

# **Industrial Automation Headquarters**

Taiwan: 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

China: 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

# Japan: 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

Korea: 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

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

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

#### Thailand: 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

Australia: Delta Electronics (Australia) Pty Ltd. Unit 20-21/45 Normanby Rd., Notting Hill Vic 3168, Australia TEL: +61-3-9543-3720

### **Americas**

USA: 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

#### Brazil: Delta Electronics Brazil

Rua Itapeva, 26 - 3°, andar Edificio Itapeva, One - Bela Vista 01332-000 - São Paulo - SP - Brazil TEL: +55-12-3932-2300 / FAX: +55-12-3932-237

#### Mexico: 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 TEL: +52-55-3603-9200

## EMEA

EMEA Headquarters: 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

**BENELUX:** 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

#### DACH: Delta Electronics (Netherlands) B.V.

Coesterweg 45, D-59494 Soest, Germany Mail: Sales.IA.DACH@deltaww.com TEL: +49(0)2921 987 0

#### France: 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

#### Iberia: 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

#### Italy: 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

#### Russia: 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

#### Turkey: 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

#### MEA: 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



# **AX-3** Series **Operation Manual**

A DELTA AX-308E



AX-3-0339420-04 2021/09/31







# **AX-3 Series Operation Manual**

# **Revision History**

Version	Revision	Date	
1 <sup>st</sup>	The first version was published.	2020/10/30	
	<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</li> </ol>		
	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.		
2 <sup>nd</sup>	3. 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.	2021/04/26	
	4. 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".		
	<ol> <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>		
3 <sup>rd</sup>	1.Chapter 2: Product name correction in section 2.2.1.	2021/05/12	
	1.Chapter 1 & 2: Added information for new products: AX-304ELA0PA1T, AX-304ELA0PA1P, AX-316EA0MA1T, AS02PU-A, AS04PU-A, AS02HC-A,		
4 <sup>TH</sup>	2.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.	2021/9/31	
	3.Updated the content of step 9 in section 8.3.4.		
	4.Added section 9.4 EtherNet/IP in chapter 9.		
	5.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.		





# **AX-3 Series Operation Manual**

# **Table of Contents**

# Chapter 1 Product Introduction

1.1	Ove	rview	1-2
1.1.	1	Related Manuals	1-2
1.1.	2	Models Descriptions	1-3
1.2	DIA	Designer-AX Software Overview	1-10
1.2.	1	Features	

# **Chapter 2 Specifications and System Configurations**

2.1	General Specifications	2-2
2.2	CPU Module Specifications	2-4
2.2	.1 Functional specifications	
2.2	.2 Electrical specifications	
2.2	.3 CPU Module Profiles	
2.2	4 CPU Module Input/Output Terminals	2-17
2.3	Power Supply Module Specifications	2-19
2.3	.1 General Specifications	
2.3	.2 Power Supply Module Profiles	
2.3	.3 Power Supply Module Terminals	
2.4	Extension Modules	2-21

# Chapter 3 Installing Hardware and Getting Started

3.1	Installing Hardware	3-2
3.1.1	I Installing and Removing a Memory Card	
3.1.2	2 Installing and Replacing a Button Cell Battery	3-3
3.1.3	Installing the AX-3 Series PLC in the Control Cabinet	3-5
3.2	Installing and Uninstalling DIADesigner-AX	3-7
3.2.1	I Installing DIADesign-AX	
3.2.2	2 Uninstalling DIADesigner-AX	



3.3	Gettir	ng Started and Setting up Communication	3-15
3.3.	1 G	etting Started	3-15
3.3.	2 S	etting up Communication	3-16

# Chapter 4 Basic Operation

4.1 Introd	luction on DIADesigner-AX	
4.1.1	Creating a New Project	
4.2 Settin	g Items on the Device Page	
4.2.1	CPU Parameter Settings	
4.2.2	Extension Module Parameter Settings	4-30
4.3 Data	Type and Variables	4-31
4.3.1	Data Type	4-31
4.3.2	Variables	
4.4 Task		4-41
4.4.1	Task Configuration	4-41
4.5 Recip	e Manager	
4.5.1	Recipe Manager	4-48
4.5.2	Recipe Definition	4-50
4.5.3	RecipeManCommand	4-52

# Chapter 5 Hardware Configuration

5.1	Env	ironment of Hardware Configuration	5-2
5.2.	Add	a Module	5-5
5.3	Ren	nove a Module	5-7
5.4	Сор	y 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	Net	work Configuration	6-2
6.1.1	1	Introduction	6-2



6.1.2	Basic Knowledge
6.1.3	Creating a Network Topology

# Chapter 7 Motion Control Basic Settings and Operation

7.1 li	ntroduction on Motion Control Instructions	5
7.1.1	Motion Control Instructions7-	5
7.1.2	Application Notes on Motion Control Instructions7-	5
7.1.3	Categories of Motion Control Instructions7-	6
7.2 C	reating Motion Control Project7-	7
7.2.1	Process Flowchart7-	7
7.2.2	Process for Creating a Project7-	8
7.3 C	ommissioning7-1	4
7.3.1	Procedure for Commissioning7-1	4
7.3.2	Example of Axis Parameter Settings7-1	4
7.3.3	Perform Axes Commissioning	6
7.4 M	lotion Control Device7-1	9
7.4.1	Overview	9
7.4.2	Introduction to Axis7-1	9
7.4.3	Procedure for Single-axis Configuration7-2	8
7.4.4	Axis Group Settings7-3	5
7.4.5	Procedure for Axis Group Configuration7-3	8
7.5 N	lotion Axis Variables7-4	3
7.5.1	Variables for Single Axis7-4	3
7.5.2	Variables for Axis Group7-4	6
7.6 N	lotion Control Programming7-4	9
7.6.1	Motion Control Program7-4	9
7.6.2	Axis State Transitions	3
7.6.3	Execution and Status Indication for Motion Control Instructions7-5	6
7.6.4	Position	6
7.6.5	CAM Tables and Framework	6
7.7 N	lotion Control Functions7-7	1
7.7.1	System Structure	1
7.7.2	Single-axis Control	1
7.7.3	Velocity Control7-8	9
7.7.4	Torque control7-9	1



7.7.5	Common Functions for Single-axis Contr	ol
7.7.6	Axis Group Control	
7.7.7	High-speed IO	
7.7.8	Other Features	
7.8 P	Programming Example	
7.8.1	Device Framework	7-136
7.8.2	Examples	

# Chapter 8 OPC UA Server

8.1	OPC UA Server	8-2
8.1	.1 Creating a Project for OPC UA Access	8-2
8.2	Setting up a Connection with the "UaExpert" Client	8-5
8.3	Setting up an Encrypted Connection	8-9
8.3	.1 Setting up User Account and Password	8-9
8.3	.2 CODESYS Security Agent	8-10
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"	8-16

# Chapter 9 Communication

9.1 Introduction to EtherCAT Communication	9-4
9.1.1 Features of EtherCAT Fieldbux	
9.1.2 Settings up EtherCAT Master	
9.1.3 Setting up the EtherCAT Slave	
9.2 Introduction to Modbus Serial Communication	9-10
9.2.1 Modbus Serial Port	9-10
9.2.2 Modbus Serial Master	9-13
9.2.3 Modbus Serial Slave	9-23
9.3 Introduction to Ethernet Communication	9-26
9.3.1 Ethernet Port	9-26
9.3.2 Modbus TCP Master (Client)	9-30
9.3.3 Modbus TCP Slave (Server)	
9.4 EtherNet/IP	9-43
9.4.1 Introduction to EtherNet/IP	9-43
9.4.2 EtherNet/IP Scanner Function	9-45
9.4.3 EtherNet/IP Adapter Function	9-67



9.4.4 CIP Object	9-75
9.4.5 Delta EIP Product List	9-84

# 9.5 Network Security......9-84

# Appendix A Troubleshooting

A.1	TroubleshottingA-2
A.1.	1 Basic Troubleshooting Steps
A.1.	2 Clear the Error States
A.1.	3 Troubleshooting SOP
A.1.	4 Viewing Log
A.2	Troubleshooting of CPU Modules
A.2.	1 ERROR LED Indicators Blinking Every 0.5 Seconds
A.2.	2 ERROR LED Indicators Blinking Rapidly Every 0.2 Seconds
A.2.	3 ERROR LED Indicators Slow Blinking Every 3 Seconds and Lighting up
	for 1 SecondA-7
A.2.	4 BAT. LOW LED Indicators Are ON
A.2.	5 BAT. LOW LED Indicators Blinking Every 0.5 Seconds
A.2.	6 OthersA-8
A.3	Troubleshooting of the Funciton Blocks
A.3.	1 DL_BuiltInIO_AX3A-9
A.3.	2 DL_MotionControl_AX3A-12
A.4	Troubleshooting of I/O Modules
A.4.	1 Troubleshooting of Analog Modules (AD/DA/XA) and Temperature Modules
	(RTD/TC)
A.4.	2 Troubleshooting of Loadcell Modules AS02LC
A.4.	3 Troubleshooting of AS02HC High Speed Counter Module
A.4.	4 Troubleshooting of AS02/04PU Positioning Module
A.5	Error Codes and LED Indicators for CPU ModulesA-18
A.5.	1 Error Codes and LED Indicators for CPU Modules
A.5.	2 Error Codes and LED Indicators for Analog and Temperature Module A-20
A.5.	3 Error Codes and LED Indicators for AS02LC Weigh Module
A.5.	4 Error Codes and LED Indicators for AS02HC High Speed Counter Module
	A-21
A.5.	5 Error Codes and LED Indicators for AS02/04PU Positioning Module A-21





# Chapter 1 Product Introduction

# Table of Contents

1.1	Ove	erview	1-2
1.1	.1	Related Manuals	1-2
1.1	.2	Models Descriptions	1-3
1.2	DIA	ADesigner-AX Software Overview	1-10
1.2	.1	Features	1-10



# 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.



#### Classification Model Name Description Input: 100-240 VAC, 50/60 Hz AS-PS02 Output: 24VDC/2A, 48W (for PLC internal use) Power Supply 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: 32 AX-3 Logic MB; Data capacity: 32 MB, removable terminal blocks Controller CPU CPU module, PNP output, built-in with 16DI (200KHz), 8 DO Module (200KHz), 2x Ethernet port switches, 1x RS-485, 1x RS-232, 1 AX-324NA0PA1P USB, Micro SD interface. Program capacity: 32 MB; Data capacity: 32 MB, removable terminal blocks 4-axis motion controller CPU module, NPN output, 16 DI (200KHz), 8 DO (200KHz NPN), 2x Ethernet port switches, 1x AX-304ELA0PA1T EtherCAT, 1x RS-485, 1x RS-232, 1 USB, Micro SD interface. Program capacity: 32 MB; Data capacity: 32 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: 32 MB; Data capacity: 32 MB, removable terminal blocks AX-3 Motion 8-axis motion controller CPU module, NPN output, 2 X built-in Controller CPU Relative Encoders, 1 X SSI, 16 DI (200KHz), 8 DO (200KHz Module AX-308EA0MA1T NPN), 2x Ethernet port switches, 1x EtherCAT, 1x RS-485, 1x RS-232, 1 USB, Micro SD interface. Program capacity: 32 MB; Data capacity: 32 MB, removable terminal blocks 8-axis motion controller CPU module, PNP output, 2x built-in Relative Encoders, 1x SSI, 16 DI (200KHz), 8 DO (200KHz), 2x AX-308EA0MA1P Ethernet port switches, 1x EtherCAT, 1x RS-485, 1x RS-232, 1 USB, Micro SD interface. Program capacity: 32 MB; Data capacity: 32 MB, removable terminal blocks 16-axis motion controller CPU module, NPN output, 2 X built-in AX-316EA0MA1T Relative Encoders, 1 X SSI, 16 DI (200KHz), 8 DO (200KHz NPN), 2x Ethernet port switches, 1x EtherCAT, 1x RS-485,

## 1.1.2 Models Descriptions



Classification	Model Name	Description
		1x RS-232, 1 USB, Micro SD interface. Program capacity: 32
		MB; Data capacity: 32 MB, removable terminal blocks
		64-axis motion controller CPU module, PNP output, 2x built-in
		Relative 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: 32
		MB; Data capacity: 32 MB, removable terminal blocks
		24VDC
		5mA
	AS08AM10N-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
	AS08AN01R-A	8 outputs
		Relay
Digital		Spring-clamp terminal block
input/output		5 - 30VDC
module	AS08AN01T-A	0.5A/output, 4A/COM
		8 outputs
		Sinking output
		Spring-clamp terminal block
		24VDC
		5mA
	AS16AM10N-A	16 inputs
		Spring-clamp terminal block
		5 - 30VDC
	AS16AN01P-A	0.5A/output, 4A/COM
		16 outputs
		Sourcing output
		Spring-clamp terminal block
	AS16AN01R-A	240VAC/24VDC



Classification	Model Name	Description
		2A/output, 8A/COM
		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
	ASTOAPTIP-A	0.5A/output, 4A/COM
		8 outputs
		Sourcing output
		Spring-clamp terminal block
		24VDC
		5mA
		8 inputs
		240VAC/24VDC
	AS16AP11K-A	2A/output, 8A/COM
		8 outputs
		Relay
		Spring-clamp terminal block
		24VDC
		5mA
		8 inputs
		5 - 30VDC
	ASTOAPTIT-A	0.5A/output, 4A/COM
		8 outputs
		Sinking output
		Spring-clamp terminal block
		24VDC
	AS32AM10N-A	3.2mA
		32 inputs



Classification	Model Name	Description
		MIL connector
		5 - 30VDC
		0.1A/output, 3.2A/COM
	AS32AN02T-A	32 outputs
		Sinking output
		MIL connector
		24VDC
		3.2mA
	AG04AMITON-A	64 inputs
		MIL connector
		5 - 30VDC
		0.1A/output, 3.2A/COM
	AS64AN02T-A	64 outputs
		Sinking output
		MIL connector
	AS04AD-A	4-channel analog input module
		Hardware resolution: 16 bits
		0–10V, 0/1–5V, -5 to +5V, -10 to +10V, 0/4–20mA, -20–+20mA
		Conversion time: 2 ms/channel
	AS08AD-B	8-channel analog input module
		Hardware resolution: 16 bits
		0 to +10V, 0/1–5V, -5V to +5V, -10V to +10V
		Conversion time: 2 ms/channel
	AS08AD-C	8-channel analog input module
Analog		Hardware resolution: 16 bits
input/output		0/4–20mA, -20mA–+20mA
module		Conversion time: 2 ms/channel
		4-channel analog output module
	AS04DA-A	Hardware resolution: 12 bits
		-10 to +10V, 0–20mA, 4–20mA
		Conversion time: 2 ms/channel
		4-channel analog input
	AS06XA-A	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
		2-channel analog output



Classification	Model Name	Description
		Hardware resolution: 12 bits
		-10 to +10V, 0–20mA, 4–20mA
		Conversion time: 2 ms/channel
		4-channe, 2-wire/3-wire RTD
		Sensor type: Pt100 / Ni100 / Pt1000 / Ni1000 / JPt100 / LG-
	AS04RTD-A	Ni1000 / Cu50 / Cu100 / 0-300 $\Omega$ / 0-3000 $\Omega$ input impedance
		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-
	AS06RTD-A	Ni1000 / Cu50 / Cu100 / 0-300 $\Omega$ / 0-3000 $\Omega$ input impedance,
Iemperature		Resolution: 0.1°C/0.1°F (16 bits)
measurement		Conversion time: 200ms/channel
module		4-channel thermocouple
		Sensor type: J, K, R, S, T, E, N, B and -100 to +100 mV
	AS041C-A	Resolution: 0.1°C/0.1°F (24 bits)
		Conversion time: 200ms/channel
	AS08TC-A	8-channel thermocouple
		Sensor type: J, K, R, S, T, E, N, B and -100 to +100 mV
		Resolution: 0.1°C/0.1°F (24 bits)
		Conversion time: 200ms/channel
		2-axis motion control
		5~24VDC, one differential input (A/B/Z phase) with a maximum
		bandwidth of 200KHz.
	A502PU-A	24VDC, 5mA, 5 inputs with a maximum bandwidth of 1KHz.
Positioning		5VDC, 2-axis (4 points) differential input with a maximum
module		bandwidth of 200KHz.
		4-axis motion control
		24VDC, 5mA, 6 inputs with a maximum bandwidth of 1KHz.
	A304P0-A	5~30VDC, 0.1A, 4-axis (8 points) NPN output with a maximum
		bandwidth of 100KHz.
		2 channels high speed counter module
Counter	AS02HC-A	Two counting methods available – pulse input (up to 200Hz) and
modulo		SSI input (up to 1.25Hz).
module		Open collector 4 - point output, 5~30VDC, 0.1A, compatible with
		high speed comparators.



Classification	Model Name	Description
		2-channel, 4-wire/6-wire load cell sensor
		Eigenvalue applicable to a load cell: 1, 2, 4, 6, 20, 40, 80 mV/V
	AS02LC-A	Highest accuracy: 0.04% of full-scale
module		ADC Resolution : 24 bits
		Conversion time: 2.5–400 ms (nine options to choose from)
	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	(3M)	USB port, use for AS Series CPU modules
cable		Use for the connection between a PLC and a PC with a RJ45
	0C-PRG030-20A	port, use for AS Series CPU modules and AS-FEN02 function
	(3101)	card
	UC-ET010-24B	
	(1M)	
	UC-ET020-24B	MIL connector, 40Pin $\leftrightarrow$ 40Pin, shielded, use for AS32AM10N-
	(2M)	A, AS32AN02T-A, AS64AM10N-A and AS64AN02T-A
	UC-ET030-24B	
I/O extension	(3M)	
cable	UC-ET010-24D	
	(1M)	Mill compositor, 40Din et 2020Din, chielded upp for AC222T A
	UC-ET020-24D	
	(2M)	ASS32F -A, AS324W1 -A, AS32AW10W-A, AS32AW021-A,
	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
		32 inputs, 40-Pin MIL connector, use for AS32AM10N-A and
Extornal	00-10-10-027	AS64AM10N-A
torminal		Terminal block (spring clamp/MIL connector), MIL connector to
module	UB-10-IO32D	40-Pin spring clamp terminal block, use for AS332T-A, AS332P-
		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

Classification	Model Name	Description
		AS32AN02T-A and AS64AN02T-A
	UC-EMC003-02A	Ethernet communication cable, 0.3M
	UC-EMC005-02A	Ethernet communication cable, 0.5M
	UC-EMC010-02A	Ethernet communication cable, 1M
	UC-EMC020-02A	Ethernet communication cable, 2M
	UC-EMC050-02A	Ethernet communication cable, 5M
	UC-EMC100-02A	Ethernet communication cable, 10M
ECAI cables	UC-EMC200-02A	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



# 1.2 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:

- HWCONFIG: for the hardware configurations and parameter managements for the system.
- NWCONFIG: for 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	General Specifications	2-2
2.2	CPU Module Specifications	2-4
2.2.	.1 Functional specifications	2-4
2.2.	.2 Electrical specifications	2-10
2.2.	.3 CPU Module Profiles	
2.2.	4 CPU Module Input/Output Terminals	2-17
2.3	Power Supply Module Specifications	2-19
2.3.	.1 General Specifications	2-19
2.3.	.2 Power Supply Module Profiles	
2.3.	.3 Power Supply Module Terminals	2-20
2.4	Extension Modules	2-21



# 2.1 General Specifications

ltem	Specifications	
Operating temperature	-20 to 55°C*1	
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 Hz $\leq$ f $\leq$ 8.4 Hz, constant amplitude 3.5 mm;	
	8.4 Hz $\leq$ f $\leq$ 150 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: 1080 ~ 795hPa (-1000 ~ 2000 m) Storage:1080 ~ 660hPa (-1000 ~ 3500 m)	

\*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	Frequency range Level (Normative)		
Enclosure port (radiated)	30-230 MHz 40 dB (µV/m) quasi-peak			
(measured at a distance of 10 meters)	230-1000 MHz	47 dB (μV/m) quasi-peak	IEC 61000-6-4	
		79 dB (μV) quasi-peak		
AC power port (conducted)	0.15-0.5 MHZ	66 dB (μV) average		
		73 dB (μV) quasi-peak	IEC 01000-0-4	
	0.5-30 MHZ	60 dB (μV) average		



#### • EMS

Environmental phenomenon	Reference standard		Test level		
Electrostatic		C	Contact		
discharge	IEC 61000-4-2	Air		± 8 kV	
Radio frequency electromagnetic field Amplitude modulated	IEC 61000-4-3	80% AM, 1 kHz sinusoidal	2.0-2.7 GHz	1 V/m	
			1.4-2.0 GHz	3 V/m	
			80-1000 MHz	10 V/m	
Power frequency	IEC 61000-4-8	60 Hz		30 A/m	
magnetic field		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	Specific interface/port	Test level	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
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> <sup>*2</sup>	
		LD instru	uction	5 nanosec	onds (ns)
Process time	Execution time	Arithmetic in (LREAL da	structions ata type)	36 nanosed	conds (ns)
	Program capacity	Сарас	city	8 N	1B
	Variable	Retaintive	Retain	768 (device memory (%	KB 6M) is counted in)
Program	memory		Persist	128	КВ
		Non-retaintive		16 1	ИВ
	Device memory (%M)	Sizo	e	512	KB
LISP port	N	umber of ports		1	
USB port		Туре		Mini I	USB
	Number of ports			1	
RS232	Baud rate			9,600, 19,200, 38,400, 57,600, 76,800, 115,200 bps	
port	Serial co	ommumication fo	ormat	Stop bit: 1, 2; Parity b Data bi	it: None, Odd, Even; it: 7, 8
	Comm	umication proto	col	Modbus ASCII/RTU	
	N	umber of ports		1	
RS485		Baud rate		9,600, 19,200, 38,400, 57,600, 76,800, 115,200 bps	
port	Serial commumication format			Stop bit: 1, 2; Parity bit: None, Odd, Even; Data bit: 7, 8	
	Comm	umication proto	col	Modbus A	SCII/RTU
	Modbus TCP	Maximum nur connec	mber of the tions	22 (Солис	(Lient)
тср	SOCKET	Maximum nur TCP conn	mber of the ections	32 (Server	+ Cherit)
TOP	Modbus TCP	Maximum data connec	a length per ction	100 words	
	SOCKET	Maximum data instruc	a length per ction	8 KB	



Туре			AX-300NA*1	<b>AX-324NA</b> <sup>*2</sup>
		Maximum number of the Scanner connections		2
		Maximum number of the Adapter connections	1	
	CIP IO Connection	Requested Packet Interval (RPI)	20~1,000 ms	s (unit: 1 ms)
		Maximum Transmission Speed	2,200	) pps
EtherNet/IP		Maximum data length per connection	Up to 510 bytes (d	lefault: 100 bytes)
	CIP Explicit	Class 3 / UCMM	Get_Attribute Get_Attribut Set_Attribute Set_Attribute	_Single (FB) es_All (FB) _Single (FB) es_All (FB)
	CIP objects supported		Identity, Message Router, Assembly, Connection, Manager, Port, TCP/IP interface, Ethernet link, Vendor specific	
	Supporte	d profiles and models	PLCopen and OPC Foundation: OPC UA Information Model for IEC 61131-3	
	Endpoints	s and connecting ports	TCP: 4840 (Rec configura	configurable via ation file)
	Maximum nu	mber of sessions (Client)	5	i
	Maximum nun	nber ofmonitored items per server	100	00
	Sampling rate	of the monitored items (ms)	100, 300, 500, 10	000, 2500, 5000
	Maximum nu	mber of subscriptions per server	100	
OPC UA server	Maximum ı ca	number of variables that n be published	10,0	000
	Maximum n that	umber of value attributes can be published	10,000	
	Maximum num that	ber of structure definitions can be published	100	
	Conditions th o	at can not be published for each network- blished variable	<ul> <li>More than three di</li> <li>Array of Array</li> <li>The OPC UA Stack to about 300 kB. This values too.</li> <li>Pointer variables, I</li> <li>Structures containii interfaces</li> </ul>	mensional arrays k will limit messages is the maximum for Interface variables ng pointers and



	Security mode and policy		None Sign - Basic256Sha256 SignAndEncrypt - Basic256Sha2566		
			Authentication	ion X.509	
Application authentication		Application uthenticationNumber of certificates that can be storedTrusted applicat Issuer certificia Rejected applicat		ications: 32 ficiates: 32 blications: 32	
	User authentication		Method of user authentication	User name / password / Anonymo	
	Number of IO en	tensio	on modules supported	32	
IO configuration		I/O ca	pacity	IN: 8,192byte OUT: 8,192byte	
	Built-in IO		High speed counter	-	6 (200KHz)
Memory card	SD card type		Micro SD (SDHC, 32GB max.)		
Real-time clock	Year, Month, Date, Hour, Minute, Second, Week		One CR1620 battery is required.		

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

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

# • Motion Controller CPU Module

	Туре			AX-304EL *1	AX-308EA* 2	AX-316EA* 3	AX-364EL *4
		LD inst	ruction		5 nanosed	conds (ns)	
Process time	Execution time	Arithmetic instructions (LREAL data type)			36 nanose	conds (ns)	
	Program capacity	Capacity		8 MB			
Varial	Variable	Retaintive	Retain	768 KB (device memory (%M) is counted in)			d in)
Program	memory	nory	Persist	128 KB			
		Non-retaintive		16 MB			
Dev men (%	Device memory (%M)	Size			512	КВ	
Numb	Number of	Number of controll		4 axes	16 axes	32 axes	64 axes
control	controlled axes	EtherC	AT axes	4 axes	8 axes	16 axes	4 axes
	unco	Pulse Out axes		-	4 axes		

-					-
		Maximum number of axes for linear interpolation axis control		-	6 axes
		Maximum number of axes for circular interpolation axis control		-	2 axes
	Maximum nu	umber of axe	es groups	-	8 groups
	Motior	Notion control period		The same process dat	e control period as that is used for the ta communications cycle for EtherCAT.
		Number of CAM	Max. points per CAM table	-	256 points
	САМ	data points	Max. points for all CAM tables	-	20,480 points
		Maximum number of CAM tables		-	80
	Number of ports			2	
	Physical media types		10BASE-	T/100BASE-TX/1000BASE-T Switch	
Ethernet		Topology			Star, linear
port	Trans	mission spe	ed		10/100/1000 Mbps
		Cable		Category 5e or later, 100 meters (Max.)	
		Protocols		ARP, IP, TCP, UDP, Modbus TCP, EtherNet/IP	
USB port	Nur	nber of port	S	1	
		Туре		Mini USB	
	Nur	nber of port	S	1	
RS232	I	Baud rate		9,600, 19,20	00, 38,400, 57,600, 76,800, 115,200 bps
port	Serial com	mumication	format	Stop bit	t: 1, 2; Parity bit: None, Odd, Even; Data bit: 7, 8
	Commu	mication pro	otocol		Modbus ASCII/RTU
	Nur	nber of port	S		1
R\$485	I	Baud rate		9,600, 19,20	00, 38,400, 57,600, 76,800, 115,200 bps
port	Serial com	mumication	format	Stop bit	t: 1, 2; Parity bit: None, Odd, Even; Data bit: 7, 8
	Commu	mication pro	otocol		Modbus ASCII/RTU
EtherCAT	Ethe	erCAT Maste	er	Class B	



port	Physical media types		100BASE-TX				
	Trans	mission speed	100 Mbps				
	-	Тороlоду	Line, daisy chain, and branching				
		Cable	Categ	ory 5e or late	r, 100 meters (I	Max.)	
	Maximum number of Slaves		16	64	64	96	
	Transmission cycle			2,000µs∼ (unit can be	-32,000µs set to 250µs)		
	Modbus TCP Maximum number of the connections			32 (Sonya	r + Client)		
тср	SOCKET	Maximum number of the TCP connections	32 (Server + Client)				
TOP	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 Connection	Maximum number of the CIP connections (Scanner)	12				
		CIP IO Connection	Maximum number of the CIP connections (Adapter)			1	
		Requested Packet Interval (RPI)		20~1,000ms (unit: 1 ms)			
EtherNet/IP		Maximum Transmission Speed		2,200 pps			
		Maximum data length per connection	Up	Up to 510 bytes (default: 100 bytes)		es)	
	CIP Explicit Message	Class 3 / UCMM	Get_Attribute_Single ( Get_Attributes_All (F Set_Attribute_Single ( Set_Attributes_All (F		e_Single (FB) tes_All (FB) e_Single (FB) tes_All (FB)		
	5	CIP objects supported	Identity, Message Router, Assembly, Connec Manager, Port, TCP/IP interface, Ethernet li Vendor specific		onnection, rnet link,		
	Supported	profiles and models	PLCopen and OPC Foundation: OPC UA Information Model for IEC 61131-3			PC UA I-3	
OPC UA server	Endpoints a	nd connecting ports	TCP: 4840 (Reconfigurable via configuration file)			ration file)	
	Maximum number of sessions (Client)		5				



	Maximum n item	number ofmonitored as per server	1000		
	Sampling ra	ate of the monitored tems (ms)	100, 300, 500, 1000, 2500, 5000		
	Maximum number of subscriptions per server			100	
	Maximum nu can	mber of variables that be published		10,000	
	Maximun attributes th	n number of value hat can be published		10,000	
	Maximum number of structure definitions that can be published Conditions that can not be published for each network- published variable Security mode and policy			100	
			<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>		
			None Sign - Basic256Sha256 SignAndEncrypt - Basic256Sha2566		
	•	Authentication	X.509		
	authenticati on	Number of certificates that can be stored	Trusted applications: 32 Issuer certificiates: 32 Rejected applications: 32		
	User authenticati on	Method of user authentication	User	name / password / Anonymous	
	Number of IC	D entension modules supported	32		
10	I/O capacity		IN: 8,192byte OUT: 8,192byte		
IO configuration		Encoder	-	2	
	Puilt in IO	SSI	-	1	
		High speed counter		6 (200KHz)	
		Pulse out	-	4 (200KHz)	
Memory card	SE	) card type	М	icro SD (SDHC, 32GB max.)	
Real-time clock	Year, Month See	, Date, Hour, Minute, cond, 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.

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

# 2.2.2 Electrical specifications

Model	AX-300NA0PA1	AX-304ELA0PA1T/P AX-324NA0PA1P	AX-308EA0MA1T/P AX-316EA0MA1T AX-364ELA0MA1T		
Supply voltage	24 VDC(20.4 VDC~28.8 VDC)(-15%~+20%)				
Power consumption (W)	4	5	11		
Weight (g)	240	300	380		

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

Model		AX-304ELA0PA1T/P, AX-308EA0MA1T/P, AX-316EA0MA1T, AX-324NA0PA1P, AX-364ELA0MA1T			
Number of inputs		16			
Connector type		Removable terminal blocks			
Input type		Digital input			
Input form		Direct current (sinking or sourcing)			
Input voltage/ current		24 VDC, 5 mA			
Action level	OFF→ON	>15 VDC			
	ON→OFF	<5 VDC			
Response time	OFF→ON	2.5 µs			
	ON→OFF	5 µs			
Maximum input frequency		200KHz			
Input impedance		5.6 kΩ			
Input signal		Voltage input Sinking: The inputs are NPN transistors whose collectors are open collectors. Sourcing: The inputs are PNP transistors whose collectors are open collectors.			
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			
Number of outputs		8				
Connector type		Removable terminal blocks				
Output form		NPN (Sinking)	PNP (Sourcing)			
Voltage		5~30VDC				
Maximum load	Resistance	0.1A/output				
	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







2

Unit: mm





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

Unit: mm



• AX-324NA0PA1P

65

Π

æ





2

5

Ц

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				
		Operating status of the CPU module				
	Run LED indicator	ON: the module is running.				
		OFF: the module is stopped.				
		Blinking: the module is detecting an error.				
		Error status of the module				
6	Error LED indicator	ON: a serious error occurs in the module.				
		Blinking: a minor error occurs in the module				
	BAT.LOW LED					
	indicator	Indicates the battery status of the CPU module.				
		Indicates the communication status of the COM port.				
	COM2 LED	OFF: no communication over the COM port				
		Blinking: communication over the COM port				
7	Run/Stop	RUN: execute the programs				
8	COM Port	Provides an interface for RS-485 and RS-232 communication				
	Input/Output LED	If there is an input signal, the input LED indicator is ON.				
9	indicator	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	Mini USB communication port				
12	SSI Port	SSI Encoder communication port				
13	Input Terminals	For input wiring				
		Ethernet Switch communication port				
		LINK indicator (Green):				
		<ul> <li>LED ON: The network connection is established.</li> <li>LED OEE: The network connection is NOT established.</li> </ul>				
14	Ethernet Port	LED OFF. The network connection is NOT established.				
		ACT indicator (Orange):				
		LED blinking: Data transmission (sending/receiving)				
		LED OFF: No data transmission				
		EtherCAT communication port				
15		LINK indicator (Green):				
		<ul> <li>LED ON: The network connection is established.</li> <li>LED OEE: The network connection is NOT established.</li> </ul>				
	EtherCAT Port	LED OFF. The network connection is NOT established.				
		ACT indicator (Orange):				
		LED blinking: Data transmission (sending/receiving)				
		LED OFF: No data transmission				
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				
	IN			
	0	8		
	1	9		
	2	10		
	3	11		
	4	12		
	5	13		
	6	14		
	7	15		
	S/S0	S/S1		
	OUT			
	0	4		
	1	5		
	2	6		
	3	7		
	CO	CO		

# 2.2.4 CPU Module Input/Output Terminals

AX-308EA0MA1T/AX-308EA0MA1P/AX-316EA0MA1T/AX-364ELA0MA1T							
		SSI		ENCNDOR		IN	
		1	DATA+	1	A1+	X0.0	X0.8
		2	DATA-	2	A1-	X0.1	X0.9
		6	CLK+	10	B1+	X0.2	X0.10
RS-485		14	CLK-	11	B1-	X0.3	X0.11
Micro SD Nicro SD	3 <b>8 9</b> 11 4 <b>9 0</b> 12	8	GND	4	Z1+	X0.4	X0.12
	5 <b>8 1</b> 3 6 <b>8 1</b> 4	15	5V	5	Z1-	X0.5	X0.13
	7 8 8 15 S/S0 8 8 S/S1			15	+5V1	X0.6	X0.14
				3	A2+	X0.7	X0.15
				9	A2-	S/S0	S/S1
				6	B2+	0	ÚT
	3 8 9 7 0 8 0 0			12	B2-	Y0.0	Y0.4
				13	Z2+	Y0.1	Y0.5
O7 O15 O7 Ethernet Encoder	r			14	Z2-	Y0.2	Y0.6
				7	+5V2	Y0.3	Y0.7
				8	0V	C0	C0


AX-324NA0	PA1P	
	IN	I
	0	8
	1	9
	2	10
	3	11
	4	12
	5	13
	6	14
	7	15
	S/S0	S/S1
	OL	Т
	0	4
01 01201 01 01105	1	5
	2	6
	3	7
	CO	C0



# 2.3 Power Supply Module Specifications

# 2.3.1 General Specifications

#### AS-PS02/AS-PS02A

I	tem	Specifications
Supply	voltage	100–240 VAC (-15% to +10%) 50/60 Hz±5%
Action specific	ations	If the input power supply is larger than 85 VAC, the power supply module can function normally.
Allowab instanta power fa	ole ineous ailure time	If the instantaneous power failure time is less than ten milliseconds, the power supply module keeps running.
Fuse		2.5A/250 VAC
Inrush c	current	< 70A@115 VAC
24 VDC	output	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 p	protection	The 24 VDC output is equipped with the short circuit protection and the overcurrent protection.
Electric	al isolaiton	1,500 VAC (Primary-secondary), 1,500 VAC (Primary-PE), 500 VAC (Secondary-PE)
Insulatio	on 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.
Woight	AS-PS02	270 g
weight	AS-PS02A	310 g

## 2.3.2 Power Supply Module Profiles

• AS-PS02



Unit: mm



• 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



2-20

#### 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.



MEMO





# Chapter 3 Installing Hardware and Getting Started

# **Table of Contents**

3.1	Installing Hardware	3-2
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	3-5
3.2	Installing and Uninstalling DIADesigner-AX	
3.2.	1 Installing DIADesign-AX	3-8
3.2.	2 Uninstalling DIADesigner-AX	3-14
3.3	Getting 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

<u>∧</u> 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 real-time 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\_

#### 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.

DELTA
your existing account
Forgot your password?
Contract of the second

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**.

S DIAInstalle	er					- 🗆 🗙
						English Sign In
Software List	DIA	Studio				
23		Product Name	Version	Size	Download/Update Installation Progres	s Install/Uninstall
Option	i	DIADesigner	0.4	1.0 GB	↓ Download	💐 İnstall
	i	DIASelector	0.4	767.4 MB	🚽 Download	💆 Install
	i	DIAScreen	0.4	1.6 GB	↓ Download	Partail
	i	COMMGR	1.3	224.0 MB	🚽 Download	🛃 Install
	i	DIADesigner-AX	0.5.0	1.3 GB		P. Install
					U	
า						Check for Download Updates All
About						

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

						English 🚯 Ray
DIA	Studio					
	Product Name	Version	Size	Download/Update Installation	Progress	Install/Uninstall
i	DIADesigner	0.4	1.0 GB	↓ Download		🛃 İnstall
i	DIASelector	0.4	767.4 MB	↓ Download		S Install
i	DIAScreen	0.4	1.6 GB	↓ Download		🛃 Install
i	COMMGR	1.3	224.0 MB	↓ Download		💐 İnstall
i	DIADesigner-AX	0.5.0	1.3 GB	Downloaded		🛃 Install
						G ₩



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



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





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

		Silles Silesia		
estinatio	on Folder at to install to this folder, or d	lick Change to install to	a different folder.	Ċ
D	Install DIADesigner-AX 64 C:\Program Files\Delta Inde V0.5.1\	Change		
illShield -				
		< Back	Next >	Cancel
DIADesig	gner-AX 64 0.5.1 - Installs	Shield Wizard		
DIADesig hange C Browse t	gner-AX 64 0.5.1 - Installs urrent Destination Folder o the destination folder.	Shield Wizard		3
DIADesig hange C Browse t Look in:	gner-AX 64 0.5.1 - Install urrent Destination Folder o the destination folder.	Shield Wizard		3
DIADesig hange C Browse t Look in:	gner-AX 64 0.5.1 - Installs urrent Destination Folder o the destination folder. Designer-AX V0.5.1	Shield Wizard	~	
DIADesig hange C Browse t Look in:	gner-AX 64 0.5.1 - Install urrent Destination Folder o the destination folder. Designer-AX V0.5.1	Shield Wizard	~	
DIADesig hange C Browse t Look in: er DIAL	gner-AX 64 0.5.1 - InstallS urrent Destination Folder o the destination folder. Designer-AX V0.5.1	Shield Wizard	~	
DIADesig hange C Browse t Look in:	gner-AX 64 0.5.1 - InstallS urrent Destination Folder o the destination folder. Designer-AX V0.5.1 ame: ram Files\Delta Industrial Aut	Shield Wizard	×	
DIADesig hange C Browse t Look in: C* DIAL Eolder na D:\Prog	gner-AX 64 0.5.1 - InstallS urrent Destination Folder o the destination folder. Designer-AX V0.5.1 ame: ram Files\Delta Industrial Aut	Shield Wizard	×	



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 - InstallSh	ield 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 the wizard.	your installation settin	gs, click Back. Click (	Cancel to exit
InstallShield			
	< Back	Install	Cancel





It may take some time to install.

	iay take several i	ninutes.	JIADesignet AA 0	+ 0.3.1. 1115	
S	tatus:				
V	alidating 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.

DIAInstall	er						- 🗆 🗙
1							English 🔹 🚺 Ray wu
Software List	DIA	Studio					
S		Product Name	Version	Size	Download/Update Installation	Progress	Install/Uninstall
C/Q) Option	i	DIADesigner	0.4	1.0 GB	↓ Download		💐 Install
	i	DIASelector	0.4	767.4 MB	↓ Download		🛃 Install
	i	DIAScreen	0.4	1.6 GB	↓ Download		sinstall
	i	COMMGR	1.3	224.0 MB	↓ Download		Install
	i	DIADesigner-AX	0.5.0	1.3 GB	Installed		🕰 Uninstall
L.							Check for Updates Download All
About							

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.



PLC1

#### 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.



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

•	
	About
	Exit Gateway Control
	Stop Gateway
	Start Gateway

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 • 4 ×	x 3 Device x						
Outilied1      Device (AX-308EA0MA1T)	Communication Settings	Scan Network Gateway • De	vice *				
Withfed1     Wetwork Configuration     A Hardware Configuration     A Network Configuration     A EtherCAT Filter     Proceedings of the state	Communication Settings Applications Backup and Restore Files Log PLC Settings PLC Shell Users and Groups Access Rights Symbol Rights System Parameters Task Deployment	Scan Network Gateway - De	Gateway Gateway P-Address: ocalhost 217		INTER to set active path		
	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 = UDP interface Name = Shared Memory = TCP interface Port COM Port COM Port UDP interface UBP Port CAN Client	Setting Default UDPinterface	
To display additional informa keys. Add top level interfac Add sub level interfar Add configuration se	ation about any item listed above, select it with your ce tting	mouse or up and down	Adi 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.

Interface	Setting	
IDP interface	setting	
Name	Default UDP interface	
Shared Memory	Dender Con Michael	
TCP interface		
Port	11743	
COM Port		
Name	Com<1>	
Port	1	
Baudrate	57600	
his setting defines the phys	ical serial port used for this interface (e.g. COM 5 on a Windows 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 Baudrate	Com<1> 1 57600
		Enable auto addressing ~	
<ul> <li>COM Port</li> <li>Name</li> <li>Dort</li> </ul>	Add top level interface Add sub level interface	Enable auto addressing Local address Parity Stealers	
Baudrate	Add configuration setting	Enable half-duplex auto negotiate Enable RTS toggle handshaking Timeout	

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**.

can Network Gateway * Device *	
	1
	•
Gateway	
Select Device	
Select the network path to the controller:	Device Name:  Scan Network
3 AX-308EA0MA1T [0005]	AX-308EA0MA1T Wink
	Device Address: 0005
	Block driver
	UDP
	Number of
	channels: 4
	Serial number:
	RTS-
	823780389108384
	Target ID: 16F7 0313 *
	OK Cancel
	Can Network Gateway - Device - Gateway Gateway Select Device Select the network path to the controller:



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 N	Network Gateway • Device •	
Applications		1000 million
Backup and Restore	2000	1
Files		
Log	Gateway	
PLC Settings	Gateway-1	<ul> <li>[0005] (active)</li> </ul>
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





# Chapter 4 Basic Operation

# Table of Contents

4.1 Intro	oduction on DIADesigner-AX	4-2
4.1.1	Creating a New Project	
4.2 Setti	ng Items on the Device Page	4-4
4.2.1	CPU Parameter Settings	
4.2.2	Extension Module Parameter Settings	
4.3 Data	Type and Variables	4-30
4.3.1	Data Type	
4.3.2	Variables	
4.4 Task		4-40
4.4.1	Task Configuration	
4.5 Reci	pe Manager	4-45
4.5.1	Recipe Manager	
4.5.2	Recipe Definition	
4.5.3	RecipeManCommand	



# 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**.

ategories		Templates
Librat Prote	ies cts	Project Project AX-308E AX-8xxE
project c lame	Untitled1	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.

	D	IADesigner-AX Version	V1.0.0	DIA	Designer-AX Version V1.1.0 or	later
Standard	d Project		×	Standard Project		>
57	You are abo objects with - One program - A cyclic tar - A cyclic tar - A reference Device PLC_PRG in	ut to create a new standard project. This w in this project: ammable device as specified below PIC_PRG in the language specified below is which calls PLC_PRG e to the newest version of the Standard libr AX-308EA0MA1T (Delta Electronics, Inc.) Ladder Logic Diagram (LD)	nary currently installed.	Information Name Vendor Description	You are about to create a new standard project. This wizard following objects within this project. - One programmable device as specified below - Two programs PLC_PRG and Motion_PRG in the language - One cyclic task which calls PLC_PRG and one cyclic task Motion_PRG - A reference to the newest version of the Standard library cu AX-308EA0MA1T Delta Electronics. Inc. AX-308EA0MA1T motion controller with Be opist Privile ID (dring la curst two:	will create the especified below which calls urrently installed.
Ladde Conti	er Logic Diag nuous Funct	gram (LD) ion Chart (CFC)	$\vee$		NPN). It can supports up to 8 EtherCAT axes and 4 pulse out axes.	
Conti	nuous Funct	ion Chart (CFC) - page-oriented		Device	AX-308EA0MA11 (Delta Electronics, Inc.)	~
Funct	tion Block Di	agram (FBD)		Version	1.0.1.0	Ŷ
Instru	uction List (I	L) rram (LD)		PLC_PRG in	Structured Text (ST)	~
Seque	ential Functi tured Text (	on Chart (SFC) ST)			Continuous Function Chart (CFC) Continuous Function Chart (CFC) - page-oriented Function Block Diagram (FBD) Ladder Logic Diagram (LD)	

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 tool bar, if nothing appears in the project management area.

Untitled1.project - DIADesigner-AX				– 🗆 X
File Edit View Project Build Online Debug Tools	Window Help			
○○○○○○○○○○○○○○○○○○○○○○○○○○○○○○○○○○○○	🦻 🎘 📑 🛅 👘 Application [Device: PLC Logic]	- <b>05</b> 00 1 = 41 (2) F2 F2 F2 F4 (3)		
Devices	<b>ч х</b>		ToolBox	- • ×
<ul> <li>Chatter ( Ar-308EA0MA1T)</li> <li>Fardware Configuration</li> <li>Andrware Configuration</li> <li>A tetrack T Fiter</li> <li>Clogic</li> <li>Application</li> <li>Motion, PRG (PRG)</li> <li>Task Configuration</li> <li>Starts Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>Brack Configuration</li> <li>B</li></ul>	tivoton)			
messages - rocal v error(s), u waming(s), 2 message(s)				
		Last build: 😳 0 🕐 0 Precomple 🖌 🖓	Project user: (n	obody) 🔮



# 4.2 Setting Items 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 G	ateway - Device -				
Applications		_	_			
Backup and Restore						
Synchronized Files			Inconcentry (			
Files		_	Gateway			 
100		Gateway-1		Y	[0005]	~
		IP-Address: localhost				
PLC Settings		Port: 1217				
PLC Shell						
Users and Groups						
Access Rights						
Symbol Pichts						

Status of the Connection



4-4

Communication Settings	Scan Network Gatev	vay - Device -			
Applications		1		1000	100
Backup and Restore		i			
Synchronized Files				•	
Files		Gateway-1	~	[0005]	<b></b>
og		IP-Address:			
PLC Settings		Port			
		1217			

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					
	Click Scan Network to open the Select Device page. This page lists all configured gateways with					
Scan Network	the associated devices. You can select one target device from this list.					
	This menu includes the following setting items:					
	• Add New Gateway: You can add and define a new gateway channel here.					
Cotoway	• Manage Gateways: This page is with an overview of all gateways. You can add or					
Gateway	delete entries here or change their order.					
	• Configure the Local Gateway: Select this setting item to open the Gateway					
	Configuration page. You can configure the block drivers for the local gateway.					
	This menu includes the following setting items:					
	Options:					
	Add Current Device to Favorites: Adds the currently set device to the list of favorite					
	devices.					
	• 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.					
	• 🗹 : 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.					
	• 🗹 : Confirm Online Mode:					
	DIADesigner-AX requires you to confirm the followings when calling the following online					
Device	commands (for safety purposes): Force values, Write values, Multiple loading, Remove					
	force list, Single cycle, Start, and Stop.					
	Store Communication Settings in Project:					
	IDADesigner-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.					
	DIADesigner-AX saves the communication settings in the options of					
	the local installation for reuse on the same computer.					
	Note: When using DIADesigner-AX SVN, the option should be cleared					
	in order to prevent blocking the device object.					
	Rename Active Device: Click this setting item to open the Change Device Name page.					
	Wink Current Device: Devices that support this function illuminate a flashing signal.					



Tab		Description		
	Send Echo Service: DIADest test the network connection, packets and then with data p communication buffer of the service delay and the scope	and Echo Service: DIADesigner-AX sends five echo services to the PLC. These are used to est the network connection, similar to the ping function. The services are sent first without data ackets and then with data packets. The scope of the data packets depends on the communication buffer of the PLC. A message box opens with information about the average echo ervice delay and the scope of the sent data packets.		
	Encrypted Communication:			
	✓: The communication to this controller is encrypted. A certificate of the controller is required in order to log in to the controller. If the certificate is not available, then an error message shows up prompting whether or not the certificate should be displayed and installed.			
	If the <b>Enforce Enc</b> Security Screen vie	<b>rypted Communication</b> option is selected as <b>Security level</b> in the ew, then the <b>Encrypted Communication</b> is disabled here.		
	<b>Change Communication Policy:</b> Click this setting item to open the Change Communication 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 controller is 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		
	New policy	<ul> <li>Drop-down list for the new policy for user management</li> <li>Optional user management: It is the responsibility of the user to enable user management on the device or leave the device unprotected.</li> <li>Enforced user management. The user management on the device is enabled and cannot be disabled by the user.</li> </ul>		

4.

## 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
Backup and Restore	(history)	Remove All
Suppressived Files		Details
synchronized rifes		Content
Files		
Log		
PLC Settings		
PLC Shell		
Users and Groups		
Access Rights		
Symbol Rights		
System Settings		
System Parameters		
Task Deployment		
Status		
Information		
		Refresh List

Button	Description
	Remove: Deletes the application selected in the list.
Remove / Remove All	Remove All: Deletes all listed applications on the PLC.
Dotaila	Click <b>Details</b> button to see information defined for the application on the Information tab
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.
Pofroch List	Click <b>Refresh List</b> button to have the controller scanned for applications and the list is
Reliesh 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	-		
Files	Backup Information			
Log	File name			Ê
PLC Settings	Size of active files Mode	0 bytes No information	~	
PLC Shell	Comment			~
Jsers and Groups				
Access Rights				~
Symbol Dights	Active Component Fi	le Size Requires STOP		

Tab	Description						
	Click Backup tab to see the followings						
	• Read Backup Information from Device: Use this function to search for application-						
	specific files from the <b>\$PIcLogic\$</b> directory of the PLC and lists them on the Backup						
Backup	tab page.						
Баскир	• 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.						
	• <b>Restore on Device:</b> 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	e 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.					



#### 4-8



#### 4.2.1.4 Files

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

#### Device ×

Communication Settings	Host Location	n	• 🗎 🗙 🕹	Rur	ntime   Locatio	on	-   🖿 🗙 4
Applications	Name	Size	Modified		Name	Size	Modified
Backup and Restore	□ D:\						
Files							
Log							
PLC Settings							
PLC Shell							
Users and Groups							
Access Rights							
Symbol Rights				>>			

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
<i></i>	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


AX-3	Series	Operation	Manual
------	--------	-----------	--------

Offline log	ging 🔲 UTC time		
verity	Time Stamp	Description	Component
0	01.01.1970 08:07:17	Channel 58628 connected	CmpChannelServer
0	01.01.1970 08:05:42	Channel 41740 dosed by request, 0	CmpChannelServer
0	01.01.1970 08:05:16	Channel 41740 connected	CmpChannelServer
0	01.01.1970 08:05:13	Channel 144 dosed by request, 0	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!	IoDrvEtherCAT
0	01.01.1970 08:00:15	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	Set operational mode	IoDrvEtherCAT
0	01.01.1970 08:00:15	All slaves safe-operational	IoDrvEtherCAT
0	01.01.1970 08:00:15	Set safe operational	IoDrvEtherCAT
0	01.01.1970 08:00:15	Synchronize Slaves	IoDrvEtherCAT
0	01.01.1970 08:00:15	Configure distributed clock settings	IoDrvEtherCAT
0	01.01.1970 08:00:15	All slaves pre-operational	IoDrvEtherCAT
0	01.01.1970 08:00:15	prepare slaves	IoDrvEtherCAT
0	01.01.1970 08:00:15	All slaves init mode	IoDrvEtherCAT
0	01.01.1970 08:00:15	Set physical addresses	IoDrvEtherCAT
0	01.01.1970 08:00:15	[CAN]IoDrvGetModuleDiagnosis set bIOErrSet[3]	IoDrvDelta
0	01.01.1970 08:00:15	[CAN]IoDrvGetModuleDiagnosis set bIOErrSet[1]	IoDrvDelta
0	01.01.1970 08:00:15	[CAN]EVT_StartDone!!	IoDrvDelta
0	01.01.1970 08:00:15	[MTCPSlave]EVT_StartDone!!	IODrvDeltaModbusTCPS
0	01.01.1970 08:00:15	[CAN]IoDrvGetModuleDiagnosis clear bIOErrSet[3]	IoDrvDelta
0	01.01.1970 08:00:15	[CAN]IoDrvGetModuleDiagnosis dear bIOErrSet[1]	IoDrvDelta
0	01.01.1970 08:00:15	[CAN]EVT_PrepareStart!!	IoDrvDelta
0	01.01.1970 08:00:15	[MTCPSlave]EVT_PrepareStart!!	IODrvDeltaModbusTCPS
0	01.01.1970 08:00:15	Read slave informations	IoDrvEtherCAT
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

ltem	Description		
	Default settings		
Offline logging	☑: 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.		
	It ime stamp of the runtime system is displayed.		
	Four categories for the severity of the event:		
	• <sup>1</sup> : Message		
	• 🕚 : Warning		
Severity	• <sup>O</sup> : 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 leg list displays only events that concern the colocted component		
component names			
	Drop-down list with all available logs. The standard setting is the <default logger=""> specified</default>		
	by the target system; now it is identical to 'StdLogger for DIADesigner-AX runtime system.		
	C Refreshes the log list		
Logger	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

## 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.

Application for I/O handling	Application	*	
PLC Settings			
Update IO while in stop			
Behaviour for outputs in stop	Keep current values V		
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	r IO mapping 🛛 EnableDiagnosis fordevice	es	
Show I/O warnings as errors	5		

#### 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 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.

Communication Settings	
Applications	
Backup and Restore	
Files	
.og	
PLC Settings	
PLC Shell	
Users and Groups	
Access Rights	
Symbol Rights	
Runtime Clock Configuration	
System Parameters	
Task Deployment	
Status	
Information	



4-12

## 4.2.1.8 Users and Groups

You can edit the device user management of the controller. You can define user accounts and user groups. In combination with the configuration on the Access Rights tab, you thus 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.

Device User Logon		×
You are currently and password o	not authorized to perform this operation on the device. Please enter the name f an user account which has got the sufficient rights.	
Device Name	Device (AX-308EA0MA1T)	1
DeviceAddress		1
User Name	Administrator	
Password	······	i l
Operation: Object:	View "Device"	
🗘 🖙 🔡 Device user: .	Administrator	
Synchronized mode: All chan -Users	ges are immediately downloaded to the device.	
Administrator     Same and a second sec	oup 'Administrator' oup 'Everyone' oup 'Administrator'	<ul> <li>Add</li> <li>Import</li> <li>Edit</li> <li>Delete</li> </ul>
Groups		
Service     S		<ul> <li>Add</li> <li>Import</li> <li>☑ Edit,</li> <li>☑ Delete</li> </ul>

4

## • Toolbar of the tab

ltem	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

4

ltem	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. <sup>2</sup>
🗹 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

Item	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
🗹 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	
3	8 Password must be changed at first login	

	Item	Description
1	Name	User name
0	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	Similar 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  $\ensuremath{\text{OK}}$  to import.

Import Users		×
Project Users		
Below you wi defined in the those users v user manage	Il find a list of all users currently project user management. Selec which you want to import into the ment.	t device
Please note ti enter the pas This passwor device user a	hat for security reasons you will f sword for each selected user acc d will be used for the correspond ccount.	ount. ing
S Owner		
	ОК С	ancel



4

### 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  $\ensuremath{\text{OK}}$  to import.

nport Groups	
Project Groups	
Below you will find a list of all grou defined in the project user manag those groups which you want to in device user management.	ups currently ement. Select aport into the
Se Everyone	
😫 Owner	
	Cancel
UN UN	Cancer



4



## 4.2.1.9 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

ltem	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			

#### 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.



4-18

## 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.

Administrator	Add/Remove	Modify	View 🕂	Execute
Developer	+	-	+	-
Everyone	-	-	+	-
Service	+		+	
test_group	24	24	26	X
Watch	-	-	+	-
	Administrator Developer Everyone Service test_group Watch	Add/Remove Administrator + Developer + Everyone - Service + test_group # Watch -	Add/Remove Modify Administrator + + Developer + - Everyone Service + - test_group # #	Add/Remove Modify View Administrator Developer Everyone Service Etst_group X X

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

Ru Ru	ntime objects	1
<u>⊜</u> . ⇒	Device	
-	🔿 Logger	
	PlcLogic	
	😑 🔿 Application	
		gration
	Backup&Restore	

#### 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.

Runtime obje	cts		
Device			
- + Logo	er		
😑 🄿 Picto	gic		
	Application		
	C-ModuleIntegrat	tion	
	Backup&Restore		

## Device > PlcLogic

Objects				
😑 🧰 R	untime objects			
	Device			
	- Logger	3		
G	PlcLogic			
	🖃 🔿 App	lication		
		C-ModuleIntegra	ation	
	⇒B	ackup&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

Run	time objects	
	Device	
	🔿 Logger	
	PlcLogic	
	🖃 🔿 Application	
	C-ModuleIntegration	



4-20

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.

Α

		Access rights				
	Operation	Add/Remove	Execute	Modify	View	
	Login	•	•	•	x	
	Create	x	•	•	•	
	Create child object	x	•	•	•	
	Delete	x	•	•	•	
	Download / online change	x	•	•	•	
	Create boot application	x	•	•	•	
	Read variable	•	•	•	x	
	Write variable	•	•	х	x	
pplication	Force variable	•	•	х	x	
	Set and delete breakpoint	•	x	х	•	
	Set next statement	•	х	х	•	
	Read call stack	•	•	•	x	
	Single cycle	•	х	•	•	
	Switch on flow control	•	x	x	•	
	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.

- Tscar	func objects
20 - y	Device
·····	🔿 Logger
	I PlcLogic
	🖃 🕂 Application
	C-ModuleIntegration
	Backun&Restore

#### 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.

0-4-	RemoteConnections
-	OPCUAServer
	Settings
	UserManagement
9 - 4	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	
10	OPCUAServer	
- =>	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.

3 =\$P	RemoteConnections	
	OPCUAServer	
	Settings	
-	UserManagement	
	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.

- 📄 Fi	le system objects
6	1
	🖦 🖶 Boot
-	⇒ cert
	- 🔿 export
	🚽 import
G	Prj Prj
	😑 🔿 PlcLogic
	- 🔿 ac_persistence
	🚽 🔿 alarms
	- Application
	⇒ trend
	···· => visu
	🗏 🕂 _cnc
	System Volume Informati

## 4.2.1.10 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.

Requirement: User management must be set up on the AX-3 Series PLC. An application was downloaded to AX-3 Series PLC for which symbol sets were defined in DIADesigner-AX project. They have access data for logging in to the AX-3 Series PLC.

Symbol Configuration 🗙						
🕅 View 👻 🛗 Build 🛛 🛱 Settings 🔻 Tools 👻						
!There are 6 configured variables which are not r	eferenced by the If	EC code. Read	ling and writir	ng to them may not have the desired effect(s).	Remove	
default	~	+ 0		Configure Symbol Rights		
Changed symbol configuration will be transferred w	vith the next downlo	oad or online	change			
Symbols	Access Rights	Maximal	Attribute	Туре	Members	Commen
E Constants						
🔲 < CompilerVersion		<b>*</b>		VERSION		the compile
🔲 🖗 RuntimeVersion		<b>*</b>		VERSION		the runtime
🗐 🐨 📝 Io Config_Globals						
	St.	<b>*</b>		IoDrvEthercatLib.ETCSlave		
	St.	<b>*</b>		IoDrvEthercatLib.ETCSlave		]
AX_COUPLER	St.	<b>*</b>		IoDrvEthercatLib.ETCSlave		]
	St.	<b>*</b>		DL_BuiltInIO_AX3.EtherCAT_Diag		
	St.	<b>*</b>		DL_BuiltInIO_AX3.EtherCAT_ErrorLED_Handle		
Image: Weighted Strates Soft Motion	St.	<b>*</b>		IoDrvEthercatLib.IODrvEtherCAT		
🐨 📝 🔌 Pulse_Output	St.	<b>*</b>		DL_BuiltInIO_AX3.DMC_PO_SLOT_REF		
	<b>*</b>	*		DL_BuiltInIO_AX3.Po_Sync		
	<b>**</b>	*		DINT		
🔍 🖉 🛊 pIoConfigTaskMap	<b>5</b>	<b>*</b>		POINTER TO IoConfigTaskMap		
B. V. PRG						
🔍 🖗 test1	<b>N</b>	<b>*</b>		BOOL		
🐨 📝 	<b>5</b>	<b>*</b>		WORD		
V 🔷 test3	<b>*</b>	<b>*</b>		REAL		



In the Symbol Sets view, all symbol sets are listed below the Application node whose definition was downloaded with the application to the AX-3 Series PLC.

Symbol Configuration	Device X		•
Communication Settings	🔯 🚔 📕 Device user: MAY		
Applications	Synchronized mode: All changes are immediat	ely downloaded to the device. Rights	
Backup and Restore	Application	Groups	Access
Files	→ Viewer	Administrator	
· · · · · · · · · · · · · · · · · · ·	→ management	Everyone	
Log		Service	
PLC Settings		Watch	
PLC Shell			
Users and Groups			
Access Rights			
Symbol Rights			

In the Rights view, the user groups defined in the user management of the controller are listed in a table. When a symbol set is selected, you see the access rights of the corresponding user group to the symbols of this set.

+: Access granted; -: Access not granted. You can change the access rights by double-clicking the symbol.

Device user: MAY		
Synchronized mode: All changes are immediately d	ownloaded to the device.	
Symbol Sets	Rights	
Application	Groups Administrator	Access
Viewer	Developer	-
management	Everyone	
	Service	
	Watch	

Click the 🖬 button to save the current access configuration to an XML file. The file type is Device symbol management files (\*.dsm). Click the 🚔 button to read a file like this from the computer.



4-24

## 4.2.1.11 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.

Communication Settings	Runtime Clock				
	1 PLC Time:	PLC Time: 2021-01-06T15:42:33,202Z			
Applications	2 Date:	Date: 2021年 1月 6日			
Backup and Restore	3 Time:	ne: 下午 03:42:39			
Synchronized Files	Time Zone				
Files	④ PLC Timezone:	(UTC+08:00) 台北	Read Timezone		
Log	5 Timezone:	Timezone: (UTC+08:00) 台北 ~			
PLC Settings	Network				
PLC Shell	cpsw0				
Users and Groups	(6) IP Address M				
Access Rights	⑦ IP address:	192 . 168 . 1 . 21			
Symbol Rights	Subnet mask: Default gatev	255 , 255 , 255 , 0			
System Settings	(B) (D) Obtain DN	IS server address automatically			
System Parameters	O Use the fo	llowing DNS server addresses:			
	Preferred DN	Sserver: 0 . 0 . 0 . 0			
Task Deployment	and the second se				
Task Deployment Status	Alternate DN	S server: 0 , 0 , 0 , 0			

#### Runtime Clock

**PLC Time**: Use the button **Read PLC Time** to read the PLC current date and time and the result will be updated here.
 **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.



## 4.2.1.12 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

Device X						
Communication Settings	Parameter	Туре	Value	Default Value	Unit	Description
•	I/O module CONFIG by Manual/Max when Power On	Enumeration of BOOL	Manual	Manual		
Applications	CPU module Stop when I/O Module No Response	Enumeration of BOOL	Stop	Stop		
Backup and Restore	CPU module Stop when I/O Module Occurred Error	Enumeration of BOOL	Keep Run	Keep Run		
	<ul> <li>Ø Select Action when 24V dc Input unstable</li> </ul>	Enumeration of BOOL	Continue Running when power stable	Continue Running when power stable		
Synchronized Files	Show Battery Low Voltage Error	Enumeration of BOOL	Enable	Enable		
Log PLC Settings PLC Shell						
Users and Groups						
Access Rights						
Symbol Rights						
System Settings						
System Parameters						

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.



## 4.2.1.13 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	I/O Deployment for Tasks			
	I/O channels	Channel	EtherCAT_Task (0)	MainTask (1)
Applications	E TIO			
Backup and Pastore	🗐 🦘 %IBO	IN:0-7	0 🗙	
buckup and Rescore	₩ %IX0.0	INO	98	
Synchronized Files	₩ %IX0.1	IN1	<b>O</b> X	
	- 🍾 %IX0.2	IN2	<b>9</b> 🗙	
Files	🁋 %IX0.3	IN3	<b>⊙</b> 🗙	
	- 🍾 %IX0.4	IN4	<b>9</b> X	
Log	- 🍾 %IX0.5	IN5	<b>9</b> X	
	₩ %IX0.6	IN6	•	
PLC Settings	👋 %IX0.7	IN7	<b>9</b> X	
	🗐 🦘 %IB1	IN:8-15	<u> 9 🗙</u>	
PLC Shell	🌳 %IX1.0	IN8	<b>⊙</b> X	
Jsers and Groups	- 🍾 %IX1.1	IN9	<b>S X</b>	
	🤟 %IX1.2	IN 10	<b>9</b> X	
Access Pights	- 🍾 %IX1.3	IN11	<b>9</b> ×	
	🁋 %IX1.4	IN12	<b>9</b> ×	
Symbol Rights	👋 %IX1.5	IN13	⊘ ×	
	👋 %IX1.6	IN14	<b>9</b> X	
System Settings	👋 %IX1.7	IN15	<b>GX</b>	
	🖶 🦘 %IB2	Encoder	<b>9</b> ×	
System Parameters	- 🍾 %IX2.0	Al	<b>9</b> 🗙	
	₩ %IX2.1	B1	<b>9</b> X	
Task Deployment	🌳 %IX2.2	Z1	<u> 9 x</u>	
Status	- 🍫 %IX2.3	Reserve	3 X	
status	- 🍾 %IX2.4	A2	<b>G</b> 🗙	
Information	- 👋 %IX2.5	B2	<u> 3 ×</u>	
	- 🍫 %IX2.6	Z2	3 X	
	%IX2.7	Reserve	<b>9 X</b>	
		OUT:0-7	3 🗙	
	<b>%</b> %QX0.0	OUTO	3 X	
	- %QX0.1	OUT1	3 🗙	
	<sup>5</sup> / <sub>2</sub> %QX0.2	OUT2	<b>9</b> 🗙	

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.



#### 4.2.1.14 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.

Device X			
Communication Settings	BuiltIn_IO	:	n/a
Applications	AX-308EA0MA1T	:	n/a
Backup and Restore	1		
Synchronized Files			
Files			
og			
PLC Settings			
PLC Shell			
Isers and Groups			
Access Rights			
ymbol Rights			
System Settings			
System Parameters			
Task Deployment			
Status			
Information			
information			

## 4.2.1.15 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.





## 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.

## • 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.<sup>\*1</sup>

## • 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	931348623157E+308 1.7976931348623157E+308		
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			

DI CI

4-30

## 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
```



## 4.3.2.2 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
X		1 bit
В	Byte	8 bit
W	Word	16 bit
D	DWord	32 bit
L	LWord	64 bit

#### 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	W3         W2         W1         W0						
D1 D0							
LO							





#### • 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.







#### 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	Reset warm	Reset cold	Download	Reset Origin		
Variable	0	0	0	0	0		
Retain Variable	Х	Х	0	0	О		
Persistent Variable	Х	Х	Х	Х	о		

#### **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 💁 🍊   🔲 🤋 🦄 🆄 🔚 🎬 - 🕤 🕮 👒 🤇	p ₩ → ■ ≪  [= 9= 4= *= 8   +  罰  ₹/
Cevices  Cevices  Cevice Cevice Ce	Image: Constraint of the imag	<ul> <li>Alarm Configuration</li> <li>Application</li> <li>Application</li> <li>Axis Group</li> <li>Can table</li> <li>CNC 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. (Receiver)</li> <li>Network Variable List (Receiver)</li> <li>Network Variable List (Sender)</li> <li>POU</li> <li>POU</li> <li>POU</li> <li>POU</li> <li>POU</li> <li>POU</li> <li>POU</li> <li>Recipe Manager</li> <li>Symbol Configuration</li> <li>Symbol Configuration</li> <li>Text List</li> </ul>
		<ul> <li>Trace</li> <li>Trend Recording Manager</li> <li>Unit Conversion</li> <li>Visualization</li> <li>Visualization Manager</li> </ul>



	Add Persistent Variables		Х	
	T Create a new global v	ariable list		
	Name PersistentVars			
		Add	Fancel	
File Edit V	iew Project Declaratio ~ X 陶 隐 X   鍋 頌 )	ons Build	Online Debug	Tools Window Help ' ∰  📽 🥨 → 🔳 📽   〔⊒ ६⊒ ६⊒ +⊒
Devices	<b>-</b> ₽ X	PLC_	PRG 🥒 🥔 Persiste	ntVars ×
🗉 🎒 Untitled1	•	1	{attribute 'qua	lified_only'}
🖹 🔟 Device (A	X-308EA0MA1T)	3	END_VAR	ISTENT RETAIN
	are Configuration			
= 🗐 PLC Lo	ogic			
= 🔘 Ap	plication			
	Library Manager PLC PRG (PRG)			
= - <b>W</b>	Task Configuration			
	EtherCAT_Task MainTask			
T	PersistentVars			
	_IO (BuiltIn_IO) LocalBus_Master (Delta Local	F		
Ether	CAT_Master_SoftMotion (Ethe			
SoftMo	otion General Axis Pool			

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





4



## 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 ;
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 ;
                                 ÷.,
            DUT Var :DUT
                                 (bVar:=TRUE,wVar:=12,iVar_Array:=[1,2,3]);
    5
                            :=
        END VAR
    6
    7
    1
        DUT_Var.bVar:=FALSE;
    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
```



4-38

```
• 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:

## 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.

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
	1	1	1

= Value retained

• = Clear to zero

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



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

4.3.2.6 Timing for the Default Value to be Valid

Invalid

○ = 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.
- S 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  $\bigcirc$ : 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.

Devices * # X   Image: Solution of the second se	File Edit View Project Build (	Dnline Debug Tools Window Help
Devices       * # x         Image: Device (AX-308EA0MA1T)       Image: Device (AX-308EA0MA1T)	🎦 🛩 🖶 I 🚙 I 🗠 🗠 🐰 🗈 🛍 🗙 I 🗛 😘	🎂 🌿   📗 🎕 🦄   🛍   🛅 • 👔   🎬   🧐 🧐 🕟 💼 🛠   💷 역 년 년 왕   ㅎ   🌋   🏷
Devices       + + ×         Image: Device (XX-308EA0MA1T)       Image: Configuration         Image: Declored Configuration       Image:		
Configuration Co	Devices - 7 ×	PLC_PRG Device S MainTask x
Priority ( 031 ): Provide (AX-308EA0MA1T) Hardware Configuration A Network Configuration PLC Logic O Application PLC Logic O Application PLC_PRG (PRG) O MainTask PLC_PRG<	Intitled1	Configuration
Hardware Configuration A Network Configuration I PLC Logic Application I Deta Logic I Deta LocaBus Master (Deta Tocat I Deta LocaBus Master (Deta Tocat) I Deta LocaBus Master (Deta Tocat)	Device (AX-308EA0MA1T)	
Image: Second secon	→ Hardware Configuration Image: A straight of the s	Priority ( 031 ): 1
Application     Application     Deta_LocaBus_Master (Delta tocal     Deta_LocaBus_Master (Delta tocal     Deta_LocaBus_Master (Delta tocal     Deta_LocaBus_Master (Delta tocal		Type
Ibrary Manager PLC_PRG (PRG) Task Configuration EtherCAT Task MainTask PLC_PRG Image:	Application	Cyclic      Interval (e.g. t#200ms)
PLC_PRG (PRG)     Watchdog     Task Configuration     SettherCAT Task     PLC_PRG     PLC_PRG     PLC_PRG     Deta_LocaBus_Master (Delta tocal     FiberCAT Master SoftMotion (Ethel	👘 Library Manager	*4
Sensitivity     Interface Inte	PLC_PRG (PRG)	
	🖻 🌃 Task Configuration	watchuog
MainTask     Del pLC_PRG     Deta_LocaBus_Master (Deta tocat	EtherCAT_Task	✓ Enable
Buitin_IO     Deta_LocaBus_Master (Delta tocalt     Generation (Ethel	B MainTask	Time (e.g. t#200ms) 500
Delta_LocalBus_Master (Delta Locali     EtherCAT_Master_SoftMation (Ethel		Sensitivity 1
I EtherCAT Master SoftMotion (Ethe	Delta_LocalBus_Master (Delta Loca	
Enclose_instal_solution (care	EtherCAT_Master_SoftMotion (Ether	
SoftMotion General Axis Pool	SoftMotion General Axis Pool	

Several consecutive timeouts:

Sensitivity: 0, watchdog timeout = time \*1 Sensitivity: n, watchdog timeout = time \*n



4-42

## 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.

Classification	Instruction Name	Task Type			
		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	
Instructions for Management	MC_Power	V	V	V	
	MC_SetPosition	V	V	V	
	MC_ReadParameter	V	V	V	
	MC_WriteParameter	V	V	V	
	MC_ReadBoolParameter	V	V	V	
	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

Oleasifiestise	Instruction Name	Task Type		
Classification		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		Cyclic	Freewheeling	Bus Cycle EtherCAT	
Motion Control Function Blocks	MC_Halt_DML	V	V	V	
	MC_Home_DML	V	V	V	
	MC_MoveAbsolute_DML	V	V	V	
	MC_MoveRelative_DML	V	V	V	
	MC_MoveVelocity_DML	V	V	V	
	MC_Stop_DML	V	V	V	
Instructions for Management	MC_Power_DML	V	V	V	
	MC_ReadBoolParameter_DML	V	V	V	
	MC_ReadParameter_DML	V	V	V	
	MC_ReadStatus_DML	V	V	V	
	MC_Reset_DML	V	V	V	
	MC_WriteBoolParameter_DML	V	V	V	
	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	×			
Create a new Recipe Definition		Devices	<b>-</b> 4	×
Name	Cancel	Recipe Device (AX Hardwin K Networ PLC Lo PLC Lo App C Builtin Builtin Ditter EtherC SoftMo	-308EA0MA1T) are Configuration rk Configuration gic plication DUT (STRUCT) Library Manager Motion_PRG (PRG) PLC_PRG (PRG) Recipes Task Configuration IO (BuiltIn_IO) O (DIO) LocalBus_Master (Di AT_Master_SoftMo tion General Axis Po	(i) n vielta vition







## 4.5.1 Recipe Manager

torage	General				
Stor	age type	Textual			Ŷ
File	path				
File	extension	.txtrecipe	2		
Sepa	arator				
OT	ab			🔘 Comma	
Os	pace		• :=	01	
	lable Colum ype lame comment tinimal Value taximal Value	ns e ve	> >> <<	Selected Columns	
	an Defaul	1		lin	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 PlcLogic/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.



Re Re	cipe Manager 🗙
Storage	General
Recip	e Management in the PLC
Save	Recipe
⊠ s	ave recipe changes to recipe files automatically
Load	Recipe
۰L	oad only by exact match of variable list
OL	oad matching variables by variablename
Write Re	cipe
Limit	the variable to min/max when recipe value is out of the range
	ot write to a variable when the recipe value is out of the min/max rang
Read Re	edpe
Chec	k 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							
Devices • 4 ×	Variable %MW3 PLC_PRG.War PLC_PRG.dwVar	_01 X Type WORD INT DWORD	Name MW3 Variable int Variable dword Variable	Comment	Minimal Value 10 100 ecipe definit	Maximal Value 500 800	Current Value	Case1 350 800 250	
Recipes_02   Recip				<b>2</b> : R	ecipe name				

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
GMW3	WORD	MW3 Variable		10	500		350
LC_PRG.iVar	INT	int Variable					800
LC_PRG.dwVar	DWORD	dword Variable		100	800		250
OR	2	Recipe	s_01 X				
OR	2	Recipe	s_01 X	e Name	Cc		
OR	2	Variable %MW3	<b>s_01 X</b>	e Name RD MW3 Variable	Cc		
OR	2	Variable %MW3 PLC_PRG.iVar	<b>s_01 X</b> Тур WOI INT	e Name RD MW3 Variable int Variable	Cc		



#### Add a new recipe

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

iable		Туре	Name	Comment	Minimal Value	<ul> <li>Maximal Value</li> </ul>	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			<b>~</b>				
	Paste							
$\times$	Delete			D Noul	Pacina			V
	Select All			+ New I	vecibe			^
49	Insert Variable			Name	Ca	se 2		
19	Add Child			Copy fro	mexisting <0	reate Empty >		~
-10	Add Sibling					acute Empty>		
C.	Update Structured	Variables				OK	Cance	ł
2	Add a New Recipe					_		-
2	Remove Recipe							
	Lond Bester							
E.	Load Recipe							

#### • Recipe files generated from the controller



4

## 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 1

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".

- 4 X	Task Configuration 🗙		
-	Monitor Variable Usage System	Events Properties	
AOMA 1T)	Add Event Handler X Ren	nove Event Handler   🜒 Event Info 📄 Open	Event Function
onfiguration nfiguration ition (STRUCT)	Name	Description	
ary Manager ion_PRG (PRG) PRG (PRG)	Add Event Handler		×
ipe Manager	Event	StartDone	~
BuiltIn_IO)	Function to call	Start_Done	
D) Bus_Master (Delta LocalBus	Scope	Application     O POUs	
laster_SoftMotion (AX-3 Se	Implementation language	Structured Text (ST)	~
eneral Axis Pool	Description	Called after application starts. Context=Communica Debugging=Disabled	tion task.
	_	ОК	Cancel
	A0MA 1T) onfiguration nfiguration ation (STRUCT) ary Manager ion_PRG (PRG) _PRG (PRG) _PRG (PRG) ipe Manager k Configuration BuiltIn_IO) O) Bus_Master (Delta LocalBus taster_SoftMotion (AX-3 Se General Axis Pool	A0MA 1T) onfiguration nfiguration ation r (STRUCT) ary Manager ion _PRG (PRG) _PRG (PRG) _PRG (PRG) ipe Manager k Configuration BuiltIn_IO) O) Bus_Master (Delta LocalBus taster_SoftMotion (AX-3 Sc General Axis Pool	▼ 4 ×         GAOMAIT)         onfiguration         infiguration         h Add Event Handler         P Add Event Handler         Image: Struct         ion         r (STRUCT)         ary Manager         ion_PRG (PRG)         jpe Manager         k Configuration         kuitin_IO)         o)         sus_Master (Delta LocalBus         laster_SoftMotion (AX-3 Se         General Axis Pool         OK



#### 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 Hardware Configuration on the Device section to open the Hardware Configurate (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.





5

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.





5

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.





5-4

## 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.





5-6

## 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			
<u> </u>	t will remove this module in his module?	n this rack. Are you su	re to remove
			ii. 1

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.





5-8

## 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.

& Har	dware Config	uration [	Device] >	<	
1	EtherCAT	~			
	Anelta AX-300E	A			
		Û.	08	08	+
		1	AM	AN	
		e 1	Cut Ctrl+	×X	
		D	Copy Ctr	rl+C	
			Paste Ct	(I+V	
		۲	Delete D	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.



☐ AS08AN01T\_A\_1 (AS08AN01T-A)

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	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

5

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	Network Configuration	6-2
6.1.	.1 Introduction	
6.1.	.2 Basic Knowledge	
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.

	Work Corniguration Editor	EdielCAT_Master_solidHodon	
General	Address	Additional	
Process Data	Auto Inc address	D Enable expert settings	ASD-A2-E
110(033 040	EtherCAT address	1001 Cptional	EIT.
Startup Parameters	Distributed Clock		
EtherCAT I/O Mapping	Select DC	DC-Synchronous	
EtherCAT IEC Objects	🖂 Enable	4000 Sync unit cycle (µs)	EFFE
Status	Sync0: Enable Sync 0	*	ASDAZ
Information	Sync unit cycle	x 1	

#### 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 . 1	168 .	1.	5			Device
Status	Subnet mask	255 . 2	255 . 2	55 .	0		AX-308EADMA1T	
Ethernet Device I/O Mapping	Default gateway	0.	0 . I	).	0		Device	
Ethernet Device IEC Objects								- <b>L</b> a 👗 🕌
Information						<b>–</b>		

#### Modbus

6

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

General			
Status	Serial Port Configuratio	n	
Tefermation	COM Port	RS-232	*
monnation	Baudrate	9600	*
	Parity	Even	÷
	Data Bits	7	1
	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



## 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.





6

MEMO





## Chapter 7 Motion Control Setup & Operation

## **Table of Contents**

7.1	Introduction on Motion Control Instructions7-5
7.1.1	Motion Control Instructions7-5
7.1.2	Application Notes on Motion Control Instructions7-5
7.1.3	Categories of Motion Control Instructions7-6
7.2	Creating Motion Control Project7-7
7.2.1	Process Flowchart
7.2.2	Process for Creating a Project7-8
7.3	Commissioning7-14
7.3.1	Procedure for Commissioning
7.3.2	Example of Axis Parameter Settings
7.3.3	Perform Axes Commissioning
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 Program7-27
7.4.3	Procedure for Single-axis Configuration
7.4.4	Axis Group Settings
7.4.	4.1 Prameters for Axis Group
7.4.	4.2 Using Axis Groups in Program
7.4.5	Procedure for Axis Group Configuration7-38
7.5	Motion Axis Variables7-43
7.5.1	Variables for Single Axis
7.5.2	Variables for Axis Group
7.6	Motion Control Programming7-49
7.6.1	Motion Control Program
7.6.	1.1 Program Architecture and Types in DIADesigner-AX



7.6.1.2	POU in DIADesigner-AX7-50
7.6.1.3	Adding POU in DIADesigner-AX7-50
7.6.1.4	PDO Mapping7-52
7.6.2 A	xis State Transitions
7.6.2.1	Axis State7-53
7.6.2.2	Axis Group State
7.6.3 E	xecution and Status Indication for Motion Control Instructions
7.6.3.1	Basic Rules of Executing Instructions7-57
7.6.3.2	Timing Diagram for Input/Outputs7-59
7.6.3.3	Repeated Execution Behavior of Single Axis Motion Instructions7-59
7.6.3.4	Multi-execution of Motion Control Instructions7-60
7.6.3.5	Synchronous Execution Eehavior of Motion Instructions7-60
7.6.4 Po	sition
7.6.4.1	Types of Positions
7.6.5 CAN	A Tables and Framework
7.6.5.1	E-CAM Framework7-66
7.6.5.2	Creating E-CAM
7.7 Mo	tion Control Functions7-71
<b>7.7 Mo</b> 7.7.1 S	tion Control Functions
<b>7.7 Mo</b> 7.7.1 S 7.7.2 S	tion Control Functions
7.7 Mo 7.7.1 S 7.7.2 S 7.7.2.1	tion Control Functions
7.7 Mo 7.7.1 S 7.7.2 S 7.7.2.1 P	tion Control Functions
7.7 Mo 7.7.1 S 7.7.2 S 7.7.2.1 P 7.7.2.2.	tion Control Functions 7-71 ystem Structure 7-71 ingle-axis Control 7-71 Cyclic Synchronous Position Mode 7-71 rofile Position Mode 7-72 7-72
7.7 Mo 7.7.1 S 7.7.2 S 7.7.2.1 P 7.7.2.2. 7.7.2.3	tion Control Functions 7-71 ystem Structure 7-71 ingle-axis Control 7-71 Cyclic Synchronous Position Mode 7-71 rofile Position Mode 7-72 Positioning 7-72
7.7 Mo 7.7.1 S 7.7.2 S 7.7.2.1 P 7.7.2.2 7.7.2.2 7.7.2.3 7.7.2.4	tion Control Functions 7-71 ystem Structure 7-71 ingle-axis Control 7-71 Cyclic Synchronous Position Mode 7-71 rofile Position Mode 7-72 Positioning 7-72 Stop Method 7-73
7.7 Mo 7.7.1 S 7.7.2 S 7.7.2.1 P 7.7.2.2 7.7.2.2 7.7.2.3 7.7.2.4 7.7.2.5	tion Control Functions 7-71 ystem Structure 7-71 ingle-axis Control 7-71 Cyclic Synchronous Position Mode 7-71 rofile Position Mode 7-72 Positioning 7-72 Stop Method 7-73 MC_GearIn 7-76
7.7 Mo 7.7.1 S 7.7.2 S 7.7.2.1 P 7.7.2.2 7.7.2.3 7.7.2.4 7.7.2.5 7.7.2.6	tion Control Functions 7-71 ystem Structure 7-71 ingle-axis Control 7-71 Cyclic Synchronous Position Mode 7-71 rofile Position Mode 7-72 Positioning 7-72 Stop Method 7-73 MC_GearIn 7-76 MC_GearInPos 7-78
7.7 Mo 7.7.1 S 7.7.2 S 7.7.2.1 P 7.7.2.2 7.7.2.3 7.7.2.4 7.7.2.5 7.7.2.6 7.7.2.7	tion Control Functions
7.7 Mo 7.7.1 S 7.7.2 S 7.7.2.1 P 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 V	tion Control Functions
7.7 Mo 7.7.1 S 7.7.2 S 7.7.2.1 P 7.7.2.2 7.7.2.3 7.7.2.4 7.7.2.5 7.7.2.6 7.7.2.6 7.7.2.7 7.7.3 V 7.7.3 V	tion Control Functions
7.7 Mo 7.7.1 S 7.7.2 S 7.7.2.1 F 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 V 7.7.3 V 7.7.3.1 7.7.3.2	tion Control Functions
7.7 Mo 7.7.1 S 7.7.2 S 7.7.2.1 P 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 V 7.7.3.1 7.7.3.2 7.7.3.3	tion Control Functions
7.7       Mo         7.7.1       S         7.7.2       S         7.7.2.1       P         7.7.2.2       7.7.2.3         7.7.2.3       7.7.2.4         7.7.2.5       7.7.2.6         7.7.2.6       7.7.2.7         7.7.3       V         7.7.3.1       7.7.3.2         7.7.3.3       7.7.3.3         7.7.4       To	tion Control Functions



7.7.5.1	Command Position	7-92
7.7.5.2	Velocity Command	7-94
7.7.5.3	Acceleration and Deceleration Command	7-95
7.7.5.4	Jerk Command	7-96
7.7.5.5	Axis Direction	7-97
7.7.6 A	Axis Group Control	
7.7.6.1	Linear Interpolation	7-99
7.7.6.2	Circular Interpolation	7-100
7.7.6.3	Group Stop Command	7-102
7.7.7 H	ligh-speed IO	7-103
7.7.7.1	IO Configuration	7-103
7.7.7.2	DIO Setting	7-104
7.7.7.3	SSI Encoder Setting	7-107
7.7.7.4	Pulse Encoder Setting	7-113
7.7.7.5	Capture/Compare Function Setting	7-120
7.7.7.6	Pulse Output Function Setting	7-126
7.7.7.7	Confirm High-Speed IO Errors	7-131
7.7.8 (	Other Features	7-132
7.7.8.1	Change Current Position	7-132
7.7.8.2	Software Limit	7-132
7.7.8.3	Position Lag Setting	7-133
7.7.8.4	Cam Switch Function	7-134
7.7.8.5	Position Capture	7-134
7.8 Pro	ogramming Example	7-136
7.8.1	Device Framework	7-136
7.8.1.1	Utilization	7-136
7.8.1.2	Configuration	7-136
7.8.2 E	Examples	7-136
7.8.2.1	Servo On	7-138
7.8.2.2	Reset and Control Single-axis Error	7-139
7.8.2.3	Control on Instruction Errors	7-142
7.8.2.4	Quick Stop for Single Axes	7-144
7.8.2.5	Home Positioning	7-146
7.8.2.6	Absolute Positioning	7-149



7.8.2.7	Switch CAM Table during CAM Operation7-150
7.8.2.8	Perform Master PhaseOffset for CAM7-159
7.8.2.9	Change Current Position in Movement7-166
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
Single-axis motion control instructions		Velocity control on single axis	"MC_": PLCopen motion
	Motion Torque control on single axis		"CONTROL INSTRUCTIONS "DMC_": Delta motion control
		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
Multiple-axis 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.

DIADesigner-AX Edit Debug File View Project Build Online Tools Window Help n n X 陶图X 网络路路 10 ণা 21 C

#### ■ 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		Templates			
Lib	raries ojects	Project AX-308EA0	Project SxxE	Standard project	
A project o Name Location	Untitled1	e, one application, two em	pty implementat	ions for PLC_PRG an	d Motion_
20101011	a. toor a fraum to				-



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.

A Network Configuration Editor 🗙		Product List Editor 🛛 🗸 🛠
A lietwork Configuration Editor X	80 O	Product List Editor  Product List  Product List  Product List  Servo Device  B Servo Device  Drive & Active Front End
EtherCAT_1		


■ 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



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	Joistributed 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	-		Additiona	əl ———	Ethorcort
Process Data	AutoIncaddress EtherCAT address	0	÷	Enal	ole expert settings ional	Euler CAL
Startup Parameters	Distributed Clock					
EtherCAT I/O Mapping	Select DC	DC-Synch	ronous		~	
EtherCAT IEC Objects	Enable	4000	Sync u	nit cycle (µs)		
Status	Sync0:					
Information	<ul> <li>Sync unit cycle</li> </ul>	x 1	- 4	4000	Cycle time (µs	5)
	User-defined			0	Shift time (µs)	)
	Sync1:					
	Enable Sync 1					
	<ul> <li>Sync unit cycle</li> </ul>	× 1		4000	Cycle time (µs	5)
	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	Concernance of the second	Error Reaction	
Einear Axis     Rotary Axis	Activated	Quick Stop Deceleration [u/s <sup>2</sup> ]: 100	
(2	Negative [u]: -10000	Velocity Ramp Type	
	Positive [u]: 10000	Trapezoid      Sin <sup>2</sup> Quadratic      Quadratic(smooth)	
	Rotary Axis Modulo Setting	Position Lag Supervision	
	Modulo value [u]: 360	Position Lag Reaction Deactivated Y Lag Limit [u]: 1	A V
Mechanism Type	(2) (4)	<ul> <li>Mechanism Setting</li> <li>(1) Command pulse per motor rotation: 10000 (Pulse ]</li> <li>(4) Pitch: 1 (Unit ]</li> </ul>	
+		Gear Box	
V	(3)	(2) Gear ratio numerator 1	
		(3) Gear ratio denominator	

• Parameters setting

Name	Setting
Axis Type <sup>①</sup>	Linear Axis
Command pulse per motor rotation 3	10,000
Pitch③ [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.

levices	+ 7 X SM_Driv	ETC_Delto_ASDA_A2_X
Lineson J     Lineson J     Lineson J     Hardware Configuration     A tetron's Configuratint     A tetron's Configuratint     A tetron's Configuration	r) r) ter SolMoton) Cell Drive Rev (54) M Drive (FTC Dotin (400 A.2)	Anii Type and Linnis Unitaria Mode Delta ASDA A2 Delta ASDA A2 Delta Constraints Transmission Mechanism Mechanism Type Ball Screev (1) (1) (1) (2) (3) (3) (4) (4) (4) (4) (4) (5) (4) (4) (5) (4) (4) (5) (4) (4) (5) (5) (5) (5) (5) (6) (6) (6) (6) (6) (6) (6) (6

Introduction of commissioning screen

			2)	
variable	set value	actual value	Status:	SMC_AXIS_STATE.power_off
Position [u]	0.00	0.00	Communicatio	one operational (100)
Velocity [u/s]	0.00	0.00	Errors	
Acceleration [u/s <sup>2</sup> ]	0.00	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:
Power		4 Error reset	_	5 Homing
Power	0	Error reset		5Homing
Power	0	Error reset		5 Homing
Power	Distance:	4 Error reset		5 Homing Start 7 Read8Write Parameter:
Power Power Inch	Distance: /elocity:	Error reset		5 Homing Start
Power Power Power	Distance: Velocity: Acceleration:	4 Error reset		5 Homing Start
Power Power	Distance: Velocity: Acceleration: Deceleration:	4 Error reset		5 Homing

I 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



Name	Function
Status	Axis status
Communication	Communication status

- 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 <sup>*2</sup>	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

Sellerar Setting	Axis Type and Li	nits		(1)	Motion Parameter			
oming Setting	Virtual mode	2		4	Error Reaction			
	Linear Axis     Rotary Axis	Linear Axis Soft	ware Limits		Quick Stop D	eceleration [u/s <sup>2</sup> ]: 100	Ť	
ommissioning	0	Negative [u]:	0	(5)	Velocity Ramp Type			
M_Drive_ETC_Delta_ASDA_A2: EC Objects		Positive [u]:	1000		Trapezoid	in² 🔿 Quadratic 🔿 Quad	ratic(smooth)	
atus	3	Rotary Axis Mod	ulo Setting	6	Position Las Supanis	ine.		
		Modulo value [I	u]: 360	A T	Position Lag Supervis	Disable Drive ~	Lag Limit [u]:	1
formation	3)							
	Transmission Me	chanism			Mechanism Setting			
	Mechanism Typ	e Ball Screw	*		(1) Command pulse	per motor rotation: 131072	Pulse	e ]
		(2)	(4)	1	(4) Pitch: 1	f Unit 1	Y LI GIO	- ]
	(1)	NO.		- 10				
	Δ			1				
					Gear Box		-	
			3)		Gear Patio -	(2) Gear ratio numerator	1	÷
					Gear reacto =	and the second se	De .	
						(3) Gear ratio denominator	1	¥
						(3) Gear ratio denominator	1	V
						(3) Gear ratio denominator	1	
						(3) Gear ratio denominator	1	Ē
c	D	Positive Com	mand Negat	ive Comr	nand	(3) Gear ratio denominator		
c	0	Positive Com	mand Negat	ive Comr	nand	(3) Gear ratio denominator	1	
c	Reverse OFF	Positive Com	mand Negat	ive Comr		(3) Gear ratio denominator	1	
c	Reverse OFF	Positive Com	mand Negat	ive Comr	nand 9 <b>7</b> .	(3) Gear ratio denominator	1	
c	Reverse OFF	Positive Com	mand Negat	ive Comr	nand J.	(3) Gear ratio denominator	1	
c	Reverse OFF	Positive Com	mand Negat	ive Comr	nand J.	(3) Gear ratio denominator	1	
c	Reverse OFF	Positive Com	mand Negat	ive Comr		(3) Gear ratio denominator	1	
c	Reverse OFF  Reverse On	Positive Com	mand Negat	ive Comr	nand ?	(3) Gear ratio denominator	1	

#### 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:

#### Ball Screw

lechanism Type	2) (4)	(1) Command pu (4) Pitch: 1	ulse per motor rotation: 1	\$	[ Pulse ]
	(3)	Gear Box	(2) Gear ratio numerator	1	
		Gear Ratio =	(3) Gear ratio denominator	1	-



## 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 (2)	(4)	(1) Command pu (4) Movement d	ulse per motor rotation: 1	Fulse ]
	Ĵ	Gear Box	(2) Gear ratio numerator	1
(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

lechanism Type	Belt Pully	*	(1) Command pu	ulse per motor rotation: 1	+	[ Pulse ]
)		(4)	(4) Diameter: 1 Movement distan	[ Unit ]	er*n	
	<b>~</b>		Gear Box			
	(3)		Con Della	(2) Gear ratio numerator	1	4
			Gear Ratio =	(3) Gear ratio denominator	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 *n)</li></ul>	Diameter (Movement distance per motor rotation: Diameter *n)
(2) Gear ratio numerator	Numerator of gear ratio
(3) Gear ratio denominator	Denominator of gear ratio



## Image: Book of the setting is a setting in the setting is a setting in the setting is a set of the set of t

* SM_Drive_ETC_Delta_ASDA	_A2 X
General Setting	Homing Mode 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

	Axis Type and Limits (2)	Motion Parameter
oming Setting ML_Drive_ETC_Delta_ASDA_A2: arameters ML_Drive_ETC_Delta_ASDA_A2: cobjects		Velocity Ramp Type Trapezoid v
atus	Tananinia Madanin	
formation	(1) (2) (4) (4) (4) (4) (4) (4) (4) (4) (4) (4	Mechanism Setting (1) Command pulse per motor rotation: 1280000 [Pulse] (4) Pitch: 10000 🛊 [Unit]
		Gear Box (2) Gear ratio numerator 1
		(3) Gear ratio denominator
	Servo Gear Ratio Setting           5         Positive Command         Negat           • Reverse OFF         Image: Command         Image: Command </td <td>tive Command</td>	tive Command



## ① Axis Type and Limits

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



<b>1echanism</b> Type	Ball Screw	*	Mechanism Setti	ng		
			(1) Command pu	ulse per motor rotation: 1	A V	[ Pulse ]
Å	Com.		(4) Pitch: 1			
	(3)		Gear box			121
				(2) Gear ratio numerator	1	-

Descriptions of different machanism types are as follows:

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	× (4)	(1) Command p (4) Movement d	ulse per motor rotation: 1	Ť	[ Pulse ]
	<u>6</u> C	( ) <del>,</del>	Gear Box			
	G ()			(2) Gear ratio numerator	1	4
v	(3)		Gear Ratio =	(3) Gear ratio denominator	1	

Name	Function
(4) 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 ٠

Mechanism Type	Belt Pully	v	(1) Command pu	ng ulse per motor rotation: 1	\$	[ Pulse ]
		(4)	(4) Diameter: 1	Unit ]	er <sup>8</sup> n	
	0		Gear Box			
	(3)		Corres Danking	(2) Gear ratio numerator	1	+
			Gear Ratio =	Sector and the sector sector	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 *n)</li></ul>	Diameter (Movement distance per motor rotation: Diameter *n)
(5) Gear ratio numerator	Numerator of gear ratio
(6) Gear ratio denominator	Denominator of gear ratio

## ⑦ Homing Setting

Seneral Setting	Homing Mode 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	
DML_Drive_ETC_Delta_ASDA_A2: EC Objects	Description	
Status	Mode 35 : Depending on the current position	
information	In mode 35, The homing instruction is executed, the axis does not more	ve and its current position is regarded as

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".





A Network Configuration Editor X - 4 × · Product List Editor اه 🖻 که 100 0 ----String for a full -EtherCAT All Vendors ModbusTCP/EtherNetIP Modbus Display All Versions CANOpen Product List PLCs A 🗣 Fieldbuses 4 & EtherCAT A SD S Delta ASDA-A2-E EtherCAT(CoE) Drive Rev4 S Delta ASDA-A2-E EtherCAT(CoE) Drive Rev4\_DML Delta ASDA-A2-E EtherCAT(CoE) Drive Rev4\_SM Belta ASDA-A3-E EtherCAT(CoE) Drive Rev0.04 S Delta ASDA-A3-E EtherCAT(CoE) Drive Rev0.04 EtherCAT\_1 Delta ASDA-A3-E EtherCAT(CoE) Drive Rev0.04 DML Delta ASDA-B3-E EtherCAT(CoE) Drive Rev0.04 Source Contraction Delta ASDA-B3-E EtherCAT(CoE) Drive Rev0.04 S Delta ASDA-B3-E EtherCAT(CoE) Drive Rev0.04\_DML R1-EC R2-EC & RTU-ECAT 6 SICK AG Delta ASDA-A2-E EtherCAT(CoE) Drive Rev4\_SM · S VFD Delta ASDA-A2-E EtherCAT (CoE) Drive 🖉 💁 Yaskawa Electric Corporation S EtherNet/IP S Modbus Modbus TCP 4.7.0.0 on: 4.7.00 CAT Slave imported from Slave XML: Delta\_ASDA2-4-00\_XML\_TSE\_20160620.xml Device: Delta ASDA-A2-E EtherCAT(CoE) Rev4

Click "Delta ASDA-A2-E EtherCAT(CoE) Drive Rev4\_SM" \*1 after entering Network Configuration page and connect 1 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 Config	uration Editor 🗙			
a) 🖻 🕼			100 0	
			EtherCAT	
			ModbusTCP/EtherNet	P
	-ovice		Modbus	
	0-		CANOpen	
	evice Device			
	i an 🔍			
EtherCAT 1 -				
EINERCAL_I				
-				
-				'
-				
-				
	Delta ASDA-A2-E EtherCAT(CoE)			
	Delta			
	ASDA-A2-E EtherCAT			
	(CoE) Drive	× 2)		
	EHC)			
	2			
	SOPOL	10		
	841			



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.

Géneral	Select the Outputs			Select the Inputs		
Process Data	Name 16#1600 1st RxPDO Mapping (exclu	Туре	Index	Name	Type	Index
Startup Parameters	Control Word TargetPosition	UINT	16#6040:00	Status Word ActualPosition	UINT	15#6041:00 16#6054:00
EtherCAT I/O Mapping	TargetVelocibr	DINT	16#60FF:00	Velocity actual value	DINT	16#6060:00
	TargetTorque	INT	16#6071:00	ActualTorque	INT	16#6077:00
EtherCAT IEC Objects	Modeoroperation	SIWI	15#5050;00	ModeutoperationDisplay	SINT	16#6051:00
Status	Control Word	UINT	16#6040:00	Status Word	UINT	16#6041:00
Information	10#1602 3rd RXPDU Mapping (exclu			16#1AU2 3rd 1XPDO Mapping (c		
	Control Word	<b>MINT</b>	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	LUNT	16=6040.00	15#1A03 4th TxPDO Happing (e		
	TargetTorque	THE	16=6075100	Status Word	UINT	16#6041:00
				ActualPosition	DINT	16#6064:00
				ActualTorque	INT	16#6077:00
	1			0		

#### 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 🗙 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									
nformation									
information									
Information									
Information									
Information									
Information									
Information									
Information									
information									
nformation									
nformation									
nformation									
formation									
information									
nformation									





■ 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"

General Setting	Axis Type and Limits	Motion Parameter
Homing Setting	Virtual mode  Iinear Axis Cartany Axis Cart	Error Reaction Quick Stop Deceleration [u/s <sup>2</sup> ]: 100
Commissioning	Negative [u]: 0	Velocity Ramp Type
M_Drive_ETC_Delta_ASDA_A2: EC Objects	Positive [u]: 1000	Inspezoia () Sinte () Quadratic () Quadratic(Sindoth)
Status	Modulo value [u]: 360	Position Lag Supervision Position Lag Reaction Deactivated Lag Limit [u]:
an Official Offi	Transmission Mechanism Mechanism Type Ball Screw	Mechanism Setting           (1) Command pulse per motor rotation:           131072           (4) Pitch:           1           (1) Pitch:
		Gear Box (2) Gear ratio numerator
		Gear Ratio =



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  Inear Axis Cinear Axis Software Limits  Rotary Axis Z Activated	Error Reaction Quick Stop Deceleration [u/s <sup>2</sup> ]: 1000
Commissioning	Negative [u]: 0	Velocity Ramp Type Trapezoid Sin <sup>2</sup> Ouadratic Ouadratic(smooth)
M_Drive_ETC_Delta_ASDA_A2: IEC Objects Status	Rotary Axis Modulo Setting Modulo value [u]: 350	Position Lag Supervision

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

	Axis Type and Limits	Motion Parameter
Homing Setting	Virtual mode	Error Reaction
Commissioning	Content Axis Content Axis Software Limits     Activated	Quick Stop Deceleration [u/s <sup>2</sup> ]: 100
commissioning	Negative [u]: 0	Velocity Ramp Type
SM_Drive_ETC_Delta_ASDA_A2: IEC Objects	Positive [u]: 1000	Trapezoid      Sin <sup>2</sup> Quadratic      Quadratic(smooth)
Status	Rotary Axis Modulo Setting	psition Lag Supervision
Information		osition Lag Reaction Disable Drive · Lag Limit [u]: 1

Scaling/ Mapping page

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

	Axis Type and Limits	Motion Parameter
loming Setting	Virtual mode     Uinear Axis     Linear Axis Software Limits     Rotary Axis     Activated	Error Reaction Quick Stop Deceleration [u/s <sup>2</sup> ]: 100
Commissioning	Negative [u]: 0	Velocity Ramp Type Trapezoid Sin <sup>2</sup> Quadratic Quadratic(smooth)
R_DHVE_EIC_Delta_ASDA_A2: EC Objects Ratus	Rotary Axis Modulo Setting Modulo value [u]: 360	Position Lag Supervision Position Lag Reaction Deactivated Lag Limit [u]: 1
formation	Transmission Mechanism Mechanism Type Ball Screw (4)	Mechanism Setting (1) Command pulse per motor rotation: 131072 (4) Pitch: 1 (1)
		Gear Box (2) Gear ratio numerator

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.

vices • 0	ĸ			
Chooled1	-	EtherCAT_Master_Soft	ftHotion x	
© Unseddi © Device (AV-302EA/39A11) A Hardware Configuration A Hetwick Configuration A Elevicat Filter © RCLEAS © Application © RCLEAS ©	•	EtherCAT_Master_Soft General Sync Unit Assignment Lug EtherCAT I/O Mapping EtherCAT I/O Mapping EtherCAT I/C Objects Status Juformation	Image: State State State     Image: State State State     Image: State State State     Image: State State       Image: State State State     Image: State State     Image: State State     Image: State       Image: State State     Image: State     Image: State     Image: State       Image: State     Image: State     Image: State     Image: State       Image: State     Image: State     Image: State     Image: State       Image: State     Image: State     Image: State     Image: State       Image: State     Image: State     Image: State     Image: State       Image: State     Image: State     Image: State     Image: State       Image: State     Image: State     Image: State     Image: State       Image: State     Image: State     Image: State     Image: State       Image: State     Image: State     Image: State     Image: State       Image: State     Image: State     Image: State     Image: State       Image: State     Image: State     Image: State     Image: State       Image: State     Image: State     Image: State     Image: State       Image: State     Image: State     Image: State     Image: State       Image: State     Image: State     Image: State     Image: State       Image: State     Image: State     I	Enable redundancy

#### Scan PLC controller



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

Elle Edit View Project Build Online Debug Tools Window Help

evices - P X	ASDA_A2_E_COE_Drive N# SM_Drive_ETC_Delta_ASDA_A2	EtherCAT_Master_SoftMotion     PLC_PRG     Device x
Instead	ASDA A2 E C6E_Drive In SH_Drive_ETC_Della_ASDA A2 Communication Settings SourceMark Application Settings Source Set Device Set Device Set Set the network path to the controller: File Internation Int	
	Tes 20.6	Humber of channels: 4 utions GmbH Serial number: 541807.7:439683A
		OK Court



A green light icon will be shown if the connection is successful, then click "Login".

evices - 4 X	ASDA_A2_E_COE_Drive	Drive_ETC_Delta_ASDA_A2	PLC_PRG Bevice X
O Unitled I     Device (CODESYS SoftMotion Win V3 x64)	Communication Settings	Scan network Gateway + Device +	
- DI PLC Logic	Applications		(CCC)
Lbrary Manager     PLC PRG (PRG)	Backup and Restore		1
<ul> <li>Task Configuration</li> <li>EtherCAT_Task (IEC-Tasks)</li> </ul>	Files		
MainTask (IEC-Tasks)	Log	Colorian S	E0003.0690.40011 (Active)
EtherCAT_Master_SoftMotion (EtherCAT Master Soft     ASDA_A2_E_CoE_Drive (Delta ASDA-A2-E EtherC	PLC Settings	IP-Address: localhost	Device Name: TWTY3N80436
SM_Drive_ETC_Delta_ASDA_A2 (SM_Drive, SoftMotion General Axis Pool	PLC Shell	Port: 1217	Device Address: 0003.0690.4001
	Access Rights		Target ED: 0000 0004
	Symbol Rights		Target Type: 4102
	Task Deployment		Target Vendor: 35 - Smart Software Solutions GmbH
	Status		Target Version: 3.5.13.10
	Information		

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

wices 👻 🕈	X 🕼 ASDA_AZ_E_COE_Drive 🐖 SM_Drive_ETC_Delta_ASDA_A2 🔐 EtherCAT_Master_SoftMotion 🙆 PLC_PRG 🖓 🖬	evice X +
Implementation         Imple	Communication Settings Scan network Gateway • Device •     Applicatione     Backup and Restore     Ries     Log     CODESVS     No online change possible due to severe changes : Do you want to perform a     Price Name:     ThrVR08036     Device Address:     0003.0669.4001     Device Address:     0003.0669.4001     Device Address:     0003.0669.4001     Device Address:     0003.0669.4001     Target Vendors     Target Vendor     Targe	s GmbH



## 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 avoc	Linear interpolation	6 axes
Maximum control axes	Circular interpolation	6 axes (3 follower axes)

#### 7.4.4.1 Prameters for Axis Group

DeltaAxisGroup X (1) Kinematic Configuration Axis Z Axes Group Axis X: Please Enter an Axis Mapping ... Axis Y: Please Enter an Axis Mapping .... Axis Y Axis Z: Please Enter an Axis Mapping ----Axis X Following Axis Following Ratio Axis A: Please Enter an Axis Mapping ----Axis B: Please Enter an Axis Mapping .... Axis C: Please Enter an Axis Mapping .... Axes Group Note Aris A 2.\* True? Auritry Axis X Aves Group Calculation 1. Axa Y ÷ Axis B Taunth Axis Z AverGrap 1. Asis C ninef d'unième 12 Tage 7 s Target Position of Following Axis Following Ratio = Target Position of Axis Group 2 Motion Parameter RampType S Curve ÷ 1000000 + (user unit)/s Max Velocity Limit (user unit)/s2 Max Acceleration Limit 2000000 + (user unit)/s2 Max Deceleration Limit 2000000 (user unit)/s<sup>3</sup> Max Jerk Limit (Reserved) 0 Т ⊿ Tasks Bus Task: EtherCAT\_TASK ...





## ① Kinematic

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

#### **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.







(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"







(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.

DeltaAxisGroup x							
Ares Y	Entre to Avit Manager		Input Assistant				×
Ans X	i narel alcard matchault		Fext Search Categories				
			Tasks	Name	Туре	Address	Origin
Following Axis Following Ratio Axis A: Please	e Enter In Avis Mapping			EtherCAT_Task			
Diana Diana	Enter in Aux Mannier			riduitase	27		
Axes et Presse	Level to see maching						
Axes Group Axes C: Presse	Enter an Axis Mapping						
Note							
Atta A							
Tear Viewer							
Aan D Aan Droop Aan D							
Acc 2							
Auto C			Citizenteretteren				
Tagettania finitar					Charles Sound	Terretori	
Following Ratio = Target Position of Following Ax Target Position of Axis Group	<u>15</u>		Documentation		- seed way advantage	sum t mation.	Hezperte Dreire
Motion Parameter							
RampType S Curve							
Y	Max Velocity Limit 1000000	(user unit)/s					
	Max Acceleration Limit 2000000	(user unit)/s <sup>a</sup>					
	Max Deceleration Limit 2000000	(user unit)/s <sup>2</sup>					
	Max Jerk Limit (Reserved) 0	(user unit)/s <sup>3</sup>				OK	Cancel
							3
d Tasks							<u> </u>
Bus Tas							
	/ Tas	ke		-			
	2103						
	Bus T	ask: EtherCAT Ta	sk				
	Dusi	usin concreating	<b>an</b>				

(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.

Devices - 7 ×	I PI	
AxisGroup     AxisGroup     Device (AX-308EA0MA1T)     A Hardware Configuration     A Network Configuration     A EtherCAT Filter	1 2 3 4 5	PRDGRAM PLC_PRG VAR DMC_GroupEnable_0: DMC_GroupEnable; END_VAR
	1	DMC_GroupEnable_0 DMC_GroupEnable EN ENO AxisGroup bDone bExecute bBusy bError ErrorID

(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

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
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
1061	fPositionPeriod	LREAL	1000	Max movement distance of rotary axis
1062	eRampType	SMC_RAMP TYPE	Trapez	Velocity ramp type: Trapezoid sin^2 Quadtatic

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



Numbering	Name	Data type	Default value	Description
				<ul> <li>Quadtatic(smooth)</li> </ul>
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



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	()	Axis error

## • Positioning Axis (Axis\_REF\_DML)

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


# 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
lrJerk	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*	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 max velocity of axis group
IrMaxAcceleration Limit	LREAL	Positive number or zero (2000000)	The max acceleration of axis group
IrMaxDecelerationLimit	LREAL	Positive number or zero (2000000)	The max deceleration of axis group
IrMaxJerkLimit (Reserved)	LREAL	Positive number or zero (0)	The max jerk of axis group (Reserved)
IrVelocityWarning Percentage	LREAL	0 ~ 1 (0)	Set the persontage 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 persontage 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.
IrDecelerationWarning Percentage	LREAL	0 ~ 1 (0)	Set the persontage 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 persontage 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.



7

Name	Data Type	Setting Value (Default Value)	Function
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: When the rotary type of axis is selected, the range of motion can NOT exceed the value set in modulo, otherwise, an error "Axis limit violated" will occur. "



# 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.

1 1	PROGRAM PLC_PRG	No.
" Scope Name Address D	lata type Initialization Comment Attributes	
<	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	- 4 X	POU 😂 EtherCAT_Task 🗙	
Unbled1     Device (AX-308EA0MAIT     device (AX-308EA0MAIT     device (AX-308EA0MAIT     device (AX-308EA0MAIT     device (AX-308EA0MAIT     device (AX-308EA0MAIT     device (AX-308EA0MAIT)	) bion	Configuration Priority ( 031 ): 1	
PLC Logic     Application     Dray Mana	ager	Type           ① Cyclic         v           Interval (e.g. t#200ms)	ms. ~
PLC_PRG (PR POU (PRG)	RG) uration	Watchdog Ensilve	
EtherCA MainTas PLC	r Task k PRG	Time (e.g. #200ms) Sensitivity	
BuiltIn_IO (BuiltIn_IC     BuiltIn_IC     Buil	)) ter (Delta LocalBus Master) oftMotion (EtherCAT Master SoftMotic	🛧 Add Call 🔀 Service Call 🔡 Change Call 👘 Move Up. 👻 Move Down 📑 Open POU	
		POU Comment	

Select the created POU and click "OK".

put Assistant			
Pograns	Application	Type Origin Applicator Art.OGAM	
Structured view		- Insert with impuments	Insert with namespace prefic
Structured view Show documentation Documentation: PROGRAM POU -		<ul> <li>passifings information</li> </ul>	Inderf with numespace prefix
			OK Cancel



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



# 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



# AX-3 Series Operation Manual

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



# 7-54

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 instructions           Cannot 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 c	an only be cl	nanged under	GroupStandby	v state, or ar	error will occu	ur
----------------------	-----------------	---------------	--------------	--------------	----------------	-----------------	----

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).



#### - 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.
- Buffered instruction: A motion control instruction that was executed during an axis motion and is waiting to 2. be executed
- Transit velocity: The velocity to use by the current instruction to trasfer to the buffered instruction. 3.
- Target Velocity: The Velocity parameters of the instruction. 4.
- 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

 $V_{2}$ 





#### Buffermode=mcBlendingNext





#### Buffermode=mcBlendingHigh

\*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

(1) Right-click "Application", choose "Add Object" and then select "CAM Table".





(2) Type the name of the CAM table.



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



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

evices 🗸 🗘 🗙	1	PLC_PRG	🙆 Can	×							
🔄 Untitled6	Cam	Cam table	Tappets T	appet table							
E Device (AX-308EA0MA1T)		Y		V	٨	i.	Segment Tune	min/Position)	max(Position)	max(IValocity))	max/lAcceleration
- 🔏 Hardware Configuration		~		1	-		segment type	mini(r Osicion)	max(rosition)	max() verocity()	maxqueceieration
🖻 🙏 Network Configuration		U	-	0	0	0		-			
A EtherCAT Filter							Poly5	0	120	1.5120000000000007	0.03283528294141416
= 1 PLC Logic	1	120	120	1	0	0					
= ( Application	0	6					Poly5	120	240	1	
Cam		240	240	1	0	0					
Library Manager	0						Poly5	240	360	1.512	0.03283528294141414
PIC PRG (PRG)		360	360	0	0	0					
= 24 Task Configuration											
EtherCAT Task											
S S MainTask											
AT PLC PPG											
t I public to (public to)											
Bullan_to (Bullan_to)											
Deita_Localbus_Master (Deita Localbus Master)											
EtherCAT_Master_SoftMotion (EtherCAT Master SoftMotid)											
ASD_A2_E (Delta ASDA-A2-E EtherCAT(CoE) Drive Re											
SM_Drive_ETC_Delta_ASDA_A2 (SM_Drive_ETC											
SoftMotion General Axis Pool											

- (5) Add or delete CAM data on the CAM Table screen
- Click to add new CAM data
- Click I 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	Cam table	Tappets	Tappe	et table							
		Х	Y	V	А	J	Segment Type	min(Position)	max(Position)	max( Velocity )	max( Acceleration )
		0	0	0	0	0					
•							Poly5	0	120	1.5120000000000007	0.032835282941414162
W		120	120	1	0	0					
•							Poly5	120	240	1	0
		240	240	1	0	0					
•							Poly5	240	360	1.512	0.032835282941414141
		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	m table Tappe	ets Ta	ppet table	
•	Track ID 1	×	positive pass	negative pass
1		180	switch ON	switch OFF
1		360	switch OFF	none
0	2			
1		90	switch ON	none
1		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 Uinear Axis Uinear Axis Retary Axis Activated	Error Reaction Quick Stop Deceleration [u/s <sup>2</sup> ]: 100
Commissioning SM_Drive_ETC_Delta_ASDA_A2: IEC Objects	Negative [u]:         0         4           Positive [u]:         1000         4	Velocity Ramp Type Trapezoid Sin <sup>2</sup> Quadratic Quadratic(smooth)
Status	Rotary Axis Modulo Setting Modulo value [u]: 360	psition Lag Supervision
	Transmission Mechanism Mechanism Type Ball Screw v (2) (4)	Mechanism Setting (1) Command pulse per motor rotation: 131072 (4) Pitch: 1
	(1)	
		Gear Box (2) Gear ratio numerator

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	Virtual mode  Uinear Axis  Kotary Axis  Virtual mode  Linear Axis Software Limits  Activated	Error Reaction Quick Stop Deceleration [u/s <sup>2</sup> ]: 1000
Commissioning	Negative [u]: 0	Velocity Ramp Type  Trapezoid Sin <sup>2</sup> Ouadratic Ouadratic(smooth)
IEC Objects	Rotary Axis Modulo Setting	Position Lag Supervision
Status	Modulo value [u]: 360	Position Lag Reaction Deactivated V Lag Limit [u]: 1
Information	Transmission Mechanism	
	Mechanism Type Ball Screw "	Mechanism Setting
	(2) (4)	(1) Command pulse per motor rotation: 10000 F [Pulse] (4) Pitch: 10000 F [Unit]
		70
		Gear Box
	(3)	(2) Gear ratio numerator
		(3) Gear ratio denominator



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).
- 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_Can	nIn
	Master AXIS_REF_SM3	BOOL InSync -
_	Slave AXIS_REF_SM3	BOOL Busy
	Execute BOOL	BOOL CommandAborted -
_	MasterOffset LREAL	BOOL Error
_	SlaveOffset LREAL	SMC_ERROR ErrorID
_	MasterScaling LREAL	BOOL EndOfProfile
_	SlaveScaling LREAL	SMC_TappetData Tappets -
_	StartMode MC_StartMode	
_	CamTableID MC_CAM_ID	
_	VelocityDiff LREAL	
_	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



	I	DMC_HCnt	
—	Counter AS500_COUNTER_REF		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



Situations:

- 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

<u> </u>	Cam	×											
Cam	Can	n table	Тар	pets	Тарре	et table							
			х		Y	Ν	′ A	J	Segm	min(P	max(P	max( V	max( A
			0		0		0 0	0					
•									Poly5	0	120	1.5120	0.0328
Ŵ			120		120		ι Ο	0					
•									Poly5	120	240	1	0
Ŵ			240		240		ι Ο	0					
•									Poly5	240	360	1.512	0.0328
			360		360		) 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

②Choose 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

6 Acceleration 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.

Cu Cu	U PLC Logic PLC Logic Application Cam			Prope	erties - Cam	Device		A			
X Cu						Loevice.	PLC LOGIC:	Applicationj			×
Pas X Del Bro Re	t py ste lete owse	nager (PRG) guration ask (IEC-Tasks) .C_PRG I Axis Pool			Dimensions Dimensions Master start position:          Slave start position:         0         Period         Smooth transition			Master end position Slave end position: Slave period:	Master end position: 360 Slave end position: 360 Slave period: 360		
Pro	operties d Object	ual_X (SM_Drive_Virtual) ual_Y (SM_Drive_Virtual)		Continuity requirement		s Velocity	Acceleration [	] Jer	🗌 Jerk		
C Adi	d Folder it Object it Object With			T	Compile form polynon one dim two dim	at nial (XYVA) ensional p ensional p	) point array point array	Elements:	256	<u>×</u>	



#### • 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

<pre>P : MC_CAM_REF;</pre>	//CamTable refe	erence
CamTableID : INT;	//CamTable Swit	ch

• Switching of CAM tables

CASE CamTableID OF
0: P:=Cam;
<pre>1: 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:



• The second Cam table (Cam\_1)





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:

Item	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:

Item	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
	Trapezoid	A trapezoidal velocity ramp (Each section is constant acceleration)
Velocity	Sin <sup>2</sup>	The velocity ramp equals to sin <sup>2</sup> function (acceleration ramp is fixed)
ramp type	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:

ltem	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:



#### • 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:

ltem	Setting	Meaning
	negative	Motion operates in a negative direction
Direction	shortest	Motion operates the shortest way (Only for rotation axis)*
	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.



(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	Continue by combining the deceleration of the previous motion and the acceleration of the current motion.

# • Supported buffer modes

Mode	Aborting	Buffered	Blending Low	Blending Previous	Blending Next	Blending High
None	А	A	N	N	N	N
Overlap	A	A	D	D	D	D

A = Supported

- N = Not supported
- D = Continue with Blending mode
- 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.



# 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 Configuration



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 Setting

The section describes setting funcitons including interrupt, filter and polarity of IOs in DIO device.

Double-click on "DIO" to enter the configuration page.					
Devices		Val altri in the	Val at at a set of the		

levices	+ + X PLC_PRG	Delta_LocalBus_Master	EtherCAT_Master_SoftMotion	DIO X 😂 Ta	sk POU
Dintitled1	· Dio Configuration				
= Device (AX-308EA0MA1T)	DIO Configuration	Configuration			
Hardware Configuration	DIO 1/O Manajara	(1)	(2)	(3) (4)	
A Network Configuration	bto to Happing		Interrupt Port	Filter (0.01us) Po	larity
A EtherCAT Filter	Status		INO	100	-14-
E I PLC Logic	20000	IN 0	f f f		
😑 🔘 Application	Information		IN 1	100	-1/-
Library Manager			_] ↓ J ↓ IN 2	100 🗘 🕂	-11-
PLC_PRG (PRG)		IN 2	f ] f] IN3	100	-14-
POU (PRG)					
😑 🌌 Task Configuration		IN 3	J t Jt IN4	100	-1/1-
🖻 🥩 EtherCAT_Task		TIN 4	1 IN 5	100	-11-
PLC_PRG			IN 6	100	11-
= 🍪 Task		🗌 IN 5	1 + 1 +		
el POU		- Inc		100	
Delta_LocalBus_Master (Delta LocalBus M	laster)	L IN 6	IN 8	100	- <b>N</b> -
EtherCAT_Master_SoftMotion (EtherCAT	Master SoftMotion)	IN 7	TI TI IN 9	100	-14-
Builtin_IO (Builtin_IO)				100 4 11	
DIO (DIO)			1 + 1 +	100	VE
<pre>K <empty></empty></pre>		IN 9	4 1 +1 IN 11	100 🕴 🕂	-V-
Pulse_Encoder (Pulse_Encoder)			IN 12	100 + ++	-14-
*  Capture_Compare (Capture_Compare)	e)	IN 10	1 + 1+	100	AL
Pulse_Output (Pulse_Output)		[] IN 11	<b>F F</b>	100	
SoftMotion General Axis Pool			IN 14	100	-1-
		IN 12	IN 15	100	-14-
			Forder A1	100 4	
		IN 13	7 4 14	100	
		IN 14	Encoder B1	100	-11-
			Encoder Z1	100	-11-
		IN 15	1 + 1 + Encoder A7	100	AL
		Encoder		100 .	
			Encoder B2	100	-N-
		Encoder	Z2 Encoder Z2	100 4	-1-
			SSIDATA	100	AL
			JSIDAIA		

# Configuration

Function	Description	
External Interrupt	Default value	
	Activate external interrupt	
	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.	
2 Port	Port number	
③ Filter	Set filter time (us), setting range is from 0 to 100000000. The default is 100us.	
@ Polority	E Set input polarity. The default is contact A.	
	Set input polarity, The default is contact B.	



- 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 X
Untiled1 Device (AX-308EA0MAIT) Hardware Configuration A Network Configuration A EtherCAT Filter PLC Logic O Application Utrary Manager PLC_PRG (PRG) POU (PRG) EtherCAT_Task PLC_PRG EtherCAT_Tas	Configuration Priority ( 0.31 ): Type Cyclic
<ul> <li>EtherCAT_Master_SoftMotion (EtherCAT Master SoftMotion)</li> <li>Builtin_IO (Builtin_IO)</li> <li>DIO (DIO)</li> <li>C <empty></empty></li> <li>Pulse_Encoder (Pulse_Encoder)</li> <li>Capture_Compare (Capture_Compare)</li> <li>Pulse_Output (Pulse_Output)</li> <li>SoftMotion General Axis Pool</li> </ul>	POU Comment ④) POU



■ Then choose the corresponding interrupt contact from the drop down list of External event.

Devices - 4 X	🔮 Task 🗙
Unbiled I Device (AX-308EA0MA IT) Hardware Configuration A Herwork Configuration A EtherCAT Filter PLC Logic PLC Logic PLC PRG PLC PRG (PRG) PLC (PRG) PLC (PRG) PLC (PRG) PLC (PRG) PLC PRG Task PLC PRG PLC PRG Task PLC PRG Task PLC PRG Task PLC PRG Task PLC PRG Task PLC PRG </td <td>Configuration Priority (031 ):  Type  Deternal Deternal Deternal Deternal Deternal Deternal Deternal Deternal Deternal Deternal Deternat</td>	Configuration Priority (031 ):  Type  Deternal Deternal Deternal Deternal Deternal Deternal Deternal Deternal Deternal Deternal Deternat

- The setting value for hardware filter time is smaller than IN input duty on time as shown below:
  - The input range for hardawre filter is from 0 to 50,000,000, unit as 0.01µs



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:  $0.01\mu$ s). 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 Setting

The IO end of AS508ECT supports one set of SSI encoder function. Through connecting D-SUB port and PLC, the port provides 5V encoder power output. 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.

		Counter SSI
	1.1	Counter 0
	IN IN	
	0 8	Z Phase use OC Capture
		Counter 2 Capture 1
SSI Data	1 9	Counter 3 Capture 2
551	2 10	Counter 4 Capture 3
SSI Clock	3 11	Counter S Capture 4
	4 12	Counter 6
	5 13	Counter 7
	6 14	Timer Capture 6
	7 15	Timer 0 Capture 7
	5/50 5/51	Timer 1
	2122 2122	Timer 2
		Timer 3
AL	our our	Compare 1
81	0 4	Timer 5 Compare 2
Z1		Compare 3
A2	1 5	Axis Compare 4
82	2 6	Pulse Output Axis 0 Compare 5
n n		Pulse Output Axis 1 Compare 6
		Pulse Output Axis 2 Compare 7
	co co	



The SSI related configuration can be set on the SSI Encoder Configuration page. Refer to below descriptions for settings respectively.

	General			
SSI Encoder Configuration	Clock Frequency		Clock Pause Time	•
Status				
Information	DataX	X_) X single-Tu	m Data	
	Encoder Type: Gray Code ~ Clock Frequency: 500	kHZ Clock Paus	e Time: 80	∎ us
	Single Turn Setting: 13	Multiple Tu	rns Setting: 12	•
	Axis Standard	4	Positive Command	Negative Command
	Encoder Type: SSI Encoder	Reverse OFF	(Go).	Con.
	Linear Axis     Rotary Axis		cw	ccw
	Annual 200 à Court	O Reverse On	Con.	67
	5 Transmission Mechanism		COW	CW
	Mechanism Type Ball Screw	Mechanism Setti (1) Command p (4) Pitch: 1	ing ulse per motor rotation: 1 Unit ]	Pulse ]
		Gear Box		
		Case Dalia a	(2) Gear ratio numerator	1

① General

Item	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)	(500)
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)



Item	Function	Setting value (Default value)
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

Item	Function	Setting value (Default value)
Encoder Type	Display encoder type	-

# 3 Axis Type

ltem	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.

### S Transmission Mechanism

Different structures are presenred in the following descriptions:

### Ball Screw

nanism Type	Ball Screw	*	(1) Command p	ulse per motor rotation: 1	+	[ Pulse ]
			(4) Pitch: 1			
	<b>CO</b>		Gear Box			
	(5)		C	(2) Gear ratio numerator	1	¢
			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

# Round Table

Mechanism Type	(2)	(4)	(1) Command pi (4) Movement d	ulse per motor rotation: 1	<b>₽</b> [P	ulse ] [ Unit ]
Å	6	U;	Gear Box		-	
				(2) Gear ratio numerator	1	
			Case Datis -			

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

Mechanism Type	Belt Pully	*	(1) Command pu	ulse per motor rotation: 1		[ Pulse ]
		(4)	(4) Diameter: 1 Movement distan	[ Unit ]	er*n	
	ĚC)		Gear Box			
	(3)		Con Della	(2) Gear ratio numerator	1	-
			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) Diameter (Movement distance motor rotation : Diameter *n)	Distance of movement per revolution of the motor. (Movement distance per rotation : Diameter *n)
(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.

Parameter	Description
EncoderPosition	Actual position of SSI Encoder
	Status of SSI Encoder Communication.
FrierD	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).



■ Click "IEC Objects" on BuiltIn\_IO page.

### Example of variable reading

Hardware IO Configuration	Variable	Туре	Configuration Function
	SSI_Encoder	DFB_SSI_ENCODER_REF	SSI Encoder
SSI Encoder Configuration	Encoder_Axis_1	DMC_ENCODER_AXIS_REF	SSI Encoder/FreeEncoder_Axis
IEC Objects			
Status			
Information			

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	Type	Configuration Function
SSI Encoder Configuration	Encoder_Axis	DMC_ENCODER_AXIS_REF	SSI Encoder/FreeEncoder_Axis
IEC Objects			
Status			
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 Setting

The connecting method for AX series and pulse-type encoders supports interface regarding differential input (2 sets) and open collector for pulse input (6 sets). Through connecting D-SUB15 port and PLC, the differential interface has 2 sets of high-speed counter to count the amount of encoder's pulse value or frequency; the open collector for pulse input regarding the external encoder requires connecting input points on the IO boards, the section contains 6 sets of high seepd counter to count the amount of encoder's pulse value or frequency. You need to click and enable pulse-type encoder function for required parameter settings, then receive encoder's data via hardware configuration channels.

The section describes the pulse-type encoder function modules of the IO (see below), the maximum amount concerning AS308E support for high speed counter and the total of high speed timers are 8 sets.

### • 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
  - 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 0, which has been selected on the previous page.

Hardware IO Configuration	Counter	D	
Counter Configuration	Counter	Mode	1
the rest of a second		Counter Mode	Description
IEC Objects			Clockowse Pulse
Status	0	UD	Counter-clockwise Pulse
Information			





- Hardware IO Configuration Counter 0 Dcounter Mode Counter Configuration Counter Mode Description IEC Objects Clockwise Pulse T\_f Status UD wise Pube Information Pulse ÷ PD Direction Clockwise A-Phase Pulse f 7 ٦ ſ ۲ AB B-Phase Pulse A-Phase Pulse ÷ 4AB 8-Fhase Pulse External Trigger 2 Axis Standard 4 Positive Command Negative Command Encoder Type: Incremental Encoder Reverse OFF 3 Axis Type Linear Axis O Rotary Axis CCW Modulo: 360 \* [Unit] O Reverse On CCW 5 Transmission Mechanism Mechanism Setting Mechanism Type Ball Screw (1) Command pulse per motor rotation: 1 Pulse ] (4) Pitch: 1 \$ [ Unit ] (1) Gear Box (2) Gear ratio numerator 1 . 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
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

Refer to section **7.7.7.3 SSI Encoder Setting** for ② ③ ④ ⑤ 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.

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	ICnt_0
	Counter_0	DFB_COUNTER_REF	Counter 0	DFB	HCnt
Counter Configuration	Encoder_Axis	DMC_ENCODER_AXIS_REF	Counter 0/FreeEncoder_Axis	EN	ENO
EC Objects				Counter_0 - Counter	bValid -
tatus				-bEnable	bBusy -
					bError -
formation					ErrorID -
				d	iCounterValue -

■ 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 IO Configuration	Variable	Type	Configuration Function	1			MC_Gea	arIn_0
Counter Configuration EC Objects Status Information	Counter_0 Encoder_Axis	DRC_DIVICIONITEL_REF	Counter 0,FreeEncoder_Avis		SM_Dr	TRUE	MC_Ge Master Slave Execute RatioNumerator Acceleration Deceleration	sarIn ENO- InGear- Busy- CommandAborted- Error- ErrorID-



# High speed timer (Tmr)



# • Enable high speed timer function

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 between 8 sets of Timer on BuiltIn\_IO page to activate with no configuration page required.




- Timer mapping variable setting
  - Right click "BuiltIn\_IO" and choose Edit IO Mapping.



Click 🛄 to add new variables on Edit IO Mapping page.

Find	Filter S	Filter Show all		- Add FB for IO Chan
Variable	Channel	Address	Туре	Description
🖻 - 🚮 DIO				
🛞 – 🍫	IN:0-7	%IB0	BYTE	8-CH Open Collector Input
🛞 - 🏘	IN:8-15	%IB1	BYTE	8-CH Open Collector Input
🗎 – 🍫	Encoder	%IB2	BYTE	2-CH of Incremental Encoder Input
😟 - 🦘	OUT:0-7	%QB0	BYTE	8-CH Open Collector Output
= M Pulse_Encoder				
🖹 🛱 Timer_0				
L.*	Timer Value	%ID1	DWORD	HSIO Timer Value



### • Use Timer in program

The Timer variables can be used for MC function blocks in POU.

■ Click "IEC Objects" on BuiltIn\_IO page.

Status	1		-
Status	L. L. L. L. L. L. L. L. L. L. L. L. L. L	Counter	SSI
		Counter 0	SSI Encoder
$\smile$		Z Phase use OC	Capture
	IN IN C	Counter 1	Capture 0
	0 8 C	Z Phase use OC	Capture 1
	1 9 L	Counter 2	Capture 2
SSI	2 10	Counter 4	Capture 2
	3 11	Counter 5	Capture 3
	4 12	Counter 6	Capture 4
1.1	5 13	Counter 7	Capture 5
		Timer	Capture 6
		Timer 0	Capture 7
	7 15	Timer 1	
	5/50 5/51	Timer 2	Compar
		Timer 3	Compare 0
A1 Tmr CH0	ουτ ουτ	Timer 4	Compare 1
B1	0 4	Timer 5	Compare 2
71		Timer 6	Compare 3
A2	1 5	Timer 7	Compare 4
82	2 6	Polse Output Avis 0	Compare 5
22		Pulse Output Axis 1	Compare 6
		Pulse Output Axis 2	Compare 7
Encoder	co co	Pulse Output Avis 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 Timer\_0.

	Type	Configuration Function
Timer_0	DFB_TIMER_REF	Timer 0
	Timer_0	DFB_TIMER_REF



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 Setting

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

are 10 Configuration	In		1 _ Configuration	
jects	Status		UI	
			Counter	201
			Z Phase use OC	D 201 EUCODEL
ation		IN IN	Counter 1	Capture
		Cap ExternalTrigger 0 0 8	Z Phase use OC	Capture 0 IN 0
	12.5		Counter 2	Cap
	1		Counter 3	Capture 2
	SSI	2 10	Counter 4	Capture 3
		3 11	Counter 5	Capture 4
	1 7 7	4 12	Counter 6	Capture 5
		5 13	Counter 7	C Contract
		6 14	Timer	Ceptore o
		7 15	Timer 0	Capture /
		5/50 5/51	Timer 1	Compare
		<u></u>	Timer 2	Comments
		lour our	Timer 3	Compare u
	1 1 1 1	001 001	Timer 4	Compare 1
	B1	0 4	Timer 5	Compare 2
	21		Timer 6	Compare 3
	A2		Timer 7	Compare 4
	82	2 6	Pulse Default Aves D	Compare 5
	n	3 7	Duine Output Avis 1	Compare 6
		<b>G G</b>	Date Output hots 1	Compare 7
		0 00	Puse Output Aos 2	-) and all a

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

The Capture variables can be used for MC function blocks in POU.

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 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.





- BuiltIn\_10 × Configuratio Hardware IO Configuration Status Ľ IEC Objects 551 Counte L Counter 0 5SI Encoder Status Z Phase use OC Capture Information Counter 1 Capture 0 Z Phase u 8 Capt ure 1 Counter 2 1 9 Counter 3 Capture 2 2 10 SSI Counter 4 Capture 3 3 11 Counter 5 Capture 4 Counter 6 4 12 Capture 5 Counter 7 5 13 Capture 6 Time 6 14 Capture 7 Timer 0 15 7 Timer 1 Compare 5/50 5/51 Timer 2 Timer 3 OUT 0 OUT OUT Compare 1 Timer 4 A1 OUT 1 OUT 2 OUT 3 0 3 Timer 5 Compare 2 4 81 Timer 6 Compare 3 **Z1** OUT 4 OUT 5 OUT 6 OUT 7 5 1 Timer 7 Compare 4 A2 A 2 6 82 Compare 5 Pulse Output Axis 0 22 Compare 6 3 7 Pulse Output Axis 1 CO CO Pulse Output Axis 2 Compare 7 Encode Pulse Output Axis 3
- 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.

- BuiltIn\_IO X Configuration Hardware IO Configuration Status IEC Objects Counter SSI Counter 0 SSI Encoder Status Z Phase use OC Capture Information Counter 1 IN IN Captur Z Phase use OC 8 Capture 1 Counter 2 1 9 Counter 3 Capture 2 10 SSI Counter 4 Capture 3 11 3 Counter 5 Capture 4 12 Counter 6 Capture 5 13 Counter 7 Capture 6 Time 14 6 Capture 7 Timer 0 7 15 Timer 1 Compare 5/50 5/51 Timer 2 Compare 0 OUT 0 v Timer 3 OUT Compare 1 OUT Timer 4 A1 Timer 5 Compare 2 ncidentOutput 0 1 81 4 Timer 6 Compare 3 **Z1** 1 5 Timer 7 Compare 4 AZ Axis 2 6 Compare 5 B2 Pulse Output Axis 0 22 Compare 6 3 Pulse Output Axis 1 7 Compare 7 Pulse Output Axis 2 CO C0 Pulse Output Axis 3 П
- 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			
Information			

■ For DFB\_Compare function block in POU, enter Compare \_0 as the axis name.





### 7.7.7.6 Pulse Output Function Setting

This section introduces pulse output function modules with built in IO shown as follows. A maximum of 4 groups pulse-output unit can be chosen to use with AX-308E series motion controllers.

• Activate axis function

Choose one of the four pulse output axes to activate on BuiltIn\_IO page.



Click "PoAxis Configuration" after activating Axis.

Configuration	Status	P. 1 1		
jects			Counter 0 Z Phase use OC	SSI
		Po Axis CH0 LSP 0 8	Counter 1 Z Phase use OC	Capture 0
ación	12.5	Po Axis CH0 LSN	Counter 2	Capture 1
		Po Axis CH0 Z	Counter 3	Capture 2
	551	Pa Axis CH0 Hame Switch	Counter 4	Capture 3
		3 11	Counter S	Capture 4
	1 5 2	4 12	Counter 6	Canture 5
		5 13	Counter 7 Timer	Capture 6
		6 14	Timer 0	Capture 7
		7 15	Timer 1	
		5/50 5/51	Timer 2	Compare
	$\cap$		Timer 3	Compare 0
	1	OUT OUT	Timer 4	Compare 1
	BI	Po Axis CH0 A	Timer 5	Compare 2
	71	Po Axis CH0 B	Timer 6	Compare 3
	A2	1 5	Timer 7 Axis	Compare 4
	82	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	



	Y		Virtual mode     Linear Axis	Linear Axis Softwar	re Limits	
) Reverse OFF	Positive Command	Negative Command	🚫 Rotary Axis	Activated Negative [u]: 0 Positive [u]: 100 Rotary Axis Modulo Modulo value [u]:	0 Setting 360	A.
) Reverse On	Contraction of the second seco	CON CON	Motion Paramet Error Reaction Quick Stop Velocity Ramp Trapezoid	Deceleration [u/s Type O Sin <sup>2</sup> O Quadr	2]: 1000 atic 🔿 Quadra	tic(smooth)
ansmission Me Mechanism Typ	e Ball Screw ×	Mechaniss (1) Comn (4) Pitch:	n Setting and pulse per motor 10000	rotation: 10000 Unit ]	🛔 [ Pulse	]
		Gear Box				121

Click to enter Axis 0 tab on PoAxis Configuration page.



• Axis-related settings can be configured on Pulse Output Setting page, which is described in the following information.

ulse Outnut Satting			
Mode Cetting			Onvie Tune and Limite
Houe Setting			Virtual mode
Mode A/B	Ť		Linear Avia Linear Axis Software Limits
	Positive Command	Negative Command	Rotary Axis     Activated
	0	0	Negative [u]: 0
	( PO -	( 0.	Desitive fully 1000
Deverse OFF	(00)	(00)	Positive [u]: 1000
Reverse OFF	1007	1007	4 Rotary Axis Modulo Setting
	18-	-	Modulo value [u]: 360
	CCW	CW	Motion Parameter
	60	600	5 Error Reaction
	1da	( An	Ouick Stop Deceleration [u/s2]: 1000
) Reverse On	VOS-	1084	C C C C C C C C C C C C C C C C C C C
		le	6 Velocity Ramp Type
	CW	CCW	Trapezoid
		Gear Box - Gear	Ratio = (2) Gear ratio numerator 1 (3) Gear ratio denominator 1
oming Setting			
oming Setting Homing Mode Mc	ode 35 🗸 🗸		
oming Setting Homing Mode Mc Homing speed dur	ode 35 v	€ [ Unit/s ]	
oming Setting Homing Mode Mo Homing speed dur	ing search for switch 100	T [Unit/s]	
oming Setting Homing Mode Mod Homing speed dur Homing speed dur	ing search for switch 100	● [ Unit/s ] e 50 ● [ Unit/s ]	
oming Setting Homing Mode Mo Homing speed dur Homing speed dur Homing Acceleratio	ode 35 v ing search for switch 100 ing search for z phase puls on 1000 4 U		
oming Setting Homing Mode Mo Homing speed dur Homing speed dur Homing Acceleratio Description	ode 35 v ing search for switch 100 ing search for z phase puls on 1000 + [Ur		
oming Setting Homing Mode Mod Homing speed dur Homing speed dur Homing Acceleratio Description Mode 35 : E	ode 35 v ing search for switch 100 ing search for z phase puls on 1000 + [ Ur Depending on the	E [ Unit/s ]     E 50     I Unit/s ]     it/s²] current position	
oming Setting Homing Mode Mod Homing speed dur Homing speed dur Homing Acceleratio Description Mode 35 : E	ode 35 v ing search for switch 100 ing search for z phase puls on 1000 t [ Ur Depending on the	e 50 € [Unit/s] e 50 € [Unit/s] nit/s²] current position	
oming Setting Homing Mode Mod Homing speed dur Homing speed dur Homing Acceleratio Description Mode 35 : E	ode 35 v ing search for switch 100 ing search for z phase puls on 1000 t [ Ur Depending on the	e 50 € [Unit/s] e 50 € [Unit/s] it/s²] current position	
oming Setting Homing Mode Mod Homing speed dur Homing speed dur Homing Acceleratio Description Mode 35 : C	ode 35 v ing search for switch 100 ing search for z phase puls on 1000 v [Ur Depending on the In mode 35, The hom	I Unit/s ]  I Unit/s ]  I Unit/s ]  I Unit/s ]  Current position  Ing instruction is executed	, the axis does not move and its current position is regarded as

### 1 Mode setting

Item	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)
		TRUE
Virtual	Activate virtual axes.	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

ltem	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

ltem	Funtion	Setting Value (Default)
Trapezoid/Sin <sup>2</sup> /Quadratic/ Quadratic (Smooth)	Set the ramp type for axis motion.	(Trapezoid)

 $\oslash\,$  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.



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.

£	MC		1
	M	TRUE	
ENO	N		
Status	xis	Pulse_Output_Axis_0	
atorRealState	nable		
tartRealState	RegulatorOn		
Busy	DriveStart		
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.

s + 4 X	Device 🎁 Library Ma	anager 👔 PLC_PRG 🚮 DIO 🗃 BuiltI	x 01_n	
Unstied I     Device [connected] (AX-308EA0M/     A Hardware Configuration     A Network Configuration	Hardware IO Configuration	Pulse_Output : Last Diagnostic Message	Bus failure	Acknowledg
E PLC Logic	IEC Objects	Diagnosis Message: "Pulse axis channel 0 has er	ror	
Library Manager	Status			
PLC_PRG (PRG)	Information			
= 🖸 🍪 MainTask	2			
- C S Task				
= A 🛐 Builtin_IO (Builtin_IO)				

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)
PLC Logic     Application [run]	IEC Objects	variable	set value	actual value	Errors
Library Manager	Status	Position [u]	0.004	0:004	- Axis Error: 0 [16#00000000]
PLC_PRG (PRG)		Velocity [u/s]	0.	0	FB Error:
= 😳 🌚 MainTask	Information	Acceleration [u/s2]	D.	0	SMC_ERROR.SMC_FB_WASNT_CALLED_DURING_MOTION
D PLC_PRG		Torque [Nm]	0.	0	uiDriveInterfaceError:
		Reverse OFF     Reverse On	cow	cw	Rotary Axis     Activated       Negative [u]:     0       Positive [u]:     1000       Rotary Xois     Modulo Setting       Modulo value [u]:     360       Motion Parameter     Error Reaction       Quick Stop     Deceleration [u/s <sup>3</sup> ]:       1000     \$
		le	~ /		Velocity Ramp Type



## 7.7.80ther 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	imits	Motion Parameter			
Homing Setting	Linear Axis     Rotary Axis	Linear Axis Software Limits	Quick Stop	Deceleration [u/s <sup>2</sup> ]: 100	•	
Commissioning SM_Drive_ETC_Delta_ASDA_A2:		Negative [u]: 0	Velocity Ramp Type Trapezoid	e Sin² () Quadratic () Quadr	ratic(smooth)	
Status		Rotary Axis Modulo Setting Modulo value [u]: 360	Position Lag Supervi Position Lag Reaction	sion Deactivated *	Lag Limit [u]: 1	A V
information	Transmission Med	chanism	Mechanism Setting			
	Mechanism Typ	e Ball Screw	(1) Command pulse	per motor rotation: 131072	Pulse ]	
	(1)		(4) Pitch: 1	🗣 [ Unit ]		
			Gear Box			
	V	(3)	Case Daka	(2) Gear ratio numerator	1	
			Gear Katio =	test and the second second		

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.

Setting mode Function Deactivated Not activated. Disable drive When position lag exceeds limit setting, axis will shift to servo off. When position lag exceeds limit setting, axis will shift to quick stop. Do quickstop Stay enabled When position lag exceeds limit setting, axis will remain as servo on. B# SM\_Drive\_ETC\_Delta\_ASDA\_A2 X General Setting Axis Type and Limits Motion Parameter Virtual mode Error Reaction Homing Setting Linear Axis Software Limits Linear Axis
 Rotary Axis Quick Stop Deceleration [u/s<sup>2</sup>]: 1000 + Activated Commissioning Negative [u]: 0 ¢ Velocity Ramp Type ● Trapezoid ○ Sin<sup>2</sup> ○ Quadratic ○ Quadratic(smooth) SM\_Drive\_ETC\_Delta\_ASDA\_A2: IEC Objects Positive [u]: 10000 -Rotary Axis Modulo Setting Position Lag Supervision Status Modulo value [u]: 360 4 \$ Stay Enabled Lag Limit [u]: 100 Position Lag Reaction ¥ Information Transmission Mechanism Mechanism Setting Mechanism Type Ball Screw (1) Command pulse per motor rotation: 10000 Pulse ] (4 (4) Pitch: 10000 \$ [ Unit ] Gear Box (2) Gear ratio numerator -1 Gear Ratio = + (3) Gear ratio denominator 1

The position lag reaction is set to be "Stay Enabled" as default.



### 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



- 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 Configuration

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		
figuration		
riority ( 031 ):		
Type Cyclic ~	Interval (e.g. t#200ms): 4000	µs ∨
Watchdog		
Enable		
Time (e.g. t#200ms):		ms
Sensitivity:		
🕈 Add Call 🗙 Remove Ca	I 📝 Change Call   🖈 Mave Up 🔿 Mave Down   → 🛛 Open POU	
POU	Comment	
EcatMotion		

Set the gear ratio as 10000:10000 for mechanism setting.

ocheron occurry	Axis Type and Limits	Motion Parameter
Homing Setting	Virtual mode     Uinear Axis     Linear Axis Software Limits     Patary Axis     Activated	Error Reaction
Commissioning	Negative [u]: 0	Velocity Ramp Type  Trapezoid Sin <sup>2</sup> Ouadratic Ouadratic(smooth)
SM_Drive_ETC_Delta_ASDA_A2: IEC Objects	Rotary Axis Modulo Setting	Position Lag Supervision
Status	Modulo value [u]: 360	Position Lag Reaction Stay Enabled V Lag Limit [u]: 100
	Mechanism Type Ball Screw	Mechanism Setting (1) Command pulse per motor rotation: 10000 (4) Pitch: 10000 (4) Pitch: 10000 (5) (5) (5) (5) (5) (5) (5) (5) (5) (5)
		Gear Box (2) Gear ratio numerator



### 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

1

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.

-	Start ServoOn
2	
	MC_Power_0
	MC_Power
	SM Drive Virtual - Axis Status TRUE
	ServoOn TRUE Enable bRegulatorRealState TRUE
	TRUE bRegulatorOn bDriveStartRealState TRUE
	TRUE bDriveStart Busy - TRUE
	Error FALSE
	ErrorID - SMC_NO_ERR

#### 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.

	•		
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

#### • Main variables used in programming

#### Timing Diagram





### LD Language

	MC Power 0	MC_MoveVelocity_0
	MC_Power	MC_MoveVelocity
SM_Drive_virtual = Axis ServeOn_TRUE_Enable IRUE_beRegulaced TRUE_beRegulaced	LAND Status THUX bRegulacozkesiSteate n bDriveStartResiState Busy Error Frida Strort Strort	M Drive Virtual Axia InVelocity Acceleration Error I MC_MoveVelocity0_Execute TRUE Execute Bary I 10000 - Velocity CommandAnceted I MC_MoveVelocity2_Acceleration 0 - Acceleration Error I 10000 - Deceleration Error I 1000 - Deceleration Error I
SM Drive Virtual - Ax MC_Reset_0_fscute 73597	MC_Reset_0 MC_Reset Done TALSE TALSE TALSE TALSE TALSE TALSE SI SI SI SI SI SI SI SI SI SI	HC ReadStatus NC ReadStatus NC ReadStatus SM Drive Virtual Axis TAIK Enable Exacts Exacts Disabled Disabled ContinuousMotion Stopping ContinuousMotion Stopping ContinuousMotion Stopping ContinuousMotion Stopping ContinuousMotion Stopping ContinuousMotion Stopping ContinuousMotion Stopping ContinuousMotion Stopping ContinuousMotion Stopping ContinuousMotion Stopping ContinuousMotion Stopping ContinuousMotion Stopping ContinuousMotion Stopping ContinuousMotion Stopping Stoppin

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.

MC M SM_Drive_Virtual = Axis MC_Reset_O_Excute #XAGE Execute	Reset_0 Reset_ Done File Busy File Error File (ErrorID - 196, 80	SM_Drive	N Virtual	C_ReadStatus_O NC_ReadStatus Valid Bany Error BroorID Disabled Erroratop Stopping St	C: TURE TURE TALSE	inatin IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	Drive_Virtual	SHC_ClearFletror
Watch 1								
Expression	Application	Туре	Value		Prepared v	Executionpoint	Address	Comment
PLC_PRG.MC_MoveVelocity_0	Device.Application	SMC_ERROR	SMC_MV_INVALI	D_ACCDEC_VALUES		Cyclic Monitoring		Error identification
				SMC_ERROR.SM	C_MV_INVALI	D_ACCDEC_VALU	ES' represei	nts raw value '301'

#### Disable Execute input of MC\_MoveVelocity to update the status of Error output.

	M	C_Power_0				MC_Move	Velocity_0	
	<u>(</u> )	MC_Power				MC_Mov	eVelocity	
ER	Ŧ	ENO			1 A	EN	ENO	-
SM Drive Virtual Az	Kis .	Status -	TRUE	51	M Drive Virtual	Axis	InVelocity	FALSE
Servoon TRUE Er	nable	bRegulatorRealState -	TRUE	MC_MoveVelocity0	Execute FALSE	Execute	Busy	FALSE
TRUE	RegulatorOn	bDriveStartRealState -	TRUE		10000 -	Velocity	CommandAborted	FALSE
IRUE - bE	DriveStart	Busy -	TRUE	MC MoveVelocity0 Accelerat	tion 0	Acceleration	Error	FALSE
		Error -	FALSE		10000 -	Deceleration	ErrorID-	SMC N
		Frent TD - 1	MC NO ERR		10000 -	Jork		



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.

#### • 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
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.





### LD Language

Check if any errors have occurred in MC\_Power before moving onto the next step.

1	Start	ServoOn
	MC_Power_0     MC_MoveVelocity_0       MC_Power     MC_MoveVelocity_0       SM_Drive_Virtual     MXIB     Status     THUE     SM_Drive_Virtual     MXIB     TASES       SM_Drive_Virtual     Axis     InVelocity     TASES       SM_Drive_Virtual     Axis     INVelocity     TASES       SM_Drive_Virtual     Axis     INVelocity     TASES       TRUE     BogulatorhealState     TTUE     CommandBood     CommandBood       TRUE     DEVISION     TOTES     TASES       TRUE     CommandBood     CommandBood     CommandBood       TRUE     TOTES     TOTES     TASES       TRUE     CommandBood     CommandBood       TRUE     CommandBood     CommandBood     CommandBood       TRUE     TOTES     TOTES     TOTES       TRUE     CommandBood     CommandBo	
3	MC_Power_0.Status	ProgNext ——(■)

### • ST Language

Enable:= ServoOn, bRegulatorOn:= TRUE, bDriveStart:= TRUE,

bRegulatorRealState=> , bDriveStartRealState=> ,

Status=>,

Busy=> , Error=> , 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,

PLC1

### 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=> ,
    Error=> ,
    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.



eral Setting	Homing Mode Mode 33		
ning Setting	Homing speed during search for switch 1000		
nmissioning	Homing speed during search for z phase pulse 100 101 [0,1 rpm ] Homing Acceleration 100 10 [1ms ]		
Drive_ETC_Delta_ASDA_A2: Objects	Description		
s	Mode 33 : Depending on Z pulse in the negative directio	n	
mation	In mode 33, The homing instruction is executed and the axis move	es at the second-phase speed ( Homing	g speed
	during search for Z phase pulse ) in the negative direction. And the p	place where the axis stands is the home	position
	once the first 7 pulse is met		
	once the list 2 pulse is met.		
			-
			1
			-0
	Stop point Start	point	=0
	Stop point Negative direction	point	=0
	Stop point Negative direction	point	1
	Stop point Negative direction	point	=0
	Stop point Negative direction	point	=0
	Stop point Negative direction	point	=0
	Stop point Negative direction	point	1

### • 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	MC_MoveAbsolute
EN	ENO	EN EN
Axis_1 - Axis	Status - TRUE	Axis_1 - Axis Don
Servoon THUE Enable	bRegulatorRealState TRUE	MC_MoveAbsolute0_Execute IRVE Execute Bus
TRUEbRegulator	On hDriveStartRealState TRUE	50000 Position CommandAborte
TRUE - bDriveStar	E Busy - TRUE	10000 Velocity Erro
	Error - FALSE	100000 - Acceleration ErrorI
	ErrorID - SMC NO E	100000 — Deceleration
		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.

• 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
CamTable1	MC_CAM_REF	-	Relating variables for Cam table1
CamTable2	MC_CAM_REF	-	Relating variables for Cam table2
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

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 :

30	slave				 	•						
20	positi	 	 	 			<u> </u>		 			
10	- <u>-</u>	 	 	 	 		 					
		 	 <u> </u>	 				<u> </u>	 	ma	ister posi	tion [u]

### CamTable2 :

300	slave			 	 ļ	<b>.</b>	 				
200	positio	 	 				 				
100	. 9 	 		 	 		 				
	· 	 						 	m	aster <u>pos</u>	ition [u]



7

• 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	

#### • LD language

Set StartFlag to be TRUE, then the normal operation of communications for both master and slave axis would be checked respectively







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.




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=> ,
Error=> ,
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.





#### 7.8.2.8 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.

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.

#### • Main variables used in programming

#### CamTable :

700	<u>n</u>	 	 	 	 	¢		 	 		
509	ve po	 			 		 	 	 		
200	itio	 	 		 		 	 	 		
-	5 E	 	 	 	 			 	 		
100		 ·	 ·					 	 ma	ster pos	ition [u]



#### • Timing diagram

StartFlag				
MC_Power0_Status				
MC_Power1_Status				
MC_MoveVelocity_InVelocity				
MC_CamIn1_InSync				
PhasingActive				1 
MC_Phasing_Done				
Axis_Master. fSetPosition				
Axis_Master. fSetVelocity	/			 
Axis_Slave. fSetPosition		~~~~~		
Axis_Slave. fSetVelocity			$\wedge$	

#### • LD language

Set StartFlag to be TRUE, then the normal operation of communications for both master and slave axis would be checked respectively.







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 Home	MC_Home0_Done
Axis_Master - Axis Done	(0)
Busy - FALSE	
MC Power0 Status CommandAborted - FALSE	
Execute Error PALSE	
0 Position ErrorID SMC NO ERB	
MC_Home_1	
MC Bome	MC Homel Done
Axis Slave HAxis Done	([])
Axis_Slave — Axis Done Busy — FAMSE	([]) <sup>_</sup>
Axis_Slave_HAxis Done Busy_ HALSP MC Power1 Status CommandAborted PALSP	
Axis_Slave_Haxis Done Busy_FXLSE MC_Power1_Status CommandAborted FXLSE Evecute Effort FXLSE	([]) <sup></sup>
Axis_Slave_Axis Done Busy FALSE MC_Power1_Status CommandAborted FALSE Decite Error FALSE ADDRESS	([]) <sup>_</sup>

	MC_MoveVeloci	ty	MC_MoveVelocity_InVelocity
Axis_Mas	ter HAxis 1	nVelocity	
		Busy - FALSE	
MC_Home0_Done	Contine	andAborted - 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		

After the homing operation of master axis is completed, execute MC\_MoveVelocity.



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.

	MC_Phasing_0		
	MC Phasing	MC_Pha	asin
Axis_Maste	Master Done		-(0)
Axis_Slav	-Slave Busy - PALSE		
	CommandAborted - PALSE		
PhasingActive MC_CamIn1_InSyn	Error - FALSE		
	Execute ErrorID SMC_NO_ER	R	
1-1			
MC_Phasing_PhaseShift 500	PhaseShift		
MC_Phasing_Velocity 300	Velocity		
MC_Phasing_Acc 5E+03	Acceleration		
MC Phasing Dec 5E+03	Deceleration		



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	IC_SetPosition_Position LREAL 3		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
			(I)
			MC_Power0_RegulatorOn
			· · · · · · · · · · · · · · · · · · ·
			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.





After the homing operation of axis is completed, execute MC\_MoveRelative.

	The	target	position	of rela	ative di	splaceme	ent = 8000
--	-----	--------	----------	---------	----------	----------	------------

4			
		MC_MoveRelative_0	
		MC_MoveRelative	MC_MoveRel_Done
	Axis_Virtual 📛	Axis Done	· · · · · · · · · · · · · · · · · · ·
		Bus	- MC_MoveRel_Busy PALSE
	MC_Home0_Done	CommandAborted	- FALSE
		Execute Error	FALSE
	MC_MoveRel_Distance 8E+03 .	Distance ErrorII	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
```

// 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=> );

7-170

#### 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.

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.

#### Main variables used in programming



7

#### AX-3 Series Operation Manual

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

StartFlag	
MC_Power0_Status	
MC_GearIn_InGear	
MC_MoveAbs_Exceute	
MC_MoveAbs_Done	
MC_MoveSuperImPosed_Execute	
MC_MoveSuperImPosed_Done	
3000 Axis_Master.fSetPosition	
Axis_Master.fSetVelocity	
7000 Axis_Slave.fSetPosition	
Axis_Slave.fSetVelocity 2000	



#### • 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	StartFlag	Axis_Slave.bCommunication	MC_Power1_Enable ([]) MC_Power1_RegulatorOn ([]) MC_Power1_DriveStart ([])

Under normal condition, Servo ON state will be set to master and slave axis.



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	MC_Home0_1
Axis_Master — Axis Done	-0
Busy - FALSE	2017
MC_Power0_Status CommandAborted = FALSE	
Execute Error PALSE	
0 - Position ErrorID SMC_NO_ERR	
MC Home 1	
MC_Home_1	MC Homel
MC_Home_1 MC_Home	MC_Home1_
MC_Home_1 Axis_SlaveAxisAxis	MC_Home1([])
MC_Home_1 Axis_Slave	MC_Home1([])
MC_Home_1 MC_Home Axis_Slave - Axis MC_Power1_Status CommandAborted - FALSE	MC_Home1_





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.

	MC_MoveAbs_Busy GR		MC_MoveSuperImposed_Execute
	Axis_Slave.fSetPosition 0 2000		
5			
	MC_MoveSup	erImposed_0	MC MotteSuperImposed Done
	Axis Slave Axis	Done	
		Busy - FALSE	
	MC_MoveSuperImposed_Execute	CommandAborted - PAUSE	
	Execute	Error - FALSE	
	MC_MoveSuperImposed_Distance 1E+03 Distance	ErrorID - SMC NO ERR	
	MC_MoveSuperImposed_VelocityDiff 1.5E+03 , VelocityDiff		
	MC_MoveSuperImposed_Acc 62+03 + Acceleration		
	MC_MoveSuperImposed_Dec 6E+03 - Deceleration		

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).



9



#### • 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
	8.1.1	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
	8.3.1	Setting up User Account and Password	8-8
	8.3.2	CODESYS Security Agent	8-9
	8.3.3	Setting up an Encrypted Connection with the "Prosys OPC UA Client"	8-11
	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.

	<b>T</b>	Malia	Description line	A.1.1	C	
ression	Type	value	Prepared value	Address	Comment	
🖗 wval1	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.



8



8-2

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 config	uration.
Name	
Symbol Configuration	
Include comments in XML	
Support OPC UA features	
Add library placeholder in Device Applica (recommended, but may brigger downlo	tion ad)
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.

! There are 6 configured variables which are not i	referenced by the I	EC code. Readi	ing and writi	ng to them may not have the desired effect(s).	Remove
hanged symbol configuration will be transferred v	with the next downl	oad or online c	hange		
Symbols	Access Rights	Maximal	Attribute	Туре	Member
- 🔲 📄 Constants					
- CompilerVersion		50		VERSION	
RuntimeVersion	50	50		VERSION	
- 🔲 📄 IoConfig_Globals					
EtherCAT_Diag		-		DL_BuiltInIO_AX3.EtherCAT_Diag	
EtherCAT_ErrorLED_Handle		<b>See</b>		DL_BuiltInIO_AX3.EtherCAT_ErrorLED_Handle	
therCAT_Master_SoftMotion		<b>N</b>		IoDrvEthercatLib.IODrvEtherCAT	
- V Pulse_Output		50		DL_BuiltInIO_AX3.DMC_PO_SLOT_REF	
- Dulse_Output_SYNC		<b>*</b>		DL_BuiltInIO_AX3.Po_Sync	
nIoConfigTaskMapCount		-		DINT	
→ pIoConfigTaskMap		-		POINTER TO IoConfigTaskMap	
PLC_PRG					
🔍 🤣 aryval4		<b>N</b>		ARRAY [020] OF BYTE	
- 🔽 🚸 bval3	30	<b>See</b>		BOOL	
- 🔽 🎓 dwval2		50		DWORD	
🔍 🧔 wval1	50	50		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 **Mathematical 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	7
onfiguration Name	
Discovery Advanced	
Endpoint Filter: No Filter	-
<ul> <li>Local Network</li> <li>Docal 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>	s rk er
Authentication Settings      Anonymous	
Usemame	Store
Password	
Pessword Certificate Private Key	20

8-4

8



(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.

Constinue Manuel ODCILAS and AV 2007 ADMANT	
Inguration Name OPCOAServer@AA-308EAUMAII	
iscovery Advanced	
E local Network	
Generation Microsoft Terminal Services	
opc.tcp://tsclient	
🖃 😏 Microsoft Windows Network	
🕀 💆 DELTA	
🖻 😏 Web Client Network	
🕀 🔍 opc.tcp://idelta.deltaww.com@!	SSL
🗄 😁 Custom Discovery	
Oouble click to Add Server >	
E opc.tcp://192.168.1.5	_
OPCUAServer@AX-308EA0MA1	T
None - None	
Recently Used	•
Authentication Settings	
Authentication Settings	
Authentication Settings	_
Authentication Settings	
Authentication Settings	Store
Authentication Settings  Authentication Settings  Anonymous  Usemame Password  Certificate Currently not supported by UaExpe	T Store
Authentication Settings  Authentication Settings  Authentication Settings  C Anonymous  Username Password  Certificate Currently not supported by UalExpe	T Store

(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.





8

(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 Information Endpoint Url	opc.tcp://AX-308EA0MA1T:4840	192.168.1	5 Endpoint Url	opc.tcp://192.168.1.5:4840	
Security Settings			-Security Settings-		
Security Policy	None		Security Policy	None	-
Message Security Mode	None	-	Message Security Mode	None	-
Authentication Settings – Anonymous Uosmane			Authentication Settings Authentication Settings Username		
Pasword		T Store	Pessword		⊂ <b>Γ</b> Store
C Capitizante Cuaze	ntly not supported by HaExperi		C Certificate Curre	ntly not supported by UaExpert	
Session Settings			Session Settings		
Session Name	m:TWTY3PC1346:UnifiedAutomati	on:UaExpert	Session Name	m:TWTY3PC1346:UnifiedAutomat	ion:UaExper

#### (7) Click Connect.

Project	8×
✓ Ø Project ✓ Ø Servers	
OPCUAServe = Remove	
Data Access Connect	
Disconnect	
Properties	
Change User	





8-6

(8) After establishing the connection, you can change the variables in AX308E through the OPC UA client. 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 0' X	C Default DA Varw							0
E D Project	Server	Node Id	Display Name	Value	Datatype	Source Timestamp	Server Timestamp	Statuscode
Servers     Servers     OPCUAServer@AX-308EA0MATT     Documents     Default DA View	AX308E AX308E AX308E AX308E AX308E	NS4 String var Delta-ARM-VxWorks NS4 String var Delta-ARM-VxWorks NS4 String var Delta-ARM-VxWorks NS4 String var Delta-ARM-VxWorks	aryval4 bval3 dvival2 vval1	0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.	Byte Boolean Ulnt32 Ulnt16	08:25:51:428 08:25:52:826 08:25:54:211 08:25:55:622	08.25.51.428 08.25.52.826 08.25.54.211 08.25.55.622	Good Good Good Good
Address Space & X	c .							
Root  Cobjects Cobjects Cobjects  Cobjects  Cobjects C								
DeviceManual     DeviceManual     DeviceMervision     Gostants     Constants     CompletVersion     SoftmerVersion     Manufacturer     Manufacturer								
invoer invoe								
SerialNumber	1							1



8

# 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 × 🗘 📄 🛃 Device user: Administrator Communication Settings Synchronized mode: All changes are immediately downloaded to the device. Applications Users O Add... E S Administrator Backup and Restore + 9 guest O Import... Synchronized Files Z Edit... Files O Delete Log PLC Settings PLC Shell Users and Groups Access Rights Groups Symbol Rights 🗏 😫 Administrator O Add... \* 😫 derived from 'Developer' Runtime Clock Configuration O Import... 9 has user member 'Administrator' + 😫 Developer 2 Edit... System Parameters = 😫 Everyone O Delete S has user member 'Administrator' Task Deployment has user member 'guest' \* 😫 Service Status Se Watch Information

8



## 8.3.2 CODESYS Security Agent

In order to encrypt data and exchange it with the client safely, the server needs a certificate that the client must classify as trusted when a connection is established for the first time. You will need **CODESYS Security Agent** for creating a certificate for the DIADesigner-AX. Go to CoDeSys Store to download the software: <u>https://store.codesys.com/codesys-security-agent.html?\_\_\_\_SID=U</u>

(1) Install the add-on **CODESYS Security Agent**. After installing, you need to restart DIADesigner-AX.

			Sort by	Name 🗸	Install
lame	Version	Installation date	Update info	License info	Umrstall
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	
CODESYS SoftMotion	4.6.0.0	2019/12/11		No license required	Undated
Delta_ASD_A2_M_Package	1.0.0.2	2019/12/2		License info not available	opuates
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 available	Download
Delta_VFD_MH300_Package	1.0.0.0	2019/12/2		License info not available	
		2010/12/2			CODESYS Store Reting
-	_			,	

(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.

Security Screen	×							
User Project Devices		Information Click the 'Refresh' button to load the data.	17 × 81	Information	Issued for	Issued by	Valid from	Valid ur

(4) Click 🔯 to refresh and all services of the controller that require a certificate are displayed in the right view.

Security Screen	×					
User	0	Information	12	Information	Issued for	ls
	19	= Device	×	OPC UA Server (not available)		
Project	( interest of the second second second second second second second second second second second second second se	Own Certificates	Table 1	Encrypted Application (not available	)	
Daulaan		Trusted Certificates	2)	Encrypted Communication	AX-308EA0MA1T	A:
Devices		Unstrusted Certificates		💱 Web Server	AX-308EA0MA1T	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	0	Information		1 1	nformation	Issued for	1
	54	E Device		X	OPC UA Server (not available)		
Project	1.2	Own Certificates		abra .	Encrypted Application (not available)	)	
Davicas		Trusted Certificates		12	Encrypted Communication	AX-308EA0MA1T	4
Devices		Unstrusted Certificates			🙀 Web Server	AX-308EA0MA1T	4
		Quarantined Certificates					
	Γ	Certificate Settings	•		×		
	[	Certificate Settings Key length (bit)	307	72	×		

Ok

Cancel



(6) Again select the service Encrypted Application and then click **1** 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
Droject	创	= 💮 Device	X	🙀 OPC UA Server	OPCUAServer@AX-308
riojeci		Own Certificates	-951	Encrypted Application (not available	)
evices		Trusted Certificates		Encrypted Communication	AX-308EA0MA1T
		Unstrusted Certificates		🙀 Web Server	AX-308EA0MA1T
		Quarantined Certificates			
	Cert	ificate Settings	•	×	
	Cert Key	ificate Settings length (bit)	3072	×	

(7) And you have created two certificates OPC UA Server and Encrypted Application on the controller.\*

User	0	Information	1.2	nformation	Issued for	issued by	Valid from	Valid until	Thumbprint
	101	= Device	×	OPC UA Server	OPCUAServer@AX-308EA0MA1T	OPCUAServer@AX-308EA0MA1T	1970/1/2 上千 08:48:15	1971/1/2 上午 08:48:15	5C3F2C0888EC97E0286210688A73
Project	100	Com Certificates	Land I	Encrypted Application	AX-30SEA0MA1T	AX-308EA0MA1T	1970/1/2 上午 08:48:55	1971/1/2 上午 08:48:55	B3882A26088664F4484EDEA91389
-		Trusted Certificates		Encrypted Communication	AX-208EA0MA1T	AX-308EA0MA 1T	1970/1/1 上午 08:00:13	1970/1/31 上平 08:00:13	508368D9F81A7C5D89816707CE67
Devices		Distrusted Certificates		Web Server	AX-308EA0MAIT	AX-308EA0MA1T	1970/1/1上年 08:00:13	1970/1/31 上午 08:00:13	508368D9F81A7C5D89816707CE67
		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	×
New Tab +		2 8	0
Disconnected opc.tcp://192.168	1.5:4840 🔶 🎹 🚺		*
Search	Attributes and References + 6		
		+ + Fullers 4 Browse Direction Forward	7
Select server and connect			

(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.

S Prosys OPC UA Client				- D X
New Tab +				
Disconnected opc.tcp://192.168.1.5:4840 -	- um:AX-308EA0MA1T:Delta%20Elec	ctronics%2C%20Inc.:AX-3	08EA0MA1T:OPCUA:Server	· > 6 4
Search Attrib	utes and References +			
			+ + Filters	Browse Direction Forward
			ReferenceType	Target
	Security Settings		×	
	Security Mode	Security Policy		
	O None	None Basic128PS415	OK	
	Sign & Encrypt	Basic256	Cancel	
Select server and connect	Show only modes	Basic256SHA256 that are supported by the	server	
condustrior and connect	L			



(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.

C Prosys OPC UA Client			- D ×
Help			
New Tab +			
Disconnected opc.tcp://192.168.1	1.5:4840 um:AX-308EA0MA1T:Delta%20Electronics%2C%20Inc:A	X-308EA0MA1T:OPCUA:Server	
Search	Attributes and References +		
		🔶 🔶 Filters 👬 🛟	Browse Direction Forward *
		, ReferenceType	Target
	S User Authentication	×	]
	O Anonymous Username and Password D Certificate a	nd Private Key Apply Cancel	
	Username Administrator Password	1888	
	and the second s		
Select server and connect	[f]	100	ļ.

(5) If you click 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.



(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. 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**.

User	0	Information	Infor	Issued for	Issued by	Valid f
Project	1	Device     Own Certificates	×	ProsysOpcUaClient	ProsysOpcUaClient	2020/5/
Devices		Trusted Certificates	2			
		Quarantined Certificates				



# AX-3 Series Operation Manual

Security Screen	×					
User	Φ	Information	1	Information	Issued for	Issued by
	-	E Device	×	22	Integration Objects' OPC UA Client	Integration Ob
Project		Own Certificates	-		ProsysOpcUaClient	ProsysOpcUa
Devices		Trusted Certificates				
		Unstrusted Certificates				
		Quarantined Certificates				

(7) Go back to ProsysOpcUaClient. Click  $\rightarrow$  as shown in (2) to connect to the AX-3 Series PLC as an Administrator.

After establishing the connection, you can edit the settings in AX308E through ProsysOpcUaClient.

S Prosys OPC UA Client			- 🗆 X
Help			
OPCUAServer@AX-308E	AOMA1T +		
Running opc.tcp.//192.168	1.5.4848 um AX-308EA0MA1T Del	ita%20Electronics%2C%20Inc A	X-308EA0MA1T:DPCUA.Server 💌 🗙 🔒 🚢 Administrato
Search	Attributes and References	s +	
Objects	0		+ + Filters 🔝 📰 Browse Direction Forward *
Types	Attribute	Value	ReferenceType Target
	<ul> <li>Nodeld</li> <li>NodeClass</li> <li>BrowseName</li> <li>DisplayName</li> <li>Description</li> <li>WriteMask</li> <li>UserWriteMask</li> <li>EventNotifier</li> </ul>	J=85 Object Objects (en-Us) Objects NONE (0) NONE (0) 0	Organizes DeviceSet Organizes Server HasTypeDefinition FolderType

# If you connect to the AX-3 Series PLC as a guest. You do not have permission to make any change on the settings.

Search	11	Attributes	and Refere	nces [	Data View	X +						
🕈 🧮 Objects		ubscriptio	n Enabled		ublishing	Interval (in r	milliseconds)	1,000	*	Subscriptio	on Settings	
<ul> <li>DeviceSet</li> <li>AX-308EA0MA1T</li> </ul>		# Nod	eld Disp	layName	Value	DataType	SourceTimestam.	. ServerTime:	stam	StatusCode	MonitoringMo.	Graph
V B Resources		0 ns=4;	s=  aaa	P	false	Boolean	29.05.2020 01:29	29.05.2020 0	1:29:	GOOD (0x	Reporting	
18		1 ns=4;	s=  bbb		false	Boolean	29.05.2020 01:29:	29.05.2020 0	1:29:	GOOD (0x	Reporting	
10 Deviceller		2 ns=4:	s=lccc		false	Boolean	29.05 2020 01:29	29.05 2020 0	29	GOOD (0x	Reporting	
Error											×	C

8

#### 8-14



# 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>Enter URL</li> <li>Enter the URL of a computer with discovery</li> </ul>	2 ×
ope.tcp://192.168.1.5	
Authentication Settings	
Authenticetion Settings Authenticetion Settings Anonymous Username Password	Store
Authentication Settings Authentication Settings Anonymous Username Password Certificate Private Key	
Ope: ktp //192.168.1.5      OK      Authenticetion Settings     @ Anonymous      Username     Password      Certificate     Private Key      Connect Automatically	



(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.

adpoint Filter: No Filter	
atpoint Filter:	
Cocal	
<ul> <li>I ocal Network</li> </ul>	
Microsoft Terminal Services	
Microsoft Windows Network	
> 💆 Web Client Network	
Reverse Discovery	
Custom Discovery	
▼ < Double click to Add Server >	
<ul> <li>Opc.tcp://192.108.1.3</li> <li>Opc.tlocar.cp.@AV.2005A0MAATT (cma.tcm)</li> </ul>	
* g OPCOAServer@AX-SUBEAVMATT (opc.tcp)	
None - None (usteriouscousting)	
None - None (uatcp-uasc-uabinary)	
Basic256Sha256 - Sign & Encrypt (uatcp-uasic-uabinary)     Basic256Sha256 - Sign & Encrypt (uatcp-uasic-uabinary)     Asuic256Sha256 - Sign (ustranuccuubinary)	
None - None (uatcp-uasc-uabinary)  Sasic2565ha256 - Sign & Encrypt (uatcp-uasc-uabinary)  Sasic2565ha256 - Sign (uatcp-uasc-uabinary)  Recently Used	)
None - None (uatcp-uasc-uabinary) Basic256Sha256 - Sign & Encrypt (uatcp-uasc-uabinary) Basic256Sha256 - Sign (uatcp-uasc-uabinary) Recently Used	)
None - None (uatcp-uasc-uabinary) Basic256Sha256 - Sign & Encrypt (uatcp-uasc-uabinary) Basic256Sha256 - Sign (uatcp-uasc-uabinary) Recently Used	)
Basic2565ha256 - Sign & Encrypt (uatcp-uasc-uabinary)      Basic2565ha256 - Sign (uatcp-uasc-uabinary)      Recently Used	)
	)
None - None (uatcp-uasc-uabinary)  Basic2565ha256 - Sign & Encrypt (uatcp-uasc-uabinary)  Recently Used	)
Authentication Settings	)
Authentication Settings	)
Authentication Settings Authentication Settings Authentication Settings Authentication Settings Authentication Settings Authentication Settings	)
Authentication Settings Authentication Settings Authentication Settings Usemanne Administrator	)
Authentication Settings Authentication Settings Authentication Settings Authentication Settings Authentication Settings Anonymous Username Administrator Password	] Store
Authentication Settings Authentication Settings Authentication Settings Authentication Settings Authentication Settings Authentication Settings Authentication Settings Authentication Settings Authentication Settings Set	Store
Authentication Settings Authentication Settings Authentication Settings Certificate	Store
Authentication Settings Authentication Settings Authentication Settings Authentication Settings Authentication Settings Anonymous Usemane Administrator Password Certificate	→ Store

(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.

Y 📁 Project	
Y 📁 Servers	
OPCUAServer@ Remove Documents Data Access Vie Disconnect Disconnect	
Properties	
Change User	



(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.

		-				
onfiguration Name	OPCUAServer@AX-308EA0MA1	T		Configuration Name	OPCUAServer@AX-308EAUMA1T	
Server Information		-		Server Information		
Endpoint Url	opc.tcp://##-988EA6MA1T.484	40 -	192.168.1.5	Endpoint Url	opc.tcp://192.168.1.5:4840	
Reverse Connect				Reverse Connect		
Security Settings				Security Settings		
Security Policy	Basic256Sha256			Security Policy	Basic256Sha256	
Message Security Mode	Sign & Encrypt	*		Message Security Mode	Sign & Encrypt	
Authentication Settings				Authentication Settings		
🔿 Anonymous				O Anonymous		
Username	Administrator	Store		Username	Administrator	Sto:
Password				Password	••••	
Certificate				Certificate		
Private Key		100		Private Key		
Session Settings				Session Settings		
Session Name	m:TWTY3NB1693:UnifiedAutor	mation:UaExpert		Session Name	m:TWTY3NB1693:UnifiedAutomat	ion:UaExpe

(7) Click Connect.

Project		8 >
<ul> <li>Project</li> <li>Image: Servers</li> </ul>		
OPCUAServe =	Remove	
Documents	Connect	
	Disconnect	
4	Properties	
2	Change User	



(8) After clicking **Connect**, you will see an error. That is because UaExpert is not a trusted certificate for AX-3 Series PLC. You need to go back to DIADesigner-AX to approve this service.

<b>\$</b> 9			
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 **(**) 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**.

		The second second second second second second second second second second second second second second second se					
User	<b>Q</b>	Information	1	Information	sued for	Issued by	V
		E Device	×	📷 🗡	UaExpert	UaExpert	1/
roject		💽 Own Certificates 🧃	(Act)				
Devices	Trusted Certificates		10				
Devices		Unstrusted Certificates					
		Quarantined Certificates					
Security Screen X		-					
Security Screen X	\$	Information	12	Information	Issued for	Issued by	Va
Security Screen X	0	Information B Device		Information	Issued for UaExpert	Issued by UaExpert	Va 1/
Security Screen X User Project	¢	Information		Information	Issued for UaExpert	Issued by UaExpert	Va 1/
Security Screen X User Project	0	Information		Information	Issued for UaExpert	Issued by UaExpert	Va 1/
Security Screen X User Project Devices	¢	Information Device Device Dun Certificates Unstrusted Certificates Unstrusted Certificates	1: ×	Information	Issued for UaExpert	Issued by UaExpert	Va 1/

(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.



8



8-18



# **Chapter 9 Communication**

# **Table of Contents**

0.1 Julie direction to 5th ex04T Operational institution	
9.1 Introduction to EtherCAI Communication	/-4
9.1.1 Features of EtherCAT Fieldbux9	}-4
9.1.2 Settings up EtherCAT Master9	)-5
9.1.3 Setting up the EtherCAT Slave9	)-7
9.2 Introduction to Modbus Serial Communication9-7	10
9.2.1 Modbus Serial Port9-	10
9.2.1.1 Adding Delta Modbus COM9-	10
9.2.1.2 Setting up Delta Modbus COM9-	11
9.2.2 Modbus Serial Master	13
9.2.2.1 Adding Delta Modbus Master/Slave COM9-	13
9.2.2.2 Setting up Delta Modbus Master COM9-	15
9.2.2.3 Setting up Delta Modbus Slave COM9-	17
9.2.3 Modbus Serial Slave9-2	23
9.2.3.1 Adding a Modbus Serial Device9-2	23
9.2.3.2 Setting up the Modbus Serial Device9-2	24
9.3 Introduction to Ethernet Communication	26
9.3.1 Ethernet Port	26
9.3.1.1 Adding an Ethernet Adapter Device9-2	26
9.3.1.2 Setting up the Ethernet9-2	27
9.3.2 Modbus TCP Master (Client)9-	30
9.3.2.1 Adding a Modbus TCP Master/Slave9-	30
9.3.2.2 Setting up the Modbus TCP Master9-	32
9.3.2.3 Setting up the Modbus TCP Slave9-	34
9.3.3 Modbus TCP Slave (Server)9-	40
9.3.3.1 Adding a Modbus TCP Slave Device9-	40
9.3.3.2 Setting up the Modbus TCP Slave Device9-	41



9.4.1 Introduction to EtherNet/IP	9-43
9.4.1.1 EtherNet/IP Overview	9-43
9.4.1.2 Definition	9-43
9.4.1.3 Features of Ethernet	9-44
9.4.1.3.1 Delta EIP Architecture	9-44
9.4.1.3.2 Features of EIP	9-44
9.4.2 EtherNet/IP Scanner Function	9-45
9.4.2.1 Setting up Compact Drive MS300	9-45
9.4.2.1.1 Hardware Configuration	9-45
9.4.2.1.2 Read-Write Setting for Implicit Messages	9-45
9.4.2.1.3 CIP Object Read-Write Setting for Explicit Messages	9-51
9.4.2.2 Read-Write to AS00SCM-A (AS-FEN02 Communication Card)	9-52
9.4.2.2.1 Setup IO modules on AS00SCM-RTU	9-52
9.4.2.2.2 Download the EDS File of AS00SCM-RTU	9-54
9.4.2.2.3 Configure EtherNet/IP Parameters of AS00SCM-RTU	9-61
9.4.2.2.4 Operate IO modules on AS00SCM-RTU	9-64
9.4.2.2.5 Parameter Information of AS00SCM-RTU Module	9-66
9.4.3 EtherNet/IP Adapter Function	9-67
9.4.3.1 Operate Software Studio 5000	9-67
9.4.3.1.1 Structure	9-67
9.4.3.1.2 Create a Project	9-67
9.4.3.2 Create a Scanner	9-67
9.4.3.2.1 Create a New Module	9-67
9.4.3.3 Adapter Connection	9-68
9.4.3.3.1 Create an EDS File	9-68
9.4.3.3.2 Import an EDS File	9-73
9.4.3.3.3 Create a New Adapter	9-73
9.4.3.3.4 Projects Download	9-74
9.4.3.3.5 Data Mapping	9-74
9.4.4 CIP Object	9-75
9.4.4.1 Object List	9-75
9.4.4.2 Data Type	9-75
9.4.4.3 Identity Object (Class ID: 01 Hex)	9-78
9.4.4.4 Assembly Object (Class ID: 04 Hex)	9-79
9.4.4.5 TCP/IP Interface Object (Class ID: F5 Hex)	9-80
9.4.4.6 Ethernet Link Object (Class ID: F6 Hex)	9-82
9.4.5 Delta EIP Product List	9-84



	9.4.5.1 Delta EIP Product List (Adapters Supported)	9-84
	9.4.5.2 Delta EIP Product List (Scanners Supported)	9-84
9.5	Network Security	9-84



# 9.1 Introduction to EtherCAT Communication

# 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 Autoconfi	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 addres	ss (MAC) e	00-00-00-00-00-00	Browse		
EtherCAT IEC Objects	) Select net	work by MAC	<ul> <li>Select netwo</li> </ul>	ork by name		
Status	3 Distributed 0	Clock	(2	Options —		
Information	Cycle time	2000	🔹 µs	Use LRW inst	tead of LWR/LRD	
	Sync offset	50 w monitoring	* %	Enable messi     Automatic res	ages pertask start slaves	
	Sync window	1	* US			

#### 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\*1)
  - 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.

AX\_308\_Series\_EtherCAT\_Master\_SoftMotion X

General	! 0 warning(s) 🖸 0 error(s) 😩	0 exception(s) 0 information(s) 0 0 debug message(s)							
Sync Unit Assignment									
	Severity Time Stamp	Description							
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		Mart Lask.
EtherCAT I/O Mapping		
EtherCAT IEC Objects		
Status		



# 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	4.7	☑ Enable exp □ Optional	pert settings	Ether	CAT
Process Data	Distributed Clock						
Startup Parameters	2 Select DC	DC-Synch	ronous		~		
EtherCAT I/O Mapping	Enable	2000	Sync u	nit cycle (µs)			
EtherCAT IEC Objects	Sync0: Enable Sync 0						_
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	3	2000 🗘	Cycle time (µs	)	
	User-defined			0	Shift time (µs)		
	3 Startup Checking			4 Timeouts			
	Check vendor ID			SDO access	2000	\$	ms
	Check product ID	ber		I -> P	3000	\$	ms
				P-> S/S-> 0	10000	1	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 sam				
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		1	Select the Inputs					
	Name	Туре	Index	^	Name	Туре	Index	^	
Process Data	16#1600 1st RxPDO Mapping (exc	U			16#1A00 1st TxPDO Mapping (e				
0-1-D	Control Word	UINT	16#6040:00		Status Word	UINT	16#6041:00		
Startup Parameters	Target Position	DINT	16#607A:00		Actual Position	DINT	16#6064:00		
EtherCAT I/O Manning	Target Velocity	DINT	16#60FF:00		Velocity actual value	DINT	16#606C:00		
concreter to mapping	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 (exc	lu			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	be Pos1 Pos Value DINT 16#60	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 (exc	lu			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#6089:00		
	Target Torque	INT	16#6071:00		Touch Probe Pos1 Pos Value	DINT	16#608A: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			
	Neativatoranalimit	ITNIT	16#6051-00	~	Status Word	LITNIT	15=5041-00	¥	

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



		I work to be the second	1.2.2.	1.41.000				100.010	
Process Data	Line	Index:Subindex	Name	Value	Bit Length	Abort on Error	Jump to Line on Error	Next Line	Commen
	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	
	- 5	16#1A02:16#00	3rd Transmit PDO Mapping	0	8			0	
EtherCAT IEC Objects	- 6	16#2104:16#00	DRV's Parameter P1-04	0	16			0	
	7	16#2006:16#00	DRV's Parameter P0-06	0	32			0	Interpolat
Status	- 8	16#6098:16#00	Homing method	35	32			0	
Toformation.	9	16#60C2:16#01	Interpolation time period	2	8			0	Interpolati
Information	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.





# 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 serival 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 conext 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.





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 🗸 🗸 🛪 🗙	Delta_Modbus_COM X
Delta_Modbus_COM (Delta Modbus COM)     Delta_Modbus_COM_1 (Delta Modbus COM)     Delta_Modbus_COM_1 (Delta Modbus COM)     SoftMotion General Axis Pool     Madvare Configuration     Autore Configuration     Autore Configuration     Action Configuration     Action Configuration     Delta_Incollection     Delta_Incollection     Delta_Incollection     Delta_Incollection     SoftMotion General Axis Pool     Delta_Modbus_COM Filter     Delta_Incollection     SoftMotion General Axis Pool     SoftMotion General Axis Pool     Delta_Incollection     SoftMotion General Axis Pool     SoftMotion General Axis Pool     Delta_Incollection     SoftMotion General Axis Pool     Delta_Incollection     SoftMotion General Axis Pool     Delta_Modbus_COM (Delta Modbus COM)     SoftMotion General Axis Pool     Device (AX-308EAMATT)     Weatware Configuration     SoftMotion General Axis Pool     Device (AX-308EAMATT)	General Status Information Serial Port Configuration COM Port Baudrate 9600 ~ Parity Even ~ Data Bits 7 ~ Stop Bits 1 ~ Transmission Mode ORTU @ 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.

us	- Serial Port Configuration	ı ————
	COM Port	RS-232 Y
rmation	Baudrate	9600 ~
	Parity	Even ~
	Data Bits	7 ~
	Stop Bits	1 ~
	Transmission Mode	🔿 RTU 💿 ASCII

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



9\_

#### 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 X					
General	ModbusSerial :	Running			
Status					
Information					

Item	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: -
	Description: 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	- 4	×	
Untitled 1		^	
AX_308EA0MA1T (AX-308EA0MA1T)			
- 🔏 Hardware Configuration			
Network Configuration			
A EtherCAT Filter			
ModbusCOM Filter			
A ModbusTCP Filter			
PLC Logic			
= Q Application			
Library Manager			
Task Configuration			
EtherCAT_Task			
Did (Did)	(and		
Deta_Localbus_Master (Detta Localbus Master	ster)	ic la	
Ethernet (Ethernet)		~	
Delta_Modbus_COM (Delta Modbus COM)			
SoftMotion General Axis Pool	*	Cut	
- M AX_308EA0MA1T_1 (AX-308EA0MA1T)		Cop	у
AX_308EA0MA1T_2 (AX-308EA0MA1T)	電	Past	e
🔏 Hardware Configuration	×	Dele	te
Retwork Configuration	-	-	
- A EtherCAT Filter		Prop	erties
A EtherCAT Filter		Add	Object
A EtherCAT Filter A ModbusCOM Filter		Add Add	Object Folder
EtherCAT Filter     ModbusCOM Filter     In PLC Logic     Application		Add Add Add	orties Object Folder Device
EtherCAT Filter     ModbusCOM Filter     PLC Logic     Application     Library Manager		Add Add Add	orties Object Folder Device t 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.

Append device	e 🔘 Plug devic	e Ol	Jpdate device		
String for a fulltext search	Ve	endor	<all vendors=""></all>		~
Name Fieldbuses Modbus Modbus Serial Device		Ven	dor	Version	Description
Modbus Serial Master				_	
Group by category Display a	ster COM Port	Delta xperts c	eElectronics, Inc.	0.40.1.0	Delta Serial Port Se
Composition of the second second matter     Delta Modbus Ma     Second Second Second Matter     Vendor: Delta Modbus Master (     Vendor: Delta Electronics, Im     Categories: Modbus Secial M     Version: 0.40.1.0     Order Number -	Il versions (for e	Delta xperts c	nly) Display	0.40.1.0	Delta Serial Port Se
Group by category Display a     Name: Delta Modbus Master     Vendor: Delta Hodbus Master     Vendor: Delta Hectronics, Im     Categories: Modbus Serial M     Version: 0, 40, 1.0     Order Number: -     Description: Delta Serial Por	Il versions (for e COM Port c. laster t Setting of Modb	xperts c	nly) Display (	0.40.1.0	Delta Serial Port Se

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			



### 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	nl/a
DeltaModbusSerialMaster I/O Mapping	1	
DeltaModbusSerialMaster IEC Objects		
Status		
Tafaamahaa	-	

#### 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
DeltaModbusSerialMaster I/O	Name: Delta Modbus Master COM Port Vendor: Delta Electronics, Inc.
Mapping	Categories: Modbus Serial Master
DeltaModbusSerialMaster IEC	<b>ID:</b> 16F7 8705
Objects	Version: 0.40.1.0
Status	Order Number: - Description: Delta Serial Port Setting of Modbus Maste



# 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
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.



#### 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	1	Name Channel 0	Access Type Read Coils	Trigger Cvclic, 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
alasta dhua Casial Claus 1/0	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							
		Movel	In A	love 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	Desci	ription		
Device Type	Standard Modbus Device	Delta Series Device		
Enable	Activates t	his channel		
Name	Defines this o	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)	<ul> <li>Read/Write Registers</li> <li>Read coils</li> <li>Read registers</li> <li>Write coils</li> <li>Write registers</li> <li>Note: PLC uses the corresponding Modbus function code according to the read/write register of the device type.</li> </ul>		
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 c	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 communi</li> <li>Set To ZERO</li> <li>Keep last value</li> </ul>	cation 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 Offset	Default Value	Length	Comment	
	0	Write Single Coll	0x0	0	1		
lodbus Slave Channel	1	Write Single Coll Write Multiple Registers	0x0	0	1		
odbus Slave Init	3	Write Multiple Colls	0x0	0	8		
eltaModbusSerialSlave1/0 lapping							
)eltaModbusSerialSlave IBC )bjects							
tatus							
formation							
	-						

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 Registers	~
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 Insta
Modbur Flave Channel	Variable	Mapping	Channel	Address	Туре	Unit	Description
noupus siave channel	-14		Channel 0	%QX4.0	BIT		Trigger variable
Modbus Slave Init	+ *		Channel 0	%IW5	ARRAY [00] OF WORD		Read/Write Multiple Registers
	= <sup>6</sup> 0 aaa		Channel 0	%QW3	ARRAY [00] OF WORD		Read/Write Multiple Registers
DeltaModbusSerialSlave I/O Mapping	£ *o		Channel 0[0]	%QW3	WORD		
Della Madhus Pasial Plana 190			Channel 1	%IW6	ARRAY [00] OF WORD		Read Input Registers
Objects	÷ 🍫		Channel 2	%IW7	ARRAY [00] OF WORD		Read Input Registers
	÷.*		Channel 3	%Q88	ARRAY (00) OF BYTE		Write Multiple Colls
Status	* *		Channel 4	%IB16	ARRAY [00] OF BYTE		Read Colls



# 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.

Devices .	- * ×	Delta_Hodbus_Slave_COM	Port x Device Delta_Modbus_Master_COM	Port	
<ul> <li>G I Device (connected) (AX-308EACMA1T)</li> </ul>	1.00	General	🗣 Add., 🧭 Edit., 🚿 Delete 🍈 Go to Vanable		
Color Converted (A4 308EA/A4.11)     Color Converted (A4 308EA/A4.11)     A tetratic Configuration     A retrack Configuration     A retrack Configuration     A retrack Configuration     A retrack Configuration     Configu		General Modbus Save Channel Modbus Save Int DetaModbusSenalSlave I/O Mapping Onterto-Objects Status Information	Expression Expression DesiceApplication.Delta_Modbus_Slave_COM.Pot % Disexe % Disolute %	Type           DL_ModusComMaster.DFB_ModusComStare           BOOL           BOOL	Value PALSE PALSE PALSE PALSE PALSE PALSE PALSE PALSE PALSE 0

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.

Seneral	DeltaModbusSerialSlave :	n/a	
10dbus Slave Channel	Last Diagnostic Message		Acknowledge
lodbus Slave Init	Diagnosis Message:		
DeltaModbusSerialSlave I/O Mapping			
DeltaModbusSerialSlave IEC Objects			
itatus			
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
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

 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.

ame Delta_Modbus_Serial_Device				]
Append device      Insert device		pdate device		
String for a fulltext search	Vendor	<all vendors=""></all>		*
Name  Peidbuses  Modbus  Modbus  Modbus  Peidbuses	Vendor		Version	Description
Delta Modbus Serial D	evice Delta Elec	tronics, Inc.	0.40.0.0	Delta Serial Port Setting
< Group by category Display all ver Mame: Delta Modbus Serial Device	isions (for experts o	nly) 🗌 Disp	lay outdated	> versions
Coroup by category Display all ver Coroup by category Display all ver Coroup C	rsions (for experts o	niy) 🗌 Disp	lay outdated	versions
Coup by category Display all ver     Mame: Delta Modbus Serial Device     Vendor: Delta Electronics, Inc.     Categories: Modbus Serial Device     Version: 0, 40, 0, 0     Order: Number:     Description: Delta Serial Port Set	sions (for experts o ting of Madbus Slave	nly) 🗌 Disp	lay outdated	versions
C Group by category Display all ver C Group by category Display all ver C Vendor. Delta Electonics, Inc. Categories: Modus Serial Device Version: 0.40.0.0 Order Number: Description: Delta Serial Port Set Append selected device as last child Delta_Modbus_COH	sions (for experts o ting of Madbus Slave of	nly) Disp	lay outdated	versions



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 • 9 X	Delta_Hodbus_Serial_Device	4					
Chatted      Chatted      Chatted      Chatted      Configuration     Accost Advance Configuratin      Accost Advance     Accost Advanceot Advance     Accost Ad	General Delta Modbus Senal Stave Device 1/0 Mapping Status Information	Serial Port Setting COM ID I Address Information Setting — Holding Register	R		Colls		
Ubrary Manager     Tark Configuration		%MW	0		%MW	0	6
EtherCAT Task		%MW Quantity	10	19	%MW Quantity	10	
S mdbsComTask		Modbus Start Address	0		Modbus Start Address	0	
= Bultin_IO (Bultin_IO)		Holding Register			Colls		
_ 🛐 DIO (DIO)		%QW	٥	4	%QW	0	\$
ij Delta LocalBus Master (Delta LocalBus Master)		%QW Quantity	10		%QW Quantity	10	
AL_306_Series_EtherCAT_Master_SoftWoodn (AX-308 Series EtherCAT Master     Ethernet (Ethernet)		Modbus Start Address	256		Modbus Start Address	256	
E Delta_Modbus_COM (Delta Modbus COM)		Input Register			Input Coils	-	-
Delta_Modbus_Serial_Device (Delta Modbus Serial Device)		56IW	0	1¢	%IW	0	- Idi
SoftMotion General Axis Pool		%IW Quantity	10	1.0	%IW Quantity	10	10
The Algorithman (2 (AX-SUBEAUMAIT)		Madine Deat Address	10		Madhee Theat Address	0	
The name for some and		Products Start Address	u		MOODUS SCART ADDRESS	U	•

### 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	+				
Status						
nformation	- Address Information Setting —					
	Holding Register			Coils		
	%MW	0	+	%MW	0	
	%MW Quantity	10	\$	%MW Quantity	10	ŀ
	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.

General	Bus Cycle Options		
	Bus cycle task	mdbsComTask	v
Delta Modbus Serial Slave Device	CC3/6-50	Use parent bus cycle setting	
I/O Mapping		EtherCAT_Task	
Status		mdbsComTask	_
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.

ce x		
Delta Modbus Serial Slave Device	n/a	
]		
	Delta Modbus Serial Slave Device	Delta Modbus Serial Slave Device

#### 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_Serial_Device	e X
General	General
Delta Modbus Serial Slave Device I/O Mapping	Name: Delta Modbus Serial Device Vendor: Delta Electronics, Inc. Categories: Modbus Serial Device
Status	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

# 9.3.1 Ethernet Port

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.

# 9.3.1.1 Adding an Ethernet Adapter Device

1. Right-click the PLC 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 Ethernet (Fieldbuses -> Ethernet Adapter -> Ethernet) or click Add Device to add this port in.





3. Find the added Ethernet (Ethernet) in the tree view and double-click it to open the setting window to set up.

Devices	<b>- 4</b> ×	Ethernet X			
Untitled1     AX_308EA0MA1T (AX-308EA0MA1T)	•	General	Interface cpsw0		
An Antional Configuration		Log	IP address	192 . 168 . 0 . 1	
		Status	Subnet mask	255 . 255 . 255 . 0	
[]] PLC Logic     [] Builtin_IO (Builtin_IO)     [] Delta _LocalBus_Master (Delta LocalBus Master)		Ethernet Device I/O Mapping	Default gateway	0 . 0 . 0 . 0	
Ethernet (Ethernet)		Ethernet Device IEC Objects			
<ul> <li>SoftMotion General Axis Pool</li> <li>Image: Device (AX-308EA0MA 1T)</li> </ul>		Information			

### 9.3.1.2 Setting up the Ethernet

#### 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.

General	Interface cpsw0	
Log	IP address	192 . 168 . 0 . 1
Status	Subnet mask	255 . 255 . 255 . 0
Ethernet Device I/O Mapping	Default gateway	0 . 0 . 0 . 0
Ethernet Device IEC Objects		
Information		

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.			

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.

General	Ethernet Device :		Running
Log	Last Diagnostic Message		
Status	EthDiag		Ethernet diagnostic information
Ethernet Device I/O Mapping	Current IP	'192.168.1.5' '255.255.255.0'	
Ethernet Device IEC Objects	IP changes	0.0.0.0	Amount of IP configuration changes since startup (IP or gateway $\epsilon$
Information			
	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



#### 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 🎽 Go	to Variable				
		Expression	Туре	Value	Prepared value	Address	
	Log	= 🧭 Device.Application.Ethernet	IoDrvEthernet.IoDrvEthernet				
		🍫 eState	ETHERNETSTATE	RUNNING			
	Status						
	Ethernet Device I/O Mapping						
٢		]					
l	Ethernet Device IEC Objects						
	Information						
	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
Log	Vendor: 3S - Smart Software Solutions GmbH Categories: Ethernet Adapter, Ethernet Adapter, Ethernet Adapter, Home&Building Automation
Status	ID: 0000 0002 Version: 3.5.15.0
Ethernet Device I/O Mapping	Order Number: - Description: Ethernet Link.
Ethernet Device IEC Objects	
Information	
# 9.3.2 Modbus TCP Master (Client)

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.

# 9.3.2.1 Adding a Modbus TCP Master/Slave

 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\_Modbus\_TCP\_Master under the Ethernet node in the tree view.

Action <ul> <li>Append device</li> <li>Insert device</li> <li>Plug</li> </ul>	device OI	Jpdate device		
String for a fulltext search	Vendor	<all vendors=""></all>		
Name  Fieldbuses  Fieldbuses  Fieldbuset	Vendor		Version	Descriptio
Delta Modbus TCP Master	Delta Flec	tronics. Inc.	0.40.1.0	A device t
<ul> <li>C     <li>✓ Group by category ☐ Display all versions     <li>Mame: Delta Modbus TCP Master     </li> </li></li></ul>	(for experts (	only) 🗌 Display outdated	dversions	,
Group by category Display all versions     Name: Delta Modbus TCP Master     Vendor: Delta Electronics, Inc.     Categories: Modbus TCP Master     Version: 0.40.10     Order Number -     Description: A device that works as a N	: (for experts ( Modbus TCP M	only)  Display outdate Display outdate aster on Ethernet.	d versions	



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.

Devices	+ 4 X
Unbited I     AX_308EA0MA IT (AX-308EA0MA IT)     AX_308EA0MA IT (AX-308EA0MA IT)     Ardware Configuration     Andware Configuration     Andware Configuration     Andware Configuration     Andware Configuration     Application     Application     Application     Application     ModeEtherTask     BuiltIn_IO (BuiltIn_IO)     Delta_LocalBus_Master (Delta LocalBus Master)	
Correct (Ednernet)     Delta_Modbus_TCP_Master     SoftMotion General Axis Pool     Device (AX-308EA0MA1T)	Image: Copy         Image: Copy         Image: Paste         Image: Delete         Refactoring         Image: Refactoring         Image: Properties         Image: Add Object         Image: Add Folder
	Add Device

4. Find and double-click Delta Modbus TCP Slave (Fieldbuses -> Modbus -> Modbus TCP Slave -> Delta Modbus TCP Slave) or click Add Device to add this port in.  $\sim$ 

(73) · · · · ·

String for a fulltext search	Vendor	<all th="" vendo<=""><th>ors&gt;</th><th>`</th></all>	ors>	`
Name 	Vendor		Version	Description
Delta Modbus TCP S	ave Delta Electro	onics, Inc.	0.40.1.0	A generic Modbus device t
< ] Group by category 🔲 Display all v	ersions (for experts o	only) 🗌 D	isplay outdat	ed versions
Group by category Display all v Name: Delta Modbus TCP Slave Vendor: Delta Electronics, Inc.	ersions (for experts o	only) 🗍 D	isplay outdat	ed versions
<ul> <li>Group by category Display all v</li> <li>Name: Delta Modbus TCP Slave Vendor: Delta Electronics, Inc. Categories: Modbus TCP Slave Version: 0,40,1.0</li> <li>Order Number: -</li> </ul>	ersions (for experts o	only) 🗌 D	isplay outdat	ed versions
<ul> <li>Group by category Display all v</li> <li>Name: Delta Modbus TCP Slave Vendor: Delta Electronics, Inc. Categories: Modbus TCP Slave Version: 0,40,1.0</li> <li>Order Number: - Description: A generic Modbus of TCP Master.</li> </ul>	ersions (for experts o device that is configur	only) D	isplay outdat for a Modbus	ed versions



9\_



After that you can find Delta\_Modbus\_TCP\_Slave under the Delta\_Modbus\_TCP\_Master node in the tree view.

5. Find the added port **Delta\_Modbus\_TCP\_Master (Delta Modbus TCP Master)** in the tree view and doubleclick it to open the setting window to set up.



### 9.3.2.2 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_Piodbus_ICP_Maste	er X			
Delta Modbus TCP Master I/O Mapping	🕂 Add 📝 Edit 🗙 Delete 😁 Go to Variable			
Delta Modbus TCP Master IEC Objects	Variable	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.

Delta_Modbus_TCP_Maste	er X		
Delta Modbus TCP Master I/O Mapping	Delta Modbus TCP Master	n/a	
Delta Modbus TCP Master 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_Maste	r X
Delta Modbus TCP Master I/O Mapping	General Name: Delta Modbus TCP Master
Delta Modbus TCP Master IEC Objects	Vendor: Dela Houbus TCP Master Vendor: Dela Electronics, Inc. Categories: Modbus TCP Master
Status	ID: 167 8729 Version: 0.40.1.0
Information	Order Number: - Description: A device that works as a Modbus TCP Master on Ethernet.

# 9.3.2.3 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.



### General

Here you can configure the basic settings for Modbus TCP Slave, such as Slave Address, Response Timeout and Device Type.

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.

Seneral		Name	Access Type	Trigger	READ Offset	Length	Error Handling
a di se di se di se si	1, 4	Channel 1	Read Coils	Cyclic, 100ms	0x0	1	Keep last Valu
odbus Slave Channel	; H	Channel 2	Read Coils	Cyclic, 100ms	0x0	1	Keen last Valu
odbus Slave Init	3 0	Channel 3	Read Coils	Cyclic, 100ms	0x0	1	Keep last Valu
eita Modbus TCP Slave I/O apping							
atus							
formation							
	_						
	1	_					
					-		

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	Descr	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)	<ul> <li>Read/Write Registers</li> <li>Read coils</li> <li>Read registers</li> <li>Write coils</li> <li>Write registers</li> <li>Note: PLC uses the corresponding Modbus function code according to the read/write register of the device type.</li> </ul>					
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 c	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 communi</li><li>Set To ZERO</li><li>Keep last value</li></ul>	cation 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.

eneral	Line	Access Type Write Single Coil	WRITE Offset 0x0	Default Value	Length 1	Comment	
odbus Slave Channel	1	Write Single Coil	0×0	0	1		
odbus Slave Init							
elta Modbus TCP Slave I/O apping							
atus							
ormation							

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 Registers	~
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**.

	Find		Filter Show all		•	♣ Add	FB for IO Channel * G	o to Instance
10dbus Slave Channel	Variable	Mapping	Channel Channel 0	Address %QX18.1	Type BIT	Unit	Description Trigger variable	
1odbus Slave Init	÷.*		Channel 0	%IB25	ARRAY [00] OF BYTE		Read Coils	
eltaModbusSerialSlave I/O lapping	* *		Channel 0[0]	%IB25	BYTE		Read Coils	
eltaModbusSerialSlave IEC Ibjects								
tatus								
nformation								

# ■ Delta Modbus TCP Slave IEC Objects

You can check the status of Modbus TCP Slave under this tab.

100	oun or	1001		otutuo	01	
Delta	Modbus	тср	Slave	×		

General	🖶 Add 🗹 Edit × Delete ⁺ 🖥 Go to Variable						
	Expression	Туре	Value	Prepared value	Address	Comment	
Modbus Slave Channel	😑 🧭 Device.Application.Delt	DL_ModbusTCP					
Modbus Slave Init	bConfirmError	BOOL	FALSE				
	🀌 bDoInit	BOOL	TRUE				
Delta Modbus TCP Slave I/O Mapping	🍫 bInitDone	BOOL	TRUE				
	🍫 bBusy	BOOL	TRUE				
Delta Modbus TCP Slave IEC Objects	🍫 bDone	BOOL	FALSE				
	🍫 bError	BOOL	FALSE				
Status	NodbusError	DFB_MB_ERRO	UNDEFINED				
	🍫 iChannelIndex	INT	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.
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 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.

seneral	Delta Modbus TCP Slave :	n/a	
odbus Slave Channel	Last Diagnostic Message		Acknowledge
odbus Slave Init	Diagnosis Message:		
elta Modbus TCP Slave I/O apping			
tatus			

# 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 Modhus TCP Slave
Modbus Slave Channel	Vendor: Delta Electronics, Inc. Categories: Modbus TCP Slave
Modbus Slave Init	ID: 167 8730 Version: 0, 40, 1, 0
Delta Modbus TCP Slave I/O Mapping	Order Number: - Description: A generic Modbus device that is configured as Slave for a Modbus TCP Master
Status	
Information	



9\_

# 9.3.3 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.

# 9.3.3.1 Adding a Modbus TCP Slave Device

 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.





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.



# 9.3.3.2 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 Settin	ng				
	Holding Register			Coils		
	%MW	0	-	%MW	0	
	%MW Quantity	10		%MW Quantity	10	
	Modbus Start Addres	is 0	-	Modbus Start Address	0	ł
	Holding Register			Coils		
	%QW	0	<u> </u>	%QW	0	
	%QW Quantity	10	-	%QW Quantity	10	-
	Modbus Start Addres	is 256		Modbus Start Address	256	ł
	Input Register			Input Coils		
	%IW	0		%IW	0	
	%IW Quantity	10		%IW Quantity	10	4
	Modbus Start Addres	s 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.

General	Bus Cycle Options		
	Bus cycle task	mdbsEtherTask	×
Delta Modbus TCP Slave Device I/O Mapping		Use parent bus cycle setting mdbsEtherTask	
Status			
Information			

### 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.

General	Delta Modbus TCP Slave Device	n/a	
Delta Modbus TCP Slave Device I/O Mapping	1		
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_De	evice X
General	General
Delta Modbus TCP Slave Device I/O Mapping	Vendor: Delta Electronics, Inc. Categories: ModbusTCP Slave Device
Status	ID: 16f7 8728 Version: 0.30. 1.0
Information	Order Number: - Description: Delta_Modbus TCP_Slave_Device



# 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.

# 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

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 Massage	Connect to EtherNet/IP and to exchange data non-cyclically. Data will be exchanged piece by
Explicit Message	piece via instructions.
RPI	Requested Packet Interval, via the I/O connection to connect to EtherNet/IP to exchange
	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
EDS	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 parameter 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:

Dovisos	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.

Devices	• 7	×			
- D Untitled3					
Device (AX-308EA0MA1T)					
Hardware Configuration					
<ul> <li>A Network Configuration</li> </ul>					
A EtherCAT Filter			<b>Z</b>		
A EtherNetIP Filter			B Add Device		
A ModbusTCP Filter			Name EtherNet IP Scanner		
😑 🗐 PLC Logic			Action		
= O Application				Constant design	
Library Manager			Append device () inset device	Half device O opdate device	
Motion_PRG (PRG)			String for a fulltext search	Vendor <all vendors=""></all>	
PLC_PRG (PRG)			Name	Vender	Varian Description
= 😹 Task Configuration			- Fileste	vendor	version Description
= 😂 EtherCAT_Task			Etherblat/7P		
Motion_PRG			E SterNet/IP Local Adapter		
= 😂 MainTask			EtherNet/IP Scanner		
E PLC_PRG			EtherNet/IP Scanner	35 Software Solutions GmbH	3.5.15.20 EtherNet/IP Scanner
BuiltIn_IO (BuiltIn_IO)			😸 💷 Modbus		
DIO (DIO)				1 au	
Delta_LocalBus_Master (Delta Lo	calBus Master)				
EtherCAT_Master_SoftMotion (A	K-3 Series EtherCAT Master SoftMot	tion)			
Ethernet (Ethernet)					
EMotion General do Cut					
(1) UB Copy		· · · · · ·			
In Paste					6 200 M
× Delet			Group by category Display all ver	sions (for experts only) Display outd	ated versions
Refac	toring +		Name: EtherNet/IP Scanner	tions GmbH	^
Ch Prope	rties		Categories: EtherNet/IP Scanner		
			Version: 3.5.15.20		
Add C	Dbject		Order Number: 1		-
🗀 Add F	older		Description: EtherNet/IP Scanner		*
Add [	Device		Append selected device as last child o	of	
Insert	Device		Ethernet		
Disab					
	le Device		(You can select another target node	e in the navigator while this window is op-	(m
llada	le Device		(You can select another target node	e in the navigator while this window is op-	en.)
Upda	le Device		(You can select another target node	e in the navigator while this window is op-	en.) Add Device 💊
Upda	le Device te Device		(You can select another target node	e in the navigator while this window is op	Add Device
Upda Dî Edit C Edit C	le Device te Device Ibject Ibject with		(You can select another target node	e in the navigator while this window is op	Add Device
Upda Li Edit C Edit C Edit C	le Device		(You can select another target node	e in the navigator while this window is op	Add Device
Upda []"Edit C Edit C Edit K	le Device te Device		(You can select another target node	in the navigator while this window is op	Add Device
Upda iii Edit C Edit C Edit M Impo	le Device te Device biject biject with D mapping t mappings from CSV Amorphic SCV		You can select another target mode	i in the navigator while this window is op:	Add Device

4. Create CMM-EIP0102. Right click on Ethernet and select Add Device to choose the relevant adapter.



\*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.

CMM_EIP0102 ×		
General	Address Settings	
Connections	IP address 192 . 168 . 1	• 30 EtherNet/IP*
Assemblies		
User-Defined Parameters	Electronic Keying Keying Options	
Log	Compatibility check	
EtherNet/IP I/O Mapping	Strict identity check	
EtherNet/IP IEC Objects	Check vendor ID 799	
Status	Check product code 260	
Information	<ul> <li>✓ Check major revision 1</li> <li>✓ Check minor revision 1</li> </ul>	
	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.

 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 al		• 中 Add FB f	or IO Chi	annel "	Go to Instand	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		
	· · · · · ·		IN_Value_29	%IW30	UINT		User Defined		
User-Defined Parameters	10 Mg		IN_Value_30	%IW31	UINT		User Defined		
	· · · · · · · · · · · · · · · · · · ·		IN_Value_31	%IW32	UINT		User Defined		
Log	÷ *•		IN_Value_32	%IW33	UINT		User Defined		
and the second second second	18 <b>*</b> ø		Operation Command 1	%QW1	UINT		VFD Control		
EtherNet/IP I/O Mapping	÷.**		Frequency command 1	%QW2	UINT				
			External Command 1	%QW3	UINT				
EtherNet/IP IEC Objects	10 <b>1</b> 0		OUT_Value_4	%QW4	UINT		Reserved		
Statue	OperationCommand		Operation Command 2	%QW5	UINT				100
	🗄 🍫 ControlMode 🧹		Control mode 2	%QW6	UINT				
Information	FrequencyCommand	·····	Frequency command 2	%QW7	UINT		New Help String	2	
	· · · ·		Troque limit 2	%QW8	UINT				
	B-50		Position Command 2, L W	%QW9	UINT				
	1		Position Command 2, H W	%QW10	UINT				
	· · · · · ·		Torque command 2	%QW11	UINT				
			Frequency limit 2	%QW12	UINT				
	· · * •		OUT_Value_13	%QW13	UINT		Reserved		
	10 - <sup>6</sup> 0		OUT_Value_14	%QW14	UINT		Reserved		
			OUT_Value_15	%QW15	UINT		Reserved		
	· · · · · ·		OUT_Value_16	%QW16	UINT		Reserved		
	18 · **		OUT_Value_17	%QW17	UINT		User Defined		
	· · * •		OUT_Value_18	%QW18	UINT		User Defined		
	B <b>*</b> ø		OUT_Value_19	%QW19	UINT		User Defined		
	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		OUT_Value_20	%QW20	UINT		User Defined		*
				Reset Map	ping	Always u	pdatevariables	Use parent device setting	~
	🐐 = Create new variable	🍬 = Map to existing var	iable						



9\_

8. Select Motion\_PRG to add programs as shown below.



9. Implement the following procedure with online monitoring:

① Turn on Motor\_Mode.

 $\ensuremath{@}$  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 Instance Attribute 0x300 + Pr. Group + Pr. Number

#### 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 ASOOSCM-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.

a c F Dunct 檔案(F) 編輯(E) 檢視(V)	工具(T) 操作(O) 説明(H)	
檔案(F) 通程(F) 檢視(V, □ □ □ □ ··· · · · · · · · · · · · · · ·	工具(T) 操作(O) 説明(H) ① ① ② ② ② ////////////////////////////////	產品列表 Communications Adapter ▲ AHRTU-ETHN-5A ▲ ASOOSCM-RTU(AS-FEND2) ↓ DVS-103I02C-DLR
	資訊         EIP 参数         設備参数           >           資訊         EIP 参数         設備参数           >         >           模組 名稱         Version         通…         IP 地址         通訊 IP 地址         連接網…	



THE NEW YORK 1996	輯(E) 設定(Q) 說	;明(L)				Ц	- 6 ×
E X D D 3	/ 2 💀 💀 🕱 🖿	0					
產品列表							
<ul> <li>AS Series</li> <li>● 數位 I/O 模組</li> <li>● 類比 I/O 模組</li> </ul>		16 04 DA AP DA AD	4				
規格	<u></u>						
	*			-			
主機群組	*		*	_			
主機群組 插槽編號	→類別	型號	▼ DDF版本	-	註解		
主機群組 插 槽編號 電源	★類別	型號	✓ DDF版本	-	註解		
主穂群組 插槽編號 電源 □遠端模組	→ 類別 功能卡	型號 ASOOSCM(RTU) + AS-F	♥ DDF版本 02.02.00	-	註解		
主機群組 插槽編號 電源 ⊇ 遠端模組 功能卡1 寸性+1	→ 類別 功能卡	型號 ASOOSCM(RTU) + AS-H	➤ DDF版本 02.02.00		註解		
主機群組 插槽編號 電源 透端模組 功能卡1 功能卡2 環組容額1	★ 類別 功能卡 勢位 1/0 複組	型號 ASOOSCM(RTU) + AS-I	◆ DDF版本 02.02.00		註解		
主機群組	類別 功能卡 數位 1/0 模組 類比 1/0 模組	型號 ASOOSCM(RTU) + AS-H AS16AP11P-A AS04DA-A	> DDF版本 02.02.00 01.00.00 01.00.00 01.00.00		註解		
主機群組 插槽編號 電源 功能卡1 功能卡2 積組資訊1 模組資訊2 積組資訊3	類別 功能卡 數位 1/0 模組 類比 1/0 模組 類比 1/0 模組	型號 ASOOSCM(RTU) + AS-H AS16AP11P-A AS04DA-A AS04DA-A	◆ DDF版本 02.02.00 01.00.00 01.00.00 01.00.00 01.00.00		註解		

1. 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.

裝置設定		
一般設定		
<ul> <li>→ ASO4DA-A</li> <li>→ 數值格式</li> <li>→ 通道 1 ~ 通道 4 模式言</li> <li>→ 通道 1 ~ 通道 4 調校 5</li> <li>→ 輸出設定</li> <li>- 報警設定</li> </ul>	<ul> <li>裝置資訊 常態交換區</li> <li>描述</li> <li>通道 1 輸出值</li> <li>通道 2 輸出值</li> <li>通道 3 輸出值</li> <li>通道 4 輸出值</li> </ul>	位 101 102 ~ D41 1042 ~ D43 1044 ~ D45 1046 ~ D47 1048 ~ D49
<ul> <li>▲</li> <li>●</li> <li>預設</li> <li>確入</li> </ul>	<b>選出</b> 更新	確定



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.

ocation	System Repository	,			4	Edit Locations.
	(C:\ProgramData)	Delta Indusi	trial Automati	on\DIAStudio\DIADesign	er-AX\Devices)	Leone and the
installed d	levice descriptions					
String for	a fulltext search		Vendor:	<all vendors=""></all>	~	Install
Name		Vendor	Version	Description		Uninstal
	liscellaneous					Brown.
	LCs					
+ 🔗 s	oftMotion drives					



	5 V	Search ASRTU_AS-I	FEN02	P
Organize 👻 New folder		855	• 🔳	0
OneDrive - Delta E Name	Date modified	Туре	Size	
This PC	02/06/2020 2:08 PN	A EDS File		50 KB
3D Objects				
Desktop				
🔁 Documents				
Downloads				
h Music				
E Pictures				
Videos				
Local Disk (C:)				
🚔 Local Disk (D:)				
Making V C				>
File name:	~	All supported a	ption files	(~
			-	

# 1.3 The download is complete.

(C:\Program	nData\Delta Industrial	Automatio	n\DIAStudio\DIADesign	er-AX\Devices)	Edit Locations
Installed device descript	tions				
String for a fulltext sear	di	Vendor:	<all vendors=""></all>	~	Install
Name		Ver	ndor	^	Uninstall
] AH	CPUS31-EN	Delt	a electronics, inc.		Export
AH	CPU560-EN2	Delt	a electronics, inc.		
AH	RTU-ETHN-SA	Delt	a electronics, inc.	-	
	000011110(0010102)	UCIU	a cicco or intay inter	×	
C:\Users\ethan	cw.chen/Desktop/ASRT	U_AS-FEN	02\031F000C4101010000	)	
UEVICE ASU	05CM-R10(A5+EN02)	installed t	o device repository.		



- 2. After the download is complete, you are allowed to add the AS00SCM-RTU device.
- 2.1 Add Ethernet device



Add Device

Close

Append selected device as last child of Device (You can select another target node in the navigator while this window is open.)





2.2 Select the desired network interface.

General	Interface cpsw0		
Log			1
Status	Network Adapter	s	4
	Interfaces		
Ethernet Device I/O Mapping	Name Descri	ption IP address	
Ethernet Device IEC Objects	cpsw0	192,168.1.5	
	100	127.0.0.1	
		-	
	IP address	192 . 168 . 1 . 5	
	IP address Subnet mask	192 . 168 . 1 . 5 255 . 255 . 255 . 0	
	IP address Subnet mask Default gateway	192 . 168 . 1 . 5         255 . 255 . 255 . 0         0 . 0 . 0 . 0	
	IP address Subnet mask Default gateway MAC address	192 . 168 . 1 . 5         255 . 255 . 255 . 0         0 . 0 . 0 . 0         00:18:23:74:F3:15	



9\_

### 2.3 Add EtherNet/IP Scanner device.





9-58



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	3.1.11	EtherNet/IP
Assemblies			
User-Defined Parameters	Electronic Keying Keying Options		
Log	O Compatibility check		
EtherNet/IP I/O Mapping	Strict identity check		
EtherNet/IP IEC Objects	Check device type	12 799	
Status	Check product code	16641	
Information	Check major revision	1	
	Restore Default Values		



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.)

	Connection Name	RPI (ms) O	>T Size (Byte	s) T	O Size (Bytes)	Proxy
Connections	- 1. RTU IO Owner	10 40		60		
Assemblies			$\sim$			
User-Defined Parameters				Ŭ		
Log						
Ethaniat/ID I/O Manaina						
EtherNet/1P 1/O Mapping						
EtherNet/IP IEC Objects	Add Connection	Delete Connec	ction Edit	Connectio	on	
Status	Configuration Data					
Information	Raw data values	Show Parameter	Groups			
	Parameters		Value	Unit	Data Type	Minimu
	RTU IO Owner					
	<ul> <li>Target Confi</li> </ul>	g data	-			
	Reserved		0		UINT	
	Master rec	onnected bandling	Stop		LIINT	0
	Record	on needed honoing	0		UINT	
	Reserved					0
	IO module	error handling	Stop		UINT	0
	IO module	error handling timeout handling	Stop 0		UINT	0
	IO module IO module Reserved	error handling timeout handling	Stop 0 0			0

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 (Ou	itput)		Target to Scanner (Inc	out)		
0>T size (bytes)	40	] (4)	T->0 size (bytes)	60		
Proxy config size (b Target config size (	ytes) 0 bytes) 52					
Connection type	Point to Point	5	Connection type	Point to Point	~	
Connection Priority	Scheduled	~ 6	Connection priority	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.

(5): 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)
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.

all The For Obron	Terb		
🖪   X 🗈 🛍 🥏	🍠 🔄 🗊 🅦 🛸	4	
Product List			
AS Series			
E Digital I/O Module			
E Analog I/O Module	n li	16 04 +	
Specification			
AS04AD-A	* <b>*</b>		
4 channels 16 bits analog 10~+10V, 0~10V, -5~+5V, 0 0/4~20 mA., -20mA~20 m	g input : - 0/1~5V, A		
4 channels 16 bits analog 10~+10V, 0~10V, -5~+5V, 0/4~20 mA <sub>**</sub> -20mA~20 m conversion time = 2ms/cl	g input : - D/1~5V, A hannel		÷
4 channels 16 bits analog 10~+10V, 0~10V, -5~+5V, 0/4~20 mA., -20mA~20 m conversion time = 2ms/cl	g input : - 0/1~5V, IA hannel		•
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	g input : - 0/1~5V, A hannel	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	g input : - 0/1~5V, A hannel	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 Remote Module	g input : - 0/1~5V, A hannel v Function Card	Module Name AS00SCM(RTU) + AS-FI	DDF Version 02.02.00
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 Function Card1	g input : - 0/1~5V, A hannel Type Function Card	Module Name AS00SCM(RTU) + AS-FI	DDF Version 02.02.00
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 Function Card1 Function Card2	g input : - 0/1~5V, A hannel Type Function Card	Module Name AS00SCM(RTU) + AS-FI	DDF Version 02.02.00
4 channels 16 bits analog 10~+10V, 0~10V, -5~+5V, 0/4~20 mA <sub>**</sub> -20mA~20 m conversion time = 2ms/cl CPU Group Extension No Power Module Remote Module Function Card1 Function Card2 Module Information1	g input : - 0/1~5V, A hannel Type Function Card Digital I/O Module	Module Name AS00SCM(RTU) + AS-FI AS16AP11T-A	DDF Version 02.02.00 01.00.00

General	Connection Name	RDI (ms)	D>T Size (But	as) T.	O Siza (Buter)
Connections	- 1. RTU IO Owner	50 4	2	102	O SIZE (bytes)
Assemblies				3	
User-Defined Parameters					
Log					
EtherNet/IP I/O Mapping					
EtherNet/IP IEC Objects	Add Connection	Delete Conn	ection Edi	t Connectio	on
EtherNet/IP IEC Objects Status	Add Connection Configuration Data	Delete Conn	ection Edi	t Connectio	on
EtherNet/IP IEC Objects Status	Add Connection Configuration Data	Delete Conn	ection Edi er Groups	t Connectio	on
EtherNet/IP IEC Objects Status Information	Add Connection Configuration Data Raw data values	Delete Conn	ection Edi er Groups Value	t Connectio Unit	Data Type
EtherNet/IP IEC Objects Status Information	Add Connection Configuration Data Raw data values Parameters RTU IO Owner	Delete Conn	ection Edi er Groups Value	t Connectio	Data Type
EtherNet/IP IEC Objects Status Information	Add Connection Configuration Data Raw data values Parameters RTU IO Owner Target Confi	Delete Conne Show Paramete	ection Edi er Groups Value	t Connectio	Data Type



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 ×		Reserved	96TW/31	UINT
Assemblies	+ *		Input_data30	%IW32	UINT
	10 - Ng		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	⊕ <b>*</b> ≱		Input_data36	%IW38	UINT
	· · · · · · · · · · · · · · · · · · ·		Input_data37	%IW39	UINT
EtherNet/IP IEC Objects	· · · 🍫		Input_data38	%IW40	UINT
Status	😟 - 🍫		Input_data39	%IW41	UINT
50005	10 - Mp		Input_data40	%IW42	UINT
Information	🗐 🍫		Input_data41	%IW43	UINT
	18- <b>1</b> 9		Input_data42	%IW44	UINT
	1 - <b>1</b>		Input_data43	%IW45	UINT
	- · · · · ·		Input_data44	%IW46	UINT
	😟 🍫		Input_data45	%IW47	UINT
	🗐 – 🧤		Input_data46	%IW48	UINT
	18-1 <b>9</b>		Input_data47	%IW49	UINT
	🖷 - 🍫		Input_data48	%IW50	UINT
			Input_data49	%IW51	UINT
	5.4		Received	94-014/1	INT

General	Find		Filter Show all		
Connections	Variable	Mapping	Channel	Address	Туре
connections	· · · ·		Reserved	%QW1	UINT
Assemblies	· · **		Reserved	%QW2	UINT
	±*		Reserved	%QW3	UINT
User-Defined Parameters	÷- **		Reserved	%QW4	UINT
			Reserved	%QW5	UINT
Log			Reserved	%QW6	UINT
			Reserved	%QW7	UINT
EtherNet/IP I/O Mapping	⊕- <b>*</b> ≱		Reserved	%QW8	UINT
Sharbat/ID ISC Objects			Reserved	%QW9	UINT
EtherNet/IP IEC Objects	🕀 - Kø		Reserved	%QW10	UINT
Status	÷*•		Reserved	%QW11	UINT
	H 🍫		Reserved	%QW12	UINT
Information			Reserved	%QW13	UINT
	B- 🍫		Reserved	%QW14	UINT
	· · · · · · · · · · · · · · · · · · ·		Reserved	%QW15	UINT
			Reserved	%QW16	UINT
	· <b>●</b> - <b>*</b>		Reserved	%QW17	UINT
	😟 <b>*</b> ø		Reserved	%QW18	UINT
	🕀 · 🍢		Reserved	%QW19	UINT
	⊕ <b>*</b> ≱		Reserved	%QW20	UINT
	· · · · · · · · · · · · · · · · · · ·		Output_data20	%QW21	UINT
				Reset Mannin	a A


#### 9.4.2.2.5 Parameter Information of AS00SCM-RTU Module

The AS00SCM-RTU status can be diagnosed via the parameter information displayed on EtherNet/IP IO Mapping tab.

General	Find		Filter Show all		
Connections	Variable	Mapping	Channel	Address	Туре
connections	RTU IO Owner	-			
Assemblies	· · · · · · · · · · · · · · · · · · ·		RTU state	%IW2	UINT
	· · · · · · · · · · · · · · · · · · ·	0	RTU error code	%IW3	UINT
User-Defined Parameters	+- *p	6	Reserved	%IW4	UINT
	主 🍫		Reserved	%IW5	UINT
Log			Reserved	%IW6	UINT
	۰. ۲		Reserved	%IW7	UINT
EtherNet/IP I/O Mapping	· · · · ·		Reserved	%IW8	UINT
and the second second	÷-*		Reserved	%IW9	UINT
EtherNet/IP IEC Objects	÷-*>		Reserved	%IW10	UINT
Chabur	۰	-	Reserved	%IW11	UINT
Scalus	· · · · ·	3	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
	· · · · · · · · · · · · · · · · · · ·		module [6467] state	%IW17	UINT
	·····		Module 1 error code	%IW18	UINT
	· · · · · · · · · · · · · · · · · · ·		Module 2 error code	%IW19	UINT
	· · *>		Module 3 error code	%IW20	UINT
	· · · · · · · · · · · · · · · · · · ·	0	Module 4 error code	%IW21	UINT
	· · · · · · · · · · · · · · · · · · ·	5	Module 5 error code	%IW22	UINT
	÷- *	i i negere	Module 6 error code	%IW23	UINT
	1 - <b>4</b>		Module 7 error code	%IW24	UINT
	1 · · · · · · · · · · · · · · · · · · ·		Module 8 error code	%IW25	UINT
	±-¥≱		Reserved	%IW26	UINT
	÷ *>		Reserved	%IW27	UINT

- 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 Operate Software Studio 5000

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.

### 9.4.3.1.1 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:



### 9.4.3.1.2 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 Create a Scanner

After the project being created, add the EtherNet/IP module on the PLC backplane, then setup the EtherNet/IP device to connect via the EtherNet/IP module.

### 9.4.3.2.1 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.



### 9.4.3.3 Adapter Connection

This section describes how to use AX-3 series products as EIP adapter in Studio 5000

#### 9.4.3.3.1 Create an EDS File

This section describes how to create EDS files with AX-3 series PLCs.

Add a Ethernet Device



9-68

Add a Delta\_EtherNet\_IP\_Adapter device •





### ■ General – Setup EDS File

General	EDS File			
Log	Vendor name	Delta electro	nics, inc.	EtherNet/IP
Delta EtherNet/IP Adapter I/O Mapping	Vendor ID	799	•	
Delta EtherNet/IP Adapter IEC Objects	Product name Product code	AX-308EA0M	1A11	
Status	Majorrevision	1	-	
Information	Minorrevision	1	<b>•</b>	
	Install to Device	e Repository	Export EDS File.	

ltem	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
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.	



- ▼ ♣ X Add Device Devices × Cholded2
   Cholded2
   Device (AX-308EA0MA IT)
   Name De Action Append device 
   Insert device 
   Plug device 
   Update device Vendor <All vendors> String for a fulltext search Name — 🛐 Fieldbuses Vendo Version Description PAC Logic

  Application

  Application

  Deterministic (RG)

  Determin EtherNet/IP Delta electronics, in 1.0.0.0 A device that 
   - ① Moton\_PRG

   ● ◎ ManTask

   - ① PLC\_PRG

   ● Ø Delta\_Localbus\_Master

   - ② Delta\_Localbus\_Master

   • ○ EtherCAT\_Master\_SoftWoton (AX-3 Series EtherCAT

   ● EtherCAT\_EtherNet\_IP\_Adopter\_Obela EtherNet/IF

   ● Delta\_EtherNet\_IP\_Adopter\_Obela EtherNet/IF

   ● Delta\_EtherNet\_IP\_Module\_(Delta EtherNet/IF

   ● Delta\_EtherNet\_IP\_Module(Delta EtherNet/IF
   Group by category Display all versions (for experts only) Display outdated versions 1 Name: Delta EtherNet/IP Module Vendor: Delta electronics, inc. Venum: Deta Becculta, Inc. Categories: EtherNet/IP Module Version: 1.0.0 Order Number: -Description: A device that works as an EtherNet/IP Module. Ż Append selected device as last child of Delta\_EtherNet\_IP\_Adapter • (You can select another target node in the navigator while this window is open.) < Add Device Close 🔀 Devices 🗋 POUs
- Add a device of Delta\_EtherNet\_IP\_Module to configure data length for data exchange.

### ■ General-Module Information

General	Module Informatio	on ————		
Delta EtherNet/IP Module I/O Mapping	Module	Byte Input Module	$\sim$	EtherNet/IP <sup>*</sup>
Delta EtherNet/IP Module IEC Objects	Vendor name	Delta electronics, inc.		
Status	Vendor ID	799		
Information	Product name	Byte Input Module		
	Product code	20224		
	Majorrevision	1		
	Minorrevision	1		



#### Module

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

### Example of adding a DWord input module

To read the data type of 1 DWORD in the scanner, add a device of Delta\_EtherNet\_IP\_Module which is set to DWord Input Module.

General	Module Informati	ion		
Delta EtherNet/IP Module I/O Mapping	Module	DWord Input Module	~	EtherNet/IP <sup>®</sup>
Delta EtherNet/IP Module IEC Objects	Vendor name	Delta electronics, inc.		
Status	Vendor ID	799		
Information	Product name	DWord Input Module		
	Product code	20228		
	Major revision	1		
	Minor revision	1		

The information of DOWRD in the scanner can be read on the I/O Mapping tab page.

General	Find		Filter Show	all			- 🕂 Add	FB
Delta EtherNet/IP Module I/O Mapping	Variable	Mapping	Channel Input Data	Address	Туре	7409	Current Value	
Delta EtherNet/IP Module IEC Objects			Input butu	/1102	Diroto			
Status								
Information								



### 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			
Log	Vendor name	Delta elect	ronics, inc.	EtherNet/IP
Delta EtherNet/IP Adapter I/O Mapping	Vendor ID	799		
Delta EtherNet/IP Adapter IEC Objects	Product name Product code	16386		
Status	Major revision	1	÷	
Information	Minorrevision	1	÷	
	Install to Device	Repository	Export EDS File	

#### 9.4.3.3.2 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.

#### 9.4.3.3.3 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.

### 9.4.3.3.4 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.

#### 9.4.3.3.5 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	Description
BOOL	False(H'00)or True(H'01)



### AX-3 Series Operation Manual

Data Type						Descr	iptio	n					
	SINT(1 byt	e), INT(2	2 bytes),	DINT(4	bytes),	LINT(	8 by	tes)					
	Number	1st	2nd	3rd	4th	5	th	6th	7th		8th	1	
	SINT	0LSB				-	-						
	INT	0LSB	1LSB		-	-							
	DINT	0LSB	1LSB	2LSB	3LSE	3 -	-						
SIGNED		0LSB	1LSB	2LSB	3LSE	3   4L	SB	5LSB	6LSE	3   7	LSB		
INTEGER													
	EX: DINT V	alue = $H$	123456	/8									
	Number		1st		2nd	2		3rd			4th		
	DINT		78		56			34			12		
	USINT(1 b												
	Ex: UDINT	value =	H'AABB	CCDD		,,			,				
UNSIGNED	Numbe	ər	1st		2nd	ł		3rd			4th		
INTEGER	UDIN <sup>-</sup>	г	DD		СС	;		BB			AA		
				ľ									
	ASCII 字元, 1 or 2 bytes/字元												
	STRING: 2	STRING: 2 bytes character count + 1 byte character											
		ontents(	ents(Charcount)				Content	s(String	g con	tents)	)		
	STRING	i (	)4	00		4D	4D			6C		6	,C
	STRING2: 2 bytes character count + 2 byte character												
STRING		C	ontents(0	Charcou	nt)			Content	s(String	g con	tents)	)	
STRING	STRING	2	04	00		4D	00 69 00		00 6	6C	00	6C	00
	SHORT S	TRING:	1 bytes o	characte	er count	+ 1 b	/te c	haracter			1		
		C	ontents(	Charcou	nt)			Content	s(String	g con	tents	)	
	STRING	i	0	4	-	4D		69		- 6C	;	6	3C
							'						
	BTIE(1 by		RD(2 DY	les), DN	3rd	Dytes	), LV >	VUKD(8	bytes)	th	7	th	8th
	Byte	7 0					•		0			-	
Fixed LENGTH	WORD	70	15.	8									
BIT STRING	DWORD	70	15.	8 2	316	31	24				-	-	
	LWORD	70	15.	8 2	316	31	24	3932	2 47.	40	55.	48	6356
				·									
	A single str	ing cons	sists mult	tiple lan	guage r	eprese	epresentation						
	Na	ame		Data T	уре				Me	eaning	9		
STRINGI	Number		US	INT		The strii	The number of internationalized character strings					cter	
	Strings		Arr Str	ay of: uct of:		Arra strii	Array of individual internationalized character strings				aracter		



Data Type				[	Descr	iption				
	Language	Char1	USINT		The lan	The first ASCII character of the ISO 639-2/T language				
	Language	Char2				e secc guage	ond ASCI	characte	r of the IS	O 639-2/T
	Language	Char3				e third guage	ASCII ch	naracter o	f the ISO 6	39-2/T
	CharString	CharStringStruct 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			The character set which the character string is based on which comes from IANA MIB Printer Code (RFC 1759).				string is 3 Printer
	Internatior	nalString	Defined CharStr	in ingStruct	An array of 8-bit octet elements which is the actual international character string					
	ISO 639-2/1	Γlanguage:								
	Lang	guage	Firs	st Characte	r	Se	cond Cha	aracter	Third C	haracter
	En	glish		e			n			G
	Fre	ench		t			r			e
	Spa Ita	lian					<u>р</u> t			a
	STRUCT of	: Any Data	Type com	poses the s	struct	ure.			۵	
	Ex.: STRUC	CT of { BOO	L, UINT,	DINT } = { T	RUE	, H'12	234, H'56 <sup>°</sup>	789ABC }		
STRUCT		1st	2nd	3rd	4tl	n	5th	6th	7th	]
311001	Byte	01	34	12	BC	2	9A	78	56	
	Array of: An	iy Data Type		es the arra	y.					
	Number	1st	2nd	3rd		4th	51	n 6	Sth	
ARRAY	Array	01	00	02		00	03	3 (	00	
					I			I	1	
EPATH	It's a path th another obj Ex.: Io	nat consists ect. dentity Obje	of multip ct, Instan	le segment	s and 5 = "	refere	ences the 1 24 01 3	e class, in: 0 05 "	stance and	l attribute of

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	Sonvice Name	Atti	ribute	Depaription
code		Class Attribute	Instance Attribute	Description
H'01	Get_Attributes_All	Х	V	Read all attributes.
H'05	Reset	Х	V	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	Get	USINT	H'01	Major Revision Range: H'01~H'7F
	Minor Revision		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
H'07	Product Name	Get	SHORT_STRING	The maximu (Dat (H	um number of a product name is 32 words. a length+Product Name) '0D) AX-308EA0MA1T

%1 Status Description (H'05)

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



Bit (s)	Name	Description
3	Reserved	0: Always OFF
4-7	Extended Device Status	0: Self-Testing 1: Firmware Update 2: At least one faulted I/O connection 3: No I/O connections established 4: Non-Volatile Configuration bad 5: Major Fault 6: At least one I/O connection in run mode 7: At least one I/O connection established, all in idle mode 8-15: Reserved
8	Minor Recoverable Fault	0: No minor recoverable fault detected 1: Minor recoverable fault detected
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

### 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 Code	Service Name	Sup	port	Description
	Service Maine	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



### AX-3 Series Operation Manual

- 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 Code	Sanviso Nomo	Sup	port	Deparintion
	Service Marile	Class Attribute	Instance Attribute	Description
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 $\gg 2$
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



Instance Attribute	Name	Access Rule	Data Type	Values	Description
	Interface Configuration :		STRUCT of		TCP/IP network interface configuration.
	IP Address		UDINT	192.168.1.5	The device's IP address
LI'05	Network Mask	Get/Set	UDINT	255.255.255.0	The device's network mask:
	Gateway Address		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 values: 0~3600

% When the master is communicating, the instance attribute H'03 and H'05 cannot be written.

• Examples of reading and writing objects

(1) To read Instance Attribute H'03, write the data as shown below:

Service code : H'0E Class ID : H'F5 Instance ID : H'01 Attribute ID : H'03

(2) To write Instance Attribute H'05, write the data as shown below:

Service code : H'10

Class ID : H'F5

Instance ID : H'01

Attribute ID : H'05

Data Byte[0~3] : IP Address=192.168.1.5

Byte[4~7] : Network Mask=255.255.255.0

Byte[8~11] : Gateway Mask=0.0.0.0

Byte[12~15] : Name Server =0

Byte[16~19] : Name Server2 =0

#### %1 Interface status

Status	Description			
0 Interface Configuration attribute has not been configured.				
1	T he Interface Configuration attribute contains valid configuration obtained from BOOTP, DHCP or non-volatile memory.			
2 The Interface Configuration attribute contains valid configuration obtained from hardware.				

### %2 Interface capability flags

Bit	Description
0	BOOTP Client
1	DNS Client
2	DHCP Client



### AX-3 Series Operation Manual

Bit	Description
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 memory or via hardware witches).
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	Sonvico Namo	Si	upport	Description
Code	Service Maine	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 Name		Access Rule	Data Type	Values	Description	
H'01	Interface Speed	Get	DWORD	0	Interface speed (indeterminate)	
1.1100	laterfees Eleve	0-1			Ethernet port status, refer to the	
H'02	Interface Flags	Get	DWORD	HD	following※1	
H'03 Physical Address		Get	ARRAY of 6 USINTs	By Product	MAC address	
	Interface Capability	Get	STRUCT		Capabilities of Ethernet interface	
			of :		<b>※2</b>	
	Capability Bits		DWORD	H'00000007	The definition of Ethernet interface capability	
H'0B	Speed/Duplex Options		STRUCT		The definition of speed and duplex	
			of :		options of Ethernet interface.	
	Speed/Duplex Array Count		USINT	H'04	The count of speed/ duplex options.	
	Speed/Duplex Array		ARRAY of		Speed and duplex settings	



Instance Attribute	Name	Access Rule	Data Type	Values	Description
			STRUCT		
			of :		
	Interface Speed	UINT	NA	Ethernet interface speed. For example, 10 bps and 100 bps would be H'0A and H'64 accordingly.	
	Interface Duplex Mode	-	USINT	NA	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 Ctatus	0 indicates an inactive link
0	LINK Status	1 indicates an active link
		0 indicates half duplex
1		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
0		0 indicates the interface detects no local hardware fault
6	Local Hardware Fault	1 indicates a local hardware fault is detected
7-31	Reserved	0

### %2 Interface Capability Bits

Bit (s)	Name	Description
0	Manual Setting Requires Reset	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 rest
1		0 indicates the interface does not support auto-negotiaiton
1	Auto-negotiate	1 indicates the interface supports auto-negotiation
2	Auto-MDIX	0 indicates the interface does not support auto MDIX operation
2		1 indicates the interface supports auto MDIX operation
3	Manual Speed/Duplex	0 indicates the interface does not support to set 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**

### 9.4.5.1 Delta EIP Product List (Adapters Supported)

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	AH10EMC-5A	V1.00
	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
Invertor	VFD-C2000 Series (CMM-EIP01 Communication Card)	V1.06
Inventer	VFD-MS300 Series (CMM-EIP03 Communication Card)	V1.00
	VFD-C2000 Series (CMM-EIP02 Communication Card)	V1.00

### 9.4.5.2 Delta EIP Product List (Scanners Supported)

Positioning	Product	Version
	AHCPU501-EN \ AHCPU511-EN \ AHCPU521-EN \ AHCPU531-EN	V2.00
	AHCPU560-EN2	V1.00
PLC	AH10EN-5A	V2.00
	AS300 Series/ AS200 Series	V1.00
	AX-3 Series	V1.01
Small PLC	DVP-ES3 Series	V1.00

# 9.5 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.



# **Appendix A Troubleshooting**

# **Table of Contents**

A.1	Т	roubleshotting	. A-2
А	A.1.1	Basic Troubleshooting Steps	. A-2
А	A.1.2	Clear the Error States	. A-2
Д	A.1.3	Troubleshooting SOP	. A-3
Д	A.1.4	Viewing Log	. A-3
A.2	Т	roubleshooting of CPU Modules	. <b>A</b> -5
Д	A.2.1	ERROR LED Indicators Blinking Every 0.5 Seconds	. A-5
Д	.2.2	ERROR LED Indicators Blinking Rapidly Every 0.2 Seconds	. A-7
Д	.2.3	ERROR LED Indicators Slow Blinking Every 3 Seconds and Lighting up for 1 Second	. A-7
Д	.2.4	BAT. LOW LED Indicators Are ON	. A-7
Д	.2.5	BAT. LOW LED Indicators Blinking Every 0.5 Seconds	. A-7
А	.2.6	Others	. A-8
A.3	Т	roubleshooting of the Funciton Blocks	. A-9
Д	.3.1	DL_BuiltInIO_AX3	. A-9
Д	.3.2	Motion Control Related Instructions	A-12
A.4	Т	roubleshooting of I/O Modules	A-13
Д	A.4.1	Troubleshooting of Analog Modules (AD/DA/XA) and Temperature Modules (RTD/TC)	A-13
А	.4.2	Troubleshooting of Loadcell Modules AS02LC	A-15
А	4.4.3	Troubleshooting of AS02HC High Speed Counter Module	A-16
Д	.4.4	Troubleshooting of AS02/04PU Positioning Module	A-17
A.5	E	rror Codes and LED Indicators for CPU Modules	A-18
А	.5.1	Error Codes and LED Indicators for CPU Modules	A-18
А	.5.2	Error Codes and LED Indicators for Analog and Temperature Module	A-20
Д	1.5.3	Error Codes and LED Indicators for AS02LC Weigh Module	A-20
Д	.5.4	Error Codes and LED Indicators for AS02HC High Speed Counter Module	A-21
А	1.5.5	Error Codes and LED Indicators for AS02/04PU Positioning Module	A-21



# 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.

Α





# 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.

Device x				
Communication Settings	🙂 3 warning	g(s) 😳 0 error(s) 匡 0 ex	cception(s) 0 285 information(s) 0 27 debug	a message(s) <all components=""></all>
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	СМ
PLC Cottingo	0	01.01.1970 08:00:13	CH_INIT_FINISHED	CmpDeltaConnHandler
PLC 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	•	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.



A

A-4



# 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.



Α

# • 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 CPU module. Execute the function block, DFB_ResetECATMaster, to reset 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
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\_AX3

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.



Α

### AX-3 Series Operation Manual

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 vet.	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 vet	Execute this function block after the execution of DFB_SetRing of this counter completes.



### AX-3 Series Operation Manual

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.

# 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 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



### AX-3 Series Operation Manual

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 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
1	6#1605	Hardware failure	If the problem persists, contact the local authorized distributors.
1	6#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 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.	Check if the terminal is disrupted or shorted (Such as a short circuit between EXC+ and EXC-) If the problem persists, contact the local authorized distributors.
16#1808	The signal received by channel 1 exceeds the range of analog inputs (temperature) or a SEN voltage error exists.	Check the signal received by channel 1
16#1809	The signal received by channel 1 exceeds the weight limit.	Check the signal received by channel 2
16#180A	CH1 Adjustment error	Check the signal received by channel 3
16#180B	The signal received by channel 2 exceeds the range of analog inputs (temperature) or a SEN voltage error exists.	Check the signal received by channel 4
16#180C	The signal received by channel 2 exceeds the weight limit.	Check the signal received by channel 5
16#180D	CH2 Adjustment error	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.4.3 Troubleshooting of AS02HC High Speed Counter Module

A.4.3.1 ERROR LED Indicators Are ON

Error Code (16#)	Description	Solution
16#1605	Error of latching count values (serious error)	Data of count values has been lost. Please power-off and restart the module. (The error code would be removed right after the reboot) If the problem persists, contact the local authorized distributors.
16#1606	Error of latching setting values of module (serious error)	Data of the module settings has been lost. Please power-off and restart the module, or download the parameters of this module so as to remove the error code. If the problem persists, contact the local authorized distributors.
16#1607	Configuration error of module' s setting values (serious error)	Check the configuration of this module' s parameters and download it once again. If the problem persists, contact the local authorized distributors.

### A.4.3.2 ERROR LED Indicators Blinking Every 0.5 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.

Error Code (16#)	Description	Solution
16#1800	CH1 Overflow borrow counter	Check the counter values and the error can be turned
16#1801	CH2 Oerflow borrow counter	off through the parameter settings on the alarm setting page. This error can be removed via the following methods: Reset the counter/ Preset the counter/ Restart the module/ Enable the DHCCNT command.
16#1802	CH1 Cunt value is over the upper/lower limit	Check the count values from channel 1 and 2. Counting would continue inside the hardware and the error code would be removed right after the count value is within the upper and lower limit range.
16#1803	CH2 Cunt value is over the upper/lower limit	
16#1804	CH1 Displacement variation of the SSI encoder exceeds the limit	Check if there's any interruption and whether setting of the maximum displacement matches the actual
16#1805	CH2 Displacement variation of the SSI encoder exceeds the limit	operating speed. The error code would be removed right after the values read from the positions go back the normal range.
16#1806	CH1 SSI communication error	Check the status of DHCCNT counter. If a parity check error exists, please check if there's any interruption and make sure the data format setting is correct. If a SSI communication error exists, check whether the wiring is disconnected and make sure the normal power supply for the encoder as well as the correct data format.
16#1807	CH2 SSI communication error	

Α

Error Code (16#)	Description	Solution
16#1808	A zero pass of CH1 SSI absolute position has occurred	Check the operating range of SSI absolute encoder. If this error warning is not required, please turn off the setting on the error setting page.
16#1809	A zero pass of CH2 SSI absolute position has occurred	This error state can be removed via the following methods: Reset, Preset, Restart the module, Re- execute the DHCCNT command.

# A.4.4 Troubleshooting of AS02/04PU Positioning Module

# A.4.4.1 ERROR LED Indicators Blinking Every 0.2 Seconds

Error Code (16#)	Description	Solution
16#1802	Hardware failure	If the problem persists, contact the local authorized distributors.



Α
# 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.
- d. 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 bardware
		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
		OFF: a warning is triggered, but the system can still run.
		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		CPU ERROR LED indicator				
(16#)	(16#)	status	ON	Blinking fast	Blinking normally	Blinking slowly	OFF
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		



A-18

Error	Description	CPU status	ERROR LED indicator				
(16#)	Description		ON	Blinking fast	Blinking normally	Blinking slowly	OFF
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	Description	CPU status ON		ERROR LED indicator				
(16#)	Description		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			



Α

## A.5.2 Error Codes and LED Indicators for Analog and Temperature Module

Error Code (16#)	Description	ERROR LED indicator		
		$\begin{array}{c} A \rightarrow D / \\ D \rightarrow A / \\ A \leftrightarrow D \end{array}$	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 them as errors.

# A.5.3 Error Codes and LED Indicators for AS02LC Weigh Module

Error Code (16#)	Description	ERROR LED indicator		
		$A \rightarrow D$	ERROR	
16#1605	Hardware failure (the diver board included)	OFF	ON	
16#1607	The external voltage is abnormal.	OFF	ON	
16#1801*1	The external voltage is abnormal.	OFF	Blinking	
16#1802*1	Hardware failure	OFF	Blinking	
16#1807*1	The CJC is abnormal.	OFF	Blinking	
16#1808	The signal received by channel 1 exceeds the range of analog inputs (temperature) or a SEN voltage error exists.	RUN: Blinking STOP: OFF		
16#1809	The signal received by channel 1 exceeds the weight limit.		Blinking	
16#180A	CH1 Adjustment error			



Error Code (16#)	Description	ERROR LED indicator		
		A → D	ERROR	
16#180B	The signal received by channel 2 exceeds the range of analog inputs (temperature) or a SEN voltage error exists.			
16#180C	The signal received by channel 2 exceeds the weight limit.			
16#180D	CH2 Adjustment error			
-	When power-on, the module is not detected by CPU module.	OFF	Blinks one or two times every two seconds.	

# A.5.4 Error Codes and LED Indicators for AS02HC High Speed Counter Module

Error Code (16#)	Description	ERROR LED indicator		
		恆亮	一般閃爍	
16#1605	Error of latching count values	V		
16#1606	Error of latching setting values of module	V		
16#1607	Configuration error of module' s setting values	V		
16#1800	CH1 Overflow borrow counter		V	
16#1801	CH2 Oerflow borrow counter		V	
16#1802	CH1 Count value is over the upper/lower limit		V	
16#1803	CH2 Count value is over the upper/lower limit		V	
16#1804	CH1 Displacement variation of the SSI encoder exceeds the limit		V	
16#1805	CH2 Displacement variation of the SSI encoder exceeds the limit		V	
16#1806	CH1 SSI communication error		V	
16#1807	CH2 SSI communication error		V	
16#1808	A zero pass of CH1 SSI absolute position has occurred		V	
16#1809	A zero pass of CH2 SSI absolute position has occurred		V	

# A.5.5 Error Codes and LED Indicators for AS02/04PU Positioning Module

Error Code (16#)	Description	ERROR LED indicator		
		A↔D	ERROR	
16#1802	Hardware failure	OFF	Blinking	



Α

MEMO





