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# **AX-3 Series Operation Manual**





# **AX-3 Series Operation Manual**

# **Revision History**

Version	Revision	Date
1 <sup>st</sup>	The first version was published.	2020/10/30

# **AX-3 Series Operation Manual**

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# Chapter 1 Product Introduction

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### 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 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.

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Classification	Model Name	Description	
	10 5000	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)	
		8-axis motion controller CPU module, 2x built-in Relative	
		Encoders, 1x SSI, 16 DI (200KHz), 8 DO (200KHz NPN),	
	AX-308EA0MA1T	2x Ethernet port switches, 1x EtherCAT, 1x RS-485,	
		1x RS-232, 1 USB, Micro SD interface. Program capacity: 32	
AX-3 Motion		MB; Data capacity: 32 MB, removable terminal blocks	
Controller CPU		64-axis motion controller CPU module, 2x built-in Relative	
Module		Encoders, 1x SSI, 16 DI (200KHz), 8 DO (200KHz NPN),	
	AX-364ELA0MA1T	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	
	AS08AM10N-A	24VDC	
		5mA	
		8 inputs	
		Spring-clamp terminal block	
		5 - 30VDC	
		0.5A/output, 4A/COM	
	AS08AN01P-A	8 outputs	
		Sourcing output	
Divital		Spring-clamp terminal block	
Digital		240VAC/24VDC	
input/output module		2A/output, 8A/COM	
module	AS08AN01R-A	8 outputs	
		Relay	
		Spring-clamp terminal block	
		5 - 30VDC	
	AS08AN01T-A	0.5A/output, 4A/COM	
		8 outputs	
		Sinking output	
		Spring-clamp terminal block	

### 1.1.2 Models Descriptions

Classification	Model Name	Description
		24VDC
		5mA
	AS16AM10N-A	16 inputs
		Spring-clamp terminal block
		5 - 30VDC
		0.5A/output, 4A/COM
	AS16AN01P-A	16 outputs
		Sourcing output
		Spring-clamp terminal block
		240VAC/24VDC
		2A/output, 8A/COM
	AS16AN01R-A	16 outputs
		Relay
		Spring-clamp terminal block
		5 - 30VDC
		0.5A/output, 4A/COM
	AS16AN01T-A	16 outputs
		Sinking output
		Spring-clamp terminal block
	AS16AP11P-A	24VDC
		5mA
		8 inputs
		5 - 30VDC
		0.5A/output, 4A/COM
		8 outputs
		Sourcing output
		Spring-clamp terminal block
		24VDC
		5mA
	AS16AP11R-A	8 inputs
		240VAC/24VDC
		2A/output, 8A/COM
		8 outputs
		Relay
		Spring-clamp terminal block

Classification	Model Name	Description
		24VDC
		5mA
		8 inputs
		5 - 30VDC
	AS16AP11T-A	0.5A/output, 4A/COM
		8 outputs
		Sinking output
		Spring-clamp terminal block
		24VDC
		3.2mA
	AS32AM10N-A	32 inputs
		MIL connector
		5 - 30VDC
		0.1A/output, 3.2A/COM
	AS32AN02T-A	32 outputs
		Sinking output
		MIL connector
		24VDC
	AS64AM10N-A	3.2mA
		64 inputs
		MIL connector
	AS64AN02T-A	5 - 30VDC
		0.1A/output, 3.2A/COM
		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
Analog		8-channel analog input module
input/output module		Hardware resolution: 16 bits
module	AS08AD-B	0 to +10V, 0/1–5V, -5V to +5V, -10V to +10V
		Conversion time: 2 ms/channel
	AS08AD-C	8-channel analog input module

Classification	Model Name	Description
		Hardware resolution: 16 bits
		0/4–20mA, -20mA–+20mA
		Conversion time: 2 ms/channel
		4-channel analog output module
		Hardware resolution: 12 bits
	AS04DA-A	-10 to +10V, 0–20mA, 4–20mA
		Conversion time: 2 ms/channel
		4-channel analog input
		Hardware resolution: 16 bits
		0–10V, 0/1–5V, -5 to +5V, -10 to +10V, 0/4–20mA, -20 to
		+20mA
	AS06XA-A	Conversion time: 2 ms/channel
		2-channel analog output
		Hardware resolution: 12 bits
		-10 to +10V, 0–20mA, 4–20mA
		Conversion time: 2 ms/channel
	AS04RTD-A	4-channe, 2-wire/3-wire RTD
		Sensor type: Pt100 / Ni100 / Pt1000 / Ni1000 / JPt100 / LG-
		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
	AS06RTD-A	Sensor type: Pt100 / Ni100 / Pt1000 / Ni1000 / JPt100 / LG-
Tomporatura		Ni1000 / Cu50 / Cu100 / 0-300 $\Omega$ / 0-3000 $\Omega$ input impedance,
Temperature		Resolution: 0.1°C/0.1°F (16 bits)
measurement		Conversion time: 200ms/channel
module		4-channel thermocouple
	AS04TC-A	Sensor type: J, K, R, S, T, E, N, B and -100 to +100 mV
	A3041C-A	Resolution: 0.1°C/0.1°F (24 bits)
		Conversion time: 200ms/channel
		8-channel thermocouple
	AS08TC-A	Sensor type: J, K, R, S, T, E, N, B and -100 to +100 mV
		Resolution: 0.1°C/0.1°F (24 bits)
		Conversion time: 200ms/channel
Load cell	AS02LC-A	2-channel, 4-wire/6-wire load cell sensor
module	1002LO-7	Eigenvalue applicable to a load cell: 1, 2, 4, 6, 20, 40, 80 mV/V

Classification	Model Name	Description	
		Highest accuracy: 0.04% of full-scale	
		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	
Programming	UC-PRG030-01A	Use for the connection between a PLC and a PC with a mini	
cable	(3M) USB port, use for AS Series CPU modules		
Cable	UC-PRG030-20A	Use for the connection between a PLC and a PC with a RJ45	
	(3M)	port, use for AS Series CPU modules and AS-FEN02 function	
	(510)	card	
	UC-ET010-24B (1M)	MIL connector, 40Pin $\leftrightarrow$ 40Pin, shielded, use for	
	UC-ET020-24B (2M)	AS32AM10N-A, AS32AN02T-A, AS64AM10N-A and	
I/O extension	UC-ET030-24B (3M)	AS64AN02T-A	
cable	UC-ET010-24D (1M)	MIL connector, 40Pin $\leftrightarrow$ 2x 20Pin, shielded, use for AS332T-A,	
	UC-ET020-24D (2M)	AS332P-A, AS324MT-A, AS32AM10N-A, AS32AN02T-A,	
	UC-ET030-24D (3M)	AS64AM10N-A, and AS64AN02T-A	
		16 inputs/outputs, 20-Pin MIL connector, use for AS332T-A,	
	UB-10-ID16A	AS332P-A, AS324MT-A, AS32AM10N-A, AS32AN02T-A,	
		AS64AM10N-A and AS64AN02T-A	
	UB-10-ID32A	32 inputs, 40-Pin MIL connector, use for AS32AM10N-A and	
	00-10-1032A	AS64AM10N-A	
External	UB-10-IO32D	Terminal block (spring clamp/MIL connector), MIL connector to	
terminal		40-Pin spring clamp terminal block, use for AS332T-A,	
module		AS332P-A, AS324MT-A, AS32AM10N-A, AS32AN02T-A	
module	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	
	0B-10-0132A	AS32AN02T-A and AS64AN02T-A	
	UC-EMC003-02A	Ethernet communication cable, 0.3M	
ECAT cables	UC-EMC005-02A	Ethernet communication cable, 0.5M	
for motion	UC-EMC010-02A	Ethernet communication cable, 1M	
controller	UC-EMC020-02A	Ethernet communication cable, 2M	
	UC-EMC050-02A	Ethernet communication cable, 5M	
	UC-EMC100-02A	Ethernet communication cable, 10M	

Classification	Model Name	Description
	UC-EMC200-02A	Ethernet communication cable, 20M
	UC-EMC003-02B	Ethernet communication cable, 0.3M
	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.

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# Chapter 2 Specifications and System Configurations

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# 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: $5 \text{ Hz} \leq f \leq 8.4 \text{ Hz}$ , constant amplitude 3.5 mm; $8.4 \text{ Hz} \leq f \leq 150 \text{ Hz}$ , constant acceleration 1g Duration of oscillation: 10 sweep cycles per axis on each direction of the three mutually perpendicular axes International Standard IEC 61131-2 & IEC 60068-2-6 (TEST Fc)
Shock resistance	Tested with: Half-sine wave: Strength of shock 15 g peak value, 11 ms duration; Shock direction: The shocks in each in direction per axis, on three mutually perpendicular axes (total of 18 shocks) International Standard IEC 61131-2 & IEC 60068-2-27 (TEST Ea)
Safety	Conforms to IEC 61131-2, UL508
Ambient air temperature-barometric pressure-altitude	Operating: 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	Level (Normative)	Reference standard
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
	0.15-0.5 MHz	79 dB (μV) quasi-peak	
AC power port		66 dB (µV) average	
(conducted)	0.5-30 MHz	73 dB (µV) quasi-peak	IEC 61000-6-4
		60 dB (µV) average	

2

### • EMS

2

Environmental phenomenon	Reference standard	-	Test level	
Electrostatic		C	Contact	
discharge	IEC 61000-4-2		± 8 kV	
Radio frequency	IEC 61000-4-3	80% AM, 1 kHz sinusoidal	2.0-2.7 GHz	1 V/m
electromagnetic field			1.4-2.0 GHz	3 V/m
Amplitude modulated		I KHZ SITUSOIUAI	80-1000 MHz	10 V/m
Power frequency		60 Hz		30 A/m
magnetic field	IEC 61000-4-8	5	30 A/m	

### Conducted immunity test

Environmenta	Environmental phenomenon		High energy surge	Radio frequency interference
Reference	Reference standard		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
auxiliary power output	DC I/O and DC auxiliary power	2 kV	0.5 kV CM 0.5 kV DM	10 V

# 2.2 CPU Module Specifications

# 2.2.1 Functional specifications

	Тур	AX-308EA0MA1T	AX-364ELA0MA1T			
		LD instr	uction	5 nanosec	conds (ns)	
Process time	Execution time Arithmetic instructions (LREAL data type)		36 nanoseconds (ns)			
	Program capacity	Сара	city	8 N	ИВ	
	Variable	Retaintive	Retain		KB %M) is counted in)	
Program	memory		Persist	128	KB	
		Non-retaintive		16	MB	
	Device memory (%M)	Siz	e	512	КВ	
		Maximum n controlle		16 axes	128 axes	
		EtherCAT axes		8 axes	64 axes	
	Number of	Pulse Out axes		4 axes	4 axes	
	controlled axes	Maximum number of axes for linear interpolation axis control		6 axes	6 axes	
		Maximum number of axes for circular interpolation axis control		2 axes	2 axes	
Motion	Maximum number of axes groups			8 groups	8 groups	
control	Motion control period			The same control period as that is used for the process data communications cycle for EtherCAT.		
	САМ	Number of	Maximum points per CAM table	256 p	points	
		CAM data points	Maximum points for all CAM tables	20,480 points		
		Maximum number of CAM tables		80		
	Ν	umber of ports		2	2	
Ethernet port	Phy	sical media type	S	10BASE-T/100BASE-TX/1000BASE-T Switch		
		Topology		Star, linear		

	Trar	nsmission speed	10/100/10	00 Mbps	
		Cable	Category 5e or later,	100 meters (Max.)	
		Protocols	ARP, IP, TCP, UDP, MODBUS TCP, EtherNet/IP		
LICD mont	N	umber of ports	1		
USB port		Туре	Mini USB		
	N	umber of ports	1		
RS232		Baud rate	9,600, 19,200, 38,40 115,20		
port	Serial co	mmumication format	Stop bit: 1, 2; Parity b Data bi		
	Comm	umication protocol	MODBUS A	SCII/RTU	
	N	umber of ports	1		
RS485	Baud rate		9,600, 19,200, 38,40 115,20		
port	Serial commumication format		Stop bit: 1, 2; Parity bit: None, Odd, Even; Data bit: 7, 8		
	Commumication protocol		MODBUS ASCII/RTU		
	Et	herCAT Master	Class B		
	Phys	sical media types	100BA\$	SE-TX	
	Trar	nsmission speed	100 N	lbps	
EtherCAT		Тороlоду	Line, daisy chain	, and branching	
port		Cable	Category 5e or later,	100 meters (Max.)	
	Maximu	m number of Slaves	64	96	
	Tra	nsmission cycle	2,000µs ~ 32,000µs (unit can be set to 250µs)		
	MODBUS TCP	Maximum number of the connections	20 (0		
TOD	SOCKET	Maximum number of the TCP connections	32 (Server	+ Client)	
TCP	MODBUS TCP	Maximum data length per connection	100 words		
	SOCKET	Maximum data length per instruction	8 KB		
		Number of adapter to be connected	8		
EtherNet/IP	CIP IO Connection CIP connections (Input T->O)		64		

		Maximum number of the CIP connections (Output O->T)	64		
		Requested Packet Interval (RPI)	20 ~ 1,000ms (unit: 1 ms)		
		Maximum Transmission Speed	3,000 pps		
		Maximum data length per connection	500 bytes		
	CIP Explicit Message	Class 3 / UCMM	Get_Attribute_Single (FB) Get_Attributes_All (FB) Set_Attribute_Single (FB) Set_Attributes_All (FB)		
		CIP objects supported	Identity, Message Router, Assembly, Connection, Manager, Port, TCP/IP interface, Ethernet link, Vendor specific		
	Supporte	d profiles and models	PLCopen and OPC Foundation: OPC UA Information Model for IEC 61131-3		
	Endpoints	s and connecting ports	TCP: 4840 (Reconfigurable via configuration file)		
	Maximum nu	mber of sessions (Client)	5		
	Maximum nun	nber ofmonitored items per server	1000		
	Sampling rate	of the monitored items (ms)	100, 300, 500, 1000, 2500, 5000		
	Maximum number of subscriptions per server		100		
	Maximum number of variables that can be published		10,000		
OPC UA server	Maximum number of value attributes that can be published		10,000		
	Maximum number of structure definitions that can be published		100		
		at can not be published for each network- blished variable	<ul> <li>More than three dimensional arrays</li> <li>Array of Array</li> <li>The OPC UA Stack will limit messages to about 300 kB. This is the maximum for values too.</li> <li>Pointer variables, Interface variables</li> <li>Structures containing pointers and interfaces</li> </ul>		
	Securi	ty mode and policy	None Sign - Basic256Sha256 SignAndEncrypt - Basic256Sha2566		
	Application	Authentication	X.509		

	authentication	Number of certificates that can be stored	Trusted applications: 32 Issuer certificiates: 32 Rejected applications: 32
	User authentication	Method of user authentication	User name / password / Anonymous
	Number of IO er	ntension modules supported	32
		I/O capacity	IN:8,192byte OUT:8,192byte
IO configuration		Encoder	2
	Built-in IO	SSI	1
		High speed counter	5 (200KHz)
		Pulse out	4 (200KHz)
Memory card	SD card type		Micro SD (SDHC, 32GB max.)
Real-time clock	Year, Month, D	Date, Hour, Minute, Second, Week	One CR1620 battery is required.
Dimension	Leng	th * Width * Height	110mm * 88mm* 100mm

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

Model Item	Maximum number of positioning axes	Maximum number of synchronization axes	Maximum number of positioning and synchronization axes	
AX-308EA0MA1T	≤ 8	≤ 8	≤ 8	
AX-364ELA0MA1T	≤ 64	≤ 8	≤ 64	

### 2.2.2 Electrical specifications

Model	AX-308EA0MA1T	AX-364ELA0MA1T			
Supply voltage	24 VDC (20.4 VDC-28.8 VDC) (-15% to +20%)				
Power consumption (W)	11 W				
Weight (g)	420 g				

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

ltem	Model	AX-308EA0MA1T	AX-364ELA0MA1T		
Number of	inputs		16		
Connector	· type	Removable terminal blocks			
Input type		Digita	al input		
Input form		Direct current (sir	nking or sourcing)		
Input volta	ige/ current	24 VDC	C, 5 mA		
Action	OFF→ON	>15 VDC			
level ON→OFF		<5 VDC			
Response	OFF→ON	2.5 µs			
time	ON→OFF	5 µs			
Maximum frequency	•	200	KHz		
Input impe	edance	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.			
Electrical i	input isolation	500VDC			
Input disp	lay	When the optocoupler is driven, the inp	out LED indicator is ON.		

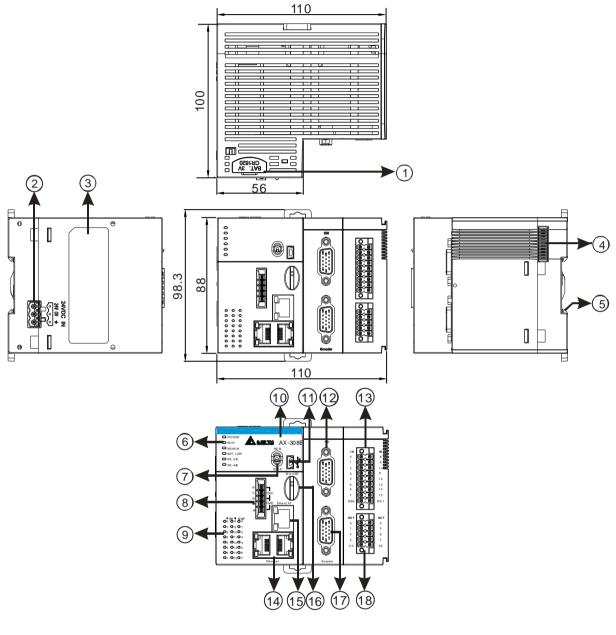
• Electrical specifications for the outputs on digital input/output module. The signals passing through the inputs are 24 VDC signals.

Item	Model	AX-308EA0MA1T	AX-364ELA0MA1T		
Number of	outputs		8		
Connector t	type	Removable te	erminal blocks		
Output form	า	Transisto	r (N-MOS)		
Voltage		24 VDC (-15% ~+20%)			
	Resistance	0.1A/c	putput		
Maximum load	Inductance	-			
IUdu	Bulb	-			
Maximum o frequency <sup>*1</sup>	utput	200 KHz			
Maximum Response time	OFF→ON	2.5	μs		

2

### 2.2.3 CPU Module Profiles

### • AX-308EA0MA1T/ AX-364ELA0MA1T



Unit: mm

Number	Name	Description
1	Battery holder	A case for holding a battary (not enclosed) for the real-time clock fuction
2	Power supply	For power supply
3	Label	Nameplate
4	External module port	Connects the modules
5	Grounding clip	For grounding
	Power LED indicator	Indicates the power status of the CPU module
	Run LED indicator	Operating status of the CPU module ON: the module is running. OFF: the module is stopped. Blinking: the module is detecting an error.
6	Error LED indicator	Error status of the module ON: a serious error occurs in the module. OFF: the module is normal. Blinking: a minor error occurs in the module.
	BAT.LOW LED indicator	Indicates the battery status of the CPU module.
	COM1 LED COM2 LED	Indicates the communication status of the COM port. OFF: no communication over the COM port Blinking: communication over the COM port
7	Run/Stop	RUN: execute the programs STOP: stop the programs
8	COM Port	Provides an interface for RS-485 and RS-232 communication
9	Input/Output LED indicator	If there is an input signal, the input LED indicator is ON. If there is an output signal, the output LED indicator is ON.
10	Model name	Shows the model name of the CPU module.
11	USB Port	Mini USB communication port
12	SSI Port	SSI Encoder communication port
13	Input Terminals	For input wiring
14	Ethernet Port	<ul> <li>Ethernet Switch communication port</li> <li>LINK indicator (Green):</li> <li>LED ON: The network connection is established.</li> <li>LED OFF: The network connection is NOT established.</li> <li>ACT indicator (Orange):</li> <li>LED blinking: Data transmission (sending/receiving)</li> <li>LED OFF: No data transmission</li> </ul>
15	EtherCAT Port	<ul> <li>EtherCAT communication port</li> <li>LINK indicator (Green):</li> <li>LED ON: The network connection is established.</li> <li>LED OFF: The network connection is NOT established.</li> <li>ACT indicator (Orange):</li> <li>LED blinking: Data transmission (sending/receiving)</li> <li>LED OFF: No data transmission</li> </ul>
16	SD Card Slot	Provides an interface for an SD card
17	Encoder Port	Incremental encoder communication port
18	Output Terminals	For output wiring

2

AX-308EA0MA1T / AX-364ELA0MA1T								
	SSI ENCNDOR IN							
		L	1	DATA+	1	A1+	X0.0	X0.8
	SSI		2	DATA-	2	A1-	X0.1	X0.9
O ERROR RUN O BAT. LOW	Ø		6	CLK+	10	B1+	X0.2	X0.10
RS-232     RS-485     STOP			14	CLK-	11	B1-	X0.3	X0.11
Micro SD		3 <b>(B) (B)</b> 11 4 <b>(B) (B)</b> 12	8	GND	4	Z1+	X0.4	X0.12
▏▏		5 8 13 6 8 14	15	5V	5	Z1-	X0.5	X0.13
	Ó	5 0 0 13 6 0 0 14 7 0 0 15 S/S0 0 S/S1			15	+5V1	X0.6	X0.14
	Ø				3	A2+	X0.7	X0.15
					9	A2-	S/S0	S/S1
		0 0 4 1 0 0 5 2 0 0 6 3 0 0 7 C0 0 C0			6	B2+	0	ŬT
0 3 01103 04 01204 05 01305					12	B2-	Y0.0	Y0.4
	Ó				13	Z2+	Y0.1	Y0.5
O7 O15O7 Ethernet	Encoder	ŗ			14	Z2-	Y0.2	Y0.6
	J				7	+5V2	Y0.3	Y0.7
					8	0V	C0	C0

### 2.2.4 CPU Module Input/Output Terminals

# 2.3 Power Supply Module Specifications

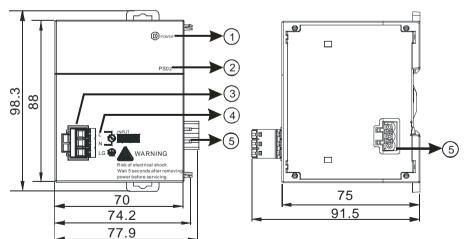
### 2.3.1 General Specifications

### AS-PS02/AS-PS02A

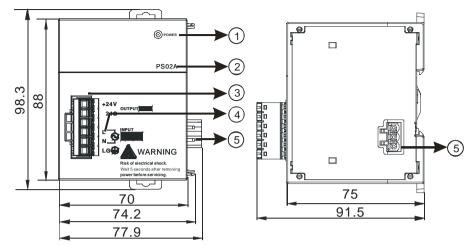
ltem		Specifications
Supply voltage		100–240 VAC (-15% to +10%) 50/60 Hz±5%
Action specifications		If the input power supply is larger than 85 VAC, the power supply module can function normally.
Allowable instantaneous power failure time		If the instantaneous power failure time is less than ten milliseconds, the power supply module keeps running.
Fuse		2.5A/250 VAC
Inrush 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 protection		The 24 VDC output is equipped with the short circuit protection and the overcurrent protection.
Surge voltage withstand level		1,500 VAC (Primary-secondary), 1,500 VAC (Primary-PE), 500 VAC (Secondary-PE)
Insulation voltage		Above 5 $\mbox{M}\Omega$ 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.
Weight	AS-PS02	270 g
	AS-PS02A	310 g

# 2.3.2 Power Supply Module Profiles

• AS-PS02



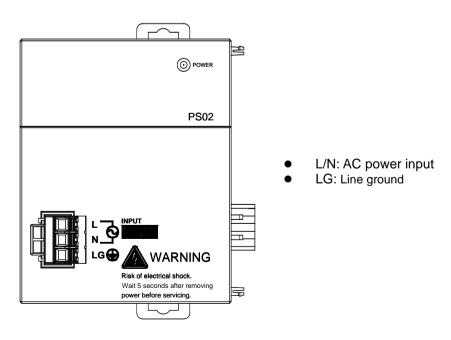
### • AS-PS02A



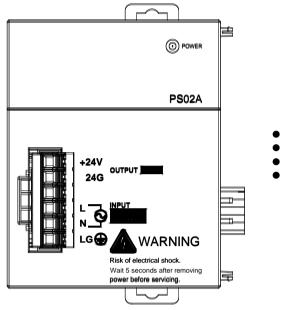
Number	Name	Description
1	POWER LED indicator (green)	Indicates the status of the power supply
2	Model name	Model name of the power supply module
3	Terminal	Terminal for wiring
4	Arrangement of the terminals	+24V: connecting external 24VDC + 24G: connecting external 24G LG: Line ground L/N: AC power input
5	Power output	Connected with AS series

### 2.3.3 Power Supply Module Terminals

### AS-PS02



AS-PS02A



+24V: connecting external 24VDC + 24G: connecting external 24G L/N: AC power input LG: Line ground

2

### 2.4 Extension Modules

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



# Chapter 3 Installing Hardware and Getting Started

# **Table of Contents**

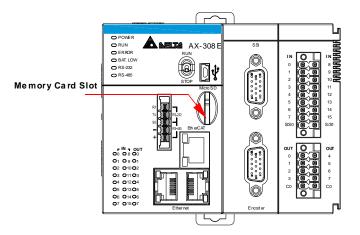
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3.3.1	Getting Started	3-15
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### 3.1 Installing Hardware

### 3.1.1 Installing and Removing a Memory Card

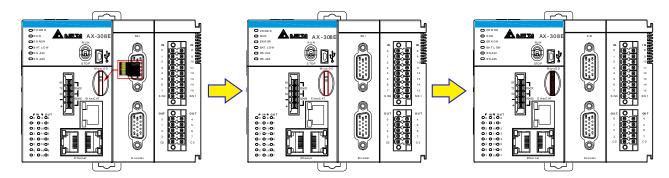
### • Memory Card Slot of the CPU Module

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



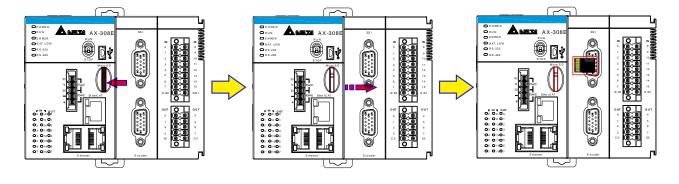
### • Installing a Memory Card

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



### Removing a Memory Card

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



### 3.1.2 Installing and Replacing a Button Cell Battery

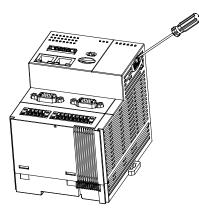
### Installation

**▲** Warning

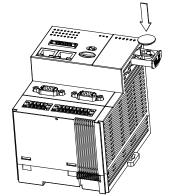
The real-time clock (RTC) cannot work unless the battery power is properly supplied. The AX-3 Series PLC does NOT include the battery when it leaves the factory. You need to purchase and install the CR1620 3V battery beforehand. And before installing the battery, you must get rid of the static electricity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

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

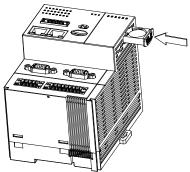
1. Pull out the battery holder from the AX-3 Series PLC with the tip of a screwdriver at the concave part of the battery compartment as shown below.



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



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



3

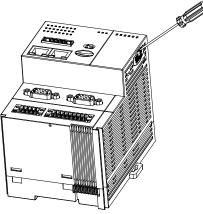
### Replacement

# ▲ Warning

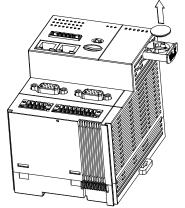
When the BAT LOW indicator of the AX-3 Series PLC is red, it indicates there is no battery installed or the battery voltage is low and you need to install or replace the battery of the AX-3 Series PLC. It is suggested to replace the battery while the AX-3 Series PLC is powered on. If you replace the 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.

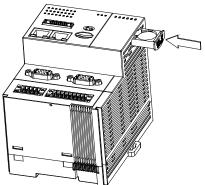
1. Pull out the battery holder from the AX-3 Series PLC with the tip of a screwdriver at the concave part of the battery compartment as shown below.



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.

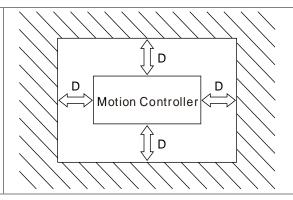
#### • Actions for Anti-interference

# ▲ 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.

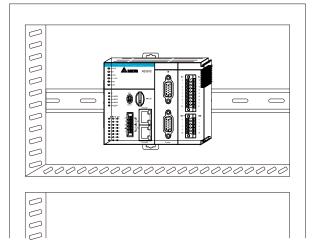
#### • Dimension Requirement for the Control Cabinet

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)

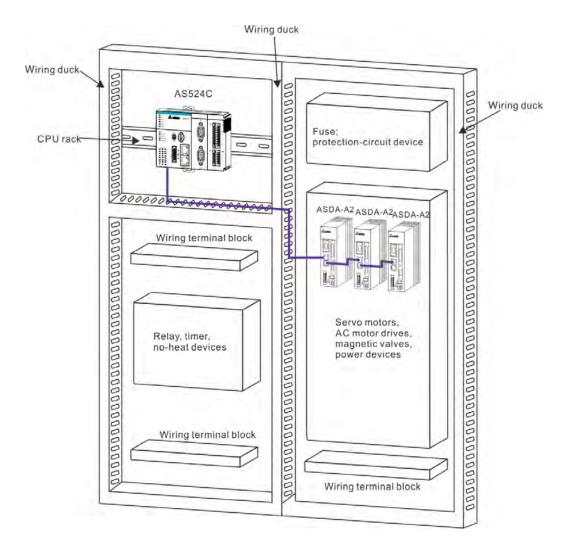


#### • Installing the AX-3 Series PLC on DIN rail

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				

#### 3.2.1 Installing DIADesign-AX

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

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

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

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

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.

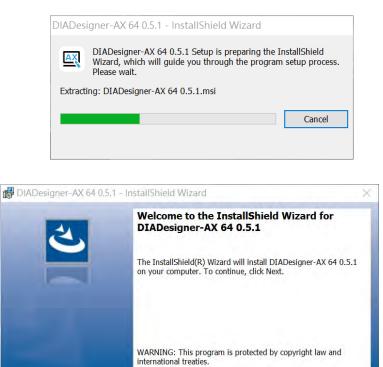
#### 2. Click **Download**.

DIAInstaller	_						
_						English	Sign In
ware List	DIA	Studio					
ŝ		Product Name	Version	Size	Download/Update Installation	Progress	nstall/Uninstall
ption	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		🛃 Install
	i	COMMGR	1.3	224.0 MB	▲ Download		Anstall
	i	DIADesigner-AX	0.5.0	1.3 GB	↓ Download		S Install
						63	
<b>Î</b> bout						Check for Updates	Download All

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

DIAInstaller							- <b>-</b> ×
							English ( Ray w
vare List		Studio					
â		Product Name	Version	Size	Download/Update Installation	Progress	Install/Uninstall
(Q) Iption	i	DIADesigner	0.4	1.0 GB	Download		S Install
	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		C. Install
_	i	DIADesigner-AX	0.5.0	1.3 GB	Downloaded		🛃 Install
							Check for Download
<u>i</u>							Updates All

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



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

< Back

Next >

Cancel

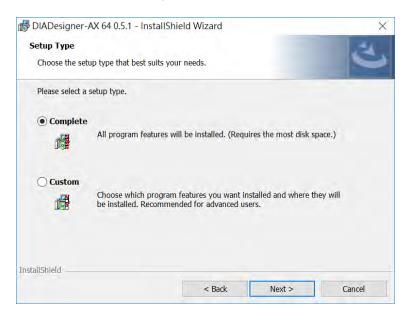
💕 DIADesigner-AX 64 0.5.1 - InstallShie	eld Wizard		$\times$
License Agreement Please read the following license agreemen	at carefully		L.
	ni carefully.		
License Agreement for the usage of a CODES Software Package	YS Softwar	e or COD	ESYS
General Terms of Lic supplied Software. P carefully before using installation of the Sod the conditions of this	lease read this So g the supplied So ftware constitutes	oftware User A ftware. Downlo	greement ading or
The following condition	ons are agreed b	etween you as	the software
• I accept the terms in the license agreement		Print	
I do not accept the terms in the license age InstallShield		Open Source Licenses	
	< Back	Next >	Cancel

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

	gner-AX 64 0.5.1 - InstallSh	neld Wizard	-
	on Folder t to install to this folder, or clic	k Change to install to a different folder.	3
D	Install DIADesigner-AX 64 0. C:\Program Files\Delta Indust V0.5.1\	5.1 to: trial Automation\DIADesigner-AX	Change
allShield -			1
		< Back Next >	Cancel
	iner-AX 64 0 5 1 - InstallSh	ield Wizard	
Change C	gner-AX 64 0.5.1 - InstallSh urrent Destination Folder o the destination folder.	ield Wizard	3
Change C Browse t	urrent Destination Folder	ield Wizard	3
Change C Browse t	urrent Destination Folder	ield Wizard	
Change C Browse t	urrent Destination Folder o the destination folder.	ield Wizard	
Change C Browse t	urrent Destination Folder o the destination folder.	ield Wizard	
Change C Browse t	Designer-AX V0.5.1	ield Wizard	
Eolder na	urrent Destination Folder o the destination folder. Designer-AX V0.5.1	nation\DIADesigner-AX V0.5.1\	
Eolder na	urrent Destination Folder o the destination folder. Designer-AX V0.5.1		

3\_

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 - InstallShie	eld Wizard		×
Ready to Install the Program			1.24
The wizard is ready to begin installation.			9
Click Install to begin the installation.			
If you want to review or change any of yo the wizard.	our installation se	ttings, click Back. Click	Cancel to exit
InstallShield	_		
	< Back	Install	Cancel

It may take some time to install.

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



# 3.2.2 Uninstalling DI ADesigner-AX

Follow the steps below for uninstalling DIADesigner-AX.

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

DIAInstall	er						- 🗆 🗙
							English 🚺 Ray v
ntware List	DIA	Studio					
<i>f</i> ê		Product Name	Version	Size	Download/Update Installation	Progress	Install/Uninstall
Option	i	DIADesigner	0.4	1.0 GB	🕁 Download		🔮 Install
	i	DIASelector	0.4	767.4 MB	↓ Download		S Install
	i	DIAScreen	0.4	1.6 GB	▲ Download		S Install
	i	COMMGR	1.3	224.0 MB	↓ Download		C Install
	i	DIADesigner-AX	0.5.0	1.3 GB	installed		🔔 Uninstall
							Check for Download
<b>ů</b> About							Updates All

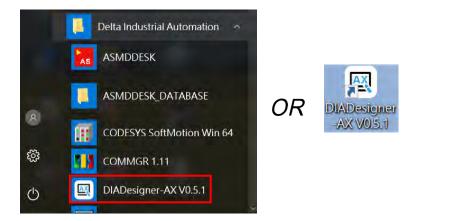
2. The system will remove DIADesigner-AX from your computer in the background.

# 3.3 Getting Started and Setting up Communication

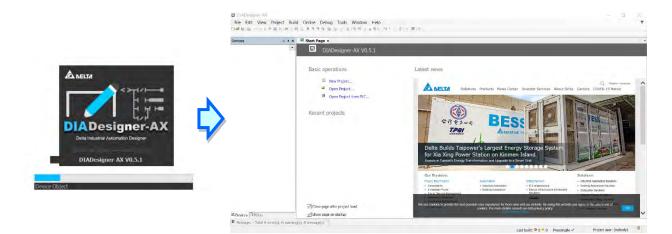
# 3.3.1 Getting Started

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

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



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

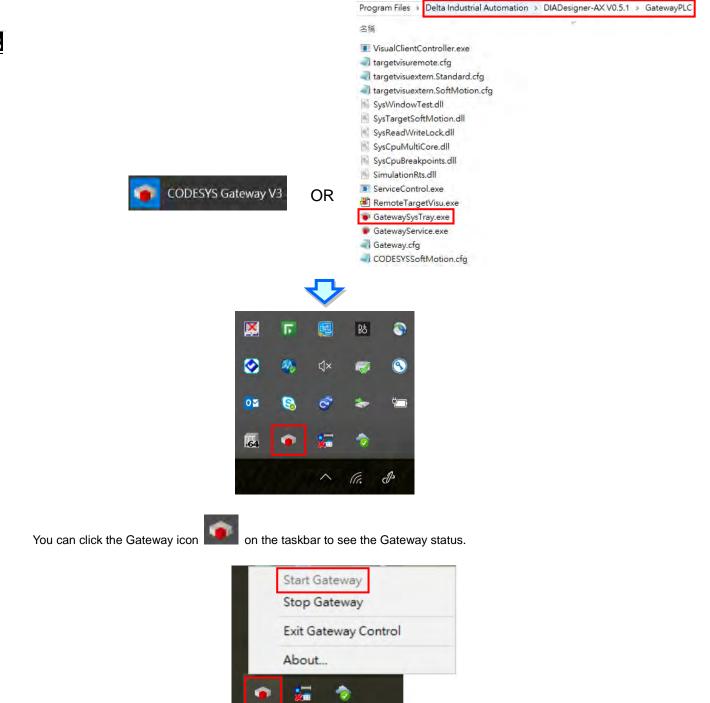


#### 3.3.2 **Setting up Communication**

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

icon

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



Click Stop Gateway if you need to stop gateway working.



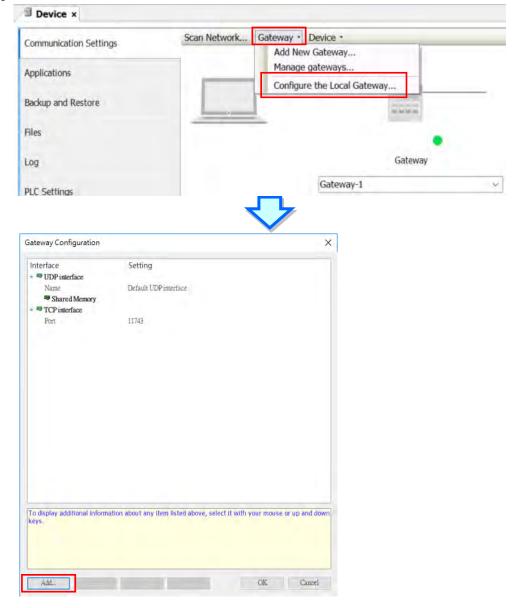
If you need to discontinue the execution of GatewaySysTray completely, you can click **Exit Gateway Control** and the icon will disappear on the taskbar.

•	<b>5</b> 🕈
	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.

Device ×					
Communication Settings	Scan Network Gateway -	Device *			
Applications Backup and Restore Files Log				Image: Control of the set active path	4
	Communication Settings Applications Backup and Restore Files Log PLC Settings PLC Shell Users and Groups Access Rights Symbol Rights System Parameters Task Deployment Status	Communication Settings       Scan Network Gateway •         Applications       Backup and Restore         Files       Image: Communication Settings         PLC Settings       PLC Shell         Users and Groups       Access Rights         Symbol Rights       System Parameters         Task Deployment       Status	Communication Settings       Scan Network Gateway - Device -         Applications       Backup and Restore         Files       Gateway-1         Log       Gateway-1         PLC Sheli       Device -         Users and Groups       Port: 1217         Access Rights       Symbol Rights         System Parameters       Task Deployment         Status       Status	Communication Settings       Scan Network Gateway · Device ·         Applications       Backup and Restore         Files       Image: Control of Contr	Communication Settings       Scan Network       Gateway • Device •         Applications       Backup and Restore         Files       Image: Content of Co

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 UDPinterface 11743	¢	Interface " UDP interface Name " TCP interface Port COM Fort USB Port CAN Client	Setting Default UDPinterface	
To display additional informa keys, Add top level interfac Add sub level interfac Add configuration se	ce	r up and down Cancel	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  = UDP interface Name Default UDP interface  TCP interface Port 11743  = COM Port Name Com<1> Port 1 Baudrate 57600  This setting defines the physical serial port used for this Interface (e.g. COM 5 on a Windows PC).		10. LUL	
Name     Default UDP interface       Shared Memory       TCP interface       Port     11743       COM Port       Name     Com<1>       Port     1       Baudrate     57600	Interface	Setting	
<ul> <li>Shared Memory</li> <li>TCP interface <ul> <li>Port</li> <li>11743</li> </ul> </li> <li>COM Port <ul> <li>Name</li> <li>Com&lt;1&gt;</li> </ul> </li> <li>Port</li> <li>Baudrate</li> <li>57600</li> </ul>			
TCP interface         Port       11743         COM Port         Name       Com<1>         Port       1         Baudrate       57600		Default UDP interface	
Port 11743 COM Port Name Con<1> Port 1 Baudrate 57600			
Name     Com<1>       Port     1       Baudrate     \$7600		N.2.0	
Name Con<1> Port 1 Baudrate \$7600		11743	
Port 1 Baudrate 57600			
Baudrate 57600		Com<1>	
	and the second s	1	
his setting defines the physical serial port used for this interface (e.g. COM 5 on a Windows PC)	Baudrate	57600	
his setting defines the physical serial port used for this interface (e.g. COM 5 on a Windows PC)			
ins setting defines the physical settin pore alou for this interface (e.g. corrs of a minuters reg.			
	his setting defines the phy	sical serial port used for this interface (e.g. COM 5 or	n 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 Com<1> Port 1 Baudrate 57600
= COM Port	Add top level interface	Enable auto addressing ~ Enable auto addressing Local address Parity
Port Baudrate	Add configuration setting	Stophits 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**.

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

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

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

MEMO



# Chapter 4 Basic Operation

# Table of Contents

	duction on DIADesigner-AX Creating a New Project	
4.2 Settin	g Items on the Device Page	
4.2.1	CPU Parameter Settings	
	Гуре and Variables	
	Data Type	
4.3.2	Variables	
4.4 Task.		
4.4.1	Task Configuration	

# 4.1 Introduction on DIADesigner-AX

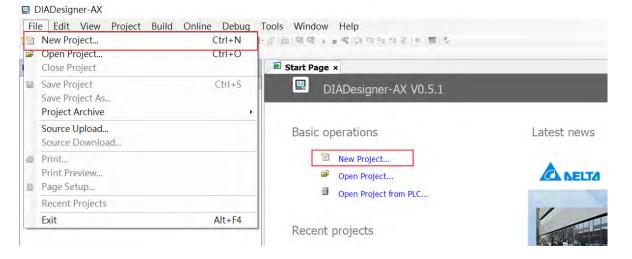
DIADesigner-AX is an open platform for PLC development system and industrial automation. The adaptable DIADesigner-AX provides an easy way to create professional engineering of IEC 61131-3 automation projects. Based on the IEC 61131-3 data structure and the high-level language programming, DIADesigner-AX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

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

### 4.1.1 Creating a New Project

Double-click the DIADesigner-AX icon to open DIADesigner-AX. Click **New Project** on the Start Page or

select *File > New Project (Ctrl+N)* to create a new project.



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

Categories		Templates
Librar Protei	ies Cts	Project Project AX-308E AX-6xxE Standard project
A project o	ontaining one device, on	e application, and an empty implementation for PLC_PRG
A project o Name	ontaining one device, on	e application, and an empty implementation for PLC_PRG

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

Standard	Project			$\times$
		t to create a new standard project. This wize n this project:	ard will create the	following
	- A program F - A cyclic tasl	mmable device as specified below PLC_PRG in the language specified below k which calls PLC_PRG to the newest version of the Standard librar	y currently installe	ed.
	Device	AX-308EA0MA1T (Delta Electronics, Inc.)		×.
	PLC_PRG in	Ladder Logic Diagram (LD)		$\sim$
			ОК	Cancel
		↓		
Ladder Logi	c Diagram (LD	)	×.	
Continuous		CFC) - page-oriented		
Function Blo Instruction	ock Diagram (F	BD)		
	c Diagram (LD			
	Function Chart	·		
Structured 7	Text (ST)			

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.

Devices	* * *	ToolBox + • ×
- @ Untitled1		
<ul> <li>B Device (AX-308EA0MA1T)</li> </ul>		
Hardware Configuration		
<ul> <li>A Network Configuration</li> </ul>		
A EtherCAT Filter		
S all PLC Logic		
O Application		
Ubrary Manager		
PLC_PRG (PRG)		
Task Configuration		
EtherCAT_Task		
= 🤩 MainTask		
BuiltIn_IO (BuiltIn_IO)		
I DIO (DIO)	a LocalDine Manhad	
Delta_LocalBus_Master (Del AX_308_Series_EtherCAT_M		
SoftMotion General Axis Pool		
<ul> <li>SoftMotion General Axis Pool</li> </ul>		
<	>	
Devices D POUs		
Messages - Total 0 error(s), 0 warning	ng(s), 1 messagu(s)	
		Last build: 🔍 0 🙁 0 Precompile 🗸 🖓 Project user: (nobody) 🤍

# 4.2 Setting I tems on the Device Page

This section introduces all the setting items on the Device Page. File Edit View Project Build Online Debug Tools Window Help 🛅 🖆 🔜 🕼 🗠 🔺 🐘 🛍 🗙 🛤 🍇 🍓 🚰 📜 🧌 🦄 👘 👘 👘 🖆 🖆 👹 🧐 👂 👘 🕞 🖷 🧐 🧐 Device × Devices **- - x** Project Scan Network... Gateway - Device -Communication Settings Device (AX-308EA0MA1T) Hardware Configuration Applications A Network Configuration A EtherCAT Filter Backup and Restore PLC Logic 🗄 🔘 Application Files 🛍 Library Manager PLC PRG (PRG) Log 🖮 🌃 Task Configuration BetherCAT\_Task PLC Settings IP-Address: localhost 🕸 MainTask PLC Shell DIC\_PRG 🖻 🗊 BuiltIn\_IO (BuiltIn\_IO) Port: 1217 Users and Groups DIO (DIO) Delta\_LocalBus\_Master (Delta Local Access Rights EtherCAT\_Master\_SoftMotion (Ethe SoftMotion General Axis Pool Symbol Rights Runtime Clock Configuration

# 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 Gatewa	ay + Device +			
Applications					ini i
Backup and Restore		1			
Files				· .	
Log		Ga	iteway		
PLC Settings		Gateway-1	$\checkmark$	[6038.A004]	Ý
PLC Shell		IP-Address: localhost			
Users and Groups		Port: 1217			
Access Rights					
Symbol Rights					
Runtime Clock Configuration					

Device ×						
Communication Settings	Scan Network Ga	teway 🔹 Device 👻				
Applications	-	_				-
Backup and Restore			· ==		1	
Files					** . (	
Log			Gateway			
PLC Settings		Gateway-1		~ [6038./	1004]	~
PLC Shell		IP-Address: localhost				
Users and Groups		Port: 1217				
Access Rights						
Symbol Rights						
Runtime Clock Configuration						

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

Red: Not be able to establish a connection

Green: A connection is established.

Black: Unknown connection status

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

Tab		Description		
Tab	the loc Note: in ord Rename Active Name page. Wink Current D Send Echo Ser are used to test sent first without packets depend	Description         ADesigner-AX saves the communication settings in the options of cal installation for reuse on the same computer.         When using DIADesigner-AX SVN, the option should be cleared er to prevent blocking the device object.         e Device: Click this setting item to open the Change Device         Device: Devices that support this function illuminate a flashing signal.         rvice: DIADesigner-AX sends five echo services to the PLC. These the network connection, similar to the ping function. The services are t data packets and then with data packets. The scope of the data ls on the communication buffer of the PLC. A message box opens about the average echo service delay and the scope of the sent data		
	packets.			
	contro not av not the If the Secur Comr	Inmunication: The communication to this controller is encrypted. A certificate of the communication to this controller is encrypted. A certificate of the communication is displayed to the controller. If the certificate is valiable, then an error message shows up prompting whether or the certificate should be displayed and installed. Enforce Encrypted Communication option is selected as rity level in the Security Screen view, then the Encrypted munication is disabled here. Function Policy: Click this setting item to open the Change		
	communication.	nication policy is selected in this dialog, then the configuration on the		
-	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</li> </ul>		

### 4.2.1.2 Applications

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

Communication Settings	Applications on the PLC	
pplications	Applcation_1 Applcation_2	Remove
ackup and Restore		Remove Al
les		Deceman
pg .		Camberry
LC Settings		
LC Shell		
sers and Groups		
couss Rights		
ymbol Rights		
untime Clock Configuration		
stem Parameters		
ask Deployment		
tatus		
nformation		

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

# 4.2.1.3 Backup and Restore

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

Communication Settings	Backup - Restore -			
Applications	Target Information			
Backup and Restore	ID Type Version	-		
Files	Backup Information			
Log	File name		Ê	
PLC Settings	Size of active files Mode	0 bytes No information	~	
PLC Shell	Comment		^	
Users and Groups				
Access Rights			×	
Symbol Rights	Active Component Fi	e Size Requires STOP		

Tab	Description
	Click <b>Backup</b> tab to see the followings
	• <b>Read Backup Information from Device:</b> Use this function to search for application-
	specific files from the \$PIcLogic\$ directory of the PLC and lists them on the Backup
Baakum	tab page.
Backup	• Create Backup File and Save to Disk: Use this function to compress the files in into
	a backup zip file. The file extension is tbf (="Target Backup File").
	• Save Backup File to Device: Use this function to save the backup file to
	the TBF directory of the PLC.
	• Load Backup File from Disk: After clicking this button, the system generates a list of
	all backup files found on the disk. Select one of these files to view its contents.
	• Load Backup File from Device: After clicking this button, the system generates a list
Restore	of all backup files found on the PLC. Select one of these files to view its contents.
	• <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	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.		
<b>Comment</b> Optional entry for comments to be saved in the meta.info file of the backup and read when the files are restored.		

#### 4.2.1.4 Files

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

Communication Settings	Host Location		• 🖻 🗙 🕫		Runtime Location			
Applications	Name	Size	Modified		Name <click on="" refre<="" td="" the=""><td>sh icon to update the list&gt;</td><td>Size</td><td>Modif</td></click>	sh icon to update the list>	Size	Modif
Backup and Restore	D:\							
Files								
Log								
PLC Settings								
PLC Shell								
Users and Groups								
Access Rights								
Symbol Rights				>>				
Runtime Clock Configuration				<<				
System Parameters								
Task Deployment								
Status								

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.	
<u> </u>	Click this button to create a new file folder	
×	Deletes the selected files or folders	
49	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 •

•

3 warning(s	) O 1error(s) E 0 exception(s)	306 information(s)     26 debug message(s) <all components="">      Logger     <pre>         Logger</pre> <pre>         Logger</pre> </all>	ogger> 🔹 🗗 🕺 🕤 🗂 🗙
Offline log	ging 🔲 UTC time		
everity	Time Stamp	Description	Component
0	01.01.1970 08:07:17	Channel 58628 connected	CmpChannelServer
0	01.01.1970 08:05:42	Channel 41740 closed 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
o	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

Item	Description			
Offline logging	<ul> <li>Default settings</li> <li>The PLC also records actions that are not related to the connection with the controller.</li> </ul>			
	However, this is currently available only for the safety version of CODESYS.			
	Standard setting; the time stamp is converted to the local time on the computer as			
UTC time	indicated by the time zone of the operating system.			
	☑: The time stamp of the runtime system is displayed.			
	Four categories for the severity of the event:			
	• <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			
	hows 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 component names	The log list displays only events that concern the selected component			
	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.			

#### 4.2.1.6 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 🛛 🗸		
Always update variables	Disabled (update only if used in a task)	~	
Bus Cycle Options			
Bus cycle task	<unspecified></unspecified>	~	
Additonal Settings			
Generate force variables for	IO mapping 🗌 Enable Diagnosis for device	15	
Show I/O warnings as errors			

#### ① Application for I/O handling

Item	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**

Item	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		
iles		
og		
.C Settings		
LC Shell		
ers and Groups		
cess Rights		
bol Rights		
time Clock Configuration		
stem Parameters		
ask Deployment		
tus		
formation		

#### 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 of	y not authorized to perform this operation on the device. Please enter the nam f an user account which has got the sufficient rights.	e
Device Name	Device (AX-308EA0MA1T)	
DeviceAddress		
User Name	Administrator	2
Password		
Operation: Object:	View "Device" OK Cancel	
🗘 😂 🔚 Device user:		
Synchronized mode: All chan -Users	ges are immediately downloaded to the device.	
Administrator	oup 'Everyone'	<ul> <li>Add</li> <li>Import</li> <li>Edit</li> <li>Delete</li> </ul>
Grauma		
Groups		♦ Add
Developer		• Import
Service		Edit
est1		Delete

### • Toolbar of the tab

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

#### • Users

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

#### • Groups

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

#### Note 1: The Add User setting page

		PLC_test1	Name	י ט
		Administrator	Default group	2) (
-		•••••	Password	3) 1
		••••••	Confirm password	D
	sword	Better	Passwordstrength	5)
		Password can be		
		Better	Password strength	

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

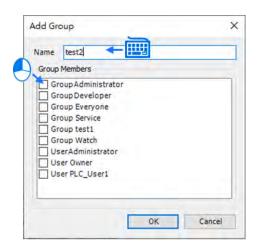
### Note 2: The Import User setting page

After selected the user from the list, click  $\ensuremath{\text{OK}}$  to import.

Import Users		×
Project Users		
defined in th	Il find a list of all users currently e project user management. Select which you want to import into the devic ment.	e
enter the pas	hat for security reasons you will have t sword for each selected user account. rd will be used for the corresponding account.	0
S Owner		
	OK Cancel	

#### Note 3: The Add Group setting page

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



#### Note 4: The Import Group setting page

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

nport Groups	,
Project Groups	
Below you will find a list of all group defined in the project user managen those groups which you want to imp device user management.	ient. Select
Se Everyone	
Se Owner	
	Cancel
ОК	Cancel

#### 4.2.1.9 Access Rights

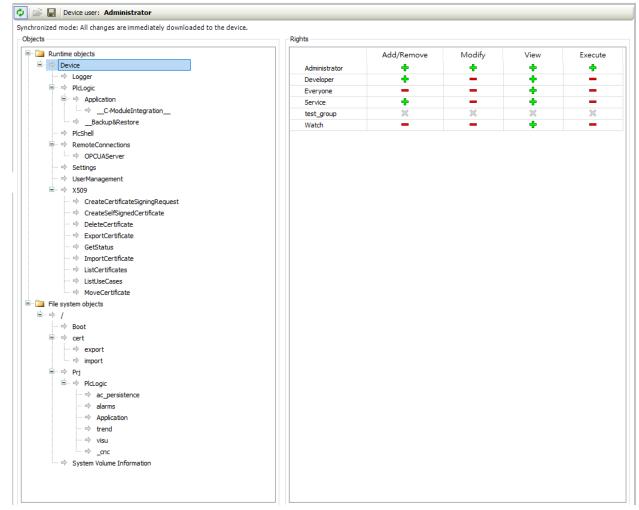
Here you can define the device access rights of device users to objects on AX-3 Series PLC. As in the project user management, users must be members of at least one user group and only user groups can be granted certain access rights.

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.

#### • 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.

Objects	Rights				
Qurtime objects     Device     Opger     opger     opger     oplogic     oplogic	Administrator	Add/Remove	Modify	View	Execute
	Developer	+	-	+	-
	Everyone	-	-	+	-
	Service	+	-	+	
	test_group	×	×	25	×
Backup&Restore	Watch	-	-	+	-

Possible actions on the object:

- Add/Remove
- Modify
- View

#### • Execute

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

This allows you to quickly see:

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

Meanings of the symbols

- +: Access right granted explicitly
- -: Access right denied explicitly
- +: Access right granted through inheritance
- Carees 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	ntime objects	
(d) - 2	Device	
	🔿 Logger	
	PlcLogic	
	😑 🔿 Application	
		egration
	→	

#### 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.

Rur	time objects			
≜. ⇒	Device			
	Logger			
	PlcLogic			
	😑 🔿 Application			
		leIntegration	23	
	→ Backupℜ	store		

#### > Device > PlcLogic

Run	ntime objects	
1. 0	Device	
	i Logger	
0	PlcLogic	
	= => Application	
	→C-ModuleIntegration	
	Backup&Restore	

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

#### PlcLogic > Application

- 🛄 F	Runtime objects	
ė.	Device	
	- 🔶 Logger	
CG.	PlcLogic	
	🗐 🔿 Application	
	C-ModuleIntegration	
	→Backup&Restore	

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

 $\boldsymbol{x}:$  The right has to be set explicitly.

-: The right is not relevant.

The light is not		Access rights						
	Operation	Add/Remove	Execute	Modify	View			
	Login	•	•	•	x			
	Create	x	•	•	•			
	Create child object	x	•	•	•			
	Delete	x	•	•	•			
Application	Download / online change	x	•	•	•			
	Create boot application	x	•	•	•			
	Read variable	•	•	•	x			
	Write variable	•	•	x	x			
	Force variable	•	•	x	x			
	Set and delete breakpoint	•	х	x	•			
	Set next statement	•	х	x	•			
	Read call stack	•	•	•	x			
	Single cycle	•	х	•	•			
	Switch on flow control	•	х	x	•			
	Start / Stop	•	х	•	•			
	Reset	•	x	•	•			
	Restore retain variables	•	x	•	•			
	Save retain variables	•	•	•	x			

#### > PlcShell

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.

Tsch	ntime objects
9 - y	Device
····	喇 Logger
	➡ PlcLogic
	🖃 🔿 Application
	C-ModuleIntegration
	Backup&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
- dan	OPCUAServer
···· (m)).	Settings
(mj)/	UserManagement
6.4	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.

B	RemoteConnections	
-	Settings	
an talk o	JserManagement	
(). I	K509	

#### 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.

:e	RemoteConnections
	OPCUAServer
(8	Settings
1	UserManagement
· · · · · · · · · · · · · · · · · · ·	×509

#### ≻ X509

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

Write (Modify)

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



#### ♦ File system objects > /

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

File system objects
- => Boot
😑 🤿 cert
export
🖦 🔿 import
🖃 🔿 Prj
😑 🔿 PlcLogic
- 🔿 alarms
⇒ trend
··· 🔿 visu
the part of the pa
System Volume Information

#### 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	referenced by the IE	EC code. Read	ding and writir	ng to them may not have the desired effect(s).	Remove	
default	~	+ 0		Configure Symbol Rights		
Changed symbol configuration will be transferred v	with the next downlo	oad or online	change			
Symbols	Access Rights	Maximal	Attribute	Туре	Members	Comme
		<b>*</b> ø		VERSION		the comp
🔲 🔌 RuntimeVersion		<b>*</b> ø		VERSION		the runtir
🗐 📝 📄 Io Config_Globals						
	<b>*</b>	<b>*</b>		IoDrvEthercatLib.ETCSlave		]
	<b>*</b>	<b>*</b>		IoDrvEthercatLib.ETCSlave		]
	<b>*</b>	<b>*</b>		IoDrvEthercatLib.ETCSlave		]
🐨 📝 🔌 EtherCAT_Diag	<b>5</b>	<b>*</b>		DL_BuiltInIO_AX3.EtherCAT_Diag		
	<b>5</b>	<b>*</b>		DL_BuiltInIO_AX3.EtherCAT_ErrorLED_Handle		
EtherCAT_Master_SoftMotion	<b>*</b>	<b>*</b>		IoDrvEthercatLib.IODrvEtherCAT		1
🐨 🔽 Pulse_Output	<b>54</b> 0	<b>N</b>		DL_BuiltInIO_AX3.DMC_PO_SLOT_REF		-
🛛 📝 🧇 Pulse_Output_SYNC	<b>5</b>	<b>N</b>		DL_BuiltInIO_AX3.Po_Sync		
🛛 🕼 🛛 🛷 nIoConfigTaskMapCount	<b>5</b>	<b>*</b>		DINT		
🛛 < pIoConfigTaskMap	-	-		POINTER TO IoConfigTaskMap		
▼	<b>5</b>	<b>*</b>		BOOL		
V test2	540	-		WORD		
V 🛊 test3	540	-		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 immediate Symbol Sets	ly downloaded to the device. Rights	
Backup and Restore	□ 🔁 Application	Groups	Access
Files	→ Viewer	Administrator Developer	
	→ 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			
unchronized 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.

#### 4.2.1.11 Runtime Clock Configuration

Here you can set up the Runtime Clock 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.

Communication Settings	Runtime Clock			
Applications	1 PLC Time:			Read PLC Time
	2Date:	Friday , July 24, 2020		Write PLC Time
Backup and Restore	3 <sup>Time:</sup>	2:06:40 PM		Sync with Local Time
Files	Time Zone			
Log	4 PLC Timezone:			Read Timezone
PLC Settings	5 Timezone:	(UTC+08:00) Taipei	~	Write Timezone
PLC Shell				
PLC Shell				
PLC Shell Users and Groups Access Rights				
PLC Shell Users and Groups				
PLC Shell Users and Groups Access Rights				
PLC Shell Users and Groups Access Rights Symbol Rights				
PLC Shell Users and Groups Access Rights Symbol Rights Runtime Clock Configuration				
PLC Shell Users and Groups Access Rights Symbol Rights Runtime Clock Configuration System Parameters				

① PLC Time: Use the button Read PLC Time to read the PLC current date and time and the result will be updated here.

- ② Date: Use the button Write PLC Time to write the date on DIADesigner-AX (PC) into PLC and the result will be updated here.
- ③ **Time**: Use the button **Sync with Local Time** to write the time on DIADesigner-AX (PC) into PLC and the result will be updated here.
- ④ PLC Timezone: Use the button Read Timezone to read the PLC current timezone and the result will be updated here.
- ③ Timezone: Use the button Write Timezone to write the timezone on DIADesigner-AX (PC) into PLC and the result will be updated here.

If you click the buttons including **Write PLC Time, Sync with Local Time** and **Write Timezone**, the DIADesigner-AX prompts confirmations as shown below. Click **OK**, if you need to change the time settings.

DIADes	igner-AX		×
?	This will change the Ru to change controller tin	nTimeClock in the contr ne?	oller, confirm



#### 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.

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		
backap and Restore	Select Action when 24V dc Input unstable	Enumeration of BOOL	Continue Running	Continue Running		
Files	Show Battery Low Voltage Error	Enumeration of BOOL	Enable	Enable		
Log						
PLC Settings						
PLC Shell						
Users and Groups						
Users and Groups Access Rights						
Access Rights						
Access Rights Symbol Rights						
Access Rights Symbol Rights Runtime Clock Configuration						
Access Rights Symbol Rights Runtime Clock Configuration 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.

ommunication Settings	I/O Deployment for Tasks	s		
pplications	I/O channels	Channel	EtherCAT_Task (1)	MainTask (1)
ackup and Restore	⊨* %IB0	IN:0-7		
ckup and Restore	<sup>*</sup> ≫ %IX0.0	INO	9	×
s	** %IX0.1	IN1		
	💜 %IX0.2	IN2		
pg	** %IX0.3	IN3		
	🐌 %IX0.4	IN4		
_C Settings	** %IX0.5	IN5		
	💜 %IX0.6	IN6		
C Shell	₩ %IX0.7	IN7		
	🖷 🖓 %IB1	IN:8-15		
ers and Groups	■ 🕈 %IB2	Encoder		
Diskie		OUT:0-7		
ccess Rights	<sup>™</sup> %QX0.0	OUT0	9	×
vmbol Rights	<sup>™</sup> %QX0.1	OUT1	9	×
ymbol Rights	<sup>*</sup> %QX0.2	OUT2		
ystem Parameters	- <sup>™</sup> %QX0.3	OUT3		
	<sup>*</sup> %QX0.4	OUT4		
ask Deployment	<sup>™</sup> %QX0.5	OUT5		
· /	<sup>*</sup> %QX0.6	OUT6		
tatus	<sup>™</sup> %QX0.7	OUT7		

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 ×			
Communication Settings	BuiltInIO	:	Running
Applications	AX-308EA0MA1T	:	Running
Backup and Restore	I		
Files			
Log			
PLC Settings			
PLC Shell			
Users and Groups			
Access Rights			
Symbol Rights			
Runtime Clock Configuration			
System Parameters			
Task Deployment			
Status			
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.

Communication Settings	General
Applications	Name: AX-308EA0MA IT Vendor: Delta Electronics, Inc. Categories: SoftMotion PLCs
Backup and Restore	Type: 4102 ID: 1677 0313 Version: 0, 40.2.0
Files	Description: AX-308EA0MA1T V0.40.2.0
Log	
PLC Settings	
PLC Shell	
Users and Groups	
Access Rights	
Symbol Rights	
Runtime Clock Configuration	
System Parameters	
Task Deployment	
Status	

# 4.3 Data Type and Variables

# 4.3.1 Data Type

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

## 4.3.2 Variables

#### Rules for identifiers of variables:

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

#### Rules for multiple use of identifiers

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

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

#### Comments

4

- 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 AX308E, there are three ranges in the memory area, including I (input memory range), Q (output memory range) and M (flag memory range). You can use specific character strings to express memory position and size. For the M flag memory range in AX-3 Series PLC, you cannot manually use the bit operation when in online mode.

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

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

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

#### • Memory Area

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

Memory Area							
X0.63~X0.56	X0.55~X0.48	X0.47~X0.40	X0.39~X0.32	X0.31~X0.17	X0.23~X0.16	X0.15~X0.8	X0.7~X0.0
X7.7~X7.0	X6.7~X6.0	X5.7~X5.0	X4.7~X4.0	X3.7~X3.0	X2.7~X2.0	X1.7~X1.0	X0.7~X0.0
B7	B6	B5	B4	B3	B2	B1	B0
W3		W	/2	W	/1	١	NO
D1 D0							
LO							

\_4

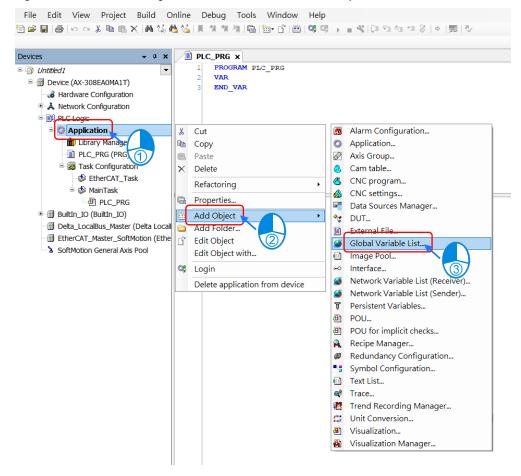
#### • Example

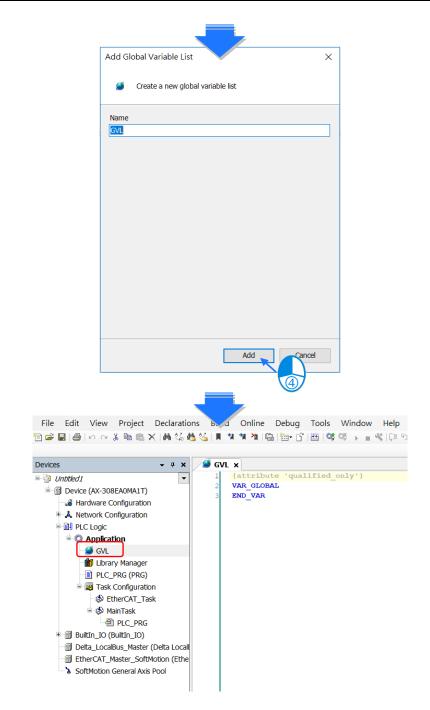
Address	Description
%QX7.5	Single bit address of the output bit 7.5
%IW215	Word address of the input word 215
%QB7	Byte address of the output byte 7
%MD48	Address of a double word at memory position 48 in flag memory
VAR wVar0 AT %IW0 : WORD; END_VAR	Variable declaration with address information of an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

#### 4.3.2.3 Variables

#### Global Variables

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





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 Or					
Variable	0	0	0	0	0	
Retain Variable	х	х	0	0	0	
Persistent Variable	Х	Х	Х	Х	0	

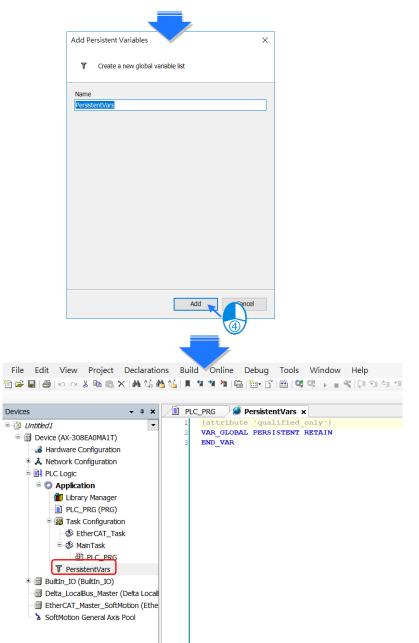
#### **Declaration of Retain Variables**

VAR	RETAIN
	bVar : BOOL ;
	byVar : BYTE ;
	wVar : WORD ;
END	VAR

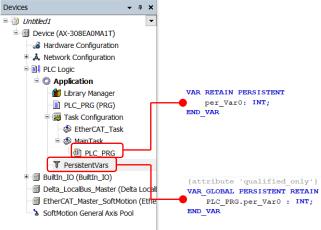
You can declare the Persistent Variable / Retain Persistent Variable / Persistent Retain Variable in the Persistent Variable Object and the results are the same.

#### Persistent Variable List:

evices - 4 ×	PLC_PRG ×	
Untitled1  Untitled1  Device (AX-308EA0MA1T)  Hardware Configuration  A Network Configuration  Del C logic  Application  M Lorary Manager		<ul> <li>Alarm Configuration</li> <li>Application</li> </ul>
PLC_PRG (PRG)	🛍 Paste	Axis Group
E 📓 Task Configuration	× Delete	🔕 Cam table
EtherCAT_Task	Refactoring	, 🔇 CNC program
MainTask     DLC_PRG	Properties	🔬 CNC settings
PLC_PRG     BuiltIn_IO (BuiltIn_IO)		Data Sources Manager
Delta_LocalBus_Master (Delta Loca	Add Object	• 😽 DUT
EtherCAT_Master_SoftMotion (Eth		🖹 External File
SoftMotion General Axis Pool	e 🗇 Edit Object (2) Edit Object with	Global Variable List
		Image Pool
	👒 Login	→ Interface
	Delete application from device	Network Variable List (Receiver)
		Network Variable List (Sender)
		T Persistent Variables
		POU for implicit checks
		Recipe Manager
		<ul> <li>Redundancy Configuration</li> <li>Symbol Configuration</li> </ul>
		🚭 Trace
		<ul> <li>Trend Recording Manager</li> <li>Unit Conversion</li> </ul>
		<ul> <li>Visualization</li> <li>Visualization Manager</li> </ul>



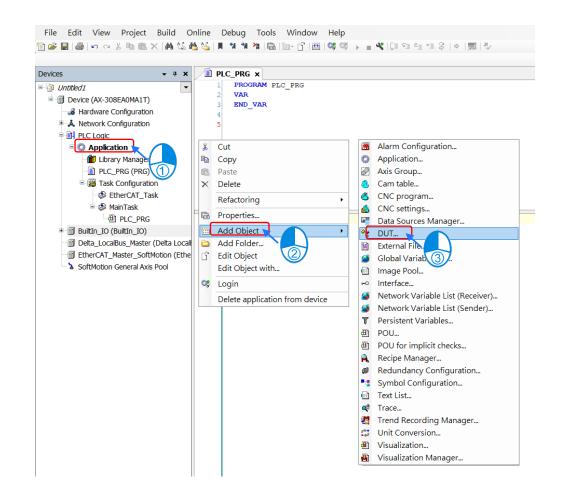
If you need to declare a local variable as persistent, you need to add the variable instance path in the persistent variable list.



#### 4.3.2.4 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
            10
                         ;
    wVar
                WORD
           1.0
                         ;
    iVar_Array
                    ARRAY[0..2]OF INT
                1
                                         ;
END STRUCT
END TYPE
```

Applications:

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

#### • Enumeration :

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

Syntax:

TYPE <Enumeration Name> :

(

<First Component Declaration>:= Component Declaration,

... ,

< Last Component Declaration >:= Component Declaration

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

END\_TYPE

Example:

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

#### AX-3 Series Operation Manual

• 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:

...

# 4.4 Task

## 4.4.1 Task Configuration

You define one or more tasks for controlling and executing the program blocks (POUs) in the PLC. You 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.

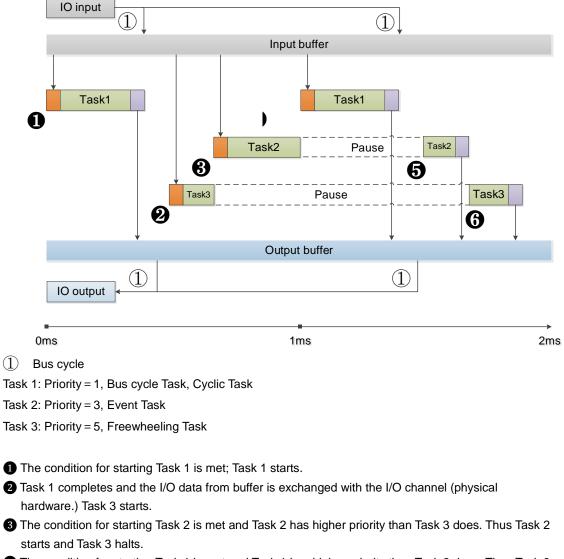
4-39

#### 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



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.

**5** 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.

File Edit View Project Build C	nline Debug Tools Window Help
🎦 🚅 🛃 🕼 🗠 🖘 🐇 🖻 🛍 🗙 🕅 😘	🎍 🍇 🛯 🗮 🦄 🎢 🏙 🏙 🕯 🛗 🧐 🥵 ଔ 🖒 🖀 🛠 🗔 연결 연결 연결 위험 😹 🐶
Devices 👻 🖣 🗙	PLC_PRG 🗊 Device 🖉 MainTask 🗙
■ Intitled1	Configuration
Device (AX-308EA0MA1T) Hardware Configuration	
A Network Configuration	Priority ( 031 ): 1
E II PLC Logic	Туре
🖹 💿 Application	Cyclic      Interval (e.g. t#200ms)     20
👘 Library Manager	*1
PLC_PRG (PRG)	Watchdog
🖻 🎆 Task Configuration	
EtherCAT_Task	I Enable
⊨ S MainTask	Time (e.g. t#200ms) 500
	Sensitivity 1
Delta_LocalBus_Master (Delta Local	
EtherCAT_Master_SoftMotion (Ethe	
SoftMotion General Axis Pool	

• Several consecutive timeouts:

Sensitivity: 0, watchdog timeout = time \*1

Sensitivity: n, watchdog timeout = time \*n

# 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.

•	Synch	ronization	axes
-	Oynon		unco

Synchroniza			Task Type			
Classification	Instruction Name	Cyclic	Freewheeling	Bus Cycle EtherCAT		
	MC_Home			V		
	MC_Stop			V		
	MC_Halt			V		
	MC_MoveAbsolute			V		
	MC_MoveRelative			V		
	MC_MoveAdditive			V		
	MC_MoveSuperImposed			V		
	MC_CamIn			V		
	MC_CamOut			V		
	MC_MoveVelocity			V		
	MC_PositionProfile			V		
Matien	MC_VelocityProfile			V		
Motion	MC_AccelerationProfile			V		
Control	MC_Jog			V		
Function Blocks	MC_GearIn			V		
BIOCKS	MC_GearOut			V		
	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		
	MC_Power	V	V	V		
	MC_SetPosition	V	V	V		
	MC_ReadParameter	V	V	V		
	MC_WriteParameter	V	V	V		
Instructions	MC_ReadBoolParameter	V	V	V		
for	MC_WriteBoolParameter	V	V	V		
Management	MC_ReadActualPosition	V	V	V		
	MC_ReadActualVelocity	V	V	V		
	MC_ReadActualTorque	V	V	V		
	MC_Reset	V	V	V		
	MC_ReadStatus	V	V	V		
	MC_ReadAxisError	V	V	V		

	Instruction Name		Task Type			
Classification		Cyclic	Freewheeling	Bus Cycle EtherCAT		
	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		

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
	MC_Halt_DML	V	V	V
Motion	MC_Home_DML	V	V	V
Control	MC_MoveAbsolute_DML	V	V	V
Function	MC_MoveRelative_DML	V	V	V
Blocks	MC_MoveVelocity_DML	V	V	V
	MC_Stop_DML	V	V	V
	MC_Power_DML	V	V	V
	MC_ReadBoolParameter_DML	V	V	V
	MC_ReadParameter_DML	V	V	V
	MC_ReadStatus_DML	V	V	V
Instructions	MC_Reset_DML	V	V	V
for Management	MC_WriteBoolParameter_DML	V	V	V
Wanagement	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

МЕМО

# 5

# Chapter 5 Hardware Configuration

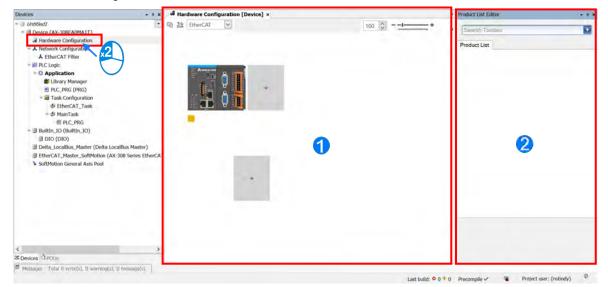
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5.4.1 Copy a Module	
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5.5 Cut and Paste a Module	5-11
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5.5.2 Paste a Module	5-12

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.

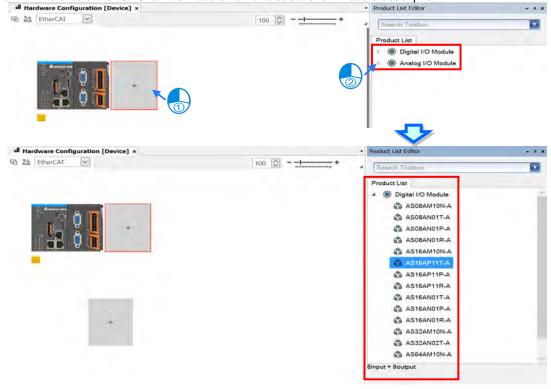


Hardware Configuration (Device): This is the main work area for system configuration and settings.

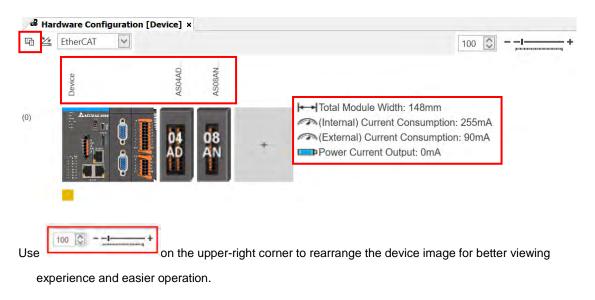
Product List Editor: Here listed out all supported modules for the selected CPU.

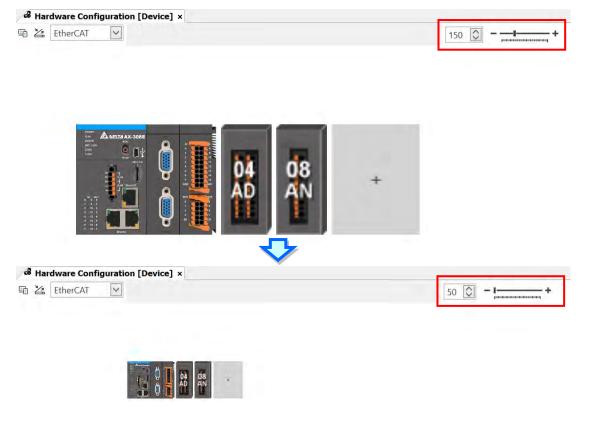
Click to see all the supported modules on the right window (Product List Editor).

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



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.





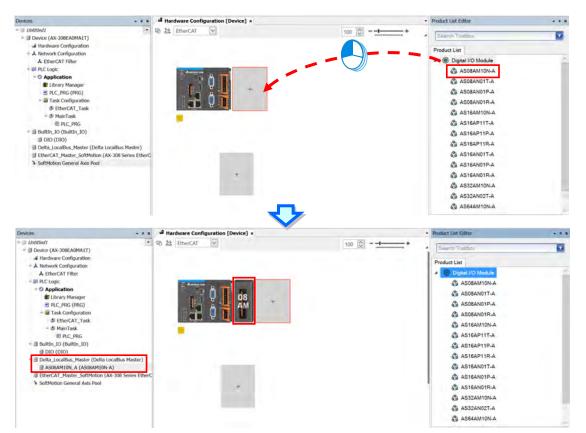
Enter a key word in the **Search Toolbox** on the right-side window and press "Enter" button on your keyboard to search for the matched modules.

Product List Editor • # ×	Product List Editor	- 4 ×
Product List	AP Product List M  Digital I/O Module A AS16AP11T-A	8
▷ 🛞 Analog I/O Module	\$ ରୁପ୍ତ AS16AP11T-A ରୁପ୍ତ AS16AP11P-A ରୁପ୍ତ AS16AP	

# 5.2. Add a Module

#### Method 1

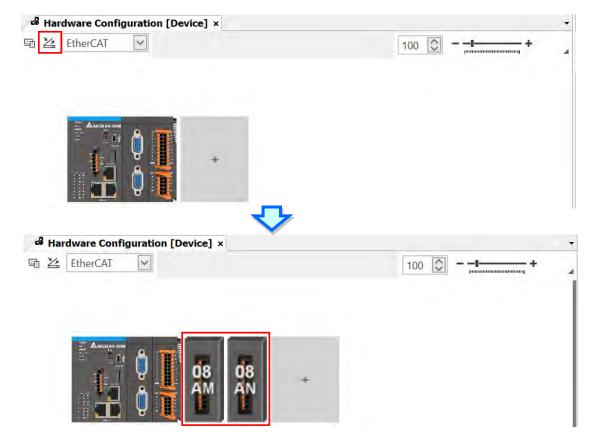
With AX-3 Series PLC backplaneless design, the extension module can install on the right-side of AX-3 Series PLC directly. Double-click or drag and drop the extension module that you'd like to add from the Product List. Newly added extension modules will apper on the right-side of the AX-3 Series PLC.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



#### • Method 2

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

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



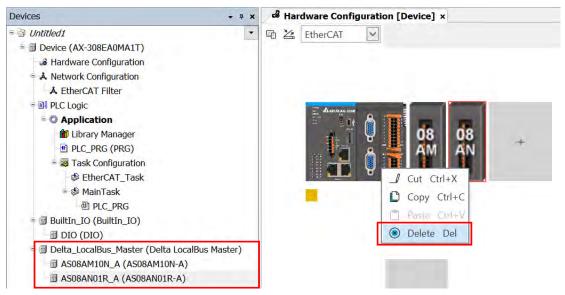
# 5.3 Remove a Module

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

#### Method 1

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

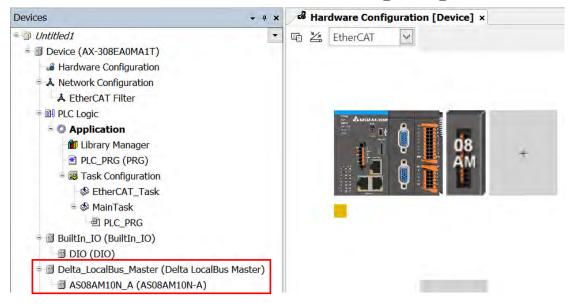
use the Delete Button on your keyboard to remove the module.



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

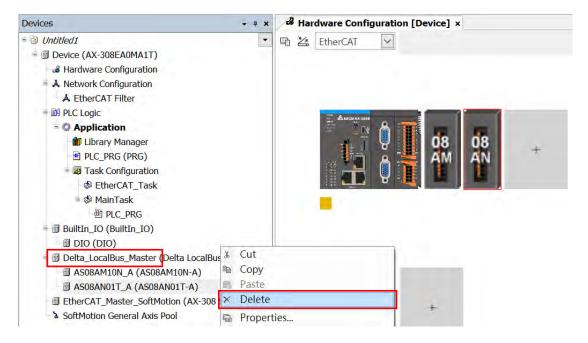
Delete			
	It will remove this module this module?	e in this rack. Are you su	ire to remove

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



#### • Method 2

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



# 5.4 Copy and Paste a Module

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

## 5.4.1 Copy a Module

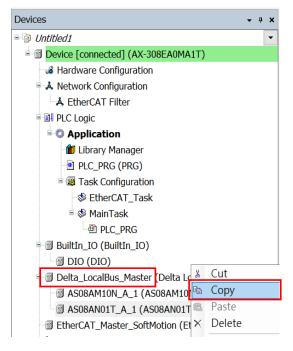
#### Method 1

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

8 Har	dware Config	uration [Device] ×	
	EtherCAT	$\checkmark$	
	Anelta Ax-308e		
		08 0	8 +
		â 🕈 🗛 A	N
		Cut Ctrl+X	
		Copy Ctrl+C	
		Paste Ctrl+V	
		🖲 Delete Del	

#### Method 2

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



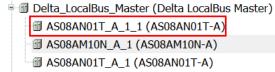
## 5.4.2 Paste a Module

#### Method 1

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

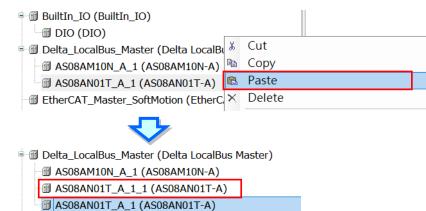


And the device names will also be updated on the left-side under Delta\_LocalBus\_Master.



#### Method 2

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



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



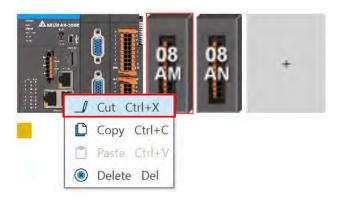
# 5.5 Cut and Paste a Module

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

### 5.5.1 Cut a Module

### Method 1

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



#### • Method 2

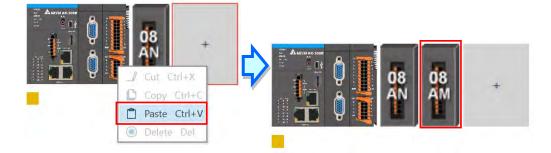
Right-click the device name under Delta\_LocalBus\_Master that you'd like to cut to open the context menu and click the option **Cut** to take out the module.

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

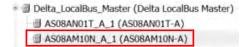
### 5.5.2 Paste a Module

### Method 1

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

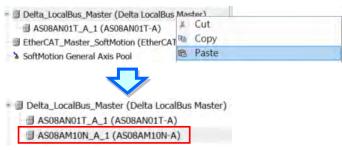


And the device names will also be updated on the left-side under Delta\_LocalBus\_Master.

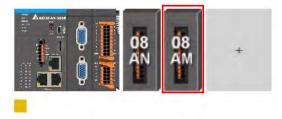


#### Method 2

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



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





# Chapter 6 Network Configuration

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# 6.1 Network Configuration

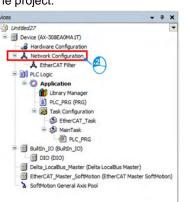
DIADesigner-AX provides a Network Configuration tool for users to configure the network in a project. Detailed network setting information will be covered in the following sections.

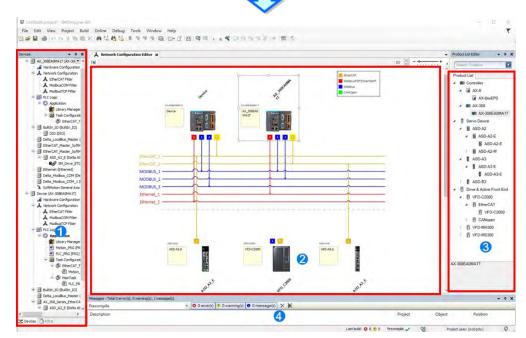
# 6.1.1 Introduction

You can use Network Configuration to:

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

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

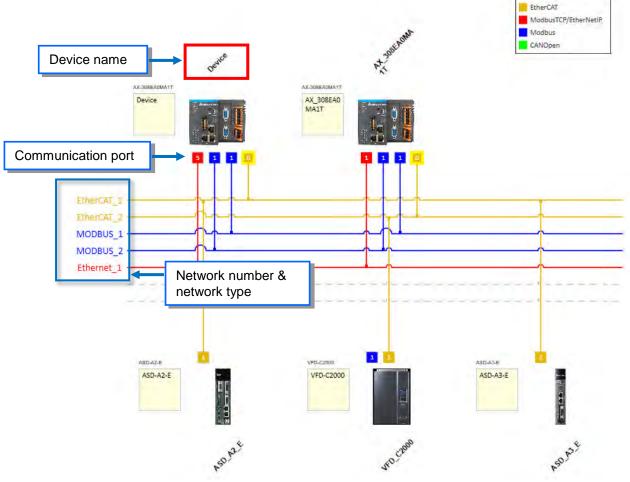




- **O** Device: Here shows all the configured devices in a tree view.
- Working area: Here is the main working area for you to create a network framework.
- Device list: Here lists all the available devices in a tree view.
- **O** Message display area: Here displays operational messages.

### 6.1.2 Basic Knowledge

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



### • Device and Network

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

### Device Name

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

### • Network Type and Communication Port

### EtherCAT

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

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

#### Modbus TCP/EtherNETIP

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

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

### Modbus

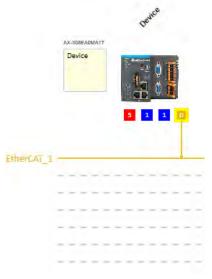
The blue line indicates the Modbus communication (RS-232 / RS-485). Double-click this line to open the Modbus communication port setting page.

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

# 6.1.3 Creating a Network Topology

### 6.1.3.1 Station Nodes

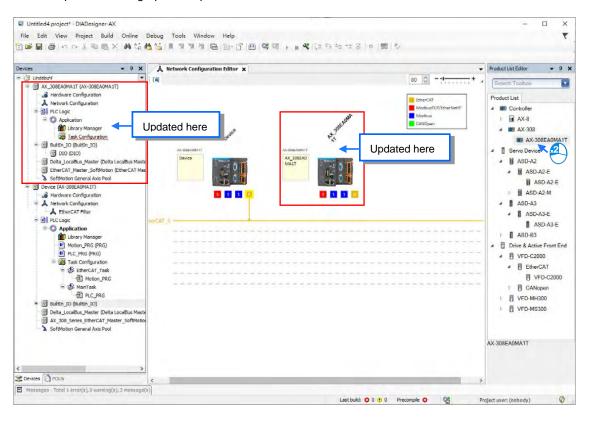
When you open the Network Configuration for the first time, the system creates a graphical representation automatically.



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

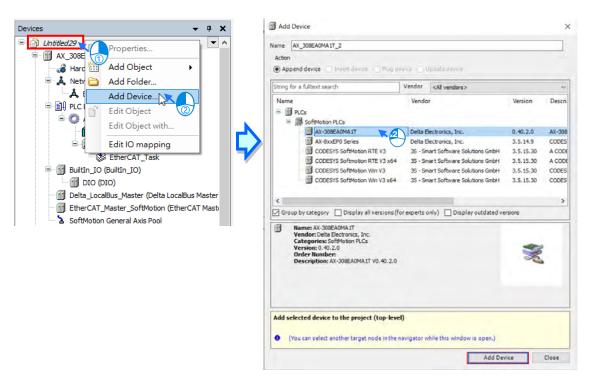
#### Method 1

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



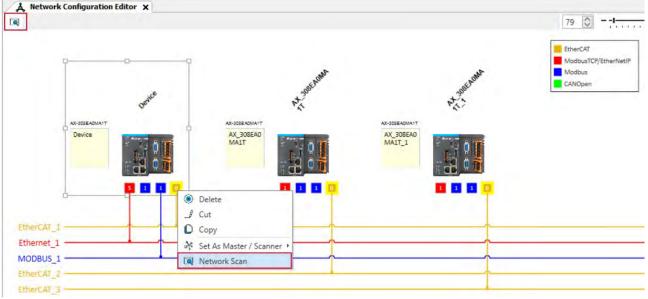
### Method 2

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



### • Method 3

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



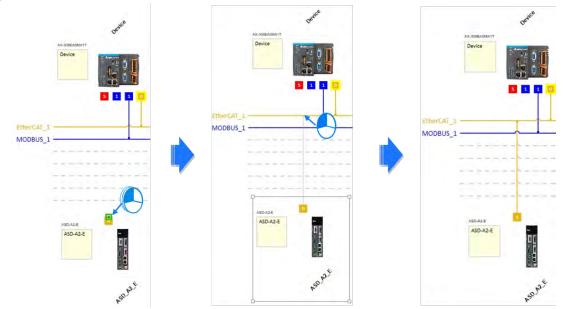
### 6.1.3.2 Creating a Connection

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

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

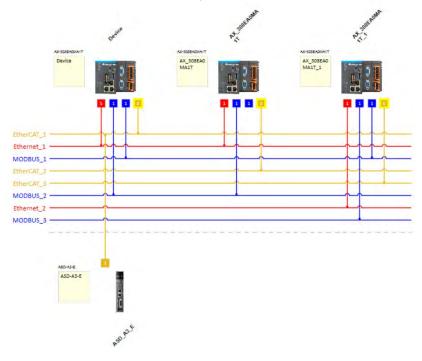
### Method 1

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



#### • Method 2

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



MEMO



# Chapter 7 Motion Control Setup & Operation

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7

# 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

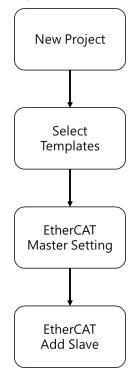
This section explains the catogeries of motion control instructions. The relating instructions can be found in the libraries of SM3\_Basic, DL\_MotionControl and DL\_MotionControlLight, which the details are set out in **AX Series Motion Controller Manual**.

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
control instructions	Administrative	Administrative functions on mutiple axes	Multiple-axes configuration, monitoring and reset function.

# 7.2 Creating Motion Control Project

# 7.2.1 Process Flowchart

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



### 7.2.2 Process for Creating a Project

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



Click File.



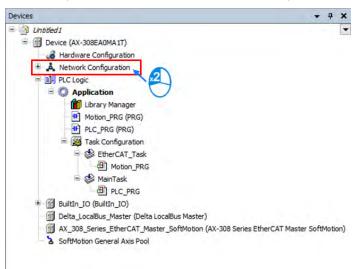
Choose New Project

1	New Project	Ctrl+N	
÷	Open Project	Ctrl+O	
	Close Project		
a.	Save Project	Ctrl+S	
	Save Project As.		
	Project Archive		٠
	Source Upload		
	Source Download		
	Print		
	Print Preview		
D).	Page Setup		
	Recent Projects		
	Exit	Alt+F4	

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".

	oraries ojects	Templates	Project 8xxE	Standard project	
A project c	ontaining one device	e, one application, two em	pty implementati	ons for PLC_PRG and	Motion
Name	Untitled 1				
Location	C:\Users\admin\D	ocuments			~ .

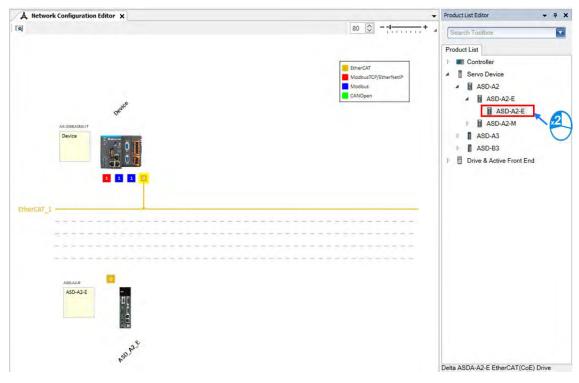
Double-click on "Network Configuration" to continue with EtherCAT settings.



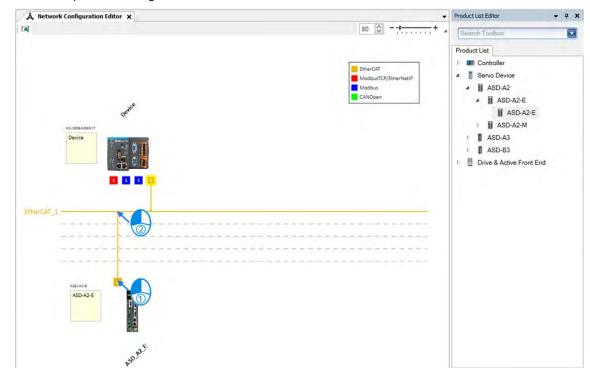
 "Network Configuration Editor" window will pop up after double-click. Find the target slave devices from "Product List Editor" on the right.

A Network Configuration Editor 🗙		Product List Editor 🗾 🖛 🗙
Retwork Configuration Editor x	80 C	Product List Editor + 4 × Search Toolbox Product List I Controller I Servo Device I Drive & Active Front End

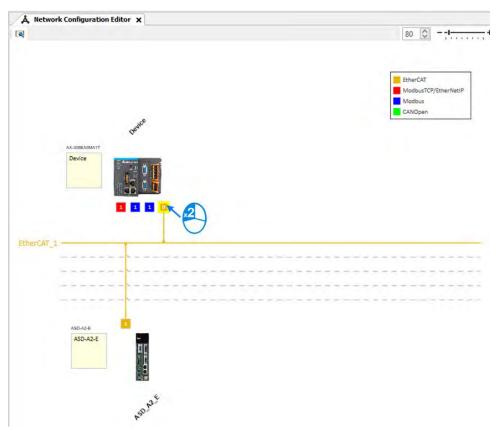
■ Choose "Servo Device" → "ASD-A2" → "ASD-A2-E" from the product list. Then, the device will be automatically added to "Network Configuration Editor" after a double-click



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.



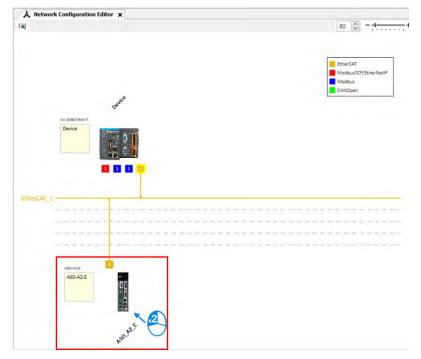
 Double-click on the yellow box of master device to continue on parameter settings for EtherCAT master device.



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) 00-00-00-00-00-00-00-00-00-00-00-00-00-	Browse
EtherCAT IEC Objects		t network by name
Status	✓ Distributed Clock	D Options
Information	Cycle time 2000 🌩 µs 🖛	
	Sync offset 50 🔹 %	
	Sync window monitoring	
	Sync window 1 🗘 µs	

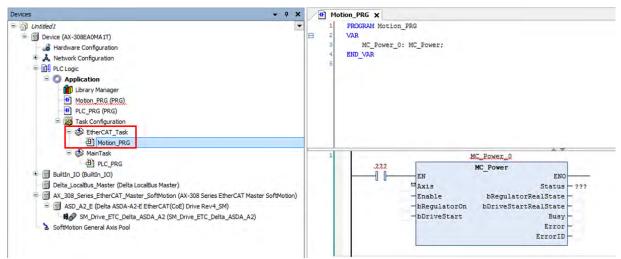
Double-click on the slave device to continue on EtherCAT slave device settings.



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

General	Address			- Addit	tional		
Process Data	AutoInc address EtherCAT address	0	+		Enable e Optiona	xpert settings	Ether <b>CAT</b>
Startup Parameters	✓ Distributed Clock	_					
EtherCAT I/O Mapping	Select DC	DC-Synchr	onous			~	
EtherCAT IEC Objects	Enable	4000	Sync u	nit cycle (µs	)		
Status	Sync0:						
Information	(ii) Sync unit cycle	× 1		4000	a v	Cycle time (µs)	
	User-defined			0	*	Shift time (µs)	
	Sync1:						
	Enable Sync 1						
	<ul> <li>Sync unit cycle</li> </ul>	¥.1		4000	4 9	Cycle time (µs)	
	User-defined			0	*	Shift time (µs)	

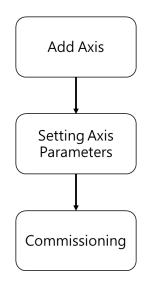
Afterwards, you can start writing programs with motion function blocks in POUs, which should be placed under "EtherCAT+Task", to ensure normal operation of function blocks.



# 7.3 Commissioning

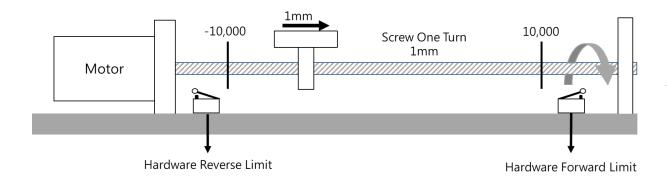
# 7.3.1 Procedure for Commissioning

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 Limits Virtual mode Uinear Axis Linear Axis Software Limits	Motion Parameter Error Reaction Quick Stop Deceleration [u/s <sup>2</sup> ]: 100
	Velocity Ramp Type Trapezoid Sin <sup>2</sup> Quadratic Quadratic(smooth)
Rotary Axis Modulo Setting Modulo value [u]: 360	Position Lag Supervision Position Lag Reaction Deactivated V Lag Limit [u]: 1 4
Transmission Mechanism Mechanism Type Ball Screw	Mechanism Setting (1) Command pulse per motor rotation: 10000  (4) Pitch: 1 (5) [Unit]
	Gear Box (2) Gear ratio numerator 1
	Gear Ratio = (3) Gear ratio denominator 1

### Parameters setting

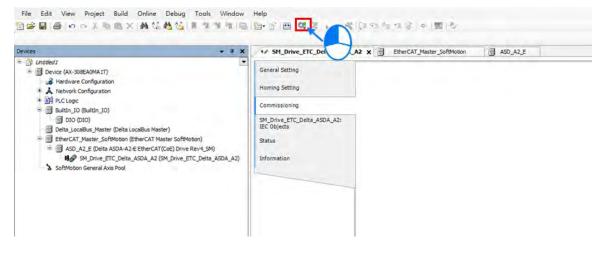
Name	Setting
Axis Type①	Linear Axis
Command pulse per motor rotation 3	10,000
Pitch③ [Unit]	1*1
Gear ratio denominator	128*2
Gear ratio numerator	1*2
Software limit_Posotive@	10,000
Software limit_Negative@	-10,000

### \*Note:

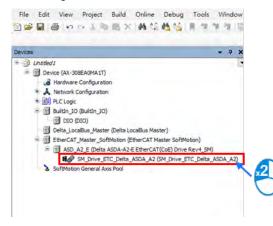
- 1. In case of the Unit [mm], the input parameter should be 0.001 for moving 1um.
- 2. It's a must to set P1-44 and P1-45 of the servo drive.

### 7.3.3 Perform Axes Commissioning

- Select "EtherCAT\_Master\_SoftMotion" and double-click on it.
  - D' Untitled1.project\* DIADesigner+ File Edit View Project Build Online Debug Tools Window Devices + 4 D Untitled 1 E Device (AX-308EA0MA1T) Hardware Configuration A Network Configuration \* PLC Logic Builtin\_IO (Builtin\_IO) DIO (DIO) EtherCAT\_Master\_SoftMotion (EtherCAT Master SoftMotion) 2 ASD\_A2\_E (Delta ASDA-A2-E EtherCAT(CoE) Drive Rev4\_SM) SM\_Drive\_ETC\_Delta\_ASDA\_A2 (SM\_Drive\_ETC\_Delta\_ASDA\_A2) SoftMotion General Axis Pool
- Left click on the "Online Config Mode" icon.



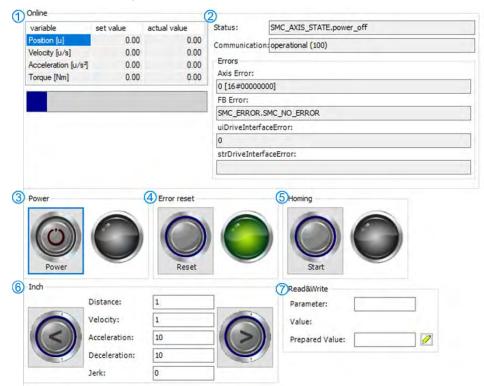
After entering online commissioning, double-click on "SM\_Drive\_ETC\_Delta\_ASDA\_A2"



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

	7 X	1 SH_Drive_ETC_Delto_ASDA_A2 x
Unstand           ■         Denic (Ax-300EARMAIT)           ■         Hindmare Configuration           ■         Henchare Configuration           ■         Henchare Econfiguration           ■         Hench Car Filter           ■         PICLopic           ■         Buildin JG (Buildin JG)           ■         Defaul Jonation, Mosterr (Defaul Location Mosterr)           ■         Ether CAT Filter           ■         Defaul Jonation, Mosterr (Defaul Location Mosterr)           ■         Ether CAT Master SolfMotion (Ether CAT Master SolfMotion)           ■         ADD J.2 (Defaul ACDA 42 E Ether CAT (Cold) Drive Rev4_SM)           ■         # SolfMotion Ceneral Avis Pool	-	Ceneral Setting     Axis Type and Limits     Mation Parameter       Homing Setting     User Axis Software Limits     Ender Axis Software Limits       Commissioning     Axivated     Quick Stop Deceleration [w[s]]: 100       Setting     Negative (Q): [00     Victure Lag Ender Axis Software Limits       Postove (Q): [100     Postove (Q): [100     Postove (Q): [100       Retary Nois Modula Setting     Postove (Q): [100     Postove (Q): [100       Retary Nois Modula Setting     Postove (Q): [100     Postove (Q): [100       Retary Nois Modula Setting     Postove (Q): [100     Postove (Q): [100       Retary Nois Modula Setting     Postove (Q): [100     Postove (Q): [100       Retary Nois Modula Setting     Postove (Q): [100     Postove (Q): [100       Retary Nois Modula Setting     Postove (Q): [100     Postove (Q): [100       Retary Nois Modula Setting     Postove (Q): [100     Postove (Q): [100       Retary Nois Modula Setting     Postove (Q): [100     Postove (Q): [100       Retary Nois Modula Setting     Postove (Q): [100     Postove (Q): [100       Retary Nois Modula Setting     Postove (Q): [100     Postove (Q): [100       Retarison Type Ball Screw     Mechanism Setting     [100       (Q)     (Q)     [100     [100
		(1) (2) Gear ratio denominator 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

Introduction of commissioning screen



① Information of axis commands

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

② Axis status and communication status

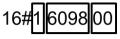
Name	Function
Status	Axis status
Communication	Communication status

- Axis power: Set power ON/ OFF.
- Error reset: Clear error messages of servo axis.
- ⑤ Homing: Make the axis back to the start position.
- 6 Inch

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

 $\ensuremath{\oslash}$  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	Comments
Positioning axis <sup>*1</sup>	Achieve basic positioning control via EtherCAT, such as functions of absolute positioning, relative positioning, and etc.
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 axes must match the function library of DL\_MotionControlLight.
- When uses Ethercat with AX-364EL and the number of axes exceeds 64, parameters of MAX\_MAILBOX\_CHANNELS and MaX\_SDO\_Channels in the Library (IODrvEtherCat → ETC\_Parameter) must be chamged 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

N# SM_Drive_ETC_Delta_ASDA_A2 X			
General Setting ① Axis Type and Lin			
Homing Setting Virtual mode			
Commissioning     One control of the second se	Activated		
SM_Drive_ETC_Delta_ASDA_A2: IEC Objects	Negative [u]: 0 Positive [u]: 1000 Trapezoid Sin <sup>2</sup> Quadratic Quadratic(smooth)		
Status (3)	Rotary Axis Modulo Setting     Image: Constraint of the setting       Modulo value [u]:     360       Position Lag Supervision       Position Lag Reaction       Disable Drive       Lag Limit [u]:       1		
Information (8)	romonical reaction Dispose prine Log prine [4]. x y		
(1) (1) (2) (2) (2) (2) (2) (2) (3) (4) (5) (5) (5) (5) (5) (5) (5) (5	Positive Command       Negative Command         Positive Command       Negative Command         CCW       CW		
■ ① Axis Type and Limits			
Name	Function		
Virtual	Activate virtual axes.		
Linear Axis / Rotary Axis	Set to be linear axis or rotary axis.		
D 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)		
	1		

7

© 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.	
	Name Trapezoid/Sin2/Quadratic/ Quadratic(Smooth) © Position Lag Supervi Name Positon Lag Reaction	

Positive / Negative Command

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

### Image: Transmission Mechanism

Descriptions of different machanism types are as follows:

٠	Ball	Screw	
	12 10 10 10 10		

echanism Type	Ball Screw	*	Mechanism Settin (1) Command pu	ulse per motor rotation: 1	-	[ Pulse ]
		12	(4) Pitch: 1	🛓 [ Unit ]		
			Gear Box			
	(3)		Gear Ratio =	(2) Gear ratio numerator	1	A.
			Gear Ratio =	(3) Gear ratio denominator	1	4

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

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

Name	Function
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
Gear ratio numerator	Numerator of gear ratio
Gear ratio denominator	Denominator of gear ratio

### Belt Pully

Mechanism Type Belt Pully ~	(1) Command pu	ng ulse per motor rotation: 1	4	[ Pulse ]
	(4) Diameter: 1	121		
	Gear Box			
(3)	Core Datio	(2) Gear ratio numerator	1	-
	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</li><li>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: Setting

Me 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

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

### Linear Axis Software Limits

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

### Rotary Axis Modulo Setting

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

### Velocity Ramp Type

Name	Function	
Trapezoid/Sin2	Motion curves setting for axes	

### Positive / Negative Command

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

### Transmission Mechanism

Descriptions of different machanism types are as follows:

♦ Ball Screw

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

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

Name	Function	
(4) Command Pulse per motor rotation	The command pulse value for per motor rotation	
(4) Diameter (Movement distance motor rotation : Diameter *n)	Diameter (Movement distance per motor rotation: Diameter *n)	
(5) Gear ratio numerator	Numerator of gear ratio	
(6) Gear ratio denominator	Denominator of gear ratio	

### Servo Gear Ratio

Name	Function	
Max.resolution(PPR)	The maximum resolution (PPR)	
Unit Numerator	Numerator of electronic gear ratio	

7

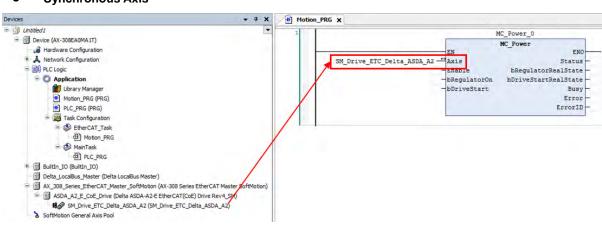
Name	Function	
Unit Denominator	Denominator of electronic gear ratio	
Pulses/rotation(PPR)	Value of pulses in rotation (PPR)	

Homing Setting

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.	

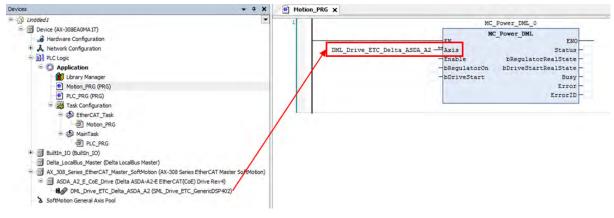
### 7.4.2.2 Axis Application in Program

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.



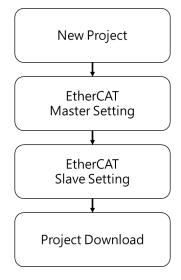
### • Synchronous Axis



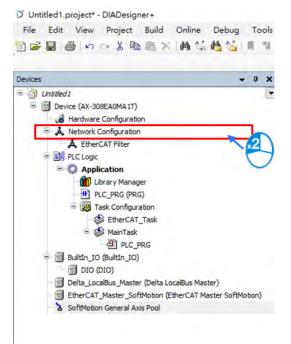


### 7.4.3 Procedure for Single-axis Configuration

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



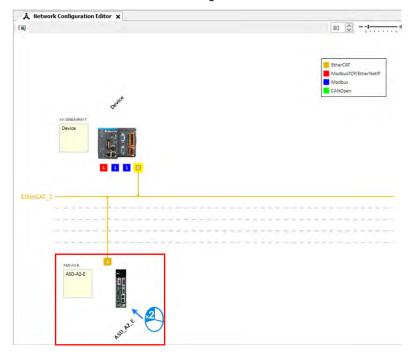
Configure EtherCAT settings after opening the project. First, click "Network Configuration".



Click "ASD-A2-E" after entering Network Configuration page and connect 1 to the line above.

levicës	- 4 × /	A Network Configuration Editor 🗙		Product List Editor      +      4      X
Constant     Constant	: Master) AT Master SoftMotion) -CAT(CGE) Drive Rev4_SM		80       •	
		ser <sup>pe</sup>		Delta ASDA-A2-E EtherCAT(CoE) Drive

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



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.

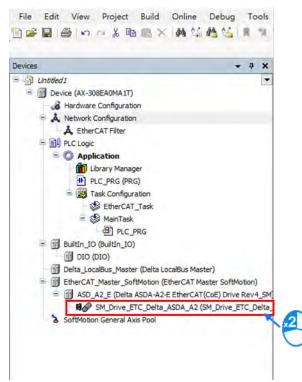
Process Data         Name         Type         Index           Startup Parameters         16#1600 1st RxPDO Mapping (exclu         0.1NT         16#604:00         16#1000 1st TxPDO Mapping (e         0.1NT         16#604:00         Status Word         0.1NT         15#6071:00         Status Word         0.1NT         15#6071:00         ActualPosition         0.1NT         15#6071:00         ModeOfOperationDisplay         SINT         15#6061:00           Status         0         16#1002 3rd RxPDO Mapping (exclu         V         16#1002 3rd RxPDO Papping (exclu         V         16#1002 3rd RxPDO Papping (exclu         V         16#604:00         ActualPosition         0.1NT         15#604:00         ActualPosition         0.1NT	Géneral	Select the Outputs			Select the Inputs		
Instantion       Instantinstention       Instantion       Insta		Name	Туре	Index	Name	Type	Index
Startup Parameters         TargetPosition         DINT         16#605/k100         ActualPosition         DINT         16#605/k00           EtherCAT 1/0 Mapping         TargetPosition         DINT         15#60F/k00         Velocity áctual value         DINT         16#606/k00           EtherCAT 1/0 Mapping         TargetPosition         SINT         15#60F/k00         Velocity áctual value         DINT         16#606/c00           EtherCAT 1/0 Mapping         SINT         15#60F/k00         ActualPosition         DINT         16#606/c00           EtherCAT 1/0 Mapping         SINT         15#60F/k00         ActualPosition         DINT         16#606/c00           Status         Control Word         UINT         16#6040:00         ActualPosition         DINT         15#6041:00           Information         I 0#1602 23rd RXPDO Happing (exclui         Status Word         UINT         15#6041:00           Information         I 0#1602 3rd RXPDO Happing (exclui         Status Word         UINT         15#6041:00           Information         I 0#1602 3rd RXPDO Happing (exclui         I 0#81002 3rd RXPDO Happing (exclui         I 0#81002 3rd RXPDO Happing (exclui         I 10#1002 3rd RXPDO Happing (exclui         I 10#1002 3rd RXPDO Happing (exclui         I 10#1002 3rd RXPDO Happing (exclui         I 10#66041:00         ActualPosition	Process Data	16#1600 1st RxPDO Mapping (exclu			16#1A00 1st TxPDO Mapping (e		
TargetPosition         DINT         16#6074:00         ActualPosition         DINT         16#6064:00           EtherCAT I/O Mapping         TargetVelocity         DINT         15#6071:00         ActualPosition         DINT         16#6060:00           EtherCAT IEC Objects         TargetTorque         INT         15#6071:00         ModeOfOperationDepkiy         SINT         16#6060:00           Status         Control Word         UINT         16#6040:00         ActualTorpue         UINT         16#6061:00           Information         Control Word         UINT         16#6040:00         ActualPosition         DINT         15#6041:00           Control Word         UINT         15#6040:00         ActualPosition         DINT         15#6041:00           Control Word         UINT         15#6040:00         ActualPosition         DINT         15#6041:00           Control Word         UINT         15#6047:00	Obadara Daramatara	Control Word	UINT	16#6040:00	Status Word	UINT	16#6041:00
EtherCAT IgO Mapping     TargetTorique     INT     16#6071:00     ActualTorque     INT     16#6077:00       EtherCAT IEC Objects     V 16#1601 2nd RxPDO Mapping     SIMT     16#6080:00     ModeOfOperationDisplay     SIMT     16#6091:00       Status     Control Word     UINT     16#6070:00     Status Word     UINT     16#6041:00       Information     Information <td>startup Parameters</td> <td>TargetPosition</td> <td>DINT</td> <td>16#607A:00</td> <td>ActualPosition</td> <td>DINT</td> <td>16#6054:00</td>	startup Parameters	TargetPosition	DINT	16#607A:00	ActualPosition	DINT	16#6054:00
TargetTorique         INT         15#8071:00         ActualTorque         INT         15#8077:00           EtherCAT IEC Objects         ModeOfOperation         SINT         16#6080:00         ModeOfOperationDiplay         SINT         16#6081:00           Status         Control Word         UINT         16#6080:00         ModeOfOperationDiplay         SINT         16#6041:00           Information         I 6#1601 2nd RXPDO Happing (exclui         Status Word         UINT         16#6041:00           Information         I 6#1602 3nd RXPDO Happing (exclui         Status Word         UINT         16#6041:00           Control Word         UINT         16#6040:00         Status Word         UINT         15#6041:00           Control Word         UINT         16#6040:00         Status Word         UINT         15#6041:00           I 6#1603 4th RxPDO Happing (exclui         I 16#1603 4th RxPDO Happing (exclui         I 16#6040:00         Status Word         UINT         16#6040:00           I 6#1603 4th RxPDO Happing (exclui         I 16#1603 4th RxPDO Happing (exclui         I 16#6071:00         ActualPosition         DINT         16#6040:00           I 6#1603 4th RxPDO Happing (exclui         I 10#1         16#6071:00         ActualPosition         DINT         16#6041:00           I 6#1603 4th Rx	EtherCAT 1/0 Manning	TargetVelocibr	DINT	16#60FF:00	Velocity actual value	DINT	16#6060:00
Status         Control Word         UINT         15#6040:00         Status Word         UINT         15#6040:00         Status Word         UINT         15#6041:00         ActualPosition         DINT         15#6041:00         DINT         15#6041:00         Control Word         UINT         15#6041:00         Status Word         UINT         15#6041:00         NT	concrete the mapping	TargetTorque	INT	16=6071:00	ActualTorque	INT	16#6077:00
Status         ✓ 16#1601 2nd RxPDO Happing         ✓ 16#1601 2nd TxPDO Happing         ✓ 16#1A01 2nd TxPDO Happing         ✓ 16#1A01 2nd TxPDO Happing         ✓ 16#6041:00         Status Word         UINT         15#6041:00         ActualPosition         DINT         15#6041:00         Control Word         UINT         15#6041:00         ActualPosition         DINT         15#6041:00	EtherCAT IEC Objects	ModeOfOperation	SINT	16#6060:00	ModeOfOperationDisplay	SINT	16#6051:00
TargetPosition         DINT         16#607A:00         ActualPosition         DINT         15#6064:00           Information         I 6#1602.3rd RXPLO Mapping (exclu Control Word         IINT         16#6040:00         Status Word         IINT         15#6041:00           TargetVoictly         DINT         15#607:00         Status Word         UINT         15#6064:00           I 6#1603.4th RxPDO Mapping (exclu Control Word         DINT         15#60F:00         ActualPosition         DINT         15#6064:00           I 6#1603.4th RxPDO Mapping (exclu Control Word         DINT         15#5040:00         Velocity actual value         DINT         15#6064:00           Control Word         LINT         15#5040:00         I 6#1603.4th RxPDO Mapping (exclu         DINT         15#6064:00           Control Word         LINT         15#5040:00         I 6#1603.4th RxPDO Mapping (exclu         DINT         15#6041:00           Control Word         LINT         16#6071:00         I 6#1603.4th TxPDO Mapping (exclu         DINT         16#6041:00           Control Word         LINT         16#6071:00         Satus Word         UINT         16#6041:00           ActualPosition         DINT         16#6041:00         ActualPosition         DINT         16#6041:00		✓ 16#1601 2nd RxPDO Mapping			✓ 16#1A01 2nd TxPDO Mapping		
Information         I 6#1602 3rd RXPID Happing (exclu         I 16#1602 3rd RXPID Happing (exclu         I 16#1604100           Control Word         UINT         16#6040100         Status Word         UINT         16#604100           TargetVelocity         DINT         15#60FF100         ActualPosition         DINT         16#604100           I 6#1603 4th RxPD0 Happing (exclu         Control Word         UINT         15#504100         Velocity actual value         DINT         16#6067100           Control Word         UINT         15#5041000         I 16#1603 4th FxPD0 Happing (exclu         DINT         16#605000         Velocity actual value         DINT         16#605100         Velocity actual value         DINT         16#604100           TargetTorque         I/(T         16#607100         Status Word         UINT         16#604100           ActualPosition         DINT         16#607100         I 16#1603 4th FxPD0 Happing (exclu         DINT         16#604100	Status	Control Word	UINT	16#6040:00	Status Word	UINT	16#6041:00
Control Word         UINT         16#604000         Status Word         UINT         15#604100           TargetVelocity         DINT         15#60FF100         ActualPosition         DINT         15#606700           ImagetTorque         IUNT         15#504100         Velocity actual value         DINT         15#606700           TargetTorque         IVT         15#504100         Status Word         UINT         15#5064100           Control Word         UINT         15#504100         Status Word         DINT         15#606700           TargetTorque         IVT         16#607100         Status Word         UINT         16#604100           ActualPosition         DINT         16#604100         DINT         16#604100         DINT         16#604100		TargetPosition	DINT	16#607A:00	ActualPosition	DINT	16#6064:00
TargetVelocity         DINT         15660FF:00         ActualPosition         DINT         1566061:00           16#1603 4th RxPDO Happing (exclu         IDNT         1555040.00         Velocity actual value         DINT         16#6665:00           Control Word         IDNT         1555040.00         16#1A03 4th TxPDO Happing (exclu         DINT         16#6665:00           TargetTorque         IVT         16#66071:00         Status Word         UINT         16#6041:00           ActualPosition         DINT         16#60400         DINT         16#6041:00	Information	16#1602 3Pd КХРОО Маррияд (exclu			10#1A02 3rd 1XPDO Mapping (e		
□ 16#1603 4th RxPD0 Happing (exclu         Velocity actual value         DINT         16#666600           Control Word         LIDNT         16#6607100         □ 16#1A03 4th TxPD0 Happing (e         INT         16#604100           TargetTorque         INT         16#607100         Status Word         UINT         16#604100           ActualPosition         DINT         16#604100         Status Word         UINT         16#604100		Control Word	<b>MINT</b>	16=6040100	Status Word	UINT	16#6041100
Control Word         LIDYT         15#5040100         15#3403 4th TxPDO Ptapping (e           TargetTorque         IVT         16#6071100         Status Word         UINT         16#604100           ActualPosition         DINT         16#604100         ActualPosition         DINT         16#604100		TargetVelocit/	DINT	16=60FF:00	ActualPosition	DINT	16=6064:00
TargetTorque         I/(T)         16#6075100         Status Word         UINT         16#6041:00           ActualPosition         DINT         16#5044:00         DINT         16#5044:00		16#1603 4th RxPDO Happing (exclu			Velocity actual value	DINT	16#606C:00
ActualPosition DINT 16#6064:00		Control Word	LUNT	16=6040000	16#1A03 4th TxPDO Mapping (e		
		TargetTorque	INC	16=6071100	Status Word	UINT	16#6041:00
ActualTorquer INT 16=6077:00					ActualPosition	DINT	16#6064:00
					ActualTorque	INT	16#6077:00

#### 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.

Seneral	🖶 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
tartup 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									
tatus									
formation									

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 "Liner Axis"

General Setting	Axis Type and Limits	Motion Parameter
Homing Setting	Virtual mode  Uinear Axis Contary Axis Cont	Error Reaction
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]: 1000	
Status	Modulo value [u]: 360	Position Lag Supervision Position Lag Reaction Deactivated  Lag Limit [u]: 1
Information	Transmission Mechanism Mechanism Type Ball Screw	Mechanism Setting (1) Command pulse per motor rotation: 131072 🖗 [Pulse] (4) Pitch: 1 🖗 [Unit]
		A CONTRACT OF
		Gear Box (2) Gear ratio numerator

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 Rotary Axis Activated	its Quick Stop Deceleration [u/s <sup>2</sup> ]: 1000 🗳
Commissioning	Negative [u]: 0	Velocity Ramp Type
SM_Drive_ETC_Delta_ASDA_A2: IEC Objects	Positive [u]: 10000	Trapezoid Sin <sup>2</sup> Quadratic Quadratic(smooth)
Status	Rotary Axis Modulo Set Modulo value [u]: 360	ng Position Lag Supervision Position Lag Reaction Stay Enabled V Lag Limit [u]: 100

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

General Setting	Axis Type and Limits	Motion Parameter
Homing Setting	Virtual mode	Error Reaction
Commissioning	Linear Axis Software Limits     Rotary Axis 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		polition 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".

General Setting	Axis Type and Limits	Motion Parameter Error Reaction	
Homing Setting		Software Limits Ouick Stop Deceleration [u/s²]: 100	
Commissioning	Negative [u	u]: 0 Velocity Ramp Type	
SM_Drive_ETC_Delta_ASDA_A2: IEC Objects	Positive [u]	Madda Califica	
Status		Position Lag Supervision ue [u]: 360 Position Lag Reaction Deactivated V Lag Limit [u]: 1	1
Information	Transmission Mechanism		1
	Mechanism Type Ball Screw		
	Mechanism Type Ball Screw (2)	(4) (4) Pitch: 1 (1 Unit ]	
	Mechanism Type Ball Screw	(4) (4) Pitch: 1 Command pulse per motor rotation: 131072 F [Pulse] (4) Pitch: 1 F [Unit]	
	(2)	(1) Command pulse per motor rotation: 131072 [Pulse]	
	(2)	(4) (4) Pitch: I I I I I I I I I I I I I I I I I I I	

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.

Cinoded1 Cinoded1 Cinode(AX-308EA0MA1T) Cinode(AX-308EA0MA1T)				
		EtherCAT_Master_Soft	Motion X	
Hardware Configuration		General	Autoconfig Master/Slaves	EtherCAT.
A EtherCAT Filter		Sync Unit Assignment	EtherCAT NIC Setting Destination address(MAC) FF-FF-FF-FF-FF-FF-FF-FF-FF-FF-FF-FF-FF-	adcast 📋 Enable redundan
Library Manager		a summer of	Source address (MAC) 40-06-A0-06-51-86 Brow	58
PLC_PRG (PRG)     Generation		EtherCAT I/O Mapping	Network Name cpsW1	
Start Computation     Setter CAT Task     Setter CAT     Setter CA	•	EtherCAT IEC objects Status Jeformation	Belect network by MAC     Select network by name     Distributed Cluck     Protocology     Protocology	

■ Scan PLC controller

	X ASDA_A2_E_COE_Drive N# SM.	Drive_ETC_Delta_ASDA_A2	ster_SoftMotion PLC_PRG Device x	
Constant  Const	Communication Settings Scan ne Applications Backup and Restore Files Log Soft PLC Settings	hoof Gateway • Device • Gateway Gateway Device • Gateway Gateway Device • Gateway Device • Gateway Device • Gateway	VITYINBOANG (active) VITYINBOANG (active) VITYINBOANG (active) VITYINBOANG Device Anne: TVITYINBOANG Device Address: DOULOFFACTURE Device Address: DOULOFFACTURE Device Address: DOULOFFACTURE Device Address: DOULOFFACTURE Device Address: DOULOFFACTURE Device Anne: Trypet Vendor: Device Address: Distributions GmbH Device Address: Distributions GmbH Device Address: Distributions GmbH Device Address: Device Address	

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

rices 🗕 🗸 🗘 🛪	ASDA_A2_E_COE_Drive N# SM_Drive_ETC_Delta_ASDA_A2	EtherCAT_Master_SoftMotion	Device x
Manded J     Manded J	Communication Settings Controller: Application Bar Select Device - Device - Application Select the setworp at to the controller: File Controller: File Controller: File Controller: File Controller: File Controller: File Controller: File Controller: File Controller: Controller: File Controller:		X None GmbH
Devices Devices		0	)

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

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

Devices	• # ×	ASDA_A2_E_COE_Drive #/ SM_Drive_ETC_Delta_ASDA_A2 🛐 EtherCAT_Master_SoftMotion 🖤 PLC_PRG 🕤 Device 🗙	
<ul> <li>Unsted1</li> <li>Deven genrected (CCCC</li> <li>RecLapc</li> <li>Application (stop)</li> <li>Tex Confourate</li> <li>Rec. Ref. PRO;</li> <li>Tex Confourate</li> <li>Effect.17:</li> <li>Maintak (E</li> <li>Effect.17:</li> <li>Maintak (E</li> <li>Effect.17:</li> <li>Saffeloton Genesi Av</li> </ul>	n k (EC-Tasks) :Tasks) Moton (EtherCAT Master S Drive (Delta ASDA-42 EEH C. Delta, ASDA-42 EEH C. Delta, ASDA-42 CEH	Communication Settings Scan network Gateway + Device + Applications Backup and Restore Files Log PLC Settings PLC Settings PLC Settings PLC Settings PLC Settings Task Deployment Status Task Deployment Status Information	

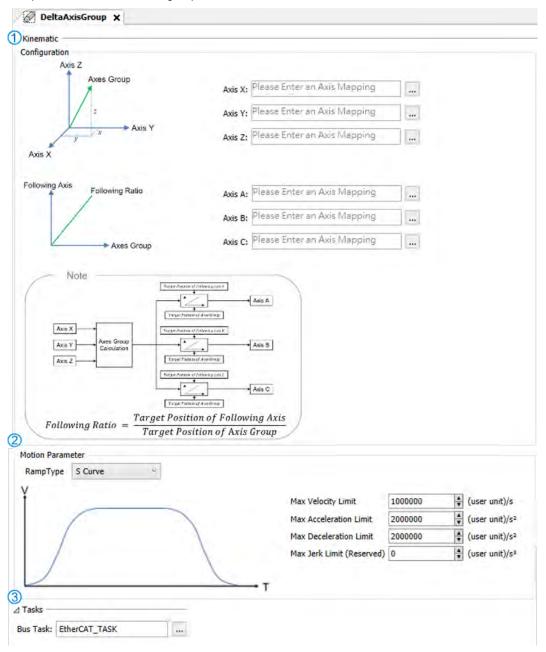
# 7.4.4 Axis Group Settings

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

Maximum controll avec	Linear interpolation	6 axes	
Maximum controll axes	Circular interpolation	6 axes (3 follower axes)	

#### 7.4.4.1 Prameters for Axis Group

The parameters used for axis group movement are as follows.



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

#### ① Kinematic

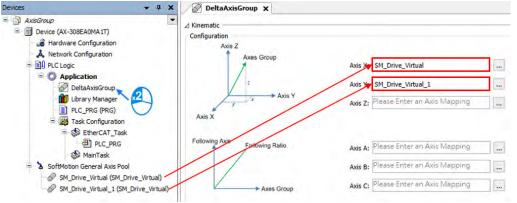
#### Ø Motion Parameter

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

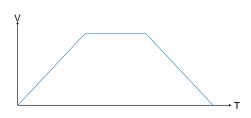
Name	Function
Bus Task	Configure the updating task for axis groups.

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

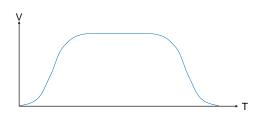


Note 2: There are two Ramp Type: Trapezoid and S-curve type, which are shown in the following figures.

#### Trapezoid



S Curve

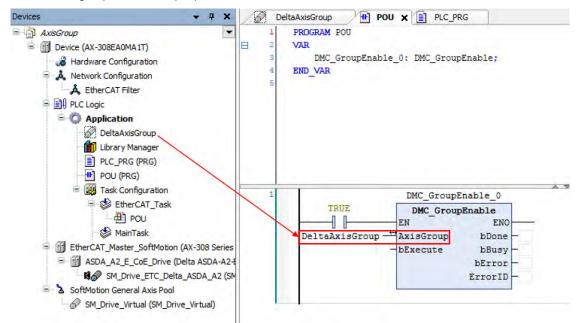


Note 3:

- 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.

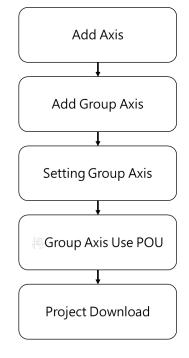
#### 7.4.4.2 Using Axis Groups in Program

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.

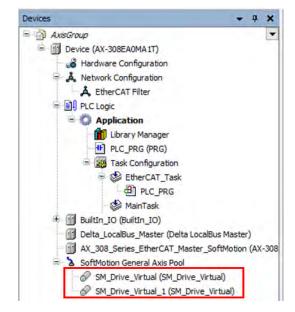


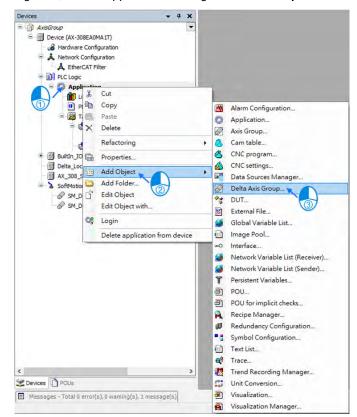
## 7.4.5 Procedure for Axis Group Configuration

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
  - Add single axes. The following example starts from creating two virtual axes.





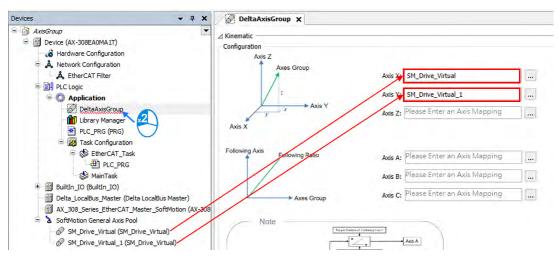
- After finish creating axes, select "Application" and right click "Add Object" → "Delta Axis Group"

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



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

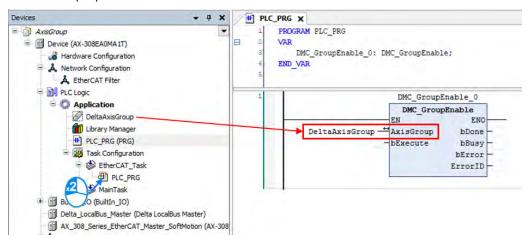
Click "DeltaAxisGroup", then enter the names of two virtual axes into the fields of "Axis X" and "Axis Y".



- 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								
Aris Y	Axis Z: Please Enter an Axis Mapp			Input Assistant				
Axis X		the second se		Text Search Categories				
Following Ratio	Axis Ar <sup>ID</sup> lease Enter an Axis Moop Axis Br <sup>ID</sup> lease Enter an Axis Moop Axis Ci I <sup>D</sup> lease Enter an Axis Moop	ing		Taka	Name ElberCAT_Task HainTask	Туре	Address	Origin
			•	2 Productions	4			1 1
	ition of Following Axis osition of Axis Group			Documentation		2 Part with arguments	E timer t with cares	essect prefe
Hoton Parameter RampType S Curve	Has Velocity Limit Max Acceleration D Hax Deceleration D	mit 2000000	(user unit)/s     (user unit)/s     (user unit)/s <sup>2</sup>					
d Tasks	Max Jerk Limit (Ren	erved) 0	(user unit)/s <sup>3</sup>				ax	3
Bus Tate		⊿ Tasks —			_			
		Bus Task:	EtherCAT_Tas	k				

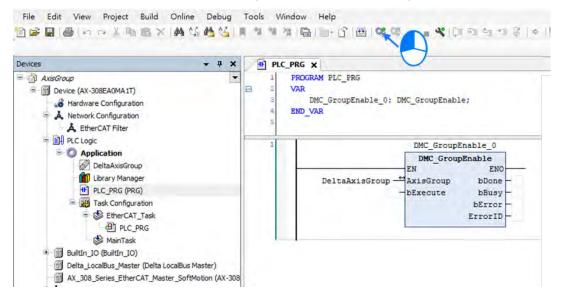
Add "DMC\_GroupEnable" function block below PLC\_PRG and connect the name of axis group to the AxisGroup input.



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

File Edit View Project Build Online Debug Tools Window Help 🛅 📽 📓 🗠 つ み 氷 剛 電 X 🛤 猛 🐴 🌜 🛯 🦄 🦄 👘 🛅 - 🕤 🕮 端 👘 • • \* () 同当当常 | • | ! Devices - 7 × PLC\_PRG X AxisGroup • PROGRAM PLC\_PRG 8 VAR Device (AX-308EA0MA1T) DMC\_GroupEnable\_0: DMC\_GroupEnable; Hardware Configuration END VAR A Network Configuration & EtherCAT Filter - PLC Logic DMC\_GroupEnable\_0 Application DMC GroupEnable DeltaAxisGroup EN ENO 1 Library Manager DeltaAxisGroup - AxisGroup bDone PLC\_PRG (PRG) bExecute bBusy Task Configuration bError EtherCAT\_Task ErrorID PLC PRG MainTask \* 🚮 BuiltIn\_IO (BuiltIn\_IO)

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



# 7.5 Motion Axis Variables

# 7.5.1 Variables for Single Axis

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

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

Numbering	Name	Data type	Default value	Description
1000	nAxisState	SMC_AXIS_ STATE(INT)	Standstill (3)	Operating state of the current axis according to MC_ReadStatus
1012	bCommunication	BOOL	FALSE	When communication is normal (refer as True), if disconnected (refer as False)
1014	uiDriveInterfaceError	UINT	0	When Driver Interface detects an error, Error Handling occurs
1021	wDriveld	WORD	Driver	The number in driver nodes on the Field bus
1025	fTaskCycle	LREAL	Driver	EtherCAT cycle time of task
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: Trapeziod sin^2 Quadtatic

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

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: Trapeziod sin^2
1101	fActPosition	LREAL	0	Feedback position (User-defined unit)
-	strDriveInte rfaceError	STRING	63	Axis error

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

\*Note 1: Only support Trapeziod 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.
Axis_X_Name	String		Display the Axis_X name for current axis group
Axis_Y_Name	String		Display the Axis_Y name for current axis group
Axis_Z_Name	String		Display the Axis_Z name for current axis group
Axis_A_Name	String		Display the Axis_A name for current axis group
Axis_B_Name	String		Display the Axis_B name for current axis group
Axis_C_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	The max velocity of axis group

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Name	Data Type	Setting Value (Default Value)	Function
		(100000)	
IrMaxAcceleration Limit	LREAL	Positive number or zero (2000000)	The max acceleration of axis group
IrMaxDecelerationLi mit	LREAL	Positive number or zero (2000000)	The max deceleration of axis group
IrMaxJerkLimit(Rese rved)	LREAL	Positive number or zero(0)	The max jerk of axis group (Reserved)

# 7.6 Motion Control Programming

# 7.6.1 Motion Control Program

Before programming in DIADesigner-AX, please take the following description 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

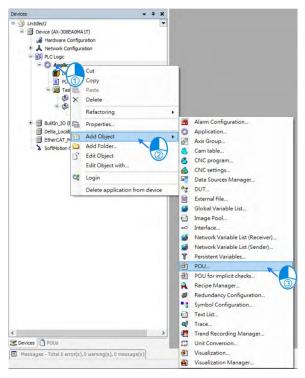
All POUs created by you are listed in the project management area with programs and function blocks been managed separately. In addition, the icon of POU may vary based on different program and function block programming languages which also includes information beside the POU name.

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	PROGRAM PLC_PRG	No. 1
" Scope Name Address Dataity	pe Intitalization Comment Attributes	
×	Program	*

#### 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"



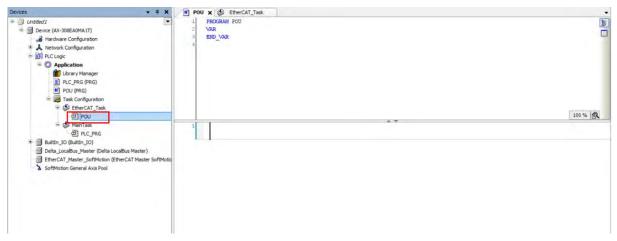
The POU appears in the left column. Double-click on "EtherCAT\_Task" and choose "Add Call".

Devices	- 4 X / the POU DE EtherCAT_Task X	
Linsted 1     Device (AX-308EA0MAIT)     Ardware Configuration     A Network Configuration	Priority (051.)2 A	
PLC Logic     Solution     Definition     Definition     Definition     PLC_PRG (PRG		ms. ~
POU (PRG)	torn	-
EtherCAT     SetterCAT     SetterCAT     SetterCAT     Bultin_IO (Bultin_IO)     Delta_LocaBus_Master     EtherCAT Master Softer	AG Sensitivity	1
SoftMotion General Axis	Pool POU Comment	

Select the created POU and click "OK".

put Assistant Text search Categories			
Programs	Name     O Application     O Proc.PRG     O Proc.PRG     O	Type Origin Apolication ACODIAN SCREW	
Structured view		- Insert with arguments	Insert with numespace prefic
PROGRAM POU -			
			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.

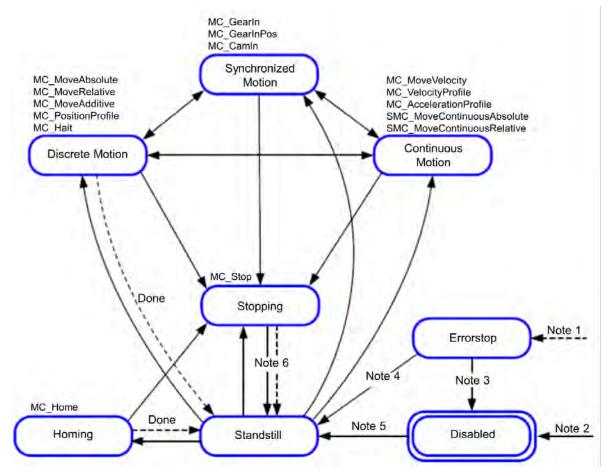
Please refer to **AX Series Motion Controller Manual** for the PDO parameters required by the related motion function blocks.

## 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

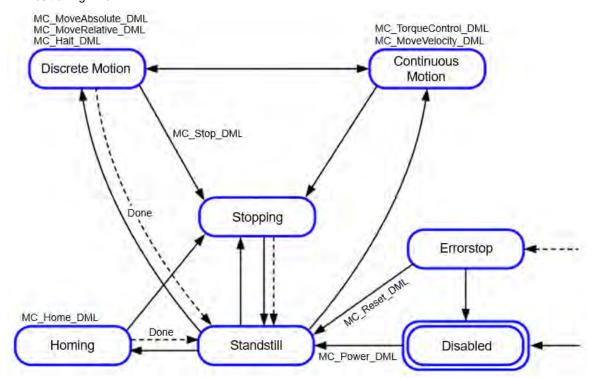
Note 5: MC\_Power.Enable = TRUE and MC\_Power.Status = TRUE

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

#### AX-3 Series Operation Manual

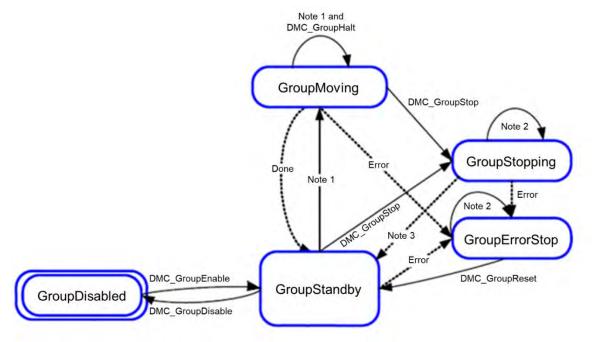
State	Meaning	
Disabled	Axis during servo OFF, standstill, ready to execute	
Standstill	Axis during servo ON, standstill	
Discrete Motion	The state would be Discrete Motion while executing single-axis motion instructions.	
Continuous Motion	The state would be Continuous Motion while executing continuous 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



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

#### 7.6.2.2 Axis Group State



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

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

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
  - 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.
  - When state GroupMoving/GroupStopping/GroupHoming disconnect the power of an axis, the axis group would be in GroupErrorStop state.
  - If all axes are in Standstill, the axis group can be in state GroupStandby, GroupDisabled or GroupErrorStop.
  - 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.
  - In case that the axis group is in GroupStandby, there's no need for all the single axes being in state SynchronizedMotion.
  - For axis group motion instructions (including MC\_GroupStop), all single axes in the axis group should be in state SynchronizedMotion.
  - 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.
  - 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.

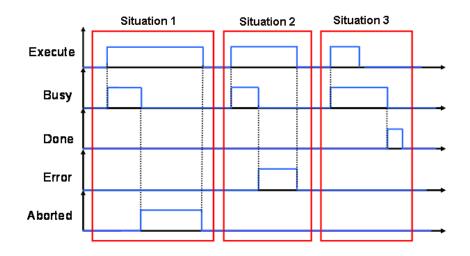
■ When a function block contains Enable input and uses Buy output to indicate incomplete execution, new output state (value) is to be generated. When Enable input signal changes from False to True and as long as Busy output is set True, changes in input state (value) can be expected.

- 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.

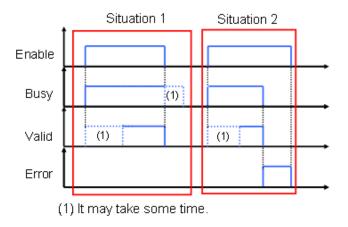


## 7.6.3.2 Timing Diagram for Input/Outputs

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.

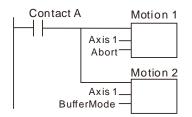
#### 7.6.3.3 Repeated Execution Behavior of Single Axis Motion Instructions

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

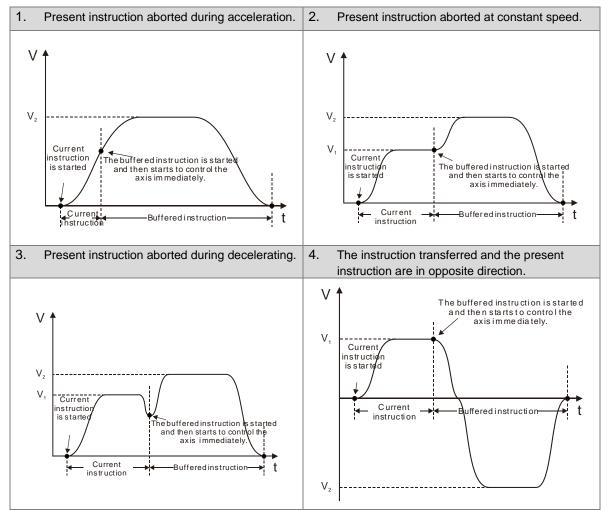
BufferMode	Description of Operation
0 : mcAborting (Aborting)	The current instruction is aborted and the multi-executed instruction is executed.
1 : mcBuffered (Buffered)	The buffered instruction is executed after the operation for the current instruction is normally finished.
2 : mcBlendingLow (Low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

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

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

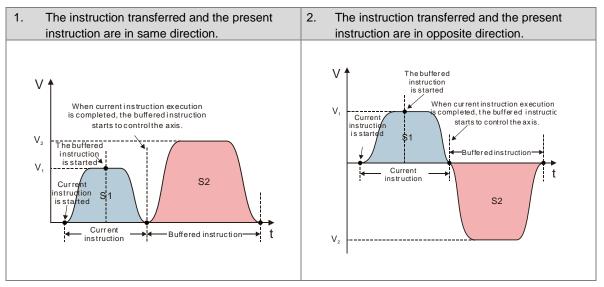
The max velocity and the displacement of the first and second instruction are respectively  $V_1$ ,  $S_1$  and  $V_2$ ,  $S_2$ .

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

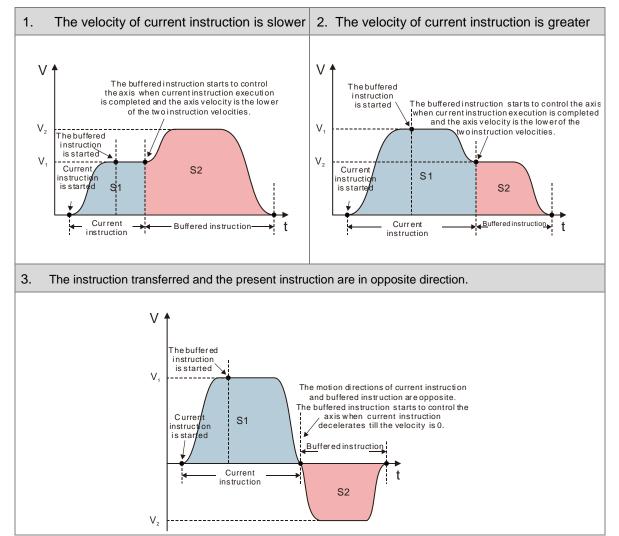


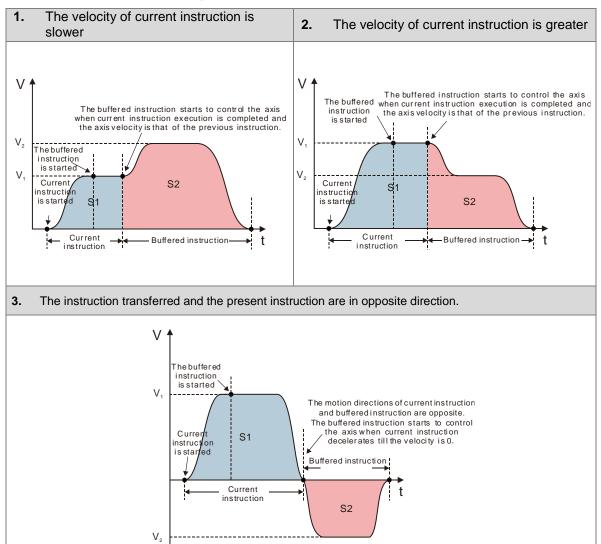
#### Buffermode=mcAborting

#### Buffermode=mcBuffered

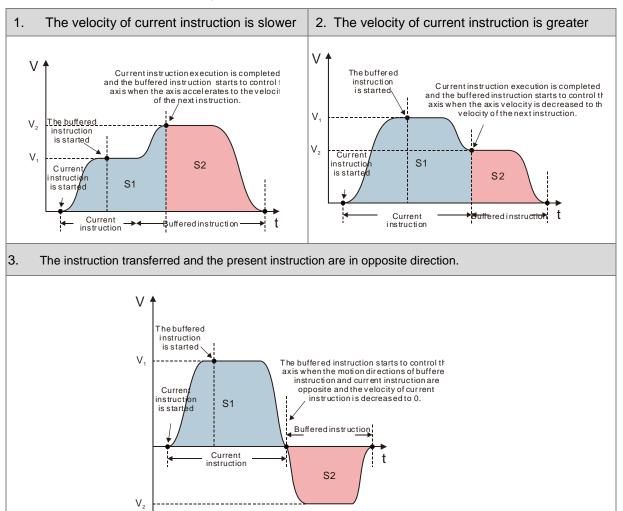


#### Buffermode=mcBlendingLow

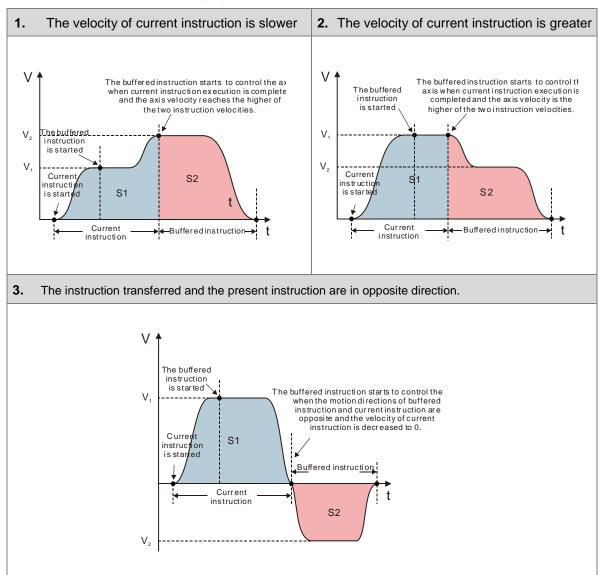




#### Buffermode=mcBlendingPrevious



#### Buffermode=mcBlendingNext



#### 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

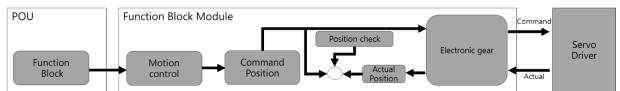
This section describes the position processes of motion control programming.

#### 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

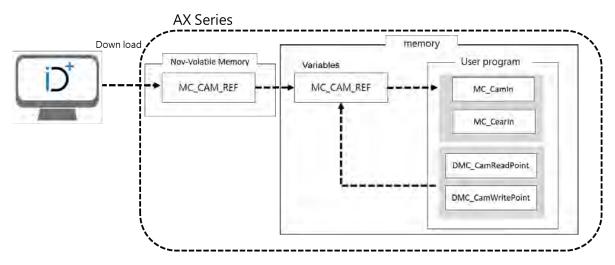
\*Note: For axes configured as Virtual, the actual position is equal to the command.

## 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:

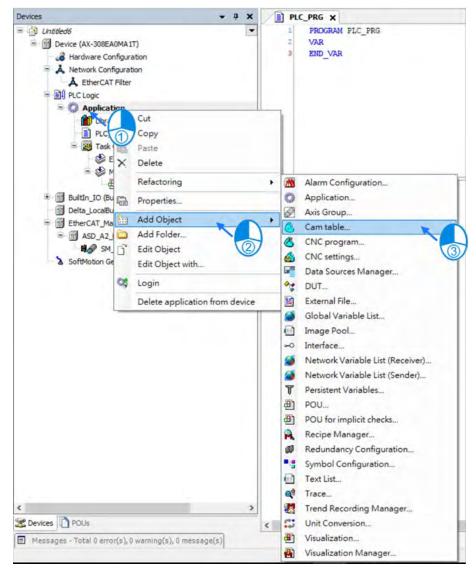
Method 1: Obtains the relationship between master and slave axis position based on E-CAM data setting.

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

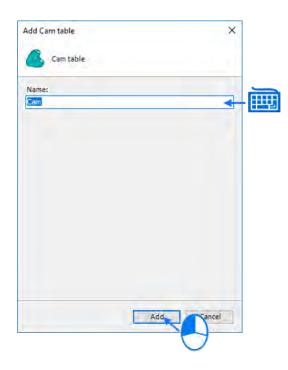
When the CAM master and slave relationship is confirmed, the slave position can be obtained based on the master axis position.

### Create DIADesigner-AX CAM tables

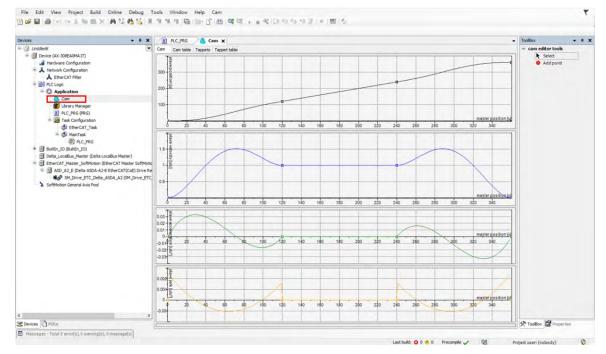
(1) Right-click "Application", choose "Add Object" and then select "CAM Table".



(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	20	am X							
Untitled6	Cam	Cam table	Tappet	Tappet	table						
E Device (AX-308EA0MA1T)		)				i J	Segment Type	min(Position)	max(Position)	max( Velocity )	max([Acceleration])
Hardware Configuration				-		0 0					
Network Configuration			1				Poly5	0	120	1.5120000000000007	0.032835282941414162
A EtherCAT Filter		12	120		1	0 0					
CLogic	0	7					Poly5	120	240	1	0
Cam	6	24	240		1	0 0					
🐻 Cam 👔 Library Manager	0						Poly5	240	360	1.512	0.032835282941414141
PLC_PRG (PRG)		36	360		0 1	0 0					
Task Configuration											
EtherCAT_Task											
E S MainTask											
DIC_PRG											
* 🛐 Builtin_IO (Builtin_IO)											
Delta_LocalBus_Master (Delta LocalBus Master)											
EtherCAT_Master_SoftMotion (EtherCAT Master SoftMotio											
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 🔍 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

am	Cam table Tap	opets Tapp	et table							
	X	Y	V	А	J	Segment Type	min(Position)	max(Position)	max( Velocity )	max( Acceleration )
	0	0	0	0	0					
•						Poly5	0	120	1.512000000000007	0.032835282941414162
Ŵ	120	120	1	0	0					
•						Poly5	120	240	1	C
W	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.

Cam	Cam table	Tappets	Tappet table										
		-										master pos	ition [u]
	ò	30	60	90	120	150	180	210	240	270	300	330	360
1	FALSE						2						X
2	FALSE			/				X					
3	*												

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

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

# 7.7 Motion Control Functions

## 7.7.1 System Structure

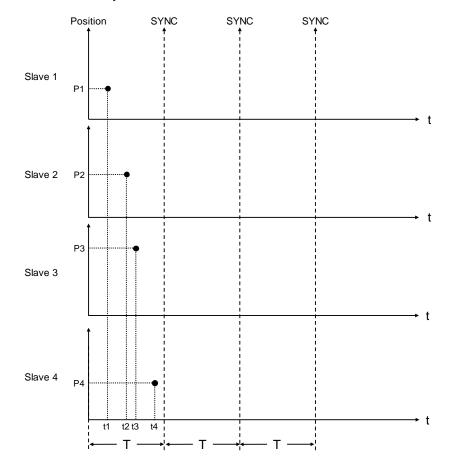
The single axis motion instructions of MC function blocks can generate specified motion path for axis based on user-defined parameters under three control modes including position control, velocity control, and torque control.

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

## 7.7.2 Single-axis Control

### 7.7.2.1 Cyclic Synchronous Position Mode

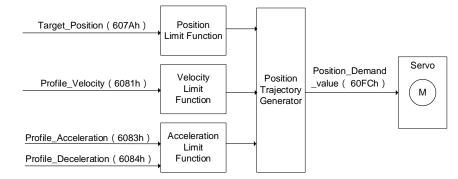
The synchrinization between AX series controllers and servo drives is implemented via sync signal transmission sent by controllers. These incoming data would not be valid until the Distributed Clocks (DC)\* in each servo drives are synchronized. In the following figure, four servo drives receive control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



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

## 7.7.2.2 Profile Position Mode

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



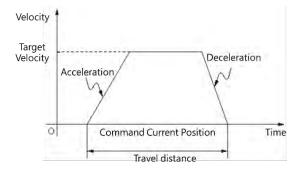
\* Profile position mode is only used for positioning axes.

## 7.7.2.3 Positioning

#### Absolute positioning

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

The following figure shows the motion trajectory for absolute positioning.



#### • Rotary axes setting

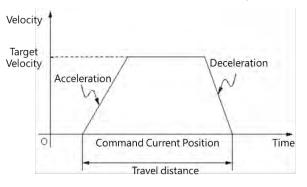
After choosing "Rotary Axis" for axis type, set the angle of rotation for rotary axis in "Modulo value" area.

General Setting	Axis Type and Limits		Motion Parameter			
Homing Setting	Virtual mode	xis Software Limits	Error Reaction	Deceleration [u/s <sup>2</sup> ]: 100	\$	
Commissioning SM_Drive_ETC_Delta_ASDA_A2: IEC Objects		e [u]: 0	Velocity Ramp Type Trapezoid	a Sin² () Quadratic () Quad	ratic(smooth)	
Status		xxis Modulo Setting value [u]: 360	psition Lag Supervision Lag Reaction	sion Disable Drive ~	Lag Limit [u]:	1
	Transmission Mechanism Mechanism Type Ball S (1)	crew ·	Mechanism Setting (1) Command pulse (4) Pitch: 1	per motor rotation: 131072	🛊 [ Pulse	2]
			Gear Box			
	1 G	(3)	Gear Ratio =	(2) Gear ratio numerator	1	•

Relative positioning

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

The following figure shows the motion trajectory for relative positioning.



#### 7.7.2.4 Stop Method

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

#### Using motion instructions to stop

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

#### MC\_Stop

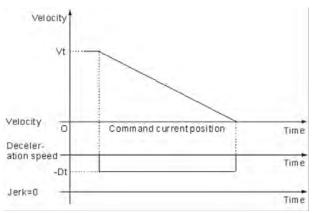
- MC\_Stop stops an axis in motion based on specified method and changes the state to "Stopping".

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

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

The following diagram shows MC\_Stop motion trajectory.

Velocity is determined by specified deceleration (DT).



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

#### MC\_Halt

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

#### Limit input stop

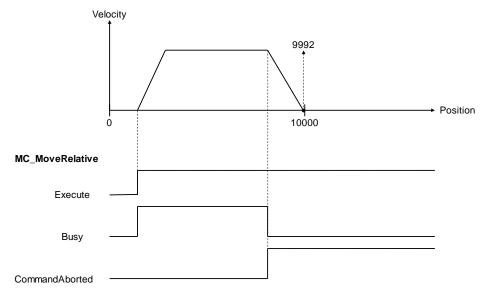
**Software limit:** You can activate/ inactivate software limit and configure its parameter settings on axis parameter setting page. When the axis is close to software limit during the movement, it will start the deceleration stop based on the axis parameters and stop under the software limit.

The example is shown as below:

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

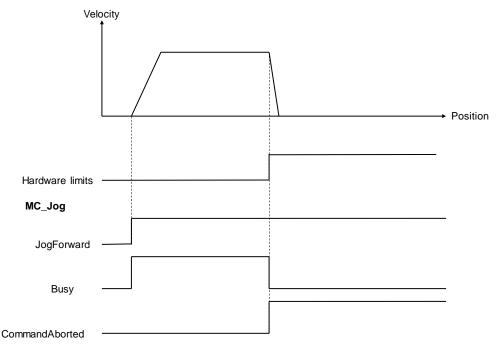
General Setting	Axis Type and Limits	Motion Parameter
Homing Setting Commissioning SM_Drive_ETC_Delta_ASDA_A2: IEC Objects Status	↓ Virtual mode         ● Linear Axis         ○ Rotary Axis         ✓ Activated         Negative [u]:         0         Positive [u]:         10000         Rotary Axis Modulo Setting         Modulo value [u]:         360	
Information	Transmission Mechanism Mechanism Type Ball Screw	Mechanism Setting (1) Command pulse per motor rotation: 10000
		Gear Box Gear Ratio = (2) Gear ratio numerator 1 (3) Gear ratio denominator 1

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:

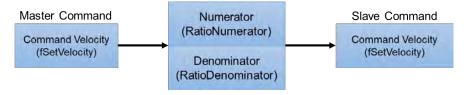
- Use MC\_Jog function block to perform axis rotating in positive direction. Once the hardware limit is reached during the rotation, ASDA-A2-E servo drive will be stopped and report error messages via communication.



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.

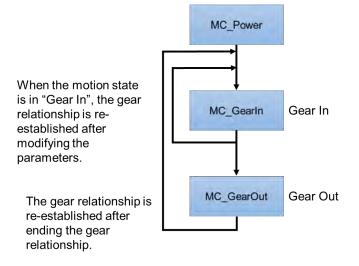
## 7.7.2.5 MC\_GearIn

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

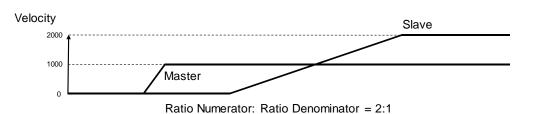


In MC\_GearIn, the master and slave axes, gear ratio numerator and gear ratio denominator, acceleration, deceleration as well as jerk are specified.

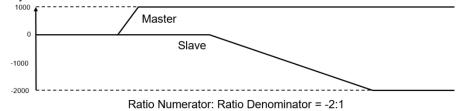
The following diagram shows the execution steps of instructions for electronic gears:



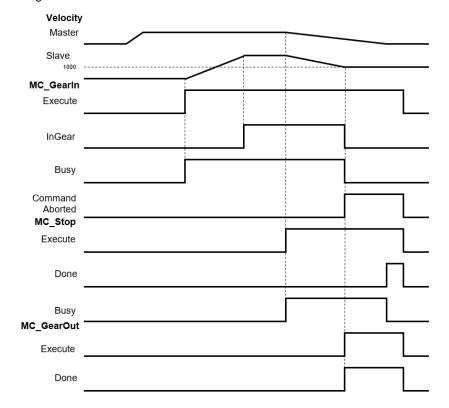
- When executing MC\_GearIn, the slave axis enters the state of synchronized motion, while for MC\_GearOut execution, the slave axis shifts awaya from sync state and maintains instant velocity to continue the movement and enters the state of continuous motion.
- During synchronized motion, when executing 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.



- When gear ratio is negative, the master and slave axes are moving in the opposite direction. Velocity



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



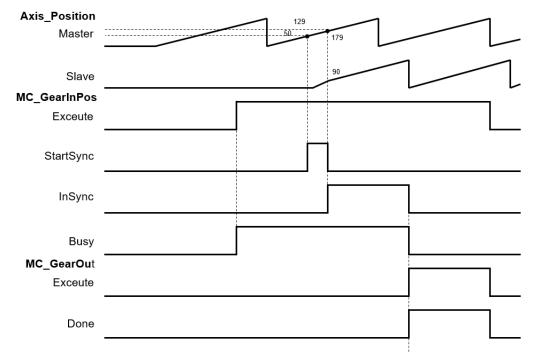
- 1. When MC\_GearIn is enabled, the slave starts to engage with the master axis and the slave velocity is twice the speed of the master velocity (RatioNumerator : RatioDenominator = 2:1).
- When InGear is True, synchronization of master and slave axes are completed and slave axis is in synchronized 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

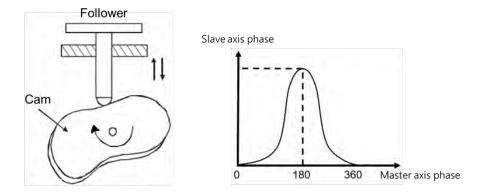
The assigned master and slave, gear ratio numerator and denominator, synchronous starting positions of master and slave axis in MC\_GearInPos executes the master start distance in sync as well as whether or not to permit reversal. The function block engages both master and slave axis in the assigned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

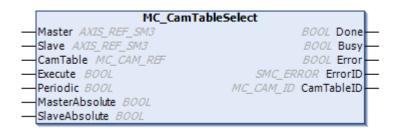
Method 2: The corresponding relationship between master and slave base on actual measurement.

#### • 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.



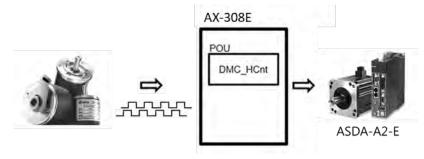
MC_Ca	imIn
	BOOL InSync
— Slave AXIS_REF_SM3	BOOL Busy
- Execute BOOL	BOOL CommandAborted
<ul> <li>MasterOffset LREAL</li> </ul>	BOOL Error
	SMC_ERROR ErrorID
<ul> <li>MasterScaling LREAL</li> </ul>	BOOL EndOfProfile
	SMC_TappetData Tappets
<ul> <li>StartMode MC_StartMode</li> </ul>	
CamTableID MC_CAM_ID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

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

Master as external pulse counter

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

System structure and DMC\_HCnt



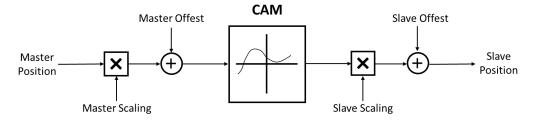
DMC_HCnt	:
Counter AS500_COUNTER_REF	BOOL Valid
Enable BOOL	BOOL Busy-
	BOOL Error
	DMC_HSIO_ERROR ErrorID
	DINT CounterValue

- 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

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.

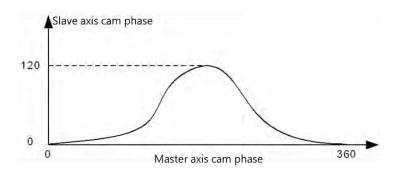
MC_CamTableSelect.MasterAbsolute	Master mode
absolute	Absolute mode
relative	Relative mode

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

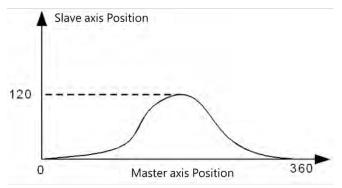
#### - Offset and scaling (MasterOffset/MasterScaling/SlaveOffset/Slavescaling)

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:

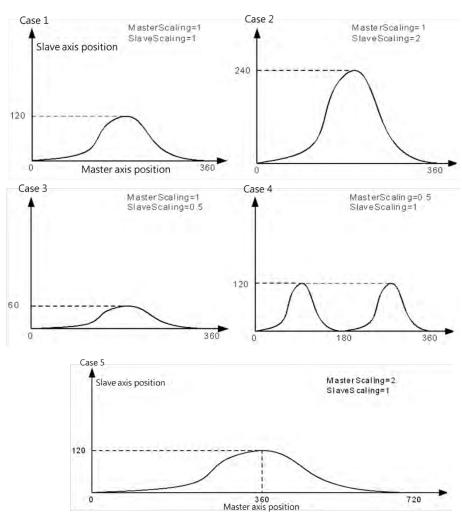


When master and slave are both in absolute mode and executes engagement, both master and slave positions are 0; when not using offset and scaling (default value), the following diagram shows the actual corresponding relationship between master and slave during the process of executing CAM:



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



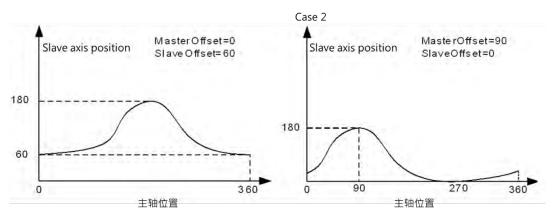
Situations:

- 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.

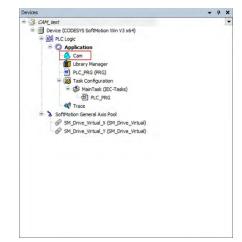
Situations:



- 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.

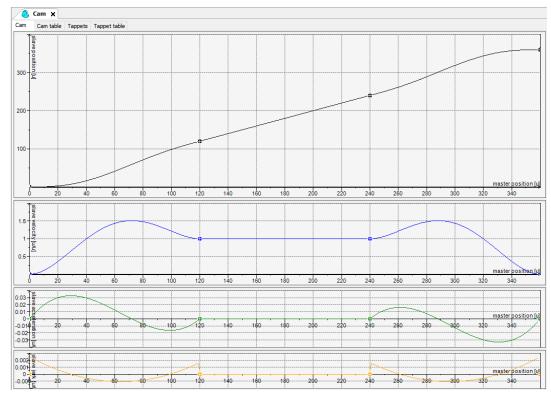


#### - Features of CAM table

- 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

Cam	Cam	table	Tappets	Tappe	t table								
			x	Υ		v	А	J	Segm	min(P	max(P	max( V	max( A.
			0	0		0	0	0					
•	•								Poly5	0	120	1.5120	0.0328.
Ŵ	1		120	120		1	0	0					
•	•								Poly5	120	240	1	
Ŵ	1		240	240		1	0	0					
•	•								Poly5	240	360	1.512	0.0328.
			360	360		0	0	0					

#### Programming editing

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

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

OAssigned CAM table

①Execute function blocks

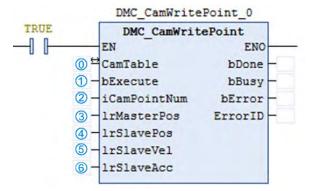
②Choose the CAM point number to read

3 Position 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.

10	CAM_test		▼ Cam	Cam tabl	Tappets	Tappet t	able				
B-0	Device (CODESYS So	ftMotion Win V3 x64)			×	Y	V	A	J	Segm	mi
	PLC Logic				n [Device:	PLC Logic	: Applicatio				×
*	Cut Copy Paste Delete Browse Refactoring	I Axis Pool		mon Build Dimensions Master star Slave start Period Smoot	tposition:[	0	Master	end position: nd position: eriod:	360 360 360		
	Properties Add Object	ual_X (SM_Drive_Virtual) _ual_Y (SM_Drive_Virtual)		Continuity r		s Velocity	Acc	eleration	🗌 Jerk		
0°	Add Folder			Comple format      onpolynomial (XYVA)      one dimensional point array      two dimensional point array							
						C	OK	Cancel		Apply	

#### • 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.

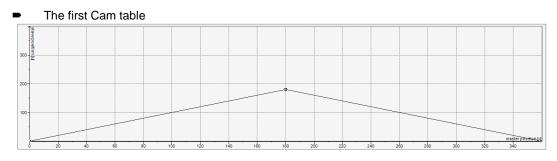
• Declaring variables

P : MC_CAM_REF;	//CamTable	reference
CamTableID : INT;	//CamTable	Switch

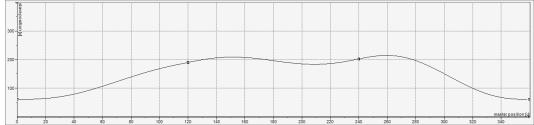
Switching of CAM tables

CASE CamTableID OF			
0: P:=Cam;			
1: P:=Cam_1;			
END_CASE			

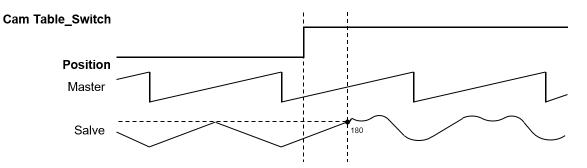
In the programming examples shown above, use the switching of CamTableID to change MC\_CAM\_REF to achieve switching of multiple CAM tables. Below are the two CAM tables:







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).

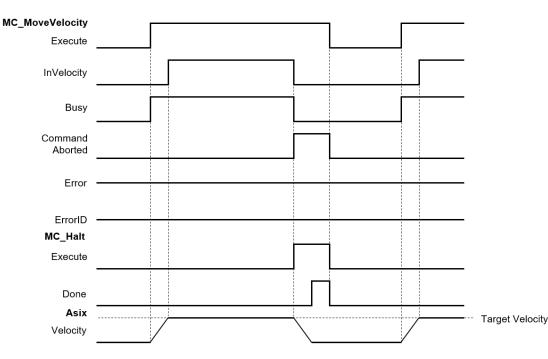
## 7.7.3.1 CSP Mode

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:

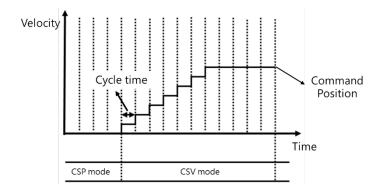


Assign velocity to 0, though the current movement is static but the system will be in continuous\_motion status.

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.

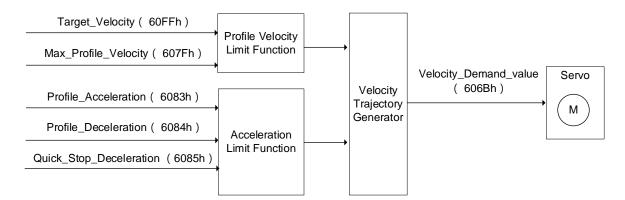


Despite external interference, cyclic velocity commands in CSV mode are send to servos that are unlikely to cause vibrations due to compensating positions found in CSP mode.

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.

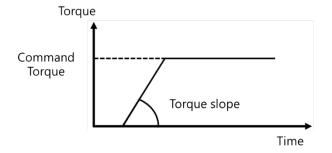


\*Note: Profile Velocity mode is used for positioning axes.

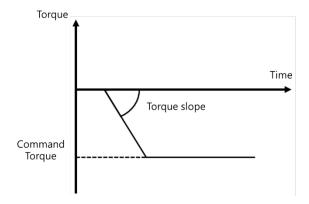
## 7.7.4 Torque control

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.



## 7.7.5 Common Functions for Single-axis Control

The common functions for single-axis control are described in the following section.

## 7.7.5.1 Command Position

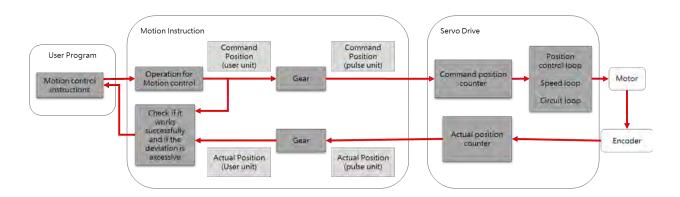
#### • Types of positions

The axis motion function modules adopt the following two types of positions.

Type of position	Meaning	
Command position	The position that MC function modules outputs to control an axis.	
Actual position	The position as feedback from the servo drive*	

\*Note: For virtual axis, there is no position feedback from the servo drive, so the command position will replaces the actual position.

#### The following figure shows the relationship between the command position and actual position:



#### A comparison between the command position and actual position:

ltem	Command position	Actual position	
Count mode	Linear axis / rotary axis	The same count mode setting as in command position	
Command unit	Length unit (m, mm, inch…) / angle unit (degree) / …	The same unit setting as in command position	
Software limits Set the range limit for MC function modules		The same range limit setting as in command positoin	
Positioning	Change to any desire position within the range limit	The same position setting as in command position, but position lag may appear*	

\*Note: Due to the settings of servomechanism, the so-called position lag may be generated between command and actual positions. As motion velocity increases, position lag also increases slightly. When limiting the lag, you can adjust axis setting to monitor the position lag and set operation for position lag being too large. For virtual axis, actual position equals to command position and position lag does not exist. Descriptions for the relevant parameters are as follows:

#### • Position unit

The unit refers to "command unit".

#### Position lag

Setting	Value	Meaning	
	Deactivated	Position lag not checked	
Position lag	Disable drive	When position lag exceeds the limit, the axis is in servo off.	
supervision	Do quick stop	When position lag exceeds the limit, the axis is in quick stop.	
	Stay enabled	When position lag exceeds the limit, the axis maintains servo on.	
Lag limit [u]	LREAL	Allowable lag limit	

Besides deactivated setting value, when other settings exceeds lag limits, the axis reports error as in SMC\_ERROR.SMC\_DI\_POSITIONLAGERROR.

#### • Software limits

Setting	Value	Meaning
Software limits Activated	Checked / Unchecked	Whether or not software limits is activated.
Negative [u]	LREAL	Negative software limit
Positive [u]	LREAL	Positive software limit

### • Description of positions in MC function modules

Please take note of the following input variables with two different interpretations that are related to positions in MC function modules:

ltem	Meaning
Position	Target position (absolute position)
Distance	Moving distance (relative position)

#### Monitoring positions

To observe change in position, you can focus on the following two axis variables (AXIS\_REF\_SM3 type) for monitoring:

Variable name	Position type	Data type
.fSetPosition	Command position	LREAL
.fActPosition	Actual position	LREAL

## 7.7.5.2 Velocity Command

#### • Types of velocity

The following two types of velocity are used in MC function modules.

Position type	Meaning	
Command velocity	The velocity in which MC function module ouputs for axis control	
Actual velocity	The velocity based on the actual feedback position of servo drives at each point in time*	

\*Note: For virtual axis, there is no position feedback from the servo drive, so the command position will replaces the actual position.

#### • Velocity unit

The velocity unit is "command unit/s".

#### • Velocity ramp type

Setting	Value	Meaning	
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:

Axis.fSetVelocity	Velocity=0 Current Velocity = 500
	Targer Velocity = -1000
Axis.fSetAcceleration	fSetAcceleration = Decceleration = 600 fSetAcceleration = Acceleration = -1200

#### 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/s3".

## • Axis settings related to jerk

(1) Types of jerk waveform

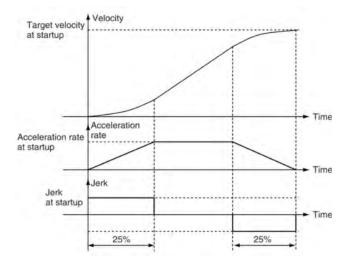
Please refer to "7.7.5.2 Velocity Command- Velocity ramp type" for more information.

#### • Description of jerk in MC function modules

The following input variable that is related to jerk in MC function modules:

ltem	Meaning		
Jerk	Target jerk*		

\***Note:** When velocity ramp type is trapezoid or in Sin<sup>2</sup>, the setting values of jerk are not applied in the movement; when velocity ramp type is quadratic or quadratic (smooth), the jerk does affect the velocity ramp.



#### • Monitoring jerk

To observe change in jerk, you can focus on the following two axis variables (AXIS\_REF\_SM3 type) for monitoring:

Variable name	Position type	Data type	
.fSetJerk	Command jerk	LREAL	
.fActJerk	Actual jerk	LREAL	

## 7.7.5.5 Axis Direction

The following situation requires specified operation directions:

- When input value of absolute during contant velocity, specified direction is required.
- When setting rotation axis, movement towards either postivie or negative direction can reach the target position, therefore, operation direction is required.
- Description of directions in MC function modules

The following input variable that is related to direction in MC function modules:

Item	Setting	Meaning			
	negative	Motion operates in a negative direction			
	shortest	Motion operates the shortest way (Only for rotation axis)*			
Direction	positive	Motion operates in a positive direction			
	current	Motion operates based on the current direction (Only for rotation axis)			
	fastest	Motion operates in the fastest way (Only for rotation axis)*			

\*Note: The concept of shortest (moving distance) and fastest (moving time) are similar but not completely the same, please refer to the following example:

• Setup:

Set axis as rotation axis, range 360

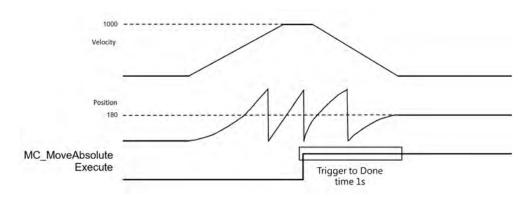
Set velocity ramp type of axis as Trapezoid.

• Procedure:

Use MC\_MoveVelocity to execute constant velocity motion. (Velocity=1000)

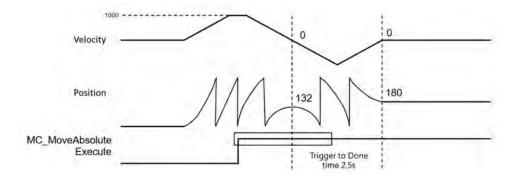
When motor reaches 350 and velocity reaches 1000, execute MC\_MoveAbsolute with 2 different direction settings

(1) Execute MC\_MoveAbsolute (Position=180, Velocity = Acceleration = Deceleration = 1000, Direction = fatest)



When MC\_MoveAbsolute.Execute triggers, the system determines the shortest way to reach position 180 is to move in positive direction and decrease velocity to 0. The process takes about 1 sec.

(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 combinig the deceleration of the previous motion and the acceleration of the current motion.		

### • Supported buffer modes

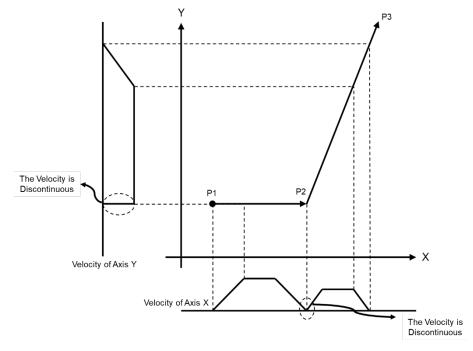
Mode	Aborting	Buffered	Blending Low	Blending Previous	Blending Next	Blending High
None	А	А	Ν	Ν	N	Ν
Overlap	А	A	D	D	D	D

A = Supported

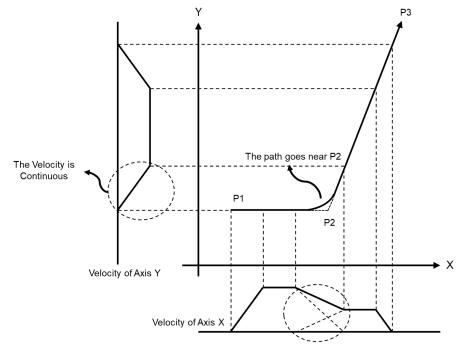
N = Not supported

D = Continue with Blending mode

• TransitionMode: For the below situation, set the mode to be None or Overlap, then choose buffered.

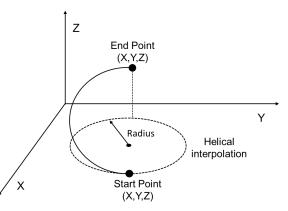


• **TransitionMode:** For the below situation, set the mode to be Overlap, then choose Blending. Plan with reference to acceleration and deceleration given to the motion function block of each axis group.



## 7.7.6.2 Circular Interpolation

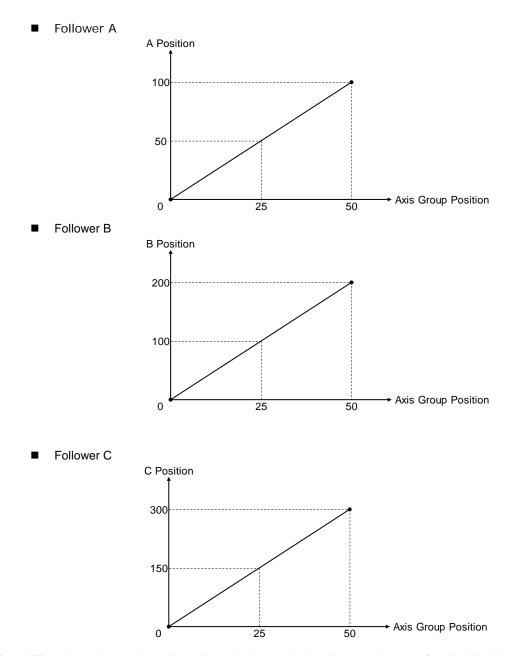
Circular movements can be run in the three main planes of the spatial coordinate system, only using X, Y, Z axis and three additional follower axes.



• 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

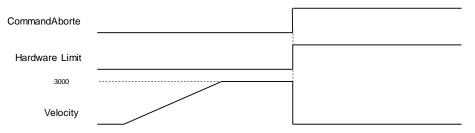
Use DMC\_GroupStop in the programming to decelerate the moving axis group to a stop. Then the group state switches to GroupStopping, which no motion instruction can be executed under this status.

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.

#### BuiltIn\_10 x Hardware IO Configuration Status Status Count sst Information inter 0 C. SSI E Z Phase Capt Counter 1 Capita Z Phase use OC Capture 1 Counter 2 Counter 3 Capture 2 2 10 551 Counter 4 tre 3 er. 11 Counter 5 Capture 4 12 unter 5 Capture 5 13 Capture 6 14 Capture 7 15 Timer 1 5/51 Con Timer 2 Comp Timer 3 our OUT Timer 4 Compare 1 A1 Compare 2 81 4 Compare J Z1 5 A2 Compare 4 6 B2 Compare 5 Pulca Outrus Ave Compare 6 22 7 Poles Outrut Avis 1 co Pulse Output Axis 2 Compare 7 Pulse Output Axis 3

# 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.

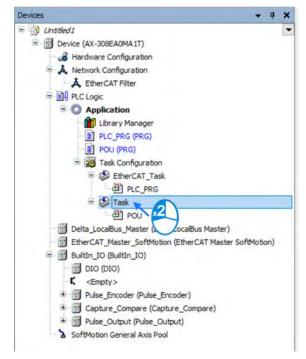
Double-click on "DIO"	" to enter the config	guration	page.		
		0	1/201	1/11	22

Devices 🗸 🕈 🛪	PLC_PRG	Delta_LocalBus_Master	EtherCAT_Mas	ter_SoftMotion	DIO X	Task	POU
Device (AX-308EA0MA1T)	DIO Configuration		1.0				
Hardware Configuration		Configura	tion	0	3)		
A Network Configuration	DIO I/O Mapping	0	Interrupt	Port C	Filter (0.01us)	Polarity	1
A EtherCAT Filter			anderrope				
= III PLC Logic	Status	IN O	flf.	IN O	100	H H - M-	
G Application	Information		And the Party of t	IN 1	100	HH HA	
Library Manager	Information	IN 1	f l fl	IN 2	100		
PLC_PRG (PRG)		IN 2	fr fr	IN 3	100		
POU (PRG)							
= 🌌 Task Configuration		🗌 IN 3	LT 7 1	IN 4	100		
EtherCAT_Task		IN 4	fl fl	IN 5	100		
D PLC_PRG			Contraction Contraction	IN 6	100	4 F -1/F	
= 😂 Task - 레 POU		🗌 IN 5	L L L	IN 7	100		
Delta_LocalBus_Master (Delta LocalBus Master)		IN 6	fl fl	IN 8	100		
EtherCAT_Master_SoftMotion (EtherCAT Master SoftMotion)			Party in the second second				
Builtin_IO (Builtin_IO)		IN 7		IN 9	100		
DIO (DIO)		🗌 IN 8	f l fl	IN 10	100	++ +/-	
K <empty></empty>		[] IN 9	f f	IN 11	100	+ F -N-	
*  Pulse_Encoder (Pulse_Encoder)			Contract Local Division in Concession	IN 12	100		
*  Capture_Compare (Capture_Compare)		🗌 IN 1		IN 13	100		
Pulse_Output (Pulse_Output)		IN 1	1 fl				
SoftMotion General Axis Pool			Provide Land State Provide State	IN 14	100		
		🗌 IN 1	2 fl	IN 15	100	HE HA	
		IN 1	3 FT FT	Encoder A1	100		
			the second se	Encoder B1	100		
		IN 1		Encoder Z1	100		
		IN 1	5 Flft		10		
		Enco	( and ( and )	Encoder A2	100	H H	
			Contrast Contrast Contrast	Encoder B2	100		
		Enco	der Z2	Encoder Z2	100		
				SSI DATA	100	HE -M	

## Configuration

Function	Description	
	Default value	
	Activate external interrupt	
External Interrupt     Setting	When external interrupt is activated, set input signals as rising edge.	
Setting	When external interrupt is activated, set input signals as falling edge.	
	When external interrupt is activated, set input signals as rising and falling edge.	
© Port	Port number	
③ Filter	Set filter time (us), setting range is from 0 to 100000000. The default is 100us.	
	BE Set input polarity. The default is contact A.	
④ Polarity	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.



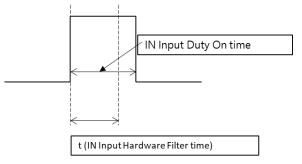
Enter Task configuration page and choose "External" from the drop down list for Type.

Devices + 4 X	Task X
Untitled1 Device (AX-308EA0MAIT) Hardware Configuration A Network Configuration A EtherCAT Filter PLC Logic Application IC_PRG (PRG) POU (PRG) EtherCAT_Task PLC_PRG EtherCAT_Task PLC_PRG EtherCAT_Task PLC_PRG EtherCAT_Task POU POU POU Delta_LocaBus_Master (Delta LocaBus Master)	Configuration Priority (031): 1 Type Ocyclic Codic C
EtherCAT_Master_SoftMotion (EtherCAT Master SoftMotion) Builtin_IO (Builtin_IO) DIO (DIO) C <empty> Simplify Pulse_Encoder (Pulse_Encoder) Pulse_Compare (Capture_Compare) Pulse_Output (Pulse_Output) SoftMotion General Axis Pool</empty>	POU Comment. ④ POU

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

Devices 🗸 🗸 🛪 🗙	🔮 Task 🗙
<ul> <li>Untitled I</li> <li>Device (AX-308EA0MA IT)</li> <li>Hardware Configuration</li> <li>A Network Configuration</li> <li>A EtherCAT Filter</li> <li>PLC Logic</li> <li>Application</li> <li>Ubrary Manager</li> <li>PLC_PRG (PRG)</li> <li>POU (PRG)</li> <li>EtherCAT_Task</li> <li>PLC_PRG</li> <li>Task</li> <li>POU</li> <li>Delta_LocaBus_Master (Delta LocaBus Master)</li> <li>EtherCAT_Master_SoftMotion (EtherCAT Master SoftMotion)</li> <li>Builtin_IO (Builtin_IO)</li> <li>Builtin_IO (Builtin_IO)</li> <li>C Empty&gt;</li> <li>Puse_Encoder (Pulse_Encoder)</li> <li>C Capture_Compare (Capture_Compare)</li> <li>Puse_Output (Pulse_Output)</li> <li>SoftMotion General Axis Pool</li> </ul>	Configuration Priority ( 0.31 ):  Type  Seternal Configuration  Type  Add Call Call Call Call Call Call Call Call

- 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:

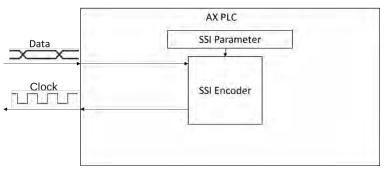
Filter frequency<sup>\*1</sup> (Hz): Filter frequency=  $1 / (2^*t)$ ; t is the filter time setting value (unit:  $0.01\mu$ s). When input frequency is higher than the filter frequency range, signals are filtered.

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.

Status	· · · · · · · · · · · · · · · · · · ·	<b>U</b>
		Counter SSI
		Counter 0
	IN IN	Counter 1
	0 8	Z Phase use OC Capture
	1 9	Counter 2 Capture 1
SSI Data		Counter 3 Capture 2
551	2 10	Counter 4 Capture 3
SSI Clock	3 11	Counter S Capture 4
	4 12	Counter 6 Capture 5
	5 13	Counter 7
	6 14	umer
	7 15	
	5/50 5/51	Timer 1 Timer 2
		Timer 3 Compare 0
	ουτ ουτ	Timer 4 Compare 1
AI	001 001	Timer 5 Compare 2
61	0 4	
Z1	1 5	Compare 5
A2		Axis Compare 4
82	2 6	Pulse Output Axis 0 Compare 5
2	3 7	Pulse Output Axis 1 Compare 6
	co co	Pulse Output Axis 2 Compare 7
Encoder		Pulse Output Axis 3

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

Hardware IO Configuration	General			
SSI Encoder Configuration	Clock Frequency		Clock Pause Time	
IEC Objects		ายย	F1	inn
Status	Data X(			
Information	Multi-Tum Del	a Single-Tu	n Data	
	Encoder Type: Gray Code ··	kHZ Clock Paus	e Time: 80	🔹 us
		-	rns Setting: 12	•
	Axis Standard	4	Positive Command	Negative Command
	Encoder Type: SSI Encoder		Tan	(Con
	Axis Type     Unear Axis     C Rotary Axis	Reverse OFF	Cont.	ccw
	Modulo: 360 4 [ Unit ]	O Reverse On	Con.	6.7
	5 Transmission Mechanism		ccw	cii
	Mechanism Type Ball Screw V	Mechanism Setti (1) Command p (4) Pitch: 1	ng ulse per motor rotation: 1 🗣 [ Unit ]	🗍 [ Pulse ]
		Gear Box	(2) Gear ratio numerator	1
		Gear Ratio =	(3) Gear ratio denominator	

I 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)

Item	Function	Setting value (Default value)
SingleTurnsSetup	Set SSI encoder singleturn setup (Need SSI encoder datasheet as reference)	(13)
Clock Pause Time	After the last falling edge of clock, the data line keeps at a low level for a while before the line rises. (Need SSI encoder datasheet as reference)	(80)

② Axis Standard

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)

Item	Function
Reverse OFF / ON	Decide on the rotation direction for positive and negative commands.

#### ■ ⑤ Transmission Mechanism

Different structures are presenred in the following descriptions:

Ball Screw

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

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	Round Table	× (4)		ng ulse per motor rotation: 1 istance per motor rotation: 1	l ₽	[Pulse]
	6	U,	Gear Box	(2) Gear ratio numerator	1	
	(3)		Gear Ratio =	(3) Gear ratio denominator	-	123

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

	Belt Pully	× (4)	(4) Diameter: 1	ulse per motor rotation: 1	•	[ Pulse ]
	U O		Gear Box	nce per motor rotation: Diamete	a - n	
V	(3)		Gear Ratio =	(2) Gear ratio numerator	1	A
			Gear Ratio =	(3) Gear ratio denominator	1	\$

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			
ErrorID	Status of SSI Encoder Communication. 0 : No Error 1 : Error Communication 2 : Wrong Parameter Setting			

#### \*Note:

ErrorID:

- 1. When SSI encoder is not connected or SSI encoder and CPU is disconnected, then ErrorID=1.
- 2. When MultiTurns + SingleTurns is bigger than 32, then ErrorID=2.

The error situations mentioned above allows BusCycle to stop updating EncoderPosition and the EncoderPosition will keep the last value, the purpose is to avoid jump from other slave axis when main axis encoder is in synchronized motion.

#### ErrorID Clear:

 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.

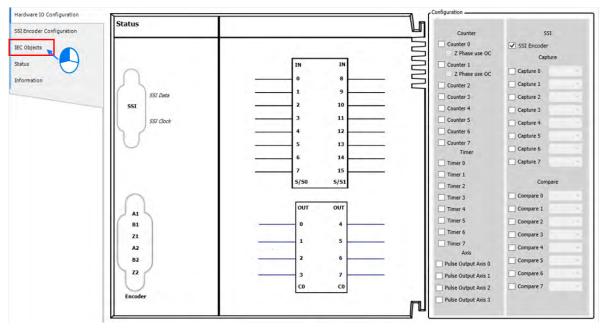
Ans: Check the connection between SSI encoder and CPU. The modified firmware will make sure the communication channel is properly connected to restore EncoderPosition updates of BusCycle. There are many reasons for cause of errors, for example: SSI encoder not properly connected, broken SSI encoder and 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

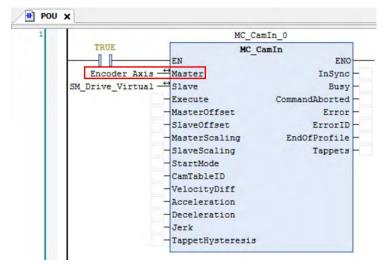
Hardware IO Configuration	Variable	Туре	Configuration Function
	SSI_Encoder	DFB_SSI_ENCODER_REF	SSI Encoder
SSI Encoder Configuration	Encoder_Axis_1	DMC_ENCODER_AXIS_REF	SSI Encoder/FreeEncoder_Axis
IEC Objects			
Status			
Information			

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	Туре	Configuration Function
SSI Encoder Configuration	SSI_Encoder Encoder_Axis	DFB_SSI_ENCODER_REF DMC_ENCODER_AXIS_REF	SSI Encoder 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.



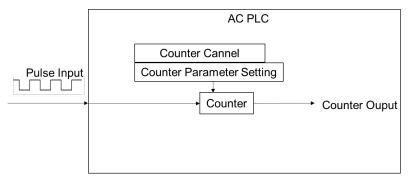
# 7.7.7.4 Pulse Encoder Setting

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.

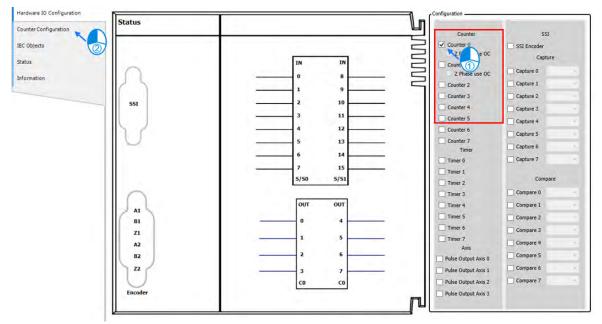
The section describes the pulse-type encoder function modules of the IO (see below), the maximum amount concerning AS508ECT-B support for high speed counter and the total of high speed timers are 8 sets.

#### • 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	0	
Counter Configuration	Counter	Mode	
The set of the set		Counter Mode	Description
IEC Objects		1.1	Clockwise 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 Pulse 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.

onfiguration	Status			Li I	
ontiguration				Counter	SSI
				Counter 0	SSI Encoder
		IN	IN	Z Phase us	se OC Capture
$\cup$	0	IN 0	8	Counter 1 Z Phase ut	se OC Capture 0
n	2.5	1	9	Counter 2	Capture 1
	1.1.1		10. C <sup>2</sup>	Counter 3	Capture 2
	551		10	Counter 4	Capture 3
			11	Counter 5	Capture 4
	$\square$	4	12	- Counter 6	Capture 5
	U	5	13	Counter 7	Capture 6
			14	Timer 0	Capture 7
			15 5/51	Timer 1     Timer 2	Compare
	$\cap$			Timer 3	Compare 0
	AI	OUT	OUT	Timer 4	Compare 1
	B1		4	Timer 5	Compare 2
	Z1			Timer 6	Compare 3
	A2		5	Timer 7	Compare 4
	B2	2	6	Pulse Output A	locis 0 Compare 5
	22		7	Pulse Output A	xis 1 Compare 6
		co	co	Pulse Output A	oxis 2 Compare 7
	Encoder			Pulse Output A	ipris 3

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

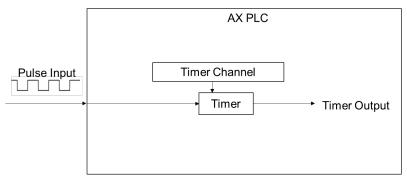
■ The column marked ① on the IEC Objects tab is the configuration function of each variable. To enable counter function, the variavle Counter\_0 needs to be input to the Counter pin of DFB\_HCnt.

Hardware IO Configuration	Variable	Туре	Configuratio	DFB_H	Cnt_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
				di	CounterValue

■ For MC\_CamIn function block in POU, the input variable corresponding to Master should be Encoder\_Axis while using variable Counter\_0 SSI as the source of the master axis.

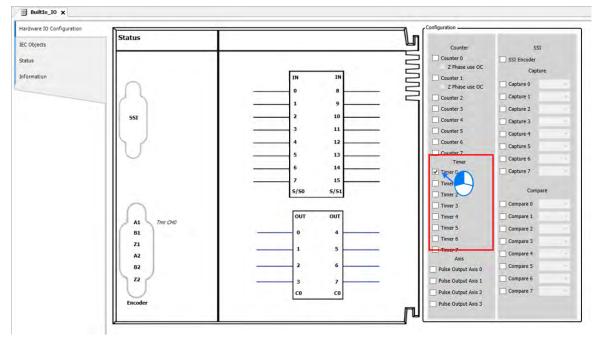
Hardware IO Configuration	Variable	Туре	Configuration Function	1		arIn_0
	Counter_0	DF8_COUNTER_REF	Counter 0	TRUE	MC_G	earIn
Counter Configuration	Encoder_Axis	DMC_ENCODER_AXIS_REF	Counter 0/FreeEncoder_Axis		EN	ENO
EC Objects				Enco	der_Axis - Master	InGear
	_			SM Drive	Virtual - Slave	Busy
Status					- Execute	CommandAborted
Information					- RatioNumerator	Error
					-RatioDenominator	ErrorID
					-Acceleration	
	-				- Deceleration	
					Jerk	

# High speed timer (Tmr)

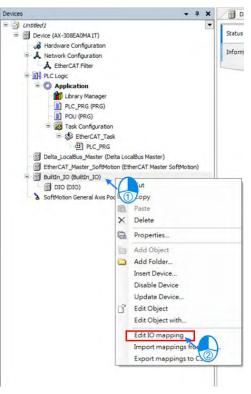


#### • Enable high speed timer function

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	Show all		•	Add FB for IO Channel.
Variable	Channel	Address	Туре	Description	
P- M DIO					
🛞 – 🍫	IN:0-7	%IB0	BYTE	8-CH Open Collector In	nput
· *	IN:8-15	%IB1	BYTE	8-CH Open Collector In	nput
۰ 🕰 🗐	Encoder	%IB2	BYTE	2-CH of Incremental Er	ncoder Input
😟 - 🍫	OUT:0-7	%QB0	BYTE	8-CH Open Collector O	utput
Pulse_Encoder					
B-B Timer_0					
- **	Timer Value	%ID1	DWORD	HSIO Timer Value	

## • Use Timer in program

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

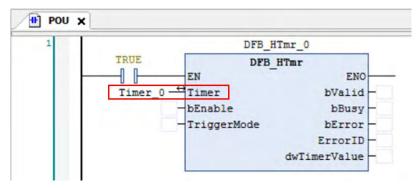
■ Click "IEC Objects" on BuiltIn\_IO page.

Status	1	Configuration	
	L	Counter	SSI
		Counter 0	SSI Encoder
		Z Phase use OC	Capture
	IN IN	Counter 1 Z Phase use OC	Capture 0
	0 8	Counter 2	Capture 1
	1 9	Counter 3	Capture 2
551	2 10	Counter 4	Capture 3
	3 11	Counter 5	Capture 4
5.2	4 12	Counter 6	Capture 5
	5 13	Counter 7	Capture 6
	6 14	Timer	Capture 7
	7 15	Timer 1	
	5/50 5/51	Timer 2	Compare
$\sim$		Timer 3	Compare 0
	ουτ ουτ	Timer 4	Compare 1
A1 Tmr CH0 B1	0 4	Timer 5	Compare 2
Z1	• •	Timer 6	Compare 3
AZ	1 5	Timer 7	Compare 4
82	2 6	Axis Pulse Output Axis 0	Compare 5
22		Pulse Output Axis 1	Compare 6
	C0 C0	Pulse Output Axis 2	Compare 7
Encoder		Pulse Output Axis 3	

The column marked ① on the IEC Objects tab is the configuration function of each variable. For the axis used in POU, the axis name should be set as Timer\_0.

Hardware IO Configuration	Variable	Туре	Configuration Function
IEC Objects	- Timer_0	DFB_TIMER_REF	Timer 0
Status			
Information			

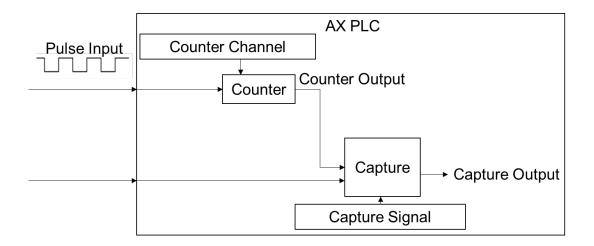
To enable Timer function, DFB\_HTmr\_0 is required to use. For DFB\_HTmr\_0 function block in POU, enter Timer\_0 as the axis name.



# 7.7.7.5 Capture/Compare Function 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

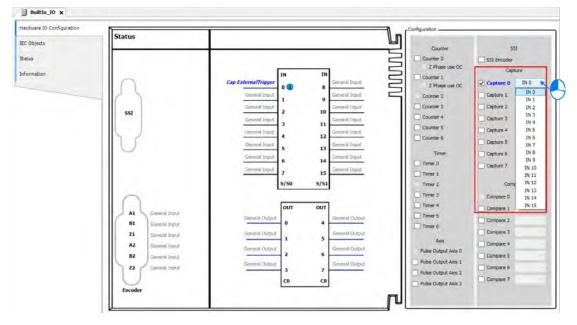


# • Enable Capture function

re 10 Configuration	In		T Configuration	
ects	Status		Counter	551
			Counter 0	551 Encoder
			Z Phase use OC	and the second second
tion		1N 1N	Counter 1	Capture
		Cap ExternalTrigger 0 0 8	Z Phase use OC	Capture IN 0
	125	1 9	Counter 2	Cap
			Counter 3	Capture 2
	551	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	Cepture 6
		6 14	Timer	
		7 15	Timer 0	Capture 7
		5/50 5/51	Timer 1	Compare
			Timer 2	
			Timer 3	Compare 0
	AL	τυο τυο	Timer 4	Compare 1
	B1	0 4	Timer 5	Compare 2
	21		Timer 6	Compare 3
	A2	1 5	Timer 7	Compare 4
	82	2 6	Axis Pulse Output Axis 0	Compare 5
	n		Pulse Output Axis 0	Compare 6
		3 7		Compare 7
	Encoder	C0 C0	Pulse Output Axis 2 Pulse Output Axis 3	C) compare /

Select one of the 8 Capture groups to activate on the BuiltIn\_IO page.

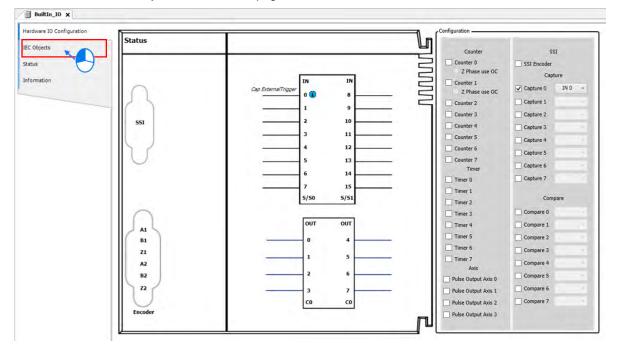
Then choose the external trigger input from the drop-down list after activating Capture.



#### • Use Capture in program

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

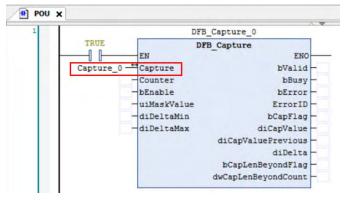
Click "IEC Objects" on BuiltIn\_IO page.



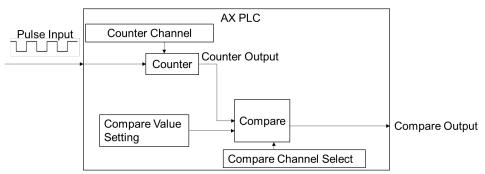
■ The column marked ① on the IEC Objects tab is the configuration function of each variable. For the axis used in POU, the axis name should be set as Capture \_0.

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.

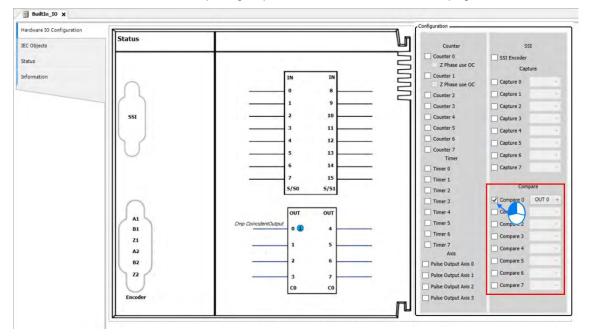


• Compare



#### Enable Compare function

Select one of the 8 Compare groups to activate on the BuiltIn\_IO page.



- BuiltIn\_10 × Configurati Hardware IO Configuration Status l IEC Objects 551 Counte L Counter 0 5SI Encoder Status Z Phase use OC Capture LU Information Counter 1 Capture 0 Z Phase u 8 Capt re 1 Counter 2 1 9 Counter 3 Capture 2 2 10 SSI Counter 4 Capture 3 3 11 Counter 5 Capture 4 Counter 6 12 4 Capture 5 Counter 7 5 13 Capture 6 Time 6 14 Capture 7 Timer 0 15 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 Cap 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 Compar 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			

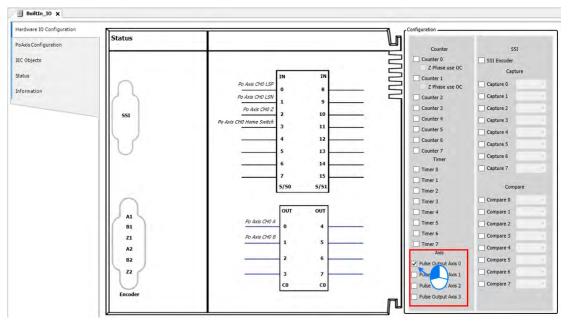
■ For DFB\_Compare function block in POU, enter Compare \_0 as the axis name.

1		DFB_Co	mpare_0
	TRUE	DFB_C	ompare
		EN	ENO
	Compare_	0 - Compare	bValid
	2- A	- Counter	bBusy
		-bEnable	bError
		Mode	ErrorID
		-wRefreshCycl	e
		diCmpValue	

# 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 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.

s Configuration	Status			Counter	SSI
bjects			_	Counter 0 Z Phase use OC	SSI
nation	0	Po Avis CHO LSP 0	IN 8	Counter 1 Z Phase use OC	Capture 0
nation	25	Po Axis CH0 LSN	9	Counter 2	Capture 1
		Po Axis CH0 Z		Counter 3	Capture 2
	551	Po Axis CH0 Home Switch	10	Counter 4	Capture 3
		3	11	Counter 5	Capture 4
	5 6		12	Counter 6	Capture 5
	0		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
	AI	OUT	OUT	Timer 4	Compare 1
	B1	Po Axis CH0 A	4	Timer 5	Compare 2
	Z1	Po Axis CHO B		Timer 6	Compare 3
	A2	1	5	Timer 7 Axis	Compare 4
	B2	2	6	Pulse Output Axis 0	Compare 5
	22	3	7	Pulse Output Axis 1	Compare 6
		C0	co	Pulse Output Axis 2	Compare 7
	Encoder			Pulse Output Axis 3	

Mode A/B	*		<ul> <li>Virtual mode</li> <li>Linear Axis</li> </ul>	Linear Axis Softw	are Limits	
) Reverse OFF		Negative Command	🚫 Rotary Axis	Activated Negative [u]: 0 Positive [u]: 10 Rotary Axis Modu Modulo value [u]	100 Ilo Setting	
) Reverse On	ccw cw	CCW	Velocity Ramp	Deceleration [u		ratic(smooth)
ansmission Mec Mechanism Typ		(4) Pitch:	nand pulse per motor	rotation: 10000 Unit ]	Ţ [Pul	se ]
		Gear Box	(2) Gear	r ratio numerator	1	\$

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.

ds 0 Julse Output Setting		
Mode Setting	(2	Axis Type and Limits
Mode A/B *		Virtual mode
The second se	Nearthin Command	Linear Axis 3 Linear Axis Software Limits
Positive Command	Negative Command	Rotary Axis     Activated
	60	Negative [u]: 0
(   ( d n (	100	Positive [u]: 1000
Reverse OFF	1007	Rotary Axis Modulo Setting
le ·	6	Modulo value [u]: 360
CCW	CW	Motion Parameter
(23) /	Can G	Error Reaction
	12h	
O Reverse On	1507	Quick Stop Deceleration [u/s <sup>2</sup> ]: 1000
	6	Velocity Ramp Type
CW	CCW	Trapezoid      Sin <sup>2</sup> Quadratic      Quadratic(smooth)
ransmission Mechanism		
	(4) Pitch: 10	d pulse per motor rotation: 10000 🗍 [Pulse] 10000 🙀 [Unit]
		1000 Training (2) Gear ratio numerator 1
	(4) Pitch: 10 Gear Box	(2) Gear ratio numerator 1
forming Setting	(4) Pitch: 10 Gear Box	1000 The contract of the contr
	(4) Pitch: 10 Gear Box Gear Ra	1000 The contract of the contr
forming Setting	(4) Pitch: 10 Gear Box	1000 The contract of the contr
toming Setting Homing Mode Mode 35	(4) Pitch: 10 Gear Box Gear Ra	1000 The contract of the contr
Aoming Setting Homing Mode Mode 35 ~ Homing speed during search for switch 100	(4) Pitch: 10 Gear Box Gear Ra	1000 The contract of the contr
toming Setting Homing Mode Mode 35 Homing speed during search for switch 100 Homing speed during search for z phase pulse 50 Homing Acceleration 1000	(4) Pitch: 10 Gear Box Gear Ra	1000 The contract of the contr
toming Setting Homing Mode Mode 35 Homing speed during search for switch 100 Homing speed during search for z phase pulse 50 Homing Acceleration 1000 C [Unit/s <sup>2</sup> Description	(4) Pitch: 10 Gear Box Gear Ra	1000 The contract of the contr
toming Setting Homing Mode Mode 35 Homing speed during search for switch 100 Homing speed during search for z phase pulse 50 Homing Acceleration 1000	(4) Pitch: 10 Gear Box Gear Ra	1000 The contract of the contr
toming Setting Homing Mode Mode 35 Homing speed during search for switch 100 Homing speed during search for z phase pulse 50 Homing Acceleration 1000 C [Unit/s <sup>2</sup> Description	(4) Pitch: 10 Gear Box Gear Ra	1000 The contract of the contr
Aoming Setting Homing Mode Mode 35 (3) Homing speed during search for switch 100 Homing speed during search for z phase pulse 50 Homing Acceleration 1000 (101/s <sup>2</sup> ) Description Mode 35 : Depending on the cur	(4) Pitch: 10 Gear Box Gear Ra	1000 The contract of the contr

## ■ 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)

Item	Funtion	Setting Value (Default)
Virtual	Activate virtual axes.	TRUE FALSE (FALSE)
Linear Axis / Rotary Axis	Set the axis type to be linear axis or rotary axis.	Linear Axis Rotary Axis (Linear Axis)

#### ■ ② Axis Type and Limits

#### ■ 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)

#### S Error Reaction

Item	Funtion	Setting Value (Default)
Quick Stop	Stop the axis immediately.	(360)
Deceleration[u/s2]	The axis will perform a deceleration stop. (functional only when Quick Stop is not activated)	(10000)

#### ■ ⑥ Velocity Ramp Type

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

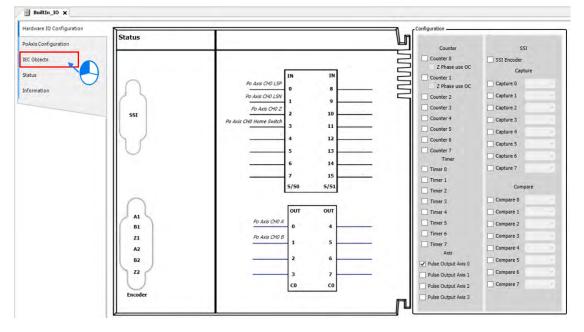
Software Configuration Page: Please refer to 7.7.7.3 SSI Encoder Setting

B 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.

C_Power_0	P	1.
MC_Power		TRUE
ENO	EN	
Status	Axis	Pulse_Output_Axis_0 -
bRegulatorRealState	Enable	
bDriveStartRealState	bRegulatorOn	
Busy	bDriveStart	
Error		
ErrorID		

## 7.7.7.7 Confirm High-Speed IO Errors

Errors in Pulse Output Axis are displayed on Status tab under BuiltIn\_IO page with messages notifying you of which pulse axis has error.

es 🔍 🕈 🕈 🖉 Device	Library Manager I PLC_PRG I DIO BuiltIn	_ 01_	
Lindtied1     Device [connected] (AX-308EA0Ms     Hardware Configuration     A Network Configuration	D Configuration Pulse_Output : Iguration Last Diagnostic Message	Bus faiure	Acknowledg
= ]] PLC Logic = O Application [run]	Diagnosis Message: 'Pulse axis channel 0 has err	or	
Library Manager Status			
PLC_PRG (PRG)     Task Configuration     Information			
● G 🔮 MainTask ④ PLC_PRG			
- 5 B Task			

You can continue to check and monitor the error information on PoAxis Configuration tab page.

<ul> <li>Untitled1</li> <li>O Device [connected] (AX-308EA0MA</li> </ul>	Hardware IO Configuration	Axis 0			
Ardware Configuration	PoAxis Configuration	Online	errorstop		Communication: operational (100)
PLC Logic     O Application [run]	IEC Objects	variable	set value	actual value	Errors Axis Error:
Library Manager	Status	Position [u]	0:004	0.064	0 [16#00000000]
= 🧱 Task Configuration	Information	Velocity [u/s]	0	0	FB Error:
= 😏 🍪 MainTask ∰ PLC_PRG		Acceleration [u/s <sup>2</sup> ]	0	0	SMC_ERROR.SMC_FB_WASNT_CALLED_DURING_MOTION uiDriveInterfaceError:
C S Task		Torque [Nm]	0.	0	0
		Reverse OFF	ccw	Regative Command	Linear Axis Software Limits     Rotary Axis     Activated     Negative [u]: 0     Positive [u]: 1000     Rotary Axis Modulo Setting     Modulo value [u]: 360     Modulo Rarameter Error Reaction
		O Reverse On	SPJ. cw	cow	Quick Stop         Deceleration [u](s²):         1000         €           Velocitir Ramp Type         ●         Trapezoid ()         Sin² ()         Quadratic (smooth)

# 7.7.80ther Features

#### 7.7.8.1 Change Current Position

#### MC\_SetPosition

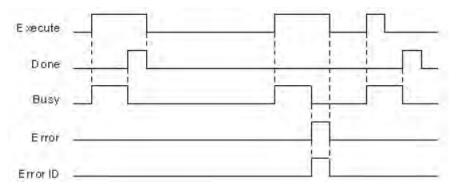
This function block is to change the current position by shifting the coordinate system of an axis.

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.

#### 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.



#### Software display

Can be configured via DIADesigner-AX software.

General Setting	Axis Type and L		Motion Parameter Error Reaction			
Homing Setting	Linear Axis     Rotary Axis	Linear Axis Software Limits		ration [u/s <sup>2</sup> ]: 100	-	
Commissioning SM_Drive_ETC_Delta_ASDA_A2: IEC Objects		Negative [u]: 0	Velocity Ramp Type Trapezoid  Sin <sup>2</sup> (	🔿 Quadratic 🔿 Quadr	ratic(smooth)	
Status		Rotary Axis Modulo Setting Modulo value [u]: 360	Position Lag Supervision Position Lag Reaction	Deactivated *	Lag Limit [u]:	1
Information	Transmission Mer Mechanism Typ (1)		Mechanism Setting (1) Command pulse per mo (4) Pitch: 1	otor rotation: 131072	🕴 [ Pulse ]	
			Gear Box (2) G	Gear ratio numerator	1	•
		(3)	Gear Ratio =			- August

The positive and negative position are able to be resized on the configuration page:

Item	Data Type	Default Setting
Negative	LRAEL	0.0
Position	LRAEL	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 dri	ive	When position lag exceeds limit setting, axis will shift to servo off.		
Do quickst	ор	When position lag exceeds limit setting, axis will shift to quick stop.		
Stay enabl	led	When position lag exceeds limit setting, axis will remain as servo on.		
B# SM_Drive_ETC_Delta_ASDA	A2 X			
General Setting Homing Setting Commissioning SM_Drive_ETC_Delta_ASDA_A2: IEC Objects Status Information	Unical Axis	Linear Axis Software Limits Activated Negative [u]: 0 Positive [u]: 10000 Rotary Axis Modulo Setting Modulo value [u]: 350 Position Lag Supervision Position Lag Reaction Stay Enabled Lag Limit [u]: 100 Lag Limit [u]: 100 Lag Limit [u]: 100		
	(1)	Marbanian Satting		

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

## 7.7.8.4 Cam Switch Function

#### MC\_DigitalCamSwitch

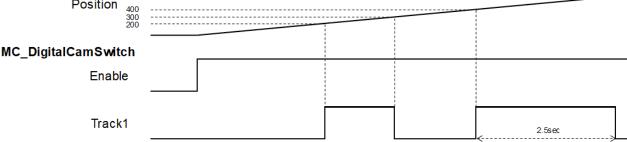
Specify the tappet position. True when the moving axis reaches the specified position, then turn to False when passing it. The following example regards to configuration settings.

- 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

_	
	sition
F US	SILIUII



- 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.

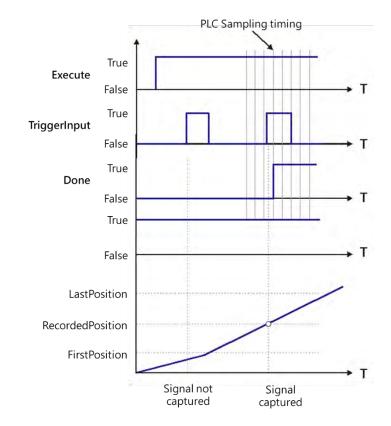
#### 7.7.8.5 Position Capture

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

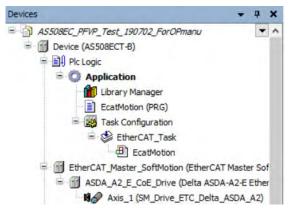
## 7.8.1.2 Configuration

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 🗙		
figuration		
riority ( 031 ):		
Туре		
🕑 Cyclic 🗸 🗸	nterval (e.g. t#200ms): 4000	µs ∨
Watchdog		
Enable		
Time (e.g. t#200ms):		mš
Sensitivity:		
Add Call X Remove Call	Change Call 🖙 Move Up 🔹 Move Down 👎 Open POU	
POU	Comment	
EcatMotion		

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

General Setting	Axis Type and Limits		Motion Parameter			
Homing Setting	Cilical Axis	ar Axis Software Limits Activated	Error Reaction	Deceleration [u/s <sup>2</sup> ]: 1000		
Commissioning SM_Drive_ETC_Delta_ASDA_A2:	Ne	ative [u]: 0	Velocity Ramp Type	e Sin² () Quadratic () Quad	ratic(smooth)	
IEC Objects Status	Rot	ary Axis Modulo Setting dulo value [u]: 360	Position Lag Supervi Position Lag Reaction	ision	Lag Limit [u]:	100
Information	Transmission Mechanis Mechanism Type Ba		Mechanism Setting (1) Command pulse (4) Pitch: 10000	e per motor rotation: 10000	🛊 [ Pulse	•]
			Gear Box	(2) Gear ratio numerator	1	*
		(5)	Gear Ratio =	(3) Gear ratio denominator	1	

### 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 varia	bles used in	programming
--	------------	--------------	-------------

Variable	Data Type	Default	Note
SM_Drive_Virtual	AXIS_REF_SM3	-	Virtual axis variable
Start	BOOL	FALSE	Shift to True when start the server and enable Servo On

#### LD language

.

Check for the successful EtherCAT communication when Start is True so as to enable MC\_Power via ServoOn output, which the status should be True.

-	Start ServoOn
2	
	MC_Power_0
	MC_Power
	EN ENO 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

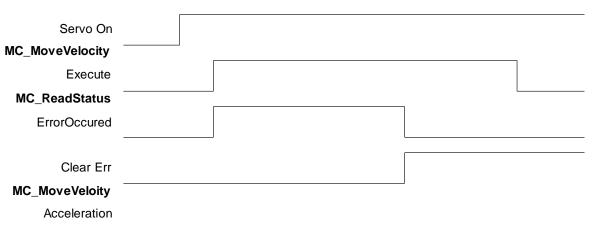
You can view the error information of variable status through Watch table. Take MC\_MoveVelocity input as example, when acceleration value is set as 0 and Execute is True, an error will occur in the fuction block and the ErrorID displays Row Data 301. You can find the complete error message in the Watch 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
EN ENO	EN ENO
SM Drive Virtual Axis Status TRUE	SM_Drive_Virtual - Axis InVelocity - FMS
ServoOn TRUE Enable bRegulatorRealState TRUE	MC_MoveVelocity0_Execute TRUE Execute Busy - FAR
TRUE bRegulatorOn bDriveStartRealState TRUE	10000 - Velocity CommandAborted - FAM
IRUE bDriveStart Busy IRUE	MC_MoveVelocity0_Acceleration 0 Acceleration Error INU
Error - FALSE ErrorID - SMC_NO_E	10000 Deceleration ErrorID - SMC
LIFOTID - SHELNOL	
	MC_DIRECTION.positive C 1 Direction
MC_Reset_0 MC_Reset_0 SM Drive Virtual = Axis Done = 72157 SM	HC ReadStatus 0 KC ReadStatus 200 Drive Virtual - Axia Valid - TRUX
MC Reset 0 Excute FALSE Execute Busy - FALSE	IRUE Enable Busy - TRUE
Error - VALSE ErrorID - SMC_NO_ERR	Error - FALSE ErrorID - SMC_NO_ERA
SEEDEED MAN LONG	Disabled - FALSE
	Errorstop - FALSE
	Stopping - FALSE
	StandStill - TRUE
	DiscreteMotion - PARSE
	ContinuousMotion - 24452
	SynchronizedMotion - WARE
	Homing - FALSE
	ConstantVelocity - FALSE
	Accelerating - PARSE
	Decelerating - PAMSE
	FBErrorOccured TRUE

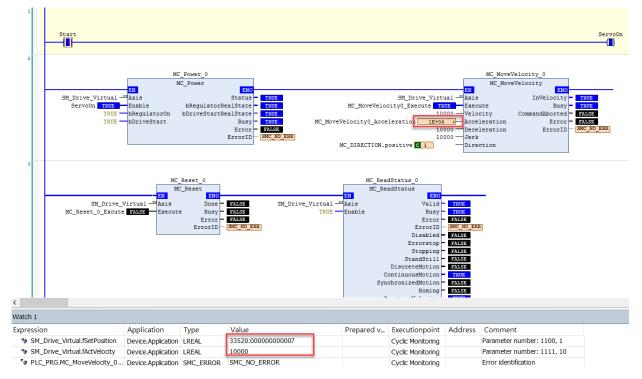
Via function SMC\_ClearFBError that error can be deleted and output FBErrorOccured of MC\_ReadStatus would shift to Fulse, once an error occurs in the function block. In addition, since input of SMC\_ClearFBError need to be tranferred via pointers, ADR(input) must be fed and use bool to clear FB error flag.

	Reset_0 _Reset _Rese				TALIE TALES FALSS CAN UN COS FALSS FALSS FALSS FALSS FALSS FALSS FALSS FALSS FALSS FALSS FALSS FALSS	ANERE	_Drive_Virtua	SMC ClearTRError 11 EDTIVE
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_INVALIE	_ACCDEC_VALU	ES' represe	nts raw value '301'

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



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 );

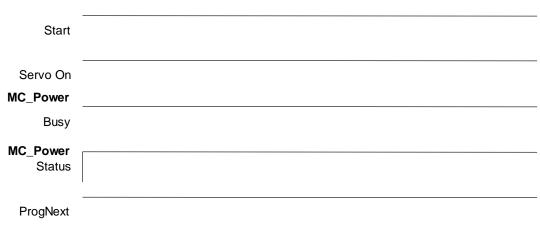
## 7.8.2.3 Control on Instruction Errors

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.

### • Timing Diagram



## • LD Language

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

1	Start ()	ServoOn
2	MC_Power_0 MC_Power_0 MC_Power_0 MC_Power_0 MC_MoveVelocity_0 MC_MoveVelocity_0 MC_MoveVelocity_ SM_Drive_Virtual = Axis Servo0n TUUE Enable bRegulatorRealState TRUE E bRegulator0n bDriveStartRealState TRUE bDriveStart Busy TWX Busy TWX MC_MOVEVelocity_CommandAborted TWX MC_MoveVelocity_CommandAborted TWX MC_MoveVelocity_CommandAborted TWX MC_MOVEVelocity_CommandAborted TWX MC_MOVEVelocity_CommandAborted TWX MC_MOVEVelocity_CommandAborted TWX MC_MOVEVelocity_CommandAborted TWX MC_MOVEVelocity_CommandAborted TWX MC_MOVEVelocity_CommandAborted TWX MC_MOVEVelocity_CommandAborted TWX MC_MOVEVelocity_CommandAborted TWX MC_DIRECTION.positive C1 Direction	9
3	MC_Power 0.Status	ProgNext

## • ST Language

IF Start THEN ServoOn :=TRUE; ELSE ServoOn :=FALSE; END\_IF IF (MC\_Power\_0.Status=TRUE) OR (MC\_Power\_0.Busy=TRUE) THEN ProgNext :=TRUE; ELSE ProgNext :=FALSE; END\_IF //MC\_Power MC\_Power\_0( Axis:= SM\_Drive\_Virtual, Enable:= ServoOn, bRegulatorOn:= TRUE

Enable:= ServoOn, bRegulatorOn:= TRUE, bDriveStart:= TRUE, Status=> , bRegulatorRealState=> , bDriveStartRealState=> , Busy=> , Error=> , ErrorID=> );

## 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

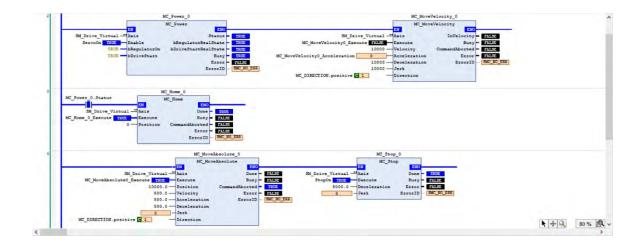
Variable	Data Type	Default	Note
SM_Drive_Virtual	AXIS_REF_SM3	-	Virtual axis variables
ServoOn	BOOL	FALSE	To enable MC_Power
MC_MoveAbsolute0_Execute	BOOL	FALSE	Execute input of MC_MoveAbsolute
MC_DIRECTION.positive	MC_Direction	-	Assigned moving direction-positive (valid for rotary axes)
StopOn	BOOL	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,
```

```
Execute:= MC_Home_0_Execu

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.

SM_Drive_ETC_Delta_ASD/	
General Setting	Homing Mode Mode 33
Homing Setting	Homing speed during search for switch 1000
ommissioning	Homing speed during search for z phase pulse 100 🖗 [ 0.1 rpm ] Homing Acceleration 100 🚯 [ ms ]
1_Drive_ETC_Delta_ASDA_A2: C Objects	Mode 33 : Depending on Z pulse in the negative direction
atus	Mode 33 : Depending on 2 pulse in the negative direction
nformation	In mode 33, The homing instruction is executed and the axis moves at the second-phase speed ( Homing spe
	during search for Z phase pulse ) in the negative direction. And the place where the axis stands is the home positi
	once the first Z pulse is met.
	Stop point Start point Negative direction
	Z pulse
	c puise

## • Main variables used in programming

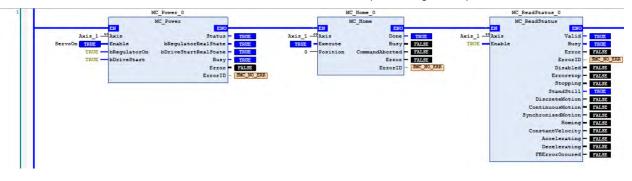
Variable	Data Type	Default	Note
Axis_1	AXIS_REF_SM3	-	Real axis variables
ServoOn	BOOL	FALSE	To enable MC_Power

## • 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_Pover_0	MC_MoveAbsolute_0
	MC_POWER	MC_MoveAbsolute
EN	ENO	EN EN
Axis_1 - Axis	Status - TRUE	Axis_1 - Axis Don
Servoon ZHUE Enable	bRegulatorRealState TRVE	MC_MoveAbsolute0_Execute Execute Bus
TRUEbRegulator	On hDriveStartRealState TROE	50000 - Position CommandAborte
TRUE - bDriveStar	t Busy - THUE	10000 Velocity Erro
	Error - FALSE	100000 Acceleration ErrorI
	ErrorID _ 3MC NO E	100000 — Deceleration
		100000000 Jerk
		MC_DIRECTION.positive 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 :

200	 	 		
. 5 100 드······		 		
	 		 	master position [u]

## CamTable2 :

Slave			•			
200	 				 	
. 9 100 드				 		
	 <b>—</b> —	 	<u></u>	 	master po	osition [u]

7

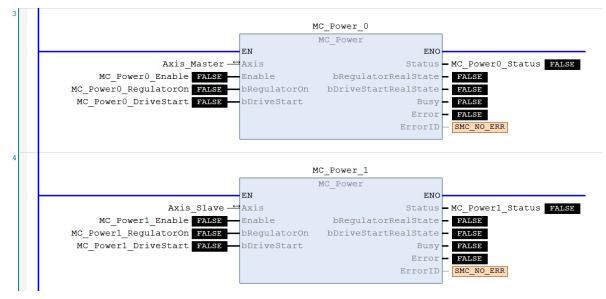
• Timing diagram

StartFlag	
MC_Power0_Status	
MC_Power1_Status	
MC_MoveAbs_Busy	_
CamTable1_En	
CamTable2_En	
MC_Camin1_InSync	
MC_Camin2_InSync	
Axis_Master. 8000 fSetPosition	
Axis_Slave. fSetPosition	

## • LD language

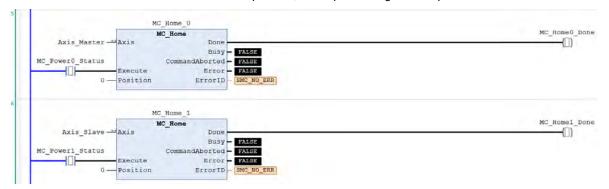
Set StartFlag to be TRUE, then the normal operation of communications for both master and slave axis would be checked respectively

	StartFlag	Axis_Master.bCommunication	MC_PowerO_Enable ([]) MC_PowerO_RegulatorOn ([]) MC_PowerO_DriveStart ([])
2	StartFlag	Axis_Slave.bCommunication	MC_Power1_Enable ([]) MC_Power1_RegulatorOn ([]) MC_Power1_DriveStart ([])

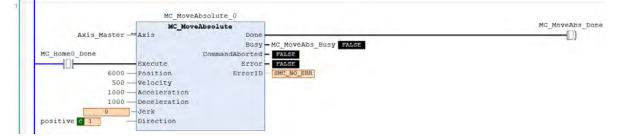


Under normal condition, Servo ON state will be set to master and slave axis.

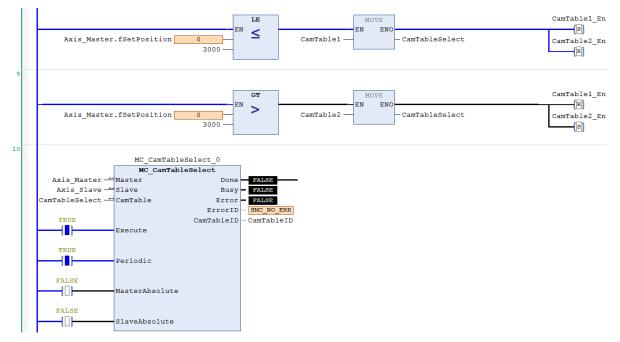
Under Servo On state and unsure of the start position, home positioning will be operated first.



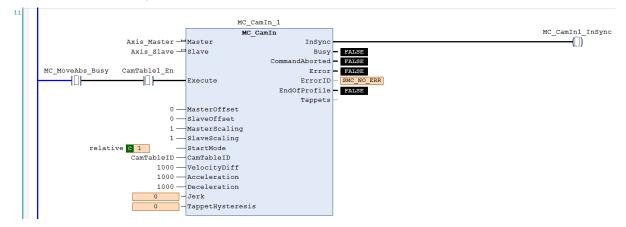
After the homing operation of master axis is completed, execute MC\_MoveAbsolute instruction.



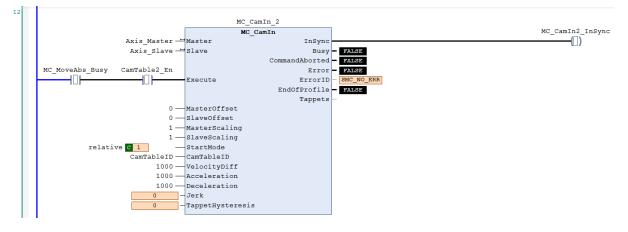
When the instruction position of master axis is below 3000, use CamTable1 (CamTable1\_En=True, CamTable2\_En=False). Conversely, when position is over 3000, use CamTable2 (CamTable1\_En=False, CamTable2\_En=True). Under both conditions, set the corresponding Cam table with MC\_CamTableSelect instruction.



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=> );

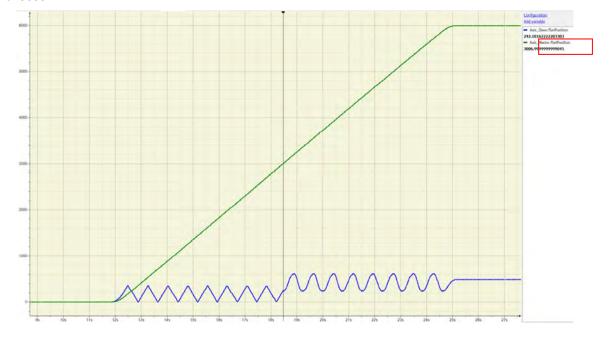
#### END\_IF

// 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.

• Main variables used in programming

Variable	Data Type	Default	Note
MC_Power0_Status	BOOL	FALSE	Status output variables of MC_Power for master, TRUE when Servo On.
MC_Power1_Status	BOOL	FALSE	Status output variables of MC_Power for slave, TRUE when Servo On.
MC_Home0_Done	BOOL	FALSE	Output Done variables of MC_Home for master, TRUE when homing completed.
MC_Home1_Done	BOOL	FALSE	Output Done variables of MC_Home for slave, TRUE when homing completed.
MC_MoveVelocity_ Velocity	LREAL	500	The target velocity for master axis to move in constant velocity motion.
MC_MoveVelocity_ InVelocity	BOOL	FALSE	The InVelocity output variables of MC_MoveVelocity, TRUE when the target velocity is reached.
CamTableID	MC_CAM_ID	-	The internal data structure of the selectedCam table, which is from MC_CamTableSelect and used as input of MC_CamIn.
MC_CamIn1_InSync	BOOL	FALSE	Output InSync variables of CamTable1, TRUE when master and slave axis are synchronized with cam.
PhasingActive	BOOL	FALSE	If the variable is TRUE and Cam is InSync, MC_Phasing will starts to be executed.
MC_Phasing_PhaseShift	LREAL	500	Specify the phaseshift values for the master and slave axis.
MC_Phasing_Velocity	LREAL	300	Specify the relative velocity for phasing operating between the master and slave axis.
MC_Phasing_Done	BOOL	FALSE	The Done output variables of MC_Phasing. TRUE when phase offset is completed.

CamTable :

700	s a					0					
500	Ū.							   <u>-</u>			
	sitic	 	 	 	 		 	 	 		
300	э с	 									
100		 	 	 	 		 	 	 m	aster positi	ion [u]

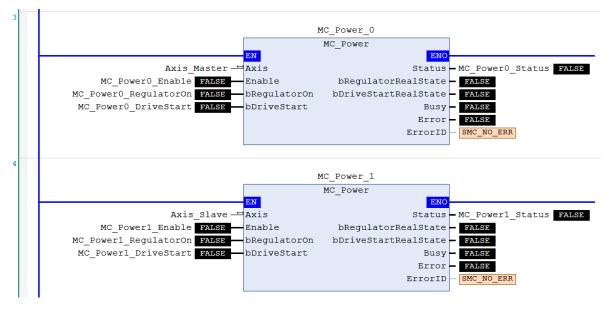
## • Timing diagram

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

## • LD language

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





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

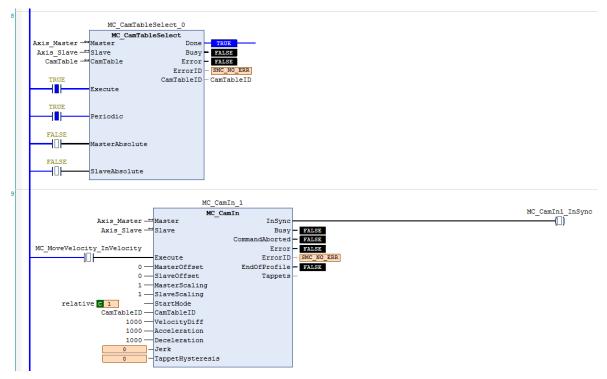
Under Servo On state and unsure of the start position, home positioning will be operated first.

MC_Home	MC_Home0_Don
Axis Master - Axis Done	(0)
Busy - FALSE	
MC_Power0_Status CommandAborted - FALSE	
Execute Error FALSE	
0 - Position ErrorID SMC_NO_ERR	
MC_Home_1	
MC_Home	MC_Home1_Don
	MC_Home1_Don
Axis_Slave - Axis Done Busy - EAASE	MC_Home1_Don ([])
Axis_Slave Axis Done	MC_Home1_Don ([])
Axis_Slave - Axis Done Busy - EAASE	MC_Homel_Don ([])

	MC_MoveVelocity		MC_MoveVelocity_InVelocity
Axis_Mast	r Axis InVelocity		
	Busy	- FALSE	
MC_Home0_Done	CommandAborted	1 - FALSE	
	Execute Error	PALSE	
MC_MoveVelocity_Velocity 500		- 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.

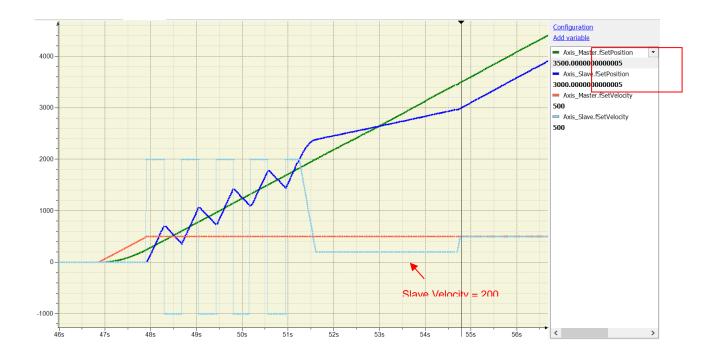
After the master axis reaches the target velocity, execute MC\_CamIn with the Cam table specified by MC\_CamTableSelect.



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_Phasin
Axis_Maste	r-Master Done	(8)
Axis_Slav	Busy - FALSE	
	CommandAborted - PALSE	
PhasingActive MC_CamIn1_InSyn	Error - FALSE	
	Execute ErrorID SMC_NO_ERR	
1-1		
MC_Phasing_PhaseShift 500	PhaseShift	
MC_Phasing_Velocity 300	Velocity	
MC Phasing Acc 5E+03	Acceleration	
MC Phasing Dec 5E+03	Deceleration	
	Jerk	

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=> , ErrorlD=> );

## 7.8.2.9 Change Current Position in Movement

Change the current position of axis to the target position in the coordinate system with the feedback of the current position. The interacting effects between MC\_MoveRelative and MC\_SetPosition are explained in the below example. The following example supports with LD and ST programming languages.

Variable	Data Type	Default	Note
Axis_Virtual	AXIS_REF_ VIRTUAL_ SM3	-	Associate variables of axis.
StartFlag	BOOL	FALSE	If this variable is TRUE and the communication with axes is normal, Servo ON will be activated and continue on further actions.
MC_Power0_Status	BOOL	FALSE	Status output variables of MC_Power for master, TRUE when Servo On.
MC_Home0_Done	BOOL	FALSE	Output Done variables of MC_Home for master, TRUE when homing completed.
MC_MoveRel_Distance	LREAL	8000	The target relative positions of MC_MoveRelative.
MC_MoveRel_Done	BOOL	FALSE	The output Done variables of MC_MoveRelative. TRUE when the relative positioning is completed.
MC_MoveRel_Busy	BOOL	FALSE	The output Busy variables of MC_MoveRelative TRUE when the instruction is triggered and executed.
MC_SetPosition_Execute	BOOL	FALSE	If TRUE, MC_SetPosition starts to be executed.
MC_SetPosition_Position	LREAL	3000	The absolute position and relative distance changed by MC_SetPosition.
MC_SetPosition_Mode	BOOL	TRUE	MC_SetPosition is to set the axis position to be absolute position or relative position.
MC_SetPosition_Done	BOOL	FALSE	The output Done variables of MC_SetPosition TRUE when the position is changed.

#### Main variables used in programming

## • Timing diagram

StartFlag	
MC_Power0_Status	
MC_Hone0_Done	
MC_MoveRel_Done	
MC_MoveRel_Busy	
MC_SetPosition_Execute	
MC_SetPosition_Done	
11000	 _
fSetPosition 4000	

# • LD language

Set StartFlag to be TRUE, then the normal operation of communication for axis would be checked.

1			
	StartFlag	Axis_Virtual.bCommunication	MC_Power0_Enable
		i di la constante di la consta	
			MC_Power0_RegulatorOn
			MC_Power0_DriveStart
			( <b>I</b> )

## Under normal condition, set the axis to be in state Servo On.

2			
		MC_Power_0	
		MC_Power	MC_Power0_Status
	Axis_Virtual 🖛	Axis Status	(I)
		bRegulatorRealState	- TRUE
	MC_Power0_Enable	bDriveStartRealState	TRUE
		Enable Busy	TRUE
		Error	FALSE
	MC_Power0_RegulatorOn	ErrorID	SMC_NO_ERR
		bRegulatorOn	
	MC_Power0_DriveStart		
		bDriveStart	

Under Servo On state and unsure of the start position, home positioning operation will be required.

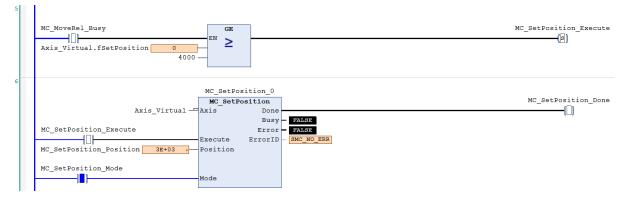


After the homing operation of axis is completed, execute MC\_MoveRelative.

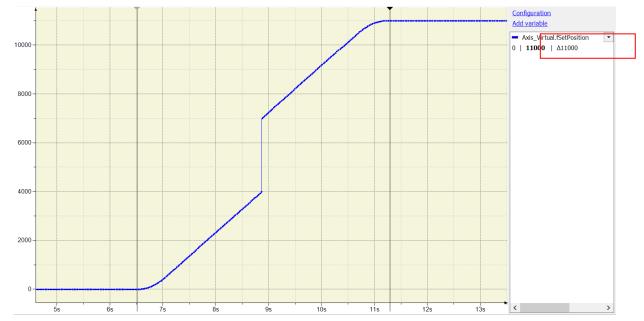
The	target	position	of	relative	dist	placement =	= 8000

4			
		MC_MoveRelative_0	
		MC_MoveRelative	MC_MoveRel_Done
	Axis_Virtual —	Axis Done	(1)
		Busy	MC_MoveRel_Busy SALSE
	MC_Home0_Done	CommandAborted	FALSE
	[]]	Execute Error	FALSE
	MC_MoveRel_Distance 8E+03 >	Distance ErrorID	- SMC_NO_ERR
	MC_MoveRel_Velocity 2E+03 .	Velocity	
	MC_MoveRel_Acc 4E+03	Acceleration	
	MC_MoveRel_Dec 4E+03 .	Deceleration	
	0 -	Jerk	

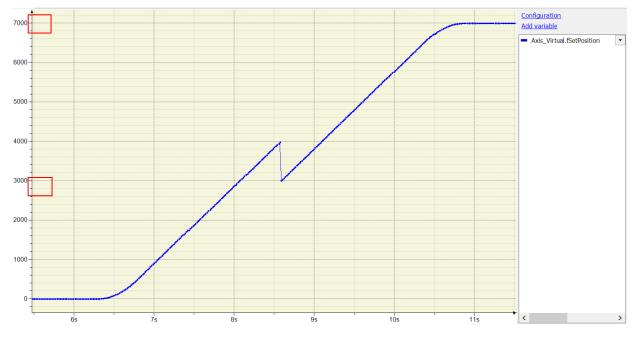
When the current position of axis passes 4000, execute MC\_SetPosition (Mode = Relative  $\cdot$  Distance = 3000) so as to change the current position to be the assigned target position.



Start a relative positioning procedure based on the current set position in coordinate system according to the above settings, which the position would finally reach 11000 (11000 = 4000 + 3000 + (8000 - 4000)) without influencing the displacement of motion body controlled by MC\_MoveRelative. The displacement is 8000 (8000 = (4000 - 0) + (11000 - 7000)) same as the original setting.



The difference between the above and the picture below is that the mode of MC\_SetPoition is changed to Absolute (Position = 3000). The actual position is set to the parameterized absolute target Position value, and the position would finally reach 7000 (7000 = 3000+(8000 - 4000)) without influencing the displacement of motion body controlled by MC\_MoveRelative. The displacement would be 8000 (8000=(4000 - 0)+(7000 - 3000))same as the original setting.



### ST language

Set StartFlag to be TRUE, then the normal operation of communication for axis would be checked.

```
IF StartFlag = TRUE THEN
```

```
IF Axis_Virtual.bCommunication = TRUE THEN
MC_Power0_Enable := TRUE;
```

```
MC_Power0_RegulatorOn := TRUE;
```

```
MC_Power0_DriveStart := TRUE;
```

END\_IF

END\_IF

// Under normal condition, set the axis to be in state Servo On.

```
MC_Power_0(
    Axis:= Axis_Virtual,
    Enable:= MC_Power0_Enable,
    bRegulatorOn:= MC_Power0_RegulatorOn,
    bDriveStart:= MC_Power0_DriveStart,
    Status=> MC_Power0_Status,
    bRegulatorRealState=> ,
    bDriveStartRealState=> ,
    Busy=> ,
    Error=> ,
    ErrorlD=> );
```

//Under Servo On state and unsure of the start position, home positioning operation will be required.

```
IF MC_Power0_Status = TRUE THEN
MC_Home0_Execute := TRUE;
END_IF
```

MC\_Home\_0(

```
Axis:= Axis_Virtual,
Execute:= MC_Home0_Execute,
Position:= 0,
Done=> MC_Home0_Done,
Busy=> ,
CommandAborted=> ,
Error=> ,
ErrorID=> );
```

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

//The target position of relative displacement = 8000

#### MC\_MoveRelative(

Axis:= Axis\_Virtual, Execute:= MC\_Home0\_Done, Distance:= MC\_MoveRel\_Distance, Velocity:= MC\_MoveRel\_Velocity, Acceleration:= MC\_MoveRel\_Acc, Deceleration:= MC\_MoveRel\_Dec, Jerk:= , Done=> MC\_MoveRel\_Done, Busy=> MC\_MoveRel\_Busy, CommandAborted=> , Error=> , ErrorID=> );

//When the current position of axis passes 4000, execute MC\_SetPosition (Mode = Relative , Distance = 3000) so as to //change the current position to be the assigned target position.

```
IF (MC_MoveRel_Busy = TRUE) AND (Axis_Virtual.fSetPosition >= 4000) THEN
MC_SetPosition_Execute := TRUE;
END_IF
```

MC\_SetPosition(

Axis:= Axis\_Virtual, Execute:= MC\_SetPosition\_Execute, Position:= MC\_SetPosition\_Position, Mode:= MC\_SetPosition\_Mode, Done=> MC\_SetPosition\_Done, Busy=> , Error=> , ErrorID=> );

## 7.8.2.10 Perform Superimposed during Gear Engagment

Perform MC\_MoveSuperImposed on the particular slave axis while the gear has been engaged in the following example. The final position of slave axis would be the displacement of gear ratio relative to master axis and plus the specific distance superimposed in motion. The following example supports with LD and ST programming languages.

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

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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

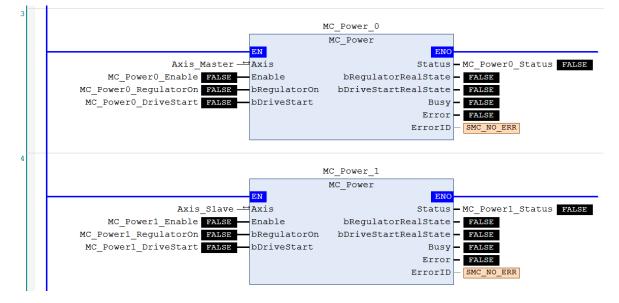
StartFlag			
MC_Power0_Status			
MC_GearIn_InGear			
MC_MoveAbs_Exceute			
MC_MoveAbs_Done			
MC_MoveSuperImPosed_Execute			
MC_MoveSuperImPosed_Done _			
3000 - Axis_Master.fSetPosition			
iooo - Axis_Master.fSetVelocity			-
7000 - Axis_Slave.fSetPosition			
Axis_Slave.fSetVelocity			
	/ I	1 <u> </u>	

## • LD language

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

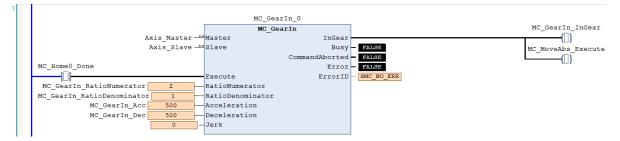
1	StartFlag Axis_Master.bCommunication	MC_Power0_Enable ([]) MC_Power0_RegulatorOn ([]) MC_Power0_DriveStart ([])
2	StartFlag Axis_Slave.bCommunication	MC_Power1_Enable

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



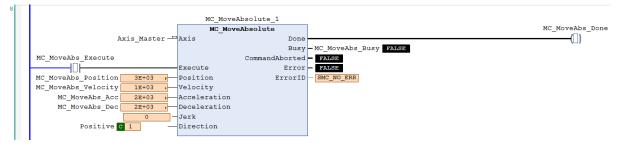
When the master and slave axis are in Servo On state and unsure of the start position, home positioning operation will be required.

MC Home	MC_Home0_Done
Axis Master Axis Done	-0)
Busy - FALSE	50.17
MC_Power0_Status CommandAborted - FALSE	
Execute Error - PALSE	
0 - Position ErrorID SMC_NO_ERR	
MC_Home_1	MC Homel Done
MC_Home	MC_Home1_Done
Axis_Slave Axis Done	MC_Home1_Done
Axis_Slave — Axis Done Busy - 12452	MC_Home1_Don
Axis_Slave Axis Done	MC_Home1_Don



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.



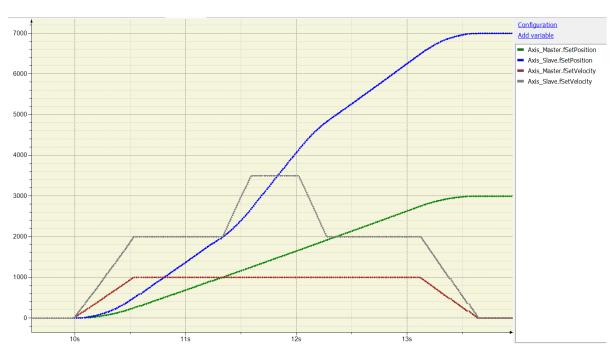
At the same time, when the slave axis moves to the preset triggering position=2000 based on the coupling relationship, MC\_MoveSuperImposed would be executed which the slave axis would move a superimposed distance of specific displacement on the original preset target position.

MC_MoveAbs_Busy CE EN >		MC_MoveSuperImposed_Execute
Axis_Slave.fSetPosition 0 2000		
	erImposed_0 perImposed	MC MoveSuperImposed Done
Axis Slave - Axis	Done	()
	Busy - FALSE	
MC_MoveSuperImposed_Execute	CommandAborted - SAMSIS	
Execute	Error - PALSE	
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		
0 Jerk		

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

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0.2	Satting up a Connection with the "lloEvport" Client	0.4
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## 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)"

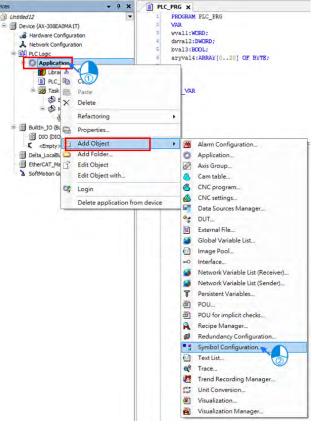
## 8.1.1 Creating a Project for OPC UA Access

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.

pression	Type	Value	Prepared value	Address	Comment	
wval1	WORD	0				
dwval2	DWORD	0				
bval3	BOOL	FALSE				
aryval4	ARRAY [020] OF B					

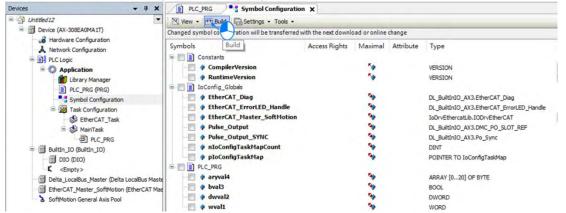
3. Go to Application -> Add Object -> Symbol Configuration to add a Symbol Configuration object.



4. Select **Support OPC UA feature** and click **Add** on the setting page of Add Symbol Configuration. After that Symbol Configuration setting page shows up automatically.

Add Symbol Configuration	×
Create a remote access symbol configurat	ion.
Name	
Symbol Configuration	
Include comments in XML	
Support OPC UA features	
Add library placeholder in Device Application (recommended, but may trigger download)	
Client Side Data Layout	
O Compatibility Layout	
Optimized Layout	
Add	Cancel

5. Click Build on the Symbol Configuration setting page. The variables are shown in a tree structure.



6. Select the variables that you want to change with an OPC UA client. Specify the access rights. After setting, click **Build** again.

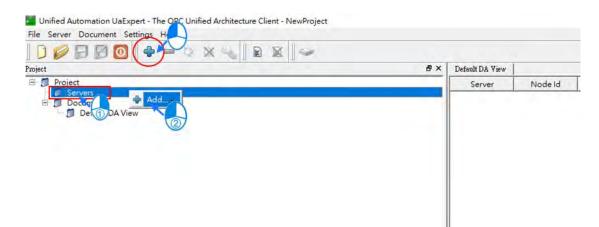
PLC_PRG Symbol Configuratio				
View - 🕮 Build 🛱 Settings - Tools -		_		
There are 6 configured variables which are not a	referenced by the I	EC code. Reading a	nd writing to them may not have the desired effect(	s). Remove
hanged symbol configuration will be transferred v	with the next downle	oad or online chang	je	
Symbols	Access Rights	Maximal Att	ibute Type	Members
Constants		and the second second		
CompilerVersion		50	VERSION	
RuntimeVersion	50	50	VERSION	
- 🔲 📄 IoConfig_Globals				
EtherCAT_Diag		-	DL_BuiltInIO_AX3.EtherCAT_Diag	
EtherCAT_ErrorLED_Handle		540	DL_BuiltInIO_AX3.EtherCAT_ErrorLED_Han	dle
- therCAT_Master_SoftMotion		<b>See</b>	IoDrvEthercatLib.IODrvEtherCAT	***
- V Pulse_Output	30	-	DL_BuiltInIO_AX3.DMC_PO_SLOT_REF	
- Pulse_Output_SYNC		-	DL_BuiltInIO_AX3.Po_Sync	
nIoConfigTaskMapCount	-	540	DINT	
→ pIoConfigTaskMap		<b>See</b>	POINTER TO IoConfigTaskMap	
PLC_PRG				
📝 🧳 aryval4	-	-	ARRAY [020] OF BYTE	
- 📝 🛷 bval3	-	540	BOOL	
- 👽 🛷 dwval2		540	DWORD	
🗸 🧳 wval1	-	-	WORD	

7. Download the project to the AX-3 Series PLC.

## 8.2 Setting up a Connection with the "UaExpert" Client

The OPC UA client "UaExpert" is freely accessible software. You can download the software here: <u>https://www.unified-automation.com/downloads/opc-ua-clients.html</u> Using this client, you can connect to the OPC UA server. The following description refers to this program. Other OPC UA clients work in a similar way. After download UAExpert, follow the following steps to set up a connection.

- (1) Double-click the UaExpert **Hara** to start the UaExpert.
- (2) Right-click **Server** and then click **Add** to open Add Server window.



(3) Go to Custom Discovery -> Double click to Add Server...> and then type in "opc.tcp://192.168.1.5" in the Enter Url dialog.

E	<ul> <li>Microsoft Terminal Services</li> <li>Microsoft Windows Networ</li> </ul>	
	Web Client Network Custom Discovery	
	Couble click to Add Server Recently Used	er >
	Enter Url	? ×
	Enter the Url of a computer with disco	very service running:
	opc.tcp://192.168.1.5	
	OK	Cancel
uth	nentication Settings	_
2	Anonymous	
	Username	
	Password	F St
	Certificate Currently not supported by	

(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.

Attentication Settings Anonymous  Attentication Settings  C Certificate Currently not supported by UnExpert	
acovery       Advanced         Local       Local Network         Microsoft Terminal Services         Opc.tcp://tsclient         Microsoft Windows Network         DELTA         Web Client Network         Opc.tcp://idelta.deltaww.com@SSL         Custom Discovery         Opc.tcp://idelta.deltaww.com@SSL         Opc.tcp://idelta.deltaww.com@SSL         Opc.tcp://idelta.deltaww.com@SSL         Opc.tcp://idelta.deltaww.com@SSL         Opc.tcp://idelta.deltaww.com@SSL         Opc.tcp://idelta.deltaww.com@SSL         Opc.tcp://idelta.deltaww.com@SSL         Opc.tcp://idelta.deltaww.com@SSL         Opc.tcp://idelta.delta.s         Opc.tcp://idelta.delta.superior         None - None         Recently Used         Unified Automation Demo Server         Authentication Settings         Anonymous         Username         Password       C	_
Local Network Microsoft Terminal Services opc.tcp://tsclient Microsoft Windows Network DELTA Web Client Network Octop://idelta.deltaww.com@SSL Custom Discovery Opc.tcp://192.168.1.5 OPCUAServer@AX-308EA0MA1T None - None Recently Used Unified Automation Demo Server Authentication Settings Anonymous Username Password	
None - None     None - None - None - None - None     None -	
Anonymous     Usemanne     Password	
Password T	
C Certificate Currently not supported by UaExpert	
	Store
Connect Automatically	Store

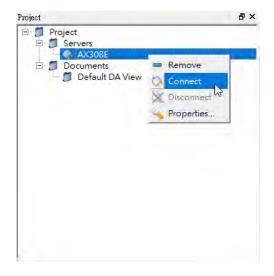
(5) If you need to edit the server properties, go back to the starting window. Expand the option **Servers** under **Project** and then right-click **AX308** to open a context menu. Click **Properties** to open the Server Settings page.

🖻 📁 Pi	roject		
	Servers		
	AX308E	P	
8.5	Documents	Remove	
	Default DA	Connect	
		X Disconnect	
	_	Properties	
	-		

(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://192.168.1.5:4840
Security Settings	
Security Policy	None
Message Security Mode	None
C Dertificate Curren	T Store
Session Settings	m:TWTY3PC1346:UnifiedAutomation:UaExpert
Session Name	part art of or

(7) Right-click AX308 to open a context menu. Click Connect to AX308E.



(8) After establishing the connection, you can change the variables in AX308E through the OPC UA client UaExpert. Select and drag the variables you'd like to modify from the left view "Address Space" to the right view "Default DA View" and then double-click the item to be modified to edit.

Project & X	C Defenit DA Yarw							0
8 🗊 Project	Server	Node Id	Display Name	Value	Datatype	Source Timestamp	Server Timestamp	Statuscode
Servers AX308E Documents Default DA View	AX308E AX308E AX308E AX308E AX308E	NS4[String]var]Delta-ARM-VW/orks_ NS4[String]var]Delta-ARM-VW/orks_ NS4[String]var]Delta-ARM-VW/orks_ NS4[String]var]Delta-ARM-VW/orks_	aryval4 bual3	(0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.	Byte Boolean Uint32 Uint16-	08:25:51:428 08:25:52:826 08:25:54:211 08:25:55:622	08:25:51.428 08:25:52.626 08:25:54.211	Good Good Good Good Good
ddmsSpec d × → Root → → Otots								
DeviceSet     DeviceSet     DeviceSet     Constants     DeviceNamual     DeviceNamual								
(a) Continue Revision     Hardware Revision     Manufacturer     Manufacturer     Rodel     Programs     Rev RVC, PKG     Rev RVC, PKG     Rev RVAI     Rev RVAI     Rev RVAI     Rev RVAI     Rev RVAI								
RevisionCounter								

## 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 Creating a Certificate for the DIADesigner-AX OPC UA Server

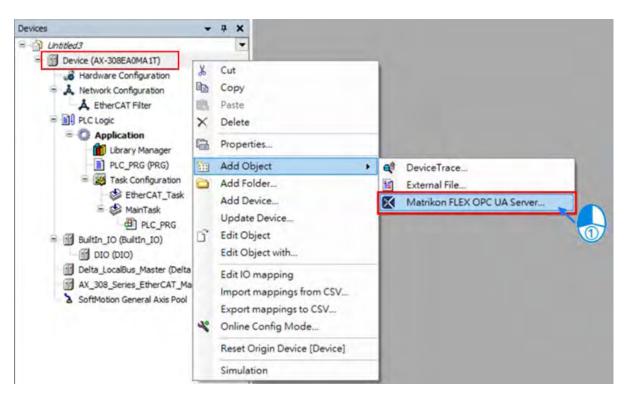
#### 8.3.1.1 Matrikon ® FLEX™ OPC UA

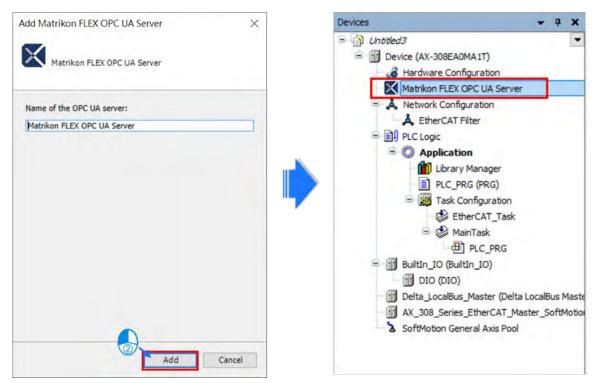
(1) Install the add-on FLE>

Matrikon ® FLEX™ OPC UA for CODESYS. After installing, you need to restart

#### DIADesigner-AX. Package Manager X Currently installed packages Sort by Name Refresh v Install. Name Version Installation date Update info License info AX-8xxEP0 Series 0.1.1.5 2020/5/26 No license required CODESYS Security Agent 1.1.0.0 2020/5/25 No license required Delta AX-308EA0MA1T Package 0.40.2.0 2020/5/25 No license required Updates Matrikon® FLEX™ OPC UA for CODESYS 1.0.0.0 2020/5/26 No license required Search Updates MotionControl\_Release\_20200518 0.5.1.0 2020/5/25 No license required **CODESYS** Store **CODESYS Store** < Display versions 🗸 Search updates in background Close

(2) Open DIADesigner-AX to create a project and then right-click AX-308EA0MA1T to bring out a context menu. Click Add Object and select Marikon FLEX OPC UA Server.... to open the setting page and add Marikon FLEX IPC US Server in.





#### (3) The setting page of Matrikon FLEX OPC UA Server

General	Communicatio	n Sattings				
Data Setup	Communicatio	an betungs				
itatus						
nformation				~	Matrikon®	FLE)
	Hostname:		Get from device	Clear Number of sessions:	1	\$
	Ethernet interface:	< Any >		Any Server cyclic rate, ms:	1	\$
	IP address:			Security policy:	Basic256 Sha256	Ý
	Port number:	4840	\$	Authentication:	Anonymous	~
	Reverse connect					

(4) Setting up the Ethernet interface by click **Browse...** Select the network you need and click **OK**.

Seneral	No. of Concession, Name					
Data Setup	Communicatio	n Settings				
Ratus					∞ Matrikon=	FLEX"
	Hostname:		Get from device	Clear Number of sessions:	1	0
	Ethernet interface:	< Any >	Browse	Server cyclic rate, ms:	100	0
	IP address:			Security policy:	Basic256 Sha256	~
	Port number: OPC UA Endpoint:	4840	•	Authentication:	Anonymous	*
	Reverse connect					
	-					
ntal 0 errorist 0 warminoist	Tmessansit					,



D Select network adapter	- 🗆 X
Name	Designer Eastern (
cpsw0	192,168.1.5
100	127.0.0.1
	OK Cancel

8-10

\_

General	Communicatio	n Settings			
Data Setup	Communicatio	n settings			
Status					
nformation			2	Matrikon*   FL	EX
				indiminent pro-	
				12	•
	Hostname:		Clear Number of sessions:	1	\$
	Ethernet interface:	cpsw0 Browse 192.168.1.5	Any Server cyclic rate, ms:	100	
	IP address:		Security policy:	Basic256 Sha256	~
	Port number:	4840 🗘	Authentication:	Anonymous	*
	OPC UA Endpoint:	opc.tcp://192.168.1.5:4840			
	Reverse connect				

(5) After that, the setting is complete. Other fields do not require changing.

(6) Download the project to the AX-3 Series PLC.

#### 8.3.1.2 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.

Communication Settings	🔷 🖙 🔜 Device user: Administrator	
Applications	Synchronized mode: All changes are immediately downloaded to the device.	
Backup and Restore	S Administrator     guest	• Add
ynchronized Files	🕷 🚆 guest	O Import
iles		2 Edit
		O Delete
og		
LC Settings		
LC Shell		
sers and Groups		
ccess Rights	Groups	
ymbol Rights	Refoups	• Add
untime Clock Configuration	Sei derived from 'Developer'     Sei derived from 'Developer'     Ausurer member 'Administrator'	O Import
ystem Parameters	🔿 😫 Developer	edit
ask Deployment	Service Servi	© Delete
tatus	Service     Watch	
nformation		

## 8.3.2 Creating a Certificate for the DIADesigner-AX OPC UA Client

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: https://store.codesys.com/matrikonflex-opc-ua-editor.html? SID=U

### 8.3.2.1 CODESYS Security Agent

- (1) Install the add-on **CODESYS Security Agent**. After installing, you need to restart DIADesigner-AX. Package Manage Currently installed packages Sort by Name Refresh ~ Install... Update info Name Version Installation date License info AX-8xxEP0 Series 1.0.0.0 No license required 2019/12/2 CODESYS Security Agent 1.1.0.0 2019/12/11 No license required CODESYS SoftMotio 4.6.0.0 2019/12/11 No license required Updates Delta\_ASD\_A2\_M\_Package 1.0.0.2 2019/12/2 License info not available Search Updates Delta\_AX-308EA0MA1T\_Package 0.30.0.9 2019/12/11 No license required Delta VFD C2000 Package 1.0.0.1 2019/12/2 License info not available Delta\_VFD\_MH300\_Package License info not available 1.0.0.0 2019/12/2 Delta\_VFD\_MS300\_Package 1.0.0.2 2019/12/2 License info not available CODESYS Store CODESYS Store Close Display versions 🔽 Search updates in background
- (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.



- Security Screen X + User φ 12 Information Information Issued for issued by Valid from Valid un 创 Click the 'Refresh' button to load the data. X Project 创 Devices
- (3) Select the **Devices** tab.

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

User	Φ	Information	1.2	Information	Issued for	k
	19	= Device	×	OPC UA Server (not available)		
Project		Own Certificates	[and	Encrypted Application (not available)		
Devices		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		Information	Issued for	ls
	- 例	E 🗊 Device	X	OPC UA Server (not available)		
Project		Own Certificates		Encrypted Application (not available	e)	
Devices		Trusted Certificates	创	Encrypted Communication	AX-308EA0MA1T	A
Devices		Unstrusted Certificates		💱 Web Server	AX-308EA0MA1T	A
		Quarantined Certificates				
		` •	•			
	Γ	Certificate Settings	•	×		
		Certificate Settings Key length (bit)	3072	×		
			3072			

8-13

(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	0	Information		Information	Issued for
Project	包	Device  Own Certificates		OPC UA Server	OPCUAServer@AX-308
		Trusted Certificates	创	Encrypted Application (not available)	AX-308EA0MA1T
Devices		Unstrusted Certificates		Web Server	AX-308EA0MA1T
		Quarantined Certificates			
			•		
		tificate Settings		×	
		tificate Settings y length (bit)	3072	×	

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

Security Screen	×								
User	0	Information	12	Information	Issued for	Issued by	Valid from	Valid until	Thumbprint
	49	= Device	×	OPC UA Server	OPQUAServer@AX-308EA0MA1T	OPCUAServer@AX-308EA0MA1T	1970/1/2 上千 08:48:15	1971/1/2 上午 08:48:15	5C3F2C0888EC97E0286210688A738
Project	1000	Com Certificates	21	R Encrypted Application	AX-SOSEA0MA 1T	AX-308EA0MA1T	1970/1/2 上午 08:48:55	1971/1/2 上午 08:48:55	53882A26088664F4484EDEA91389A
Devices		Trusted Certificates		Encrypted Communication	AX-208EA0MA1T	AX-308EA0MA 1T	1970/1/1 上午 08:00:13	1970/1/31 上平 08:00:13	508368D9F81A7C5D89816707CE675
Venices		Unstrusted Certificates		Web Server	AX-308EA0MAIT	AX+308EA0MA1T	1970/1/1上年 08:00:13	1970/1/31上年 03:00:13	508368D9F81A7C5D89836707CE675
		Quarantined Certificates							

#### 8.3.2.2 Setting up an Encrypted Connection with the "Prosys OPC UA Client"

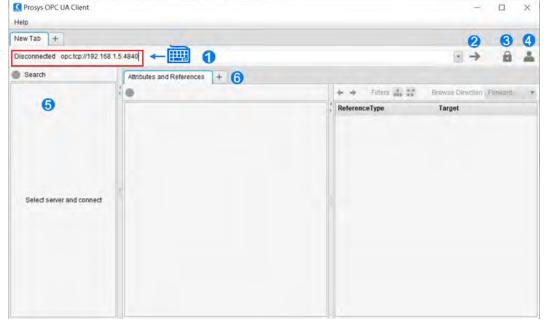
The OPC UA client "Prosys OPC UA Client" is freely accessible software. You can download the software here: https://downloads.prosysopc.com/opc-ua-client-downloads.php

Using this client, you can connect to the OPC UA server. The following description refers to this program. 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.



(3) Click 🔒 as shown in (3) to open the Security Settings window. Only the connection type Basic256SHA256 is

supported. Select "Show only modes that are supported by the server". Click OK.

Security Mode	Security Policy	
None	None	OK
) Sign	Basic128RSA15	
Sign & Encrypt	Basic256	Cancel
internation of the second second	Basic256SHA256	

(4) Click as shown in ④ to open the User Authentication setting window. Set up the username and password and click **Apply** to apply the settings.

Anonymous 💿	Username and Passv	vord 🔘 Certificate	and Private Key	Apply	Cance
Username	Administrator	Password	****		1

(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.

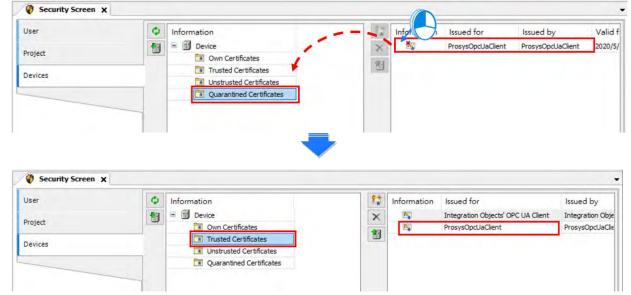


(8) Go back to DIADesigner-AX. Click **View** on the toolbar and then click the option **Security Screen** to open the setting page. Select the **Devices** tab.

User	\$	Information	T.	Information	Issued for	ls
	相	E Device	×	OPC UA Server (not available)		
Project	-	Own Certificates	-101	Encrypted Application (not available)		
Devices		Trusted Certificates	图	Encrypted Communication	AX-308EA0MA1T	A
Devices		Unstrusted Certificates		💱 Web Server	AX-308EA0MA1T	A.
		Quarantined Certificates				

(9) 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.



(10) Go back to ProsysOpcUaClient. Click is as shown in (2) to connect to the AX-3 Series PLC as an Administrator.

S Prosys OPC UA Client				- 🗆 X
OPCUAServer@AX-30	08EA0MA1T +			
Running opc.tcp.//192.1	68 1 5 4840 um AX-308EA0MA1T Del	ta%20Electronics%2C%20Inc_AX	-308EA0MA1T.OPCUA.Server	🔹 🗙 🔒 🏯 Administrato
Search	Attributes and References	+		
Objects	0		+ + Filters 🔝 💱	Browse Direction Forward
Types Views	Attribute	Value	ReferenceType	Target
VIEWS	► Nodeld	i=85	Organizes	DeviceSet
	NodeClass	Object	Organizes	Server
	BrowseName	Objects	HasTypeDefinition	FolderType
	DisplayName	(en-Us) Objects		
	Description			
	WriteMask	NONE (0)		
	UserWriteMask	NONE (0)		
	EventNotifier	0		

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

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

OPCUAServer@AX-308EA0N	IA1T	+									
Running opc.tcp://192.168.1.5	4840	- um AX-308EA	0MA1T:Delta%2	OElectron	ics%2C%20	Dinc AX-308EA0	MA1T:C	PCUA Server		× 🗎	🍰 gue
9 Search	11	Attributes and F	References [	Data View	× +						
Objects     Objects     Objects     AX-308EA0MA1T		Subscription En	abled V P	ublishing	Interval (in r	milliseconds)		1,000 *	Subscrip	tion Settings	
		# Nodeld	DisplayName	Value	DataType	SourceTime	stam	ServerTimestam	StatusCod	e MonitoringMo.	Graph
V Resources		0 ns=4;s=[	aaa	false	Boolean	29.05.2020 0	1.29:	29.05.2020 01:29:	GOOD (0x.	Reporting	
1.0		1 ns=4;s=	bbb	false	Boolean	29.05.2020 01	1:29:	29.05.2020 01:29:	GOOD (0x.	Reporting	
III Destantion	<u>نا ان</u>	2 ns=4:s=1	000	false	Boolean	29.05.2020.01	1:29:	29.05.2020 01:29	GOOD (0x	Reporting	
Error										>	ς
Write fa	iled: 6	rror=ServiceFa	ult Bad_UserAc	cessDen	ied (0x801F	0000) "User doe	es not h	ave permission to per	form the requ	uested operation."	
Diagno	stic In	fo:									

МЕМО



# **Chapter 9 Communication**

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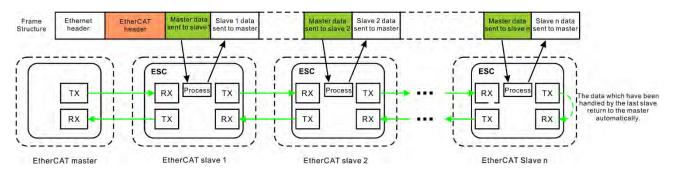
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## 9.1 Introduction to EtherCAT Communication

## 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.

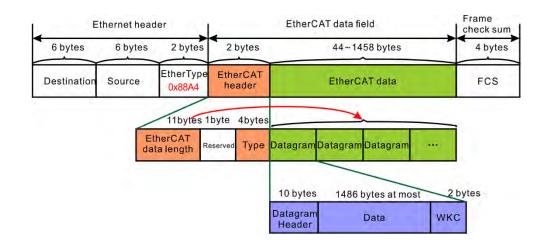
Thanks to the ESC chips in slaves, the master can make a communication with all slaves in an EtherCAT data frame and thus the communication efficiency is enhanced.



#### 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 Autoconfig	Master/Slave	s		Ether CAT.
Sync Unit Assignment	2 EtherCAT NIC S	Setting			
Log	Destination ad	ddress(MAC)	FF-FF-FF-FF-FF	Broadcast	Enable redundancy
EtherCAT I/O Mapping	Source addres		00-00-00-00-00-00	Browse	
EtherCAT IEC Objects	) Select netv	e vork by MAC	Select netwo	ork by name	
Status	3 Distributed C	lock —	(2	Options	
Information	Cycle time	2000	÷ μs	Use LRW inst	ead of LWR/LRD
	Sync offset	50	* %	Enable messa	
	Sync window	w monitoring		Automatic res	tartslaves
	Sync window	+	÷ μs		

#### 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)	E 0 exception(s)	0 information(s)	0 debug message(s)	I I I
Sync Unit Assignment	UTC time					
	Severity Tim	e Stamp	Descri	ption		
Log						
EtherCAT I/O Mapping						
EtherCAT IEC Objects						
Status						
Information						

#### • EtherCAT I/O Mappting

Here you can select the bus cycle task for EtherCAT communication. The bus cycle task selected will be synchronized with the specified EtherCAT\_Master cycle time.

Bus cycle task: Select a bus cycle task to synchronize with the EtherCAT communication time. When the option "Use parent bus cycle setting is selected", the system use the shortest cycle time as the EtherCAT cycle time.

Bus cycle task	
	EtherCAT_Task ~
	Use parent bus cycle setting
	EtherCAT_Task MainTask
	Plaintask

## 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			Additio	onal -		
Process Data	AutoInc address	0 1001	4 7	_	nable e	xpert settings	Ether <b>CAT</b>
Startup Parameters	Distributed Clock						
EtherCAT I/O Mapping	2 Select DC	Free Run				~	
EtherCAT IEC Objects	Enable	2000	Sync un	it cycle (µs)			
Status	Sync0:						
Information	🔘 Sync unit cycle	1	-		-	Cycle time (µs	5)
	🔘 User-defined			0	*	Shift time (µs	)
	Sync1:				_		
	Enable Sync 1						
	🔘 Sync unit cycle		-		*	Cycle time (µs	;)
	O User-defined			0	*	Shift time (µs)	)

#### General

#### Address

 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.

#### 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			1.1	Select the Inputs			
	Name	Туре	Index	^	Name	Туре	Index	^
Process Data	16#1600 1st RxPDO Mapping	(exclu			16#1A00 1st TxPDO Mapping	(e		- 1
2	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 Mapping	Target Velocity	DINT	16#60FF:00		Velocity actual value	DINT	16#606C:00	
cherch'i fo happing	Touch Probe Function	UINT	16#60B8:00		Touch Probe Status	UINT	16#60B9:00	
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	g (exclu			Actual Torque	INT	16#6077:00	
	Control Word	UINT	16#6040:00		Touch Probe Status	UINT	16#60B9:00	
	Target Position	DINT	16#607A:00		Touch Probe Pos1 Pos Value	DINT	16#60BA:00	
	Target Velocity	DINT	16#60FF:00		Digitalinputs	UDINT	16#60FD:00	
	Target Torque	INT	16#6071:00		16#1A02 3rd TxPDO Mapping	(e		
	Mode Of Operation	SINT	16#6060:00		Status Word	UINT	16#6041:00	
	Touch Probe Function	UINT	16#60B8:00		Actual Position	DINT	16#6064:00	
	16#1603 4th RxPDO Mapping	) (exclu			Velocity actual value	DINT	16#606C:00	
	Control Word	UINT	16#6040:00		Actual Torque	INT	16#6077:00	
	Target Position	DINT	16#607A:00		Mode Of Operation Display	SINT	16#6061:00	
	Target Velocity	DINT	16#60FF:00		Touch Probe Status	UINT	16#60B9:00	
	Target Torque	INT	16#6071:00		Touch Probe Pos1 Pos Value	DINT	16#60BA:00	
	Mode Of Operation	SINT	16#6060:00		Digitalinputs	UDINT	16#60FD:00	
	Positivetorquelimit	UINT	16#60E0:00		16#1A03 4th TxPDO Mapping	(e		
	Nantivatornualimit	LITNIT	15=6051-00	¥	Statue Mard	LITAIT	16#6041-00	1

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.

<b>Funciton Button</b>	Description
Add	By specifying new index/subindex entries, a new object can be added to the SDO that is not yet described in the EDS file. This is useful if only an incomplete object directory or none at all is present.
Edit	In this window you can change the parameters of the SDO before the SDO is added to the configuration.
Move Up	Moves the selected line upwards by one line
Move Down	Moves the selected line downwards by one line

General	-P Add	e cuit A Delete	Move Up 🔮 Move Down						_
Process Data	Line	Index:Subindex	Name	Value	Bit Length	Abort on Error	Jump to Line on Error	Next Line	Commen
nocess bata	- 1	16#0000:16#00	16#0000:16#00	0	8			0	
Startup Parameters	- 2	16#6060:16#00	Op mode	8	8			0	Op mode
	- 3	16#2119:16#00	DRV's Parameter P1-25	0	16			0	
EtherCAT I/O Mapping	- 4	16#1603:16#00	4th Receive PDO Mapping	0	8			0	
	- 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	Interpolati
Status	8	16#6098:16#00	Homing method	35	32			0	
Information	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.

SubIndex: 16#	0	Value	0		-	-	Cancel
Index: 16#	2001	Bit length	16		-		ОК 💌
Name	DRV's Parameter P0-01						
16#2012:16#0	0 DRV's Parameter F	0-18	RW	UINT			Y
16#2011:16#0	0 DRV's Parameter F	0-17	RW	UINT			
16#2007:16#0	0 DRV's Parameter F	0-07	RW	UDINT			
16#2006:16#0		0-06	RW	UDINT			
16#2005:16#0	0 DRV's Parameter F	0-05	RW	UDINT			
16#2004:16#0	0 DRV's Parameter P	0-04	RW	UDINT			
16#2003:16#0	0 DRV's Parameter F	0-03	RW	UINT			
16#2002:16#0			RW	UINT			
16#2001:16#0			RW	UINT			
- 16#1C33:16#0	0 SM input paramete	r				100	
16#1C32:16#0	0 SM output paramet	ter					
16#1C13:16#0	0 TxPDO assign						
16#1C12:16#0	0 RxPDO assign						
16#1A03:16#0	0 4th Transmit PDO N	Mapping					
16#1A02:16#0		Mapping					
16#1A01:16#0	0 2nd Transmit PDO	Mapping					
ndex:Subindex	Name		Flags	Туре	Default		^

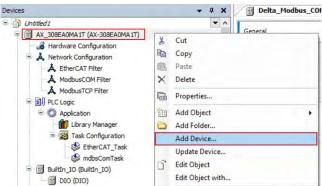
## 9.2 Introduction to Modbus Serial Communication

## 9.2.1 Modbus Serial Port

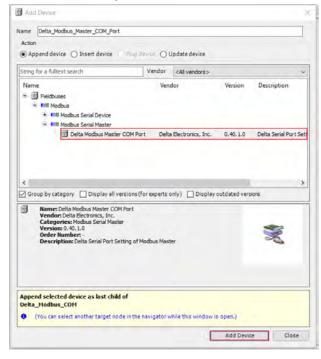
DIADesigner-AX supports the following Modbus network types, including one RS-232 and one RS-485. Each Modbus Serial Port allows one master. A maximum of 32 slaves can be attached to a master. But since RS-232 has no multipoint capability, only point-to-point connection is possible. And only the FIRST 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.

evices - 4 X	Delta_Modbus_COM X			
	General Status Information	- Serial Port Configuration COM Port Baudrate Parity Data Bits Stop Bits Transmission Mode	RS-232       >         9600       >         Even       >         7       >         1       >         O RTU       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.

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

Item	Description
COM Port	Communication interface: RS-232/RS-485
Baudrate         The communications speed in bits per second (bps): 9600/19200/38400/57600/115200	
Parity	None/Odd/Event
Data Bits	7/8 (when the transmission mode is RTU, you need to set the data bits to 8)
Stop Bits	1 bit/2bits
Transmission Mode	RTU/ASCII

#### Status

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

Delta_Modbus_COM X		
General	ModbusSerial :	Running
Status	1	
Information		

ltem	Description
Modbus Serial	The status of Modbus Serial Communication

#### Information

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

Delta_Modbus_COM X	
General	General
	Name: Delta Modbus COM
Status	Vendor: Delta Electronics, Inc.
	Categories: Modbus Serial Port
Information	Type: 40001
	ID: 16F7 8702
	Version: 0.30.1.0
	Order Number: -
	<b>Description:</b> Delta serial port of Modbus

## 9.2.2 Modbus Serial Master

AX-3 Series PLC can act as a Modbus Serial Master, after you have created Modbus Master COM port and Modbus Slave COM port. Follow the below section to set up the Modbus Serial Master.

#### 9.2.2.1 Adding Delta Modbus Master/Slave COM

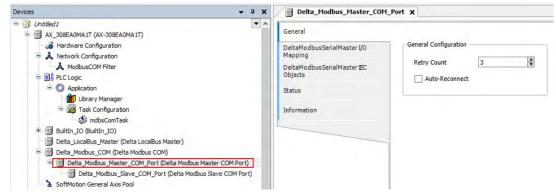
1. Right-click the created Delta\_Modbus\_COM (Delta Modbus COM) in the tree view to open up a conext menu. And click **Add Device...**to open the Add Device setting window.

Devices	- 4	×
Untitled I  AX_308EA0MAIT (AX-308EA0MAIT)  Hardware Configuration  Ketwork Configuration  K	•	×
Delta_LocalBus_Master (Delta LocalBus Mas     AX_308_Series_EtherCAT_Master_SoftMoti     Ethernet (Ethernet)		
Delta_Modbus_COM (Delta Modbus COM)		
SoftMotion General Axis Pool	*	Cut
- AX_308EA0MA1T_1 (AX-308EA0MA1T)		Сору
AX_308EA0MA1T_2 (AX-308EA0MA1T)	E.	Paste
Hardware Configuration	×	Delete
<ul> <li>A Network Configuration</li> <li>A EtherCAT Filter</li> </ul>	6	Properties
A ModbusCOM Filter		A LLOUS A
	1000	Add Object
		Add Folder
= Application		
Application     Ibrary Manager		Add Device
Application     Ibrary Manager     E Wask Configuration		Add Device Insert Device

 Find and double-click Delta Modbus Master COM Port (Fieldbuses -> Modbus -> Modbus Serial Master -> Delta Modbus Master COM Port) or click Add Device to add this port in. You can only add one Master COM Port. After you added one master, the other added devices are slave ports: Delta\_Modbus\_Master\_COM\_Port, the Delta\_Modbus\_Slave\_COM\_Port.

Action				
Action				
Append device	Plug device	O Update device		
String for a fulltext search	Vend	or <all vendors=""></all>		~
Name =- 🚮 Fieldbuses		Vendor	Version	Description
Modbus     Modbus Serial Device     Modbus Serial Master				
Delta Modbus Master	COM Port I	Delta Electronics, Inc.	0.40.1.0	Delta Serial Port Ser
<ul> <li></li> <li>✓ Group by category ☐ Display all ve</li> <li>✓ Name: Delta Modbus Master COM</li> </ul>		erts only) 🗌 Display	outdated vers	sions
Group by category Display all ve Name: Delta Modbus Master COM Vendor: Delta Electronics, Inc. Categories: Modbus Serial Maste Version: 0.40.1.0	Port	erts only) 🗌 Display	outdated vers	sions
Group by category Display all ve Name: Delta Modbus Master COM Vendor: Delta Electronics, Inc. Categories: Modbus Serial Maste	l Port		outdated vers	sions
Group by category Display all ve Name: Delta Modbus Master COM Vendor: Delta Electronics, Inc. Categories: Modbus Serial Maste Version: 0.40.1.0 Order Number: -	i Port r tting of Modbus I		outdated vers	sions
Group by category Display all ve Name: Delta Modbus Master COM Vendor: Delta Electronics, Inc. Categories: Modbus Serial Maste Version: 0.40.1.0 Order Number: -	l Port		outdated vers	sions

3. Find the added port **Delta\_Modbus\_Master\_COM\_Port (Delta Modbus Master COM Port)** in the tree view and double-click it to open the setting window to set up.



#### 9.2.2.2 Setting up Delta Modbus Master COM

#### General

Here you can configure the basic settings for Modbus Serial Master.

General	
DeltaModbusSerialMaster I/O Mapping	General Configuration
DeltaModbusSerialMaster IEC Objects	Retry Count 3
Status	
Information	

ltem	Description
Retry Count	Set up the number of times for the COM port to reconnect if the connection is lost.
Auto-Reconnect	Enable this option to have this port to reconnect automatically if an error occurs or commection timeout occurs.

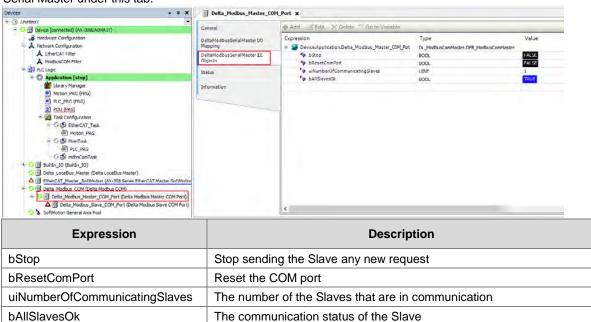
#### Delta Modbus Serial Master I/O Mapping

Bus cycle task: Select a bus cycle task to synchronize with the Modbus communication time. When the option "Use parent bus cycle setting is selected", the system use the shortest cycle time as the bus cycle time. Refer to section 4.2.1.6 PLC Settings for more information.

General	Bus Cycle Options		
	Bus cycle task	mdbsComTask 🗸 🗸	
DeltaModbusSerialMaster I/O Mapping		Use parent bus cycle setting mdbsComTask	
DeltaModbusSerialMaster IEC Objects			
Status			
Information			

#### Delta Modbus Serial Master IEC Objects

Here is the correspondings of the DFB\_ModbusCOMMaster function block. You can check the status of Modbus Serial Master under this tab.



#### Status

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

General	DeltaModbusSerialMaster	nl/a
DeltaModbusSerialMaster I/O Mapping	1	
DeltaModbusSerialMaster IEC Objects		
Status		
Information		

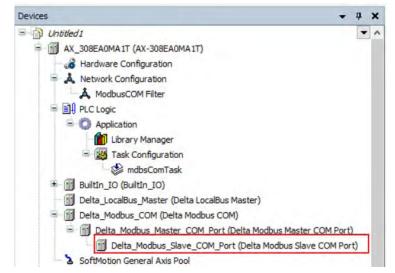
#### Information

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

General	General
DeltaModbusSerialMaster I/O	Name: Delta Modbus Master COM Port Vendor: Delta Electronics, Inc.
Mapping	Categories: Modbus Serial Master
DeltaModbusSerialMaster IEC	Type: 40001 ID: 16F7 8705
Objects	Version: 0.40.1.0 Order Number: -
Status	Description: Delta Serial Port Setting of Modbus 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
Moddus Slave Init	Device Type	Standard Modbus Devices v
DeltaModbusSerialSlave I/O Mapping		
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.

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### Modbus Slave Channel

Here you can define slave channels. Each channel represents a single Modbus request. You can create up to 10 channels for each slave. AX-3 Series PLC will send out Modbus request packets in chronological order. All channels share the same Modbus connection.

General	0	~	Name Channel 0	Access Type Read Coils	Trigger Cyclic, 100ms	READ Offset 0x0	Length 1	Error Handling Keep last Value
Modbus Slave Channel	1	~	Channel 1	Read Coils	Cyclic, 100ms	0x0	1	Keep last Value
	2		Channel 2	Read Coils	Cyclic, 100ms	0x0	1	Keep last Value
Modbus Slave Init	3	~	Channel 3	Read Coils	Cyclic, 100ms	0x0	1	Keep last Value
DeltaModbusSerialSlave I/0	4		Channel 4	Read Coils	Cyclic, 100ms	0x0	1	Keep last Value
Mapping	5		Channel 6	Read Coils	Cyclic, 100ms	X Coil 0x0	1	Keep last Value
DeltaModbusSerialSlave IEC	6		Channel 7	Read Coils	Cyclic, 100ms	0x0	1	Keep last Value
Objects	7		Channel 8	Read Coils	Cyclic, 100ms	0x0	1	Keep last Value
Status	8		Channel 9	Read Coils	Cyclic, 100ms	X Coil 0x0	1	Keep last Value
Information								
	4							
		Move	11	fove Down		Add Channel	Delete	Edit

Click Add Channel, you can edit the channel before adding it in. The **Device Address** shows the Modbus protocol address whether the device type you selected is **Standard Modbus Device** or **Delta Devices** under the **General** tap. Since the system converts the protocol used into Modbus protocol automatically, you do NOT need to refer to the register map for the conversion.

Modbus Channel ×	Modbus Channel ×
Enable	Enable
Channel	Channel
Name Channel 0	Name Channel 0
Access Type Read Coils	Access Type Read Coils
Trigger Cyclic 💙 100 ms	Trigger Cyclic 💙 100 ms
Comment	Comment
Read Register	Read Register
Device Address 0x0	Device Address X Coil 🖌 0x0
Length 1	Length 1
Error Handling Keep last Value	Error Handling Keep last Value
OK Cancel	OK Cancel

### Device Type : Standard Modbus Device

### Device Type : Delta AH Series

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Item	Desc	ription
Device Type	Standard Modbus Device	Delta Series Device
Enable	Activates t	this channel
Name	Defines this	channel name
Access Type	Modbus function code Read coils (0x01) Read discrete inputs (0x02) Read holding registers (0x03) Read input registers (0x04) Read single coil (0x05) Write single register (0x06) Write multiple coils (0x0F) Write multiple registers (0x10) Read/Write multiple registers (0x17)	Read/Write Registers <ul> <li>Read coils</li> <li>Read registers</li> <li>Write coils</li> <li>Write registers</li> </ul> <li>Note: PLC uses the corresponding Modbus function code according to the read/write register of the device type.</li>
Trigger	<ul> <li>Cyclic: The request occurs periodically.</li> <li>Rising edge: The request occurs as a reaction to a rising edge of the Boolean trigger variables. The trigger variable is defined in the tab I/O Mapping.</li> <li>Application: The Modbus request is triggered by DFB_ModbusComChannel</li> </ul>	<ul> <li>Cyclic: The request occurs periodically.</li> <li>Rising edge: The request occurs as a reaction to a rising edge of the Boolean trigger variables. The trigger variable is defined in the tab I/O Mapping.</li> <li>Application: The Modbus request is triggered by DFB_ModbusComChannel</li> </ul>
Comment	Description	of the channel
Device Address	Modbus protocol address	Delta register address (will be converted into Modbus protocl in the background)
Length	Number of the register to be read/written to. (up to 100 coils and 100 registers)	Number of the register to be read/written to. (up to 256 coils and 100 registers)
Error Handling	<ul> <li>What to do with the data in case of a commun</li> <li>Set To ZERO</li> <li>Keep last value</li> </ul>	ication error:

### Modbus Slave Init

After the Modbus connection between AX-3 Series PLC and the slaves is established, you can use **Add Channel** button to edit the Initialization Value of the Coil/Register.

General	Line	Access Type Write Single Coil	WRITE Offset 0x0	Default Value	Length 1	Comment		
Modbus Slave Channel	1	Write Single Coil	0x0	0	1			
fodbus Slave Init	2	Write Multiple Registers Write Multiple Colls	0x0 0x0	5	1 8			
DeltaModbusSerialSlave1/0 Mapping								
DeltaModbusSerialSlave IEC Objects								
Status								
Information								
	14	ove Up Nove Down			Ad	d Channel	Delete	Edit

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
Modbus Slave Channel	Variable.	Mapping	Channel Channel 0	Address	Туре ВІТ	Unit	Description
Modbus Slave Init			Channel 0	%QX4.0 %IW5	ARRAY [00] OF WORD		Trigger variable Read/Write Multiple Registers
	= <b>*</b> aaa		Channel 0	%QW3	ARRAY (00) OF WORD		Read/Write Multiple Registers
DeltaModbusSerialSlaveI/O Mapping	÷ **		Channel 0[0]	%QW3	WORD		
	4.49		Channel 1	%IW6	ARRAY (00) OF WORD		Read Input Registers
DeltaModbusSerialSlave IBC Objects	* *		Channel 2	%IW7	ARRAY [00] OF WORD		Read Input Registers
	8- <b>1</b> 9		Channel 3	%Q68	ARRAY [00] OF BYTE		Write Multiple Colls
Status	H. M.		Channel 4	%IB16	ARRAY [00] OF BYTE		Read Cols
	-						

### Delta Modbus Serial Slave IEC Objects

Here is the correspondings of the DFB\_ModbusCOMMaster function block. You can check the status of Modbus Serial Slave under this tab.

Devices	- # X	Delta_Hodbus_Slave_COM	Port x Device Deita_Modbus_Master_COM,	Port	
Childed:     Concerning (Ak-3088A04641)     Generic Configuration     A return Configuration     A return Configuration     A return Configuration     A return Configuration	- • x	General Modbus Slave Channel Modbus Slave Init	Port × () Device () Delta_Madaus_Master_COM ↑ Add., SLdit. >> Delete ** Go to Vanable Expression SuperciseApplication.Delta_Madbus_Slave_COM.Pot ↑ bTrigger ↑ Breast	Pert Type DL, ModbusComMaster.DFB_ModbusComSlave 800L 800L	Value FALSE FALSE
A NobacCM Hite ■ SP RC Logic ■ A cypication (stop) ■ boon, PRG (PRG) ■ hcpmc PRG (PRG) ■ hcpmc PRG (PRG) ■ hcpmc PRG ■ G SteecAT Task ■ G SteecAT T		DeltaModbusSenalSlaveLiO Mapping ObleModbusSenalSlaveBLC Objects Status Information	% Disest         %           % biotowie des         %           % biotowie         %           %         %           %         %           %         %           %         %           %         %           %         %           %         %           %         %           %         %	800. 800. 800. 800. 800. 800. 900. 900.	RALSS TRUE TRUE TRUE TRUE TRUE COTE_RESPONSE_TIMEOUT 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
blnitDone	The initialization of the Slave is complete.
bBusy	This channel is in data transmission.
bDone	The data transmission via this channle is complete.
bError	Error occurs when this channels is in data transmission.
ModbusError	Record of the Modbus error
iChannelIndex	The number of the channel that is in execution.

### Status

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

# Delta\_Modbus\_Slave\_COM\_Port X General Modbus Slave Channel Modbus Slave Init DeltaModbusSerialSlave I/O Mapping DeltaModbusSerialSlave IEC Objects Status Information

### Information

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

General	General Name: Delta Modbus Slave COM Port
Modbus Slave Channel	Vendor: Delta Electronics, Inc. Categories: Modbus Serial Slave
Modbus Slave Init	Type: 40001 ID: 16F7 8706 Version: 0, 40, 1, 0
DeltaModbusSerialSlave IEC Objects	Order Number: - Description: A generic device that works as a Modbus Slave on a serial bus test
Status	
Information	

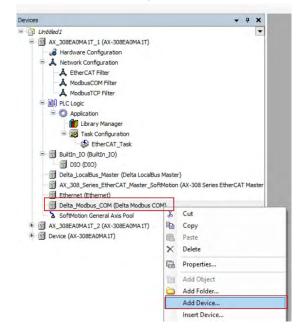
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### 9.2.3 Modbus Serial Slave

AX-3 Series PLC can act as a Modbus Serial Slave, after you add Modbus Serial Device in and set up the allowable areas for Coils/Register. If Modbus Serial Master uses Delta device communication protocol, there is no access restrictions. Follow the below section to set up the Modbus Serial Slave.

### 9.2.3.1 Adding a Modbus Serial Device

1. Right-click the created Delta\_Modbus\_COM (Delta Modbus COM) in the tree view to open up a conext menu. And click **Add Device...**to open the Add Device setting window.



 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.

Action Append device      Insert device	C RUE DEVICE O	Update device		
String for a fulltext search	Vendor	<all th="" vendors<=""><th>&gt;</th><th>1</th></all>	>	1
Name  Fieldbuses  Modbus  Modbus  Fieldbuses	Vendor		Version	Description
Delta Modbus Seria	Device Delta E	ctronics, Inc.	0.40.0.0	Delta Serial Port Setting
Ima Modbus Serial Master      Group by category Display all      Name: Delta Modbus Serial Dev		only) 🗌 Disp	olay outdated	) versions
<ul> <li>Group by category Display all</li> <li>Name: Delta Modbus Serial Dev Vendor: Delta Electronics, Inc. Categories: Modbus Version: 0, 40.0.0</li> <li>Order Number: -</li> </ul>	ice lice		olay outdated	
<ul> <li>✓ Group by category □ Display all</li> <li>Imame: Delta Modbus Sena Dev Vendor: Delta Betorios, Jr.c. Categories: Modbus Sena Dev Version: 0.40.0.0</li> </ul>	ice lice		oley outdeted	

3. Find the added port **Delta\_Modbus\_Serial\_Device (Delta Modbus Serial Device)** in the tree view and double-click it to open the setting window to set up.

Devices 👻 🗘 🗶	Delta_Modbus_Serial_Device >	K					
United     United     X_308EA0MAIT_1 (AX-308EA0MAIT)     AX_308EA0MAIT_1 (AX-308EA0MAIT)     Attractives Configuration     A Network Configuration     A Network Configuration     A Network Configuration     A Network Configuration     A ModuseCOM Filter	General Delta Modbus Serial Slave Device 1/0 Mapping Status	Serial Port Setting COM ID	B				
A ModbusTCP Filter	Information	Address Information Setting					
= O Application		Holding Register			Colls		
Library Manager		%MW	0	\$	%MW	0	\$
= 🥁 Task Configuration		%MW Quantity	10	1¢	%MW Quantity	10	\$
BtherCAT_Task mdbsComTask		Modbus Start Address	0		Modbus Start Address	0	
= Bultin_IO (Bultin_IO)		Holding Register			Colls		
DIO (DIO)		%QW	0	1	%QW	0	
Delta_LocalBus_Master (Delta LocalBus Master)		%QW Quantity	10		%QW Quantity	10	
AX_308_Series_EtherCAT_Master_SoftMotion (AX-308 Series EtherCAT Master Ethernet (Ethernet)		Modbus Start Address	256		Modbus Start Address	256	
😑 🔟 Delta_Modbus_COM (Delta Modbus COM)		Input Register			Input Coils		
Delta_Modbus_Serial_Device (Delta Modbus Serial Device)		56IW	0	4	%IW	0	
SoftMoton General Axis Pool  AX_308EA0MA1T_2 (AX-308EA0MA1T)		%IW Quantity	10	1	%IW Quantity	10	1
<ul> <li>Device (AX-308EA0MA1T)</li> </ul>		Modbus Start Address	0	1	Modbus Start Address	0	4

9.2.3.2 Setting up the Modbus Serial Device

### General

Here you can configure the basic settings for Modbus Serial Device. Set up the allowable areas for Coils/Register. If Modbus Serial Master uses Delta device communication protocol, there is no access restrictions.

General	Serial Port Setting					
Delta Modbus Serial Slave Device I/O Mapping	COM ID 1	A V				
Status						
Information	-Address Information Setting					
	Holding Register			Coils		
	%MW	0	+	%MW	0	+
	%MW Quantity	10	*	%MW Quantity	10	\$
	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.

Connel	Bus Cycle Options		_
General	Bus cycle task	mdbsComTask	V
Delta Modbus Serial Slave Device I/O Mapping	Tenderoor	Use parent bus cycle setting 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.

Delta_Modbus_Serial_Device X							
Delta Modbus Serial Slave Device	n/a						

### Information

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

Delta_Modbus_Serial_Device	
General	General
	Name: Delta Modbus Serial Device
Delta Modbus Serial Slave Device	Vendor: Delta Electronics, Inc.
I/O Mapping	Categories: Modbus Serial Device Type: 40001
Status	ID: 16F7 8703
50003	Version: 0.40.0.0
	Order Number: -
Information	Description: Delta Serial Port Setting of Modbus Slave

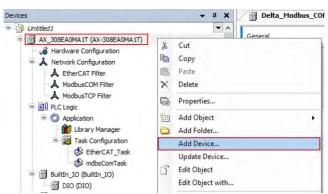
# 9.3 Introduction to Ethernet Communication

# 9.3.1 Ethernet Port

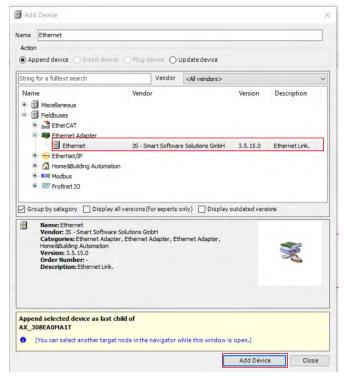
DIADesigner-AX supports the following Modbus network types, including Modbus TCP and EtherNet/IP. Follow the below section to set up the basic settings for communication via the Ethernet Adapter.

### 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.



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

Devices	• 4 ×	Ethernet 🗙			
Untited1     MX_308EA0MA1T (AX-308EA0MA1T)     MArdware Configuration	•	General	Interface cpsw0		***
A Network Configuration		Log	IP address	192 . 168 . 0 . 1	
A ModbusTCP Filter		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></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	
.og	IP address	192 . 168 . 0 . 1
Status	Subnet mask	255 . 255 . 255 . 0
thernet Device I/O Mapping	Default gateway	0 . 0 . 0 . 0
thernet Device IEC Objects		
nformation		

ltem	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.

### 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     Current subnet mask	'192.168.1.5' '255.255.255.0'	
Ethernet Device IEC Objects	Current gateway address     IP changes	'0.0.0.0' 0	Amount of IP configuration changes since startup (IP or gateway $\epsilon$
nformation			
	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

1	🔟 Ethernet 🗙			
	General	Bus Cycle Options	Use parent bus cycle setting	7
	Log	Bus cycle task	Use parent bus cycle setting	
	Status			
	Ethernet Device I/O Mapping			
	Ethernet Device IEC Objects			
	Information			
l				

### Ethernet Device IEC Objects

Here you can find the objects defined by Ethernet Adapter Device. "Objects" are listed that allow for access to the device from the IEC application. In online mode, you can use the table of IEC objects as a monitoring view.

	General	🕂 Add 🗹 Edit 🗙 Delete 🧦 Go to Variable							
		Expression	Туре	Value	Prepared value	Address			
	Log	Device.Application.Ethernet	IoDrvEthernet.IoDrvEthernet						
		🍫 eState	ETHERNETSTATE	RUNNING					
	Status								
	Ethernet Device I/O Mapping								
$\left( \right)$	Ethernet Device IEC Objects								
	Information								

### Information

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

General	General Name: Ethernet
Log	Vendor: 3S - Smart Software Solutions GmbH Categories: Ethernet Adapter, Ethernet Adapter, Ethernet Adapter, Home&Building Automation
Status	Type: 110 ID: 0000 0002 Version: 3.5.15.0
Ethernet Device I/O Mapping	Order Number: - Description: Ethernet Link.
Ethernet Device IEC Objects	
Information	

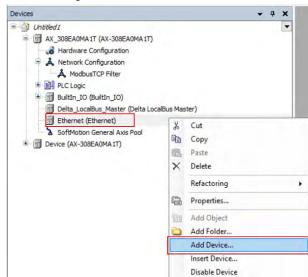
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# 9.3.2 Modbus TCP Master (Client)

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

1. Right-click the **Ethernet (Ethernet)** node in the tree view to open up a conext menu. And click **Add Device...**to open the Add Device setting window.



 Find and double-click Delta Modbus TCP Master (Fieldbuses -> Modbus -> Modbus TCP Master -> Delta Modbus TCP Master) or click Add Device to add this port in. After that you can find Delta\_Modbus\_TCP\_Master under the Ethernet node in the tree view.

Action				
Append device      Insert device	Vendor	<all vendors=""></all>		
Name Fieldbuses Fieldbuses Fieldbuses Modbuses	Vendor		Version	Description
Modbus TCP Master	nter Delta Fler	TODICE IDC	0.40.1.0	A device th
Pelta Modbus TCP May     Modbus TCP May     Modbus TCP Master     ModbusTCP Slave Device     Group by category Display all ver	3S - Smarl	ronics, Inc. Software Solutions GmbH nly) Display outdated	0.40.1.0 3.5.15.0 d versions	A device t
	3S - Smarl	Software Solutions GmbH	3.5.15.0	A device ti A device ti
	35 - Smari sions (for experts (	Software Solutions GmbH	3.5.15.0	A device t

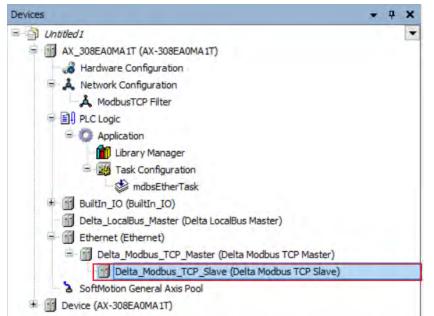
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3. Right-click **Delta\_Modbus\_TCP\_Master** under the **Ethernet** node in the tree view to open up a conext menu. And click Add Device...to open the Add Device setting window.

Devices	+ 4 ×
SoftMotion General Axis Pool	X       Cut         Copy       Paste         X       Delete         Refactoring       >         Properties       Add Object         Add Folder       >
	Add Device

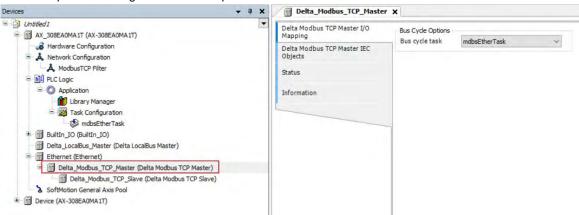
4. Find and double-click Delta Modbus TCP Slave (Fieldbuses -> Modbus -> Modbus TCP Slave -> Delta Modbus TCP Slave) or click Add Device to add this port in.

ame Delta_Modbus_TCP_Slave					
Action					
Append device O Insert device O Pl	ug device OU	pdate devic	e		
tring for a fulltext search	Vendor	<all th="" vendo<=""><th>rs&gt;</th><th></th><th>~</th></all>	rs>		~
Name Fieldbuses Util Modbus Util Modbus TCP Slave	Vendor		Version	Description	
Delta Modbus TCP Slave	Delta Electro	onics, Inc.	0.40.1.0	A generic Mode	ous device th
] Group by category 🔲 Display all versio	ns (for experts o	nly) 🗌 Di	splay outdate	ed versions	>
Categories: Modbus TCP Slave Vendor: Delta Electronics, Inc. Categories: Modbus TCP Slave Version: 0.40.1.0 Order Number: - Description: A generic Modbus device TCP Master				ed versions	> 
Group by category Display all versio Name: Delta Modbus TCP Slave Vendor: Delta Electronics, Inc. Categories: Modbus TCP Slave Version: 0.40.1.0 Order Number: - Description: A generic Modbus device TCP Master.				ed versions	>
Group by category Display all versio Name: Delta Modbus TCP Slave Vendor: Delta Electronics, Inc. Categories: Modbus TCP Slave Version: 0.40.1.0 Order Number: - Description: A generic Modbus device TCP Master.	e that is configure	ed as Slave 1	for a Modbus	NW.	~



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 Modbus TCP Master I/O Mapping	🕂 Add 📝 Edit 🗙 Delete	+ Go to V	/ariable
Delta Modbus TCP Master IEC Objects	Variable Wolta_Modbus_TCP_M	Mapping	Type DFB_ModbusTCPMaster
Status			
Information			

- bStop: TRUE => Stop sending Modbus TCP packets.
- bSlaveError: TRUE => connection/communication with the Slave is abnormal
- uiConnectedSlaves: the number of the connected Slaves
   EX: (ST programming language): Delta Modbus TCP Master.bStop:= TRUE;

### Status

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

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			

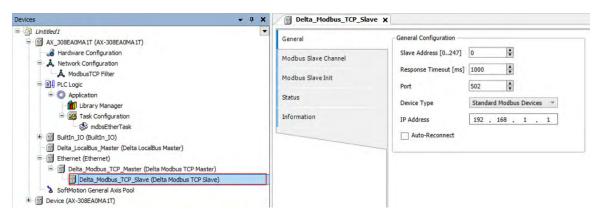
### Information

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: Delta Electronics, Inc. Categories: Modbus TCP Master
Status	Type: 34601 ID: 16f7 8729 Version: 0.40.1.0
Information	Order Number: - Description: A device that works as a Modbus TCP Master on Ethernet.

### 9.3.2.3 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.

ltem	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.

Delta_Modbus_TCP_Slave	×						
General	0 0	Name Channel 0	Access Type Read Coils	Trigger Cyclic, 100ms	READ Offset 0x0	Length 1	Error Handling Keep last Value
fodbus 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
Delta Modbus TCP Slave I/O Mapping							
tatus							
nformation							
	5						
	Molve	16	Move Down		Add Channel	Delete	Edit
	Move	nb 1	Move Down		Add Channel	Delete	Egut

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	0	Name	Channel 0			
Access Type Read Coi	ils	Access Type	Read Coils			~
Trigger Cyclic	✓ 100 ms	Trigger	Cyclic	~	100	ms
Comment		Comment				
Read Register		Read Register				
Device Addres	ss OxO	Devic	e Address	X Coil	~	0x0
Length	1	Lengt	th	1		
Error Handling	Keep last Value	Error	Handling	Keep last Value	e	~
	OK Cancel				ОК	Cancel

### **Device Type : Standard Modbus Device**

### Device Type : Delta AH Series

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Item	Description					
Device Type	Standard Modbus Device	Delta Series Device				
Enable	Activates t	his channel				
Name	Defines this o	channel name				
Access Type	<ul> <li>Modbus function code</li> <li>Read coils (0x01)</li> <li>Read discrete inputs (0x02)</li> <li>Read holding registers (0x03)</li> <li>Read input registers (0x04)</li> <li>Read single coil (0x05)</li> <li>Write single register (0x06)</li> <li>Write multiple coils (0x0F)</li> <li>Write multiple registers (0x10)</li> <li>Read/Write multiple registers (0x17)</li> </ul>	Read/Write Registers <ul> <li>Read coils</li> <li>Read registers</li> <li>Write coils</li> <li>Write registers</li> </ul> <li>Note: PLC uses the corresponding Modbus function code according to the read/write register of the device type.</li>				
Trigger	<ul> <li>Cyclic: The request occurs periodically.</li> <li>Rising edge: The request occurs as a reaction to a rising edge of the Boolean trigger variables. The trigger variable is defined in the tab I/O Mapping.</li> <li>Application: The Modbus request is triggered by DFB_ModbusTCPChannel</li> </ul>	<ul> <li>Cyclic: The request occurs periodically.</li> <li>Rising edge: The request occurs as a reaction to a rising edge of the Boolean trigger variables. The trigger variable is defined in the tab I/O Mapping.</li> <li>Application: The Modbus request is triggered by DFB_ModbusTCPChannel</li> </ul>				
Comment	Description of the channel					
Device Address	Modbus protocol address	Delta register address (will be converted into Modbus protocl in the background)				
Length	Number of the register to be read/written to.	Number of the register to be read/written to. (up to 256 coils and 100 registers)				
Error Handling	<ul> <li>What to do with the data in case of a communication error:</li> <li>Set To ZERO</li> <li>Keep last value</li> </ul>					

### Modbus Slave Init

After the Modbus connection between AX-3 Series PLC and the slaves is established, you can use **Add Channel** button to edit the Initialization Value of the Coil/Register.

eneral	Line 0	Access Type Write Single Coil	WRITE Offset 0x0	Default Value 0	Length 1	Comment		1
odbus Slave Channel	1	Write Single Coil	0×0	0	1			
odbus Slave Init	1							
elta Modbus TCP Slave I/O apping								
atus								
ormation								
	-							
		ove Up Move Down			-	dd Channel	Delete	Edit

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	FB for IO Channel	* Go to Instan	ce
Modbus Slave Channel	Variable	Mapping	Channel Channel 0	Address %QX18.1	Type BIT	Unit	Description Trigger variable		
Modbus Slave Init	s 🍫		Channel 0	%IB25	ARRAY [00] OF BYTE		Read Coils		
DeltaModbusSerialSlave I/O Mapping	± *9		Channel 0[0]	%IB25	BYTE		Read Coils		
DeltaModbusSerialSlave IEC Objects									
Status									
Information									
	-								

### ■ Delta Modbus TCP Slave IEC Objects

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

Delta_Modbus_TCP_Slave ×						
General	🕈 Add 🗹 Edit 🗙 Delete	→ Go to Variable	9			
	Expression	Туре	Value	Prepared value	Address	Comment
Modbus Slave Channel	🗉 🧭 Device.Application.Delt	DL_ModbusTCP				
	bConfirmError	BOOL	FALSE			
Modbus Slave Init	🍫 bDoInit	BOOL	TRUE			
Delta Modbus TCP Slave I/O	⁵≱ bInitDone	BOOL	TRUE			
Mapping	🍫 bBusy	BOOL	TRUE			
Delta Modbus TCP Slave IEC Objects	🍫 bDone	BOOL	FALSE			
Delta Modbus TCP Slave IEC Objects	Serror	BOOL	FALSE			
Status	NodbusError	DFB_MB_ERRO	UNDEFINED			
Status	🍫 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.
bDolnit	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.

Delta Modbus TCP Slave I/O		n/a	Delta Modbus TCP Slave 🔅	General
Delta Modbus TCP Slave I/O	Acknowledge		Last Diagnostic Message	Modbus Slave Channel
			Diagnosis Message:	Modbus Slave Init Delta Modbus TCP Slave I/O Mapping
Status				Status

### 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.

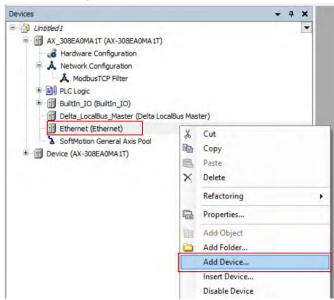
General	General
Modbus Slave Channel	Name: Delta Modbus TCP Slave Vendor: Delta Electronics, Inc. Categories: Modbus TCP Slave Tvpe: 34602
Modbus Slave Init	ID: 16f7 8730 Version: 0.40.1.0
Delta Modbus TCP Slave I/O Mapping	Order Number: - Description: A generic Modbus device that is configured as Slave for a Modbus TCP Master
Status	
Information	

## 9.3.3 Modbus TCP Slave (Server)

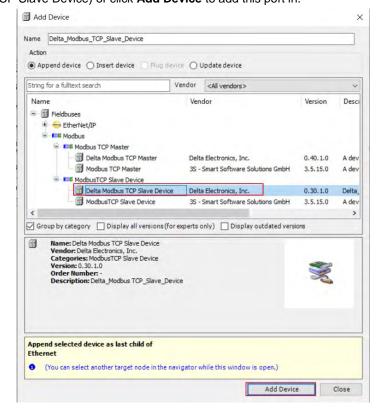
AX-3 Series PLC can act as a Modbus TCP Slave, after you add Modbus TCP Slave Device in and set up the allowable areas for Coils/Register. If Modbus TCP Master uses Delta device communication protocol, there is no access restrictions. Follow the below section to set up the Modbus TCP Slave.

### 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.

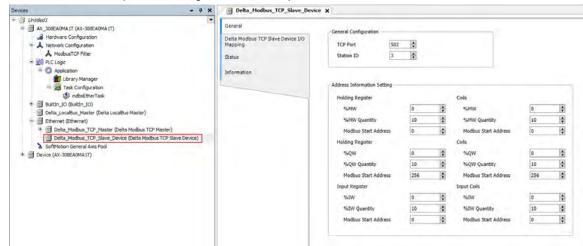


Find and double-click Delta Modbus TCP Slave Devie (Fieldbuses -> Modbus -> Modbus TCP Slave Device
 -> Delta Modbus TCP Slave Device) or click Add Device to add this port in.



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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	Å	%MW Quantity	10	
	Modbus Start Addres	as O	+	Modbus Start Address	0	-
	Holding Register			Coils		
	%QW	0	*	%QW	0	
	%QW Quantity	10	*	%QW Quantity	10	
	Modbus Start Addres	s 256	+	Modbus Start Address	256	ł
	Input Register			Input Coils		
	%IW	0	-	%IW	0	\$
	%IW Quantity	10	+	%IW Quantity	10	+
	Modbus Start Addres	s O	×	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			
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 Name: Delta Modbus TCP Slave Device
Delta Modbus TCP Slave Device I/O Mapping	Vendor: Delta Electronics, Inc. Categories: ModbusTCP Slave Device
Status	Type: 34600 ID: 16f7 8728 Version: 0.30.1.0
Information	Order Number: - Description: Delta_Modbus TCP_Slave_Device



# **Appendix A Troubleshooting**

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# A.1 Troubleshotting

# A.1.1 Basic Troubleshooting Steps

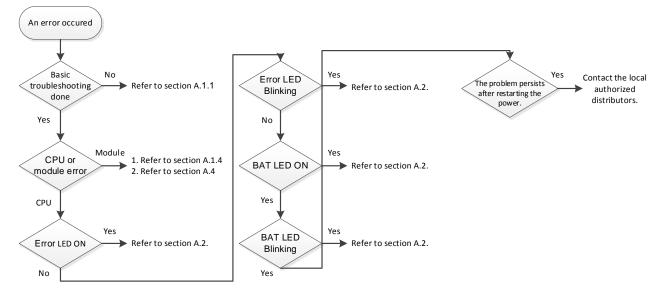
This chapter includes the possible errors the can occur during operation, their causes, and corrective actions.

- (1) Check the following:
  - The PLC should be operated in a safe environment (consider environmental, electronic, and vibration safeties).
  - Connect power supply correctly to the PLC.
  - Secure the module, terminal, and cable installations.
  - All LED indicators show correctly.
  - Set all switches correctly.
- (2) Check the following operational functions:
  - Switch the RUN/STOP state
  - Check the settings for the AX-3 Series to RUN/STOP
  - Check and eliminate errors from external devices
  - Use the System Log function in DIADesigner-AX to check system operation and logs
- (3) Identify possible causes:
  - AX-3 Series or external device
  - CPU or extension modules
  - Parameters or program settings

# A.1.2 Clear the Error States

Use the following methods to clear the error states. If the error source is not corrected, the system continues to show errors.

- (1) Switch the CPU model state to STOP and then to RUN.
- (2) Turn off the CPU and turn it on again.
- (3) Use DIADesigner-AX to perform Reset Warn to clear the error logs.
- (4) Use DIADesigner-AX to perform **Reset Origin** to reset the CPU to default settings and then redownload the program to start again.



# A.1.3 Troubleshooting SOP

# A.1.4 Viewing Log

When an error occurs, the system generates corresponding error codes and stores the error messages in the PLC. You can find events during the startup and shutdown of the system, application download and loading of the boot application, custom entries, log entries from I/O drivers, and log entries from data sources on the Log tab of the Device setting page. Refer to section 4.2.1.5 for more information on Log.

### 1. Log Tab

Double-click the **Device** in the tree view to open the Device setting page and then you can find Log tab on the left section.

Communication Settings	🙂 3 warnin	g(s) 🔮 0 error(s) 🕒 0 ex	cception(s) <b>1</b> 285 information(s) <b>1</b> 27 debug	<pre>(message(s) <all components=""></all></pre>
Applications	Offline I	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 Settings	0	01.01.1970 08:00:13	CH_INIT_FINISHED	CmpDeltaConnHandler
FEC 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
Chathan	۲	01.01.1970 08:00:13	Retain size in config changed, or retain are	CmpRetain
Status	0	01.01.1970 08:00:13	Bootproject of application [Application] loa	CmpApp

### 2. Files

The system generates log files (.csv) when the PLC is power-off or the log exceeds 64 KB. You can read the log file from the Files tab of the Device setting page.

Communication Settings	Host Location		$\cdot   \cong \times \cdot \circ  $	Runtime   Loc	ation	- 🖻 🗙
Applications	Name	Size	Modified	Name		Size
ackup and Restore	C:\			<click on="" t<="" td=""><td>he refresh icon to up</td><td>pdate the lis</td></click>	he refresh icon to up	pdate the lis
iles	💷 E:\					
og						
LC Settings						
.C Shell						
ers and Groups						
ccess Rights						
mbol Rights			Г	>>		
stem Parameters						
sek Donlovmont				<<		
isk Deployment						
tatus						
atus Device ×	Host Location		• • • • • •	Runtime	ation   🚞 /	-   🖻 X
Device ×	Name	Size	• • • • • • • • • • • • • • • • • • •	Name	ation   🎦 /	- 🖻 X Size Modified
atus           J Device ×           ommunication Settings           opplications	Name C:\ D:\	Size		Name PicLogic Cert	ation 📄 /	
Device x	Name	Size		Name	ation 🔁 /	
tatus       Device ×       ommunication Settings       opplications       ackup and Restore       les	Name C:\ D:\	Size		Name PicLogic Cert	ation   🚞 /	
bevice x	Name C:\ D:\	Size		Name PicLogic Cert	ation 🔁 /	
tatus	Name C:\ D:\	Size		Name PicLogic Cert	ation 💽 /	
atus	Name C:\ D:\	Size		Name PicLogic Cert	ation 📄 /	
tatus Device × Device	Name C:\ D:\	Size		Name PicLogic Cert	ation 🔁 /	
atus	Name C:\ D:\	Size		Name PicLogic Cert	ation [ 🦳 /	
tatus  Device ×	Name C:\ D:\	Size		Name PicLogic cert Log 2	ation i in /	
Task Deployment Status Status Device × Communication Settings Supplications Communication Settings Communication Settings Communication Settings Communication Settings Communication Co	Name C:\ D:\	Size		Name PicLogic cert Log	ation i i i i i i i i i i i i i i i i i i	

Communication Settings	Host Location		•   🖿 🗙	÷	Runtime Location 📄 /		• 🗀 🗙 <
Applications	Name	Size	Modified		Name L	Size	Modified
Backup and Restore	□ D:\ □ E:\				StdLogger52276_19700:		
Files	L. (				StdLogger52277_19700:	64.50 K	1980/1/
Log					StdLogger52279_19700:		
PLC Settings					StdLogger52		
PLC Shell					StdLogger5219700:	64.50 K	1980/1/
Users and Groups					StdLogger5219700:	64.50 K	1980/1/
Access Rights					StdLogger52 ;_19700:		
Symbol Rights				>>			
System Parameters							
Task Deployment				<<			

# A.2 Troubleshooting of CPU Modules

Check the LED indicators and the error codes from the CPU module and refer to the following table for troubleshooting.

# A.2.1 ERROR LED Indicators Blinking Every 0.5 Seconds

# CPU ERROR

Error Code (16#)	Description	Solution
140E	More than eight remote modules on the right side of the CPU module.	Check the total number of remote modules on the right side of the CPU module (maximum is 8).
1600	The extension module ID exceeds the range.	<ol> <li>Make sure the module is properly connected to the CPU module and turn the modules on again.</li> <li>If the problem persists, contact the local authorized distributors.</li> </ol>
1601	The extension module ID cannot be set.	<ol> <li>Make sure the module is properly connected to the CPU module and turn the modules on again.</li> <li>If the problem persists, contact the local authorized distributors.</li> </ol>
1602	The extension module ID is duplicated.	<ol> <li>Make sure the module is properly connected to the CPU module and turn the modules on again.</li> <li>If the problem persists, contact the local authorized distributors.</li> </ol>
1603	The extension module cannot be operated.	<ol> <li>Make sure the module is properly connected to the CPU module and turn the modules on again.</li> <li>If the problem persists, contact the local authorized distributors.</li> </ol>
1604	Extension module communication timeout	<ol> <li>Make sure the module is properly connected to the CPU module and turn the modules on again.</li> <li>If the problem persists, contact the local authorized distributors.</li> </ol>
2000	CPU memory access is denied.	If the problem persists, contact the local authorized distributors.
2001	CPU external memory access is denied.	If the problem persists, contact the local authorized distributors.
2100	The number of MODBUS TCP connections exceeds the range.	Check if the number of Modbus TCP connection (Server+Client) exceeds the maximum number 32.
2200	The arrangement of the I/O modules is not consistent with the settings.	Check whether the settings in Hardware Configuration are consistent with the arrangement of the I/O modules.
2201	The number of connected communication modules exceed the maximum number 4.	Check the total number of communication modules.
2202	The number of connected positioning modules exceed the maximum number 8.	Check the total number of positioning modules.
2203	The number of connected extension modules exceed the maximum number 32.	Check the total number of extension modules.

# • EtherCAT ERROR

Error Code (16#)	Description	Solution	
1	EtherCAT communication lost	Make sure the terminal and cable are properly connected to the CPU module. Execute the function block, DFB_ResetECATMaster, to reset the EtherCAT Master.	
2	EtherCAT data mapping failed	Make sure the terminal and cable are properly connected to the 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.

Error Code (16#)	Item Name	Description	Solution
186B6	DFB_CMP_INVALID_CO MPARE_REF	The variable of the function block pin is NOT a Compare_REF type.	Make sure to select <b>Compare</b> on the IO Configuration setting page and import IEC Object to the pin "Counter" of the function block DMC_Compare.
186B7	DFB_CMP_INVALID_CO UNTER_REF	The variable of the function block pin is NOT a Counter_REF type.	Make sure to select <b>Counter</b> on the IO Configuration setting page and import IEC Object to the pin "Counter" of the function block DMC_Compare.
186B8	DFB_CMP_INVALID_CM PVALUE	When the encoder of high- speed counter is a rotary axis and the pin of "diCompareValue" exceeds the range.	Set the pin "diCompareValue" of the function block DFB_Compare in the range of [0 ~ EncoderAxis.Modulo Value ].
186B9	DFB_CMP_INVALID_RE FRESHCYCLE	The setting value of input pin "wRefreshCycle" exceeds the range of [0-30000], unit 0.1us.	Set the pin "wRefreshCycle" of the function block DFB_Compare in the range of [0 ~ 30000].
186BA	DFB_CMP_ COMPARE_ALREADY_E NABLE	The device for high-speed compare is already enabled.	Check if the device for high-speed compare is already enabled by other DFB_Compare.
186C0	DFB_HC_INVALID_ COUNTER_REF	The variable of the function block pin is NOT a Counter_REF type.	Make sure to select <b>Counter</b> on the IO Configuration setting page and import IEC Object to the pin "Counter" of the function block DMC_HCnt.
186C1	DFB_HC_COUNTER_AL READY_ENABLE	The device for high-speed counter is already enabled.	Check if the device for high-speed counter is already enabled by other DFB_HCnt.
186C2	DFB_HC_COUNTER_R EF_CHANGED_ DURING_ OPERATION	The input pin "Counter" has been changed during the execution of the function block.	Check if the variable of the pin "Counter" has been changed after the execution of the DFB_HCnt.
186C8	DFB_HT_INVALID_ TIMER_REF	The variable of the function block pin is NOT a Timer_REF type.	Make sure to select <b>Timer</b> on the IO Configuration setting page and import IEC Object to the pin "Timerr" of the function block DFB_HTmr.
186C9	DFB_HT_TIMER_ ALREADY_ENABLE	The device for high-speed timer is already enabled.	Check if the device for high-speed timer is already enabled by other DFB_HTmr.
186CA	DFB_HT_TIMER_REF_ CHANGED_DURING_O PERATION	The input pin "Timer" has been changed during the execution of the function block.	Check if the variable of the pin "Timer" has been changed after the execution of the DFB_HTmr.
186D0	DFB_PV_INVALID_ COUNTER_REF	The variable of the function block pin is NOT a Counter_REF type.	Make sure to select <b>Counter</b> on the IO Configuration setting page and import IEC Object to the pin "Counter" of the function block DFB_PresetValue.
186D1	DFB_PV_NOT_ ENABLE_EXTERNAL_T RIGGER	The counter is not set as triggered externally but the mode of DFB_PresetValue is set to "EXTERNAL_TRIGGER".	Make sure to select <b>External Trigger</b> on the Counter Configuration page.
186D2	DFB_PV_PREVIOUS_P RESET_NOT_DONE	The preset counting function of the counter has been enabled by other function block	Execute this function block after the execution of DFB_PresetValue of this counter completes.

Error Code (16#)	Item Name	Description	Solution
		DMC_PresetValue and is not done yet.	
186D3	DFB_PV_CANNOT_ PRESET_WHEN_SAMP LING	The counter is executing DFB_Sample.	Disable the sample function of this counter. Disable DFB_Sample of this counter.
186D4	DFB_PV_SETRING_ NOT_DONE	The counter is executing DFB_SetRing and is not done yet.	Execute this function block after the execution of DFB_SetRing of this counter completes.
186D5	DFB_PV_INVALID_ PRESET_VALUE	When the encoder of high- speed counter is a rotary axis and the pin of "diPresetValue" exceeds the range.	Set the pin "diPresetValue" of the function block in the range of [0 ~ EncoderAxis.Modulo Value ].
186D6	DFB_PV_COUNTER_RE F_CHANGED_ DURING_ OPERATION	The input pin "Counter" has been changed during the execution of the function block.	Check if the variable of the pin "Counter" has been changed after the execution of the DFB_PresetValue.
186DC	DFB_SP_INVALID_ COUNTER_REF	The variable of the function block pin is NOT a Counter_REF type.	Make sure to select <b>Counter</b> on the IO Configuration setting page and import IEC Object to the pin "Counter" of the function block DMC_Sample.
186DD	DFB_SP_COUNTER_N OT_ENABLE	The function block DFB_Counter is not enabled yet.	Execute DFB_Sample after making sure this counter is enabled by DFB_HCnt.
186DE	DFB_SP_ALREADY_SA MPLING	The counter is executing DFB_Sample.	Check if this counter is enabled by other DFB_Sample.
186DF	DFB_SP_PRESET_ NOT_DONE	The counter is executing DFB_PresetValue and is not done yet.	Execute this function block after the execution of DFB_PresetValue of this counter completes.
186E0	DFB_SP_INVALID_ SAMPLE_TIME	The setting value of input pin "wSampleTime" of the function block DFB_Sample exceeds the range of [10-65535].	Set the pin "wSampleTime" of the function block DFB_Sample in the range of of [10-65535].
186E1	DFB_SP_COUNTER_RE F_CHANGED_ DURING_ OPERATION	The input pin "Counter" has been changed during the execution of the function block.	Check if the variable of the pin "Counter" has been changed after the execution of the DFB_Sample.
186E7	DFB_SR_INVALID_ COUNTER_REF	The variable of the function block pin is NOT a Counter_REF type.	Make sure to select <b>Counter</b> on the IO Configuration setting page and import IEC Object to the pin "Counter" of the function block DFB_SetRing.
186E8	DFB_SR_COUNTER_H AS_NO_CHILD_ ENCODER_AXIS	No child node of the high-speed counter is connected to the encoder.	Insert EncoderAxis into the counter and set the encoder type to rotary axis and reexecute the function block.
186E9	DFB_SR_COUNTER_N OT_RING	The encoder of the high-speed counter is not a rotary axis type.	Select the encoder type to rotary axis on the Counter Configuration page.
186EA	DFB_SR_PREVIOUS_S ETRING_NOT_ DONE	The preset counting function of the counter has been enabled by other function block DMC_SetRing and is not done yet.	Execute this function block after the execution of DFB_SetRing of this counter completes.

Error Code (16#)	Item Name	Description	Solution
186EB	DFB_SR_PRESET_ NOT_DONE	The counter is executing DFB_PresetValue and is not done yet.	Execute this function block after the execution of DFB_PresetValue of this counter completes.
186EC	DFB_SR_INVALID_ RING_RANGE	When the encoder of high- speed counter is a rotary axis and the pin of "diPositionPeriod" is less than 0 and bigger than the setting value of bSetDown.	Set the pin "diPositionPeriod" of the function block bigger than 0 and less than the setting value of bSetDown.
186ED	DFB_SR_COUNTER_R EF_CHANGED_ DURING_ OPERATION	The input pin "Counter" has been changed during the execution of the function block.	Check if the variable of the pin "Counter" has been changed after the execution of the DFB_SetRing.

# 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.

# A.4 Troubleshooting of I/O Modules

### • Introduction to troubleshotting modules

The following AS series modules can be installed in an AX-3 Series system. There are 2 types of error codes; error and warning. The CPU module and its modules stop operating when errors occur. The CPU modules and its modules do not stop operating when warnings are triggered.

# A.4.1 Troubleshooting of Analog Modules (AD/DA/XA) and Temperature Modules (RTD/TC)

### A.4.1.1 ERROR ERROR LED Indicators Are ON

You can set up the option to be **True** in **Module Alarm Setting** to have the following errors appear as warnings when they occur. Otherwise, when an error occurs, only an error message appears.

Error Code (16#)	Description	Solution
16#1605	Hardware failure	If the problem persists, contact the local authorized distributors.
16#1607	The external voltage is abnormal.	Check the power supply.
16#1608	The factory calibration or the CJC is abnormal.	If the problem persists, contact the local authorized distributors.

### A.4.1.2 ERROR LED Indicators Blinking Every 0.2 Seconds

The following errors are specified as warnings to ensure that the AX-3 Series CPU can still run even when the warnings are triggered by its AIO modules. If you need the CPU STOP running immediately when the first 4 errors occur, you need to set the them as errors.

Error Code (16#)	Description	Solution
16#1801	The external voltage is abnormal.	Check the power supply.
16#1802	Hardware failure	If the problem persists, contact the local authorized distributors.
16#1804	The factory calibration is abnormal.	If the problem persists, contact the local authorized distributors.
16#1807	The CJC is abnormal.	If the problem persists, contact the local authorized distributors.
16#1808	The signal received by channel 1 exceeds the range of analog inputs (temperature).	Check the signal received by channel 1
16#1809	The signal received by channel 2 exceeds the range of analog inputs (temperature).	Check the signal received by channel 2
16#180A	The signal received by channel 3 exceeds the range of analog inputs (temperature).	Check the signal received by channel 3
16#180B	The signal received by channel 4 exceeds the range of analog inputs (temperature).	Check the signal received by channel 4

Error Code (16#)	Description	Solution
16#180C	The signal received by channel 5 exceeds the range of analog inputs (temperature).	Check the signal received by channel 5
16#180D	The signal received by channel 6 exceeds the range of analog inputs (temperature).	Check the signal received by channel 6
16#180E	The signal received by channel 7 exceeds the range of analog inputs (temperature).	Check the signal received by channel 7
16#180F	The signal received by channel 8 exceeds the range of analog inputs (temperature).	Check the signal received by channel 8
-	When power-on, the module is not detected by CPU module.	Check if the connection between module and CPU module is working. If not, connect again.

# A.4.2 Troubleshooting of Loadcell Modules AS02LC

### A.4.2.1 ERROR ERROR LED Indicators Are ON

You can set up the option to be **True** in **Module Alarm Setting** to have the following errors appear as warnings when they occur. Otherwise, when an error occurs, only an error message appears.

Erro Coc (16#	de	Description	Solution
16#16	605	Hardware failure	If the problem persists, contact the local authorized distributors.
16#16	607	The external voltage is abnormal.	Check the power supply.

### A.4.2.2 ERROR LED Indicators Blinking Every 0.2 Seconds

The following errors are specified as warnings to ensure that the AX-3 Series CPU can still run even when the warnings are triggered by its LC modules. If you need the CPU STOP running immediately when the first 4 errors occur, you need to set the them as errors.

Error Code (16#)	Description	Solution
16#1801	The external voltage is abnormal.	Check the power supply.
16#1802	Hardware failure	If the problem persists, contact the local authorized distributors.
16#1807	The CJC is abnormal.	If the problem persists, contact the local authorized distributors.
16#1808	The signal received by channel 1 exceeds the range of analog inputs (temperature).	Check the signal received by channel 1
16#1809	The signal received by channel 2 exceeds the range of analog inputs (temperature).	Check the signal received by channel 2
16#180A	The signal received by channel 3 exceeds the range of analog inputs (temperature).	Check the signal received by channel 3
16#180B	The signal received by channel 4 exceeds the range of analog inputs (temperature).	Check the signal received by channel 4
16#180C	The signal received by channel 5 exceeds the range of analog inputs (temperature).	Check the signal received by channel 5
16#180D	The signal received by channel 6 exceeds the range of analog inputs (temperature).	Check the signal received by channel 6
-	When power-on, the module is not detected by CPU module.	Check if the connection between module and CPU module is working. If not, connect again.

# A.5 Error Codes and LED Indicators for CPU Modules

### A. Columns

- a. Error code: If an error occurs in the system, an error code is generated.
- **b.** Description: The description of the error
- **c.** CPU status: If the error occurs, the CPU stops running, keeps running, or shows the status you defined for the error.
  - > Stop: The CPU stops running when the error occurs.
  - > Continue: The CPU keeps running when the error occurs.
- 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 hardware Failure.         Blinking normally (every 0.5 second): system program errors or system cannot run.       Built (every 0.5 second): system program errors or system		
		Warning type: Blinking slowly (every 1 second and off for 3 seconds): a warning is		
		triggered, but the system can still run.		
		OFF: a warning is triggered, but the system can still run. You can modify the rules and use DIADesigner-AX to show the warnings, instead of using indicators to show the errors.		

# A.5.1 Error Codes and LED Indicators for CPU Modules

Refer to Section A.2 for the status descriptions of the Error LED indicators.

### • CPU ERROR

Error Code	Description	CPU	ERROR LED indicator				
(16#)	Description	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		
1601	The ID of the extension module cannot be set.	Stop			V		
1602	The ID of the extension module is duplicated.	Stop			V		
1603	The extension module cannot be operated.	Stop			V		
1604	Extension module communication timeout	Stop			V		
2000	CPU memory access is denied.	Stop			V		
2001	CPU external memory access is denied.	Stop			V		
2002	RTC cannot keep track of the current time (the battery LED is blinking.)	Continue					V
2003	Battery low (the battery LED is ON.)	Continue					V
2004	24VDC power supply is not sufficient and then is recovered from low-voltage for less than 10 ms.	Continue		V			
2100	The number of MODBUS TCP connections exceeds the range.	Continue			V		
2200	The arrangement of the I/O modules is not consistent with the settings.	Stop			V		
2201	The number of connected communication modules exceed the maximum number 4.	Stop			V		
2202	The number of connected positioning modules exceed the maximum number 8.	Stop			V		
2203	The number of connected extension modules exceed the maximum number 32.	Stop			V		
2500	The firmware version of the PLC is not in accordance with what stated on the DDF (Device Description File).	Continue					V
2501	SSI encoder is NOT connected to PLC.	Continue					V
2502	The setting value of the single turn and multiturn SSI encoders exceed the setting limit. (up to 32 bits).	Continue					V
2503	An error occurs when the pulse outputs.	Continue					V

# • EtherCAT ERROR

Error Code	Description	CPU	ERROR LED indicator				
(16#)	Description	status	ON	Blinking fast	Blinking normally	Blinking slowly	OFF
1	EtherCAT communication lost	Continue			V		
2	EtherCAT data mapping failed	Continue			V		
4	Incorrect EtherCAT network name	Continue			V		
5	EtherCAT Slave failed to initialize	Continue			V		
6	Vendor ID of the Slave does NOT match.	Continue			V		
7	Product ID of the Slave does NOT mathc.	Continue			V		

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

Error Code		ERROR LED indicator			
Error Code (16#)	Description	$\begin{array}{c} A \rightarrow D / \\ D \rightarrow A / \\ A \leftrightarrow D \end{array}$	ERROR		
16#1605	Hardware failure (the diver board included)	OFF	ON		
16#1607	The external voltage is abnormal.	OFF	ON		
16#1608	The factory calibration or the CJC is abnormal.	OFF	ON		
16#1801* <sup>1</sup>	The external voltage is abnormal.	OFF	Blinking		
16#1802* <sup>1</sup>	Hardware failure	OFF	Blinking		
16#1804* <sup>1</sup>	The factory calibration is abnormal.	RUN: Blinking STOP: OFF	Blinking		
16#1807* <sup>1</sup>	The CJC is abnormal.	OFF	Blinking		
16#1808	The signal received by channel 1 exceeds the range of analog inputs (temperature).				
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	Blinking		
16#180D	The signal received by channel 6 exceeds the range of analog inputs (temperature).				
16#180E	The signal received by channel 7 exceeds the range of analog inputs (temperature).				
16#180F	The signal received by channel 8 exceeds the range of analog inputs (temperature).				

\*1: The errors are specified as warnings to ensure that the AX-3 Series CPU can still run even when the warnings are triggered by its AIO modules. If you need the CPU STOP running immediately when the first 4 errors occur, you need to set the them as errors.