🔮 =		Channel 0	%QW3	ARRAY [00] OF WORD		Read/Write Multiple Registers
DeltaModbusSerialSlave I/O Mapping	÷*•		Channel 0[0]	%QW3	WORD		
DeltaModbusSerialSlave IEC	- · · · ·		Channel 1	%IW6	ARRAY (00) OF WORD		Read Input Registers
Objects	* *		Channel 2	%IW7	ARRAY [00] OF WORD		Read Input Registers
	8- <b>1</b> 9		Channel 3	%Q88	ARRAY [00] OF BYTE		Write Multiple Colls
Status	H. M		Channel 4	%IB16	ARRAY [00] OF BYTE		Read Cols

#### Delta Modbus Serial Slave IEC Objects

Here is the correspondings of the DFB\_ModbusCOMMaster function block. You can check the status of Modbus Serial Slave under this tab.

Pevices .	- * ×	Delta_Hodbus_Slave_COM	Port x Device Deita_Modbus_Master_COM	Port	
Gill Device (connected) (AX-308EACMA1T)		General	& Add. BEdit. X Delete - Go to Vanable		
Comparison (and a second		Modbus Slave Channel Modbus Slave Int Detection Slave Int Detection Slave IIIC Objects Status Information	Expression Cence Application Data Modbus Slave (XOM Port Standard Standards) Deset Standards Debote Debote	Type DL, ModbusConNaster, DFB_ModbusConSilave 8000, 80	Value

Expression	Description
bTrigger	Trigger all Modbus channels at one time.
bReset	Re-establish the connection and reset bError and ModbusRrror when the connection status shows error. And this function is only available when the option "Auto-Reconnect" is NOT enabled.
bAcknowledge	Re-establish the connection and the Modbus channel that showed error previously continues to execute the data transmission. And this function is only available when the option "Auto-Reconnect" is NOT enabled.
bDoInit	Initialized the Slave
bInitDone	The initialization of the Slave is complete.
bBusy	This channel is in data transmission.
bDone	The data transmission via this channle is complete.
bError	Error occurs when this channels is in data transmission.
ModbusError	Record of the Modbus error
iChannelIndex	The number of the channel that is in execution.

#### Status

Here you can find the Modbus Slave COM Port status information, for example 'Running' or 'Stopped', and specific diagnostic messages from the respective device, also information about the card used and the internal bus system.

# Delta\_Modbus\_Slave\_COM\_Port X General Modbus Slave Channel Modbus Slave Init DeltaModbusSerialSlave I/O Mapping DeltaModbusSerialSlave IEC Objects Status Information

#### Information

Here you can find general information that originates from the device description file: name, vendor, categories, version, order number, description, and other relevant information.

General	General Name: Delta Modbus Slave COM Port
Modbus Slave Channel	Vendor: Delta Electronics, Inc. Categories: Modbus Serial Slave
Modbus Slave Init	Type: 40001 ID: 16F7 8706 Version: 0.40.1.0
DeltaModbusSerialSlave IEC Objects	Order Number: - Description: A generic device that works as a Modbus Slave on a serial bus test
Status	
Information	

# 9.2.3 Modbus Serial Slave

AX-3 Series PLC can act as a Modbus Serial Slave, after you add Modbus Serial Device in and set up the allowable areas for Coils/Register. If Modbus Serial Master uses Delta device communication protocol, there is no access restrictions. Follow the below section to set up the Modbus Serial Slave.

#### 9.2.3.1 Adding a Modbus Serial Device

1. Right-click the created Delta\_Modbus\_COM (Delta Modbus COM) in the tree view to open up a conext menu. And click **Add Device...**to open the Add Device setting window.



2. Find and double-click **Delta Modbus Serial Devie** (Fieldbuses -> Modbus -> Modbus Serial Master -> Delta Modbus Serial Device) or click **Add Device** to add this port in.

Append device O Insert device				
String for a fulltext search	Vendor	<all th="" vendors<=""><th>&gt;</th><th>1</th></all>	>	1
Name  Fieldbuses  Modbus  Modbus  Modbus  Modbus	Vendor		Version	Description
Delta Modbus Serial Device	e Delta Elec	tronics, Inc.	0.40.0.0	Delta Serial Port Setting
	ns (for experts o	nly) 🗌 Disp	olay outdated	yersions.
Group by category Display all versic     Mame: Delta Modbus Senal Device     Vendor: Delta Electronics, Inc.     Categories: Modbus Senal Device     Version: 0.40.0.0	ns (for experts o	nly) 🗌 Disp	olay outdated	
Group by category Display all versice     Name: Delta Modbus Senal Device     Vendor: Delta Electronics, Inc.     Categories: Modbus Senal Device			olay outdated	

3. Find the added port **Delta\_Modbus\_Serial\_Device (Delta Modbus Serial Device)** in the tree view and double-click it to open the setting window to set up.

Devices 👻 🤋 🗙	Delta_Modbus_Serial_Device	4					
Unsted:     MX_308EA0MAIT_1 (AX:308EA0MAIT)     AX_308EA0MAIT_1 (AX:308EA0MAIT)     AHdware Configuration     A Hotowick Configuration     A EtherCAIT Filter     A ModourCOP Filter     A ModourCOP Filter     DIC Logic	General Delta Modbus Senal Slave Device 1/O Mapping Status Information	Serial Port Setting COM ID 1 Address Information Setting	ł		Cois		
Application     Application     Application     Application     Stark Configuration     Stark Configuration     Stark Configuration     Stark Configuration     Stark Configuration     Stark Configuration     Diol D(10)     Diol D(10)     Diol D(10)     Axis and the Application (AX-308 Series EtherCAT Master     Stark Software()     Axis and Application (AX-308 Series EtherCAT Master     Stark Module (AX-30		Holang Kepiser SeMW SeMW Quantity Modbus Start Address Holding Register SuQW SuQW Quantity Modbus Start Address Input Register	0 10 0 10 256		Tom Start Address Softw Quantity Modbus Start Address Colls SogW NoQW Quantity Modbus Start Address Input Colls	0 10 0 10 10 256	*
Detra Modbus, Serial Device (Detra Modbus Serial Device)     Soffwoton General Aws Pool     March 200EA0MA1T2 (AN-300EA0MA1T)     Device (AN-300EA0MA1T)		shpur kegisser %IW %IW Quantity Modbus Start Address	0	*	%IW %IV Quantity Modbus Start Address	0	* *

9.2.3.2 Setting up the Modbus Serial Device

#### General

Here you can configure the basic settings for Modbus Serial Device. Set up the allowable areas for Coils/Register. If Modbus Serial Master uses Delta device communication protocol, there is no access restrictions.

General	- Serial Port Setting					
Delta Modbus Serial Slave Device I/O Mapping	COM ID 1	A V				
Status						
Information	-Address Information Setting					
	Holding Register			Coils		
	%MW	0	+	%MW	0	+
	%MW Quantity	10	-	%MW Quantity	10	4
	Modbus Start Address	0	*	Modbus Start Address	0	
	Holding Register			Coils		
	%QW	0	*	%QW	0	
	%QW Quantity	10	*	%QW Quantity	10	
	Modbus Start Address	256	*	Modbus Start Address	256	
	Input Register			Input Coils		
	%IW	0		%IW	0	
	%IW Quantity	10	-	%IW Quantity	10	
	Modbus Start Address	0	\$	Modbus Start Address	0	

#### Delta Modbus Serial Slavel/O Mapping

Bus cycle task: Select a bus cycle task to synchronize with the Modbus communication time. When the option "Use parent bus cycle setting is selected", the system use the shortest cycle time as the bus cycle time. Refer to section 4.2.1.6 PLC Settings for more information.

Delta_Modbus_Serial_Device	e X	
General	Bus Cycle Options	President and a second second
D. H. M. A. C. 11 Charles De 1	Bus cycle task	mdbsComTask
Delta Modbus Serial Slave Device I/O Mapping		Use parent bus cycle setting
ио марріng		EtherCAT_Task
Status		mdbsComTask
50005		
To farmer Man		
Information		

#### Status

Here you can find the Modbus Serial Slave Device status information, for example 'Running' or 'Stopped', and specific diagnostic messages from the respective device, also information about the card used and the internal bus system.

×		1
Delta Modbus Serial Slave Device	n/a	

#### Information

Here you can find general information that originates from the device description file: name, vendor, categories, version, order number, description, and other relevant information.

Seneral	General
Delta Modbus Serial Slave Device I/O Mapping	Name: Delta Modbus Serial Device Vendor: Delta Electronics, Inc. Categories: Modbus Serial Device
Status	Type: 40001 ID: 16F7 8703 Version: 0.40.0.0
Information	Order Number: - Description: Delta Serial Port Setting of Modbus Slave

# 9.3 Introduction to Ethernet Communication

DIADesigner-AX supports the following Modbus network types, including Modbus TCP and EtherNet/IP. Follow the below section to set up the basic settings for communication via the Ethernet Adapter.

#### 9.3.1 Network Security

We suggest you to use closed network or use local network with a firewall to secure and prevent the Ethernet network as well as our products from any unwanted attack.

# 9.3.2 Ethernet



#### 9.3.2.1 Adding an Ethernet Adapter Device

1. Right-click the PLC in the tree view to see a conext menu. Click Add Device...to open the setting window.



2. Find and double-click Ethernet (Fieldbuses -> Ethernet Adapter -> Ethernet) or click Add Device to add it in.



#### 9.3.2.2 Setting up the Ethernet

Find the added Ethernetrnet (Ethernet) in the tree view and double-click it to open the setting window for setup.



#### General

Here you can configure Ethernet Parameters. Settings include Interface, IP address, Subnet mask, Default gateway and Adjust operating system settings can be set here.

Log       IP address       192.168.1.5         Status       Subnet mask       255.255.0         Ethernet Device I/O Mapping       Default gateway       0.0.0	General	Interface cpsw0		1
Ethernet Device I/O Mapping     Default gateway     0 . 0 . 0 . 0       Ethernet Device IEC Objects     Adjust operating system settings	Log			
Ethernet Device IEC Objects	Status	Subnet mask	255 . 255 . 255 . 0	
Ethernet Device IEC Objects	Ethernet Device I/O Mapping	Default gateway	0.0.0.0	
			ayaccin accompa	

Item	Description
Interface	Current communication interface
IP address	
Subnet mask	Settings of the selected network interface
Default gateway	
Adjust operating system settings*	The settings on the target system will be overwritten by the values above.
system settings*	The settings on the target system will be overwritten by the values above.

Note: For FW V1.0.1.0 or later, you can find the DDF of AX-3 Series PLC on the setting page. Go to Device -> System Setting. Refer to section 4.2.1.11 for more information.

#### Status

Here you can find the device status information, for example 'Running' or 'Stopped', and specific diagnostic messages from the respective device.

🗹 Ethernet 🗙			
General	Ethernet Device :		Running
Log	Last Diagnostic Message		
Status Ethernet Device I/O Mapping Ethernet Device IEC Objects Information	EthDiag Current IP Current subnet mask Current gateway address IP changes	'192.168.1.5' '255.255.255.0' '0.0.0.0' 0	Ethernet diagnostic information Amount of IP configuration changes since startup (IP or gateway a
	Ethernet :		Running

Item	Description
Ethenet Device	The status of Ethenet Communication
Last Diagnostic Message	Network diagnosis

#### Ethernet Device I/O Mapping

Bus cycle task: Select a bus cycle task to synchronize with the communication time. When the option "Use parent bus cycle setting is selected", the system use the shortest cycle time as the bus cycle time. Refer to section 4.2.1.6 PLC Settings for more information

U Ethernet ×							
	General	Bus Cycle Options Bus cycle task	Use parent bus cycle setting	~			
	Log	bus cycle task	Use parent bus cycle setting				
	Status						
$\left( \right.$	Ethernet Device I/O Mapping						
	Ethernet Device IEC Objects						
	Information						
l							
## Ethernet Device IEC Objects

Here you can find the objects defined by Ethernet Adapter Device. "Objects" are listed that allow for access to the device from the IEC application. In online mode, you can use the table of IEC objects as a monitoring view.

General	🗣 Add 🗹 Edit 🗙 Delete 🗎 G	io to Variable			
Log	Expression S    S    Device.Application.Ethernet	Type IoDrvEthernet.IoDrvEthernet	Value	Prepared value	Address
Status	*ø eState	ETHERNETSTATE	RUNNING		
Ethernet Device I/O Mapping					
Ethernet Device IEC Objects					
Information					

#### Information

Here you can find general information that originates from the device description file: name, vendor, categories, version, order number, description, and other relevant information.

General	General Name: Ethernet
Log	Vendor: 35 - Smart Software Solutions GmbH Categories: Ethernet Adapter, Ethernet Adapter, Ethernet Adapter, Home&Building Automation Type: 110
Status	ID: 0000 0002 Version: 3,5,15,0
Ethernet Device I/O Mapping	Order Number: - Description: Ethernet Link.
Ethernet Device IEC Objects	
Information	

# 9.3.3 Modbus TCP Master (Client)

In addition to providing the standard Modbus communication protocol, the AX-3 Series PLC further executes the Delta controller internal device conversion (X, M, D devices, etc.), eliminating the need for you to check the conversion table. AX-3 Series PLC can act as a Modbus TCP Master, after you have created Modbus TCP Master and Modbus TCP Slave. Follow the below section to set up the Modbus TCP Master.



## 9.3.3.1 Adding a Modbus TCP Master/Slave

1. Right-click the **Ethernet (Ethernet)** node in the tree view to open up a conext menu. And click **Add Device...**to open the Add Device setting window.



 Find and double-click Delta Modbus TCP Master (Fieldbuses -> Modbus -> Modbus TCP Master -> Delta Modbus TCP Master) or click Add Device to add this port in. After that you can find
 Delta Master -> Delta find the Ethernet mathe in the transition

Delta\_Modbus\_TCP\_Master under the Ethernet node in the tree view.

🕤 Add	Device						>
Name	Delta_Modbus_TCP_Master						
Action							
Apple App	pend device O Insert device	O Plug de	evice Ol	Jpdate	device		
String	for a fulltext search		Vendor	<all< td=""><td>vendors&gt;</td><td></td><td>~</td></all<>	vendors>		~
Nam	e	Venc	dor			Version	Description
B 🗊	Fieldbuses						
	etherNet/IP						
-	Modbus						
	Delta Modbus TCP Master	r Delta	Electronics,	Inc		0.30.1.0	A device that
	Modbus TCP Master		Smart Softwa		GmbH	3.5.15.0	A device that
	ModbusTCP Slave Det		' תר		2 \		
	m Profinet IO	7 C		7			
					$\smile$		
<							>
Gro	up by category 📄 Display all vers	ions (for ex	(perts only)		Display outdate	ed versions	
1	Name: Delta Modbus TCP Master						
	Vendor: Delta Electronics, Inc.						
	Categories: Modbus TCP Master					1	
	Version: 0.30.1.0						
	Order Number: -						
	Description: A device that works	as a Modb	us TCP Mast	er on E	Ethernet.		
Appei Ether	nd selected device as last child o	of				(	
						F	
0	(You can select another target node	in the nav	igator while	this wi	ndow is open.)		1)
					Add De	evice	Close

3. Right-click **Delta\_Modbus\_TCP\_Master** under the **Ethernet** node in the tree view to open up a conext menu. And click **Add Device...**to open the Add Device setting window.

File Edit View Project Build Online E	Debug	Tools	Window Help		
🎦 🛩 🖬   🍏   🗠 🔍 🖇 🛍 🗶   🛤 😘 🍓 🌿   📕	લા ગા	湾   畠	🏝 - 🖆   🛗   🥞 🧐 🔸 🗉	🖋   Ç= 9= 4	*≣ \$   ¢
Devices 👻 🕈 🗙					
Ethernet_Parameter					
Device (AX-308EA0MA1T)					
Hardware Configuration					
<ul> <li>A Network Configuration</li> <li>EtherCAT Filter</li> </ul>		*	Cut		
A EtherCAT Filter		en en en en en en en en en en en en en e	Сору		
		Ē.	Paste		
BuiltIn IO (BuiltIn IO)		×	Delete		
Delta_LocalBus_Master (Delta LocalBus Master			Refactoring	•	
AX_308_Series_EtherCAT_Master_SoftMotion		æ	Properties		
Ethernet (Ethernet)		襺	Add Object		
Delta_Modbus_TCP_Master (Delta Modbus	J	<b></b>	Add Folder		
a SoftMotion General Axis Pool			Add Device		
			Insert Device		
			Disable Device		
			Update Device		
		D	Edit Object		
			Edit Object with		
			Edit IO mapping		
			Import mappings from CS	5V	
			Export mappings to CSV		

4. Find and double-click **Delta Modbus TCP Slave** (Fieldbuses -> Modbus -> Modbus TCP Slave -> Delta Modbus TCP Slave) or click **Add Device** to add it in.

Name				
Name	Delta_Modbus_TCP_Slave			
Acti	on			
•	Append device O Insert device	O Plug device	Update device	
Strir	ng for a fulltext search	Vendor	<all vendors=""></all>	
Na	me	Vendor	Version	Description
B(	🕤 Fieldbuses			
	- Modbus			
	Image: Book of the second	veDelta Electronics, I	nc. 0.30.2.0	A conoria Madhua davisa th
		ve Deita Electronics, 1	nc. 0.30.2.0	A generic Modbus device th
			$\bigcirc$	
<				
	Froup by category Display all v	versions (for experts only)	Display outo	lated versions
1	Name: Delta Modbus TCP Slav			
	Vendor: Delta Electronics, Inc			
	Onternational Medical TCD Char			
	Categories: Modbus TCP Slav	/e		<b>S</b>
	Version: 0.30.2.0	re		×.
	Version: 0.30.2.0 Order Number: -		d as Slave for a	Ň
	Version: 0.30.2.0		d as Slave for a	Ż
	Version: 0.30.2.0 Order Number: - Description: A generic Modbu Modbus TCP Master.	is device that is configured	d as Slave for a	
	Version: 0.30.2.0 Order Number: - Description: A generic Modbu Modbus TCP Master.	is device that is configured	d as Slave for a	×
	Version: 0.30.2.0 Order Number: - Description: A generic Modbu Modbus TCP Master.	is device that is configured	d as Slave for a	<b>R</b>
	Version: 0.30.2.0 Order Number: - Description: A generic Modbu Modbus TCP Master.	is device that is configured		en.)
Del	Version: 0.30.2.0 Order Number: - Description: A generic Modbu Modbus TCP Master. end selected device as last chill ta_Modbus_TCP_Master	is device that is configured	this window is ope	en.)

After that you can find Delta\_Modbus\_TCP\_Slave under the Delta\_Modbus\_TCP\_Master node in the tree view.



# 9.3.3.2 Setting up the Modbus TCP Master

### Delta Modbus TCP Master I/O Mapping

Bus cycle task: Select a bus cycle task to synchronize with the Modbus communication time. When the option "Use parent bus cycle setting is selected", the system use the shortest cycle time as the bus cycle time. Refer to 4.2.1.6 section "PLC Settings" for more information.

Delta Modbus TCP Master I/O Mapping	Bus Cycle Options	
	Bus cycle task	mdbsEtherTask
Delta Modbus TCP Master IEC Objects		Use parent bus cycle setting mdbsEtherTask
Status		
Information		

#### Delta Modbus TCP Master IEC Objects

You can check the status of Modbus TCP Master under this tab.

Delta Modbus TCP Master I/O Mapping	🕂 Add 📝 Edit 🗙 Delete	+ Go to \	/ariable
Delta Modbus TCP Master IEC Objects	Variable — @ Delta_Modbus_TCP_M	Mapping	Type DFB_ModbusTCPMaster
Status			
Information			

- bStop: TRUE => Stop sending Modbus TCP packets.
- bSlaveError: TRUE => connection/communication with the Slave is abnormal
- uiConnectedSlaves: the number of the connected Slaves
   EX: (ST programming language): Delta Modbus TCP Master.bStop:= TRUE;

#### Status

Here you can find the device status information, for example 'Running' or 'Stopped', and specific diagnostic messages from the respective device, also information about the card used and the internal bus system.



#### Information

Here you can find general information that originates from the device description file: name, vendor, categories, version, order number, description, and other relevant information.

Delta Modbus TCP Master I/O	General
Mapping	Name: Delta Modbus TCP Master
Delta Modbus TCP Master IEC	Vendor: Delta Electronics, Inc.
Objects	Categories: Modbus TCP Master
Status	Type: 34601 ID: 16f7 8729 Version: 0.40.1.0
Information	Order Number: - Description: A device that works as a Modbus TCP Master on Ethernet.

# 9.3.3.3 Setting up the Modbus TCP Slave

1. In the tree view, find the **Delta\_Modbus\_TCP\_Slave (Delta Modbus TCP Slave)** and double-click it to open the setting window to set up.

File Edit View Project Build Online De	bug Tools Window Help		
🖹 🖆 🔚   🚳   🗠 🖓 🐇 🐚 🛍 🗙   🛤 🌿 📥 🜿   📕 1	위 케 챔   🖻   🔤 - 🔓   🛗   💜 💜 🔸	🛯 🖋   ÇI 91 dı 14 18   d	∭ ∛
Devices • 7 ×	Delta_Modbus_TCP_Slave ×		
Ethernet_Parameter     Device (AX-308EA0MA1T)	General	General Configuration	
- 🔏 Hardware Configuration	Modbus Slave Channel		
A EtherCAT Filter	Modbus Slave Init	Response Timeout [ms]	502
® আ PLC Logic ® আ BuiltIn_IO (BuiltIn_IO)	Delta Modbus TCP Slave I/O Mapping	Device Type	Standard Modbus Devices v
Delta_LocalBus_Master (Delta LocalBus Master)     AX_308_Series_EtherCAT_Master_SoftMotion (#	Delta Modbus TCP Slave IEC Objects	IP Address	192 . 168 . 1 . 111
Ethernet (Ethernet)     Endernet (Delta_Modbus_TCP_Master (Delta_Modbus T	Status	Auto-Reconnect	
Delta_Modbus_TCP_Slave (Delta Modbus_ SoftMotion General Axis Pool	Information		

## General

Here you can configure the basic settings for Modbus TCP Slave, such as Slave Address, Response Timeout and Device Type.

Delta_Modbus_TCP_Slave ×		
General	General Configuration —	
Modbus Slave Channel	Slave Address [0247]	0
Modbus Slave Init	Response Timeout [ms]	1000 A
Delta Modbus TCP Slave I/O	Port	502
Mapping	Device Type	Standard Modbus Devices Y
Delta Modbus TCP Slave IEC Objects	IP Address	192 . 168 . 1 . 111
Status	✓ Auto-Reconnect	
Information		

Item	Description				
Slave Addres	Address of a serial Modbus device				
Response Timeout	Time interval for the master to wait for the response from the slave. This is especially configured for this slave node and overwrites the general response timeout setting of the respective master.				
Port	Port number				
Device Type	You can select standard Modbus devices or Delta devices. If you select Delta devices, the system converts the protocol used into Modbus protocol automatically so that you do NOT need to refer to the register map for the conversion.				
IP Address	Slave IP address				
Auto-Reconnect	Enable this option to have this port to reconnect automatically if an error occurs or commection timeout occurs.				

### Modbus Slave Channel

Here you can define slave channels. Each channel represents a single Modbus request. You can create up to 10 channels for each slave. AX-3 Series PLC will send out Modbus request packets in chronological order. All channels share the same Modbus TCP connection.

2	Delta_Modbus_TCP_Slave ×								-
	General	0	<b>v</b>	Name Channel 0	Access Type Read Holding Registers	Trigger Cyclic, 100ms	READ Offset	Length 10	Error Handlin Keep last Val
1	Modbus Slave Channel	1	~	Channel 1	Read Holding Registers	Cyclic, 100ms	0x64	100	Keep last Val
٦		2	$\checkmark$	Channel 2	Read Holding Registers	Cyclic, 100ms	0x164	100	Keep last Val
	Modbus Slave Init	3	$\checkmark$	Channel 3	Read/Write Multiple Registers	Cyclic, 100ms	0x200	100	Keep last Val
	Delta Modbus TCP Slave I/O Mapping								
	Delta Modbus TCP Slave IEC Objects								
	Status								
	Information								
		<							
			Move L	Ip M	love Down		Add	Channel	Delete

Click Add Channel, you can edit the channel before adding it in. The **Device Address** shows the Modbus protocol address whether the device type you selected is **Standard Modbus Device** or **Delta Devices** under the **General** tap. Since the system converts the protocol used into Modbus protocol automatically, you do NOT need to refer to the register map for the conversion.

Modbus Channel ×	Modbus Channel
Enable	Enable
Channel	Channel
Name Channel 0	Name Channel 0
Access Type Read Coils	Access Type Read Coils 🗸
Trigger Cyclic 💙 100 ms	Trigger Cyclic 💙 100 ms
Comment	Comment
Read Register	Read Register
Device Address 0x0	Device Address X Coil 0x0
Length 1	Length 1
Error Handling Keep last Value	Error Handling Keep last Value
OK Cancel	OK Cancel

### Device Type : Standard Modbus Device

### Device Type : Delta AH Series

Item	Desc	ription
Device Type	Standard Modbus Device	Delta Series Device
Enable	Activates	this channel
Name	Defines this	channel name
Access Type	Modbus function code Read coils (0x01) Read discrete inputs (0x02) Read holding registers (0x03) Read input registers (0x04) Read single coil (0x05) Write single register (0x06) Write multiple coils (0x0F) Write multiple registers (0x10) Read/Write multiple registers (0x17)	Read/Write Registers <ul> <li>Read coils</li> <li>Read registers</li> <li>Write coils</li> <li>Write registers</li> </ul> <li>Note: PLC uses the corresponding Modbus function code according to the read/write register of the device type.</li>
Trigger	<ul> <li>Cyclic: The request occurs periodically.</li> <li>Rising edge: The request occurs as a reaction to a rising edge of the Boolean trigger variables. The trigger variable is defined in the tab I/O Mapping.</li> <li>Application: The Modbus request is triggered by DFB_ModbusTCPChannel</li> </ul>	<ul> <li>Cyclic: The request occurs periodically.</li> <li>Rising edge: The request occurs as a reaction to a rising edge of the Boolean trigger variables. The trigger variable is defined in the tab I/O Mapping.</li> <li>Application: The Modbus request is triggered by DFB_ModbusTCPChannel</li> </ul>
Comment	Description	of the channel
Device Address	Modbus protocol address	Delta register address (will be converted into Modbus protocl in the background)
Length	Number of the register to be read/written to.	Number of the register to be read/written to. (up to 256 coils and 100 registers)
Error Handling	<ul> <li>What to do with the data in case of a commun</li> <li>Set To ZERO</li> <li>Keep last value</li> </ul>	

## Modbus Slave Init

After the Modbus connection between AX-3 Series PLC and the slaves is established, you can use **Add Channel** button to edit the Initialization Value of the Coil/Register.

Delta_Modbus_TCP_Slave ×						
General	Line 0	Access Type Write Multiple Registers	WRITE Of 0x1000	fset Default Valu 100	ie Length 10	Comment
Modbus Slave Channel						
Modbus Slave Init						
Delta Modbus TCP Slave I/O Mapping						
Delta Modbus TCP Slave IEC Objects						
Status						
Information						
	<					
	M	ove Up Move Down			Add Channel	Delete

Click **Add Channel**, you can edit the Access Type, Device Address, Length, Initialization Value and Comment. Click OK to confirm the settings.

Access Type	Write Mu	Itiple Reg	gisters	1
Device Address	0x0			
Length	1	1		
Initialization Value	5			
Comment				

### Modbus Generic Serial Slave I/O Mapping

After you have added channels under the tab of Modbus Slave Channel, you can find the variables and the set access types under this tab. Here you can define the variables for mapping. The descriptions here reflect what you have set for the **Access Type** in Modbus Slave Channel tab. When the **Trigger type** is set to **Rising edge** in Modbus Slave Channel, the description here adds one more condition, **Trigger variable**.



- ① The descriptions here reflect what you have set for the Access Type in Modbus Slave Channel tab.
- 2 The triggered Boolean variable for this channel.
- ③ The controller registers that are read/written by this channel.
- ④ Timing for the data refreshing; refer to section 4.2.1.6 PLC Settings for more information.

### ■ Delta Modbus TCP Slave IEC Objects

You can check the status of Modbus TCP Slave under this tab.

General	🖶 Add 🗹 Edit 🗙 Delete 🍈 Go to Variable							
Modbus Slave Channel	Expression	Type DL_ModbusTCP	Value	Prepared value	Address	Comment		
Modbus Slave Init	<ul> <li>≯ bConfirmError</li> <li>≯ bDoInit</li> </ul>	BOOL BOOL	FALSE TRUE					
Delta Modbus TCP Slave I/O Mapping	<ul> <li>✓ bInitDone</li> <li>✓ bBusy</li> </ul>	BOOL BOOL	TRUE TRUE					
Delta Modbus TCP Slave IEC Objects	file bDone file bError	BOOL BOOL	FALSE FALSE					
Status	ModbusError iChannelIndex	DFB_MB_ERRO INT	UNDEFINED 3					
Information								

Expression	Description
bConfirmError	If the option "Auto-Reconnect" is NOT enabled, during the data transmission, any channel that showed error stops. After the bConfirmError shows "TRUE", the channel that showed error previously continues to execute.
bDolnit	Initialized the Slave
blnitDone	The initialization of the Slave is complete.
bBusy	This channel is in data transmission.
bDone	The data transmission via this channle is complete.
bError	Error occurs when this channels is in data transmission.

Expression	Description
ModbusError	Record of the Modbus error
iChannelIndex	The number of the channel that is in execution.

## Status

Here you can find the Modbus TCP Slave status information, for example 'Running' or 'Stopped', and specific diagnostic messages from the respective device, also information about the card used and the internal bus system.

Delta_Modbus_TCP_Slave ×			
General	Delta Modbus TCP Slave :	n/a	
Modbus Slave Channel	Last Diagnostic Message		
Modbus Slave Init	Diagnosis Message:		
Delta Modbus TCP Slave I/O Mapping			
Delta Modbus TCP Slave IEC Objects			
Status			
Information			

### Information

Here you can find general information that originates from the device description file: name, vendor, categories, version, order number, description, and other relevant information.

Delta_Modbus_TCP_Slave ×	
General	General
Modbus Slave Channel	Name: Delta Modbus TCP Slave Vendor: Delta Electronics, Inc.
Modbus Slave Init	Categories: Modbus TCP Slave Type: 34602
Delta Modbus TCP Slave I/O Mapping	ID: 16f7 8730 Version: 0.40.4.0
Delta Modbus TCP Slave IEC Objects	Order Number: - Description: A generic Modbus device that is configured as Slave for a Modbus TCP Master.
Status	
Information	

# 9.3.4 Modbus TCP Slave (Server)

AX-3 Series PLC can act as a Modbus TCP Slave, after you add Modbus TCP Slave Device in and set up the allowable areas for Coils/Register. If Modbus TCP Master uses Delta device communication protocol, there is no access restrictions. Follow the below section to set up the Modbus TCP Slave.



# 9.3.4.1 Adding a Modbus TCP Slave Device

1. Right-click the **Ethernet (Ethernet)** node in the tree view to open up a conext menu. And click **Add Device...**to open the Add Device setting window.



Find and double-click Delta Modbus TCP Slave Devie (Fieldbuses -> Modbus -> Modbus TCP Slave Device
 -> Delta Modbus TCP Slave Device) or click Add Device to add this port in.

Add Device				×
Name         Delta_Modbus_TCP_Slave_Device_1           Action <ul></ul>	evice Ol	Jpdate device		
String for a fulltext search	Vendor	<all vendors=""></all>		$\sim$
Name  Fieldbuses  Fieldbuses  Fieldbuses  Fieldbuse  Modbus  Modbus  Modbus  Modbus  Modbus  Fieldbus  ieldbus Fieldbu	Vendor		Version	Descri
Modbus TCP Slave Device	Delta Electro 35 - Smart : OF	Software Solutions GmbH	0.30.1.0 3.5.15.0	Delta_N A device
Group by category Display all versions (for e	xperts only)	Display outdated ver	sions	
<ul> <li>Name: Delta Modbus TCP Slave Device</li> <li>Vendor: Delta Electronics, Inc.</li> <li>Categories: ModbusTCP Slave Device</li> <li>Version: 0.30.1.0</li> <li>Order Number: -</li> <li>Description: Delta_Modbus TCP_Slave_De</li> </ul>	vice		Ŵ	
Append selected device as last child of Ethernet • (You can select another target node in the name	vigator while	this window is open.)		
		Add Device		Close

3. Find the added port **Delta\_Modbus\_TCP\_Slave\_Device (Delta Modbus TCP Slave Device)** in the tree view and double-click it to open the setting window to set up.

Devices - 7 X	Delta_Modbus_TCP_Slave_Devic	×				
Chelled:     Ar_JOBEAOMAIT (Ax-JOBEAOMAIT)     Ar_JOBEAOMAIT (Ax-JOBEAOMAIT)     Ardware Configuration     A lettorick Configuration     AndosuTCP Filter     Differ Clogic     Configuration	General Delta Modbus TCP Slave Device I/O Mapping Status Information	General Configuration TCP Port 502 Station ID 3				
Butherry Manager     Butherry Manager     Butherry Manager     Butherrisk     Butherrisk		Address Information Setting Holding Register SLMW SuMW Quantity Modbus Start Address Holding Register SuQW SuQW Quantity Modbus Start Address	0 • • • • • • • • • • • • • • • • • • •	Colis 1(4NV 56NV Quantity Modbus Start Address Colis 54QW 74QW Quantity Modbus Start Address	0 10 0 10 256	9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9
		Input Register %GIW %GIW Quantity Modbus Start Address	0 0 10 0	Input Colls %IW %IW Quantity Modbus Start Address	0	10

# 9.3.4.2 Setting up the Modbus TCP Slave Device

### General

Here you can configure the basic settings for Modbus TCP Slave Device. Set up the allowable areas for Coils/Register. If Modbus TCP Slave uses Delta device communication protocol, there is no access restrictions.

General	General Configuration					
Delta Modbus TCP Slave Device I/O Mapping	TCP Port 502	+				
status	Station ID 3	×.				
nformation						
	Address Information Setting —					
	Holding Register			Coils		
	%MW	0	*	%MW	0	1
	%MW Quantity	10	*	%MW Quantity	10	-
	Modbus Start Address	0	*	Modbus Start Address	0	-
	Holding Register			Coils		
	%QW	0	*	%QW	0	H
	%QW Quantity	10	*	%QW Quantity	10	
	Modbus Start Address	256	-	Modbus Start Address	256	
	Input Register			Input Coils		
	%IW	0	-	%IW	0	ł
	%IW Quantity	10	-	%IW Quantity	10	
	Modbus Start Address	0	×	Modbus Start Address	0	

### ■ Delta Modbus TCP Slave Device I/O Mapping

Bus cycle task: Select a bus cycle task to synchronize with the Modbus communication time. When the option "Use parent bus cycle setting is selected", the system use the shortest cycle time as the bus cycle time. Refer to section 4.2.1.6 PLC Settings for more information.

	Delta_Modbus_TCP_Slave_Device ×					
	General	Bus Cycle Options Bus cycle task	mdbsEtherTask	~		
	Delta Modbus TCP Slave Device I/O Mapping	bus cycle tusk	mubsEtherrusk			
	Status					
	Information					
l						

### Status

Here you can find the Modbus TCP Slave Device status information, for example 'Running' or 'Stopped', and specific diagnostic messages from the respective device, also information about the card used and the internal bus system.

	Delta_Modbus_TCP_Slave_Devi	ice x	
	General	Delta Modbus TCP Slave Device	n/a
	Delta Modbus TCP Slave Device I/O Mapping		
(	Status		
	Information		

#### Information

Here you can find general information that originates from the device description file: name, vendor, categories, version, order number, description, and other relevant information.

		_
General	General	
	Name: Delta Modbus TCP Slave Device	
Delta Modbus TCP Slave Device I/O	Vendor: Delta Electronics, Inc.	
Mapping	Categories: ModbusTCP Slave Device	
	Type: 34600 ID: 16f7 8728	
Status	Version: 0.30.1.0	
	Order Number: -	
Information	Description: Delta_Modbus TCP_Slave_D	evice

# 9.3.5 PROFINET IO

PROFINET IO is a fieldbus protocol that enables communication between programmable controllers and distributed field devices in Ethernet. With specific service sets, devices are classified into IO Controllers, IO Supervisors, and IO Devices. PROFINET IO uses three different communication channels to exchange data: Standard UDP/IP and TCP/IP channels, Real-time (RT) channels and Instant Real-time channels.

The standard UDP/IP and TCP/IP channels are used for parameterization and configuration of devices and non-cyclical operations; the Real-Time (RT) channel is used for cyclic data transmission and alarms; while the Instant Real-Time (IRT) channel is used for motion control applications.

Note: This function is only available for the following devices and software versions.

- DIADeigner-AX: V1.4.0 or later
- AX-3 Series PLC CPU: V1.0.5.0 or later
- Library "IoDrvProfinetDevice": V4.3.0.0 or later

# 9.3.5.1 PROFINET Device

# 9.5.3.1.1 Add a PROFINET Device

This section will explain how to add a PROFINET device. Refer to the following steps for configuration.

• Adding a PROFINET Device :

Devices		- 4 ×
Profinet_AX3     Device (AX-308EA0MA1T)     Hardware Configuration     A Network Configuration     DEC Logic     DuitIn_IO (BuiltIn_IO)	% ₪ ×	Cut Copy Paste Delete Refactoring
🖬 DIO (DIO)	m	Properties
EtherCAT_Master_SoftMotion (AX Ser		Add Object Add Folder
		Add Device Insert Device Disable Device Update Device
	ß	Edit Object Edit Object With
		Edit IO mapping Import mappings from CSV Export mappings to CSV

String for a full text search	Vendor	<all vendors=""></all>	
Name Miscellaneous Fieldbuses EtherNet/IP Modbus Profinet IO Confinet IO Device	Vendo		Version
CODESYS PROFINET D	9	art Software Solutions Gm OR Inly) Display outda	-2)
Name: CODESYS PROFINET Device Vendor: 3S - Smart Software Solution Categories: Profinet IO Device Version: 4.3.0.0 Order Number: -		Î	Ň



9-52

• Setting up the data structure for PROFINET Device:

You can set up the data structure according to your prefeence.

Devices	-	ф <b>х</b>
Profinet_AX3 Device (AX-308EA0MA1T) Hardware Configuration Network Configuration PLC Logic Delial PLC Logic Delia_LocalBus_Master (Delta LocalBus Master) EtherCAT_Master_SoftMotion (AX Series EtherCAT Master Ethernet (Ethernet) CODESYS_PROFINET_Device (CODESYS PROFINET Device) SoftMotion General Axis Pool	in	Cut Copy Paste Delete Refactoring Properties Add Object Add Folder Add Device Disable Device Update Device Update Device Update Device Edit Object Edit Object Edit IO mapping Import mappings from CSV Export mappings to CSV





# 9.3.5.1.2 Settings of PROFINET Device

This section introduces the PROFINET Device setting pages.

• General :

Define the IP address and station name for the PROFINET Device here.

General	IP and Name Assignment
PROFINET Device I/O Mapping	Load remanent data     PNDevice.data
PROFINET Device IEC Objects	○ Use project parameters
Log	Station name PN-Device
	I/O Provider / Consumer Status
Status	Use incoming (recommended)
Information	Use outgoing
	Substitute values
	Inactive
	O Last value

IP and Name Assignment

Setting Item	Description	
	The IP Address and Station Name of PROFINET Device are determined by the "PNDDevice.data" from the controller.	
Load remanent data	Defaults:	
	• IP: 0.0.0.0	
	Station name: Leave it blank.	
Use project parameters	The IP address of the PROFINET Device is the same as the controllers IP address,	
	and the Station Name can be set through this page. (Do not use this option.)	

# • PROFINET Device IEC Objects

This page displays the current status and number of connections of the PROFINET Device.

CODESYS_PROFINET_Device X				
General	🕂 Add 📝 Edit 🗙 Delete → Go to Variable			
PROFINET Device I/O Mapping	Expression	Type IoDrvProfinetDevice.ProfinetDevice	Value	
PROFINET Device IEC Objects	🍫 Status	DEVICESTATE	Run	
	SonnectionCount	DINT	1	
Log				
Status				
Information				

# • Status

You can check the running status of the PROFINET Device on this page, including IP address, Station Name, time intervals for packet transmission, and many more to help you get to know the current operation.

CODESYS_PROFINET_Device	<		
General			
Scherdi	Diagnosis data		
PROFINET Device I/O Mapping	Module		
PROFINET Device IEC Objects	<ul> <li>(Subslot 0x0001)</li> <li>(Subslot 0x8000)</li> </ul>		
Log	(Subslot 0x8001)		
Status			
Information			
	PROFINET-Ethernet :		Running
	Land drama Manager		
	Last diagnostic message		
	Driver Diag		PROFINET IO Device Driver diagnostic information
	PN-Device Status	Run	
	Connections	1	Number of established connections
	Online	TRUE	Device is Online, DCP-Services available (e.g. Identify)
	IP Active	TRUE	UPD/IP based services active (e.g. Connect, Read/Write-Data)
	Stationname	'device 1'	current Name of Station
	IPParameter		currently active IP-Settings
	- IP	[192, 168, 1, 6]	IP
	Netmask	[255,255,255,0]	Netmask
	Gateway	[192, 168, 1, 6]	Gateway
	Ethernet Statistic		
	Received Frames	947192	Overall number of received Frames
	Received RT-Frames	919175	Overall number of received PROFINET-RT Frames
	Invalid Cyclic Frames	0	Number of received invalid Cyclic Data Frames
	Send Errors	0	Number of failed raw-ethernet frame transmissions (CmpSysEthernet)
	Recy Time (Avg)	LTIME#22us893ns	Average Time for receiving Ethernet Frames per BusCycle
	Recv Time (Max)	LTIME#234us124ns	Max Time for receiving Ethernet Frames per BusCycle
	Send Time (Avg)	LTIME#19us620ns	Average Time for sending Ethernet Frames per BusCycle
	Send Time (Max)	LTIME#191us208ns	Max Time for sending Ethernet Frames per BusCycle
	Link Status	Up	· · ·
	MAUType	1000BASE-T full duplex mode	

### 9.3.5.1.3 Export GSDML File

Fill Comption

<

n Card

🖹 83\_0000 1017\_4.3.0.0.devdesc.xml

This section introduces how to export a GSDML file.



SSDML-V2.42-3S - Smart Software Solutions GmbH-Codesys PLC-20210927.xml

>

Close

# 9.4 EtherNet/IP

DIADesigner-AX supports the following Modbus network types, including Modbus TCP and EtherNet/IP. Follow the below section to set up the basic settings for communication via the Ethernet Adapter.

The compatibility of the firmware version of AX-3 Series PLC CPU and the version of the EtherCAT function library:

Firmware Version	IODrvEtherCAT 3.5.15.30	IODrvEtherCAT 4.4.0.0
V1.0.4.2 or previous	Compatible	Incompatible
V1.0.5.0 or later	Compatible	Compatible

# 9.4.1 Introduction to EtherNet/IP

# 9.4.1.1 EtherNet/IP Overview

Ethernet Industrial Protocol (EtherNet/IP) is an open industrial networking standard, managed by ODVA (Open DeviceNet Vendors Association).

EtherNet/IP works on a TCP/UDP/IP based Ethernet network and uses most widely deployed collections of Ethernet standards to provide a broad range of applications in different industries that require high-speed and stability including Factory Automation (FA), Building Automation (BA), Process Automation (PA) and many more.

Delta covers a full range of controller and drive products supported by EtherNet/IP, including Programmable Logic Controllers (PLC), inverters, Human Machine Interfaces (HMI) and so on. Refer to section 9.4.5 for a full product list supported by EtherNet/IP. In addition, users can also use the EDS file to connect to the EtherNet/IP devices of other brands.

9.4.	1.2	Definition
		<b>D</b> 011111011

Term	Definition
ODVA	Open DeviceNet Vendor Association for EtherNet/IP
	EtherNet/IP, an industrial Ethernet network, provides interoperability for system providers.
EIP	IP stands for Industrial Protocol. The term "EIP" (EtherNet/IP) will be used throughout this
	manual.
I/O Connection	Via the I/O connection to connect to EtherNet/IP and to exchange data cyclically
Explicit Message	Connect to EtherNet/IP and to exchange data non-cyclically. Data will be exchanged piece by
	piece via instructions.
RPI	Requested Packet Interval, via the I/O connection to connect to EtherNet/IP to exchange
RF1	data at regular time intervals
ACD	Address Conflict Detection to detect IP address duplications.
	Produced / Consumed TAG. A produced TAG sends its data to consumed TAGs (consumers)
P/C TAG	without using logic.TAGs are the methods used for assigning and referencing memory locations
	for Rockwell PLCs, the same as the registers for Delta PLCs.
EDS	Electronic Data Sheets; EDS files are simple text files used by EtherNet/IP network configuration

	tools to help you identify EtherNet/IP products and easily commission them on a network.
Data Mapping	Exchange data between devices.
EIP Scanner	The master station is called Scanner in EtherNet/IP.
EIP Adapter	The slave station is called Adapter in EtherNet/IP.
MODBUS TCP	MODBUS TCP is a MODBUS communication protocol, widely used on Ethernet.

# 9.4.1.3 Features of Ethernet

# 9.4.1.3.1 Delta EIP Architecture

This typical Delta EIP architecture includes EIP Scanner and Adapter; data mapping can be achieved between devices via an I/O connection and explicit message.



## 9.4.1.3.2 Features of EIP

- Flexibility
  - Flexible topology: EIP devices may include an Ethernet single port as well as Ethernet dual port, and provide applicable networks such as linear topology, ring topology and ring topology for faster expansion and easier management.
  - Network compatible: IT specialists are not required for Internet connection setup, while the Wi-Fi connection is provided.
- Simplicity
  - Via a connector: Delta provides a full range of product line, including human machine interfaces (HMI), programmable logic controllers (PLC) and inverter drives, for application in an industrial operation. Simply via a RJ-45 connector, a network can be built up, saving costs on cables and other connecting tools.
  - Single network: In replace with the 3-tier industrial architecture, single network architecture provides 100Mbps high-speed cyclical and non-cyclical data mapping function, ensuring a complete network diagnosis and effectively shortening debugging time.

# 9.4.2 EtherNet/IP Scanner Function

# 9.4.2.1 Setting up Compact Drive MS300

## 9.4.2.1.1 Hardware Configuration

This application example is to connect AX-308E to compact drive MS300 and CMM-EIP communication card via Ethernet.



Note: The version of CMM-EIP communication card should be V2.04.01 or above.

### 9.4.2.1.2 Read-Write Setting for Implicit Messages

Map the read/write address to the register in option card via the master station (Scanner) to exchange data cyclically and one-time read/write data via the register for implicit messages in EtherNet/IP.

- To use compact drives with EIP communication card
  - Drive's settings

Make sure you've changed the control settings of the drive to option cards before operating compact drives via internet by using option cards. Refer to the following steps to configure the settings.

- 1. When the option card is attached, check if parameters 09 to 60 are null, which the value should be displayed as 5 (EtherNet/IP).
- 2. Set parameter 09-75=0 (static IP) and the IP address is user-defined.
- 3. Change the IP address of option card to 192.168.1.30 (default is 192.168.1.5) from parameter 09-76 to parameter 09-79. Then set parameter 09-91 to 2.
- 4. Set parameter 00-20 to 8 (Set the source for AUTO frequency command to communication card.).
- 5. Set parameter 00-21 to 5 (Set the source for AUTO control to communication card.).

- Set parameter 09-30 to 1 (Set communication decoding method to 60xx or 20xx, which the decoding methods are detailed in section 4.2 EtherNet/IP Control Method Standard of VFD EtherNet/IP Application Manual.)
- Example for creating EIP

The IP address of the devices applied in this example are shown as follows:

Deviees	AX-308E	192.168.1.5 (default)
Devices	MS300 <sup>*</sup> CMM-EIP02	192.168.1.30

1. Create Ethernet Device





2. Create Interface. Go to Ethernet -> General.



3. Create EtherNet/IP Scanner.

evices		Ψ×		
Untitled3		*		
G Device (AX-308EA0MA1T)				
- Jardware Configuration				
A Network Configuration				
A EtherCAT Filter			and the second se	
A EtherNetIP Filter			i Add Device	
A ModbusTCP Filter			Name EtherNet_IP_Scanner	
😑 🗐 PLC Logic				
= O Application			Acton	
Library Manager			Append device      Insert device      Plug device      Update device	
Motion_PRG (PRG)			String for a fulltext search Vendor <all vendors=""></all>	
PLC_PRG (PRG)				
= 🧱 Task Configuration				escription
😑 🤩 EtherCAT_Task			= 🗊 Pieldbuses = 🗧 EtherNet/IP	
d Motion_PRG			* EtherNet/IP Local Adapter	
😑 🍪 MainTask			EtherNet/IP Scaner	
PLC_PRG				herNet/IP Scann
BuiltIn_IO (BuiltIn_IO)			* III Modbus	
DIO (DIO)				
Delta_LocalBus_Master (Delta LocalBus	s Master)			
EtherCAT_Master_SoftMotion (AX-3 Se	eries EtherCAT Master Soft	(Motion		
Tak some (Tak som all				
Ethernet (Ethernet)				
Billiotion Genera			<b>Y</b>	
Billiotion Genera			Y	
Cut Copy			Group by category Display all versions (for experts only) Display outdated versions	
Cut Copy Paste X Delete				
Cut Copy Paste	g	•		
Cut Copy Paste X Delete	*	•	Name: Etherte(JP Scrimer     Vendor: 35 - Smit 5 Oftware Solutions Grabit     Categories: Celtrale(JP Scrimer	
toffoton General & Cut 10 Copy 10 Poste ∞ Delete Refactorin 10 Properties	ц	•	Rame: Ethertet/IP Scorner     Vendor: 35 - Smart Software Solutions GribH     Categories: Ethertet/IP Scorner     Version: 3: 5: 32	*
Cut     Copy     Paste     Refactorin     Add Objet     Add Objet	α.	•	Name: Etherte(JP Scrimer     Vendor: 35 - Smit 5 Schware Solutions Gibbi     Categories: 26 - Ional 5 Schware Solutions     Version: 35. 31.5.20     Order Number: 1	SAM -
Add Object	и., СТ И		Rame: Ethertet/IP Scorner     Vendor: 35 - Smart Software Solutions GribH     Categories: Ethertet/IP Scorner     Version: 3: 5: 32	See.
Cut     Cut     Copy     Copy     Paste     Refactorin     Poperties     Add Objet	и., СТ И		Rame: EtherNet/IP Scrimer     Vendor: 35 - Smit 5 Schwar Solutions Glibbi     Categories: 26 - Isinet 3 Schwar Solutions Glibbi     Version: 35 - 35 - 30     Order Rumbers I     Description: EtherNet/IP Scamer     v	*
reficition General & Cut			Name: Etherte(JP Scrimer     Vendor: 35 - Smit 5 Schware Solutions Gibbi     Categories: 26 - Ional 5 Schware Solutions     Version: 35. 31.5.20     Order Number: 1	×
copy     copy			Name: Ethertet/IP Scorner     Vendor: 35 - Somet Software Solutions Globit     Categories: Ethertet/IP Scorner     Version: 35.35.30     Order Number: 1     Description: Ethertet/IP Scanner     v  Append selected device as last child of	*
esfoton General & Cut Topy Paste Paste Poperties Add Folde Add Folde Add Folde Disble De Disble De	evice		Name: Ethertet/IP Scamer     Vendor: 3: - Sant 5 Othorse Solutions GribH     Categories: Ethertlet/IP Scamer     Version: 3: 5: 5: 20     Order Number: 1     Description: Ethertlet/IP Scamer     v  Append selected device as last child of Ethernet	***
Cut     Capy     Paste     Copy     Paste     P	ct r		Name: Ethertet/IP Scamer     Vendor: 3: - Sant 5 Othorse Solutions GribH     Categories: Ethertlet/IP Scamer     Version: 3: 5: 5: 20     Order Number: 1     Description: Ethertlet/IP Scamer     v  Append selected device as last child of Ethernet	
Cut Topy Paste X Delete Refactorin Add Obvic Insert Dev Disable Do Update Du Update Du Update Du Update Du	tini cr tice evice evice tr tr tr tr tr tr tr tr tr tr		Name: Ethertet/IP Scorner     Vendor: 35 - Somet 5 Ontwore Solutions GrabH     Categories: Ethertet/IP Scorner     Version: 35, 35, 30     Order Number: 1     Description: Ethertet/IP Scanner     v  Append selected device as last child of     Ethernet     @ (You can select another target node in the mangator while this window is open.)	No. of the second second second second second second second second second second second second second second se
Cut Copy Paste Paste Refactorin Copy Add Folde Add Povic Inset Devi Disable De Update Du	tini cr tice evice evice tr tr tr tr tr tr tr tr tr tr	×	Name: Ethertet/IP Scorner     Vendor: 35 - Somet 5 Ontwore Solutions GrabH     Categories: Ethertet/IP Scorner     Version: 35, 35, 30     Order Number: 1     Description: Ethertet/IP Scanner     v  Append selected device as last child of     Ethernet     @ (You can select another target node in the mangator while this window is open.)	×.
Cut The Copy Paste X Delete Refactorin Add Obvic Insert Devi Add Folde Add Folde Disable Do Update Du Update Du Update Du	ar ar ar ar ar ar ar ar ar ar		Name: Ethertet/IP Scorner     Vendor: 35 - Somet 5 Ontwore Solutions GrabH     Categories: Ethertet/IP Scorner     Version: 35, 35, 30     Order Number: 1     Description: Ethertet/IP Scanner     v  Append selected device as last child of     Ethernet     @ (You can select another target node in the mangator while this window is open.)	×
Cut Balance Copy Paste Paste Popeties Add Folde Add Folde Add Folde Cut Popeties Add Folde Cut Popeties Add Folde Edit Objec Edit Objec Edit IOme	ar ar ar ar ar ar ar ar ar ar	×	Name: Ethertet/IP Scorner     Vendor: 35 - Somet 5 Ontwore Solutions GrabH     Categories: Ethertet/IP Scorner     Version: 35, 35, 30     Order Number: 1     Description: Ethertet/IP Scanner     v  Append selected device as last child of     Ethernet     @ (You can select another target node in the mangator while this window is open.)	See R
Cut Barrier Copy Paste X Delete Refactorin Copy Paste X Delete Refactorin Copy Paste Refactorin Copy Paste Refactorin Copy Paste Refactorin Copy Paste Refactorin Copy Paste Refactorin Copy Paste Refactorin Copy Paste Refactorin Copy Copy Paste Refactorin Copy Copy Paste Refactorin Copy	ar ar ar ar ar ar ar ar ar ar	*	Name: Ethertet/IP Scorner     Vendor: 35 - Somet 5 Ontwore Solutions GrabH     Categories: Ethertet/IP Scorner     Version: 35, 35, 30     Order Number: 1     Description: Ethertet/IP Scanner     v  Append selected device as last child of     Ethernet     @ (You can select another target node in the mangator while this window is open.)	**

4. Create CMM-EIP0102. Right click on Ethernet and select Add Device to choose the relevant adapter.

-		_Master (Delta LocalBus Master)	String for a fulltext search	Vendor <all vendors=""></all>
🖻 🛐 Ethernet	(Ethe	ID. Connect Attraction Attractions Attraction Attractio	Name	Vendor         Vention           M154         Dela electrona, inc.         Major Revision - 16# II, Minor Revision - 16# II, Minor Revision - 10# III,  IIIIIIIIIIIIIIIIIIIIIIIIIIIII
ices POUs	G	Scan For Device Disable Device Update Device Edit Object Edit Object with Edit IO mapping Import mappings from CSV Export mappings to CSV	Rame: CM4/EIP032     Vindor Della elcitori Categories: Elbenhell Version: Nago Relation Order Humber: CM4/EIP032 Device: CM4/EIP032     Append selected device as Etherrite1, IP-Scamer	DP Bendle Addott 

\*Note: Adapters can be created via "Scan For Device".

9\_

5. Click on CMM\_EIP0102.



6. Go to General and set IP Address to 192.168.1.30.

General	Address Settings	
Connections	IP address 192 . 168 . 1 . 30	EtherNet/IP
Assemblies		
Jser-Defined Parameters	Electronic Keying	
.og	O Compatibility check	
EtherNet/IP I/O Mapping	Strict identity check      Check device type	
EtherNet/IP IEC Objects	Check vendor ID 799	
Status	Check product code 260	
information	Check major revision 1	
	Restore Default Values	

Item	Description
IP address	The IP address of the target device.
Compatibility check	Check the compatibility between the target device and information of EDS files.
Strict identity check	Strickly check the information of the target device and EDS files. Inspection information is user-defined.
Check Device type	Check the device type.
Check Vendor ID	Vendor ID
Check Product code*	Product code*
Check Major revision	Major revision
Check Minor revision	Minor revision

\*Note: If Adapter and Scanner are required at the same time, please unselect Check Product code.

7. Go to EtherNet/IP I/O Mapping and add variable name for channels of Operation Command 2, Control Mode 2 and Frequency command 2.

General	Find	Filter Show all		• 峥 Add FB f	or IO Cha	nnel	Go to Instanc	ce	
Connections	Variable	Mapping	Channel	Address	Туре	Unit	Description		
connections	· · · · · ·		IN_Value_27	%IW28	UINT		User Defined		
Assemblies	÷-*		IN_Value_28	%IW29	UINT		User Defined		
	i≣ -×p		IN_Value_29	%IW30	UINT		User Defined		
User-Defined Parameters	10 - Mp		IN_Value_30	%IW31	UINT		User Defined		
	te Mp		IN_Value_31	%IW32	UINT		User Defined		
.og	10 Mp		IN_Value_32	%IW33	UINT		User Defined		
O strengthered in	· · · · ·		Operation Command 1	%QW1	UINT		VFD Control		
therNet/IP I/O Mapping	10 <b>1</b>		Frequency command 1	%QW2	UINT				
therNet/IP IEC Objects	10 <b>5</b>		External Command 1	%QW3	UINT				
chenvergie iec objects	÷ *ø		OUT_Value_4	%QW4	UINT		Reserved		
tatus	* 🗘 OperationCommand	- "*	Operation Command 2	%QW5	UINT				- 1
	🕀 🍫 ControlMode 🚤		Control mode 2	%QW6	UINT				
nformation	FrequencyCommand		Frequency command 2	%QW7	UINT		New Help String	1	
	÷ •		Troque limit 2	%QW8	UINT				
	B 🍫		Position Command 2, L W	%QW9	UINT				
	10 To		Position Command 2, H W	%QW10	UINT				
	(B- <b>*</b> )		Torque command 2	%QW11	UINT				
			Frequency limit 2	%QW12	UINT				
	· · · · · ·		OUT_Value_13	%QW13	UINT		Reserved		
	÷ **		OUT_Value_14	%QW14	UINT		Reserved		1
	÷ *		OUT_Value_15	%QW15	UINT		Reserved		
	· · · · •		OUT_Value_16	%QW16	UINT		Reserved		
	÷ *ø		OUT_Value_17	%QW17	UINT		User Defined		
	# <b>*</b> ø		OUT_Value_18	%QW18	UINT		User Defined		
	÷ *ø		OUT_Value_19	%QW19	UINT		User Defined		
	÷. %		OUT_Value_20	%QW20	UINT		User Defined		
				Reset Map	ping	Always u	pdatevariables	Use parent device setting	
	🍫 = Create new variable 🍫	= Map to existing var	0.6						

9\_

8. Select Motion\_PRG to add programs as shown below.



- 9. Implement the following procedure with online monitoring:
  - Turn on Motor\_Mode.
  - © Execute Motor\_Speed and write 100 to the speed. (The unit is Hz; value is in two decimal places. For example, write 100 to get 1.00 Hz.)
  - ③ Write in 129 to execute Motor\_Run, while value 128 is for excitation.



\*Note: Information concerning CMM-EIP parameters are detailed in VFD EtherNet/IP Application Manual.

### 9.4.2.1.3 CIP Object Read-Write Setting for Explicit Messages

Please refer to Appendix A <EtherNet/IP Service and Object> in VFD EtherNet/IP Application Manual to check the objects supported by the option card and make sure to understand read-write methods for explicit messages before using this function. The master is allowed to configure the setting values of drives directly with the relevant Object Class address. The object class code is 0x300 for drives and the address is formatted as the following shown.

```
EIP communication data format
                     Object class
                                                          Attribute
                                        Instance
                        0x300
                                                        Pr. Number
                                       Pr. Group
                                  +
                                                    +
Read-write example
To read and write parameter 09-30 (Decoding with Ethernet/IP)
      Declare function blocks and variables
PROGRAM PLC_PRG
                          VAR
                              Get_Attribute_Single_0: ENIP.Get_Attribute_Single;
                              Set_Attribute_Single_0: ENIP.Set_Attribute_Single;
                              getsingledata: ARRAY[0..999] OF BYTE;
                              setsingledata: ARRAY[0..999] OF BYTE;
                          END VAR
```

■ Read parameter 9-30 via the function block as shown below.



Write 1 to parameter 9-30 via the function block as shown below.



# 9.4.2.2 Read-Write to AS00SCM-A (AS-FEN02 Communication Card)

The way to connect AS00SCM-RTU (AS-FEN02) via EtherNet/IP would be explained in this section. Please do read chapter 9 "Serial Communication Module AS00SCM" in AS Series Module Manual to understand the related settings and application of this module before actual operation.

Setup Steps:



\*1: Please refer to chapter 9 "Serial Communication Module AS00SCM" in AS Series Module Manual for more details concerning setups of AS00SCM-A IP address and RTU mode.

### 9.4.2.2.1 Setup IO modules on AS00SCM-RTU

Before connecting to AS00SCM-RTU (AS-FEN02), it is necessary to setup the IO modules on the right side of AS00SCM-RTU (AS-FEN02) by using EIP Builder software on your PC.

• Steps to operate the software EIP Builder are shown below.

Add the remote module to the hardware configuration manually or via Scan for Devices. Click on the remote module to open HWCONFIG so as to scan and download the IO module on the right side.



	TU) + FEN02) - RTU HW	CONFIG		- 🗆 X
Eile Edit Option	Help			- 6 x
EX DO A	8 9 9 3 3	0		
Product List	1.			
AS Series     Digital I/O Module     Analog I/O Module     Analog I/O Module			+	
201.0	-		¥.,	
CPU Group		_	•	
Extension No	туре	Module Name	* DDF Version	Comment
Extension No Power Module	Туре			Comment
Extension No Power Module Remote Module		Module Name AS00SCM(RTU) + AS-F		Comment
Extension No Power Module Remote Module Function Card1	Туре			Comment
Extension No Power Module Remote Module Function Card1 Function Card2	Type Function Card	A500SCM(RTU) + AS-F	02.02.00	Comment
Extension No Power Module Remote Module Function Card1 Function Card2 Module Information1	Type Function Card Digital 1 O Module	A500SCM(RTU) + AS-F A516AP11P-A	02.02.00	Comment
Extension No Power Module Remote Module Function Card1 Function Card2	Type Function Card Digital I/O Module Analog I/O Module	A500SCM(RTU) + AS-F	02.02.00	Comment
Extension No Power Module Remote Module Function Card1 Function Card2 Module Information1 Module Information2	Type Function Card Digital I/O Module Analog I/O Module	AS00SCM(RTU) + AS-F AS16AP11P-A AS04DA-A	02.02.00	Comment
Extension No Power Module Remote Module Function Card1 Function Card2 Module Information1 Module Information2	Type Function Card Digital I/O Module Analog I/O Module	AS00SCM(RTU) + AS-F AS16AP11P-A AS04DA-A	02.02.00	Comment

 Data would be exchanged according to the sequence in the Normal Exchange Area on the third-party device. Take AS04DA-A for example, the first input value is an error code (All the error codes of the module are input values, which are defined to be tranmitted from the remote module to the scanner). The data type of the first to the fourth value output from channel 1 to 4 are REAL.

☐ AS04DA-A — format — CH1~CH4 Mode setting	Device Information Normal Exchange Area						
	Description	Address					
- CH1~CH4 Calibration	Error code	D40 ~ D41					
- OutPut Setting	CH1 Output	D42 ~ D43					
- Alarm settings	CH2 Output	D44 ~ D45					
	CH3 Output	D46~D47					
	CH4 Output	D48 ~ D49					

9\_

### 9.4.2.2.2 Download the EDS File of AS00SCM-RTU

Please download the EDS file of AS00SCM-RTU module from Delta's official website.

- 1. Download the EDS file.
- 1.1 Open Device Repository.



1.2 Choose the target EDS file.

Location	System Repositor	y			~	Edit Locations.
	(C:\ProgramData	Delta Indus	trial Automati	on\DIAStudio\DIADesigr	er-AX\Devices)	
Installed d	evice descriptions					
String for	a fulltext search		Vendor:	<all vendors=""></all>	*	Install
Name		Vendor	Version	Description		Uninstall
_	liscellaneous					Beon.
₩ 🖬 F	ieldbuses					-
_	oftMotion drives					

	5 V	Search ASRTU_AS-FEI	V02	P
Organize 👻 New folder				0
OneDrive - Delta E Name	Date modified	Туре	Size	
This PC	02/06/2020 2:08 PN	1 EDS File		50 K
3D Objects				
Desktop				
Documents				
🕹 Downloads				
h Music				
E Pictures				
Videos				
Eccal Disk (C:)				
🚔 Local Disk (D:)				
Alaberta V C				
File name:	~	All supported a	otion files	(~
		Open	Cancel	

# 1.3 The download is complete.

Location	System Repository (C:\ProgramData\Delta Industrial Automation\DIAStudio\DIADesigner-AX\Devices)			Edit Locations	
Installed d	evice descriptions				
String for a fulltext search		Vendor:	<all vendors=""></all>	~	Install
Name		Ver	ndor	^	Uninstall
	AHCPU531-EN		a electronics, inc.		Export
	AHCPU560-EN2	Delta electronics, inc.			
	AS00SCM-RTU(AS-FEN02	the second second second second second second second second second second second second second second second se			
<	-			>	
	:\Users\ethancw.chen\Desktop\ASR Device *AS00SCM-RTU(AS-FEN02			)	Details
- 2. After the download is complete, you are allowed to add the AS00SCM-RTU device.
- 2.1 Add Ethernet device



Add Device

Close





2.2 Select the desired network interface.

General	Interface cpsw0	
Log		
Status	Network Adapters	
	Interfaces	
Ethernet Device I/O Mapping	Name Descrip	ption IP address
Ethernet Device IEC Objects	cpsw0	192,168,1.5
Information	100	127.0.0.1
	IP address	192 . 168 . 1 . 5
	Subnet mask	255 . 255 . 255 , 0
	Subnet mask Default gateway MAC address	255 . 255 . 255 . 0 0 . 0 . 0 . 0 00:18:23:74:F3:15

9\_

#### 2.3 Add EtherNet/IP Scanner device.







2.4 Add EtherNet/IP Adapter (AS00SCM-RTU).







### 9.4.2.2.3 Configure EtherNet/IP Parameters of AS00SCM-RTU

You are allowed to open the parameter setting page or download the settings from AS00SCM-RTU device so as to start the operation with the IO module.



1. Set the IP address of AS00SCM-RTU.

General	Address Settings		
Connections	IP address 192 . 168	. 1 . 11	EtherNet/IP
Assemblies			
Jser-Defined Parameters	Electronic Keying Keying Options		
log	Compatibility check		
EtherNet/IP I/O Mapping	Strict identity check     Check device type	2	
EtherNet/IP IEC Objects		99	
Status	Check product code	6641	
information	Check major revision		
	Check minor revision 1		

2. Set Connection parameters for EtherNet/IP, which should be configured according to the actual IO module. (Refer to section 9.4.2.2.1 for more details of parameter settings.)

General						_
	Connection Name	RPI (ms)	O>T Size (Byte	es) T>	O Size (Bytes)	Proxy (
Connections	- 1. RTU IO Owner	10 4	10	i0		
Assemblies			AP C	2012 ELLER 		
User-Defined Parameters						
Log						
EtherNet/IP I/O Mapping						
EtherNet/IP IEC Objects	Add Connection	Delete Conn	ection Edi	t Connectio	)n	
Status	Configuration Data					
Information	Raw data values	Show Paramet	er Groups			
Information	Parameters		Value	Unit	Data Type	Minimu
	= RTU IO Owner					
	- Target Confi	g data				
	Reserved		0		UINT	
	Reserved		0		UINT	
	- Master rec	connected handlin	g Stop		UINT	0
	Reserved		0		UINT	
	IO module	error handling	Stop		UINT	0
		timeout handling	0		UINT	0
	IO module	uncournationing				
	- IO module - Reserved	uncournarialing	0		UINT	

General Parameters						OK
Connection Path	20 04 24 80 2C 64 2C 65					Cance
Trigger type	Cyclic	1	RPI (ms)	10		
Transporttype	Exclusive owner	2	Timeout multiplier	4 ~		
canner to Target (Out	tput)		Target to Scanner (Inp	put)		
0>T size (bytes)	40	] 4	T>0 size (bytes)	60		
Proxy config size (by						
Target config size (b	oytes) 52					
Connection type	Point to Point	] 6	Connection type	Point to Point	~	
Connection Priority	Scheduled ~	6	Connectionpriority	Scheduled	~	
Fixed/Variable	Fixed		Fixed/Variable	Fixed		
Transfer format	32-bit run/idle		Transfer format	Pure data		
Inhibit time (ms)	0 ‡		Inhibit time (ms)	0 *		

①: RPI: Requested Packet Interval. Connect to EtherNet/IP to exchange data at regular time intervals via the IO connection.

(2): Timeout multiplier: Set up the timeout time according to the RPI or the multiple of RPI.

(3):  $O \rightarrow T$  size (bytes): The length of the data transmitted from the scanner to the adapter, which is considered to be the output data for the scanner.

(4):  $T \rightarrow O$  size (bytes): The length of the data transmitted from the adapter to the scanner, which is considered to be the input data for the scanner.

S: Connection type: There are "Point to Point" and "Multicast" modes.

6: Connection Priority: The priority of connection. AS00SCM-RTU only supports "Scheduled" mode".

Note 1: Configure settings of T  $\rightarrow$  O size and O  $\rightarrow$  T size according to the IO module configured in section 9.4.2.2.1. The following table shows the relevant data length of each model type of modules.

Digital I/O Module	$T \rightarrow O$ size bytes (Input)	$O \rightarrow T$ size bytes (Output)
AS08AM10N-A	2	0
AS08AN01T-A	0	2
AS08AN01P-A	0	2
AS08AN01R-A	0	2
AS16AM10N-A	2	0
AS16AP11T-A	2	2
AS16AP11P-A	2	2
AS16AP11R-A	2	2
AS16AN01T-A	0	2
AS16AN01P-A	0	2
AS16AN01R-A	0	2
AS32AM10N-A	4	0
AS32AN02T-A	0	4
AS64AM10N-A	8	0
AS64AN02T-A	0	8

The input/output data length of different DIO modules

• The input/output data length of different AIO modules

Analog I/O Module	$T \rightarrow O$ size bytes(Input)	$O \rightarrow T$ size bytes(Output)
AS02ADH-A	40	0
AS04AD-A	40	0
AS08AD-B	40	0
AS08AD-C	40	0
AS04DA-A	4	36
AS06XA-A	20	20
AS04RTD-A	40	0
AS06RTD-A	40	0
AS04TC-A	40	0
AS08TC-A	40	0

#### 9.4.2.2.4 Operate IO modules on AS00SCM-RTU

After the EtherNet/IP connection setting is complete, input and output data can be found on EtherNet/IP IO Mappping tab. Then you would be allowed to operate the IO module on the right side of AS00SCM-RTU. The following configuration shows that AS16AP11T-A (T  $\rightarrow$  O: 2 Bytes; O  $\rightarrow$  T: 2 Bytes) and AS04AD-A module (T  $\rightarrow$  O: 40 Bytes; O  $\rightarrow$  T: 0 Bytes) are connected to the right side of AS00SCM-RTU, which the total data length of T  $\rightarrow$  O and O  $\rightarrow$  T respectively are 102 Bytes and 42 Bytes.

File Edit Option			
🖪 🕺 🗈 🛍 🥜 🛛	🍠 😨 😨 🎇 🛸	\$	
Product List			
AS Series			
<ul> <li>Digital I/O Module</li> <li>Analog I/O Module</li> </ul>	n E		
Specification			
AS04AD-A	- J		
4 channels 16 bits analog 10-+10V, 0~10V, -5~+5V, ( 0/4~20 mA., -20mA~20 m conversion time = 2ms/cl	0/1~5V, LA	t	v
4 channels 16 bits analog 10~+10V, 0~10V, -5~+5V, 0/4~20 mA., -20mA~20 m conversion time = 2ms/cl	0/1~5V, IA hannel	Module Name	
4 channels 16 bits analog 10-+10V, 0~10V, -5~+5V, ( 0/4~20 mA., -20mA~20 m conversion time = 2ms/cl	0/1~5V, LA	Module Name	DDF Version
4 channels 16 bits analog 10~+10V, 0~10V, -5~+5V, ( 0/4~20 mA,, -20mA~20 m conversion time = 2ms/cl CPU Group Extension No Power Module	0/1~5V, IA hannel	Module Name AS00SCM(RTU) + AS-F	DDF Version
4 channels 16 bits analog 10~+10V, 0~10V, -5~+5V, ( 0/4~20 mA,, -20mA~20 m conversion time = 2ms/cl CPU Group Extension No Power Module	0/1~5V, AA hannel		DDF Version
4 channels 16 bits analog 10~+10V, 0~10V, -5~+5V, 0/4~20 mA,, -20mA~20 m conversion time = 2ms/cl CPU Group Extension No Power Module Remote Module	0/1~5V, AA hannel		DDF Version
4 channels 16 bits analog 10~+10V, 0~10V, -5~+5V, 0 0/4~20 mA., -20mA~20 m conversion time = 2ms/cl CPU Group Extension No Power Module Remote Module Function Card1	0/1~5V, AA hannel		DDF Version

General	Connection Name	RPI (ms)	Q>T Siz	e (Bytes)	T>0 Siz	e (Bytes)
Connections	- 1. RTU IO Owner	50	42	. Ibytes	102	c (bytes)
Assemblies						
User-Defined Parameters						
Log						
EtherNet/IP I/O Mapping						
EtherNet/IP IEC Objects	Add Connection	Delete Co	onnection	Edit Co	onnection	1
Status	Configuration Data					
Information	Raw data values	Show Paran	neter Groups			
Information	Parameters		Val	Je l	Unit D	ata Type
	= RTU IO Owner					
	RIO IO Owner					
	Target Conf	g data				

Note 1: Please be noticed that channel mode and other related parameters of AIO modules should be configured first as detailed in section 9.4.2.2.1. Only reading and opearating with IO channels would be explained in this section.

Note 2: If the data type of values to read or write is floating point, you would need to exchange the high word andlow word so as to display the correct values.

General	Find		Filter Show all		
Connections	Variable	Mapping	Channel	Address	Туре
connections	1		Deserved	P/TW/31	UINT
Assemblies	± *>		Input_data30	%IW32	UINK
	B- 🍫		Input_data31	%IW33	UINT
User-Defined Parameters	· · *>		Input_data32	%IW34	UINT
	🛞 – 🐐		Input_data33	%IW35	UINT
Log	÷- 🍫		Input_data34	%IW36	UINT
	÷ *		Input_data35	%IW37	UINT
EtherNet/IP I/O Mapping			Input_data36	%IW38	UINT
EtherNet/IP IEC Objects			Input_data37	%IW39	UINT
EtherNet/IP IEC Objects	🕀 - 🍫		Input_data38	%IW40	UINT
Status			Input_data39	%IW41	UINT
5.0.03	😟 - Mg		Input_data40	%IW42	UINT
Information	🕀 👋		Input_data41	%IW43	UINT
	😟 - 🏘		Input_data42	%IW44	UINT
			Input_data43	%IW45	UINT
			Input_data44	%IW46	UINT
			Input_data45	%IW47	UINT
	⊞- <b>*</b> ≱		Input_data46	%IW48	UINT
	🕀 👋		Input_data47	%IW49	UINT
	i∰- <b>*</b> ≱		Input_data48	%IW50	UINT
	· ₩- ₩		Input_data49	%IW51	UINT
	5.4		Decerved	94010/1	INAT

General	Find		Filter Show all		
Connections	Variable	Mapping	Channel	Address	Туре
connections	⊕- <b>*</b> ≱		Reserved	%QW1	UINT
Assemblies	· · · ·		Reserved	%QW2	UINT
	÷		Reserved	%QW3	UINT
Jser-Defined Parameters			Reserved	%QW4	UINT
			Reserved	%QW5	UINT
og	) 🕀 – 🍫		Reserved	%QW6	UINT
1. 20 1. 20 1. 20 1. 20 1.	÷ **		Reserved	%QW7	UINT
EtherNet/IP I/O Mapping	<u>ب</u>		Reserved	%QW8	UINT
	÷ *		Reserved	%QW9	UINT
EtherNet/IP IEC Objects	÷.**		Reserved	%QW10	UINT
Status	+ <b>*</b>		Reserved	%QW11	UINT
Julus	÷ *>		Reserved	%QW12	UINT
information	÷- *>		Reserved	%QW13	UINT
	🛞 - 🍫		Reserved	%QW14	UINT
	÷ **		Reserved	%QW15	UINT
	- · · · ·		Reserved	%QW16	UINT
	· <b>●</b> - <b>*</b> ø		Reserved	%QW17	UINT
			Reserved	%QW18	UINT
			Reserved	%QW19	UINT
			Reserved	%QW20	UINT
	±.~*ø		Output_data20	%QW21	UINT
				Reset Mapping	

### 9.4.2.2.5 Parameter Information of AS00SCM-RTU Module

General	Find		Filter Show all		
Connections	Variable	Mapping	Channel	Address	Туре
connections	RTU IO Owner	-			
Assemblies	😟 🦄	2	RTU state	%IW2	UINT
	🕀 – 🍫	- ă	RTU error code	%IW3	UINT
User-Defined Parameters	😟 - 🍫	0	Reserved	%IW4	UINT
	主 – 🍫		Reserved	%IW5	UINT
Log	🔿 – 🏘		Reserved	%IW6	UINT
	💼 🐨 🏘 🗤		Reserved	%IW7	UINT
EtherNet/IP I/O Mapping	😥 🦄		Reserved	%IW8	UINT
	😟 👻 👋		Reserved	%IW9	UINT
EtherNet/IP IEC Objects	😟 🦄		Reserved	%IW10	UINT
Status	😟 – 🍫		Reserved	%IW11	UINT
50005	🔿 - 🍫	4	Power State	%IW12	UINT
Information	🛞 👋	•	module [015] state	%IW13	UINT
	· · · · · ·		module [1631] state	%IW14	UINT
		-	module [3247] state	%IW15	UINT
	* *	4	module [4863] state	%IW16	UINT
	۰. ۲۰		module [6467] state	%IW17	UINT
	🗰 - 🍫		Module 1 error code	%IW18	UINT
	۰. 🌪		Module 2 error code	%IW19	UINT
	🛞 - 🍫		Module 3 error code	%IW20	UINT
	😟 🍫	0	Module 4 error code	%IW21	UINT
	😸 - 🍫	- 6	Module 5 error code	%IW22	UINT
	😟 - 🍫		Module 6 error code	%IW23	UINT
	· *		Module 7 error code	%IW24	UINT
	😟 🍫		Module 8 error code	%IW25	UINT
	🕀 - 🍫		Reserved	%IW26	UINT
			Reserved	%IW27	UINT

The AS00SCM-RTU status can be diagnosed via the parameter information displayed on EtherNet/IP IO Mapping tab.

- (1): RTU state: Communication module status (0 = Normal; 1 = Error)
- (2): RTU error code: Please refer to section 9.7 Error Codes in AS Series Module Manual.
- ③: Power State: The power status of communication module. (0 = Normal; 1 = Error)
- ④: Module state [0..67]: I/O module status, expressed with bits. (0 = Operate normally; 1 = Operate improperly)
- (5): Module error code: I/O module error codes. For more details of error codes, please refer to the manual of each module.

# 9.4.3 EtherNet/IP Adapter Function

# 9.4.3.1 EtherNet/IP Adapter

This section will explain how to add an EtherNet/IP adapter and set up its data structure. Refer to the following steps for configuration.

# 9.4.3.3.1 Add an EtherNet/IP Adapter

• Add an Ethernet device.

Devices	- 7	×
etherNetIP_AX3		•
Device (AX-308EA0MA1T)	X	Cut
Hardware Configuration		Сору
🗟 👗 Network Configuration 🛛 🖤	隐	Paste
A EtherCAT Filter	×	Delete
🖲 🗐 PLC Logic 🖶 🛐 BuiltIn_IO (BuiltIn_IO)	G	Properties
Delta_LocalBus_Master (Delta LocalB		Add Object +
EtherCAT_Master_SoftMotion (AX So SoftMotion General Axis Pool		Add Folder
Solution General Axis Pool		Add Device
		Update Device
¢	Dĩ	Edit Object
Sevices POUs		Edit Object With
		Edit IO mapping
		Import mappings from CSV
		Export mappings to CSV
	40	Online Config Mode
		Startup Command
		Reset Origin Device [Device]
		Simulation
		Firmware Update
		Device Diagnosis
		Startup Command

### AX-3 Series Operation Manual



• Add Delta\_EtherNet\_IP\_Adapter device.

Devices	- 4	×
etherNetIP_AX3		•
E Device (AX-308EA0MA1T)	x	Cut
- 🔏 Hardware Configuration		Сору
🖻 🙏 Network Configuration	隐	Paste
🙏 EtherCAT Filter	×	Delete
A EtherNetIP Filter	6	Properties
E PLC Logic	***	Add Object +
E BuiltIn_IO (BuiltIn_IO)		Add Folder
Delta_LocalBus_Master (Delta Loc	alE	Add Device
EtherCAT_Master_SoftMotion (A)	(Se	Update Device
Ethernet (Ethernet)	G	Edit Object
SoftMotion General Axis Pool	7	Edit Object With
		Edit IO mapping
<	_	Import mappings from CSV
2 Devices Devices		Export mappings to CSV
	40	Online Config Mode
		Startup Command
		Reset Origin Device [Device]
		Simulation
		Firmware Update
		Device Diagnosis
		Startup Command

# AX-3 Series Operation Manual

Action	Net_IP_Adapter_1				
	O Insert device O Plug o	device Ol	Jpdate device		
String for a full text	search	Vendor	<all th="" vendors:<=""><th>&gt;</th><th></th></all>	>	
Name		Vendor		Version	Descriptior ^
Fieldbuses	et/IP				
T. T.	erNet/IP Local Adapter				
- <b>G</b>	Delta EtherNet/IP Adapter	Delta elec	tronics, inc.	1.0.0.0	A device that
	Delta EtherNet/IP Adapter	Delta Elec	tronics, Inc.	1.0.5.1	A device that
Eth	erNet/IP Scanner		OR	~ (	<u>م</u>
Group by catego	ry 🔽 Display all versions (i	for experts o	only) 🗌 Disp	lay outdated	versions
Name: Delt	a EtherNet/IP Adapter			^	
	Ita electronics, inc.				-
Vendor: De					3
Vendor: De Categories	s: EtherNet/IP Local Adapter				
Vendor: De	0.0.0			~	~
Vendor: De Categories Version: 1. Order Num	0.0.0			*	~

• Set up the data structure for EtherNet/IP Adapter.

Devices	- 4	×
etherNetIP_AX3		•
		Cut Copy Paste Delete Refactoring Properties Add Object Add Folder
Delta_EtherNet_IP_Adapter (Delta EtherNet/IP Ad     SoftMotion General Axis Pool	G	Insert Device Disable Device Update Device Edit Object Edit Object With Edit IO mapping Import mappings from CSV Export mappings to CSV Find Master

### AX-3 Series Operation Manual

ame	Delta_EtherNet_IP_Module				1	
Action						
<ul> <li>Ap</li> </ul>	opend device O Insert device O Plug	device OI	Update device	8		
String	for a full text search	Vendor	<all th="" vendors<=""><th>s&gt;</th><th>Ŷ</th></all>	s>	Ŷ	
Nan	ne	Vendor		Version	Description	
B-6	Fieldbuses					
I.	EtherNet/IP					
	EtherNet/IP Module					
	Delta EtherNet/IP Module	Delta elect	tronics, inc.	1.0.0.0	A device that wo	
Delta EtherNet/IP Module		Delta Electronics, Inc.		1.0.5.1	A device that wo	
	Delta EtherNet/IP Module	Delta Elect	tronics, Inc.	1.0.5.1	A device that we	
<	Delta EtherNet/IP Module	Delta Elect	tronics, Inc.	1.0.5.1		
<				•	>	
Gr	oup by category 🗹 Display all versions			•	>	
Gr	oup by category 🗹 Display all versions Name: Delta EtherNet/IP Module			•	>	
Gr	oup by category  Display all versions Name: Delta EtherNet/IP Module Vendor: Delta Electronics, Inc.			•	>	
Gr	oup by category Display all versions Name: Delta EtherNet/IP Module Vendor: Delta Electronics, Inc. Categories: EtherNet/IP Module			•	>	
	oup by category  Display all versions Name: Delta EtherNet/IP Module Vendor: Delta Electronics, Inc.			•	>	
Gr	Name: Delta EtherNet/IP Module Vendor: Delta Electronics, Inc. Categories: EtherNet/IP Module Version: 1.0.5.1			•	>	
Z Gri	Name: Delta EtherNet/IP Module Vendor: Delta Electronics, Inc. Categories: EtherNet/IP Module Version: 1.0.5.1			•	>	
Gri Gri Appe	oup by category Display all versions Name: Delta EtherNet/IP Module Vendor: Delta Electronics, Inc. Categories: EtherNet/IP Module Version: 1.0.5.1 Order Number: -			•	>	
Appe Delta	oup by category Display all versions Name: Delta EtherNet/IP Module Vendor: Delta Electronics, Inc. Categories: EtherNet/IP Module Version: 1.0.5.1 Order Number: -	(for experts o	only) 🗋 Dis	play outdate	ed versions	
Gri Appe Delta	Dup by category ☑ Display all versions Name: Delta EtherNet/IP Module Vendor: Delta Electronics, Inc. Categories: EtherNet/IP Module Version: 1.0.5.1 Order Number: - Ind selected device as last child of _EtherNet_IP_Adapter	(for experts o	only) 🗋 Dis	play outdate	ed versions	

• Setting up the Delta\_EtherNet\_IP\_Module

Example of Delta EtherNet/IP Module (V1.0.0.0)

You can set up the data structure of EtherNet/IP Adapter by adding or setting up Delta EtherNet/IP module.

General	Module Informati	ion	
Delta EtherNet/IP Module I/O Mapping	Module	Byte Input Module	~
Delta EtherNet/IP Module IEC Objects	Vendor name	Delta electronics, inc.	
Status	Vendor ID	799 ‡	
	Product name	Byte Input Module	
Information	Product code	20224 📫	
	Major revision	1 ‡	
	Minorrevision	1 🌲	

Item	Description
Byte Input Module	1 Byte input
Byte Output Module	1 Byte output
Word Input Module	1 Word input
Word Output Module	1 Word output
DWord Input Module	1 DWord input
DWord Output Module	1 DWord output
Real Input Module	1 Real input
Real Output Module	1 Real output
100 words Input Module	100 Words input
100 words Output Module	100 Words output

9\_

Delta_EtherNet_IP_Module	×
Assemblies Delta EtherNet/IP Module I/O Mapping	Consuming Assembly       Consuming Assembly (Instance 16#64)       Producing Assembly       Producing Assembly
Delta EtherNet/IP Module IEC Objects Status Information	Name Data Type Bit Length Unit Help String

Name	Generic Pa	arameter			
Jnit					
Help String					
Data type	USINT	Ŷ	BYTE BOOL		
Bit length		8 🜲	WORD		
Count		1	LWORD		
			UINT	OK	Cancel
			ULINT		

9-90

# 9.4.3.1.2 Setting up EtherNet/IP Adapter

# • Delta EtherNet/IP Adapter

■ General – Setup EDS File

General	EDS File				
Tags	Vendor name	Delta electro	nics, inc.		EtherNet/IP
Log	Vendor ID	799	* *		Etheriter
Delta EtherNet/IP Adapter I/0	Product name	AX-308EA0M	A1T		
Mapping	Product code	16386	-		
Delta EtherNet/IP Adapter IEC Objects	Major revision	1	÷		
Status	Minorrevision	1	-		
Information	Enable ACD				
	Install to Device	e Repository	Export ED	S File	

Item	Description	Default
Vender name	The name of the supplier	Delta electronics, inc.
Vendor ID	Supplier ID	799
Product name	The name of the product	AX-308EA0MA1T
Product code	Product code	16386
Major revision	Major revision	1
Minor revision	Minor revision	1
Enable ACD	Ethernet/IP Adapter IP conflict detection. (This function is supported only in Delta EtherNet/IP Adapter V1.0.5.1 or later and must be used with DIADesigner-AX V1.4 or later.)	Disable
Install to Device Repository	In case that a device with the same device identification has already been installed, you would be asked whether the device should be overwritten. If the device is taken as the remote adapter inserted directly below the EtherNet/IP scanner, you would be asked to update the device automatically.	
Export EDS File	The EDS file is created and stored on the local computer. In this way, the EDS file can be used in an external configuration file.	

### 9.4.3.1.3 Export an EDS File

#### Export EDS File

After the configuration is complete, export the EDS file and store the EDS file – AX-308EA0MA1T.eds in the PC.

General	EDS File			
Tags	Vendor name	Delta electro	onics, inc.	EtherNet/IP
Log	Vendor ID	799	*	Luientevir
Delta EtherNet/IP Adapter I/O	Product name	AX-308EA0M	MA 1T	
Mapping	Product code	16386	-	
Delta EtherNet/IP Adapter IEC Objects	Major revision	1	-	
Status	Minorrevision	1	-	
Information	Enable ACD			
	Install to Devic	e Repository	Export EDS	File

# 9.4.3.2 Example of Connecting to a Third Party (Allen Bradley Controllogix 1756-L71)

This section introduces how to connect Delta's EtherNet/IP adapter via EtherNet/IP by using other brands' software. The Rockwell's software is used as an example in the following section.

#### 9.4.3.2.1 Structure

RA EIP scanner connects to Delta's adapter via Ethernet, while connecting to PC via Ethernet or USB.



※ Rockwell Software Studio 5000, ControlLogix, RSLogix are the trademark of Rockwell Automation.

The operation process is shown as follows:



### 9.4.3.2.2 Create a Project

- Open Studio 5000 and click "New Project" from "Create".
- Select the model type of PLC. Model 1756-L71 is used in the following example.
- Click "Finish" to finish creating projects.
- The configuration page would be opened automatically after the project has been successfully added.

### 9.4.3.2.3 Create a Scanner

After the project being created, add the EtherNet/IP module (1756-EN2TR) on the PLC backplane, then setup the EtherNet/IP device to connect via the EtherNet/IP module.

#### 9.4.3.2.4 Create a New Module

- Right click on 1756 Backplane 1756-A7 and select "New Module".
- Enter "1756-EN2TR" in the Filter field and select "Create".
- Enter the information of Name and IP address, then click "OK" to complete the task of creating EtherNet/IP modules.
- Expand project tree on the 1756-EN2TR module.

#### 9.4.3.2.5 Import an EDS File

- Choose EDS Hardware Installation Tool from Tools
- Select "Register an EDS file (s)".
- Select Browse from Register a single file and find the target EDS file to download: AX-308EA0MA1T.eds •
- Follow the instructions to click "Next" until the EDS file is successfully created.

### 9.4.3.2.6 Create a New Adapter

- Right click "Ethernet" and select "New Module" under EtherNet/IP Scanner module in the project tree.
- Enter the module number of the imported EDS file and select the target model type (such as AX-308EA0MA1T), then click "Create".
- Enter the product name and IP address, which should be same as the information shown in the Module Definition section.
- To change Connections information, click "Change" in Module Definition to open the modification page.
  - Change Connections information (1) Name: Tap the arrow next to Name to list all the available connections supported by the device.
    - (2) Size: the value indicates the length of the input/ output datat for data exchange.
    - \* For general purposes, there is no need to change the parameters from the imported EDS files which often can be used directly for connection.
- On Connection tab page, settings of RPI and input type can be modified, which the former is set as the interval time of periodic data exchange with scanners (unit: ms). Select the input type between Unicast and Multicast according to the feature supported by each product.
- Click OK after the Delta adapter has been successfully added and the model name would be displayed in the project tree.

### 9.4.3.2.7 Projects Download

After the creation of the Delta Adapter device is done, download the project to the PLC and go online.

- Click the "Communications" tab to and then select the option "Who Active". For establishing a connection, select the PC connected Scanner model number and then go to Communications > Download.
- After the connection is successfully established, the I/O status will show OK.

### 9.4.3.2.8 Data Mapping

Click the "Program TAGs" under the "Tasks" node for data mapping setups, including Configure, Input and Output. After the device is created in the I/O Configuration, the TAG will be added automatically.

- Click the "Program TAGs".
- You will see the tags corresponding to each product name on the right-hand side of the window.

TAG: C contains information from Adapter EDS file, including Input and Output parameters. Users can edit the parameters of Input and Output here.

TAG: I1, the mapping starts from TAG: I1[0], and will be mapped to the first parameters of the Adapter Output. The length is the output length provided by the Adapter.

TAG: O1, the mapping starts from TAG: O1[0], and will be mapped to the first parameters of the Adapter Input. The length is the input length provided by the Adapter.



# 9.4.4 CIP Object

# 9.4.4.1 Object List

In EtherNet/IP, object is referred to as a set of parameter that is structured accordingly by Class, Instance and Attribute. For example, Instance 0 contains basic information of every object, e.g. version and length. While Instance 1~N creates connection or status of required parameters for each product. Users can obtain product parameters from the supported service code via objects (see diagram below).



Read or write objects by using EtherNetIP Services.library or explicit message tool. The supported EtherNet/IP objects are listed below. Refer to the section 9.4.4.2 for the data type definition. Refer to the section 9.4.4.3~9.4.4.6 for object contents.

Object Name	Function	Class ID
Identity Object	Provides information including manufacturer, device types and versions.	1(H'01)
Assembly Object	Defines parameter of I/O connection data exchange	4(H'04)
TCP/IP Interface Object	Displays methods of IP configuration and interface	245(H'F5)
Ethernet Link Object	Shows the connection status of each Ethernet port on the device.	246(H'F6)

# 9.4.4.2 Data Type

This section will provide an overview of the supported data types by objects.

Data Type						Desc	riptio	'n						
BOOL	False(H'00	False(H'00)or True(H'01)												
	SINT(1 byt	e), INT(	2 bytes),	DINT(	4 bytes),	LINT	- (8 by	tes)				_		
	Number	1st	2nd	3rd	4th		5th	6th	7th	n 🛛	8th	]		
	SINT	0LSB												
	INT	0LSB	1LSB											
SIGNED	DINT	0LSB	1LSB	2LSI	B 3LSI	в								
INTEGER	LINT	0LSB	1LSB	2LSI	B 3LSI	B 4	LSB	5LSB	6LS	B 7	LSB			
	Ex: DINT v	alue = F	l'123456	78										
	Numbe	er	1st		2n	d		3rd		4	4th			
	DINT		78		56	;		34			12			
	USINT(1 b	yte), UIN	IT(2 byte	es), UD	DINT(4 by	∕tes),	ULIN	T(8 byte	s)					
UNSIGNED	Ex: UDINT	value =	ie = H'AABBCCDD											
INTEGER	Numbe	ər	1st		2n	d		3rd		4	4th			
	UDIN	г	DD		СС	)		BB			AA			
	ASCII, 1 or	2 bytes												
	STRING: 2 bytes character count + 1 byte character													
			ontents(C	Charco	ount)			Content	s(Strin	ng con	tents	)		
	STRING	i   (	04 00 4D 69 6C						6	С				
	STRING2: 2 bytes character count + 2 byte character													
STRING		С	ontents(C	Charco	ount)			Contents	s(Strin	ig con	tents)	1		
	STRING	2	04	0	00	4D	00	69	00	6C	00	6C	00	
	SHORT_S		1 hvtes c	harac	ter count	· + 1 ł		haracter		1				
			ontents(C				<i>y</i> to 0	Content	s(Strir	na con	itents	)		
	STRING		0			40	)	69		6C			SC 33	
	BYTE(1 by	te), WO	RD(2 byt	es), D	WORD(4	l byte	s), LV	VORD(8	bytes	)				
		1st	2n	d	3rd	4	th	5th	(	5th	7	th	8th	
Fixed LENGTH	Byte	70					-					-		
BIT STRING	WORD	70	15.	8		-	-				-	-		
	DWORD	70	15.	8	2316	31.	24					-		
	LWORD	70	15.	8	2316	31.	24	3932	47	40	55.	48	635	6

Data Type				[	Descr	ription				
	A single strir	ng consists	multiple l	anguage r	epres	entatior	۱.			
	Nar	ne	Data	а Туре				Meaning	3	
	Number		USINT			The number of internationalized character strings				racter
	Strings		Array of Struct o			Array of individual internationalized character strings				
	Language	Char1	USINT		e first A nguage	SCII cha	racter of	the ISO	639-2/T	
	Language	Char2	USINT	USINT			d ASCII	characte	r of the Is	SO 639-2/T
	Language	Char3	USINT	USINT			ASCII cha	aracter of	the ISO	639-2/T
STRINGI	CharString	Struct	USINT			The structure of the character string, limited to the Elementary Data type value 0xD0(STRING), 0xD5(STRING2), 0xD9(STRINGN)and 0xDA(SHORT_STRING)				
	CharSet		UINT		Th ba	The character set which the character string is based on which comes from IANA MIB Printer Code (RFC 1759).				er string is
	Internation	alString		Defined inAn array of 8-bit octet elements which iCharStringStructactual international character string			ch is the			
	ISO 639-2/T language:									
	Lang			t Characte	er Second Character Third Chara			Character		
	Eng		е			n		G		
	Fre	nch		f		r				е
	Spa	nish		S			р			а
	Ital	ian		i			t			а
	STRUCT of:	Any Data	Type com	poses the	struct	ture.				
STRUCT	Ex.: STRUC	T of { BOC	DL, UINT,	DINT } = { <sup>-</sup>	TRUE	E, H'123	4, H'567	89ABC }		
STRUCT		1st	2nd	3rd	4t	:h	5th	6th	7th	
	Byte	01	34	12	B	c	9A	78	56	
	Array of: Any		-		ıy.					
ARRAY	Ex.: ARRAY									
	Number	1st	2nd	3rd		4th	5th		th	
	Array	01	00	02		00	03	1	00	
	-		s of multip	le segment	s and	d referer	nces the	class, ins	stance ar	nd attribute of
EPATH	another obje			sibuto 5 "	20.0	1 0 / 0 /	20.05 "			
	Ex.: Identity	Object, In	stance att	" = C 91Uan	20.0	1 24 01	30 05 "			

9\_\_\_\_

# 9.4.4.3 Identity Object (Class ID: 01 Hex)

Identity information is stored in the Identity Object and consists of the Vendor ID, Device Type, Product Code and Major Revision for your device.

Service Code

Service		Attt	ribute	Description	
code	Service Name	Class Attribute Instanc		Description	
H'01	Get_Attributes_All	х	V	Read all attributes.	
H'05	Reset	set X		Reset.	
H'0E	Get_Attribute_Single	х	V	Read one attribute.	

- Class
  - Class ID: H'01
- Instance
  - H'01: Instance Attribute
  - When Instance =1, the Instance attributes are listed below:

Instance Attribute	Name	Access Rule	Data Type	Values	Description	
H'01	Vendor ID	Get	UINT	H'31F	Delta Electronics, inc.	
H'02	Device Type	Get	UINT	H'0C	Data Type: Communication Adatper	
H'03	Product Code	Get	UINT	H'4002	Product code	
	Revision		STRUCT		Revision of this device: Major.Minor	
H'04	Major Revision Minor Revision	Get	USINT	H'01	Major Revision Range: H'01~H'7F	
			USINT	H'01	Minor Revision Range: H'01~H'FF	
H'05	Status	Get	WORD	H'64	Status, refer to the following%1	
H'06	Serial Number	Get	UDINT	H'2374F75C	The last 8 characters of the MAC address 23: 74: f7: 5C	
		The		The maximu	Im number of a product name is	
H'07	Product Name	Get	SHORT_STRING	32 words. (Data length+Product Name)		
		Gei				
				(H	20D) AX-308EA0MA1T	

Bit (s)	Name	Description
0	Owned	Display if the device has an owner connection. 0: No 1: Yes
1	Reserved	0: Always OFF
2	Configured	Display if the device is configured or not. 0: No 1: Yes
3	Reserved	0: Always OFF
4-7	Extended Device Status	<ul> <li>0: Self-Testing</li> <li>1: Firmware Update</li> <li>2: At least one faulted I/O connection</li> <li>3: No I/O connections established</li> <li>4: Non-Volatile Configuration bad</li> <li>5: Major Fault</li> <li>6: At least one I/O connection in run mode</li> <li>7: At least one I/O connection established, all in idle mode</li> <li>8-15: Reserved</li> </ul>
8	Minor Recoverable Fault	<ul><li>0: No minor recoverable fault detected</li><li>1: Minor recoverable fault detected</li></ul>
9	Minor Unrecoverable Fault	0: No minor unrecoverable fault detected 1: Minor unrecoverable fault detected
10	Major Recoverable Fault	0: No major recoverable fault detected 1: Major recoverable fault detected
11	Major Unrecoverable Fault	0: No major unrecoverable fault detected 1: Major unrecoverable fault detected

%1 Status Description (H'05)

9\_

### 9.4.4.4 Assembly Object (Class ID: 04 Hex)

Assembly Objects are used to aggregate data for the input data and output data associated with I/O connections.

Service Code

	Service Service Name		Sup	port	Description
			Class Attribute	Instance Attribute	Description
	H'0E	Get_Attribute_Single	х	V	Read a single attribute

- Class
  - Class ID: H'04
- Instance
  - H'64: Output assembly
  - · H'65: Input assembly
  - H'66: Dummy (needed for compatibility)
  - When Instance = 64~66, the Instance Attributes are listed below:

Instance Attribute	Name	Access Rule	Data Type	Values	Description
H'03	Data	Get	ARRAY of BYTE	H'2	IO Connection Data

- Examples of reading and writing objects
  - (1) To read output assembly data, write the data as shown below:
    - Service code: H' 0E
    - Class ID: H' 04
    - Instance ID: H' 64
    - Attribute ID: H' 03
  - (2) To read input assembly data, write the data as shown below:
    - Service code: H' 0E
    - Class ID: H' 04
    - Instance ID: H' 65
    - Attribute ID: H' 03

# 9.4.4.5 TCP/IP Interface Object (Class ID: F5 Hex)

• Service Code

Service	Service Name	Sup	port	Description	
Code		Class Attribute	Instance Attribute		
H'0E	Get_Attribute_Single	V	V	Read a single attribute	
H'10	Set_Attribute_Single	Х	V	Set values of a single attribute	

Class

• Class ID = H'F5

• Instance

- H'00 : Class Attribute
- H'01 : Instance Attribute

• When Instance = 0, the class attributes are listed below:

Class Attribute	Name	Access Rule	Data Type	Values	Description
H'01	Revision	Get	UINT	H'4	Object revision

#### • When Instance =1, the Instance attributes are listed below:

Instance Attribute	Name	Access Rule	Data Type	Values	Description
H'01	Status	Get	DWORD	H'2	IP status X1
H'02	Configuration Capability	Get	DWORD	H'20	Configuration capability, refer to the following %2
H'03	Configuration Control	Get/Set	DWORD	H'0	Configuration Control, refer to the following X3
	Physical Link Object :		STRUCT of		Path to physical link object
H'04	Path Size	Get	UINT	H'0	Size of Path
	Path		EPATH		Logical segments identifying the physical link object
	Interface Configuration :		STRUCT of		TCP/IP network interface configuration.
	IP Address		UDINT	192.168.1.5	The device's IP address
	Network Mask		UDINT	255.255.255.0	The device's network mask:
H'05	Gateway Address	Get/Set	UDINT	0	Default gateway address
	Name Server		UDINT	0	Primary name server
	Name Server 2		UDINT	0	Secondary name server
	Domain Name		STRING	00 00	Default domain name
H'06	Host Name	Get	STRING	AX-308EA0MA1T	Device name
H'13	Encapsulation Inactivity Timeout	Get/Set	UINT	120	EIP equipment connection time; unit: seconds; range of

# AX-3 Series Operation Manual

Instance Attribute	Name	Access Rule	Data Type	Values	Description			
					values: 0~3600			
💥 Whe	※ When the master is communicating, the instance attribute H'03 and H'05 cannot be written.							
-	of reading and writing o	-						
	Instance Attribute H'03	, write the data	as shown below	<i>N</i> :				
	e code:H'0E							
Class I	D : H'F5							
Instanc	e ID:H'01							
Attribut	e ID:H'03							
Service Class I Instanc Attribut Data B B B	Instance Attribute H'05 e code : H'10 D : H'F5 e ID : H'01 e ID : H'05 yte[0~3] : IP Address= yte[4~7] : Network Mas yte[8~11] : Gateway M yte[12~15] : Name Ser yte[16~19] : Name Ser	192.168.1.5 sk=255.255.255 ask=0.0.0.0 ver =0		w:				
%1 Interface st								
Status	Interface Configurati	on ottributo bas		ription				
0	Interface Configurati			•				
1	non-volatile memory.	-	e contains valio	i configuration obtaine	ed from BOOTP, DHCP or			
2	· · · · · ·		oontoine valid	configuration obtaine	d from bordword			
۷			s comains vallu	configuration obtaine	น กังกา กลเนพลเษ.			

### %2 Interface capability flags

Bit	Description
0	BOOTP Client
1	DNS Client
2	DHCP Client
3	DHCP-DNS Update
4	Configuration Settable
5	Hardware Configurable
6	Interface Configuration Change Requires Reset

### **%3** Interface Configuration Control

Status	Description
0	The device shall use the interface configuration values previously stored (for example, in non-volatile
0	memory or via hardware witches).

Status	Description
1	The device shall obtain its interface configuration values via BOOTP.
2	The device shall obtain its interface configuration values via DHCP upon start-up.

# 9.4.4.6 Ethernet Link Object (Class ID: F6 Hex)

#### • Service Code

Service		Su	upport	
Code	Service Name	Class Attribute	Instance Attribute	Description
H'0E	Get_Attribute_Single	V	V	Read a single attribute

- Class
  - Class ID : H'F6

#### • Instance

- H'00 : Class Attribute
- H'01 : Instance Attribute

#### • When Instance =0, the Instance attributes are listed below:

Class Attribute	Name	Access Rule	Data Type	Values	Description
H'01	Revision	Get	UINT	H'04	Object revision

### • When Instance =1, the Instance attributes are listed below:

Instance Attribute	Name	Access Rule	Data Type	Values	Description
H'01	Interface Speed	Get	DWORD	0	Interface speed (indeterminate)
H'02	Interface Flags	Get	DWORD	H'0F	Ethernet port status, refer to the following %1
H'03	Physical Address	Get	ARRAY of 6 USINTs	By Product	MAC address
	Interface Capability	Get	STRUCT of :		Capabilities of Ethernet interface %2
	Capability Bits		DWORD	H'02000000	The definition of Ethernet interface capability
H'0B	Speed/Duplex Options		STRUCT of :		The definition of speed and duplex options of Ethernet interface.
TIOB	Speed/Duplex Array Count		USINT	H'00	The count of speed/ duplex options.
	Speed/Duplex Array		ARRAY of STRUCT of :		Speed and duplex settings

# AX-3 Series Operation Manual

Instance Attribute	Name	Access Rule	Data Type	Values	Description
	Interface Speed		UINT	H'00	Ethernet interface speed. For example, 10 bps and 100 bps would be H'0A and H'64 accordingly.
	Interface Duplex Mode		USINT	H'00	Duplex mode capability of Ethernet interface. For example, half and full duplex would be H'00 and H'01 accordingly.

# %1 Interface Flag Table

Bit (s)	Name	Description
0	Link Otatur	0 indicates an inactive link
0	Link Status	1 indicates an active link
1		0 indicates half duplex
I	Half/Full Duplex	1 indicates full duplex
		0 : Auto-negotiation in progress
	Negotiation Status	1 : Auto-negotiation and speed detection failed
2-4		2 : Auto negotiation failed but detected speed
		3 : Successfully negotiated speed and duplex
		4 : Auto-negotiation not attempted. Forced speed and duplex.
5	Manual Setting Requires Reset	shall be set zero
6	Local Hardware Fault	0 indicates the interface detects no local hardware fault
0		1 indicates a local hardware fault is detected
7-31	Reserved	0

### %2 Interface Capability Bits

Bit (s)	Name	Description
		Indicates whether or not the device requires a reset when
0	Manual Satting Paguiros Pasat	Indicates whether or not the device requires a reset when instance attribute #6 (Interface Control attribute) changes. 0 indicates the device does not require a reset 1 indicates the device requires a reste0 indicates the device requires a rest 0 indicates the interface does not support auto-negotiaiton 1 indicates the interface does not support auto MDIX operation 0 indicates the interface does not support auto MDIX operation 1 indicates the interface does not support to set speed/duplex.d/Duplex0 indicates the interface supports to set speed/duplex.
0	Manual Setting Requires Reset	0 indicates the device does not require a reset
		1 indicates the device requires a rest
1		0 indicates the interface does not support auto-negotiaiton
I	Auto-negotiate	1 indicates the interface supports auto-negotiation
2		0 indicates the interface does not support auto MDIX operation
2	Auto-MDIX	1 indicates the interface supports auto MDIX operation
		0 indicates the interface does not support to set speed/duplex.
3	Manual Speed/Duplex	(Instance attribute #6, Interface Control attribute)
		1 indicates the interface supports to set speed/duplex
4-31	Reserved	shall be set 0

# 9.4.5 Delta EIP Product List

Positioning	Product	Version
	AHCPU501-EN \ AHCPU511-EN \ AHCPU521-EN \ AHCPU531-EN	V2.00
	AHCPU560-EN2	V1.00
	AH10EN-5A	V2.00
	AHRTU-ETHN-5A	V1.00
Mid-range PLC	AH10EMC-5A	V1.00
FLC	AS300 Series	V1.00
	AS200 Series	V1.00
	AS300Series (AS-FEN02 communication card)	V1.06 (V1.00)
	AS00SCM-A (AS-FEN02 communication card)	V2.02 (V1.00)
	AX-3 Series	V1.01
	DVPES2-E Series	V3.60
Small PLC	DVP26SE	V1.00
	DVP-ES3 Series	V1.00
	VFD-MS300 Series (CMM-EIP01/02 Communication Card)	V1.00
las conton	VFD-C2000 Series (CMM-EIP01 Communication Card)	V1.06
Inverter	VFD-MS300 Series (CMM-EIP03 Communication Card)	V1.00
	VFD-C2000 Series (CMM-EIP02 Communication Card)	V1.00

# 9.4.5.1 Delta EIP Product List (Adapters Supported)

# 9.4.5.2 Delta EIP Product List (Scanners Supported)

Positioning	Product	Version
	AHCPU501-EN \ AHCPU511-EN \ AHCPU521-EN \ AHCPU531-EN	V2.00
Midan	AHCPU560-EN2	V1.00
Mid-range PLC	AH10EN-5A	V2.00
	AS300 Series/ AS200 Series	V1.00
	AX-3 Series	V1.01
Small PLC	DVP-ES3 Series	V1.00

9\_

MEMO



# **Chapter 10 Convenience Funcitons**

# **Table of Contents**

10.1	SD Card Functions	
10.1.	I Instructions for Reading/Writing from/to an SD Card	
10.1.2	2 Startup Command	
10.1.3	Backup and Restore EtherCAT Slave Parameters	
# 10.1 SD Card Functions

This chapter introduces the functions related to the AX-3 Series PLC and SD card.

## 10.1.1 Instructions for Reading/Writing from/to an SD Card

If the user wants to write controller data to the SD card or read data from the SD card to the controller, it can be achieved through the "DFB\_MemoryRead" and "DFB\_MemoryWrite" instructions in the "DL\_MemRW\_AX3.Library" library.

Note: For detailed information, please refer to Chapter 9 "instructions for Reading and Wring a Memory Card" in the AX Series Standard Instruction Manual.

#### 10.1.1.1 DFB\_MemoryRead

FB/FC	Instruction	Graphic Expression	ST Language
FB	DFB_ MemoryRead	DFB_MemoryRead BOOL bDone - 	DFB_MemoryRead( bExecute:= , FileInfo:= , bDone=> , bBusy=> , bError=> , ErrorID=> );

#### Input

	Name	Function	Data Type	Setting Value (Default value)
bE	Execute	Execute the function block. (Rising-edge triggered)	BOOL	True/False (False)
F	FileInfo	Parameter setting for reading a file.	DFB_READ_FILE_INFO	

#### DFB\_READ\_FILE\_INFO

Name	Function	Data Type	Setting Value (Default value)
sFilePath	The name of the file to read.	STRING	('')
wDataMode	ASCII CODE / BINARY mode	DFB_DATA_ MODE	DFB_DATA_MODE. ASCII_MODE DFB_DATA_MODE.BINARY_MODE (DFB_DATA_MODE.ASCII_MODE)
wAsciiShowMode	The display mode of data to be read. (Deximal / Hexadecimal)	DFB_ASCII SHOW_MODE	DFB_ASCIISHOW_MODE.DECIMAL DFB_ASCIISHOW_MODE.HEX (DFB_ASCIISHOW_MODE.DECIMAL)

Name	Function	Data Type	Setting Value (Default value)
wAsciiDec DataType	Data type of the variables to be read.	DFB_DEC_ DATATYPE	DFB_DEC_DATATYPE.BYTE_SIZE DFB_DEC_DATATYPE.WORD_SIZE DFB_DEC_DATATYPE.DWORD_SIZE DFB_DEC_DATATYPE.LWORD_SIZE DFB_DEC_DATATYPE.SINT_SIZE DFB_DEC_DATATYPE.USINT_SIZE DFB_DEC_DATATYPE.INT_SIZE DFB_DEC_DATATYPE.UINT_SIZE DFB_DEC_DATATYPE.UINT_SIZE DFB_DEC_DATATYPE.UDINT_SIZE DFB_DEC_DATATYPE.LINT_SIZE DFB_DEC_DATATYPE.LINT_SIZE DFB_DEC_DATATYPE.ULINT_SIZE DFB_DEC_DATATYPE.ULINT_SIZE DFB_DEC_DATATYPE.ULINT_SIZE DFB_DEC_DATATYPE.REAL_SIZE DFB_DEC_DATATYPE.LREAL_SIZE (DFB_DEC_DATATYPE.BYTE_SIZE)
dwRead StartPos	The starting position of the address to read the memory card's data.*	DWORD	(0)
dwElement Length	the controller's memory		1 ~ 25,000 (0)
pDestination	The address of the destination to store the controller's memory data.	POINTER TO BYTE	NULL

\*Note: The unit is defined in DFB\_READ\_FILE\_INFO.wAsciiDecDataType.

#### • Output

Name	Function	Data Type	Output Range (Default value)
bDone	The FB instruction execution is completed.	BOOL	True/False (False)
bBusy	The FB instruction is being executed.	BOOL	True/False (False)
bError	FB instruction error flags.	BOOL	True/False (False)
ErrorID	Error codes	DL_MEMRW_ERROR	DL_MEMRW_ERROR (DFB_NO_ERR)

## 10.1.1.2 DFB\_MemoryWrite

FB/FC	Instruction	Graphic Expression	ST Language
FB	DFB_ MemoryWrite	DFB_MemoryWrite — bExecute BOOL bDone — FileInfo DFB_WRITE_FILE_INFO BOOL bBusy BOOL bError DL_MEMRW_ERROR ErrorID	DFB_MemoryWrite ( bExecute:= , FileInfo:= , bDone=> , bBusy=> , bError=> , ErrorID=> );

#### • Input

Name	Function	Data Type	Setting Value (Default value)
bExecute	Execute the function block. (Rising-edge triggered)	BOOL	True/False (False)
FileInfo	Parameter setting for writing a file.	DFB_WRITE _FILE_INFO	

## DFB\_WRITE\_FILE\_INFO

Name	Function	Data Type	Setting Value (Default value)
sFilePath	The name of the file to create.	STRING	(")
wDataMode	ASCII CODE / BINARY mode	DFB_DATA_MODE	DFB_DATA_MODE.ASCII_MODE DFB_DATA_MODE.BINARY_MODE (DFB_DATA_MODE.ASCII_MODE)
wAsciiShowMode	The display mode of data to be written. (Deximal/ Hexadecimal)	DFB_ASCIISHOW_MODE	DFB_ASCIISHOW_MODE.DECIMAL DFB_ASCIISHOW_MODE.HEX (DFB_ASCIISHOW_MODE.DECIMAL)
wAsciiDecData Type	Data type of the variables to be written.	DFB_DEC_DATA TYPE	DFB_DEC_DATATYPE.BYTE_SIZE DFB_DEC_DATATYPE.WORD_SIZE DFB_DEC_DATATYPE.DWORD_SIZE DFB_DEC_DATATYPE.DWORD_SIZE DFB_DEC_DATATYPE.IWORD_SIZE DFB_DEC_DATATYPE.SINT_SIZE DFB_DEC_DATATYPE.USINT_SIZE DFB_DEC_DATATYPE.UINT_SIZE DFB_DEC_DATATYPE.UINT_SIZE DFB_DEC_DATATYPE.UDINT_SIZE DFB_DEC_DATATYPE.UINT_SIZE DFB_DEC_DATATYPE.UINT_SIZE DFB_DEC_DATATYPE.ULINT_SIZE DFB_DEC_DATATYPE.ULINT_SIZE DFB_DEC_DATATYPE.REAL_SIZE DFB_DEC_DATATYPE.LREAL_SIZE (DFB_DEC_DATATYPE.BYTE_SIZE)
wAccessMode	Ways to create files on a memory card	DFB_ ACCESS_MODE	DFB_ACCESS_MODE.NEW DFB_ACCESS_MODE.APPEND DFB_ACCESS_MODE.OVERWRITE DFB_ACCESS_MODE.INSERT (DFB_ACCESS_MODE.NEW)
wCarriageReturn	CRLF character*	WORD	(0)

Name	Function	Data Type	Setting Value (Default value)
dwWriteStartPos	The starting position of the address to write data to the memory card.*	DWORD	(0)
dwElementLength	The data length of the file to be written to the memory card.*	DWORD	1 ~ 25,000 (0)
pSource	The address of the memory card to stroe data.	POINTER TO BYTE	NULL

\*Note: The unit is defined DFB\_WRITE\_FILE\_INFO.wAsciiDecDataType.

#### • Output

Name	Function	Data Type	Setting Value (Default value)
bDone	The FB instruction execution is completed.	BOOL	True/False (False)
bBusy	The FB instruction is being executed.	BOOL	True/False (False)
bError	FB instruction error flags.	BOOL	True/False (False)
ErrorID	Error codes	DL_MEMRW_ERROR	DL_MEMRW_ERROR (DFB_NO_ERR)

5

## 10.1.2 Startup Command

The Startup Command provides several different commands for users to execute functions, including project backup, project restore, and firmware update. With these commands, a quick mass replication can be applied on controllers, saving time on individual controller setup.



#### • Startup Commands

- Restore Application from Selected Device
- Restore Application from Portable Device
- Restore Source from Current Project
- Restore Source from Portable Device
- Restore to Factory Settings
- Backup Application
- Backup Source
- Firmware Update

#### • The followings support Startup Commands

- AX-3 Series PLC with firmware version V1.0.5.8 or later
- DIADesigner-AX version V1.4 or later

#### 10.1.2.1 Operation of Startup Command

#### Open Startup Command Setting Page

You can open the setting page of Starup Command with a specific controller or without. If you open Startup Command Setting Page without selecting a specific controller, you can edit the startup commands, but the applications or project archive cannot be generated.

Open Startup Command setting page without selecting a specific controller.



■ Open Startup Command setting page with a specific controller

ices 👻	% Cut
J Untitled 30	в Сору
E Device (AX-308EA0MA1T)	Paste
Hardware Configuration	× Delete
A EtherCAT Filter	Properties
PLC Logic	Add Object
Library Manager	🚞 Add Folder
Motion_PRG (PRG)	Add Device
PLC_PRG (PRG)	Update Device
E Task Configuration	🕤 Edit Object
EtherCAT_Task	Edit Object With
Motion_PRG	Edit IO mapping
PLC_PRG	Import mappings from CSV
BuiltIn_IO (BuiltIn_IO)	Export mappings to CSV
DIO (DIO)	Y Online Config Mode
Delta_LocalBus_Master (Delta LocalE	
SoftMotion General Axis Pool	Reset Origin Device [Device]
	Simulation
	Firmware Update

#### • Startup Command Setting Page

4	Ð					$\downarrow \uparrow$	L T
Lie	ne	Command	Settings	Description	Keep	Execution Time	e Exit
1		Restore Application from Selected Device		Restore application files from current application to controller.		1	
2		Restore Application from Portable Device		Restore application files from portable device to controller.	1		
3		Restore Source from Current Project	Additional Files	Restore source file from current project to controller.	1	T.	
4		Restore Source from Portable Device		Restore source file from portable device to controller.	$\checkmark$		
5		Reset to Factory Settings		A factory reset erases the data and settings on the controller.	$\checkmark$	- C	
6		Backup Application		Backup application files from controller to portable device.		1	
7		Backup Source		Backup source file from controller to portable device.		1	
8		Firmware Update 🚺	C:\Users\ethancw.chen\Des	Update firmware with portable device.	V	2	
ess	ages				_		
					1		ed disk sp

\_10

Function Button	Description
t <u>–</u>	Add or insert Startup Command
<t></t>	Startup Command template
	Save Startup Comman setting file
1	Import Startup Command setting file
$\downarrow$	Move the selected command downward
$\uparrow$	Move the selected command upward
<u>+</u>	Move the selected command to the last row
Ť	Move the selected command to the first row
č	Delete the selected command
	Ticked: always keep the command
Кеер	Unticked: unselected, after the set execution time has met,
	the unselected command will be deleted.
Execution Times	The number of times that a command to be executed.
Exit	After this selected command is executed, exit from the startup command. And the rest of the commands are not executed.

#### • Startup Commands

Startup Command	Description
Restore Application from Selected Device (*1)	Copy the applications from the selected device and save them in a designed folder of a SD card for restoration.
Restore Application from Portable Device	The applications are already stored in a SD card for restoration.
Restore Source from Current Project (*1) (*2)	Copy the project archive from the current project and save it in a designed folder of a SD card for restoration.
Restore Source from Portable Device	The project archive of configuration files is already stored in a SD card for restoration.
Restore to Factory Settings	Restore to factory settings
Backup Application	Backup the applications
Backup Source	Backup the project archive
Firmware Update (*3) (*4)	Firmware update

- \*1 : Open the Startup Command settings page from the Device tree view to use this command.
- \*2 : This command allows you to select which types of files need to be imported from the Project Archive.
- \*3 : To use this command, you need to have the firmware file ready and be able to provide the file path.
- \*4 : After the firmware update is complete, you need to restart the AX-3 Series PLC and after that the controller can run on the new version of the firmware.

#### • Export Startup Command

After adding and arranging the startup commands on DIADesigner-AX, click **Generate** to export the commands to the SD card. After that you can insert this SD card to AX-3 Series PLC and after power off and then power on, the generated Startup Commands will be executed automatically.

		6.03				
Line 1	Command Backup Application	Settings	Description Backup application files from controller to portable device.	Keep	Execution Time:	Exit
2	Backup Source		Backup source file from controller to portable device.		1	
3	Restore Application from Portable Device		Restore application files from portable device to controller.	~	1	
4	Restore Source from Portable Device		Restore source file from portable device to controller.	~	7	
						_

#### 10.1.2.2 Usage Example

- Example 1: Copying the startup commands of one AX-3 Series PLC (A) to another AX-3 Series PLC (B).
  - Operation steps:
  - 1. Click to open **Startup Command Template** selection page. Select and add "Backup & Restore Application" for your startup commands. Click **Generate** to export the command to the SD card inserted on your PC.
  - Insert the SD card to the AX-3 Series PLC (A) and then turn the power off and on again to copy the startup commands for backup. Wait for the RUN LED stops blinking to complete the task. And then take out this SD card.
  - Insert this SD card to the other AX-3 Series PLC (B). Turn the power off and then power on this AX-3 Series PLC (B) and the backup startup commands will be copied to this AX-3 Series PLC (B). Wait for the RUN LED stops blinking to complete the task. And then AX3- Series PLC (B) is loaded with applications from AX3-Series PLC (A).





#### • Example 2: Firmware update on AX-3 Series PLC.

- Operation steps:
- 1. Click and add "Firmware Update" for your startup commands. Click **Generate** to export the command to the SD card inserted on your PC.
- 2. Insert the SD card to the AX-3 Series PLC and then turn the power off and on again to update firmware. Wait for the RUN LED stops blinking to complete the task.
- 3. Take out this SD card and turn the power off and on again. After that the controller can run on the new version of the firmware. (If you did not restart the controller, it will run on the old version of the firmware.)



- Example 3: If the login account and password of the AX-3 Series PLC are lost, it is necessary to restore it to its factory settings and restore the applications as well as the project achive.
  - Operation steps:
  - 1. Click and add "Reset to Factory Settings", "Restore Application from Portable Device" and "Restore Source from Portable Device" for your startup commands. Click **Generate** to export the commands to the SD card inserted on your PC.
  - 2. Insert the SD card to the AX-3 Series PLC and then turn the power off and on again to execute the startup commands. Wait for the RUN LED stops blinking to complete the task.
  - 3. Take out this SD card. The AX-3 Series PLC is now reset to factory settings and with applications and project archive from the SD card.

	Command	Settings	Description	Keep	Execution Time:	Exit
1	Reset to Factory Settings		A factory reset erases the data and settings on the controller.		1	
2	Restore Application from Portable Device		Restore application files from portable device to controller.	$\checkmark$	t -	
3	Restore Source from Portable Device		Restore source file from portable device to controller.		1	

## 10.1.3 Backup and Restore EtherCAT Slave Parameters

#### Supported version for backup and recovery

- AX-3 series firmware version: V1.0.2.0 and above
- DIADesigner-AX version: V1.2 and above
- Only models ASDA-A3-E and ASDA-B3-E are supported for parameter backup and recovery.
  - ♦ ASDA-A3-E firmware version: V11165 sub 92 and above
  - ASDA-B3-E firmware version: V10665 sub 75 and above

#### Data that is backed up

Servo parameters P0~P4 (Not including P0.001 and P4.000), P5.0003, P5.0008~P5.0009, P5.0020~P5.0030 and P6.0000~P6.0001.

Note: For more details, please refer to section 9.1.4 "Backup Parameters for EtherCAT Slaves" in the AX-3 series operating manual.

#### • Parameter Backup and Restore page

General	Action:			
	Backup to SD Card	Backup to File		
	Generate Target Device Li	ist Backup to SD Card		
	Current Project v	Restore from File	SoftMotion	
	Online Device	Restore from SD Card		
		¥		
	Device Type: Device ID: Device Version:			
	Device ID:			
	Device ID:	gs 🚯 0 Messages 🔐		
	Device ID: Device Version:	Message	e supports parameter backup and r	
	Device ID:			



# **Appendix A Troubleshooting**

# Table of Contents

A.1 Tro	publeshottingA-2
A.1.1	Basic Troubleshooting Steps A-2
A.1.2	Clear the Error States
A.1.3	Troubleshooting SOP A-3
A.1.4	Viewing Log
A.2 Tro	publeshooting of CPU ModulesA-6
A.2.1	ERROR LED Indicators Blinking Every 0.5 Seconds A-6
A.2.2	ERROR LED Indicators Blinking Rapidly Every 0.2 Seconds A-8
A.2.3	ERROR LED Indicators Slow Blinking Every 3 Seconds and Lighting up
	for 1 Second A-8
A.2.4	BAT. LOW LED Indicators Are ON A-8
A.2.5	BAT. LOW LED Indicators Blinking Every 0.5 Seconds
A.2.6	Others
711210	outers
	publeshooting of the Funciton BlocksA-10
A.3 Tro	
<b>A.3 Tro</b> A.3.1 A.3.2	Dubleshooting of the Funciton Blocks
<b>A.3 Tro</b> A.3.1 A.3.2	Dubleshooting of the Funciton Blocks       A-10         DL_BuiltInIO_AX3       A-10         Motion Control Related Instructions       A-13         Dubleshooting of I/O Modules       A-14
<ul> <li>A.3 Tro</li> <li>A.3.1</li> <li>A.3.2</li> <li>A.4 Tro</li> </ul>	Dubleshooting of the Funciton Blocks       A-10         DL_BuiltInIO_AX3       A-10         Motion Control Related Instructions       A-13         Dubleshooting of I/O Modules       A-14         Troubleshooting of Analog Modules (AD/DA/XA) and Temperature Modules
<ul> <li>A.3 Tro</li> <li>A.3.1</li> <li>A.3.2</li> <li>A.4 Tro</li> </ul>	Dubleshooting of the Funciton Blocks       A-10         DL_BuiltInIO_AX3       A-10         Motion Control Related Instructions       A-13         Dubleshooting of I/O Modules       A-14
<ul> <li>A.3 Tro A.3.1 A.3.2</li> <li>A.4 Tro A.4.1</li> <li>A.4.2</li> </ul>	Dubleshooting of the Funciton Blocks       A-10         DL_BuiltInIO_AX3       A-10         Motion Control Related Instructions       A-13         Dubleshooting of I/O Modules       A-14         Troubleshooting of Analog Modules (AD/DA/XA) and Temperature Modules (RTD/TC)       A-14
<ul> <li>A.3 Tro A.3.1 A.3.2</li> <li>A.4 Tro A.4.1</li> <li>A.4.2</li> </ul>	Dubleshooting of the Funciton Blocks       A-10         DL_BuiltInIO_AX3       A-10         Motion Control Related Instructions       A-13         Dubleshooting of I/O Modules       A-14         Troubleshooting of Analog Modules (AD/DA/XA) and Temperature Modules (RTD/TC)       A-14         Troubleshooting of Loadcell Modules AS02LC       A-16

# A.1 Troubleshotting

## A.1.1 Basic Troubleshooting Steps

This chapter includes the possible errors the can occur during operation, their causes, and corrective actions.

- (1) Check the following:
  - The PLC should be operated in a safe environment (consider environmental, electronic, and vibration safeties).
  - Connect power supply correctly to the PLC.
  - Secure the module, terminal, and cable installations.
  - All LED indicators show correctly.
  - Set all switches correctly.
- (2) Check the following operational functions:
  - Switch the RUN/STOP state
  - Check the settings for the AX-3 Series to RUN/STOP
  - Check and eliminate errors from external devices
  - Use the System Log function in DIADesigner-AX to check system operation and logs
- (3) Identify possible causes:
  - AX-3 Series or external device
  - CPU or extension modules
  - Parameters or program settings

## A.1.2 Clear the Error States

Use the following methods to clear the error states. If the error source is not corrected, the system continues to show errors.

- (1) Switch the CPU model state to STOP and then to RUN.
- (2) Turn off the CPU and turn it on again.
- (3) Use DIADesigner-AX to perform Reset Warn to clear the error logs.
- (4) Use DIADesigner-AX to perform **Reset Origin** to reset the CPU to default settings and then redownload the program to start again.



# A.1.3 Troubleshooting SOP

## A.1.4 Viewing Log

When an error occurs, the system generates corresponding error codes and stores the error messages in the PLC. You can find events during the startup and shutdown of the system, application download and loading of the boot application, custom entries, log entries from I/O drivers, and log entries from data sources on the Log tab of the Device setting page. Refer to section 4.2.1.5 for more information on Log.

#### 1. Log Tab

Double-click the **Device** in the tree view to open the Device setting page and then you can find Log tab on the left section.

Communication Settings	<u> </u>	5(-) (-)	cception(s) • 285 information(s) • 27 debug	,
Applications	Offline l	ogging 🗌 UTC time		
	Severity	Time Stamp	Description	Component
Backup and Restore	0	01.01.1970 08:05:31	[CAN]EVT_StartDone!!	IoDrvDelta
	0	01.01.1970 08:05:31	[MTCPSlave]EVT_StartDone!!	IODrvDeltaModbusTCPS
Files	0	01.01.1970 08:05:31	[CAN]EVT_PrepareStart!!	IoDrvDelta
	0	01.01.1970 08:05:31	[MTCPSlave]EVT_PrepareStart!!	IODrvDeltaModbusTCPS
Log	0	01.01.1970 08:00:13	CODESYS Control ready	CM
PLC Settings	0	01.01.1970 08:00:13	CH_INIT_FINISHED	CmpDeltaConnHandler
FLC Settings	0	01.01.1970 08:00:13	Application [Application] not started	СтрАрр
PLC Shell	0	01.01.1970 08:00:13	Application [Application] denied to start ev	СтрАрр
	0	01.01.1970 08:00:13	CH_INIT_COMM	CmpDeltaConnHandler
Users and Groups	0	01.01.1970 08:00:13	CH_INIT_COMM	IoDrvAX308_Counter_Timer
	0	01.01.1970 08:00:13	CH_INIT_COMM	IoDrvAX308_Capture_Compare
Access Rights	0	01.01.1970 08:00:13	CH_INIT_TASKS	CmpDeltaConnHandler
	0	01.01.1970 08:00:13	CH_INIT_TASKS	IoDrvAX308_Counter_Timer
Symbol Rights	0	01.01.1970 08:00:13	CH_INIT_TASKS	IoDrvAX308_Capture_Compare
	0	01.01.1970 08:00:13	Setting router 2 address to (2ddc:c0a8:0	CmpRouter
System Parameters	0	01.01.1970 08:00:13	Setting router 1 address to (0000)	CmpRouter
	0	01.01.1970 08:00:13	Setting router 0 address to (0005)	CmpRouter
Task Deployment	0	01.01.1970 08:00:13	IoDrvEthernetIP	IoDrvEtherNetIP
Chabura	٠	01.01.1970 08:00:13	Retain size in config changed, or retain are	CmpRetain
Status	0	01.01.1970 08:00:13	Bootproject of application [Application] loa	CmpApp

#### 2. Files

The system generates log files (.csv) when the PLC is power-off or the log exceeds 64 KB. You can read the log file from the Files tab of the Device setting page.

Communication Settings	Host Location		• 🖿 🗙 🕂	Runtime Location		-   🖿 🗙 -
Applications	Name	Size	Modified	Name <click ic<="" on="" refresh="" td="" the=""><td>Size</td><td>ified</td></click>	Size	ified
Backup and Restore	D:\					
Files	E.\					
Log						
PLC Settings						
PLC Shell						
Users and Groups						
Access Rights						
Symbol Rights				>>		
System Parameters						
Task Deployment				<<		
Device ×	Host Location		·   = × *	Runtime   Location   🍃	/	-   🖻 X 4
Device × Communication Settings	Name	Size	• • • •	Name	/ Size	• I 🖿 🗙 4 Modified
Device × Communication Settings Applications	Name C:\ D:\	Size		Name		
Status  Device ×  Communication Settings  Applications Backup and Restore Files	Name	Size		Name		
Device x Communication Settings Applications Backup and Restore	Name C:\ D:\	Size		Name		
Device × Communication Settings Applications Backup and Restore Files	Name C:\ D:\	Size		Name		
Device × Communication Settings Applications Backup and Restore Files Log PLC Settings	Name C:\ D:\	Size		Name		
Device × Communication Settings Applications Backup and Restore Files Log PLC Settings PLC Shell	Name C:\ D:\	Size		Name		
Device × Communication Settings Applications Backup and Restore Files Log PLC Settings PLC Settings PLC Shell Users and Groups	Name C:\ D:\	Size		Name		
Device × Communication Settings Applications Backup and Restore Files Log PLC Settings PLC Shell Users and Groups Access Rights	Name C:\ D:\	Size	Modified	Name		
Device × Communication Settings Applications Backup and Restore Files Log PLC Settings PLC Settings PLC Shell Users and Groups Access Rights Symbol Rights	Name C:\ D:\	Size	Modified	Name PicLogic cert log		
Device × Communication Settings Applications Backup and Restore Files Log	Name C:\ D:\	Size	Modified	Name PicLogic cert Log		

Communication Settings	Host Location		-   🖿 🗙	÷	Runtime Location 📴 /		• 🗀 🗙 🖸
Applications	Name	Size	Modified		Name L	Size	Modified
Backup and Restore	□ D:\ □ E:\				StdLogger52276_19700:		
Files					StdLogger52277_19700:	64.50 K	1980/1/
Log					StdLogger52279_19700:		
PLC Settings					StdLogger5219700		
PLC Shell					StdLogger52         :_19700:           StdLogger52         :_19700:		
Users and Groups					StdLogger5219700:	64.50 K	1980/1/
Access Rights					StdLogger52 '_19700		
Symbol Rights				>>			
System Parameters					_		
Task Deployment				<<			

# A.2 Troubleshooting of CPU Modules

Check the LED indicators and the error codes from the CPU module and refer to the following table for troubleshooting.

# A.2.1 ERROR LED Indicators Blinking Every 0.5 Seconds

# CPU ERROR

Error Code (16#)	Description	Solution
140E	More than eight remote modules on the right side of the CPU module.	Check the total number of remote modules on the right side of the CPU module (maximum is 8).
1600	The extension module ID exceeds the range.	<ol> <li>Make sure the module is properly connected to the CPU module and turn the modules on again.</li> <li>If the problem persists, contact the local authorized distributors.</li> </ol>
1601	The extension module ID cannot be set.	<ol> <li>Make sure the module is properly connected to the CPU module and turn the modules on again.</li> <li>If the problem persists, contact the local authorized distributors.</li> </ol>
1602	The extension module ID is duplicated.	<ol> <li>Make sure the module is properly connected to the CPU module and turn the modules on again.</li> <li>If the problem persists, contact the local authorized distributors.</li> </ol>
1603	The extension module cannot be operated.	<ol> <li>Make sure the module is properly connected to the CPU module and turn the modules on again.</li> <li>If the problem persists, contact the local authorized distributors.</li> </ol>
1604	Extension module communication timeout	<ol> <li>Make sure the module is properly connected to the CPU module and turn the modules on again.</li> <li>If the problem persists, contact the local authorized distributors.</li> </ol>
2000	CPU memory access is denied.	If the problem persists, contact the local authorized distributors.
2001	CPU external memory access is denied.	If the problem persists, contact the local authorized distributors.
2100	The number of MODBUS TCP connections exceeds the range.	Check if the number of Modbus TCP connection (Server+Client) exceeds the maximum number 32.
2200	The arrangement of the I/O modules is not consistent with the settings.	Check whether the settings in Hardware Configuration are consistent with the arrangement of the I/O modules.
2201	The number of connected communication modules exceed the maximum number 4.	Check the total number of communication modules.
2202	The number of connected positioning modules exceed the maximum number 8.	Check the total number of positioning modules.
2203	The number of connected extension modules exceed the maximum number 32.	Check the total number of extension modules.

# • EtherCAT ERROR

Error Code (16#)	Description	Solution		
1	EtherCAT communication lost	Make sure the terminal and cable are properly connected to the CPU module. Execute the function block, DFB_ResetECATMaster, to reset the EtherCAT Master.		
2	EtherCAT data mapping failed	Make sure the terminal and cable are properly connected to the CF module. Execute the function block, DFB_ResetECATMaster, to rest the EtherCAT Master.		
4	Incorrect EtherCAT network name	Make sure the Network Name/address is correctly set on the setting page of the EtherCAT Master.		
5	EtherCAT Slave failed to initialize	Make sure the actual placement is the same as the settings in the Network Configuration.		
6	Vendor ID of the Slave does NOT match.	<ul> <li>Make sure the actual placement is the same as the settings in the Network Configuration.</li> <li>Make sure the ESI file of the Slave is matched.</li> <li>Disable the Startup Checking item to canel checking Vendor ID on the EtherCAT Master setting page.</li> </ul>		
7	Product ID of the Slave does NOT mathc.	<ul> <li>Make sure the actual placement is the same as the settings in the Network Configuration.</li> <li>Make sure the ESI file of the Slave is matched.</li> <li>Disable the Startup Checking item to canel checking Product ID on the EtherCAT Master setting page.</li> </ul>		

Note: EtherCAT error LED is defined by the Library IODrvEtherCAT.

# A.2.2 ERROR LED Indicators Blinking Rapidly Every 0.2 Seconds

The blinking happens when the power supply 24 VDC of the CPU module is disconnected, or the power supply is not sufficient, not stable or abnormal.

Error Code (16#)	Description	Solution
2004	The external voltage is abnormal.	Check whether the external 24 V power supply to the module is normal.

# A.2.3 ERROR LED Indicators Slow Blinking Every 3 Seconds and Lighting up for 1 Second

Error Code (16#)	Description	Solution	
7	The operation system file of the firmware is broken.	<ol> <li>Upgrade device firmware</li> <li>After firmware is upgraded, if the problem persists, contact the local authorized distributors.</li> </ol>	
8	Parts of the firmware compoents are broken.	<ol> <li>Upgrade device firmware</li> <li>After firmware is upgraded, if the problem persists, contact the local authorized distributors.</li> </ol>	
D	Checksum error occurs in the %M device.	<ol> <li>Make sure the external 24 V power supply to the module is functioning normally.</li> <li>After firmware is upgraded, if the problem persists, contact the local authorized distributors.</li> </ol>	
1800 ~ 180F	Errors occurred in the extension modules	Refer to section A.4 for more information on the extension module error codes.	

# A.2.4 BAT. LOW LED Indicators Are ON

The blinking happens when there is no battery (CR1620) or the power is low. Turn this functionality off on the System Parameter setting page. (Device -> System Parameter -> Show Battery Low Voltage Error) when you don't need the RTC function to keep track of the current time (default is "enabled").

Error Code (16#)	Description	Solution
2003	Battery Low	Change battery or turn this option off

# A.2.5 BAT. LOW LED Indicators Blinking Every 0.5 Seconds

The blinking happens when RTC cannot keep track of the current time.

Error Code (16#)	Description	Solution
2002	RTC cannot keep track of the current time	If the problem persists, contact the local authorized distributors.

## A.2.6 Others

Error Code (16#)	Description	Solution
2500	The firmware version of the PLC is not in accordance with what stated on the DDF (Device Description File).	Check the firmware version o fthe PLC and the requirement on the DDF.
2501	SSI encoder is NOT connected to PLC.	Check the connection between SSI concoder and PLC.
2502	The setting value of the single turn and multiturn SSI encoders exceed the setting limit. (up to 32 bits).	The setting value of the single turn and multiturn SSI encoder should not exceed the maximum of 32 bits.
2503	An error occurs when the pulse outputs.	Check the log of the corresponding pluse on the ON-LINE monitioing page.

# A.3 Troubleshooting of the Funciton Blocks

# A.3.1 DL\_BuiltInIO

The following errors are specified as warnings; however no error indicators will appear and the AX-3 Series CPU can still run.

Error Code (16#)	Item Name	Description	Solution
0	DFB_HSIO_NO_ERR	No error on the high speed IO function block	-
186A0	DMC_HP_INVALID_ HOME_SPEED	The speed set in the homing motion on the pulse axis is invalid.	The setting value in the fields of Search for Switch and Search for Z Phase Pulse on the setting page of Pulse Axis cannot not be set to 0. Set a non-zero value.
186A1	DMC_HP_INVALID_ HOME_ACC_DEC	The acceleration set or the deceleration set in the homing motion is invalid.	The setting value in the fields of acceleration and deceleration in the homing motion on the setting page of Pulse Axis cannot not be set to 0. Set a non-zero value.
186A2	DMC_HP_INVALID_ HOME_POSITION	The position set in the homing motion is invalid.	Set the function block pin, IrPosiotion, in the range of [0 ~ PulseAxis.Modulo Value ].
186A3	DMC_HP_AXIS_NOT_P ULSEAXIS	The variable of the function block pin is NOT a PulseAxis_REF type.	Make sure to select <b>Pulse Axis</b> on the IO Configuration setting page and import IEC Object to the pin "Axis" of the function block DMC_Home_P.
186A4	DMC_HP_HOMING_ME THOD_RESERVED	This version does NOT support this type of homing mode.	Check if this type of homing mode is supported in this version. Refer to the specification and then change the mode accordingly.
186A5	DMC_HP_HOMING_MO VEMENT_HW_LIMIT	If the positive/negative limit is activated, the axis cannot move in this homing mode.	Make sure the hardware limit used is supported by this homing mode. Refer to the specification and then change the mode or the setting accordingly.
186A6	DMC_HP_HOMING_ AXIS_STATE_NOT_ STANDSTILL	The state of the pulse axis is not at standstill.	Make sure the function block DMC_Home_P is executed when the axis state is at standstill.
186AC	DFB_CAP_INVALID_CA PTURE_REF	The variable of the function block pin is NOT a Capture_REF type.	Make sure to select <b>Capture</b> on the IO Configuration setting page and import IEC Object to the pin "Capture" of the function block DMC_Capture.
186AD	DFB_CAP_INVALID_CO UNTER_REF	The variable of the function block pin is NOT a Counter_REF type.	Make sure to select <b>Counter</b> on the IO Configuration setting page and import IEC Object to the pin "Counter" of the function block DMC_Capture.
186AE	DFB_CAP_INVALID_ VALUE_SETTING	The mask setting value (uiMaskValue) in DFB_Capture exceeds the range of rotary axis.	Set the pin "uiMaskValue" of the function block DFB_Capture in the range of [0 ~ EncoderAxis.Modulo Value ].
186AF	DFB_CAP_INVALID_DE LTARANGE	When the encoder of high- speed counter is a rotary axis and the pin of "diDeltaMax" or "diDeltaMin" exceeds the range of rotary axis.	Set the pin "diDeltaMax" or "diDeltaMin" of the function block DFB_Capture in the range of [0 ~ EncoderAxis.Modulo Value ].
186B0	DFB_CAP_CAPTURE_A LREADY_ENABLE	The device for high-speed capture is already enabled.	Check if the device for high-speed capture is already enabled by other DFB_Capture.

Error Code (16#)	Item Name	Description	Solution
186B6	DFB_CMP_INVALID_CO MPARE_REF	The variable of the function block pin is NOT a Compare_REF type.	Make sure to select <b>Compare</b> on the IO Configuration setting page and import IEC Object to the pin "Counter" of the function block DMC_Compare.
186B7	DFB_CMP_INVALID_CO UNTER_REF	The variable of the function block pin is NOT a Counter_REF type.	Make sure to select <b>Counter</b> on the IO Configuration setting page and import IEC Object to the pin "Counter" of the function block DMC_Compare.
186B8	DFB_CMP_INVALID_CM PVALUE	When the encoder of high- speed counter is a rotary axis and the pin of "diCompareValue" exceeds the range.	Set the pin "diCompareValue" of the function block DFB_Compare in the range of [0 ~ EncoderAxis.Modulo Value ].
186B9	DFB_CMP_INVALID_RE FRESHCYCLE	The setting value of input pin "wRefreshCycle" exceeds the range of [0-30000], unit 0.1us.	Set the pin "wRefreshCycle" of the function block DFB_Compare in the range of [0 ~ 30000].
186BA	DFB_CMP_ COMPARE_ALREADY_E NABLE	The device for high-speed compare is already enabled.	Check if the device for high-speed compare is already enabled by other DFB_Compare.
186C0	DFB_HC_INVALID_ COUNTER_REF	The variable of the function block pin is NOT a Counter_REF type.	Make sure to select <b>Counter</b> on the IO Configuration setting page and import IEC Object to the pin "Counter" of the function block DMC_HCnt.
186C1	DFB_HC_COUNTER_AL READY_ENABLE	The device for high-speed counter is already enabled.	Check if the device for high-speed counter is already enabled by other DFB_HCnt.
186C2	DFB_HC_COUNTER_R EF_CHANGED_ DURING_ OPERATION	The input pin "Counter" has been changed during the execution of the function block.	Check if the variable of the pin "Counter" has been changed after the execution of the DFB_HCnt.
186C8	DFB_HT_INVALID_ TIMER_REF	The variable of the function block pin is NOT a Timer_REF type.	Make sure to select <b>Timer</b> on the IO Configuration setting page and import IEC Object to the pin "Timerr" of the function block DFB_HTmr.
186C9	DFB_HT_TIMER_ ALREADY_ENABLE	The device for high-speed timer is already enabled.	Check if the device for high-speed timer is already enabled by other DFB_HTmr.
186CA	DFB_HT_TIMER_REF_ CHANGED_DURING_O PERATION	The input pin "Timer" has been changed during the execution of the function block.	Check if the variable of the pin "Timer" has been changed after the execution of the DFB_HTmr.
186D0	DFB_PV_INVALID_ COUNTER_REF	The variable of the function block pin is NOT a Counter_REF type.	Make sure to select <b>Counter</b> on the IO Configuration setting page and import IEC Object to the pin "Counter" of the function block DFB_PresetValue.
186D1	DFB_PV_NOT_ ENABLE_EXTERNAL_T RIGGER	The counter is not set as triggered externally but the mode of DFB_PresetValue is set to "EXTERNAL_TRIGGER".	Make sure to select <b>External Trigger</b> on the Counter Configuration page.
186D2	DFB_PV_PREVIOUS_P RESET_NOT_DONE	The preset counting function of the counter has been enabled by other function block	Execute this function block after the execution of DFB_PresetValue of this counter completes.

Error Code (16#)	Item Name	Description	Solution
		DMC_PresetValue and is not done yet.	
186D3	DFB_PV_CANNOT_ PRESET_WHEN_SAMP LING	The counter is executing DFB_Sample.	Disable the sample function of this counter. Disable DFB_Sample of this counter.
186D4	DFB_PV_SETRING_ NOT_DONE	The counter is executing DFB_SetRing and is not done yet.	Execute this function block after the execution of DFB_SetRing of this counter completes.
186D5	DFB_PV_INVALID_ PRESET_VALUE	When the encoder of high- speed counter is a rotary axis and the pin of "diPresetValue" exceeds the range.	Set the pin "diPresetValue" of the function block in the range of [0 ~ EncoderAxis.Modulo Value ].
186D6	DFB_PV_COUNTER_RE F_CHANGED_ DURING_ OPERATION	The input pin "Counter" has been changed during the execution of the function block.	Check if the variable of the pin "Counter" has been changed after the execution of the DFB_PresetValue.
186DC	DFB_SP_INVALID_ COUNTER_REF	The variable of the function block pin is NOT a Counter_REF type.	Make sure to select <b>Counter</b> on the IO Configuration setting page and import IEC Object to the pin "Counter" of the function block DMC_Sample.
186DD	DFB_SP_COUNTER_N OT_ENABLE	The function block DFB_Counter is not enabled yet.	Execute DFB_Sample after making sure this counter is enabled by DFB_HCnt.
186DE	DFB_SP_ALREADY_SA MPLING	The counter is executing DFB_Sample.	Check if this counter is enabled by other DFB_Sample.
186DF	DFB_SP_PRESET_ NOT_DONE	The counter is executing DFB_PresetValue and is not done yet.	Execute this function block after the execution of DFB_PresetValue of this counter completes.
186E0	DFB_SP_INVALID_ SAMPLE_TIME	The setting value of input pin "wSampleTime" of the function block DFB_Sample exceeds the range of [10-65535].	Set the pin "wSampleTime" of the function block DFB_Sample in the range of of [10-65535].
186E1	DFB_SP_COUNTER_RE F_CHANGED_ DURING_ OPERATION	The input pin "Counter" has been changed during the execution of the function block.	Check if the variable of the pin "Counter" has been changed after the execution of the DFB_Sample.
186E7	DFB_SR_INVALID_ COUNTER_REF	The variable of the function block pin is NOT a Counter_REF type.	Make sure to select <b>Counter</b> on the IO Configuration setting page and import IEC Object to the pin "Counter" of the function block DFB_SetRing.
186E8	DFB_SR_COUNTER_H AS_NO_CHILD_ ENCODER_AXIS	No child node of the high-speed counter is connected to the encoder.	Insert EncoderAxis into the counter and set the encoder type to rotary axis and reexecute the function block.
186E9	DFB_SR_COUNTER_N OT_RING	The encoder of the high-speed counter is not a rotary axis type.	Select the encoder type to rotary axis on the Counter Configuration page.
186EA	DFB_SR_PREVIOUS_S ETRING_NOT_ DONE	The preset counting function of the counter has been enabled by other function block DMC_SetRing and is not done yet.	Execute this function block after the execution of DFB_SetRing of this counter completes.

Error Code (16#)	Item Name	Description	Solution
186EB	DFB_SR_PRESET_ NOT_DONE	The counter is executing DFB_PresetValue and is not done yet.	Execute this function block after the execution of DFB_PresetValue of this counter completes.
186EC	DFB_SR_INVALID_ RING_RANGE	When the encoder of high- speed counter is a rotary axis and the pin of "diPositionPeriod" is less than 0 and bigger than the setting value of bSetDown.	Set the pin "diPositionPeriod" of the function block bigger than 0 and less than the setting value of bSetDown.
186ED	DFB_SR_COUNTER_R EF_CHANGED_ DURING_ OPERATION	The input pin "Counter" has been changed during the execution of the function block.	Check if the variable of the pin "Counter" has been changed after the execution of the DFB_SetRing.

Note: DL\_BuiltInIO\_AX3, the library name, has changed to DL\_BuiltInIO for AX-3 Series PLC CPU with firmware version V1.0.5.0 or later.

# A.3.2 Motion Control Related Instructions

The errors occured in DL\_MotionControl or DL\_MotionControlLight are specified as warnings; however no error indicators will appear and the AX-3 Series CPU can still run. Refer to AX Series Motion Controller Manual for the troubleshooting of DL\_MotionControl.

Δ

# A.4 Troubleshooting of I/O Modules

#### • Introduction to troubleshotting modules

The following AS series modules can be installed in an AX-3 Series system. There are 2 types of error codes; error and warning. The CPU module and its modules stop operating when errors occur. The CPU modules and its modules do not stop operating when warnings are triggered.

# A.4.1 Troubleshooting of Analog Modules (AD/DA/XA) and Temperature Modules (RTD/TC)

#### A.4.1.1 ERROR ERROR LED Indicators Are ON

You can set up the option to be **True** in **Module Alarm Setting** to have the following errors appear as warnings when they occur. Otherwise, when an error occurs, only an error message appears.

Error Code (16#)	Description	Solution
16#1605	Hardware failure	If the problem persists, contact the local authorized distributors.
16#1607	The external voltage is abnormal.	Check the power supply.
16#1608	The factory calibration or the CJC is abnormal.	If the problem persists, contact the local authorized distributors.

### A.4.1.2 ERROR LED Indicators Blinking Every 0.2 Seconds

The following errors are specified as warnings to ensure that the AX-3 Series CPU can still run even when the warnings are triggered by its AIO modules. If you need the CPU STOP running immediately when the first 4 errors occur, you need to set the them as errors.

Error Code (16#)	Description	Solution
16#1801	The external voltage is abnormal.	Check the power supply.
16#1802	Hardware failure	If the problem persists, contact the local authorized distributors.
16#1804	The factory calibration is abnormal.	If the problem persists, contact the local authorized distributors.
16#1807	The CJC is abnormal.	If the problem persists, contact the local authorized distributors.
16#1808	The signal received by channel 1 exceeds the range of analog inputs (temperature).	Check the signal received by channel 1
16#1809	The signal received by channel 2 exceeds the range of analog inputs (temperature).	Check the signal received by channel 2
16#180A	The signal received by channel 3 exceeds the range of analog inputs (temperature).	Check the signal received by channel 3
16#180B	The signal received by channel 4 exceeds the range of analog inputs (temperature).	Check the signal received by channel 4

A

Error Code (16#)	Description	Solution
16#180C	The signal received by channel 5 exceeds the range of analog inputs (temperature).	Check the signal received by channel 5
16#180D	The signal received by channel 6 exceeds the range of analog inputs (temperature).	Check the signal received by channel 6
16#180E	The signal received by channel 7 exceeds the range of analog inputs (temperature).	Check the signal received by channel 7
16#180F	The signal received by channel 8 exceeds the range of analog inputs (temperature).	Check the signal received by channel 8
-	When power-on, the module is not detected by CPU module.	Check if the connection between module and CPU module is working. If not, connect again.

# A.4.2 Troubleshooting of Loadcell Modules AS02LC

#### A.4.2.1 ERROR ERROR LED Indicators Are ON

You can set up the option to be **True** in **Module Alarm Setting** to have the following errors appear as warnings when they occur. Otherwise, when an error occurs, only an error message appears.

Error Code (16#)	Description	Solution
16#1605	Hardware failure	If the problem persists, contact the local authorized distributors.
16#1607	The external voltage is abnormal.	Check the power supply.

### A.4.2.2 ERROR LED Indicators Blinking Every 0.2 Seconds

The following errors are specified as warnings to ensure that the AX-3 Series CPU can still run even when the warnings are triggered by its LC modules. If you need the CPU STOP running immediately when the first 4 errors occur, you need to set the them as errors.

Error Code (16#)	Description	Solution	
16#1801	The external voltage is abnormal.	Check the power supply.	
16#1802	Hardware failure	If the problem persists, contact the local authorized distributors.	
16#1807	The CJC is abnormal.	If the problem persists, contact the local authorized distributors.	
16#1808	The signal received by channel 1 exceeds the range of analog inputs (temperature).	Check the signal received by channel 1	
16#1809	The signal received by channel 2 exceeds the range of analog inputs (temperature).	Check the signal received by channel 2	
16#180A	The signal received by channel 3 exceeds the range of analog inputs (temperature).	Check the signal received by channel 3	
16#180B	The signal received by channel 4 exceeds the range of analog inputs (temperature).	Check the signal received by channel 4	
16#180C	The signal received by channel 5 exceeds the range of analog inputs (temperature).	Check the signal received by channel 5	
16#180D	The signal received by channel 6 exceeds the range of analog inputs (temperature).	Check the signal received by channel 6	
-	When power-on, the module is not detected by CPU module.	Check if the connection between module and CPU module is working. If not, connect again.	

# A.5 Error Codes and LED Indicators for CPU Modules

#### A. Columns

- a. Error code: If an error occurs in the system, an error code is generated.
- b. Description: The description of the error
- **c.** CPU status: If the error occurs, the CPU stops running, keeps running, or shows the status you defined for the error.
  - > Stop: The CPU stops running when the error occurs.
  - > Continue: The CPU keeps running when the error occurs.
- $\textbf{d.} \quad \text{LED indicator status: If the error occurs, the LED indicator is ON, OFF, or blinks.}$ 
  - > ERROR: System error

#### Descriptions

Module Type	LED indicator	Descriptions			
CPU	Error LED	There are five types of indicators for of the CPU module errors, including LED indicator ON, OFF, blinking fast, blinking normally, and blinking slowly. When the LED indicator is ON, blinking fast/normally, clear the problems first for the CPU module to keep on running. When the LED indicator is blinking slowly, indicating a warning type of error codes, it does not require immediate action. Clear the problems when the module is powered off. Error type: ON: A serious error occurs in the module. Blinking fast (every 0.2 seconds): unstable power supply or hardware Failure. Blinking normally (every 0.5 second): system program errors or system cannot run.			
		Warning type: Blinking slowly (every 1 second and off for 3 seconds): a warning is triggered, but the system can still run. OFF: a warning is triggered, but the system can still run. You can modify the			
		rules and use DIADesigner-AX to show the warnings, instead of using indicators to show the errors.			

## A.5.1 Error Codes and LED Indicators for CPU Modules

Refer to Section A.2 for the status descriptions of the Error LED indicators.

#### • CPU ERROR

Error		CPU status	ERROR LED indicator				
Code (16#)	Description		ON	Blinking fast	Blinking normally	Blinking slowly	OFF
7	The operation system file of the firmware is broken.	Stop				V	
8	Parts of the firmware compoents are broken.	Stop				V	
D	Checksum error occurs in the %M device.	Stop				V	
140E	Number of remote modules exceeds the limit of eight on the right side of the CPU module.	Stop			V		
1500	Connection lost in the remote modules	Continue				V	
1600	The ID of the extension module exceeds the range.	Stop			V		
1601	The ID of the extension module cannot be set.	Stop			V		
1602	The ID of the extension module is duplicated.	Stop			V		
1603	The extension module cannot be operated.	Stop			V		
1604	Extension module communication timeout	Stop			V		
2000	CPU memory access is denied.	Stop			V		
2001	CPU external memory access is denied.	Stop			V		
2002	RTC cannot keep track of the current time (the battery LED is blinking.)	Continue					V
2003	Battery low (the battery LED is ON.)	Continue					V
2004	24VDC power supply is not sufficient and then is recovered from low-voltage for less than 10 ms.	Continue		V			
2100	The number of MODBUS TCP connections exceeds the range.	Continue			V		
2200	The arrangement of the I/O modules is not consistent with the settings.	Stop			V		
2201	The number of connected communication modules exceed the maximum number 4.	Stop			V		
2202	The number of connected positioning modules exceed the maximum number 8.	Stop			V		
2203	The number of connected extension modules exceed the maximum number 32.	Stop			V		
2500	The firmware version of the PLC is not in accordance with what stated on the DDF (Device Description File).	Continue					V
2501	SSI encoder is NOT connected to PLC.	Continue					V
2502	The setting value of the single turn and multiturn SSI encoders exceed the setting limit. (up to 32 bits).	Continue					V
2503	An error occurs when the pulse outputs.	Continue					V

# • EtherCAT ERROR

Error Code (16#)	Description	CPU	ERROR LED indicator				
		status	ON	Blinking fast	Blinking normally	Blinking slowly	OFF
1	EtherCAT communication lost	Continue			V		
2	EtherCAT data mapping failed	Continue			V		
4	Incorrect EtherCAT network name	Continue			V		
5	EtherCAT Slave failed to initialize	Continue			V		
6	Vendor ID of the Slave does NOT match.	Continue			V		
7	Product ID of the Slave does NOT mathc.	Continue			V		

## A.5.2 Error Codes and LED Indicators for Analog and Temperature Module

Error Code (16#)		ERROR LED indicator			
	Description	$\begin{array}{c} A \rightarrow D / \\ D \rightarrow A / \\ A \leftrightarrow D \end{array}$	ERROR		
16#1605	Hardware failure (the diver board included)	OFF	ON		
16#1607	The external voltage is abnormal.	OFF	ON		
16#1608	The factory calibration or the CJC is abnormal.	OFF	ON		
16#1801* <sup>1</sup>	The external voltage is abnormal.	OFF	Blinking		
16#1802* <sup>1</sup>	Hardware failure	OFF	Blinking		
16#1804* <sup>1</sup>	The factory calibration is abnormal.	RUN: Blinking STOP: OFF	Blinking		
16#1807* <sup>1</sup>	The CJC is abnormal.	OFF	Blinking		
16#1808	The signal received by channel 1 exceeds the range of analog inputs (temperature).		Blinking		
16#1809	The signal received by channel 2 exceeds the range of analog inputs (temperature).				
16#180A	The signal received by channel 3 exceeds the range of analog inputs (temperature).				
16#180B	The signal received by channel 4 exceeds the range of analog inputs (temperature).	RUN: Blinking			
16#180C	The signal received by channel 5 exceeds the range of analog inputs (temperature).	STOP: OFF			
16#180D	The signal received by channel 6 exceeds the range of analog inputs (temperature).				
16#180E	The signal received by channel 7 exceeds the range of analog inputs (temperature).				
16#180F	The signal received by channel 8 exceeds the range of analog inputs (temperature).				

\*1: The errors are specified as warnings to ensure that the AX-3 Series CPU can still run even when the warnings are triggered by its AIO modules. If you need the CPU STOP running immediately when the first 4 errors occur, you need to set the them as errors.

A