H5U Application Guidance

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INOVANCE

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Features

- IT7000&H5U Simulation
- Online Modification
- FB/FC
- Sub Program

H5U Error Code

- H5U Error Code

Application Example

- Application Example

H5U Products

Features Overview

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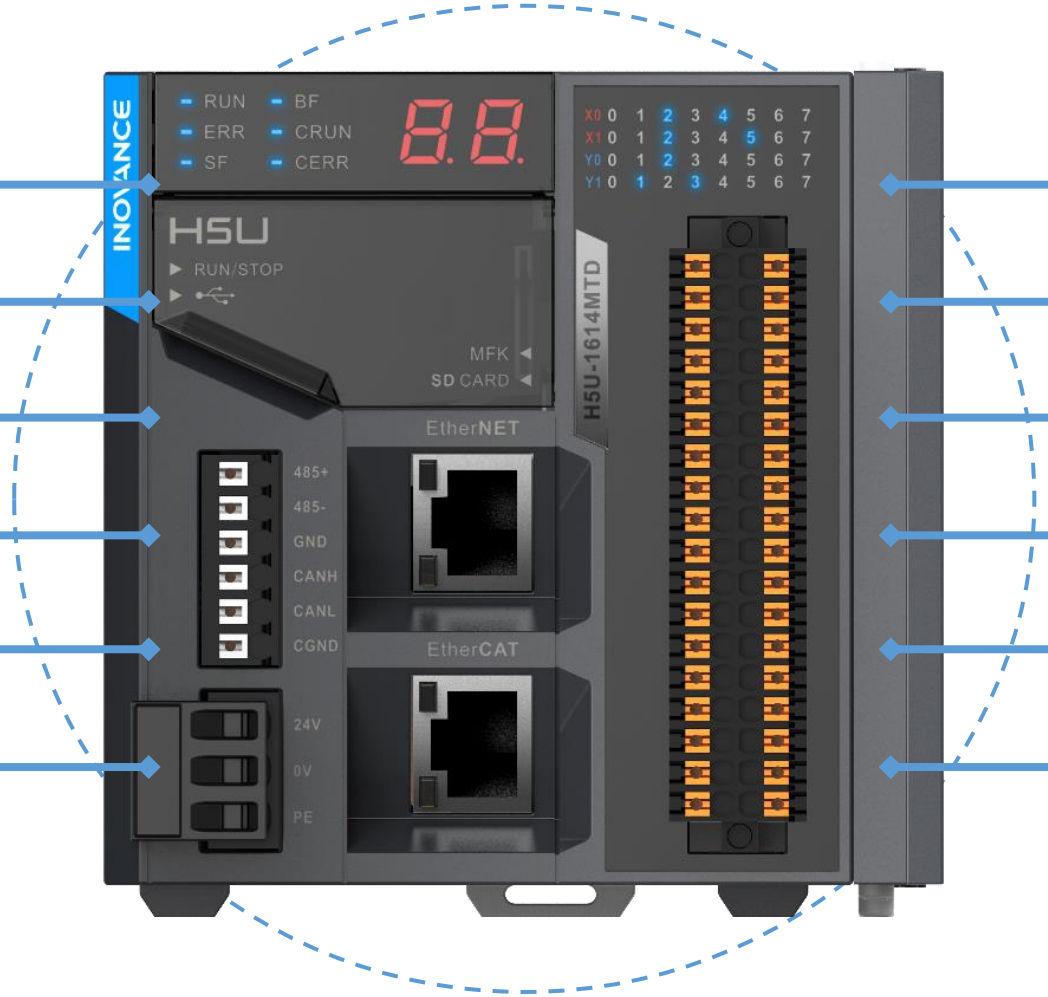
- Function Block + Library Encapsulation(FB/FC)
- User Defined Variable
- High Speed IO
- Socket Communication
- FBD + LD Programming
- CAM + Interpolation Motion



- EtherCAT Technology Group
- CANlink
- CANopen
- RS485
- Modbus TCP
- PLCopen motion control

H5U Series EtherCAT High Performance Small Size PLC

Hardware Configuration

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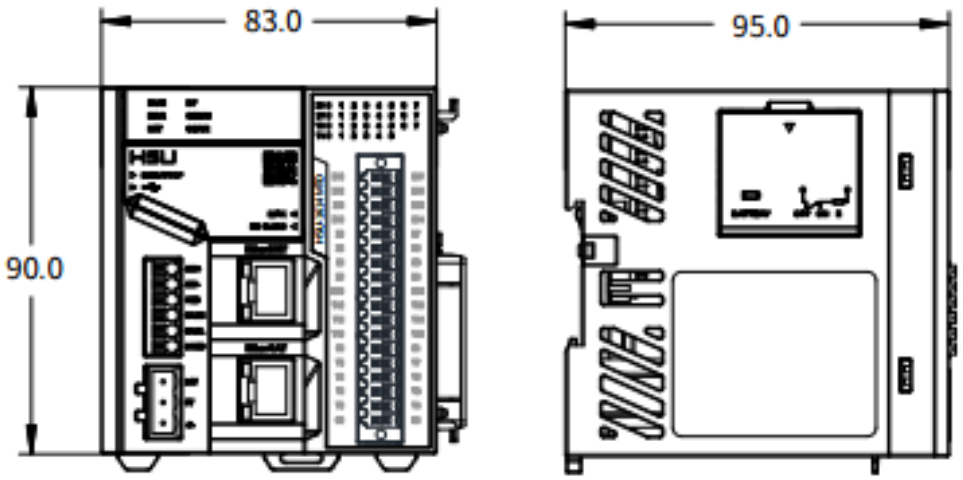
H5U	Specifications
Storage	200K program storage, 2MByte custom variable storage
Axes	EtherCAT: 32 axes Local Pulse: 4 axes
Serial port	1 x RS485
CAN port	CANlink, CANopen
Fast input	4 channel 200K
Fast output	4 channel 200K
Extension modules	16 Up to 72 EtherCAT stations (including Servos)
Program Language	LD, SFC, supports FB/FC (LD)
Ethernet	Modbus TCP, Socket, program upload/download Supports EtherCAT
USB、SD card	Program upload/download and firmware upgrade (only SD card)
Structure	Compact and small size: 83 x 90 x 95 (mm)



Hardware Interface

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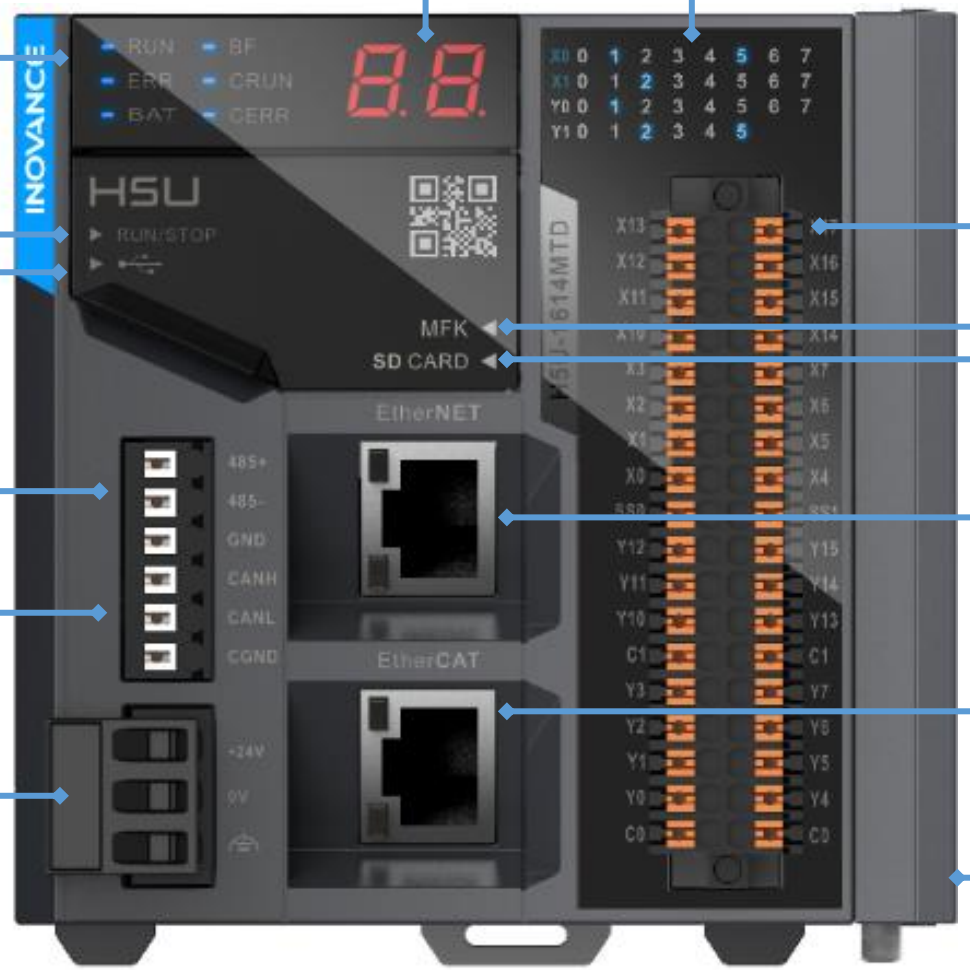

LED Display

IO Indicator

Status Indicator

RUN/STOP Switch

USB mini B port, programming download/upload

RS485 port

CANopen/CANlink port

24VDC power supply port

IO connector, spring type

Multi Function Key

SD Card Slot

Ethernet Port

EtherCAT port, support up to 72 slaves(32 axes)

Local Extension Interface, support up to 16 modules(under the end cover plate)

Typical Topology

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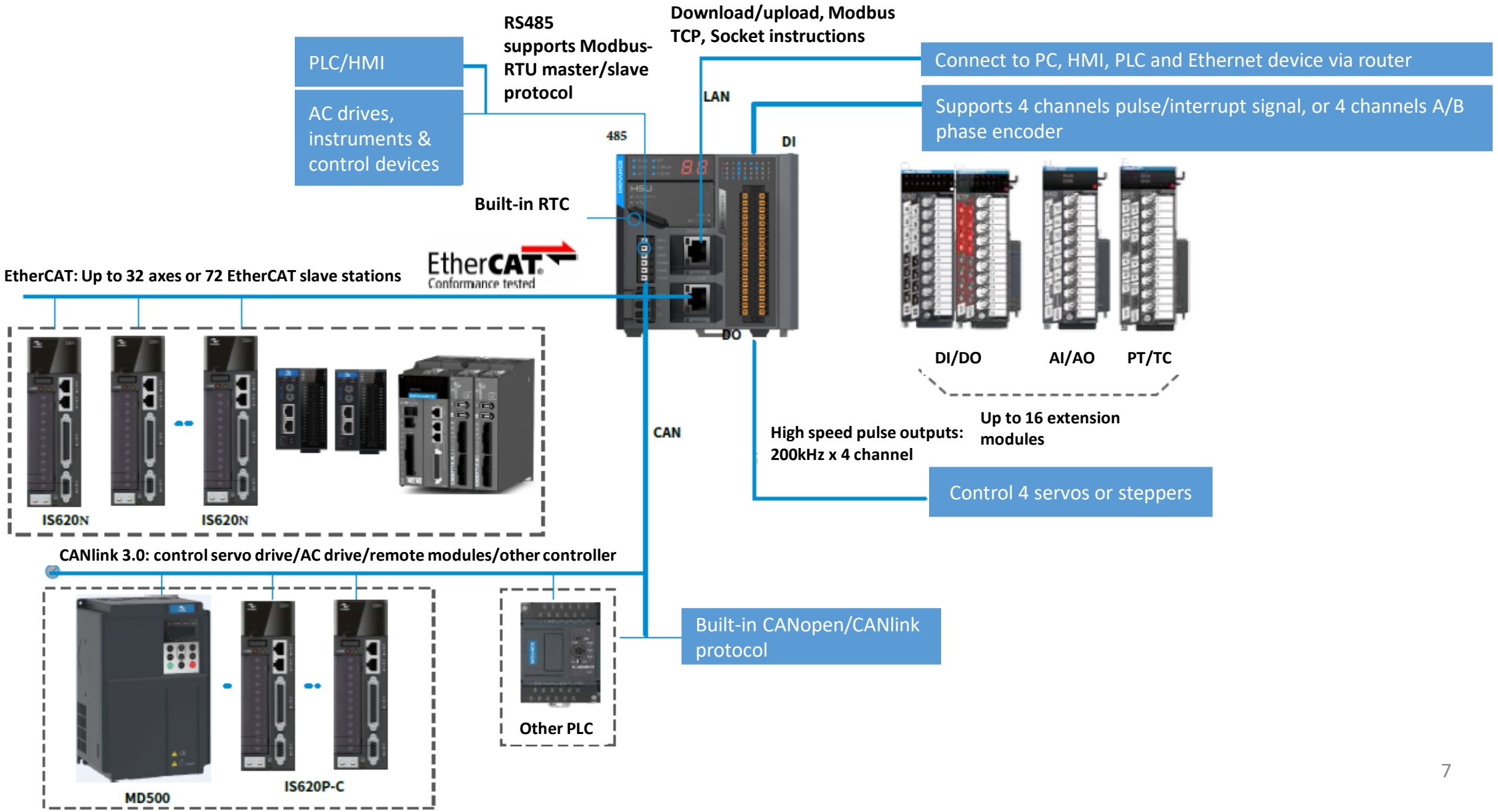

Available Models

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Model	Part No.	Description	CE
H5U-1614MTD	01440087	Programmable Logic Controller-H5U-1614MTD-H5U Series 16 Input 14 Output Programmable Logic Controller	Yes

AutoShop Software

Download and Installation

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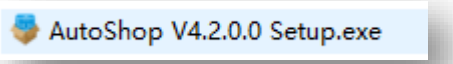
Download software(V4.2.0.0 or above) from website: https://www.inovance.com/hc/allResult?key=Autoshop, or contact local inovance representative to get the latest software.
After download the software, click the Autoshop V**** startup.exe file to install the software.



Create Project

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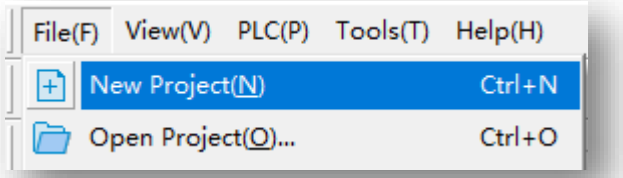
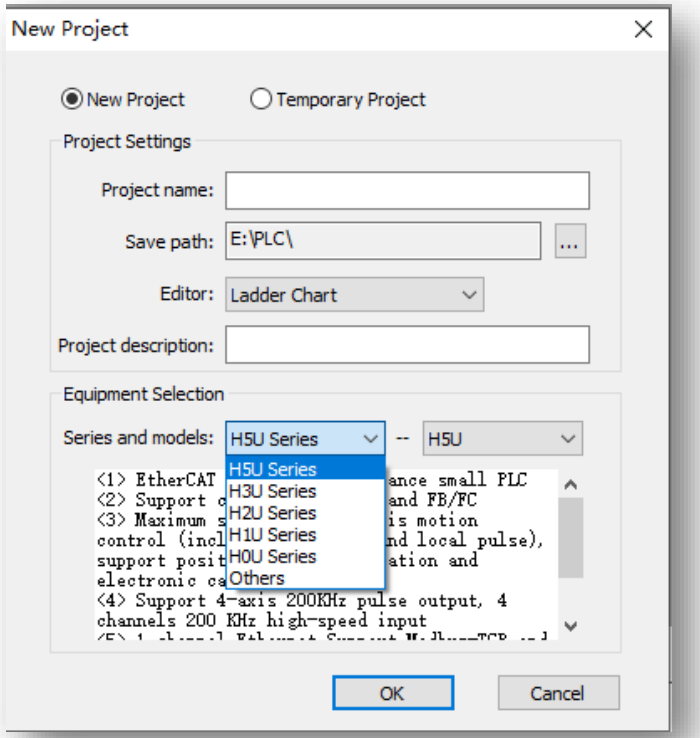
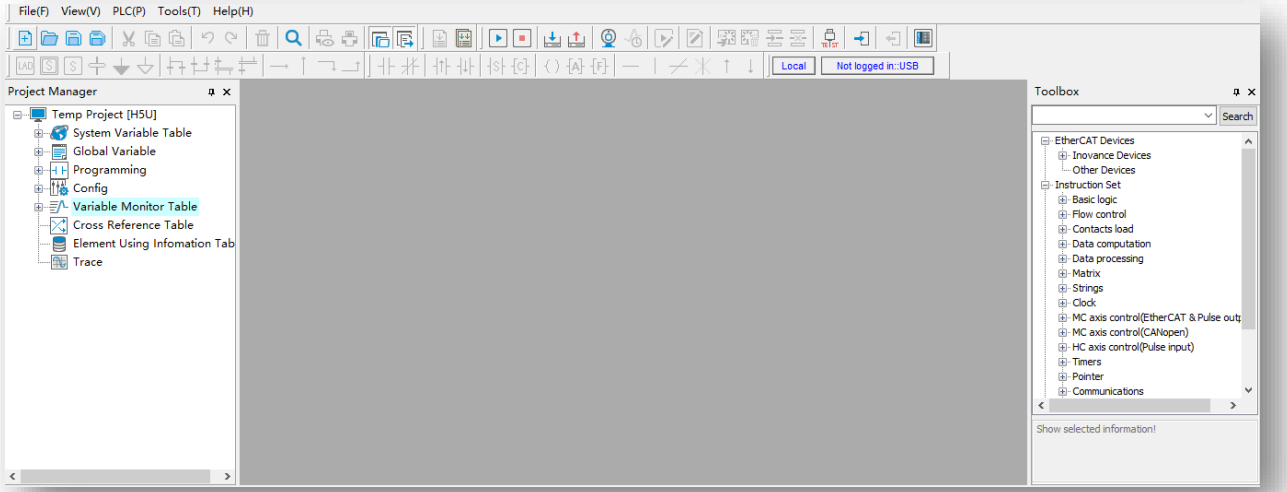
Click the icon to open Autoshop software, then select <File>→<New Project>



Set project name and save path according real demand, select <H5U Series> IN <Series and models>, then click <OK> button, a new project will be created.





UI Introduction

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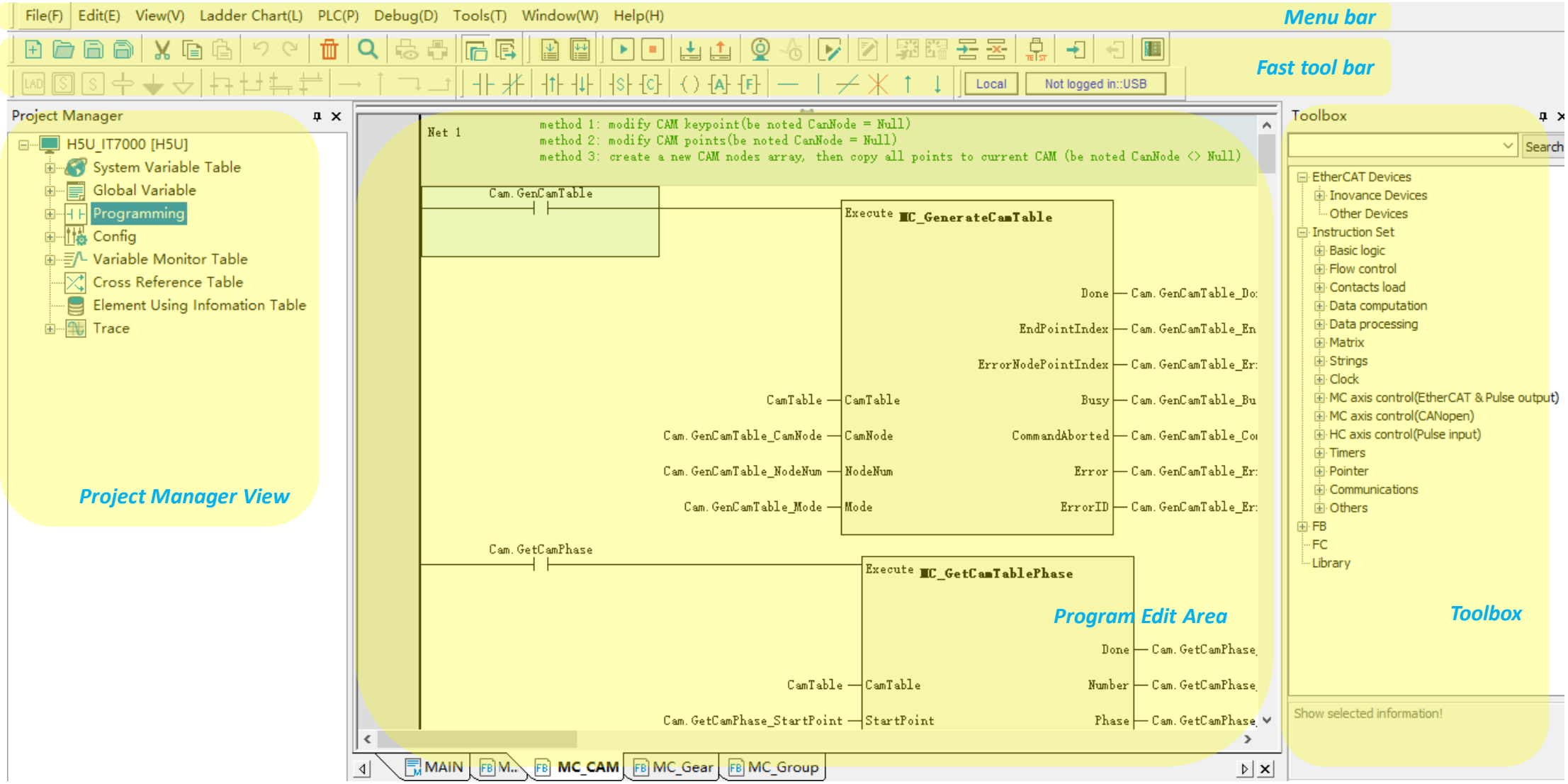
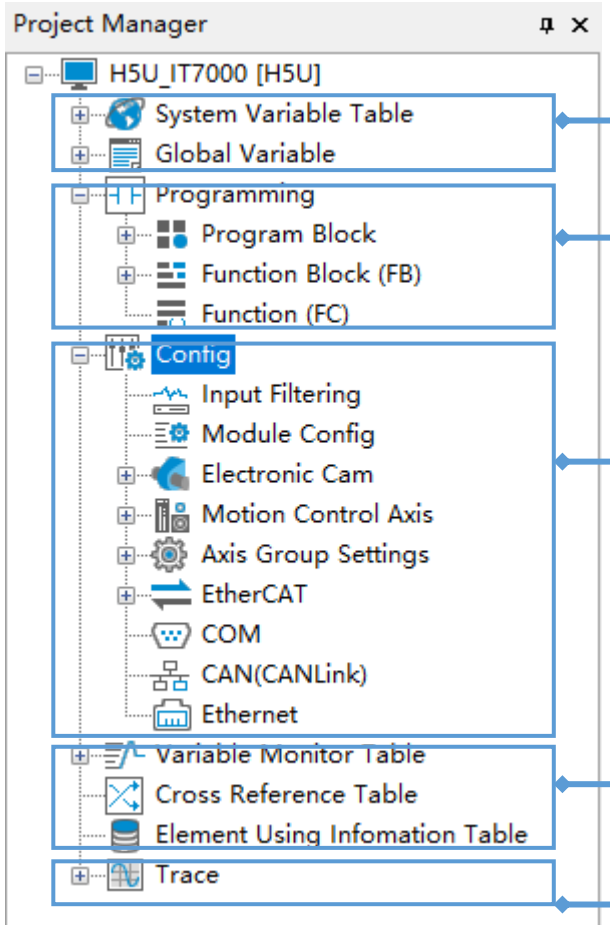


Project Manager



Variable area, include system variable and user defined variable

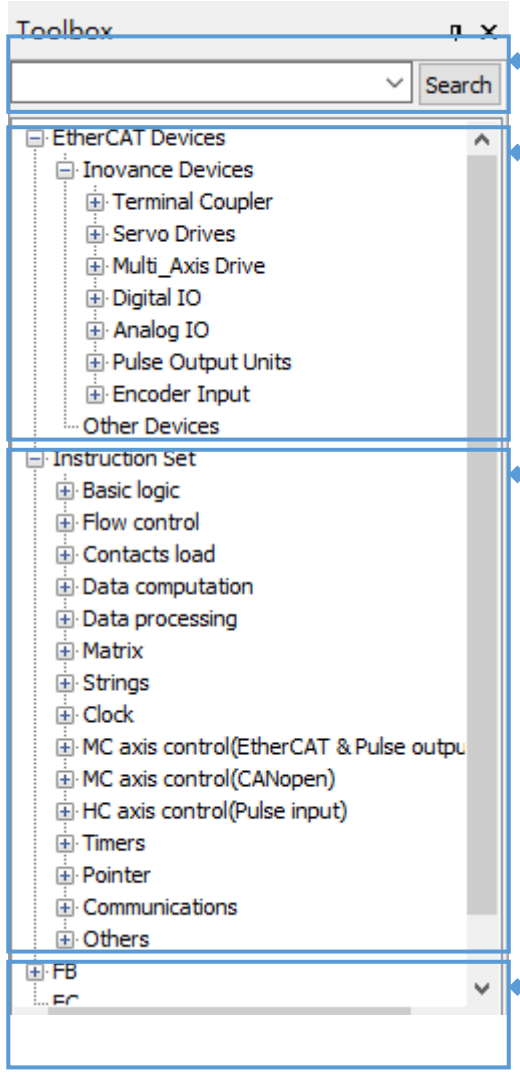
Programming area, include program block, function block and function

Configuration area, Input filter time setting, extension module configuration, CAM table edit, motion axis and axes group setting, etc.

Variable monitoring, cross reference table and element information table

Trace function

Toolbox



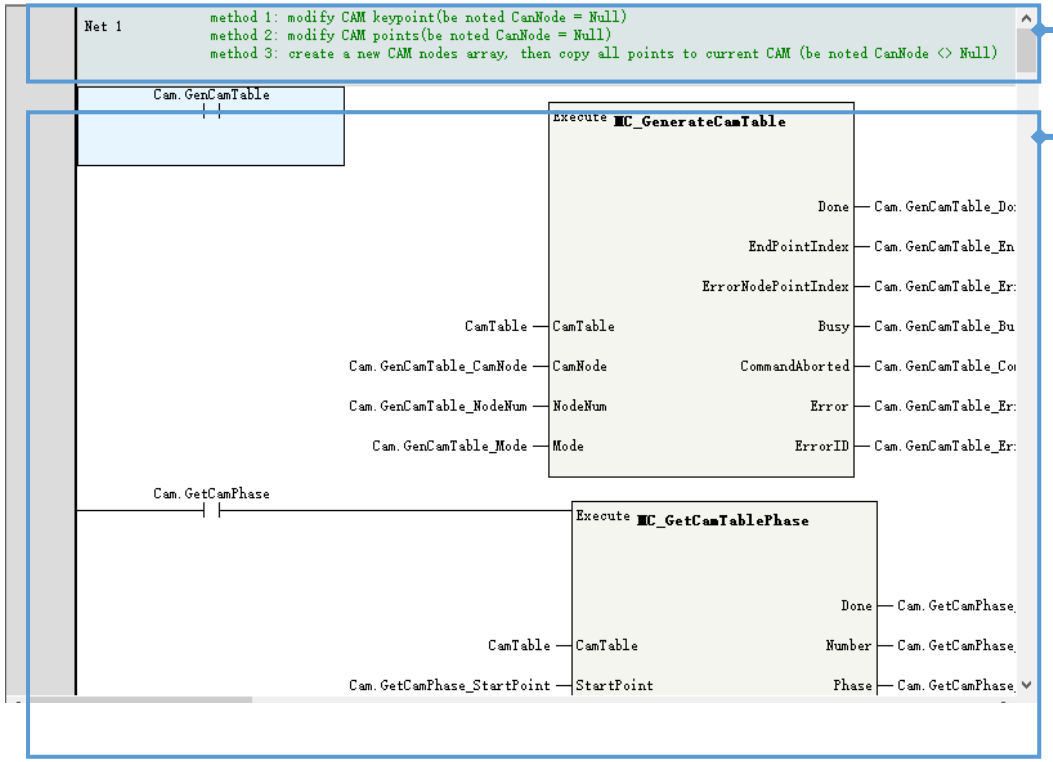
User can search the wanted item in this area

EtherCAT device, double click to add to EtherCAT configuration

Instruction guidance, double click to add to program edit area

If users use a self defined function block, they can find the FB/FC in this area, double click to add to program edit area

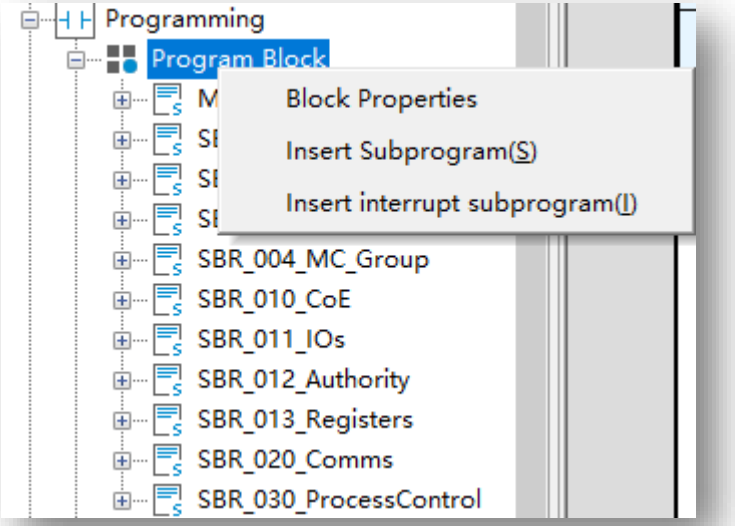
Program Edit Area



Comment area for a network

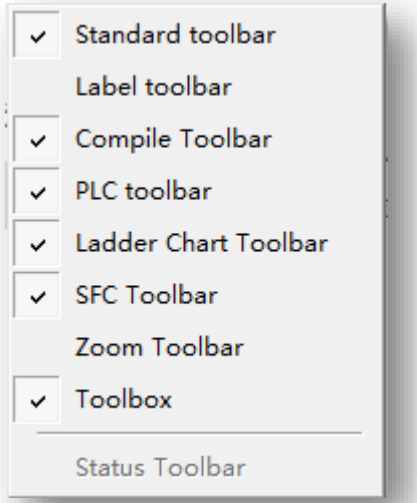
Programming area

Network is the basic unit of a program, a program is consist of different network and a project is consist of different programs(main program/sub program/interruption program)

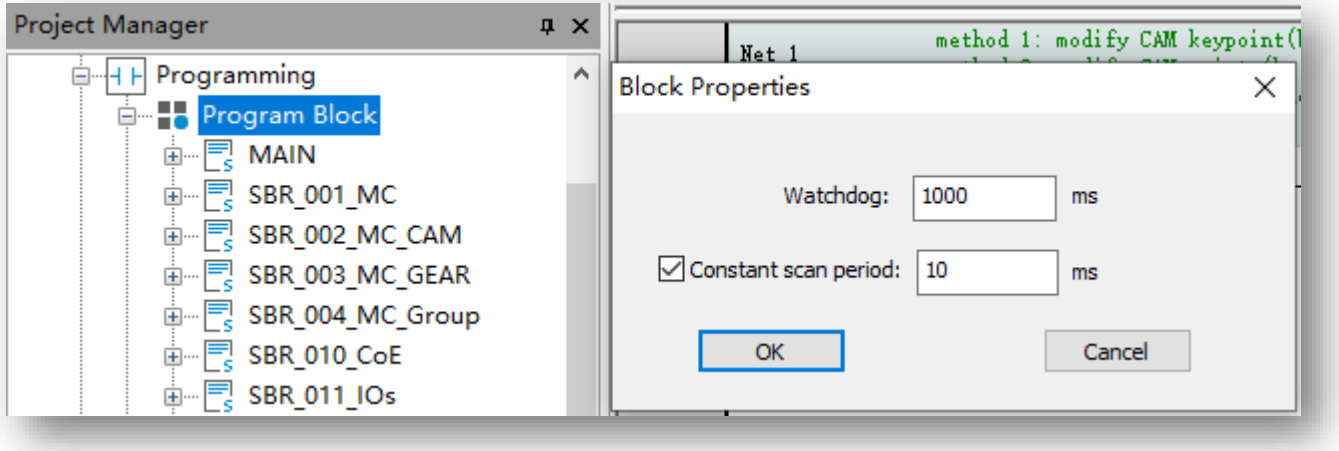


Fast Tool Bar

Fast tool bar integrated normal used function button for fast editing purpose, such like open/create/save a project, programming edit tool, online simulation and compile/download, etc. Users can add/delete the tool bar according the real demand. Users can right click in this area to select the wanted tools(Normally not recommend to modify this area).



➢ PLC program executing cycle

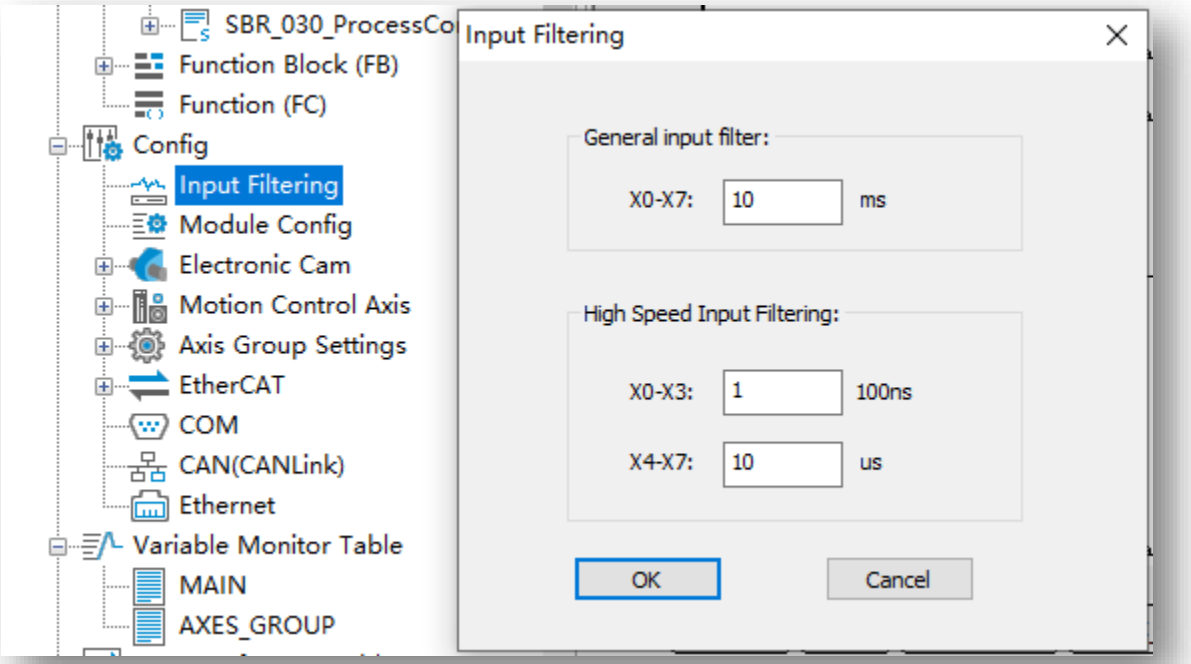


In the <Project Manager>—<Programming>, double click <Program Block> to get into project executing cycle setting view.

If <Constant scan period> not checked, the scan cycle decided by the real scan time
If <Constant scan period> checked, the scan cycle will follow the preset time, be noted while the real executing time greater than the preset constant time, the scan cycle will follow the real project executing time

<Watchdog> is used to monitoring the project executing, if the executing time over the watchdog time, the error will occur, in this case, please increase the watchdog time appropriately or check the program logic. If the program logic is complicated and need time to calculation, users can use the WDT instruction in the program to restore the monitoring time.

Input filter Setting



In the <Project Manager>—<Config>, double click <Input Filtering> to get into project input filter setting view.

While using external high speed input(encoder/or servo pulse feedback), the input frequency is high and the signal could not stable, in this case, users can adjust the input filter to filter the signal disturbance. (Usually use the default value.)

Module Configuration

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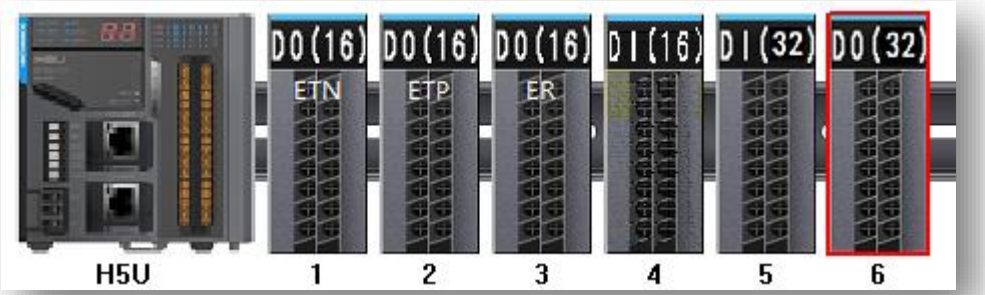
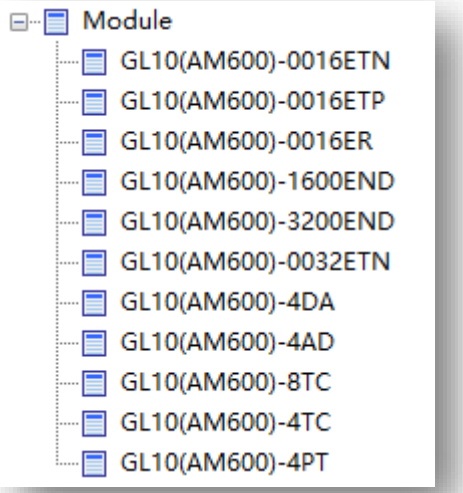
H5U support up to 16 local extension modules, the configuration diagram and the supported modules show as below:





Model type	Description
GL10-0016ETN	16 NPN output module
GL10-0016ETP	16 PNP output module
GL10-0016ER	16 relay output module
GL10-1600END	16 source/sink input module
GL10-3200END	32 source/sink input module
GL10-0032ETN	32 NPN output module
GL10-4DA	4 analog output module
GL10-4AD	4 analog input module
GL10-8TC	8 channels temperature detection module (thermocouple)
GL10-4TC	4 channels temperature detection module(thermocouple)
GL10-4PT	4 channels temperature detection module(thermal resistance)

Module Configuration

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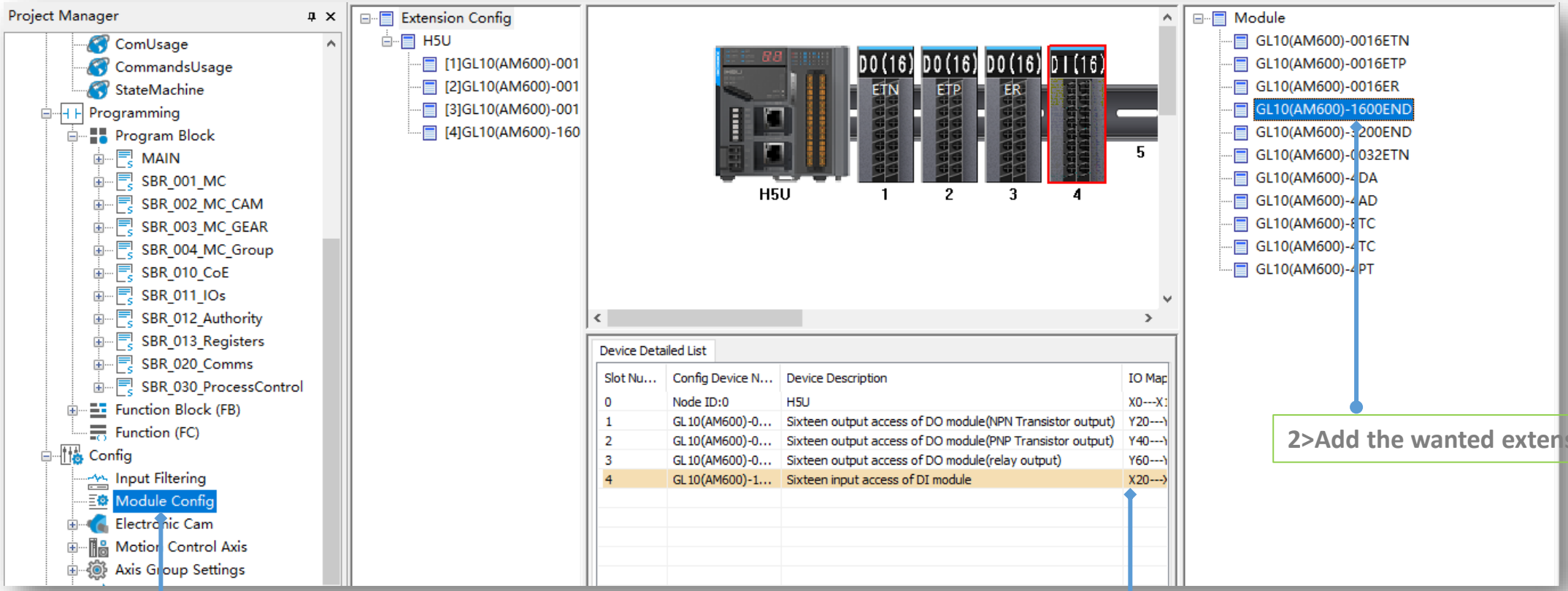

2>Add the wanted extension module

1>Double click <Module Config> to open the module configuration view

Take note that make sure the configuration extension modules are same with the real product(sequence, quantity, model type, etc.)

3>Click the corresponding extension module to get into dedicated module setting view(**Next page**)

Module Configuration

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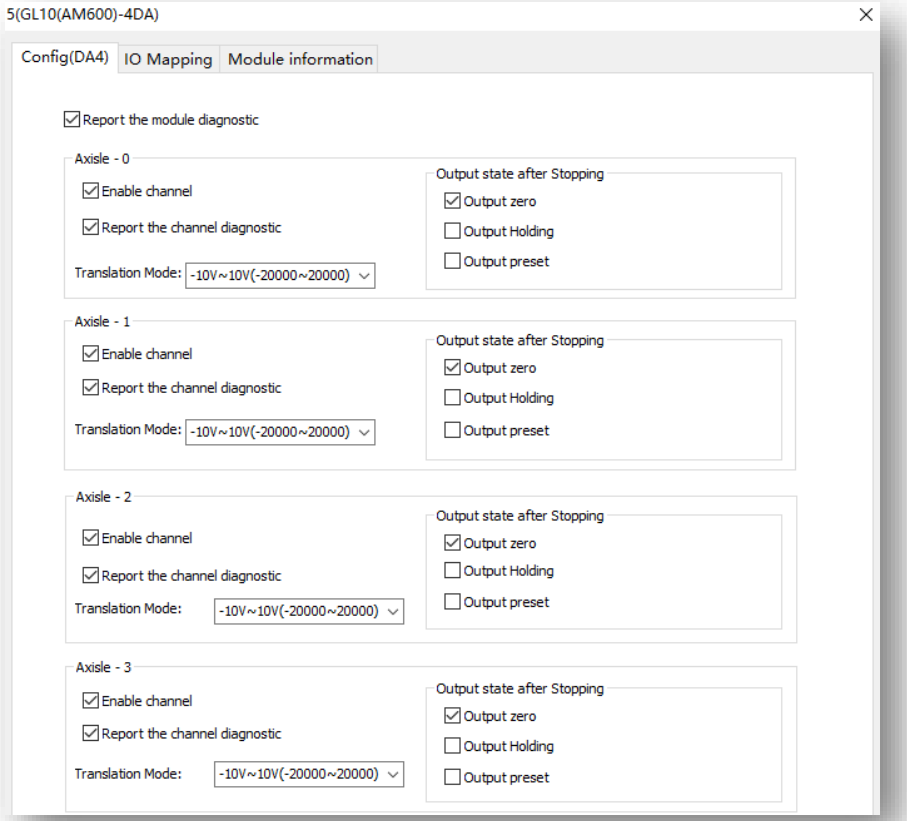
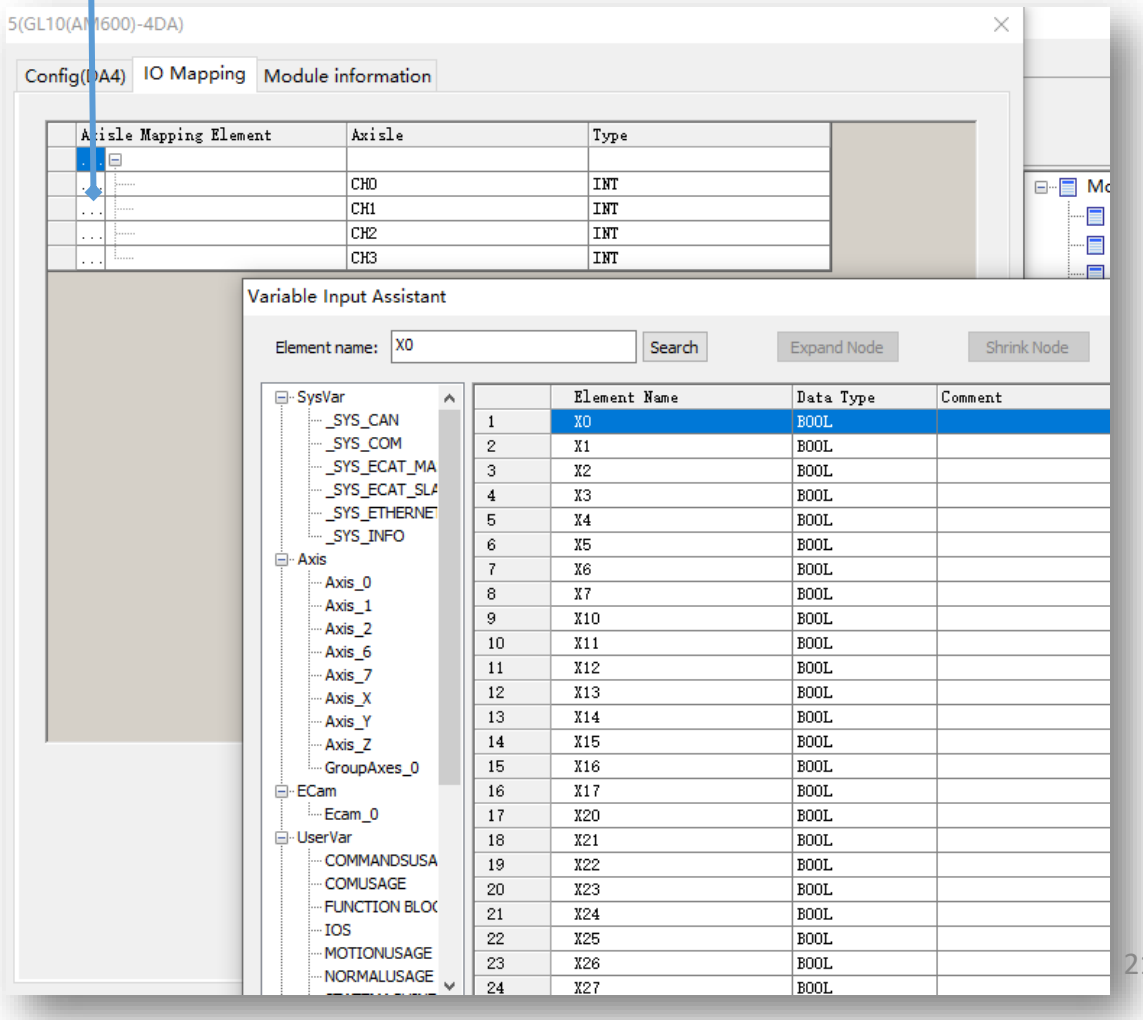
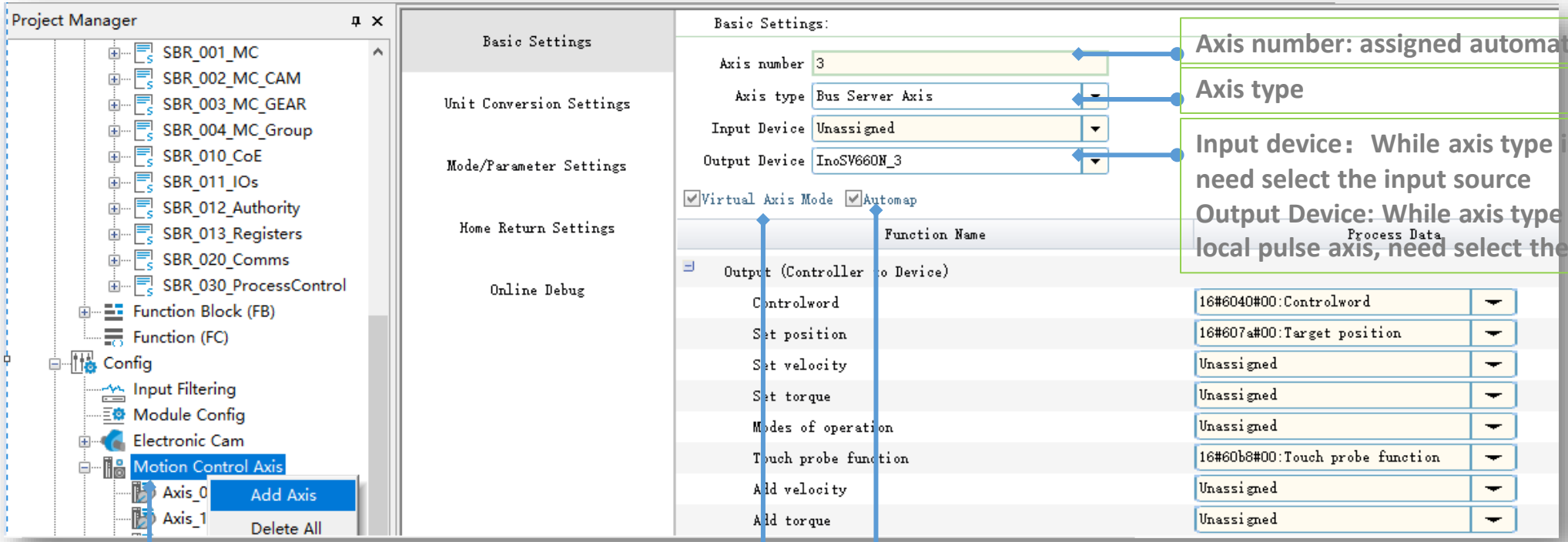


The parameters meaning please refer to the corresponding module's guidance.

Click <...> to assign the variable or soft element to extension module's input/output



➢ Basic Settings



Axis number: assigned automatically

Axis type

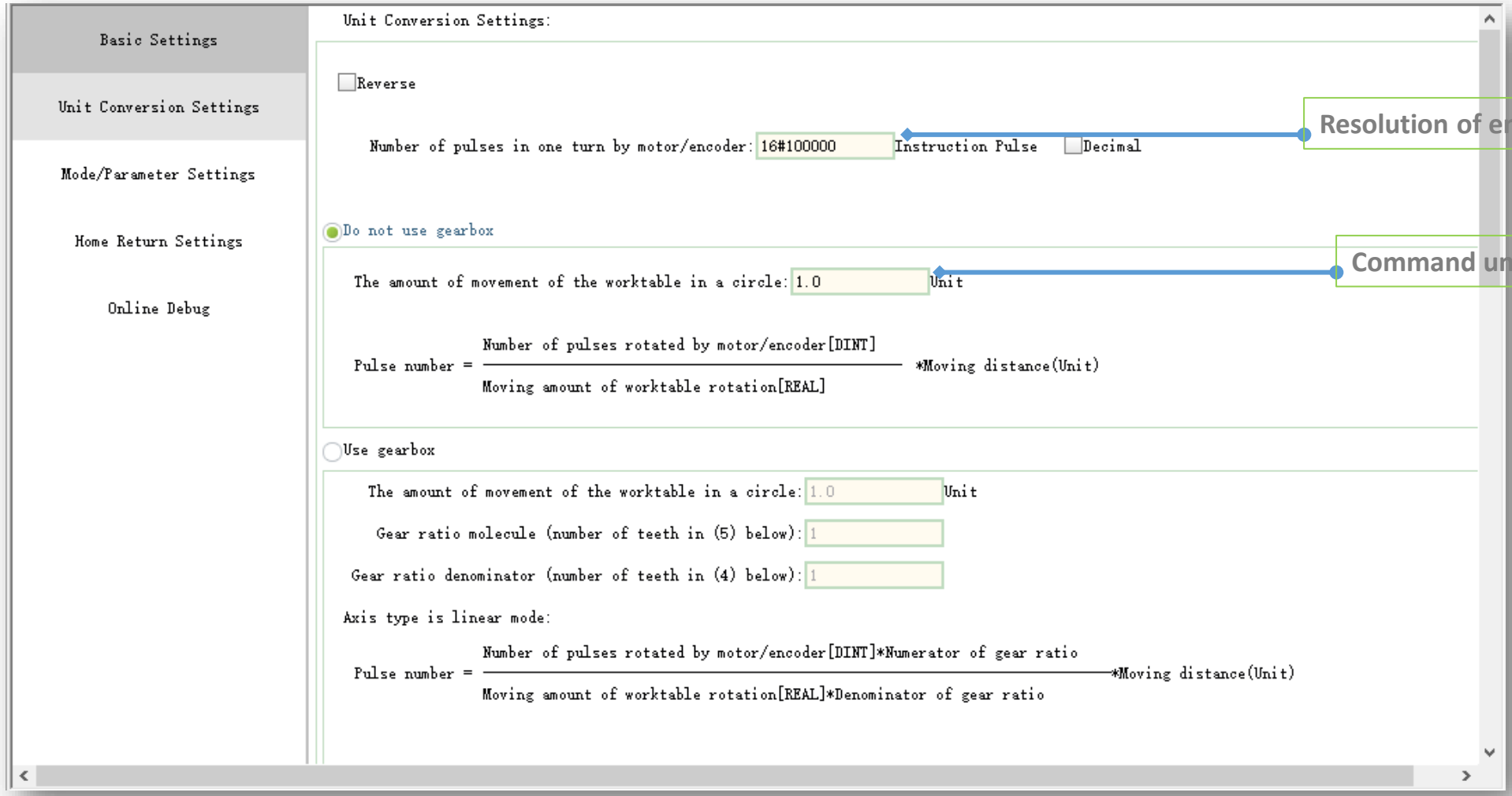
Input device： While axis type is encoder axis, need select the input source
Output Device: While axis type is bus axis/or local pulse axis, need select the output source

Auto map to process data of EtherCAT slave, **do not manually set**

Right click <Motion Config Axis> to add an axis, then click the <Axis Name> to open the axis configuration view

While <Virtual Axis Mode> Checked, the axis will work at virtual mode, which means there is no instant axis operated by the controller, all axis parameters generated by controller

Unit Conversation Setting



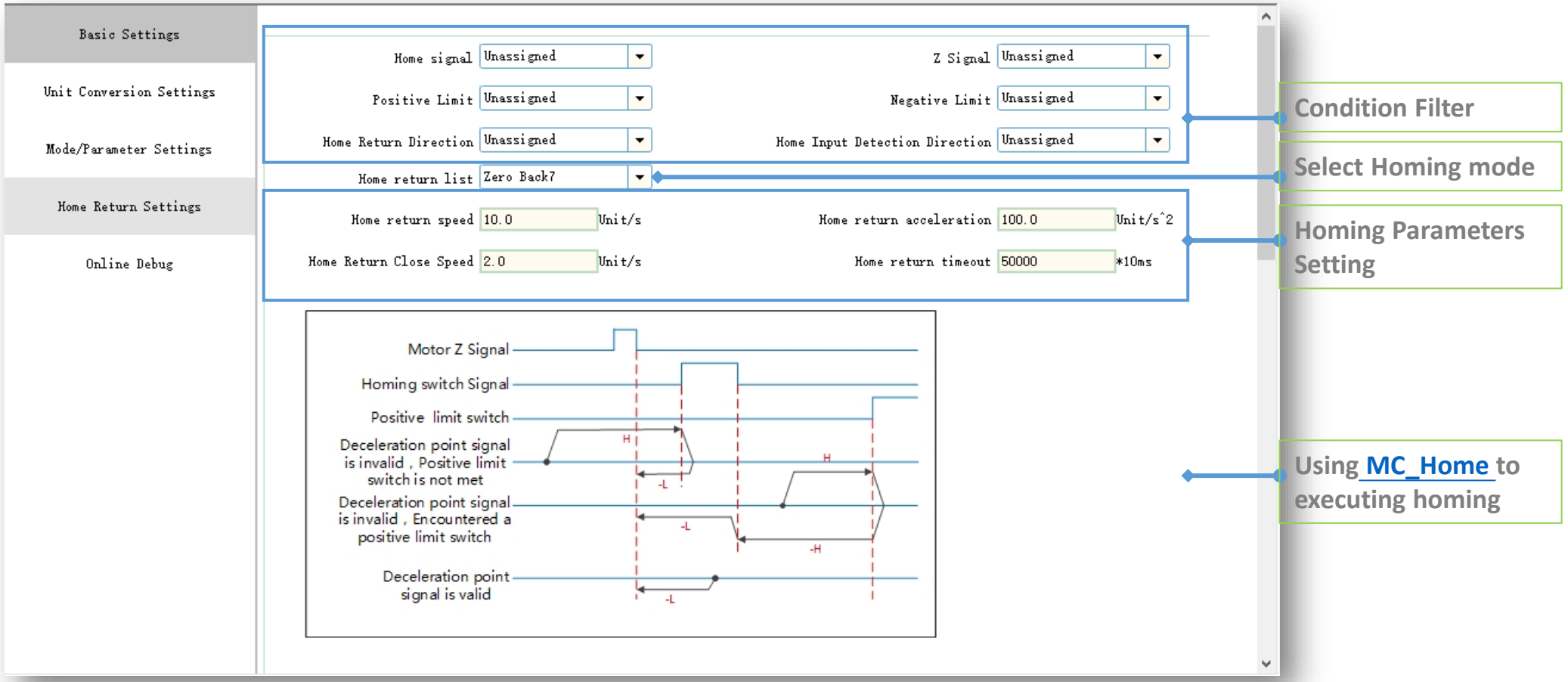
Resolution of encoder

Command unit in a circle

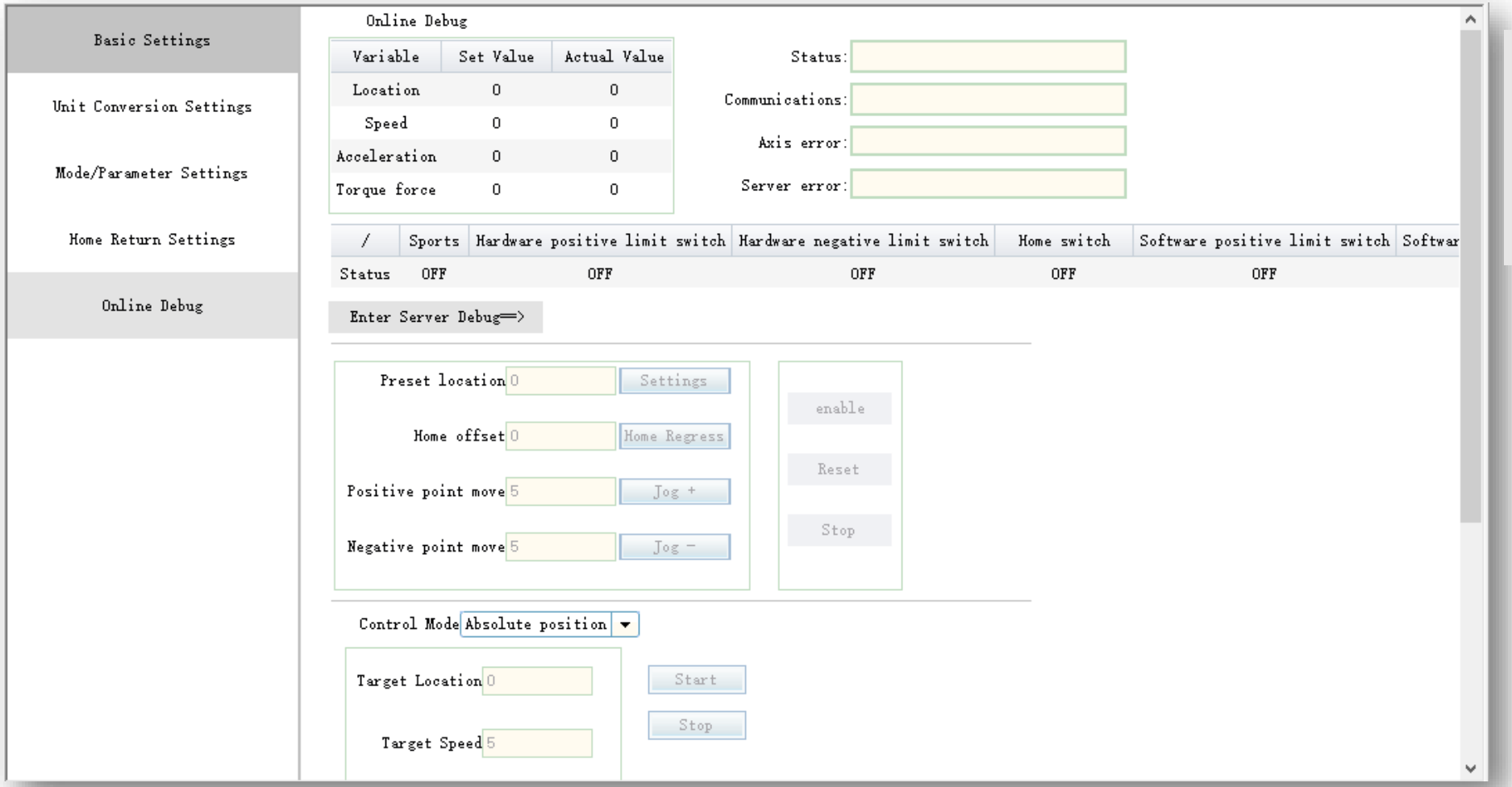
➢ Mode/Parameters Setting

Set the encoder mode, drive working mode and velocity limit, etc.

Home Return Settings



Online Debug



H5U support online debug without programming, it is a convenient function for machine commissioning stage.

EtherCAT Configuration

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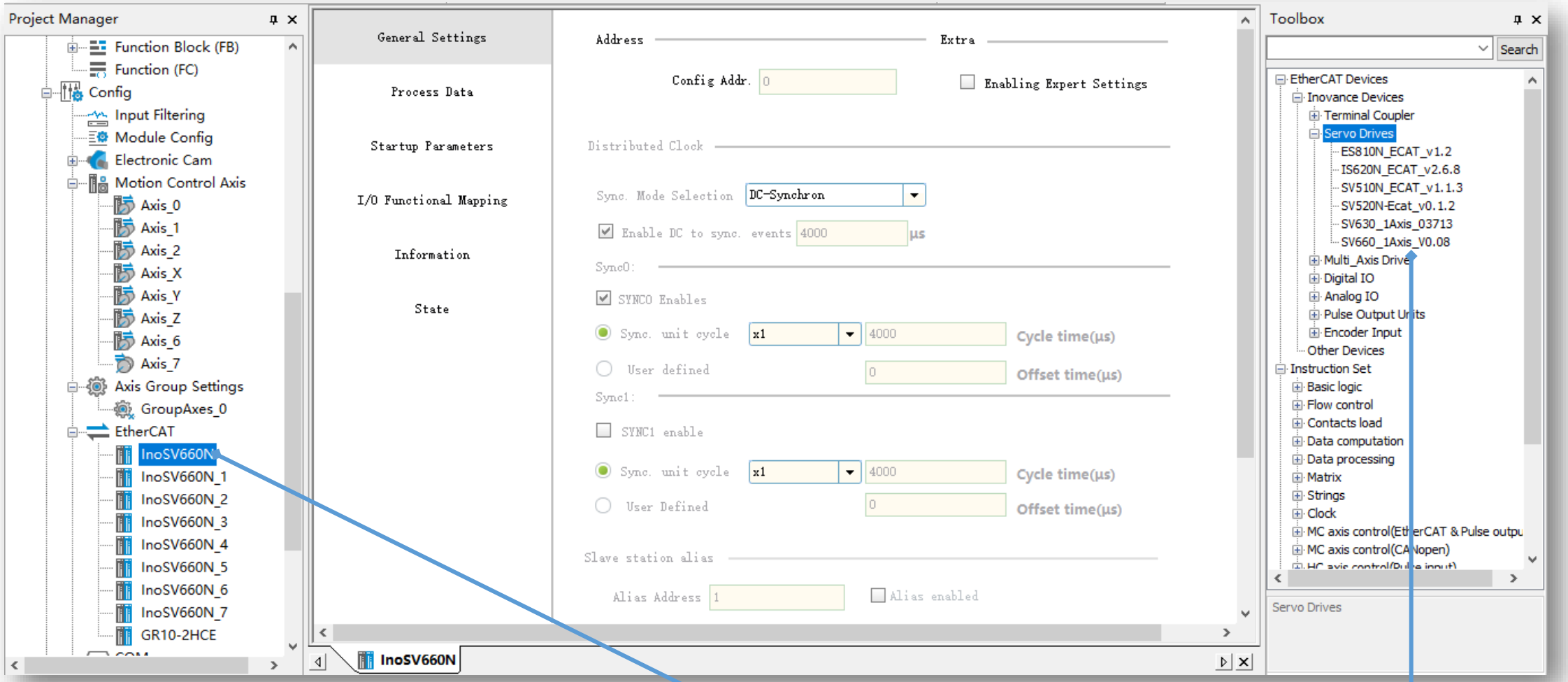
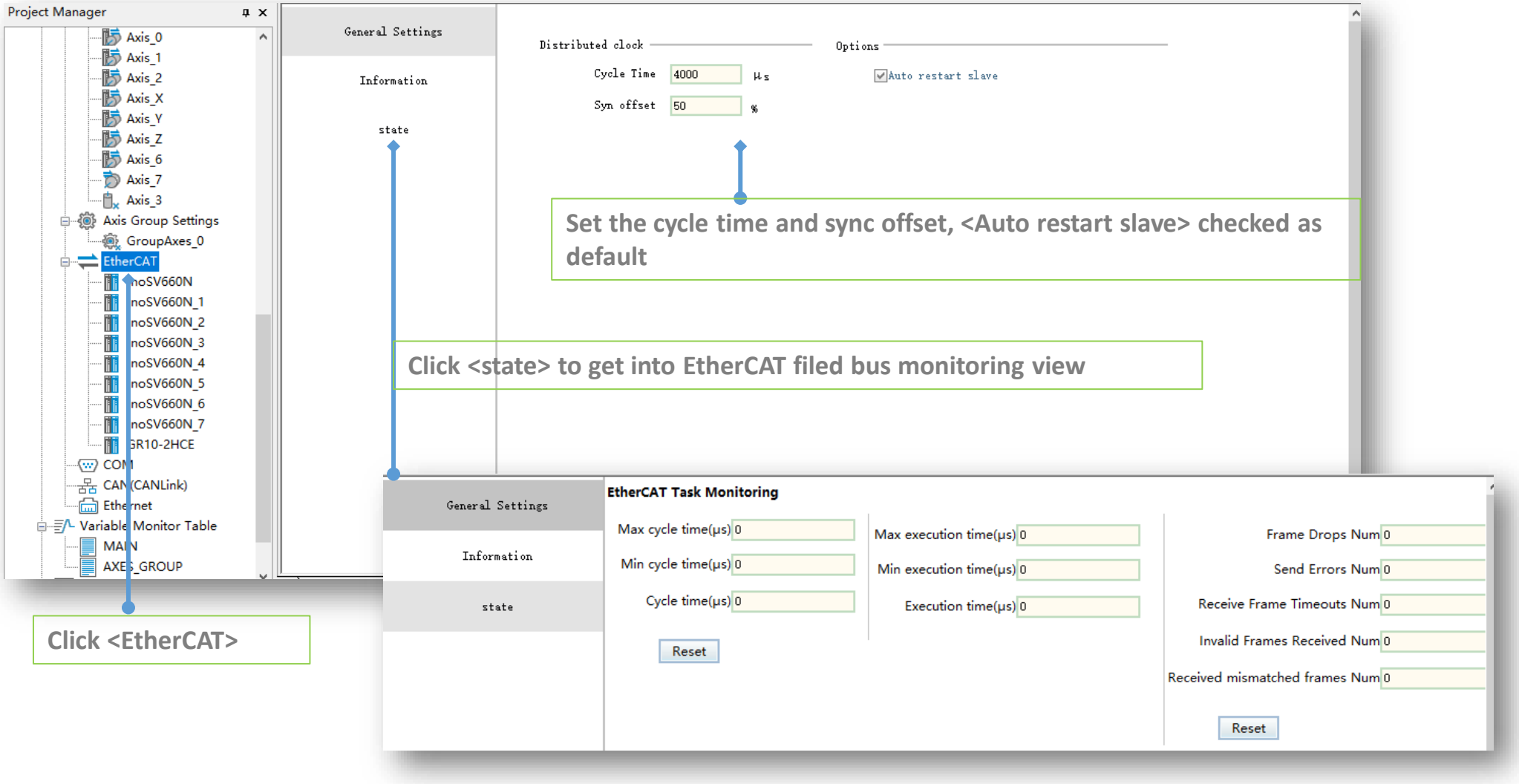


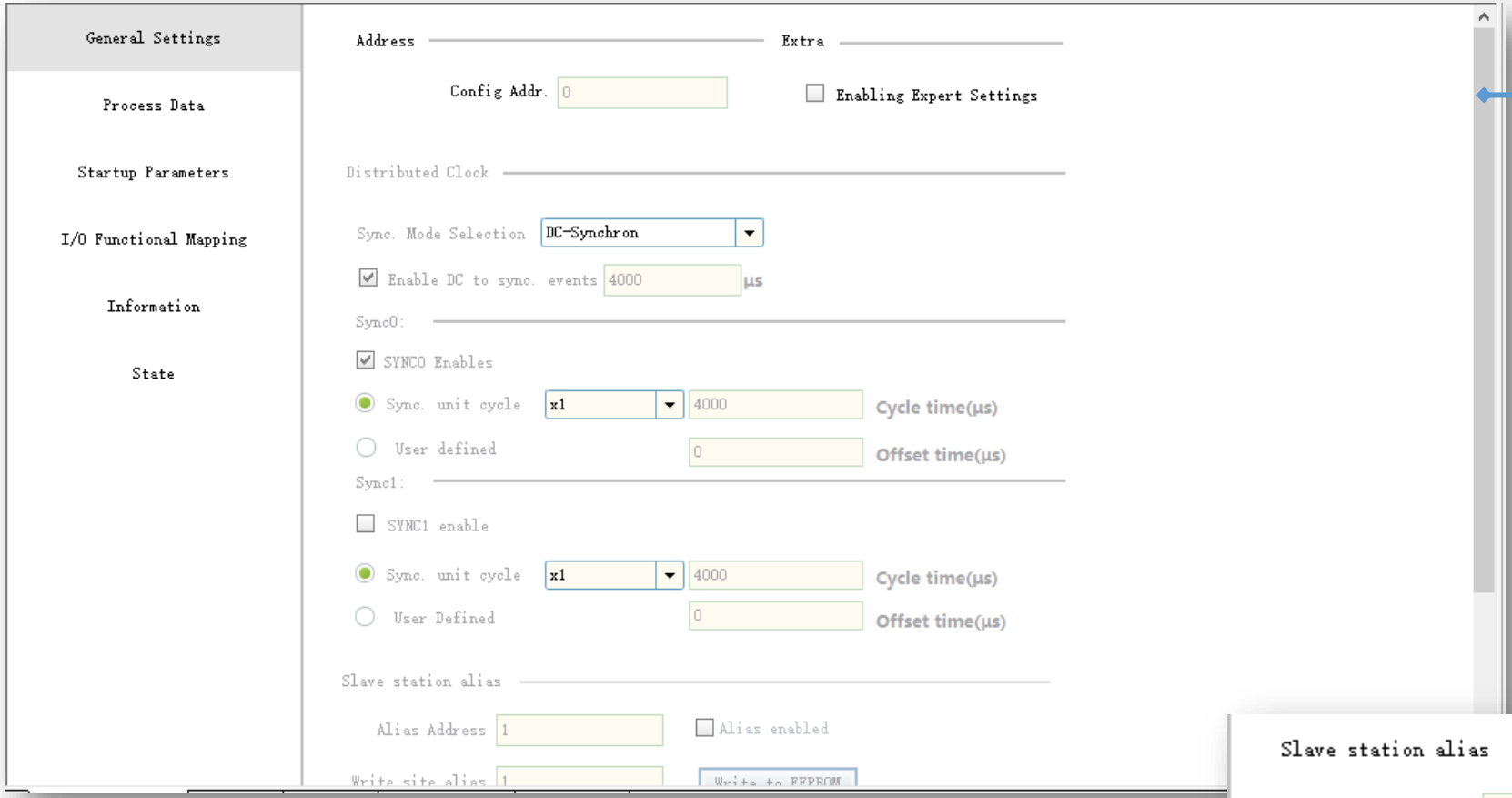
Be noted only when EtherCAT slaved added users can select corresponding <Bus Server Axis> _<Output Device> in <Motion Controller Axis> configuration

Double click in the <Toolbox> to add the device to <EtherCAT>

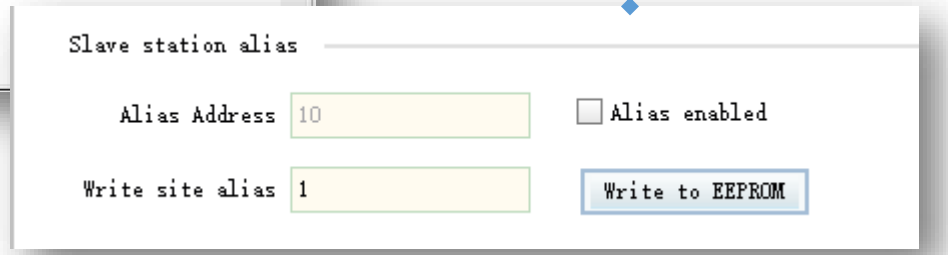
➢ EtherCAT Setting



General Setting



Set the sync mode, sync cycle and alias slave address. Using the default setting in this page unless when users need to set the slave alias, check the <Enabling Export Settings>



➢ Process Data

General Settings

Process Data

Startup Parameters

I/O Functional Mapping

Information

State

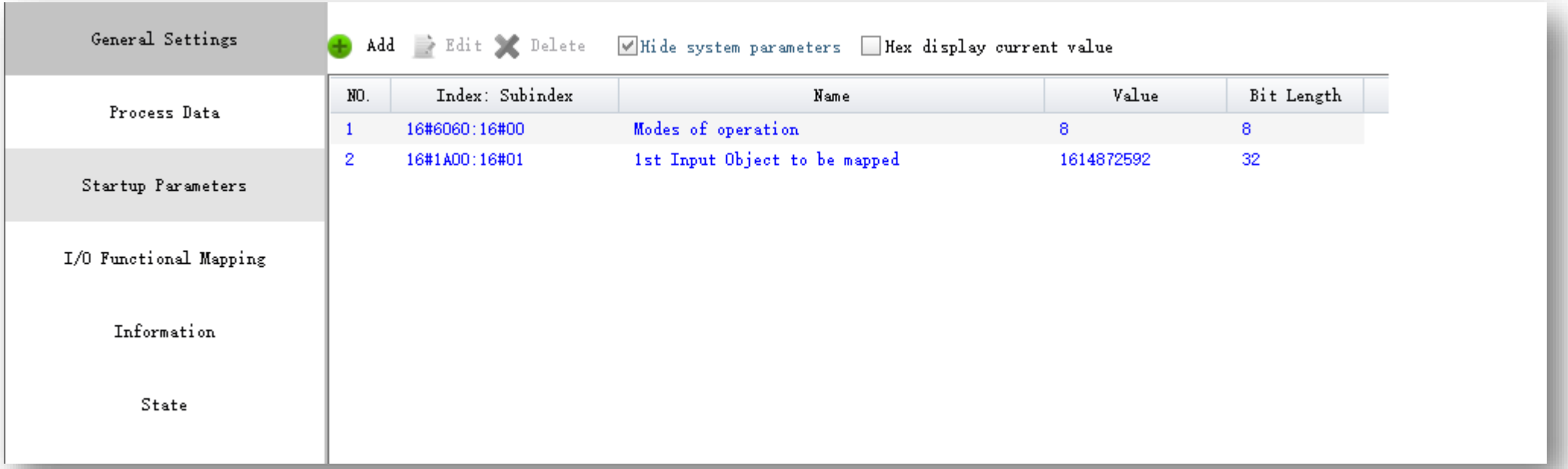
Add | Edit | Delete | Collapse | Show All | PDO Assign | PDO Config | PDO Data Size | Output(Byte):10 Input(Byte):28

Input/Output	Name	Index	Subindex	Length	Sign	SM	Type
Output	Outputs	16#1600	16#00	10	Editabl	2	
Output	Following error time out	16#6066	16#0	2			UINT
Output	Controlword	16#6040	16#0	2			UINT
Output	Target position	16#607A	16#0	4			DINT
Output	Touch probe function	16#60B8	16#0	2			UINT
Output	Outputs	16#1701	16#00	12	F		
Output	Outputs	16#1702	16#00	19	F		
Output	Outputs	16#1703	16#00	17	F		
Output	Outputs	16#1704	16#00	23	F		
Output	Outputs	16#1705	16#00	19	F		
Input	Inputs	16#1A00	16#00	22	Editabl		
Input	Inputs	16#1B01	16#00	28	F	3	
Input	Error code	16#603F	16#0	2			UINT
Input	Statusword	16#6041	16#0	2			UINT
Input	Position actual value	16#6064	16#0	4			DINT
Input	Torque actual value	16#6077	16#0	2			INT
Input	Following error actual value	16#60F4	16#0	4			DINT
Input	Touch probe status	16#60B9	16#0				
Input	Touch probe pos1 pos value	16#60BA	16#0				
Input	Touch probe pos2 pos value	16#60BC	16#0				

Set the RPDO(Output) and TPDO(Input) of the EtherCAT slave, while adding the slave there is default PDOs checked. Users can modify the OD in a PDO by real demand or select other pre-defined PDO. About the PDO specifications please refer to dedicated slave manual, for example, SV660N support 6 RPDO and 5 TPDO.

RPDO (Six)	1600h	Variable mapping
	1701h to 1705h	Fixed mapping
TPDO (Five)	1A00h	Variable mapping
	1B01h to 0x1B04h	Fixed mapping

➢ Startup Parameters(SDO)



Set the SDO (service data object) data. These data will be written to slave in the fieldbus start process(pre-operational state), when the field bus running(OP state), these data will not update to slave unless using CoE command to read/write a certain object dictionary. Usually users can configure some initialization parameters which not need to modify many times like gear ratio, homing acceleration/deceleration velocity, etc. If not familiar with these operation, just leave it and use the default setting.

I/O Functional Mapping

General Settings

Process Data

Startup Parameters

I/O Functional Mapping

Information

State

Hex display current value

Variable		Channel	Type	Current Value
_IQ10_0	...	Controlword	UINT	
_IQ10_1	...	Target position	DINT	
_IQ10_2	...	Touch probe function	UINT	
_IQ10_3	...	Physical outputs	UDINT	
_IQ10_4	...	Error code	UINT	
_IQ10_5	...	Statusword	UINT	
_IQ10_6	...	Position actual value	DINT	
_IQ10_7	...	Torque actual value	INT	
_IQ10_8	...	Following error actual value	DINT	
_IQ10_9	...	Touch probe status	UINT	
_IQ10_10	...	Touch probe pos1 pos value	DINT	
_IQ10_11	...	Touch probe pos2 pos value	DINT	
_IQ10_12	...	Digital inputs	UDINT	

Map the process data to local variable, be noted if using an EtherCAT axis, these variables can only be operated by motion control blocks.

Trace Function

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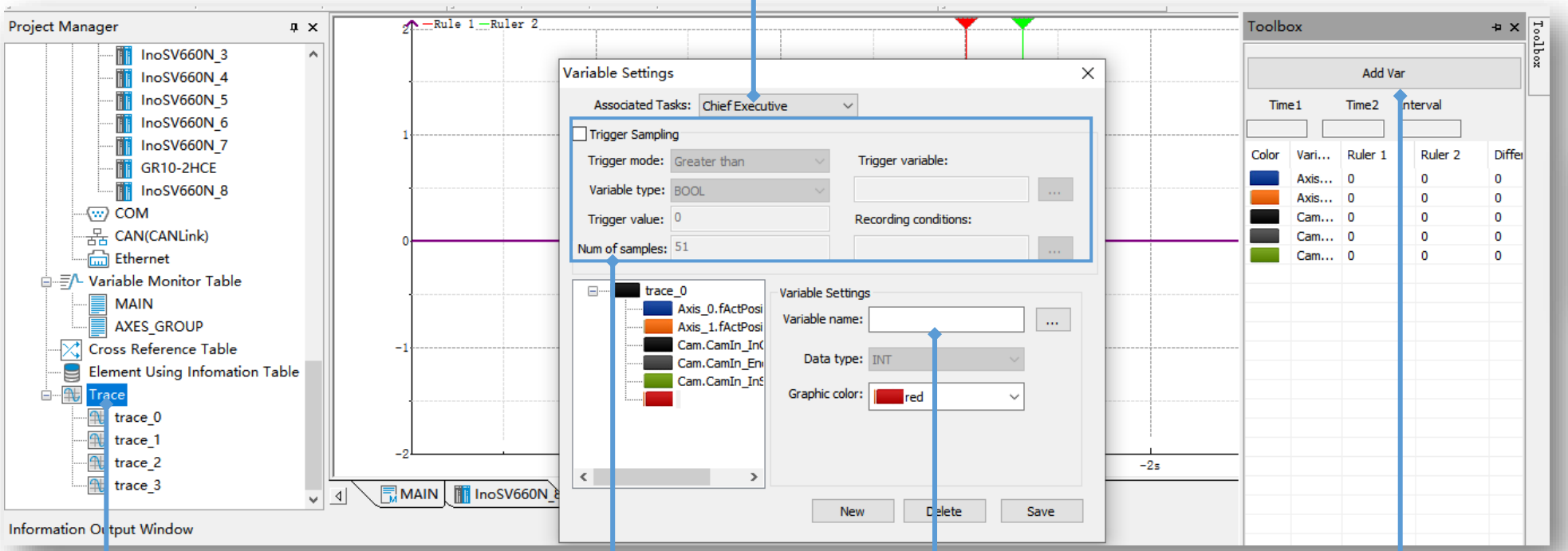
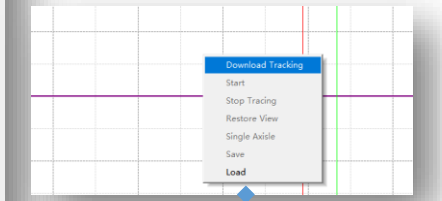
3>Select the trace cycle—follow main cycle or EtherCAT cycle





5>While PLC running(or simulation), right click to download the trace

1>Right click to add a trace

Trigger sampling setting

4>Select the variable to monitoring

2>Click <Add Var> to add variable

Connection with PLC

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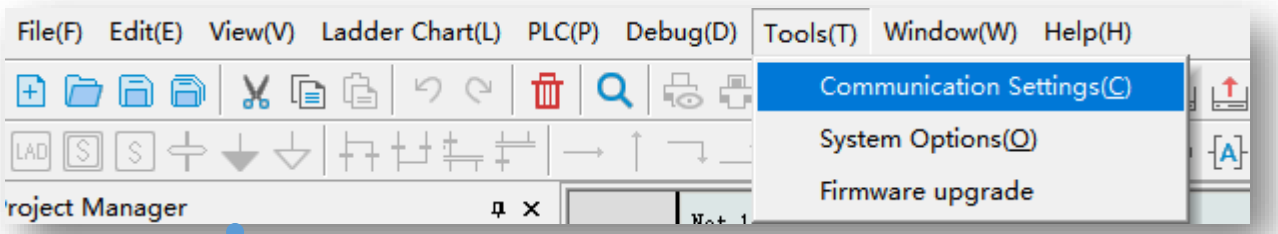
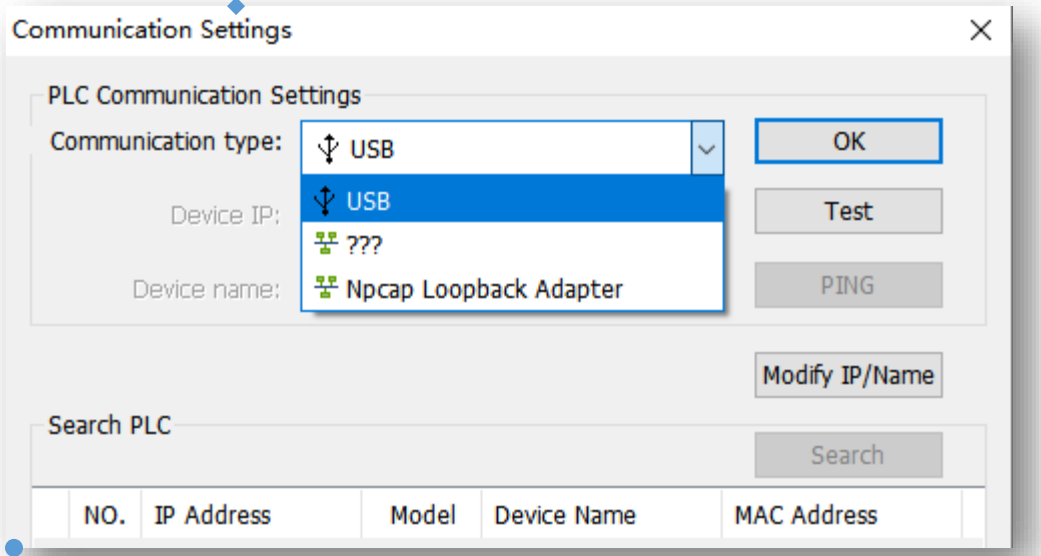
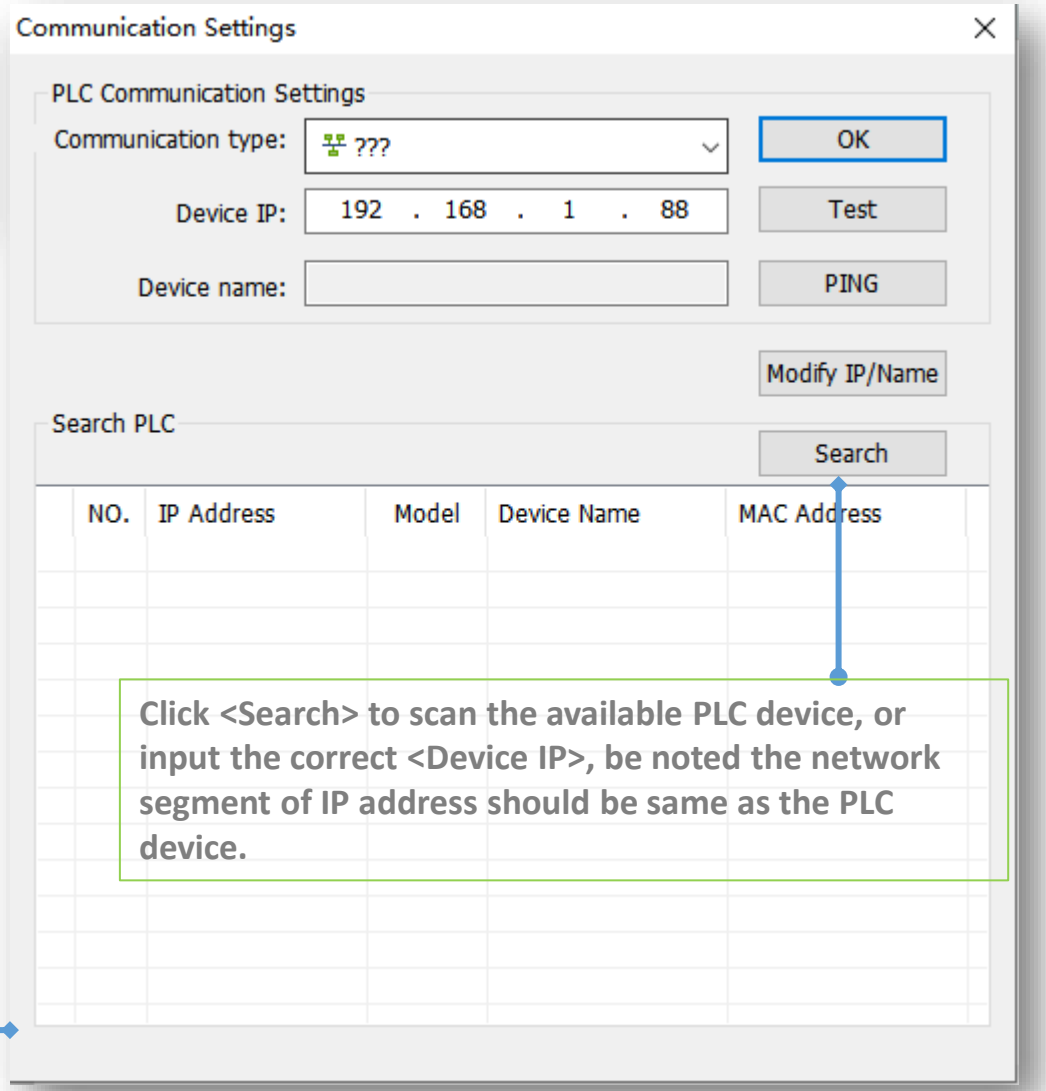


<Tool>→<Communication>



USB: using mini B port to upload/download/monitoring
???(it is software bug, will be fixed in next version):Ethernet port



Click <Search> to scan the available PLC device, or input the correct <Device IP>, be noted the network segment of IP address should be same as the PLC device.

Connection with PLC

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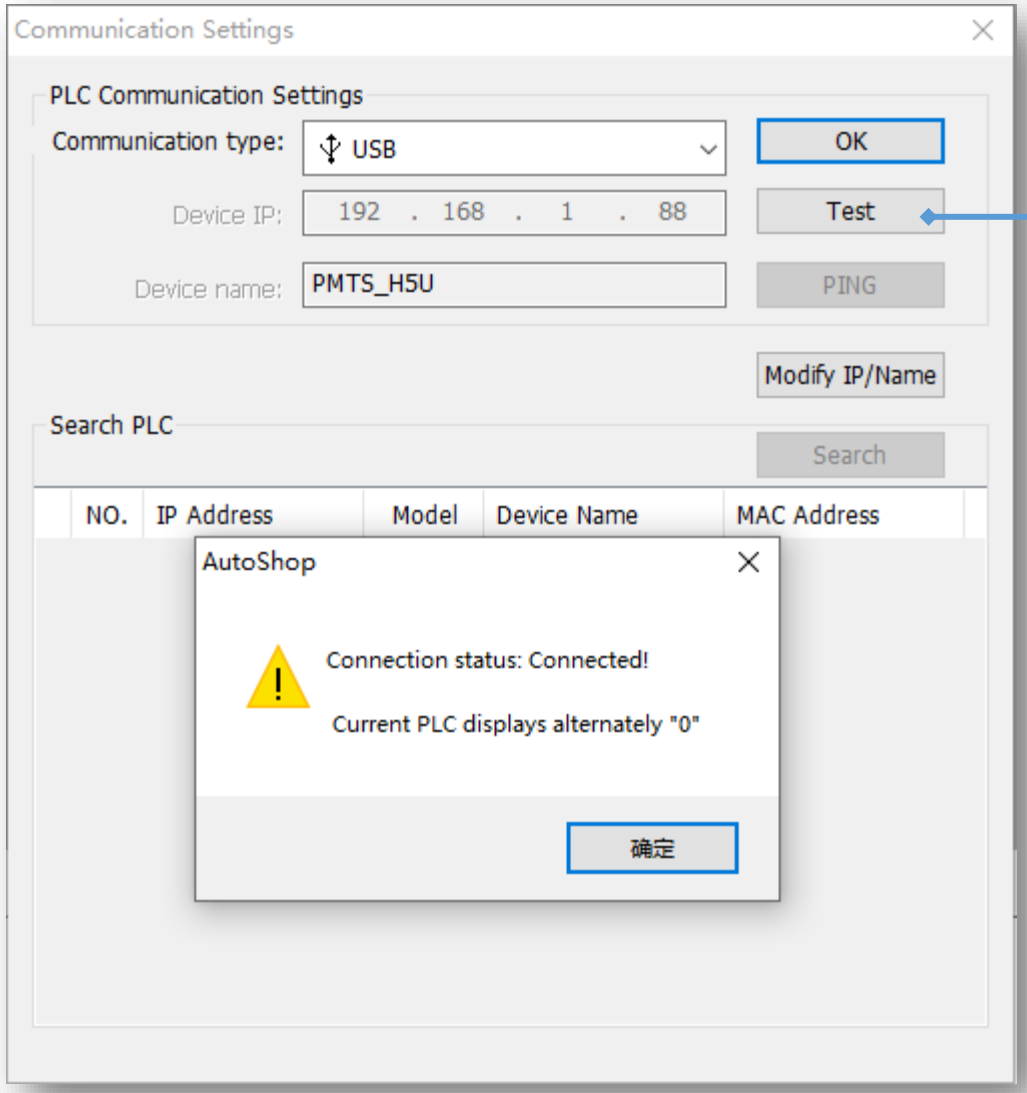

Click <Test> to check if the connection is good.

Programming Download & Upload

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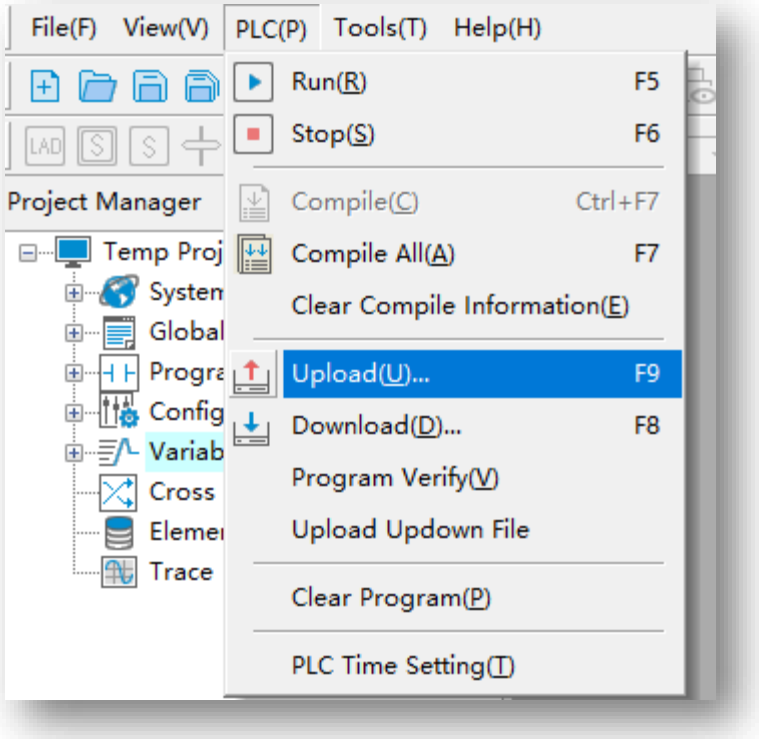
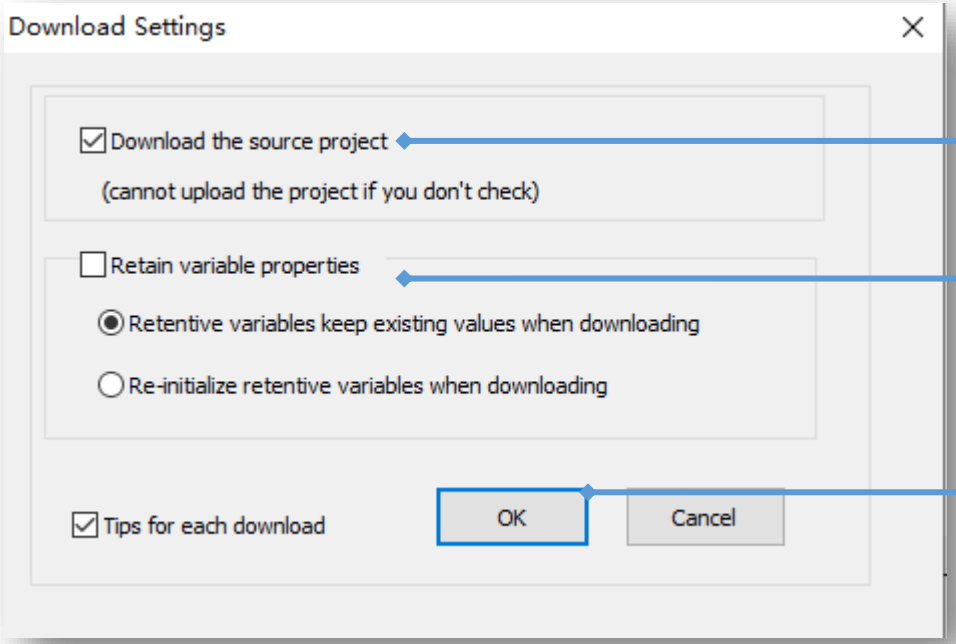
After connected well with PLC, select <PLC>→<Upload> or <Download> to upload/download program.

Take note:
Upload: get the program file from the H5U hardware
Download: download the program file to the H5U hardware.



Download

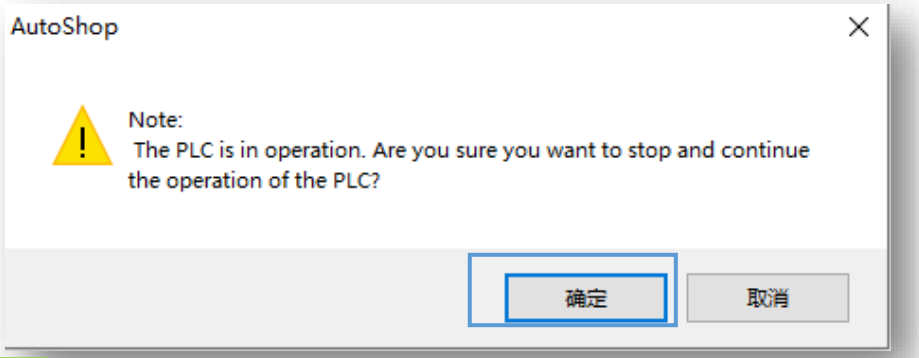
Click the <Download>, users will see a pop up window show as below:

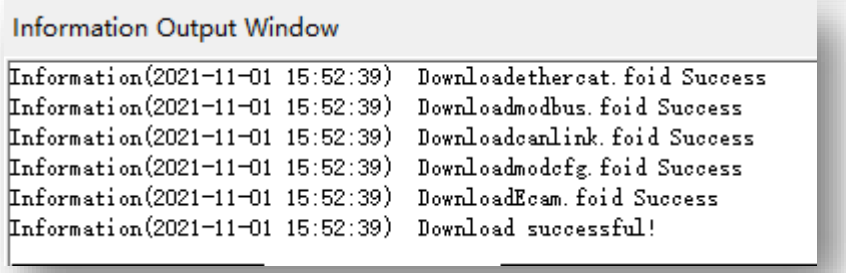


<Download the source project>: checked as default, be noted if this option unchecked, the program download to the controller will be not abled to be upload by <Upload> command.

To set the operation for non-volatile area.

Click <OK> button to continue, then below message box will show, just click <OK> button to download the program

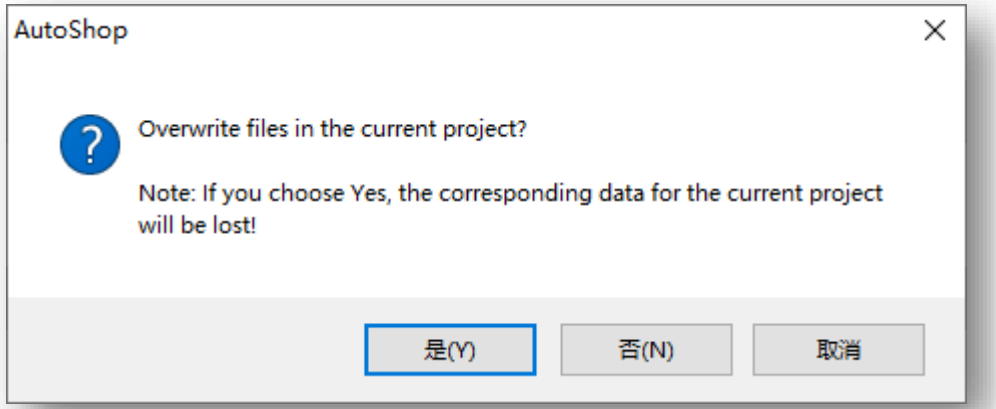




From the <Information Output Window> to check the download status.

Upload

Click the <Upload>, users will see a message box show as below, confirm this information, make sure the upload operation will not cover the existed valuable program (recommend to create an empty project first before to upload the program).



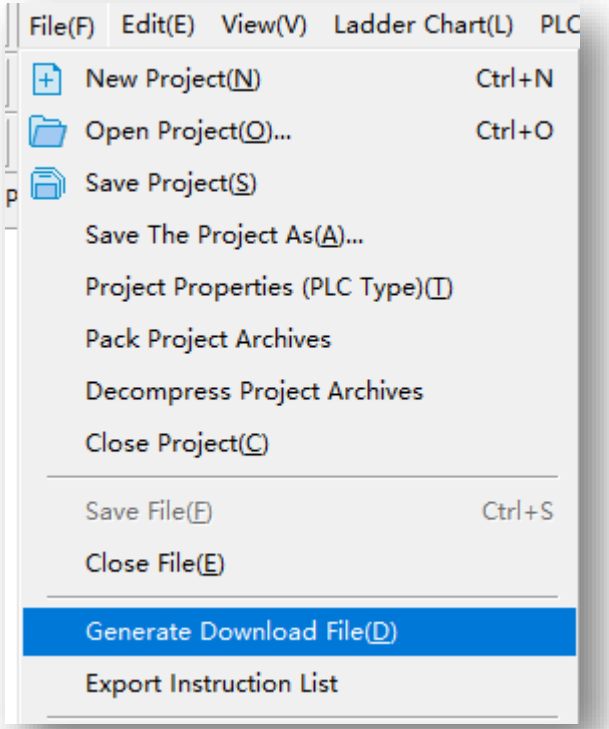
Click <Yes>, the program will be upload and cover the current project.

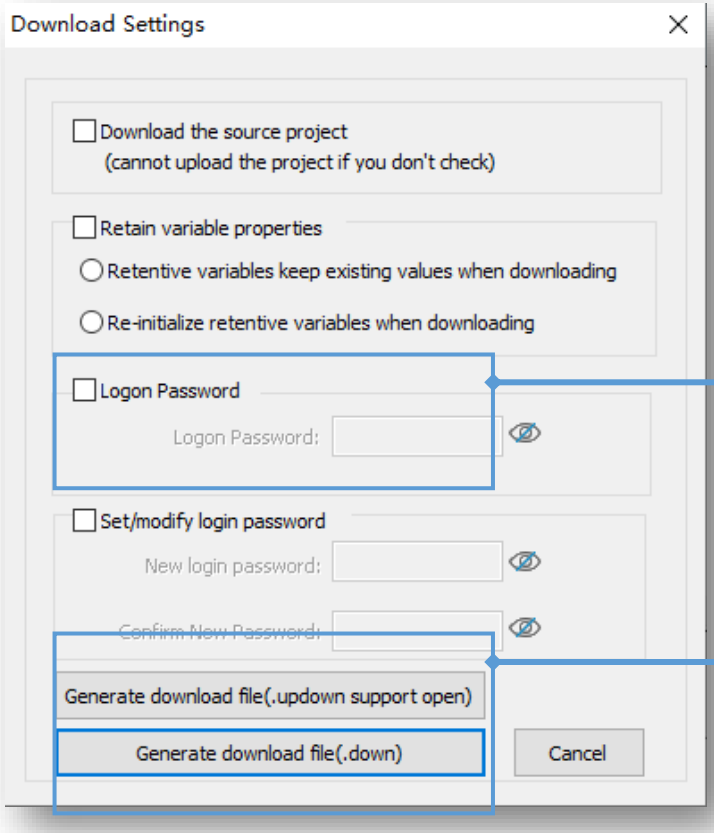
Take note, if the project in controller not select <Download the source project> while downloading, the project will not support to be upload!

Download file is used to download H5U program without opening the project, there are 2 method to download the down file to PLC:
>Using SD card to download the program
>Using AutoShop to download the program

➢ Generate down file

Open the project, select <File> → <Generate Download File>, in the pop up window to set the down file properties.





If the login password of PLC is valid, need enter the correct login password, or the generated download file cannot be download to controller.

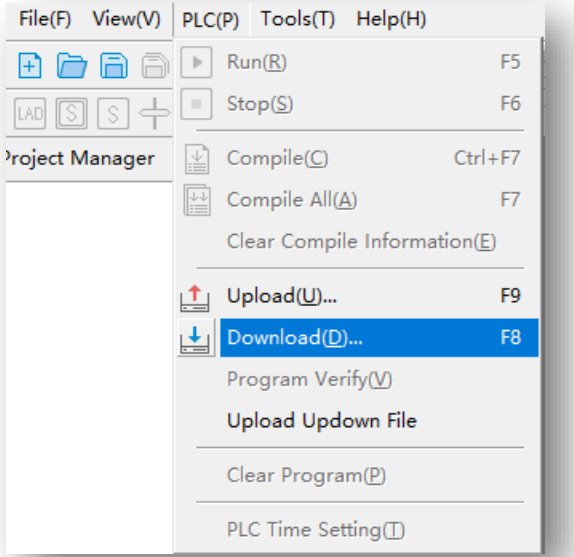
Take note:
There are 2 types of download file:
.down file: cannot be upload or opened
.updown file: can be upload and be opened

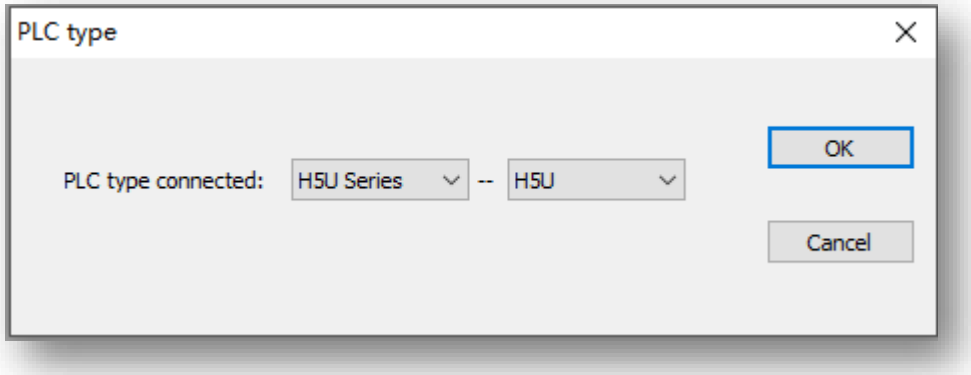
➢ Download .down/.updown file with SD

Put the generated download file to a SD card, then insert the SD card to H5U SD slot. Press the <MFK> key of H5U for 3 second to get into <SD> menu, then press <MFK> again to start the download process. The progress of downloading will show in the LED display(00~99), after downloading done, the LED display <PP>.
Take note: if the password not correct, the error <E5> will display.

➢ Download .down/.updown file with Autoshop

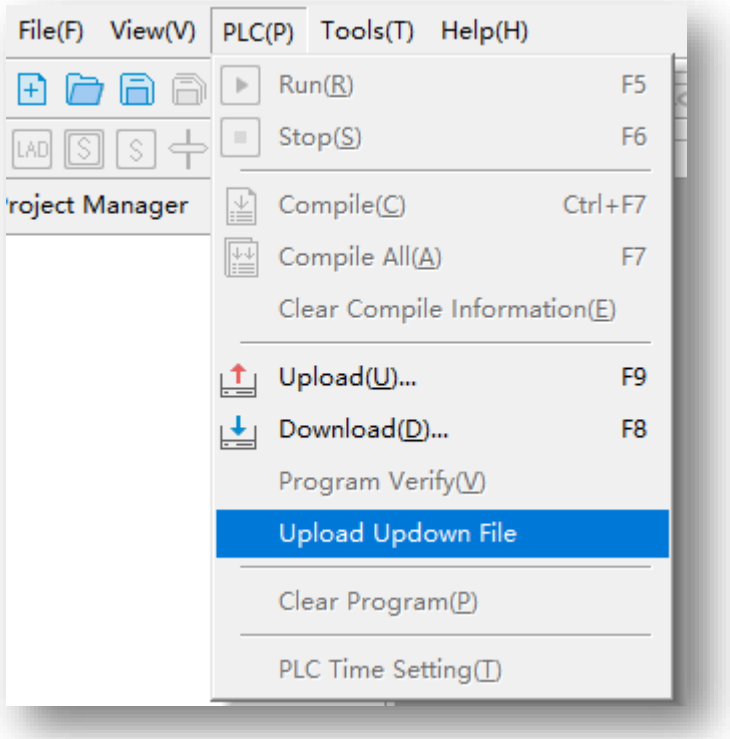
Open Autoshop (without project opened), select <PLC> → <Download>, in the pop up window select PLC model type, click <OK> button to download the project.





➢ Upload updown file with Autoshop

Select <PLC> → <Upload Updown File>



Pack Project Archives

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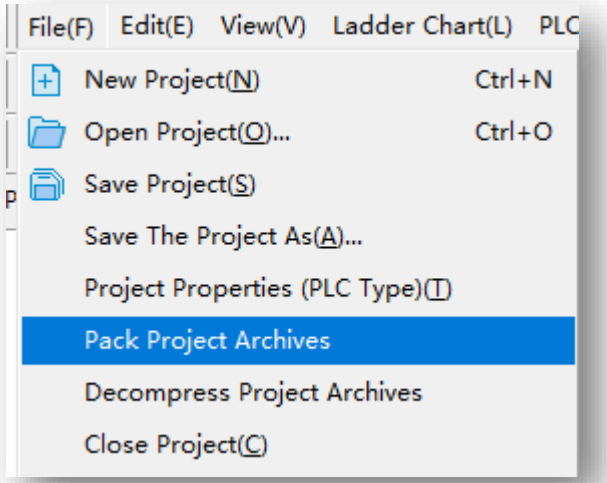
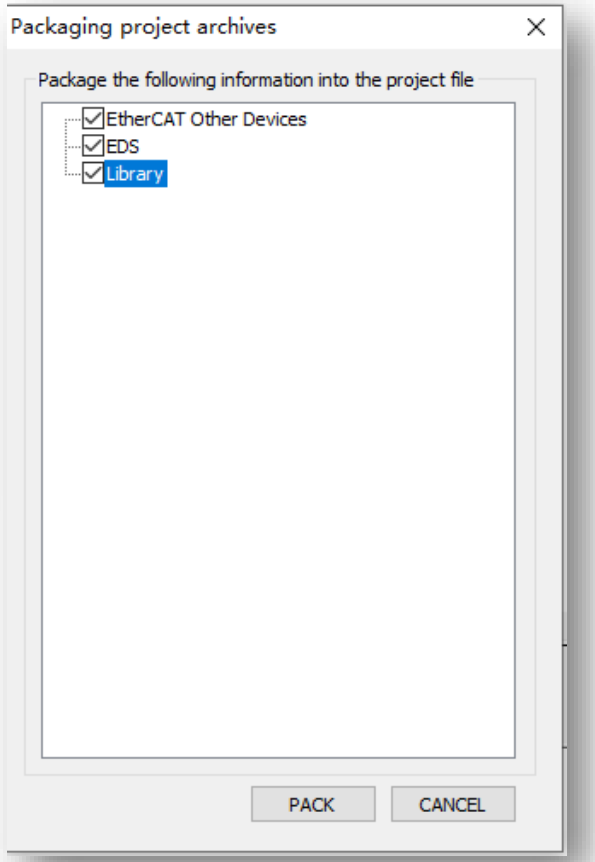
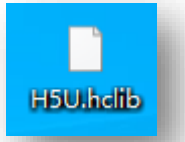
Pack project archives function is used to pack the whole project including program/configuration/library/EDS file/XML file etc. With the archived file, users can pass the complete project to their customers without passing EDS or XML files again.
In the <File> → <Pack Project Archives> to pack the current project, in the pop up window, user can select the files that need to be added into the packed archive file. Click <PACK> to continue, select save path then users can get an .hclib file.







Pack Project Archives

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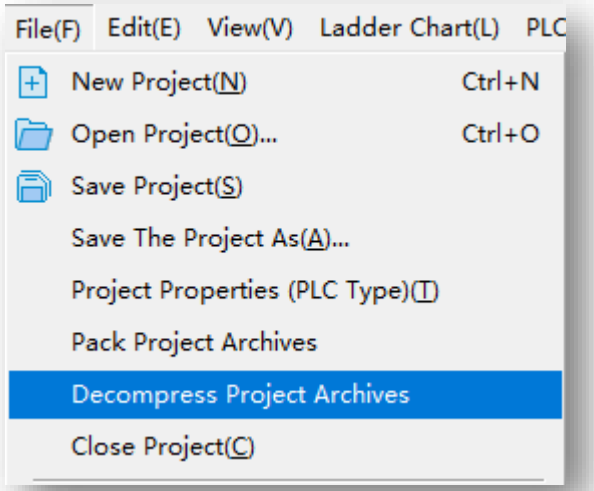
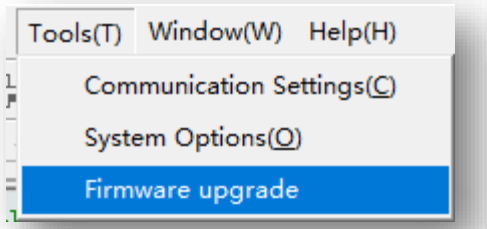
To decompress the packed file, select <File> → <Decompress Project Archives>.

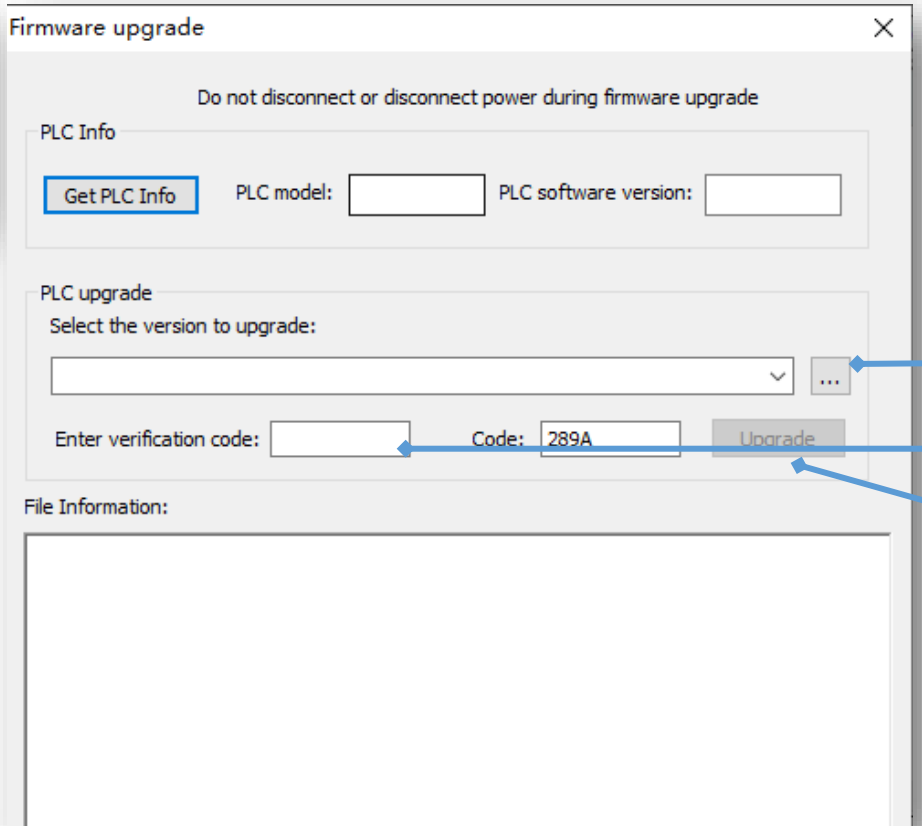


>Upgrade firmware with Authshop (Only support Ethernet connection)

➢ Upgrade firmware with Autoshop

Connect with PLC via Ethernet port, make sure the connection is good, then select <Tool> → <Firmware upgrade>





1>Select the upgrade file.

2>Enter the verification code

3>Click <Upgrade> to start upgrading

Data and Memory

Memory Assignment

INOVANCE

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Soft Element about 150KB	Which can be used in program directly, no need to clarify/or define. X/Y/D/M/R, etc.
User Defined Variable 2MB	Before using this variable, users have to clarify/or define these variables in <Global Variable>. The basic data type: BOOL/INT/DINT/REAL Advanced data type: ARRAY/POINTER/STRUCT
System Variable	Built in variable which used to get system info like: Time/IP/Communication State/Axis data

Soft Element

INOVANCE

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Element	Description	H3U	H5U	Comparison
X/Y	Physical Input & Output	X0~X377/Y0~Y377	X0~X1777/Y0~Y1777	IO range expend
M	Auxiliary Contact	M0~M7999	M0~M7999	H5U：M0-M999 volatile M1000 non volatile
S	Step Contact	S0~S4095	S0~S4095	H5U：S0-S999 volatile S1000+ non volatile
B	Auxiliary contact	——	B0~B32767	H5U：B0-B999 volatile B1000+ non volatile
D	Word Register	D0~D8000	D0~D8000	H5U：D0-D999 volatile D1000+ non volatile
R	Work Register	R0~R32767 (Non volatile)	R0~R32767	H5U：R0-R999 volatile R1000+ non volatile
W	Word Register	——	W0~W32767	H5U：W0-W999 volatile W1000+ non volatile

H5U have a extension of soft element compared with H3U. Besides, H5U don’t allow users to modify the non-volatile area.

Special(System) Soft Element

INOVANCE

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Element	Description	H3U	H5U	Comparison
Z/V	Address Register	**Z0~Z7/V0~V7**	--	H5U using pointer to achieve address function
M	System Contact	**M8000 +**	Only keep partial	H5U：check next slide
D	System Register	**D8000 +**	--	--
SM/SD	System Register	**System used**	--	--

Compared with H3U, H5U delete most of the special registers;
For the information provided by special registers, H5U using system variable to get these information.

Special(System) Soft Element

INOVANCE

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Element	Function
M8000	Program running monitoring
M8001	Opposite status of M8000
M8002	On in the first scan cycle of the program
M8003	Opposite status of M8002
M8011	10ms cycle clock
M8012	100ms cycle clock
M8013	1S cycle clock
M8014	1Min cycle clock

Element	Function
M8020	Operation zero flag
M8021	Operation borrow flag
M8022	Operation carry flag
M8029	Multi cycle instruction complete flag
M8040	SFC control flag
M8161	OFF-16 bit mode， ON-8 bit mode Bit process mode of ASCII / HEX / CCD / LRC / CRC / RS
M8163	BINDA output string last byte(00h or 20h)
M8165	SORT2 descending sort enable flag
M8168	SMOV data format set， OFF-BCD mode， ON-HEX mode

System Variable

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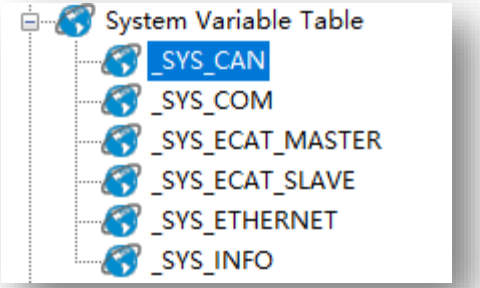
System Variable	Description
_SYS_CAN	CAN communication related info, like station number, baud rate, slave online status, etc.
_SYS_COM	COM communication related info, like station number, baud rate, slave online status, etc.
_SYS_ECAT_MASTER	EtherCAT Master info
_SYS_ECAT_SLAVE	EtherCAT Slave info
_SYS_ENCODER_AXIS	External encoder info
_SYS_ETHERNET	Ethernet communication info, like IP, MAC, online status, error diagnosis, etc.
_SYS_INFO	PLC system info, like SN, firmware version, RTC, module diagnosis, system log, etc.



System variable is used to describe the system status.

System Variable

INOVANCE

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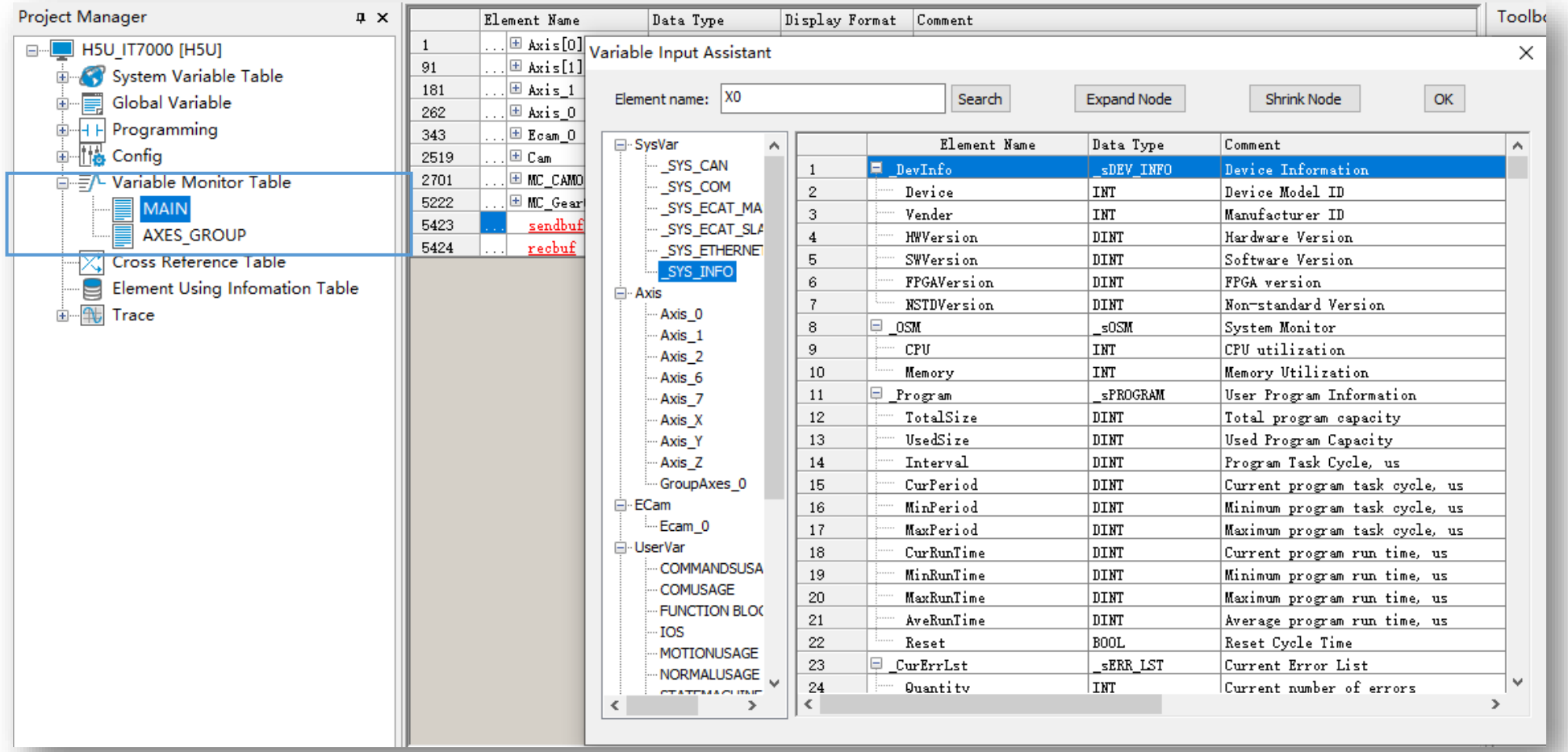

Check the system variable status in <Variable Monitor Table>.

System Variable

INOVANCE

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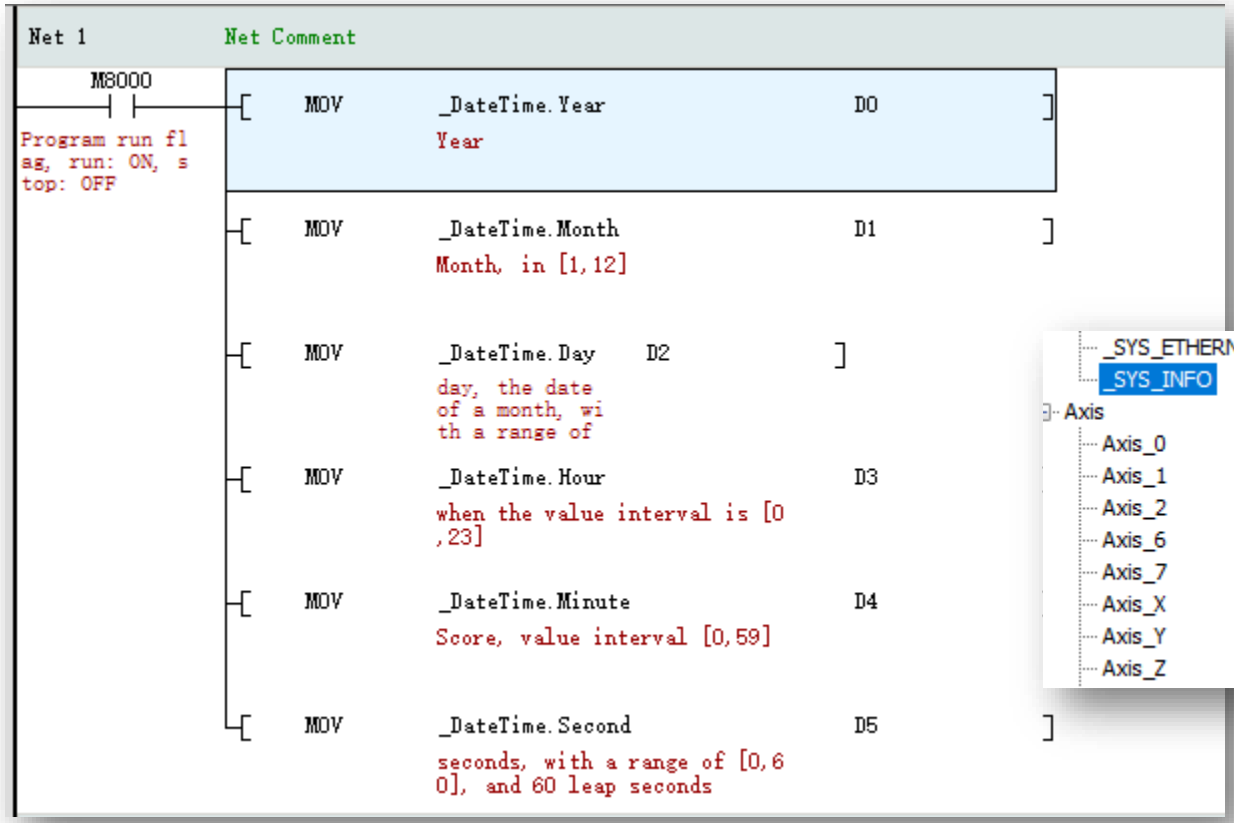
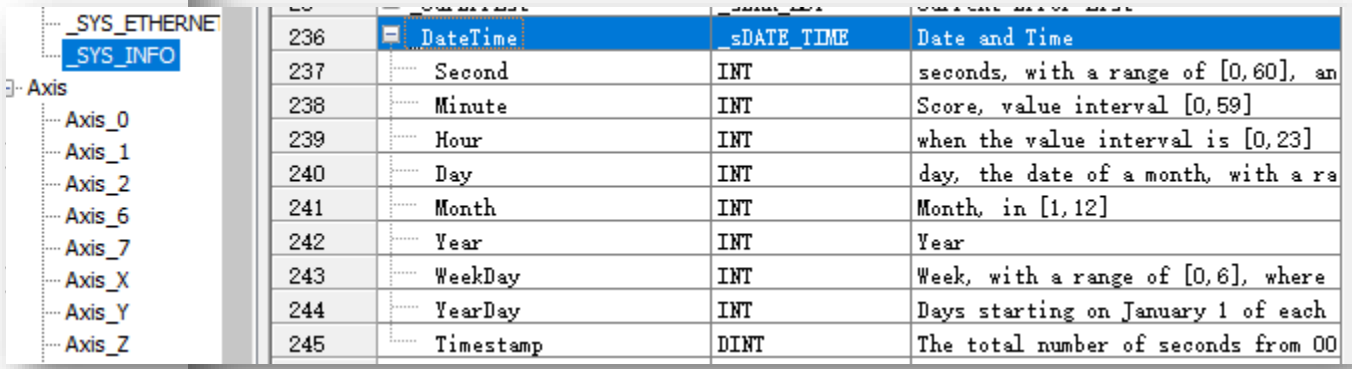
Program example: read RTC via system variable.





User Defined Variable

INOVANCE

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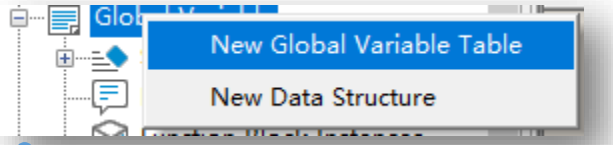
H5U provide 2M storage for user defined variable, and 256KB of the storage support non-volatile save.

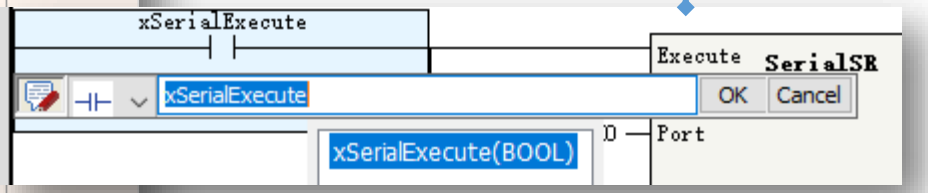


<Global Variable> right click to add <New Global Variable Table>

System assign the variable address, no need to consider the soft element address distribution, besides, name the variable according to the variable meaning, no need add extra comment, the program will be more readable.

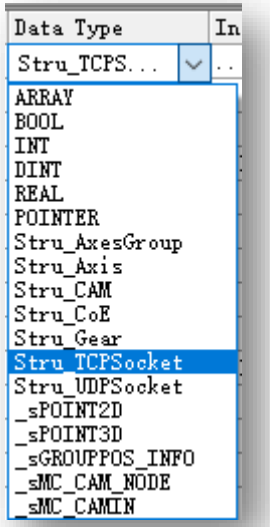
NO.	Variable...	Data Type	Initial Value	Power Down Hold	Comment	Element Addr.	Length	CurValue	☑Value1	☐Value2
1	⊞ sTCP	Stru_TCPSocket	...	Non Retained			nBitLen:224			
30	⊞ aSenBuf_TCP	INT[50]	...	Non Retained			nBitLen:800			
81	⊞ aRecBuf_TCP	INT[50]	...	Non Retained			nBitLen:800			
132	xEnable_TCP	BOOL	OFF	Non Retained			nBitLen:1			
133	iSenSize_TCP	INT	0	Non Retained			nBitLen:16			
134	IRecSize_TCP	INT	0	Non Retained			nBitLen:16			
135	⊞ sUDP	Stru_UDPSocket	...	Non Retained			nBitLen:224			
152	⊞ aSendBuf_UDP	INT[50]	...	Non Retained			nBitLen:800			
203	⊞ aRecBuf_UDP	INT[50]	...	Non Retained			nBitLen:800			
254	xEnable_UDP	BOOL	OFF	Non Retained			nBitLen:1			
255	iSenSize_UDP	INT	0	Non Retained			nBitLen:16			
256	iRecSize_UDP	INT	0	Non Retained			nBitLen:16			
257	⊞ aSenBuf_Se...	INT[256]	...	Non Retained			nBitLen:4096			
514	iSenSize_S...	INT	0	Non Retained			nBitLen:16			
515	⊞ aRecBuf_Se...	INT[256]	...	Non Retained			nBitLen:4096			
772	iRecSize_S...	INT	100	Non Retained			nBitLen:16			
773	xSerialExe...	BOOL	OFF	Non Retained			nBitLen:1			
774	SerialSR_Done	BOOL	OFF	Non Retained			nBitLen:1			
775	SerialSR_S...	INT	0	Non Retained			nBitLen:16			
776	SerialSR_Sent	INT	0	Non Retained			nBitLen:16			
777	SerialSR_R...	INT	0	Non Retained			nBitLen:16			
778	iRec_Timeout	INT	0	Non Retained			nBitLen:16			
779										

Enter the variable in program, support input assistant. If the variable not defined, after enter the variable, it will automatically added in variable table.



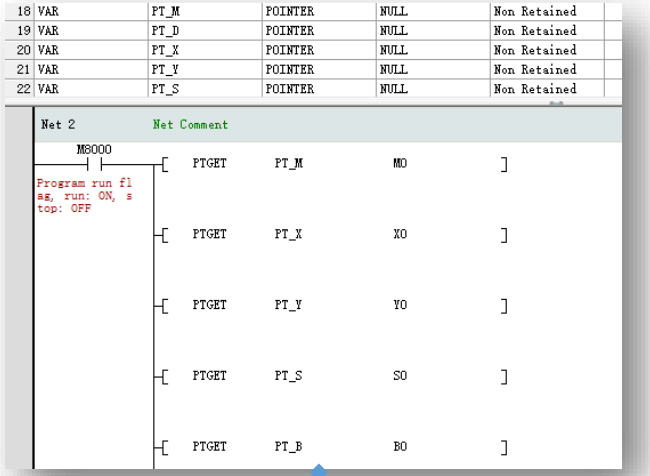
Data Type

H5U support below data type:
ARRAY
BOOL: 1 bit, 0 or 1
INT: 16 bit signed integer, take 2 byte
DINT: 32 bit signed integer, take 4 byte
REAL: 32 bit float number, take 4 byte
POINTER: point to address
STRUCT



NO.	Member name	Data type
1	AxisID	INT
2	Enable	BOOL
3	MCPower_Status	BOOL
4	MCPower_Busy	BOOL
5	MCPower_Error	BOOL
6	MCPower_ErrorID	INT
7	MCSetPos_Exe...	BOOL
8	MCSetPos_Pos...	REAL
9	MCSetPos_Mode	INT
10	MCSetPos_Done	BOOL
11	MCSetPos_Busy	BOOL
12	MCSetPos_Error	BOOL
13	MCSetPos_Err...	INT
14	MCJog_Enable	BOOL
15	MCJog_FWD	BOOL
16	MCJog_BWD	BOOL
17	MCJog_VEL	REAL
18	MCJog_ACC	REAL
19	MCJog_DEC	REAL
20	MCJog_CurveType	INT
21	MCJog_Busy	BOOL
22	MCJog_CMDAbo...	BOOL
23	MCJog_Error	BOOL
24	MCJog_ErrorID	INT
25	MCMoveVel_Ex...	BOOL
26	MCMoveVel_VEL	REAL
27	MCMoveVel_ACC	REAL
28	MCMoveVel_DEC	REAL
29	MCMoveVel_Cu...	INT
30	MCMoveVel_In...	BOOL
31	MCMoveVel_Busy	BOOL
32	MCMoveVel_CM	BOOL

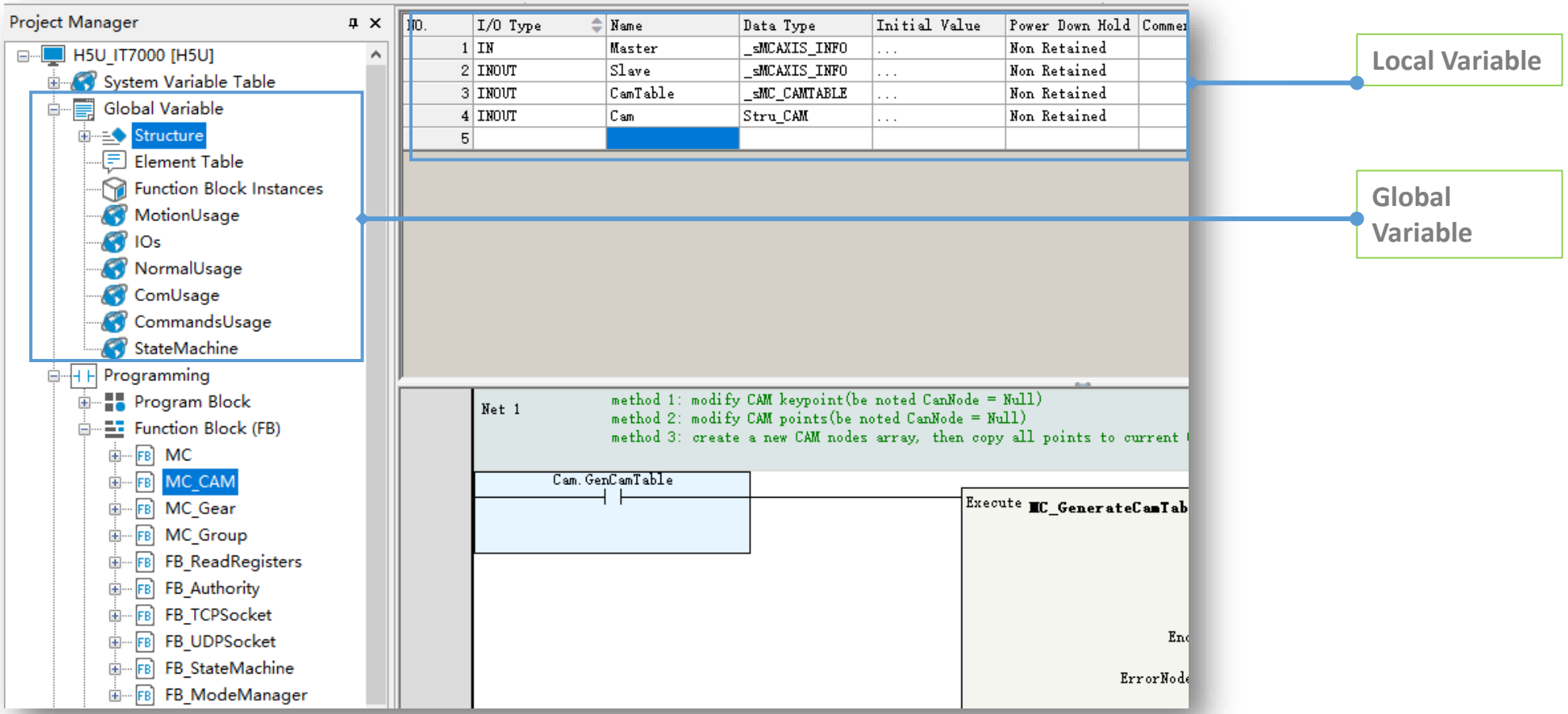
STRUCT include different sub item or object property.



Point initial value is NULL, using PTGET instruction to get the point value—Point to a certain address.

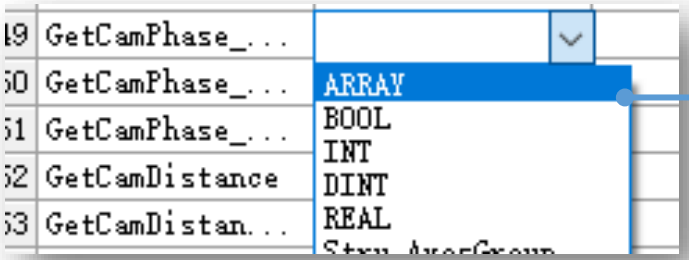
Work Area

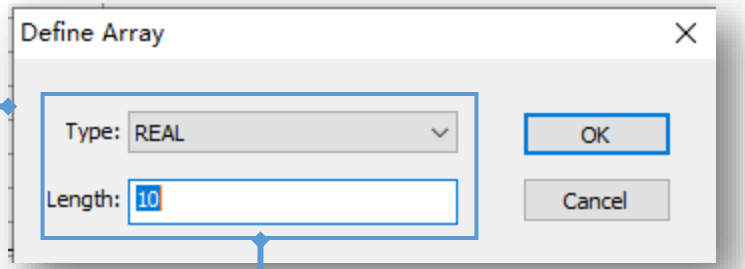
Besides global variable, H5U also support create a variable in a function block, the difference show as below:
Global variable: works in whole project, system variables and soft elements are global variable, users can invoke this variable at any place in program.
Local variable: works only in current function block, other program/or function block cannot using the variables.



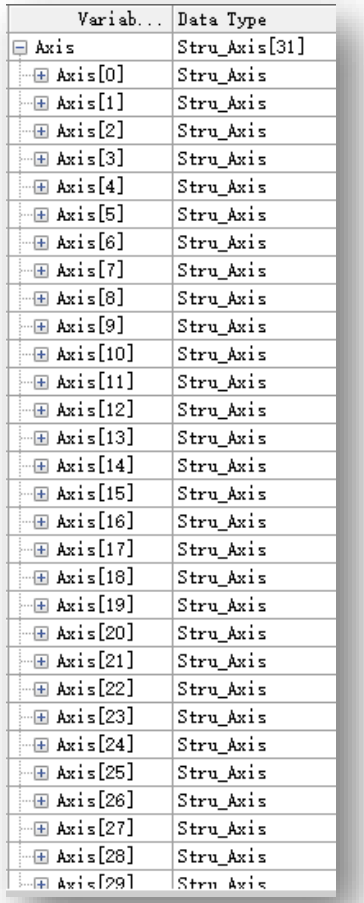
➢ Array

Array is an ordered sequence of elements. All elements in a array are same data type. H5U support 1 dimension array.



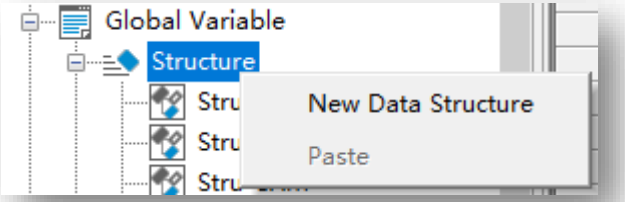


Set the data type and length of an array, for example, if the length set as 2, then there are 2 elements in this array: <arrayname>.[0], <arrayname>.[1]

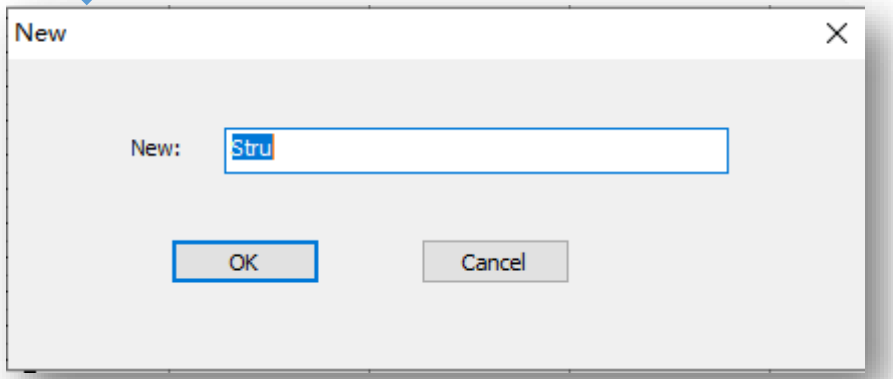


Structure

Structure is a new data type composed of a batch of data. In most project, axis reference structure is normally used which include related operations and properties of an axis.



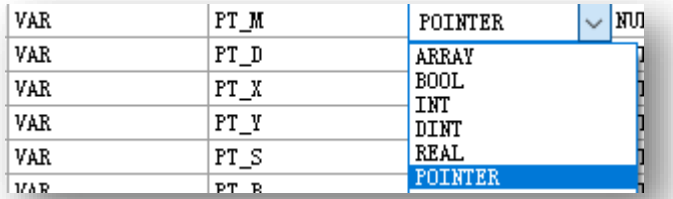
<Structure> right click to add <New Data Structure>



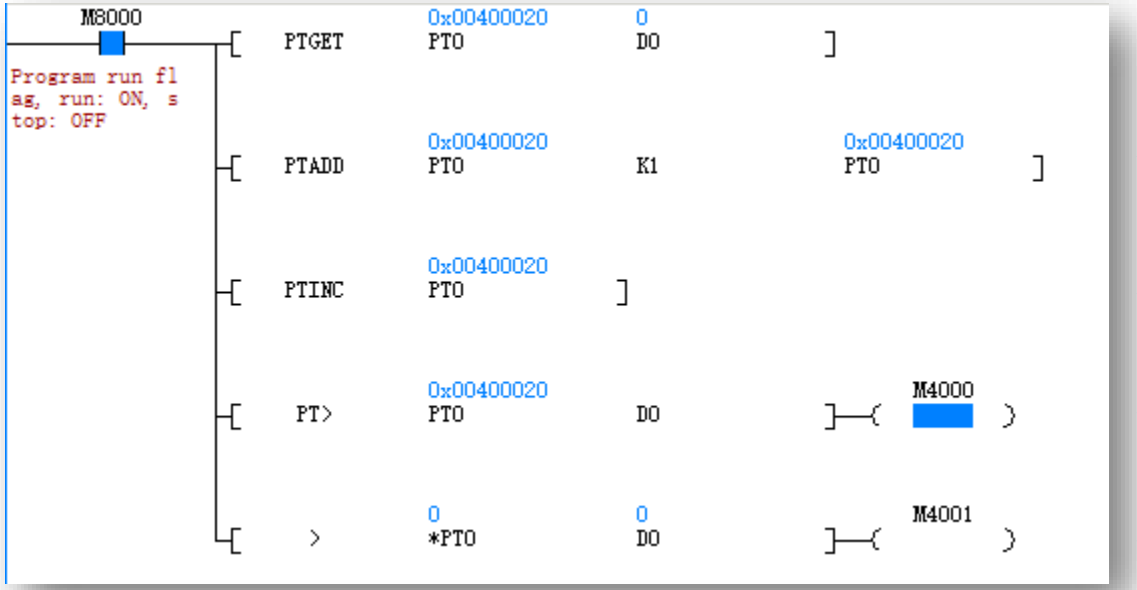
1	Axis	Stru_Axis[31]	...
2	Axis[0]	Stru_Axis	...
3	AxisID	INT	0
4	Enable	BOOL	OFF
5	MCPower_Status	BOOL	OFF
6	MCPower_Busy	BOOL	OFF
7	MCPower_Error	BOOL	OFF
8	MCPower_ErrorID	INT	0
9	MCSetPos_Execute	BOOL	OFF
10	MCSetPos_Posi...	REAL	0.000000
11	MCSetPos_Mode	INT	0
12	MCSetPos_Done	BOOL	OFF
13	MCSetPos_Busy	BOOL	OFF
14	MCSetPos_Error	BOOL	OFF
15	MCSetPos_ErrorID	INT	0
16	MCJog_Enable	BOOL	OFF
17	MCJog_FWD	BOOL	OFF
18	MCJog_BWD	BOOL	OFF
19	MCJog_VEL	REAL	1000.000
20	MCJog_ACC	REAL	1000.000
21	MCJog_DEC	REAL	1000.000
22	MCJog_CurveType	INT	0
23	MCJog_Busy	BOOL	OFF
24	MCJog_CMDAborted	BOOL	OFF
25	MCJog_Error	BOOL	OFF
26	MCJog_ErrorID	INT	0
27	MCMoveVel_Exe...	BOOL	OFF
28	MCMoveVel_VEL	REAL	1000.000
29	MCMoveVel_ACC	REAL	1000.000
30	MCMoveVel_DEC	REAL	1000.000
31	MCMoveVel_Cur	INT	0

Pointer

Pointer is variable which used to store the internal memory address, to provide the method to operate variable address.



PT operation instruction	
Instruction	Description
PTGET	Get the address of pointer
PTINC	Increase pointer address by 1
PTDEC	Decrease pointer address by 1
PTADD	Add pointer address by set offset
PTSUB	Decrease pointer address by set offset
PT>、PT>=、PT<、PT<=、PT=、PT<>	PT variable address comparison



Before using a pointer, have to use <PTGET> to get an variable address. This instruction means PT0 point to D0.

Add the pointed address. This instruction means PT0 point to D1

Add the pointed address by 1. This instruction means PT0 point to D2

PT compared instruction. Means compare the value of register address

Normal compared instruction. Means compare the value of registers

Instruction Introduction

Instructions

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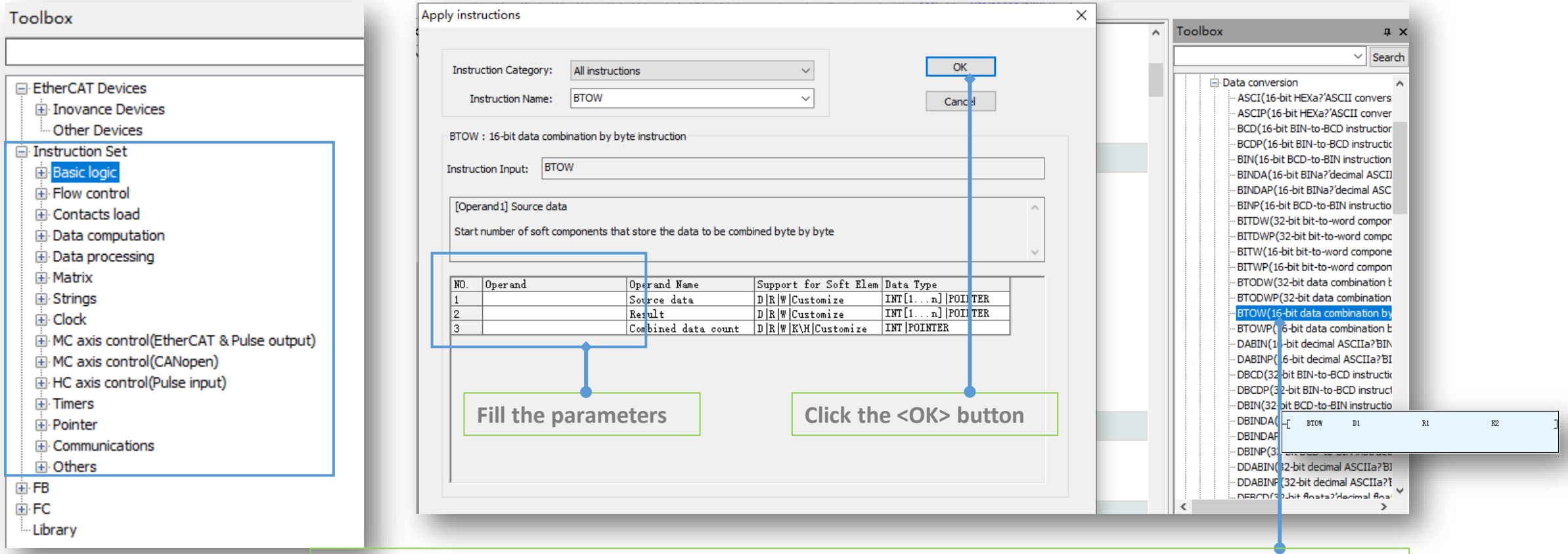
All available instructions can be found in <Toolbox>→<Instruction Set>, most of basic instruction and data processing instruction are same with H3U, for motion control or high speed IO instruction, H5U have totally different style (conform PLCopen, will be introduced in next chapters)



For basic instructions, double click the instruction name in <Toolbox>, an assistant dialog box will pop up, users can find the parameters definition and data type(range), and they can fill the parameters in this view, after that, click <OK> button, the complete instruction with parameters will be added to program

Program Logic

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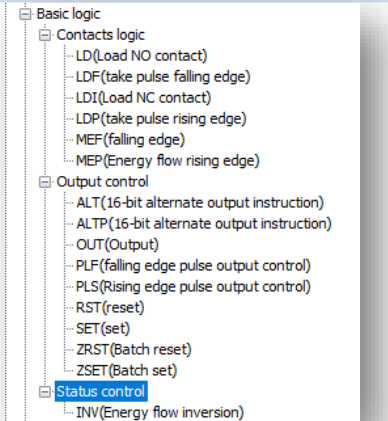
Instruction	Function
LD	Normally open contact
LDI	Normally close contact
AND	Serial connection of NO contact
ANI	Serial connection of NC contact
OR	Parallel connection of NO contact
ORI	Parallel connection of NC contact
LDP	Use of rising edge pulse
LDF	Use of falling edge pulse
ANDP	Serial connection for AND rising edge pulse detection
ANDF	Serial connection for AND falling edge pulse detection
ORP	Parallel connection for OR rising edge pulse detection
ORF	Parallel connection for OR falling edge pulse detection
MEP	Circuit result rising edge detection
MEF	Circuit result falling edge detection

Instruction	Function
OUT	Coil output
SET	Set value for a coil
RST	Reset value for a coil
ZSET	Set value for multi coils
ZRST	Reset value for multi coils
PLS	Rising edge detection
PLF	Falling edge detection
ALT	Alternate output
INV	Operation result inversion

Same with H3U



Flow Control

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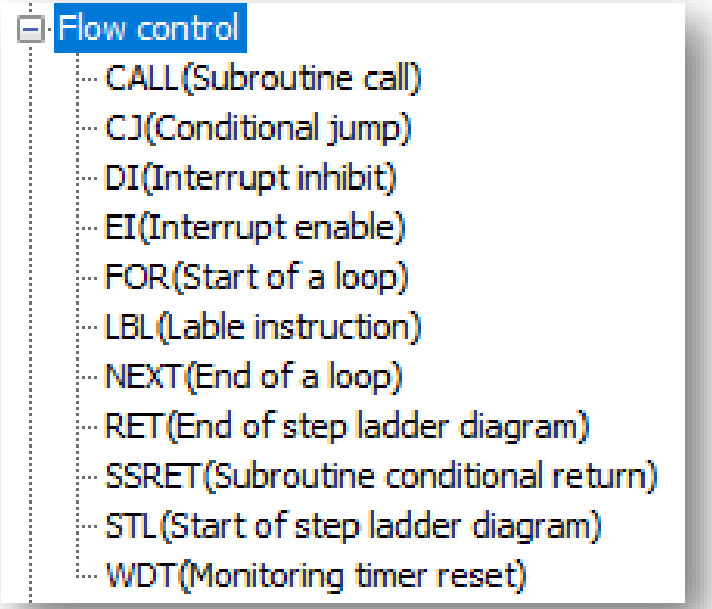
Instruction	Function
CALL	Sub routine call
CJ	Conditional jump
DI	Interrupt Inhibit
EI	Interrupt enable
FOR	Start of a loop
LBL	Label instruction
NEXT	End of a loop
RET	End of step ladder diagram
SSRET	Sub routine conditional return
STL	Start of step ladder diagram
WDT	Monitoring timer reset



Same with H3U

Contact Load

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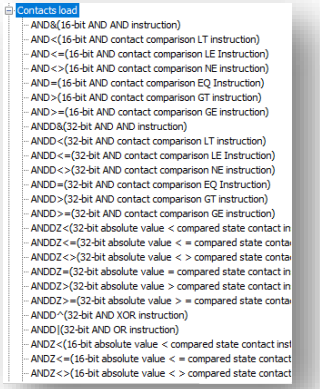
Instruction	# or *
AND#	=, >, <, <>, >=, <=
LD#	=, >, <, <>, >=, <=
OR#	=, >, <, <>, >=, <=
FLDD#	=, >, <, <>, >=, <=
FANDD#	=, >, <, <>, >=, <=
FORD#	=, >, <, <>, >=, <=
LDZ#	=, >, <, <>, >=, <=
ANDZ#	=, >, <, <>, >=, <=
ORZ#	=, >, <, <>, >=, <=
LD*	&, |, ^
AND*	&, |, ^
OR*	&, |, ^

operator	Description
=	Equal to
>	Greater than
<	Less than
<>	Not equal to
>=	Greater than or equal to
<=	Less than or equal to
&	Logic AND operation
|	Logic OR operation
^	Logic XOR operation

Same with H3U



Data Computation

INOVANCE

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Arithmetic	Function
(D)ADD(P)	Integer add function
(D)SUB(P)	Integer Subtraction function
(D)MUL(P)	Integer Multiplication function
(D)DIV(P)	Integer Division function
(D)MOD(P)	Integer Mod function(get remainder)
(D)EADD(P)	Float add function
(D)ESUB(P)	Float subtraction function
(D)EMUL(P)	Float multiplication function
(D)EDIV(P)	Float division function
(D)INC(P)	Add by 1
(D)DEC(P)	Subtract by 1

D means 32 bit instruction (without D means 16 bit instruction)
P means instruction works on rising edge
***Most instructions support add D prefix and/or P suffix, some of them only support 1/or 2 format of them , details please check in <Toolbox> of Autoshop.**

Data Logic Operation	Function
(D)WAND(P)	Word logic AND operation
(D)WOR(P)	Word logic OR operation
(D)WXOR(P)	Word logic XOR operation
(D)NEG(P)	Word Inverter operation
(D)ENEG(P)	Float inverter operation(sign bit inverter)

Bit of Word Operation	Function
(D)BLD	Word bit normally open contact
(D)BLDI	Word bit normally close contact
(D)BAND	Word bit NO serial connection
(D)BANDI	Word bit NC serial connection
(D)BOR	Word bit logic OR operation(NO)
(D)BORI	Word bit logic OR operation(NC)
(D)BOUT	Word bit output
(D)BSET	Word bit set value
(D)BRST	Word bit reset value

Data Computation

INOVANCE

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Trigonometric	Function
(D)SIN(P)	Sine
(D)TAN(P)	Tangent
(D)COS(P)	Cosine
(D)ASIN(P)	Anti sine
(D)ACOS(P)	Anti cosine
(D)ATAN(P)	Anti tangent
(D)RAD(P)	Convert angle to radians
(D)DEG(P)	Convert radians to angle
(D)SINH(P)	Hyperbolic sine
(D)COSH(P)	Hyperbolic cosine
(D)TANH(P)	Hyperbolic tangent

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Table Operation	Function
(D)WSUM(P)	Calculate summary value
(DMEAN(P)	Calculate mean value
(D)LIMIT(P)	Output limit control
(D)BZAND(P)	Output dead zone control
(D)ZONE(P)	Output offset control
(D)SCL(P)	Coordinates according to given curve
(D)SCL2(P)	Coordinates according to given curve

Exponent arithmetic	Function
(D)EXP(P)	Exponential operation base on e(2.71828)
(DLOG(P)	Logarithm operation base on 10
(D)LOGE(P)	Logarithm operation base on e(2.71828)
(D)ESQR(P)	Square root of binary float data
(D)SQR(P)	Square root operation
(D)POW(P)	Pow operation

Data Processing

INOVANCE

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Data Conversion	Function
(D)INT(P)	Float to integer
(D)BCD(P)	BIN data to BCD data
(D)BIN(P)	BCD data to BIN data
(D)FLT(P)	BIN integer to BIN float
(D)EBCD(P)	BIN float to DEC float
(D)EBIN(P)	DEC float to BIN float
(D)DABIN(P)	DEC ASCII to BIN
(D)BINDA(P)	BIN to DEC ASCII
(D)WTOB(P)	Word divided by byte
(D)BITW(P)	Bit element assignment word element
(D)BTOW(P)	Combination of byte to word

Data Conversion	Function
(D)WBIT(P)	Word element assignment bit element
(D)WTODW(P)	16 bit word to 32 bit double word
(D)DWTOW(P)	32 bit double word to 16 bit word
(D)MCPY(P)	Data Copy(memory copy)
(D)MSET(P)	Data set(memory set)
(D)UNI(P)	Combination of lower 4-bit of continuous 16 bit data
(D)DIS(P)	Word divided by 4-bit
(D)ASCI(P)	HEX to ASCII
(D)HEX(P)	ASCII to HEX

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Data Processing

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Data Transmission	Function
(D)MOV(P)	Data assignment
(D)EMOV(P)	BIN float data assignment
(D)BMOV(P)	Data batch assignment
(D)SMOV(P)	Bit data transmission
(D)FMOV(P)	Data assignment to multi registers
(D)CML(P)	Data inverter via bit then transmission
(D)CMP(P)	Data comparison output
(D)ECMP(P)	Float data comparison output
(D)ZCP(P)	Regional comparison
(D)EZCP(P)	Float data regional comparison

Table Operation	Function
(D)SER(P)	Data search
(D)FDEL(P)	Delete table data
(D)FINS(P)	Insert data to table
(D)POP(P)	Read the latest data of SFWR

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Data Processing

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Data Shift	Function
(D)ROR(P)	Data right shift by bit
(D)ROL(P)	Data left shift by bit
(D)RCR(P)	Data right shift by bit(with carry flag M8022)
(D)RCL(P)	Data left shit by bit(with carry flag M8022)
(D)SFTR(P)	Data right shift by multi bits(high bits replaced by specified data)
(D)SFTL(P)	Data left shift by multi bits(low bits replaced by specified data)
(D)WSFR(P)	Data right shit by multi words(high words replaced by specified data)
(D)WSFL(P)	Data left shift by multi words(low words replaced by specified data)
(D)SFWR(P)	FIFO write data
(DSFRD(P)	FIFO read data

Data Shift	Function
(D)SFR(P)	Data right shift by bit(with carry flag M8022, high bit(s) discarded)
(D)SFL(P)	Data left shift(with carry flag M8022,low bit(s) discarded)
Others	**Function**
(D)SWAP(P)	High byte and low byte exchange
(D)BON(P)	Word data bit status to control other bit status
(D)SUM(P)	Calculate quantities of ‘1’ in a BIN data
(D)RAND(P)	Generate rand data within a range
(D)XCH(P)	Word registers data exchange
(D)ABS(P)	Integer absolute value calculation
(D)EABS(P)	Float absolute value calculation
(D)EFMOV(P)	Multi float data transmission
(D)CCD(P)	Summation check
(DCRC(P)	Cyclical redundancy check
(D)LRC(P)	Longitudinal redundancy check

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Matrix

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Data Shift	Function
(D)BK+(P)	Data block add operation
(D)BK-(P)	Data block subtract operation
(D)MAND(P)	Matrix AND operation
(D)MOR(P)	Matrix OR operation
(D)MXNR(P)	Matrix XNR operation
(D)MXOR(P)	Matrix XOR operation
(D)MINV(P)	Matrix INV operation
(D)BLCMP#(P)	Matrix comparison(#: =, >, <. <>, <=, >=)

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***Most instructions support add D prefix and/or P suffix, some of them only support 1/or 2 format of them , details please check in <Toolbox> of Autoshop.**

String Processing

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String Processing	Function
(D)STR(P)	Integer convert to string(ASCII)
(D)STRMOV(P)	Assignment string directly
(D)VAL(P)	String(ASCII) convert to integer
(D)ESTR(P)	Float convert to string(ASCII)
(D)EVAL(P)	String(ASCII) to float
(D)$ADD(P)	Contact string
(D)LEN(P)	Calculate bytes of string
(D)INSTR(P)	Retrieve given string in an existed string
(D)RIGHT(P)	Take out given length string from an existed string (from right side)
(DLEFT(P)	Take out given length string from an existed string (from left side)

String Processing	Function
(D)MIDW(P)	Replace specified string with specified string
(D)MIDR(P)	Take out given length string form an existed string (from any position)
(D)$MOV(P)	String transmission

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***Most instructions support add D prefix and/or P suffix, some of them only support 1/or 2 format of them , details please check in <Toolbox> of Autoshop.**

Clock

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String Processing	Function
(D)TCMP(P)	Compared dedicated time with RTC
(D)TZCP(P)	Compared dedicated time range with RTC
(D)TADD(P)	Time add operation
(D)TSUB(P)	Time subtract operation
(D)HTOS(P)	Convert ‘hh:mm:ss’ to second format
(D)STOH(P)	Convert second format to ‘hh:mm:ss’
(D)TRD(P)	Read RTC(year/month/day/hour/minute/second/week)
(D)TWR(P)	Refresh RTC with given time
(D)HOUR(P)	Time record, while up to pre-set time, output valid

D means 32 bit instruction (without D means 16 bit instruction)
P means instruction works on rising edge
***Most instructions support add D prefix and/or P suffix, some of them only support 1/or 2 format of them , details please check in <Toolbox> of Autoshop.**

Timer

INOVANCE

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String Processing	Function
(D)TPR(P)	Normal timer
(D)TONR(P)	On delay timer
(D)TOFR(P)	Off delay timer
(D)TACR(P)	Time accumulation timer

D means 32 bit instruction (without D means 16 bit instruction)
P means instruction works on rising edge
***Most instructions support add D prefix and/or P suffix, some of them only support 1/or 2 format of them , details please check in <Toolbox> of Autoshop.**

Pointer

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String Processing	Function
(D)PTGET(P)	Get the address of pointer
(D)PTINC(P)	Increase pointer address by 1
(D)PTDEC(P)	Decrease pointer address by 1
(D)PTADD(P)	Add pointer address by set offset
(D)PTSUB(P)	Decrease pointer address by set offset
(D)PTSET(P)	Point to set length variable by bit
(D)PTMOV(P)	Pointer variable assignment
(D)PT#(P)	PT variable address comparison(#: >, >=, <>, <, <=)

D means 32 bit instruction (without D means 16 bit instruction)
P means instruction works on rising edge
***Most instructions support add D prefix and/or P suffix, some of them only support 1/or 2 format of them , details please check in <Toolbox> of Autoshop.**

Communication

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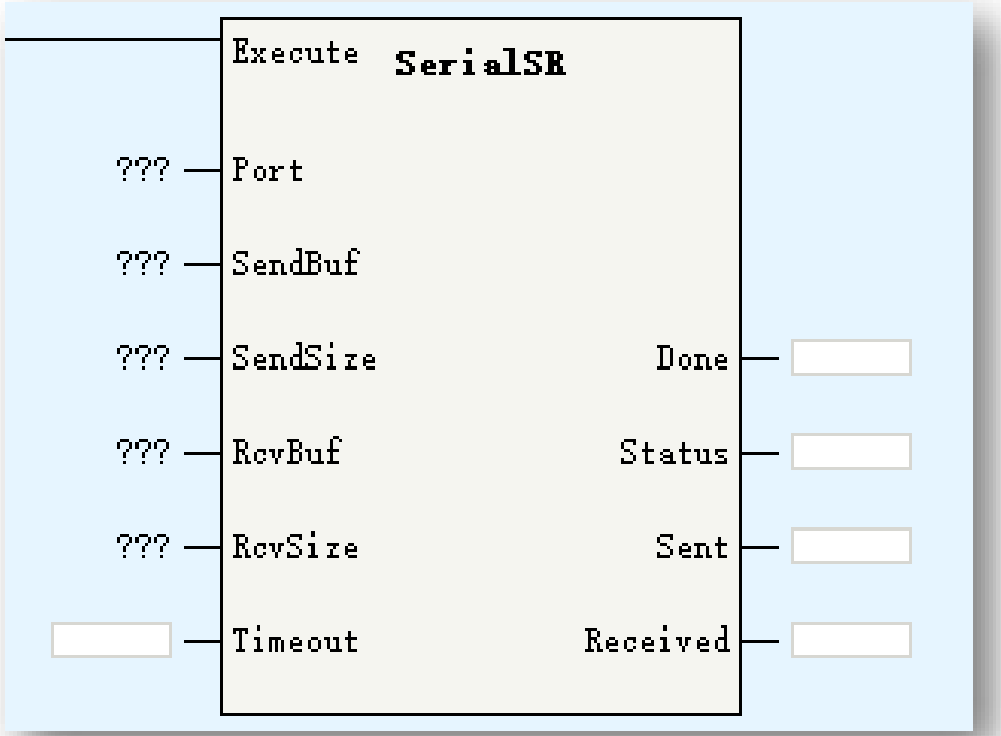
String Processing	Function
SerialSR	Serial free protocol instruction
TCP_Listen	TCP socket listen
TCP_Accept	TCP socket accept
TCP_Connect	TCP socket connect
TCP_Close	TCP socket close
TCP_Send	TCP socket send
TCP_Receive	TCP socket receive
UDP_Bind	UDP socket bind
UDP_Receive	UDP socket receive
UDP_Send	UDP socket send

String Processing	Function
ETC_ReadParameter_CoE	SDO read via CoE
ETC_WriteParameter_CoE	SDO write via CoE

SerialSR

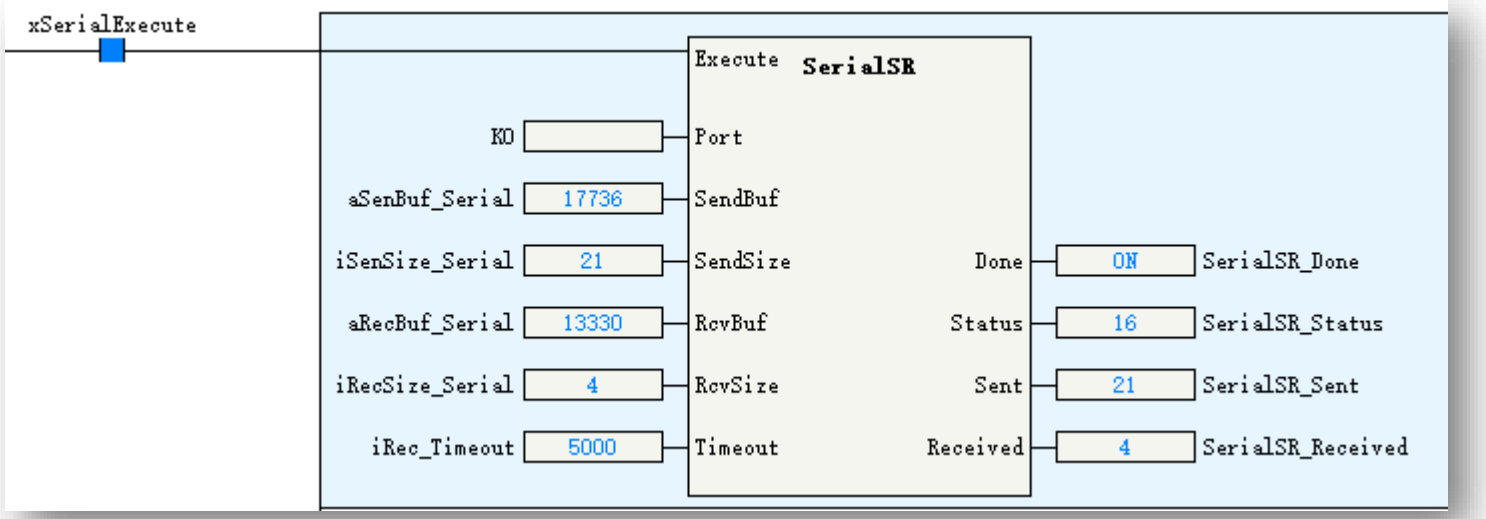


Parameters	Description
Port	Port number
SendBuf	Send data buffer area
SendSize	Send byte size
RcvBuf	Receive data buffer area
RcvSize	Receive byte size
Timeout	Receive timeout
Done	Communication done
Status	Command Status
Sent	Sent data size(Byte)
Received	Receive data size(Byte)

SerialSR is used for serial free communication.

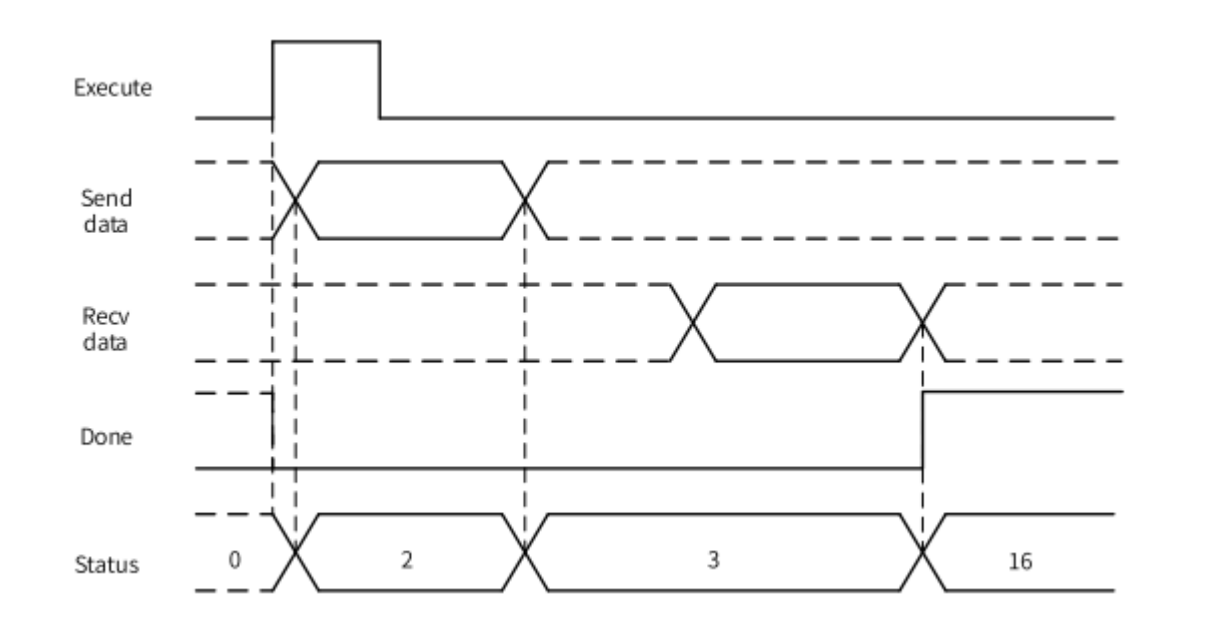
SerialSR

Port: H5U only have 1 serial port, default as 0, no need to modify.
SendBuf: array type data, specified the send data store area
SendSize: specified send data size
RcvBuf: array type data, specified the receive data store area
RcvSize: specified receive size data
Timeout: limit for summary of send time and receive time, if there is no feedback data frame within timeout, the <Status> will display the abnormal status
Done: communication complete
Status: 0-empty, 1-reserved, 2-send, 3-receive 16-Done, 32-send abnormal, 48-receive abnormal, 64-Other abnormal
Sent: sent data size
Received: received data size



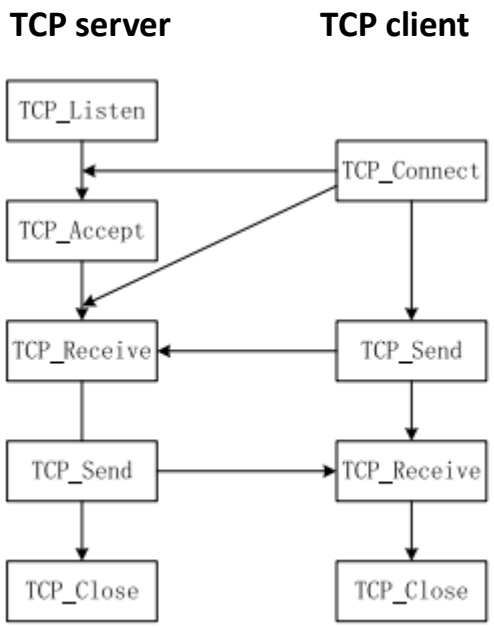
SerialSR

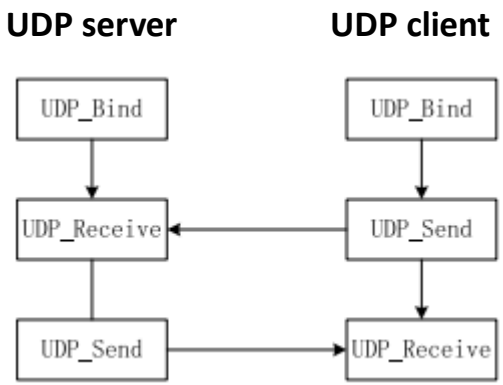
The sequence diagram:



Socket Communication

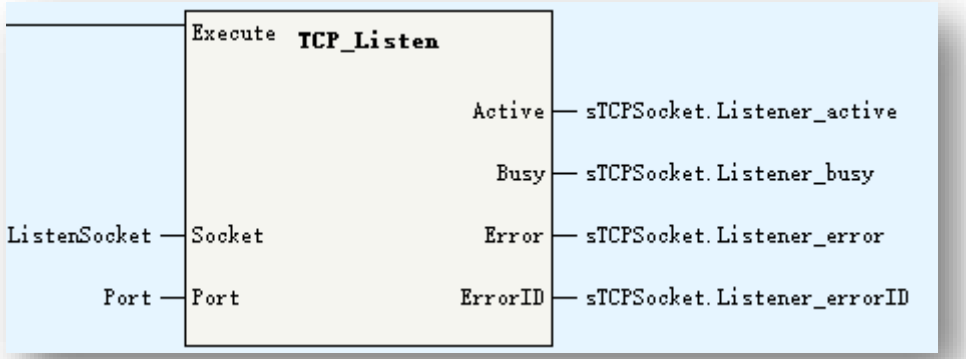
Socket is the port used for dual direction communication.
H5U support TCP socket(connection oriented) and UDP socket (non connection oriented), the communication logic show as below:





TCP is transmission control protocol, UDP is user data protocol, they are both the transmission layer protocol of OSI communication prototype.
The difference is TCP protocol need built a connection before communication but UDP no need built the connection. TCP is reliable communication on connection mechanism normally used in the scenario that need keep the data accuracy. UDP is not reliable communication, which means UDP no need concern about the content of data message and no demand for check if receiver already got the data, it has simple data process and fast speed, normally used in the scenario that need the real-time ability.

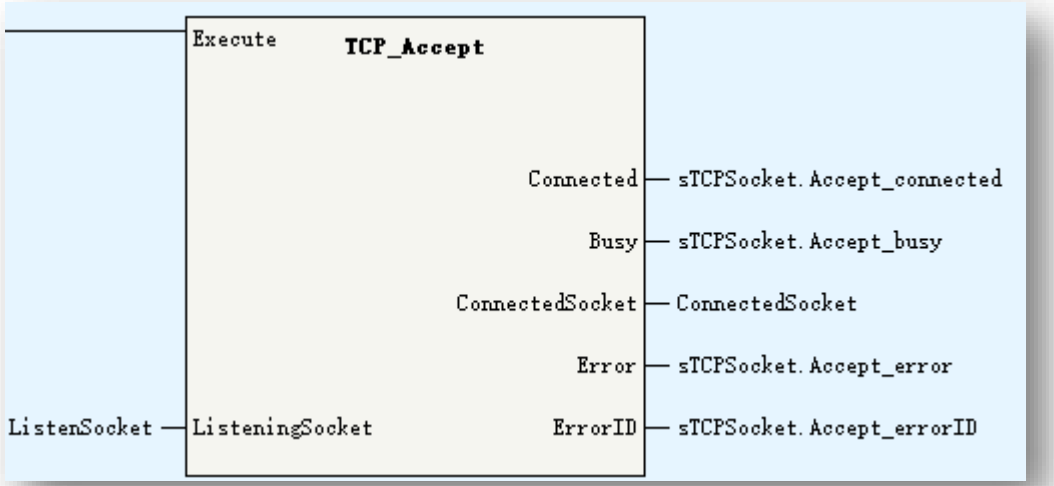
TCP_Listen



Parameters	Description
Socket	Socket. Currently don't support _sSocket data type, users can use an INT[20] as socket, take note this parameters is an input/output type data
Port	The listen port of H5U *Don't use 23/12939/12940/502, this port used by system
Active	Socket active status

TCP server have to listen the specified port to wait the connection request from client, while the server receive the connection request, need use TCP_Accept to built the connection with client.

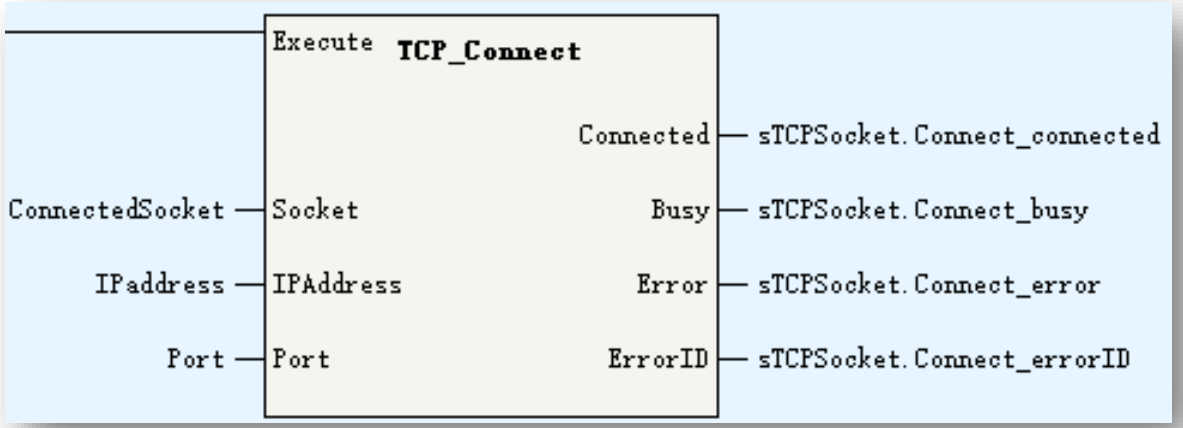
TCP_Accept



Parameters	Description
ListeningSocket	Socket. Currently don't support _sSocket data type, users can use an INT[20] as socket, take note this parameters is an input/output type data
Connected	The listen port of H5U *Don't use 23/12939/12940/502, this port used by system
ConnectedSocket	Connected Socket. Data transmission will base on this socket

TCP_Accept used to accept the connection request from client and build a connection socket while controller used as TCP socket server, the data transmission will base on this <ConnectedSocket>.

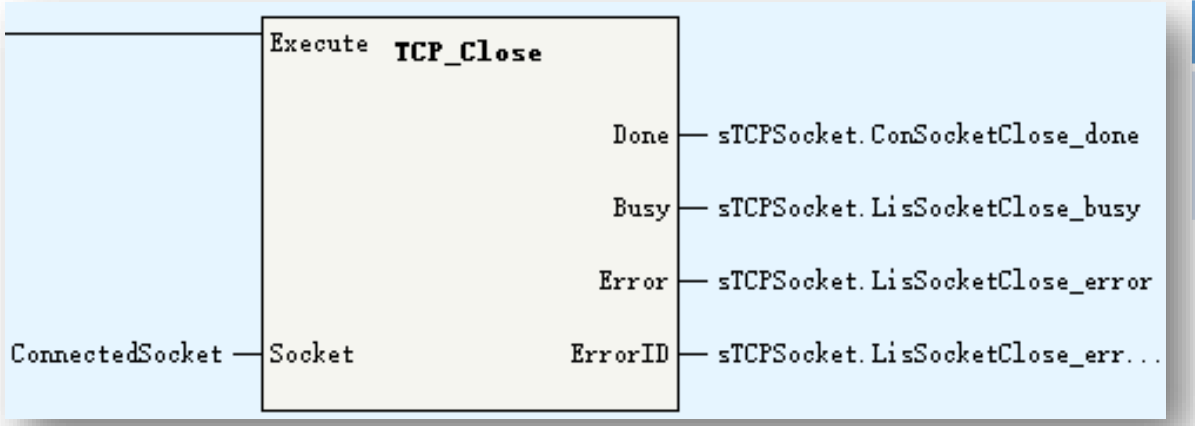
➢ TCP_Connected



Parameters	Description
Socket	Socket. Currently don't support _sSocket data type, users can use an INT[20] as socket, take note this parameters is an input/output type data
IPaddress	Server IP address
Port	Connected port
Connected	Connected

TCP_Connect used to connect the specified port of server while controller used as TCP socket client, if the connection built, <Connected> will be valid. After that, user can use TCP_Send and TCP_Receive to send or receive data.
Take note, while TCP client send connection request to server, and there is no response from server after 127 second, the connection operation is failed.

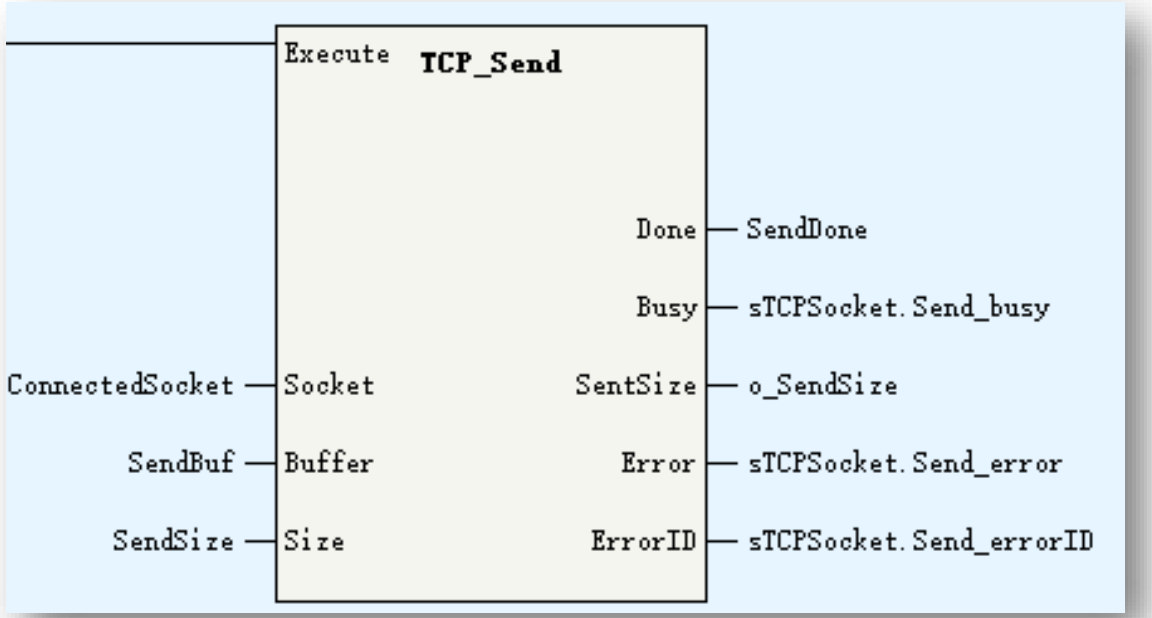
TCP_Close



Parameters	Description
Socket	Socket. Currently don't support _sSocket data type, users can use an INT[20] as socket, take note this parameters is an input/output type data

TCP_Close is used to close the connection or listening after communication done.

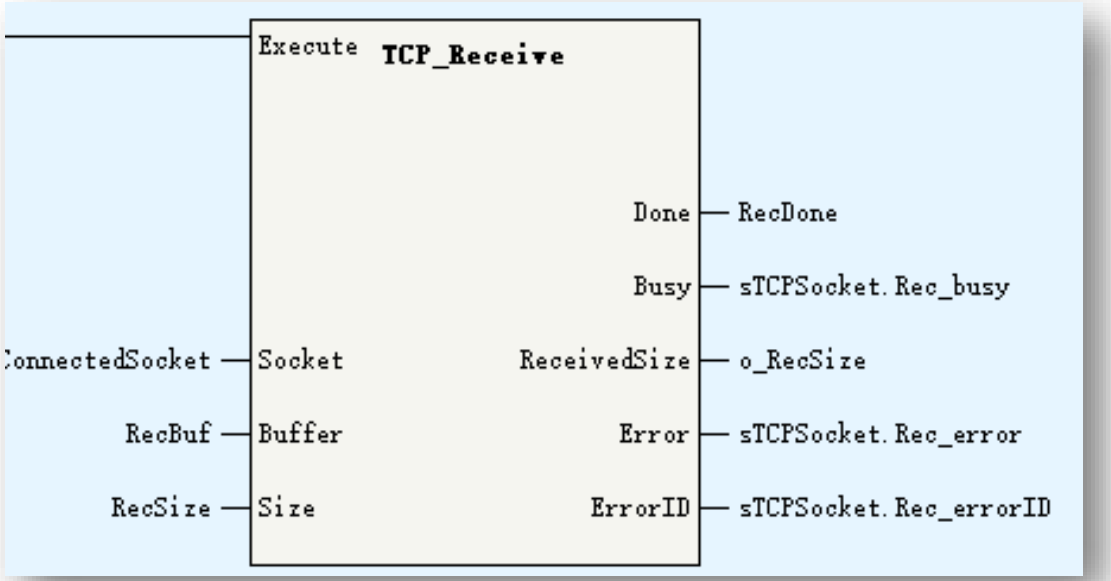
➢ TCP_Send



Parameters	Description
Socket	Socket. Currently don't support _sSocket data type, users can use an INT[20] as socket, take note this parameters is an input/output type data
Buffer	Send buffer
Size	Receive data size
SentSize	Sent data size

TCP_Send used to send data to server/client while the connection is built.
Take note the <Size> have to be less than <Buffer> size.

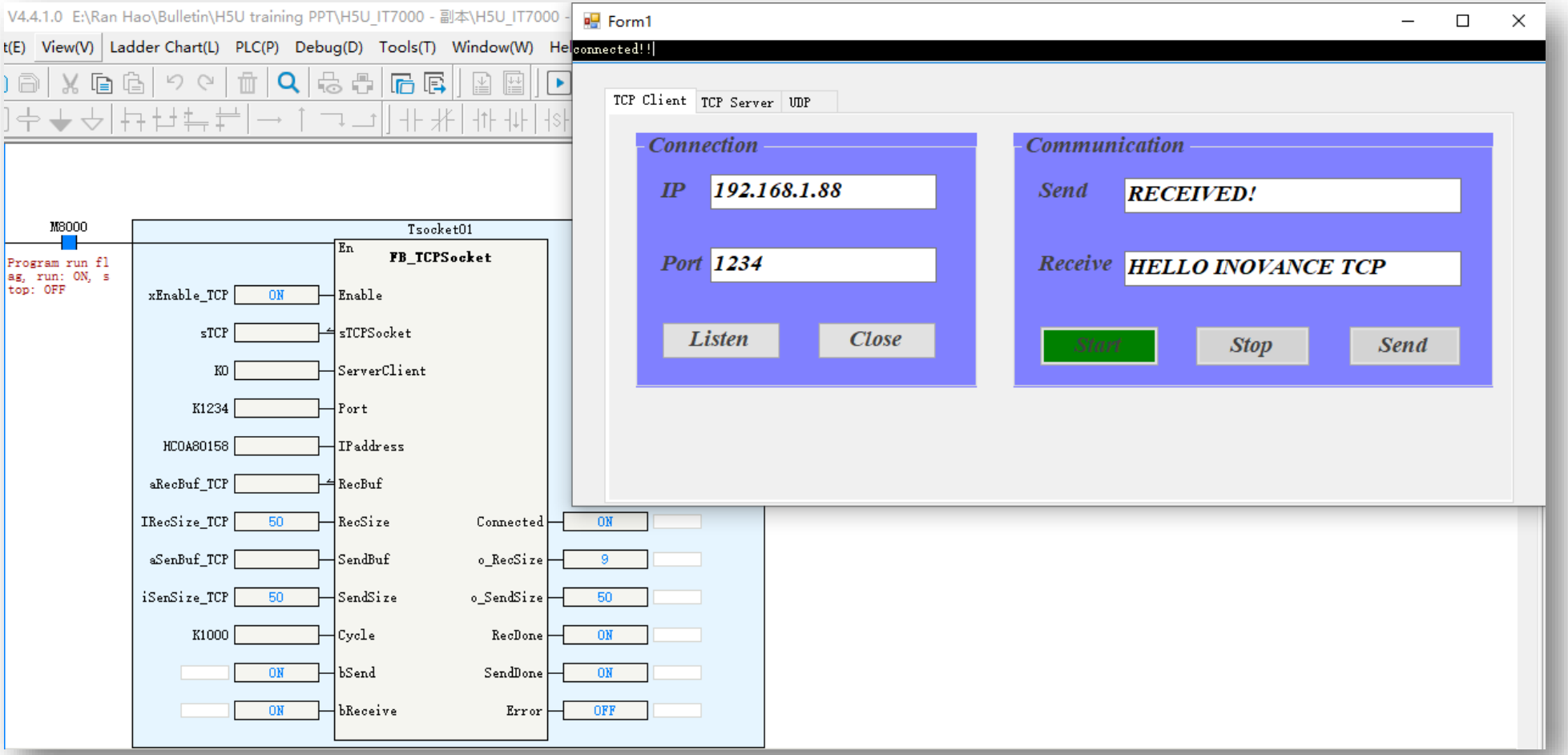
TCP_Receive



Parameters	Description
Socket	Socket. Currently don't support _sSocket data type, users can use an INT[20] as socket, take note this parameters is an input/output type data
Buffer	Receive buffer
Size	Receive data size
ReceivedSize	Received data size

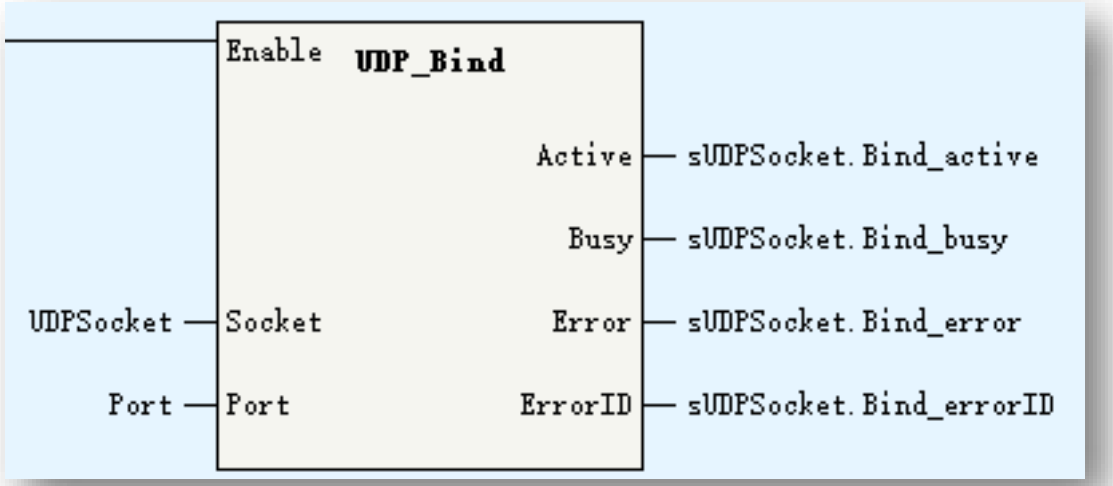
TCP_Receive used to receive data from server/client while the connection is built.
Take note the <Size> have to be less than <Buffer> size.

TCP socket test



For more details refer the application example.

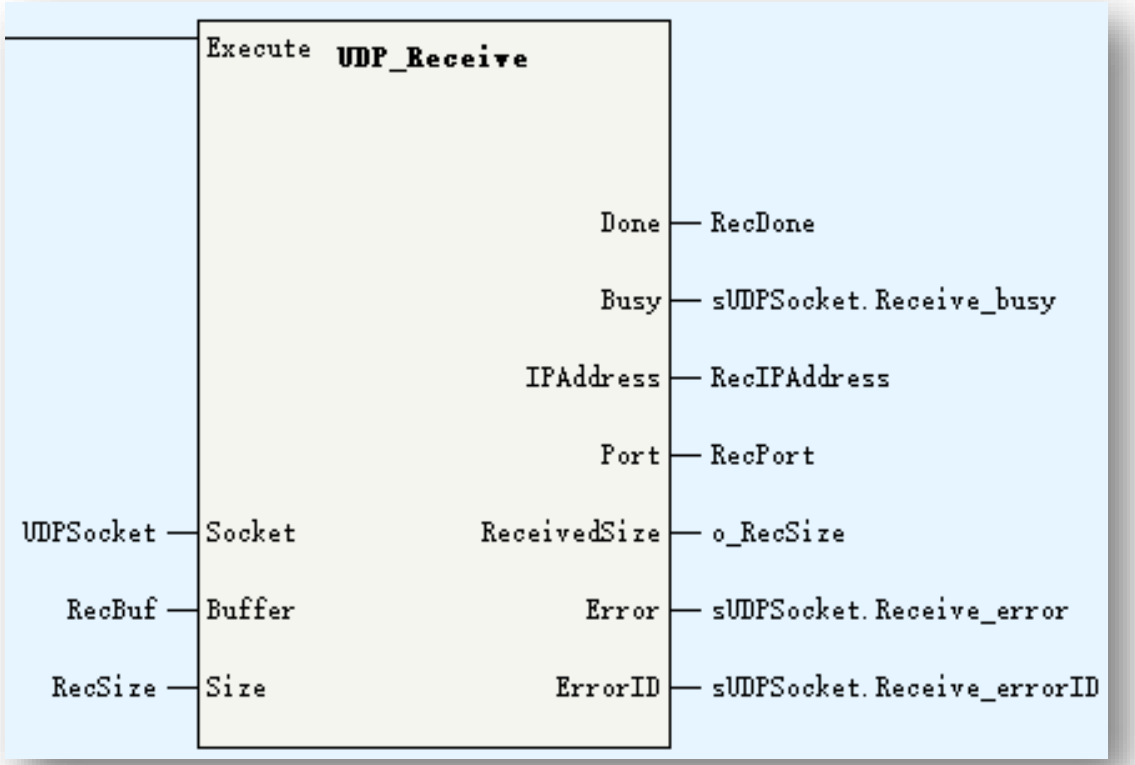
UDP_Bind



Parameters	Description
Socket	Socket. Currently don't support _sSocket data type, users can use an INT[20] as socket, take note this parameters is an input/output type data
Port	UDP port

UDP_Bind is used to bind UDP socket to local port.

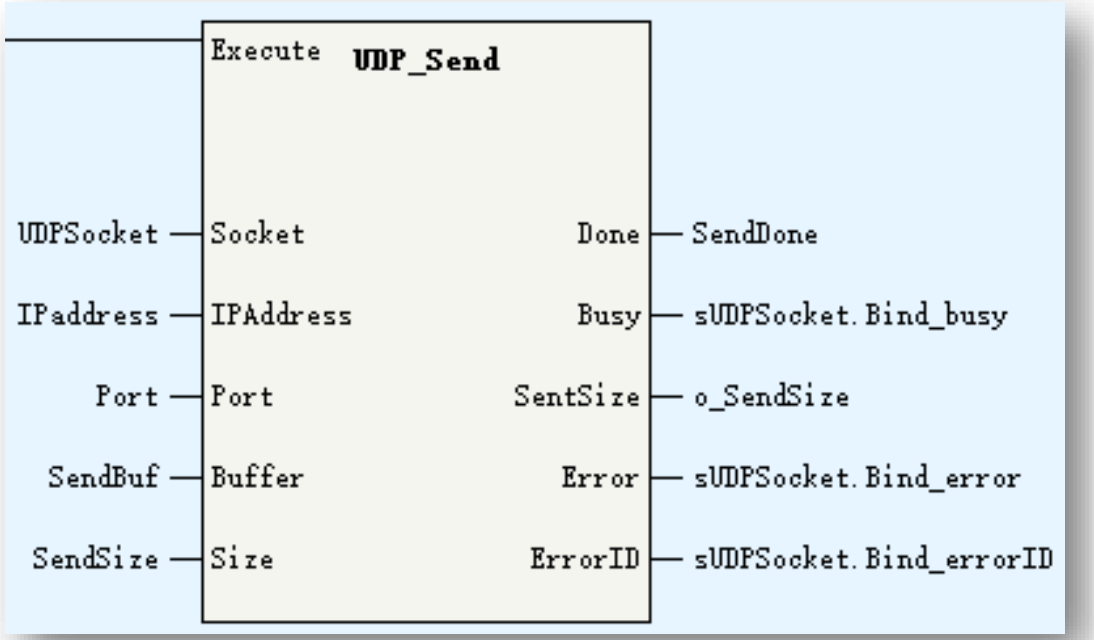
➢ UDP_Receive



Parameters	Description
Socket	Socket. Currently don't support _sSocket data type, users can use an INT[20] as socket, take note this parameters is an input/output type data
Buffer	Receive buffer
Size	Receive size
IPAddress	IP address
Port	UDP port
ReceivedSize	Received size

UDP_Receive used to receive data.
Take note the <Size> have to be less than <Buffer> size.

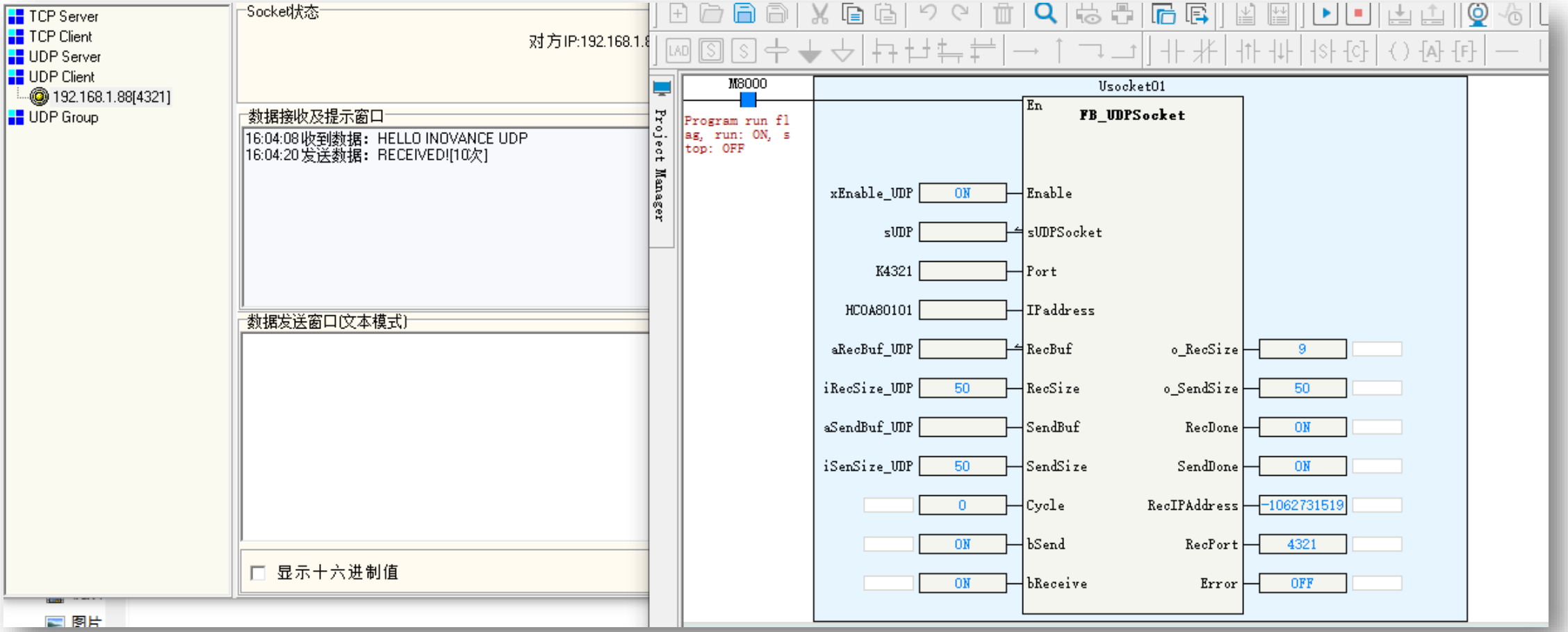
➢ UDP_Send



Parameters	Description
Socket	Socket. Currently don't support _sSocket data type, users can use an INT[20] as socket, take note this parameters is an input/output type data
IPAddress	IP address
Port	UDP port
Buffer	Send buffer
Size	Send size
SentSize	Sent data size

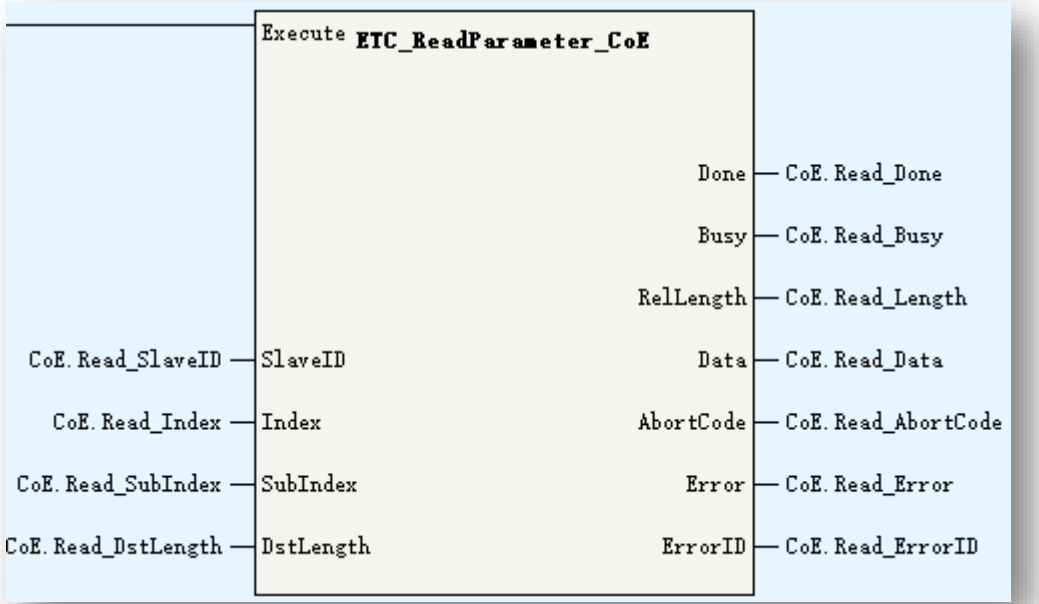
UDP_Send used to send data.
Take note the <Size> have to be less than <Buffer> size.

➢ UDP socket test



For more details refer the application example.

ETC_ReadParameter_CoE

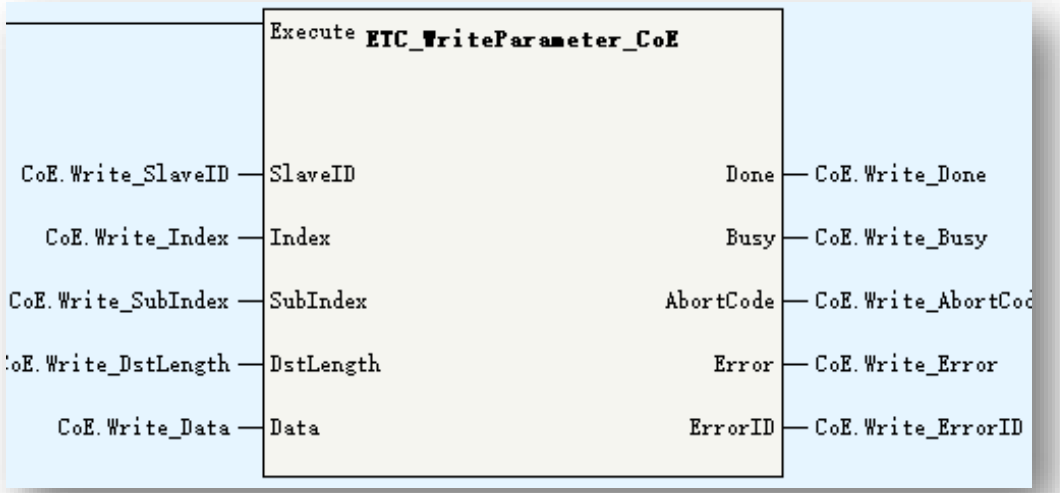


Parameters	Description
SlaveID	Slave sequence address
Index	Object dictionary index
SubIndex	Object dictionary sub index
DstLength	Read length(byte)
RelLength	Actual read length
Data	Read data
AbortCode	Abort code while failed to read slave

ETC_ReadParameter_CoE is used to read slave parameters via CoE.
<SlaveID> specified the slave,
<Index> and <SubIndex> used to specified the object dictionary address which wanted read,
<DstLength> specified the wanted read data length, the unit is byte.

Take note:
If master is failed to read slave, there will be an <AbortCode>, users can check the <AbortCode> to find the fault reason.

ETC_WriteParameter_CoE



Parameters	Description
SlaveID	Slave sequence address
Index	Object dictionary index
SubIndex	Object dictionary sub index
DstLength	Write length(byte)
Data	Write data
AbortCode	Abort code while failed to write slave

ETC_WriteParameter_CoE is used to write slave parameters via CoE.
<SlaveID> specified the slave,
<Index> and <SubIndex> used to specified the object dictionary address which wanted read,
<DstLength> specified the wanted write data length, the unit is byte.

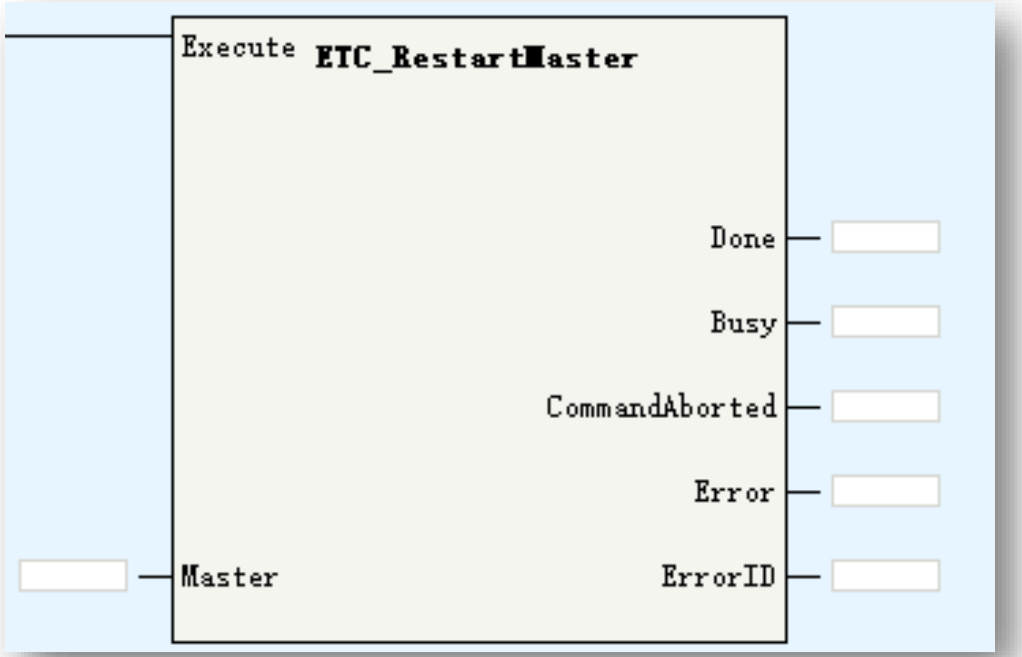
Take note:
If master is failed to write slave, there will be an <AbortCode>, users can check the <AbortCode> to find the fault reason.

SDO abort code

Abort code	Description
0503 0000h	Toggle bit not alternated.
0504 0000h	SDO protocol timed out.
0504 0001h	Client/server command specifier not valid or unknown.
0504 0002h	Invalid block size (block mode only).
0504 0003h	Invalid sequence number (block mode only).
0504 0004h	CRC error (block mode only).
0504 0005h	Out of memory.
0601 0000h	Unsupported access to an object.
0601 0001h	Attempt to read a write only object.
0601 0002h	Attempt to write a read only object.
0602 0000h	Object does not exist in the object dictionary.
0604 0041h	Object cannot be mapped to the PDO.
0604 0042h	The number and length of the objects to be mapped would exceed PDO length.
0604 0043h	General parameter incompatibility reason.
0604 0047h	General internal incompatibility in the device.
0606 0000h	Access failed due to an hardware error.
0607 0010h	Data type does not match, length of service parameter does not match
0607 0012h	Data type does not match, length of service parameter too high
0607 0013h	Data type does not match, length of service parameter too low
0609 0011h	Sub-index does not exist.

Abort code	Description
0609 0030h	Invalid value for parameter (download only).
0609 0031h	Value of parameter written too high (download only).
0609 0032h	Value of parameter written too low (download only).
0609 0036h	Maximum value is less than minimum value.
060A 0023h	Resource not available: SDO connection
0800 0000h	General error
0800 0020h	Data cannot be transferred or stored to the application.
0800 0021h	Data cannot be transferred or stored to the application because of local control.
0800 0022h	Data cannot be transferred or stored to the application because of the present device state.
0800 0023h	Object dictionary dynamic generation fails or no object dictionary is present (e.g. object dictionary is generated from file and generation fails because of an file error).
0800 0024h	No data available

ETC_RestartMaster



Parameters	Description
Master	EtherCAT master

ETC_RestartMaster is used to restart EtherCAT master.

PID

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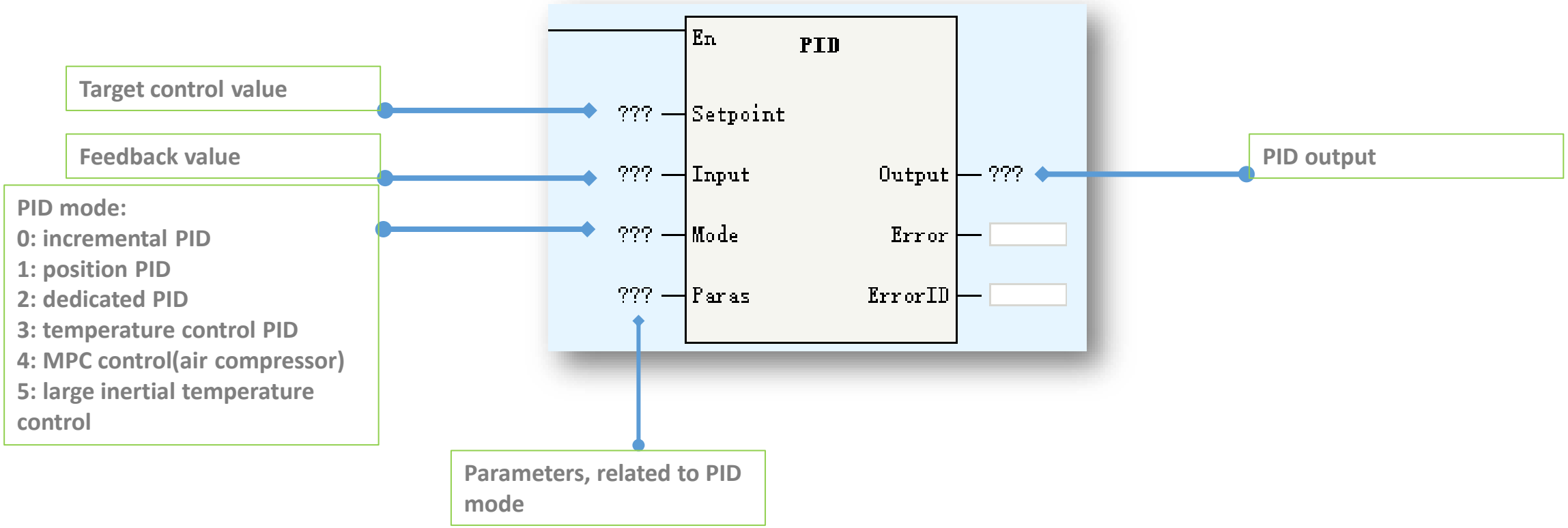
String Processing	Function
PID	PID instruction



PID-Mode 0: Incremental PID Parameters

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Address	Function	Description
S4(start address)	Capture time(TS)	1~32767ms, need over than PLC scan cycle
S4+1	Action direction(ACT)	Bit 0: 0=positive action, 1=negative action Bit 1: 0=input variation alarm invalid, 1=input variation alarm valid Bit2:0=output variation alarm invalid, 1=output variation alarm valid Bit3: reserved Bit4: 0=auto tune invalid, 1=auto tune valid(currently not support) Bit5: output up/down limit, 0=invalid, 1=valid Bit6~15: reserved Be noted: don't let bit5 and bit2 ON at the same time
S4+2	Input filter time(α)	0~99%, 0=no input filter
S4+3	Proportion gain(Kp)	1~32767%
S4+4	Integration time(T1)	0~32767(*100ms), 0=no integration
S4+5	Differentiation gain(KD)	0~100%, 0 = no differentiation
S4+6	Differentiation time	0~32767(*10ms), 0=no differentiation
S4+(7~19)	Internal usage	Clear before first executing PID
While <ACT> Bit1=1, Bit2=1 or Bit5=1, S4+(20~24) will be used, the definition show as below:		
S4+20	Input increase variation alarm value	0~32767, valid while <ACT> Bit1=1
S4+21	Input decrease variation alarm value	0~32767, valid while <ACT> Bit1=1
S4+22	Output increase variation(or up limit) alarm value	0~32767, valid while <ACT> Bit2=1, Bit5=0 /-32768~32767, output up limit while <ACT> bit1=0, bit5=1
S4+23	Output decrease variation(or low limit) alarm value	0~32767, valid while <ACT> Bit2=1, Bit5=0 /-32768~32767, output up limit while <ACT> bit1=0, bit5=1
S4+24	Alarm output	Bit0 input increase variation overflow, Bit1 input decrease variation overflow Bit2 output increase variation overflow, Bit3 output decrease variation overflow
S4+25	Internal usage	--

PID-Mode 1: Position PID Parameters

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Address	Function	Description
S4(start address)	Capture time(TS)	1~32767ms, default 10
S4+1	Control mode	0:positive 1:negative
S4+2	Proportion gain(Kp1)	0~32767%
S4+3	Integration gain(Ki1)	0~32767%
S4+4	Differentiation gain(Kd1)	0~32767%
S4+5	Deviation dead zone	0~32767, 0=invalid, while deviation less than set value, recognize deviation as 0
S4+6	Output up limit	-32768~32767
S4+7	Output low limit	-32768~32767
S4+8	Integration up limit	-32768~32767
S4+9	Integration low limit	-32768~32767
S4+10/11	Accumulative integration	32bit float
S4+12	Internal usage	Last time output
S4+13	Kp2	0~32767%
S4+14	Ki2	0~32767%
S4+15	Kd2	0~32767%
S4+16	Gain exchange condition	0: invalid(S4-17~19 not work) 1: according to deviation 2: customized
S4+17	Deviation low limit E1	-32768~32767
S4+18	Deviation up limit E2	-32768~32767
S4+19	Customized gain exchange	-32768~32767
S4+20~26	Internal usage	--

PID-Mode 1: Position PID Parameters

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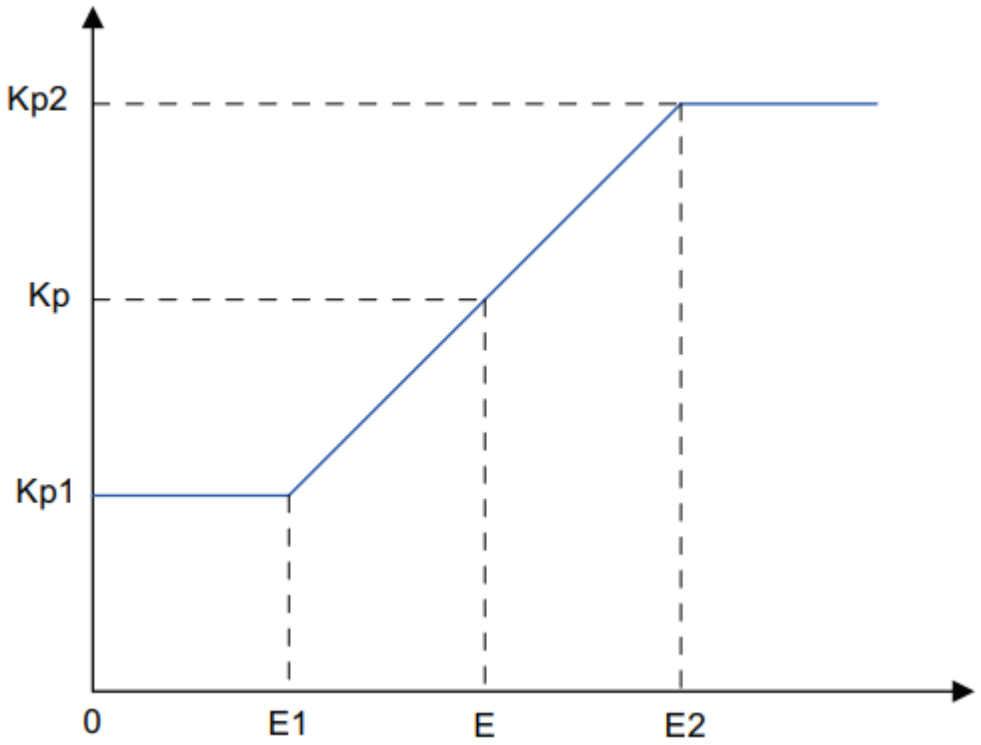

Gain exchange principle(proportion gain as example):
While E<=E1, Kp=Kp1;
While E1<E<E2, Kp=Kp1+ (Kp2-Kp1)*(E-E1)/(E2-E1);
While E>=E2, Kp=Kp2;

*While S4+16=0, no gain exchange
S4+16=1, E=|Sv-Pv|
S4+16=2, E=S4+19

Par	Description
Kp1	S4+2
Kp2	S4+13
E1	S4+17
E2	S4+18
E	Exchange reference

PID-Mode 3: Temperature control PID Parameters

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Address	Function	Description
S4(start address)	Capture time(TS)	1~32767ms, need over than PLC scan cycle
S4+1	Control mode	Bit0: 0:positive 1:negative Bit4: 0=auto tune invalid 1= auto tune, reset after auto tune done
S4+2	Auto tune mode	0: common mode, appropriate overshoot 1: slow mode, small overshoot, but slow temperature increment 2: fast mode, fast temperature increment, but large overshoot
S4+3	Proportion band	1~32767, proportion band lower, proportion effect stronger. Auto tune will generate proportion band
S4+4	Integration time	1~32767, 0=no integration, auto tune will generate integration time
S4+5	Differentiation time	1~32767, 0=no differentiation, auto tune will generate differentiation
S4+6	Output up limit	-32768~32767
S4+7	Output low limit	-32768~32767
S4+8	Reserved	--
S4+9	Proportion output	Current proportion calculation output
S4+10	Integration output	Current integration proportion calculation output
S4+11	Differentiation output	Current differentiation calculation output
S4+12~19	Internal usage	--

Compared with H3U, H5U have different command format(H3U using ladder whereas H5U using function block), except this, H5U parameters setting almost same as H3U.

Motion Control(EtherCAT & Pulse Output)

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Basic Motion Control	Function
MC_Power	Axis enable control
MC_Reset	Axis error reset
MC_ReadStatus	Read axis status
MC_ReadAxisError	Read axis error
MC_ReadDigitalInput	Read drive digital input
MC_ReadActualPosition	Read actual position
MC_ReadActualVelocity	Read actual velocity
MC_ReadActualTorque	Read actual torque
MC_SetPosition	Set axis position
MC_TouchProbe	Touch probe function
MC_MoveRelative	Axis position relatively
MC_MoveAbsolute	Axis position absolutely
MC_MoveVelocity	Axis speed command
MC_Jog	Axis jog command
MC_TorqueControl	Axis torque control
MC_Home	Axis homing

Basic Motion Control	Function
MC_Stop	Axis stop
MC_Halt	Axis pause
MC_ImmediateStop	Axis emergency stop
MC_MoveFeed	Axis interruption position
MC_MoveBuffer	Multi position command
MC_MoveSuperImposed	Axis position superimposed command
MC_MoveVelocityCSV	CSV velocity control(with PWM function)
MC_SyncMoveVelocity	CSV velocity control(with PWN function, without acceleration/deceleration)
MC_SyncTorqueControl	Sync torque control

Motion Control(EtherCAT & Pulse Output)

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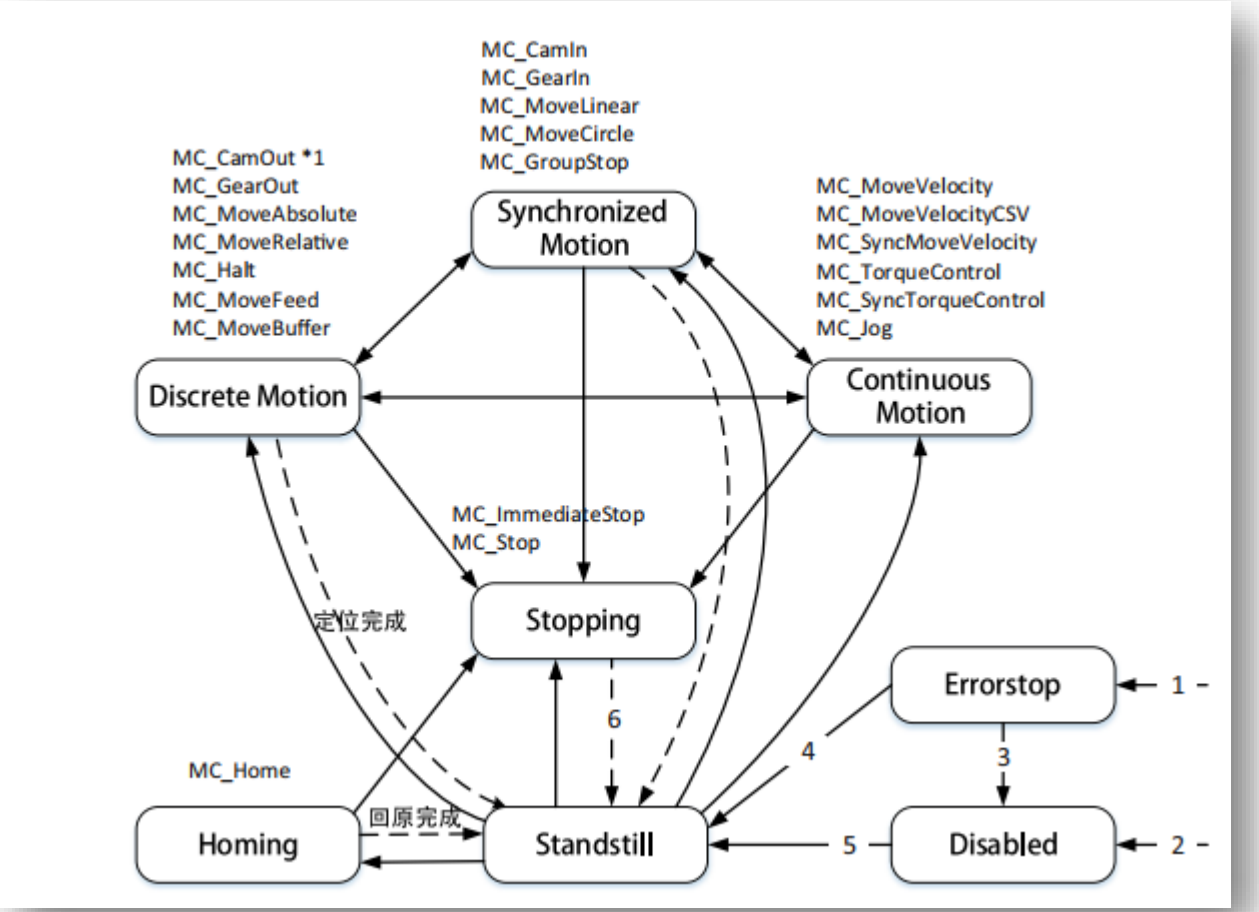
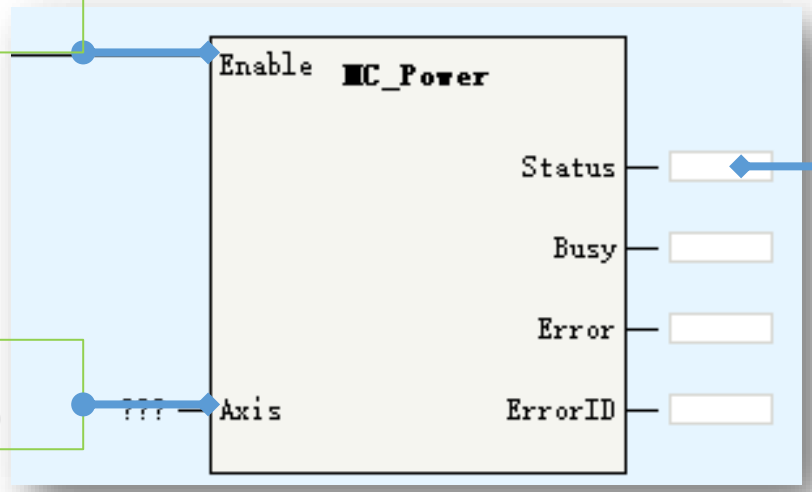


H5U manage axis based on PLCopen state machine.

The state switch conditions show as below:
While axis error detected
While axis no error and MC_Power.Enable=OFF
While using MC_Reset and MC_Power.Status=OFF
While using MC_Reset and MC_Power.Status=ON
While MC_Power.Enable=ON and MC_Power.Status=ON
While MC_Stop(MC_ImmediateStop).Done=ON and MC_Stop(MC_ImmediateStop).Execute=OFF

➢ MC_Power

Enable Axis



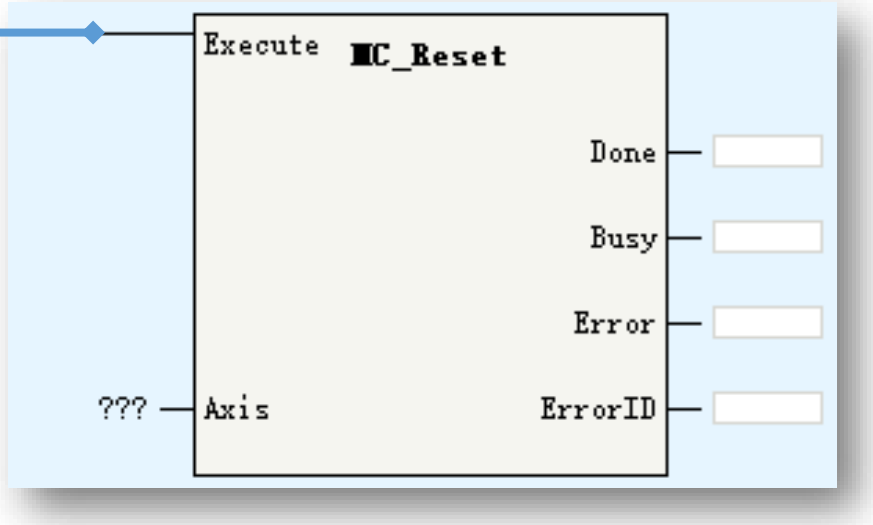
Axis No(INT) or Axis name(_sMCAXIS_INFO)

While Status=ON, axis is ready to move

MC_Power command is used to switch the axis status from disable to standstill, while get into standstill status, axis is ready to move.

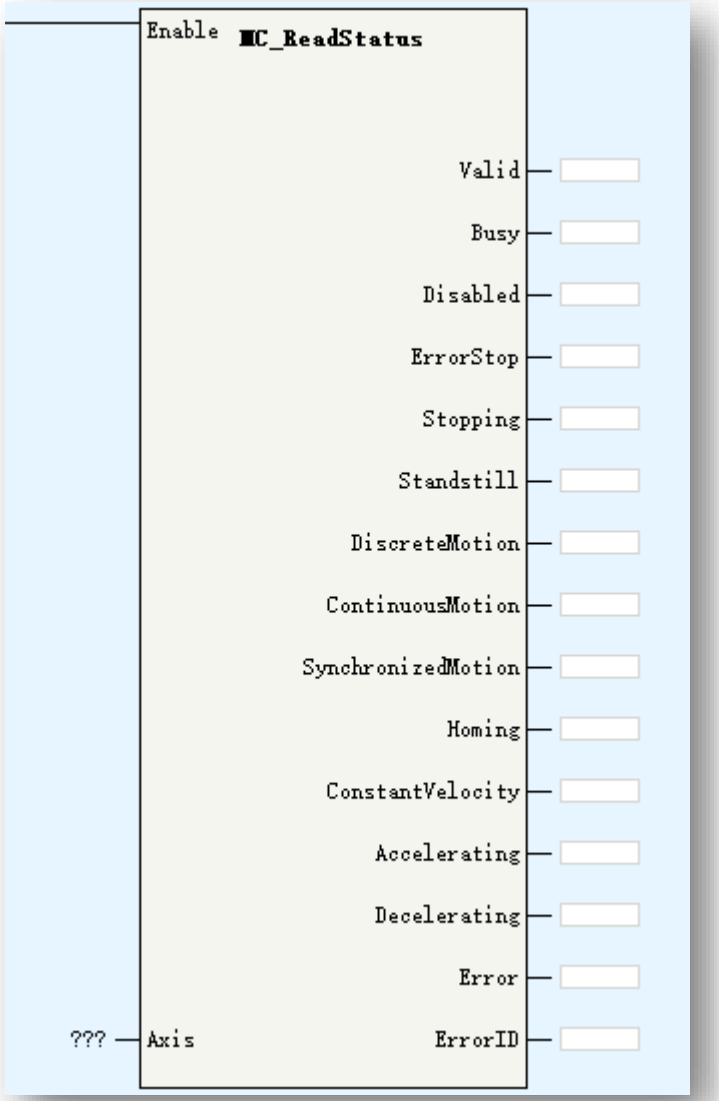
MC_Reset

Execute command



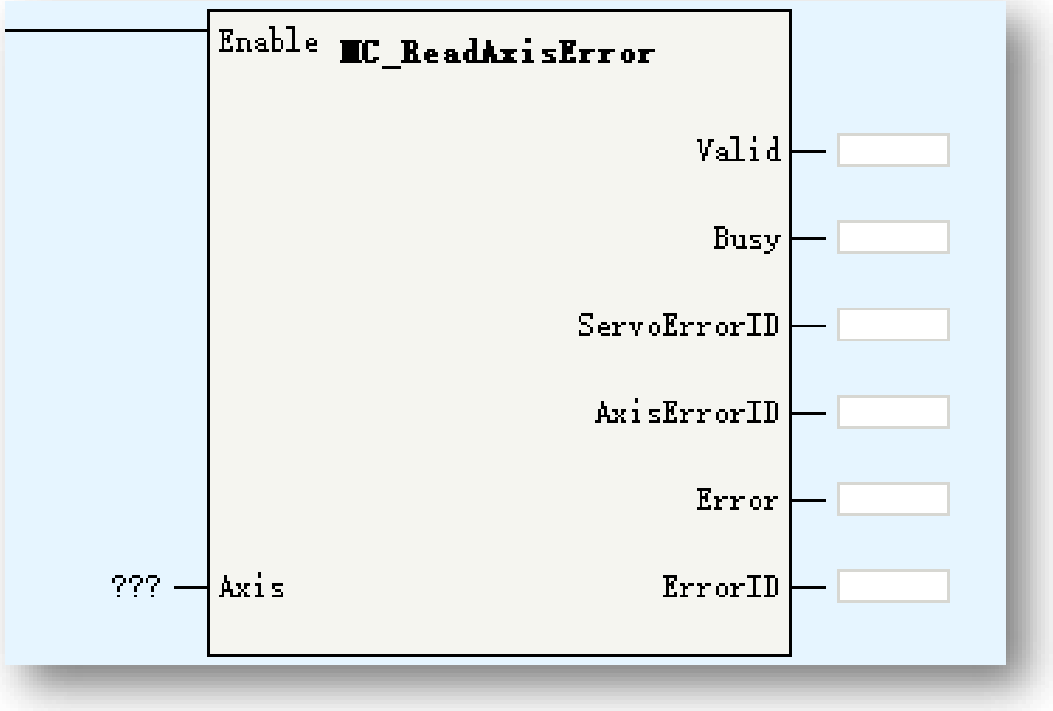
After MC_Reset.Done, axis get into disabled or standstill state.
Be noted if using MC_Reset while there is no error of axis, this function block will have an error.

MC_ReadStatus



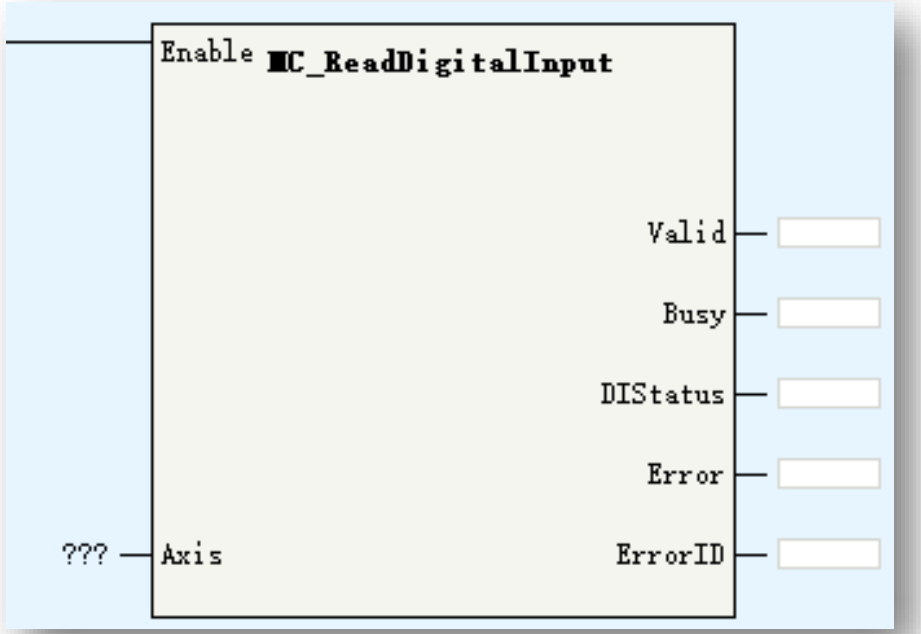
While Enable=ON, this block will read axis PLCopen state and accelerating/decelerating state.
In torque control mode, ConstantVelocity/Accelerating/Decelerating will be off.

MC_ReadAxisError



While Enable=ON, if the axis existed and there is no configuration error, <Valid> will be ON. <AxisErrorID> is used to show the error code, users can find the error information according to the error code(while <AxisErrorID>=0, there is no error). <ServoErrorID> display the value of 0x603F(while 0x603F configured in PDO, or <ServoErrorID> will display 0)

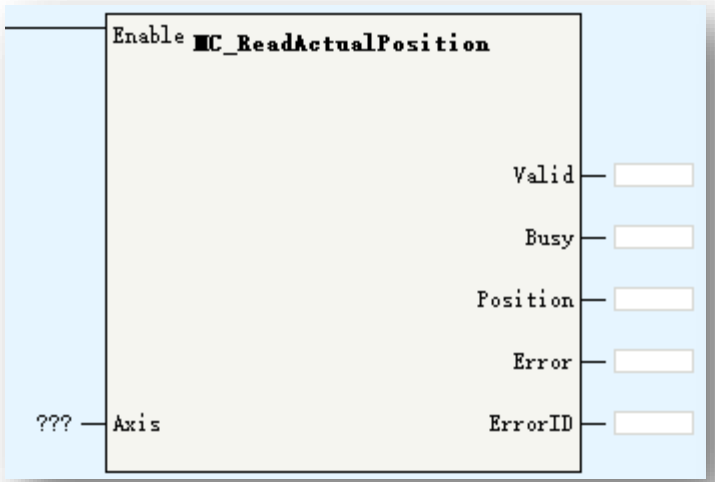
MC_ReadDigitalInput

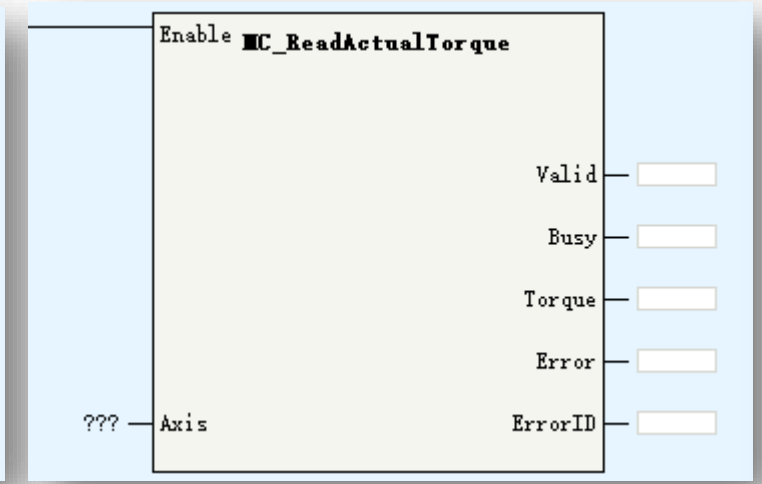


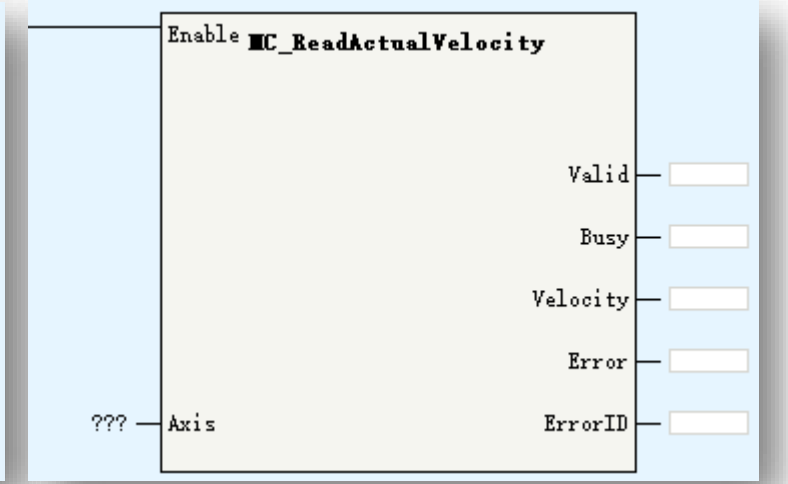
Read the digital input status of axis.
While Enable=ON, if the EtherCAT axis or pulse axis positive limit/or negative limit enabled, the <Valid>=ON.

While using with EtherCAT axis, need configure 0x60FD in PDO.
Details for input definition please find corresponding servo manual.

- MC_ReadActualPosition
- MC_ReadActualTorque
- MC_ReadActualVelocity

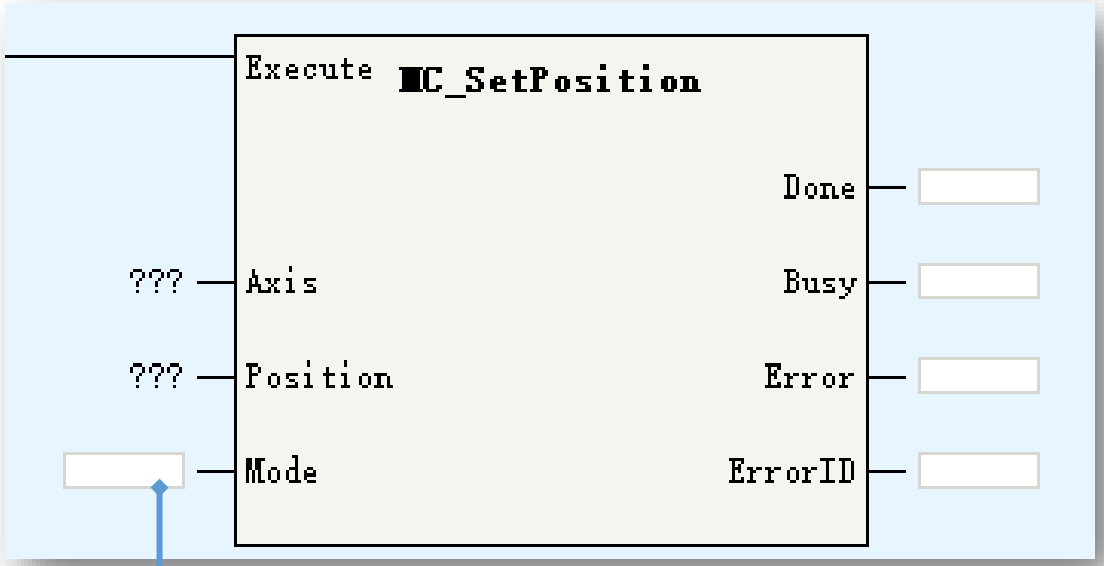






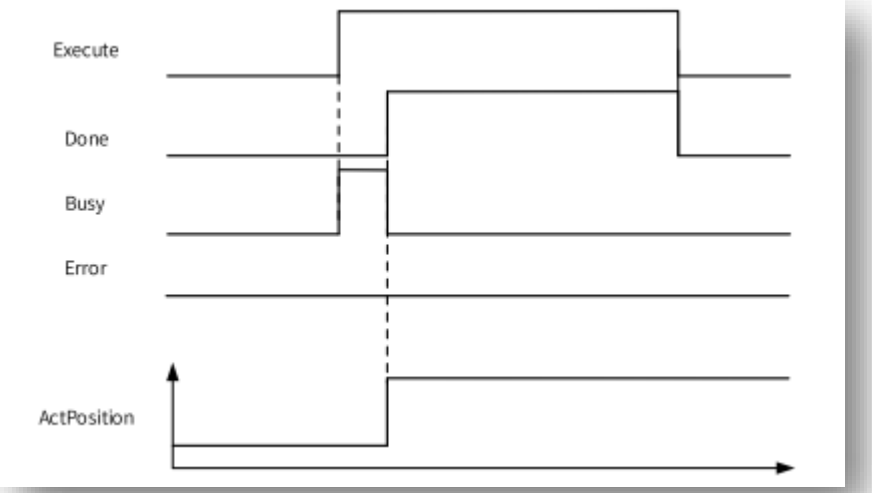
While Enable = ON,
For MC_ReadActualPosition, if 0x6064 configured in PDO, Valid=ON;
For MC_ReadActualTorque, if 0x6077 configured in PDO, Valid =ON;
For MC_ReadActualVelocity, if 0x606C configured in PDO, Valid =ON;
These FBs are used to read axis real time velocity/position/torque, besides, users can also read the axis structure directly to get this value by using _sMCAXIS_INFO.dActPosition/_sMCAXIS_INFO.dActVelocity/_sMCAXIS_INFO.dActTorque

MC_SetPosition

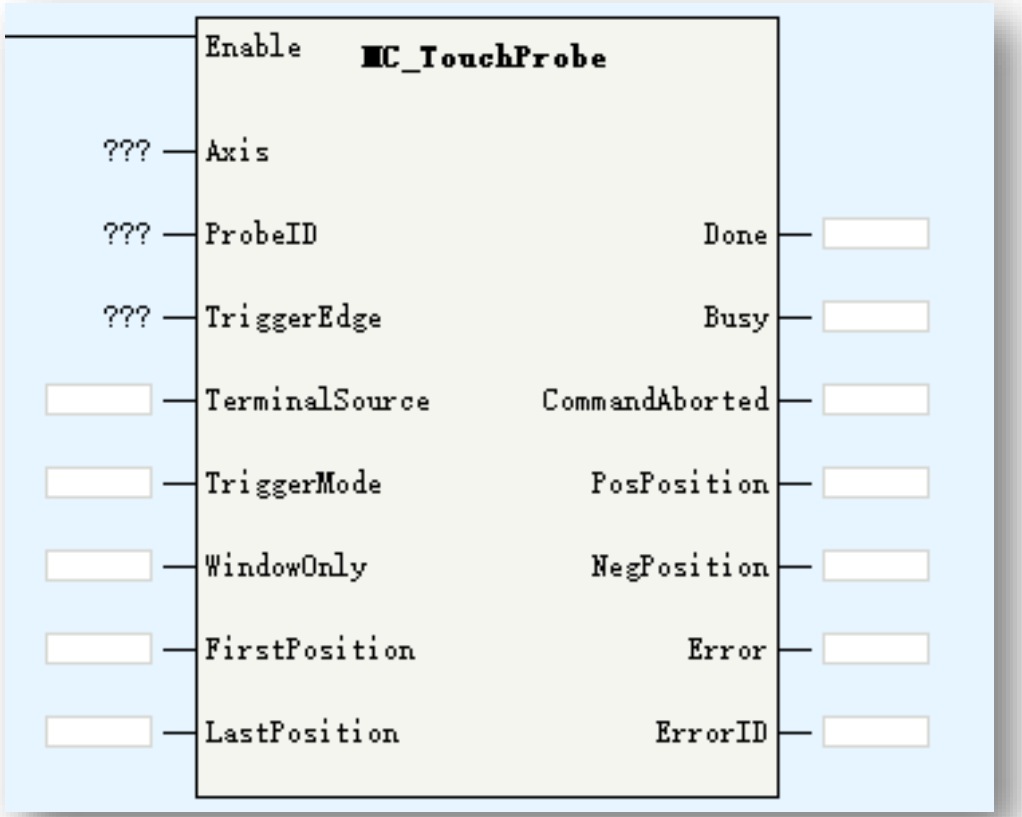


MC_Setposition can modify axis position without moving. Be noted, only in standstill/disabled/errorstop status, axis can execute this command, or the FB will have an error.

0: Absolute mode, set <Position> value as axis ActPosition
1: Relative mode, add <Position> value base on current ActPosition



➢ MC_TouchProbe

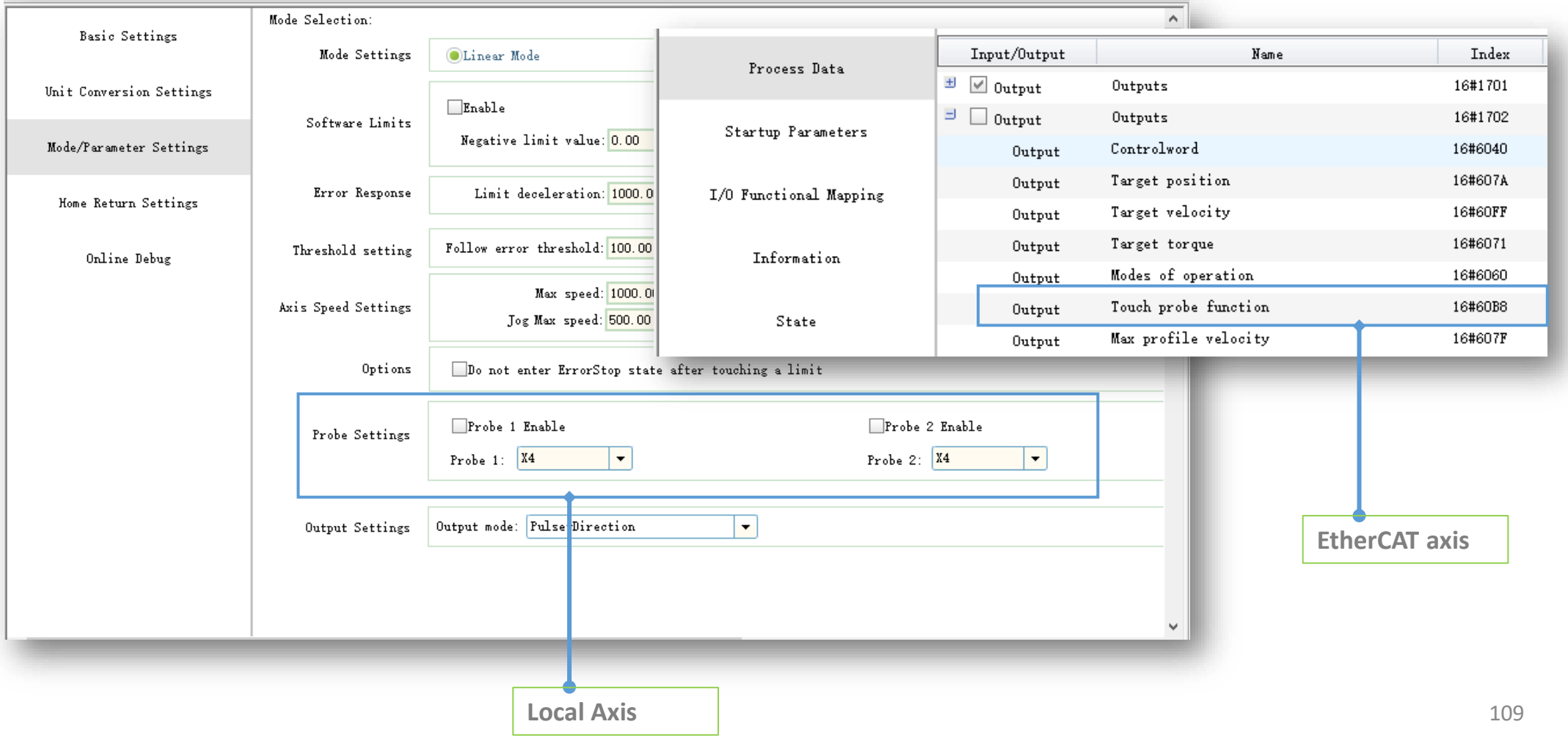


Parameters	Description
Axis	Axis ID/Axis name
ProbeID	0: TP1 1:TP2
TriggerEdge	0: rising edge 1:falling edge 2:both of rising and falling edge
TerminalSource	TP trigger source: 0:DI 1:encoder Z signal
TriggerMode	0: single 1: continuous
WindowOnly	0: disabled window function, detect TP signal in any position 1: enable window function, detect TP signal in <FirstPosition, LastPosition> range
FirstPosition	TP window start position
LastPosition	TP window last position
PosPosition	Positive(rising edge) latch value
NegPosition	Negative(falling edge) latch value

Touch probe FB is used to read the locked position value of servo while signal triggered without software delay, which means the latch position will not impacted by EtherCAT cycle and data transmission time.

MC_TouchProbe

While using local pulse axis, need configure the touch probe input in axis configuration view.
While using field bus axis, need select touch probe related PDO in EtherCAT slave configuration.

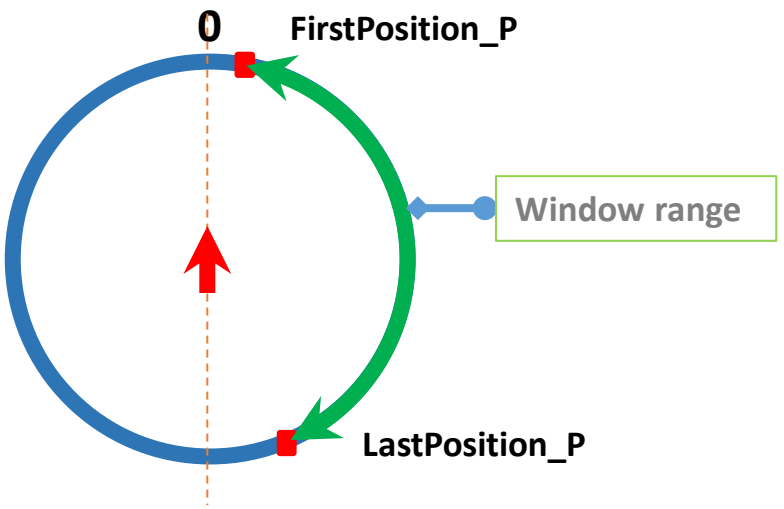


MC_TouchProbe

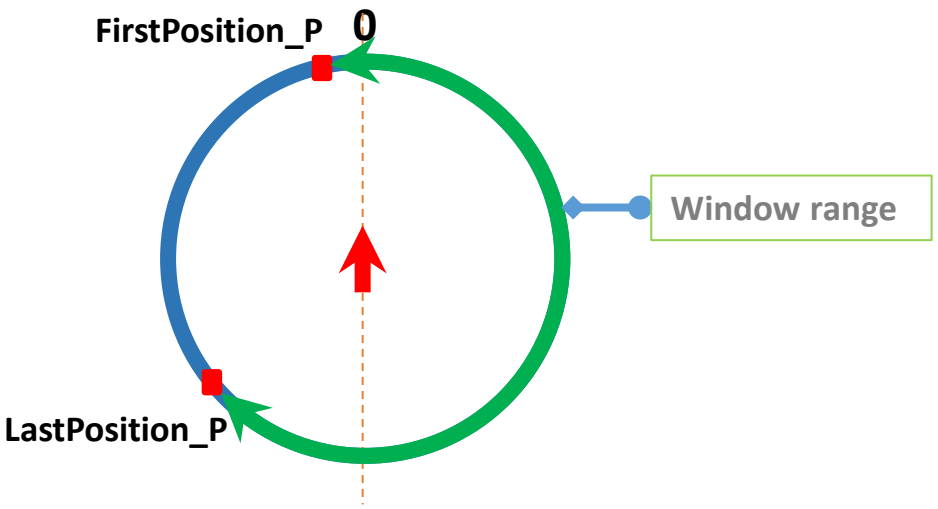
While <Enable>=ON(rising edge), FB will lock the input parameters.

If <WindowOnly>=OFF, the window detection function will not work, the touch probe in full position range.

If <WindowOnly>=ON, the window detection function will be enabled, in this case:
While axis is in linear mode, only when the touch probe triggered in <FirstPosition> and <LastPosition> range, the position value will be latched.
While axis is in rotation mode, firstly do modulo operation to the <FirstPosition> and <LastPosition> based on the rotation cycle. For example, if <FirstPosition> is set as 540, the rotation cycle is 360, then the <540 Mod 360> = 180. After modulo operation, we get the modulo value FirstPosition_P and LastPosition_P.

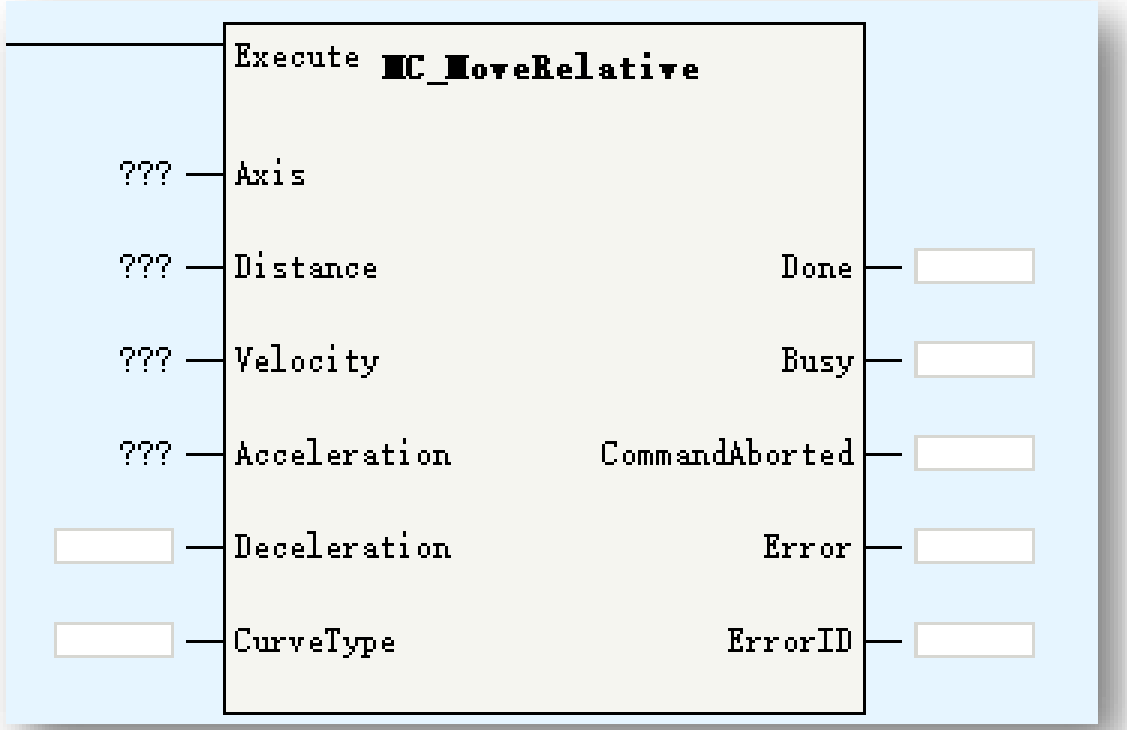


*While FirstPosition_P < LastPosition_P



*While FirstPosition_P > LastPosition_P

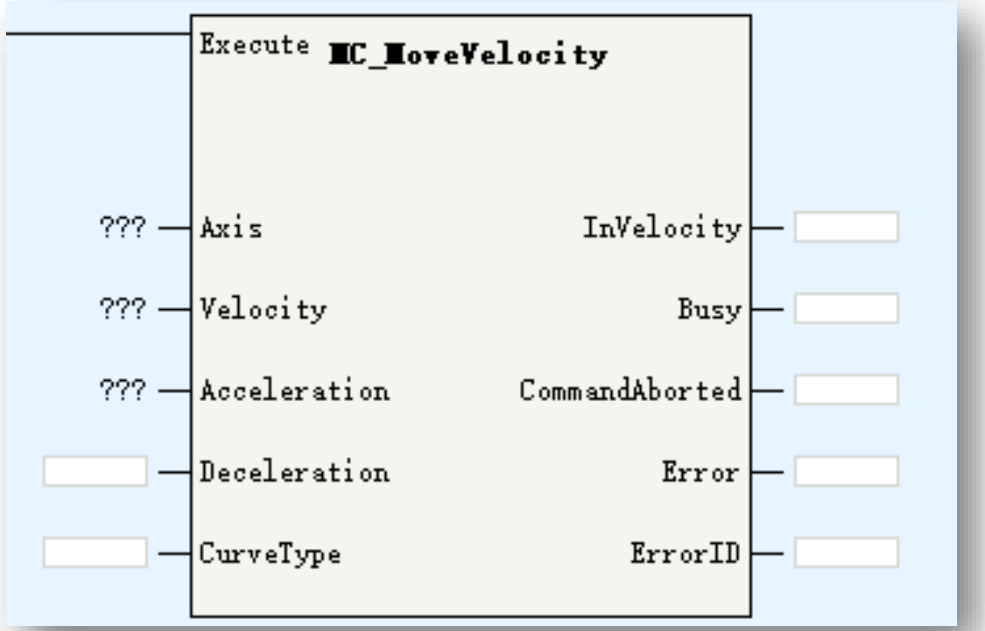
➢ MC_MoveRelative



Parameters	Description
Axis	Axis ID/Axis name
Distance	Moving distance
Velocity	Moving velocity
Acceleration	Acceleration
Deceleration	Deceleration
CurveType	Velocity ACC/DEC curve: 0: T curve 1: S curve

This command works while axis in standstill/discretemotion/continousmotion status, after executing this command, axis get into discretemotion status.

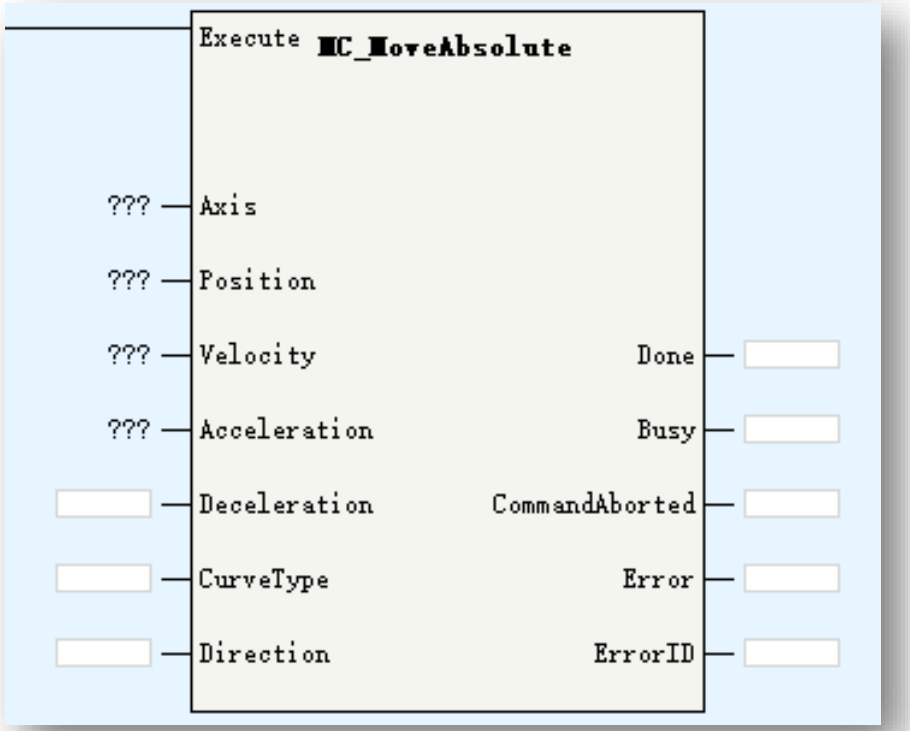
➢ MC_MoveVelocity



Parameters	Description
Axis	Axis ID/Axis name
Velocity	Target velocity
Acceleration	Acceleration
Deceleration	Deceleration
CurveType	Velocity ACC/DEC curve: 0: T curve 1: S curve
InVelocity	Up to target velocity

This command works while axis in standstill/discretemotion/continousmotion status, after executing this command, axis get into continousmotion status.

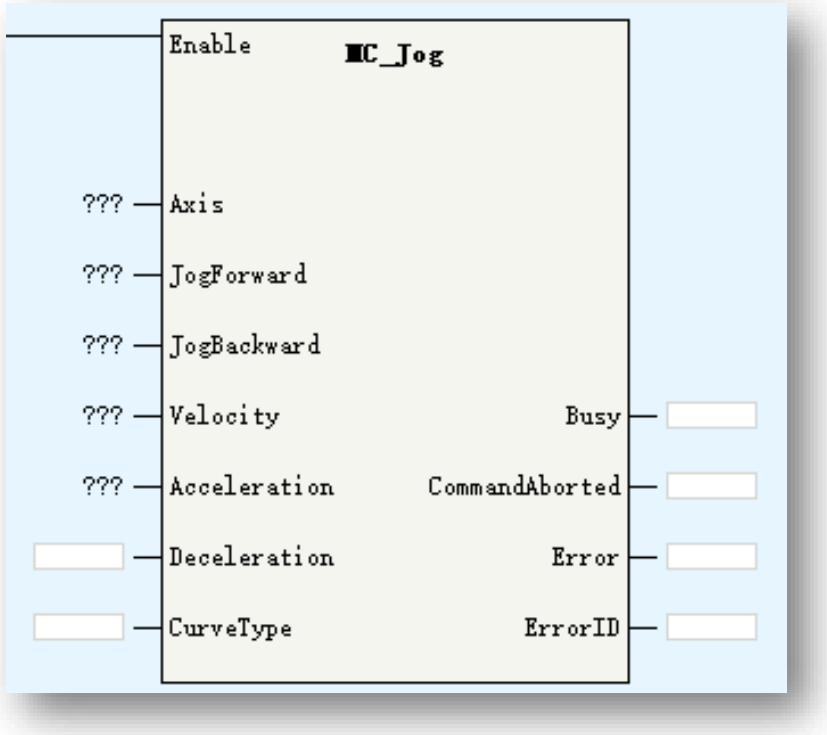
➢ MC_MoveAbsolute



Parameters	Description
Axis	Axis ID/Axis name
Position	Target position
Velocity	Target velocity
Acceleration	Acceleration
Deceleration	Deceleration
CurveType	Velocity ACC/DEC curve: 0: T curve 1: S curve
Direction	Only works in rotation mode 0: positive 1: negative 2: shortest 3: current direction

This command works while axis in standstill/discretemotion/continousmotion status, after executing this command, axis get into discretemotion status.

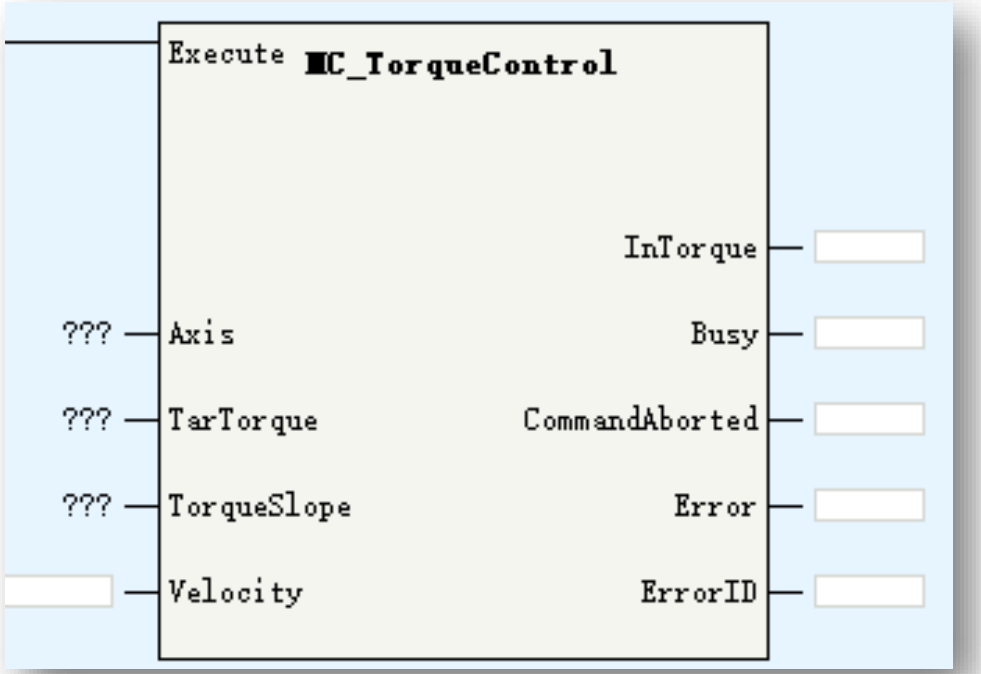
➢ MC_Jog



Parameters	Description
Axis	Axis ID/Axis name
JogForward	Moving forward
JogBackward	Moving backward
Velocity	Target velocity
Acceleration	Acceleration
Deceleration	Deceleration
CurveType	Velocity ACC/DEC curve: 0: T curve 1: S curve

This command works while axis in standstill/discretemotion/continousmotion status, after executing this command, axis get into continousmotion status. While JogForward and JogBackward enabled at the same time, the FB will report an error, but axis will not get into errorstop status.

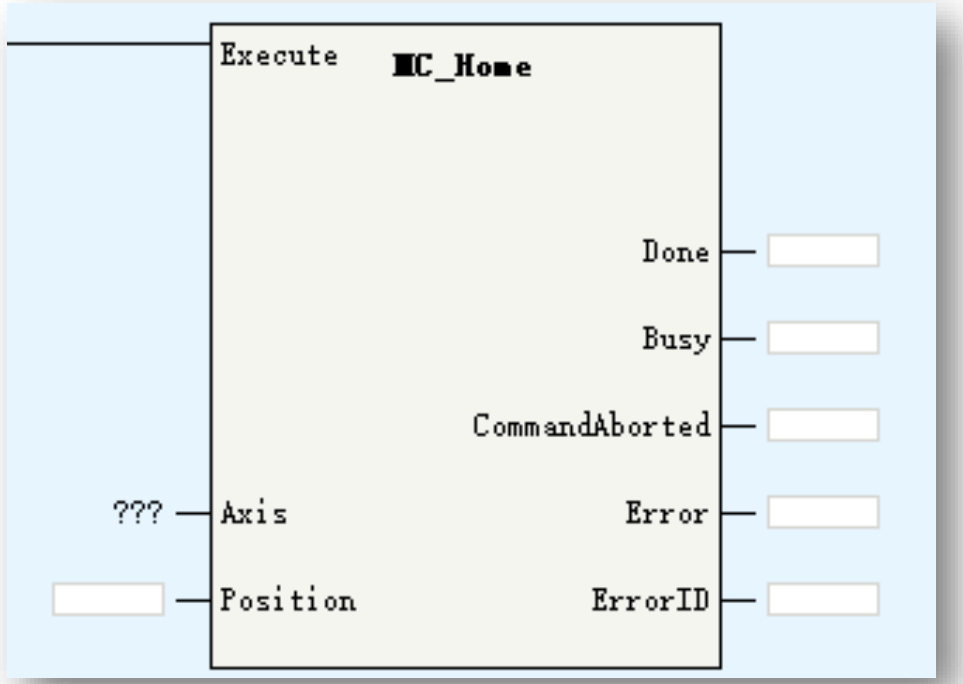
➢ MC_TorqueControl



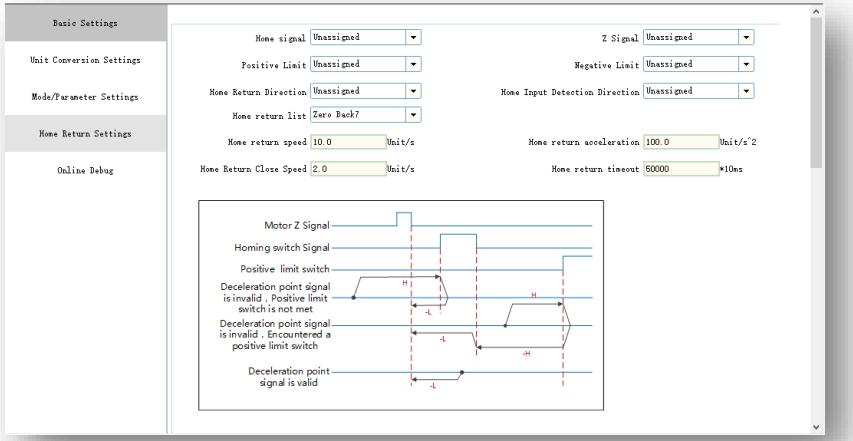
Parameters	Description
Axis	Axis ID/Axis name
TarTorque	Target torque(unit 1%)
TorqueSlope	Torque slope(unit 1%)
Velocity	Limit velocity
InTorque	While difference of target torque and set torque in 5%, InTorque valid

This command works while axis in standstill/discretemotion/continousmotion status, after executing this command, axis get into continousmotion status.

➢ MC_Home

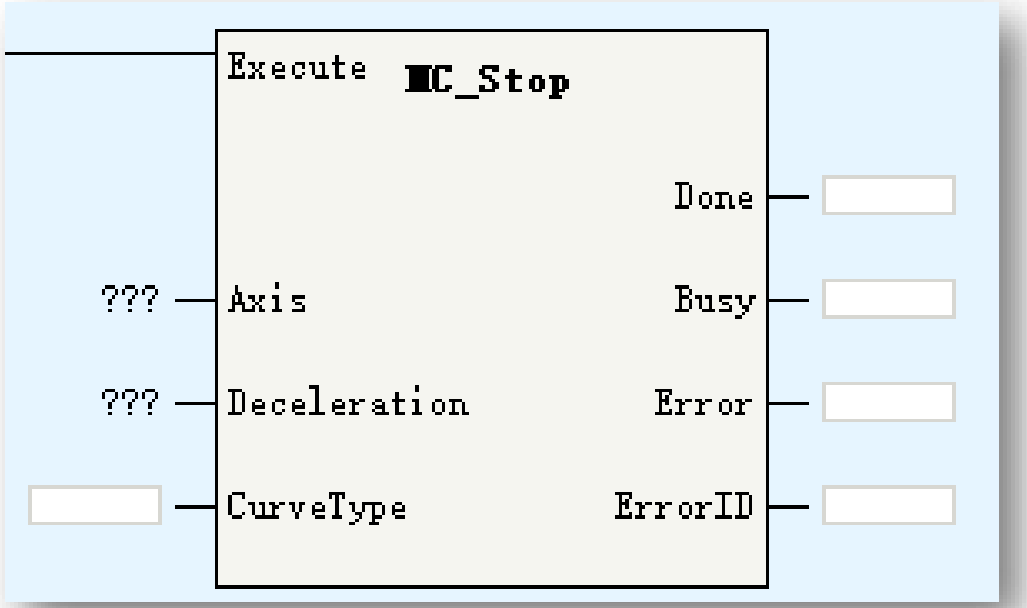


Parameters	Description
Axis	Axis ID/Axis name
Position	Origin offset



This command works while axis in standstill status, after executing this command, axis get into homing status. Homing related parameters set in axis configuration. While axis in virtual mode, the homing method is CIA402 No. 35.

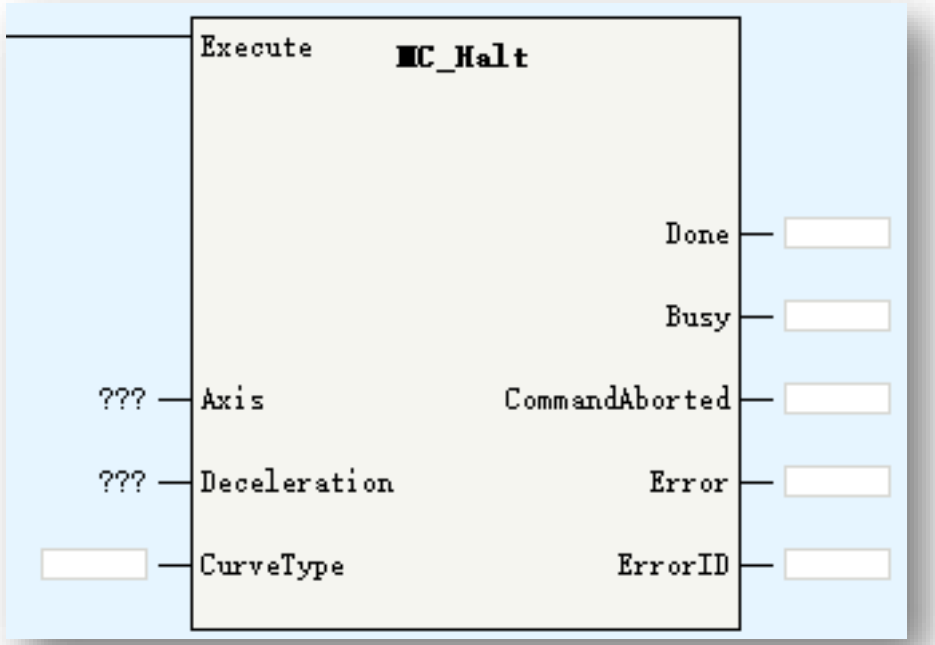
MC_Stop



Parameters	Description
Axis	Axis ID/Axis name
Deceleration	Stop deceleration
CurveType	Velocity ACC/DEC curve: 0: T curve 1: S curve

After executing MC_Stop, axis get into stopping state.
While stopping complete, <Done> signal valid,
if execute is ON, axis is still in stopping state, IF Execute is OFF, axis get into standstill state.
This command can be aborted by MC_ImmediateStop, while aborted, there is FB error 9142 occur.

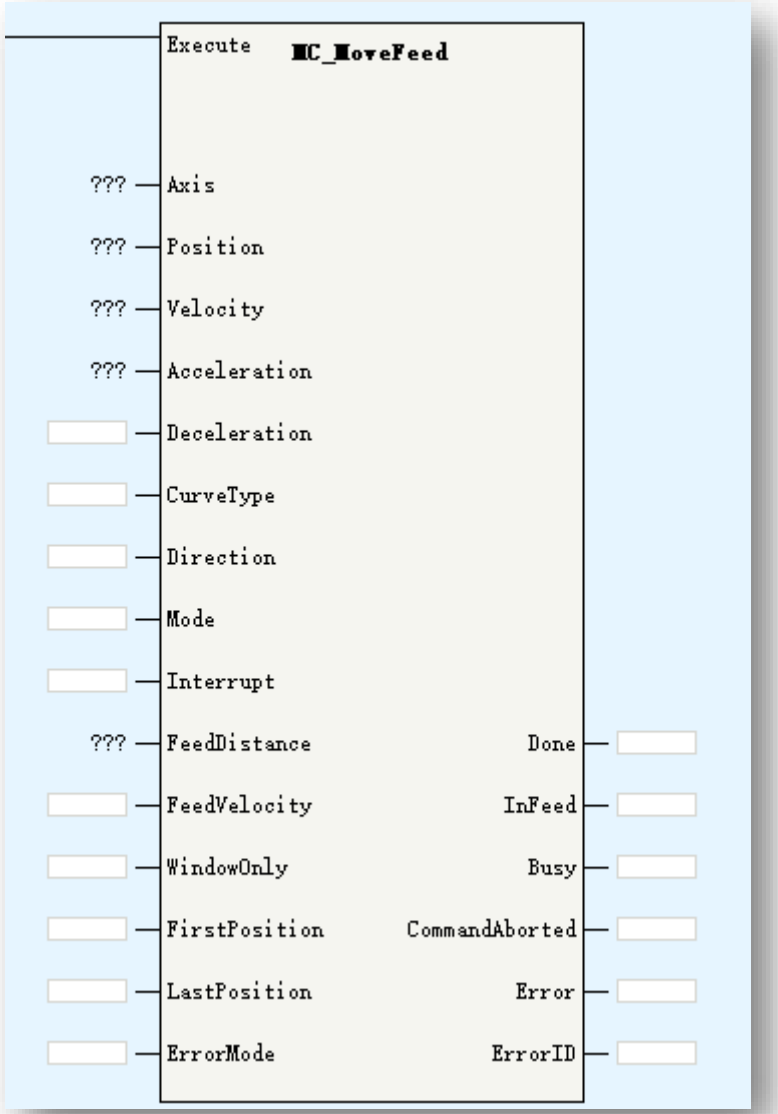
➢ MC_Halt



Parameters	Description
Axis	Axis ID/Axis name
Deceleration	Stop deceleration
CurveType	Velocity ACC/DEC curve: 0: T curve 1: S curve

MC_Halt is used to pause an axis motion.
After executing MC_Halt, axis get into discrete motion state. This command can be aborted by MC_Stop/MC_immediateStop and other motion control FBs.

➢ MC_MoveFeed



Parameters	Description
Axis	Axis ID/Axis name
Position	Target position
Velocity	Target velocity
Acceleration	Acceleration
Deceleration	Deceleration
CurveType	Velocity ACC/DEC curve: 0: T curve 1: S curve
Direction	Rotation mode absolute position direction: 0:pos 1:neg 2:shortest 3:current
Mode	0:abs 1:rel 2:vel
Interrupt	0:TP1 1:TP2
FeedDistance	Position after interruption signal triggered: Positive value means move current direction a certain distance, negative value means move revert direction a certain distance
FeedVelocity	Velocity after interruption signal triggered
WindowOnly	Window function: 0:disabled 1:enabled
FirstPosition	Interruption window start position
LastPosition	Interruption window end position
ErrorMode	While up to <Position>, if there is no interruption signal detected: 0:no error 1:error
InFeed	Interruption signal valid

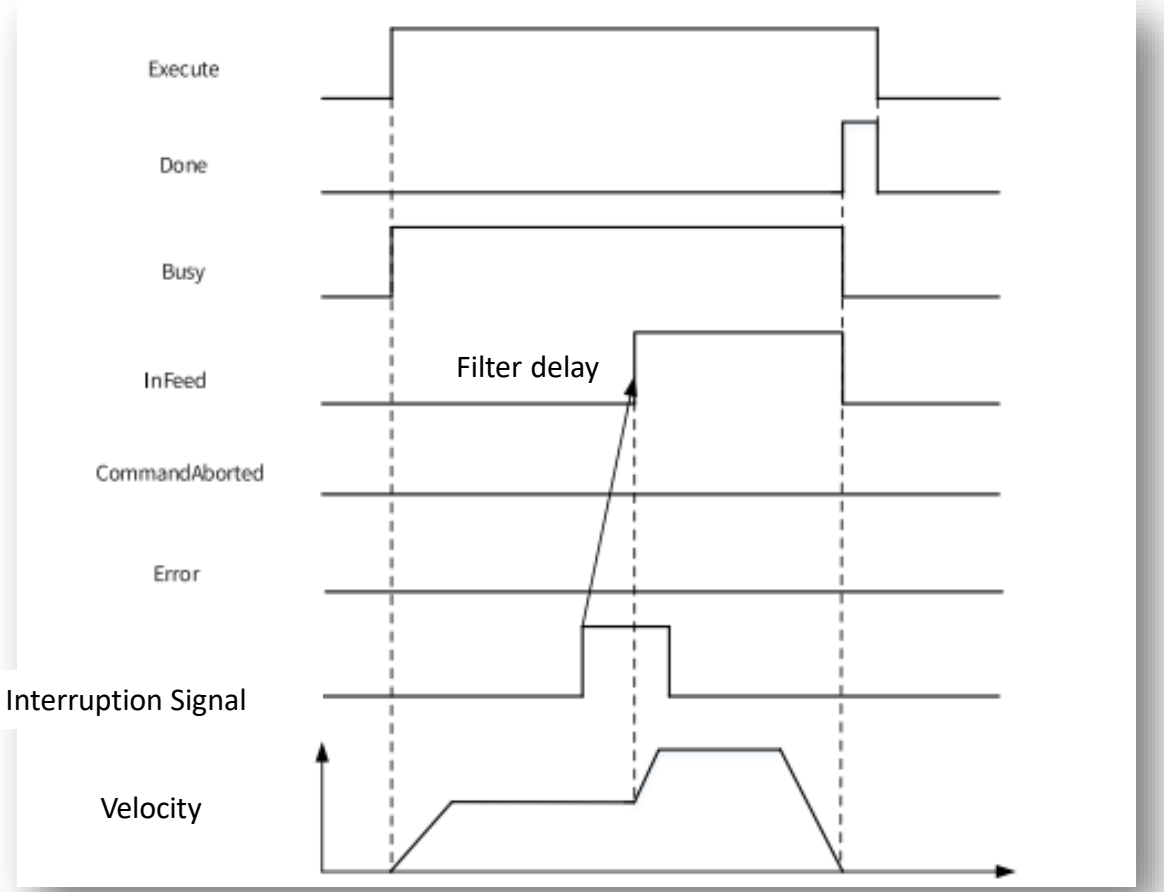
➢ MC_MoveFeed

MC_MoveFeed is used to move a certain distance according to interruption signal in a moving process.

Before the interruption signal triggered, axis move according to the parameters <Position>/<Velocity>/<Acceleration>/<Deceleration>/<Mode>, while the interruption signal triggered, axis move relatively according to the parameters <FeedPosition>/<FeedVelocity>.

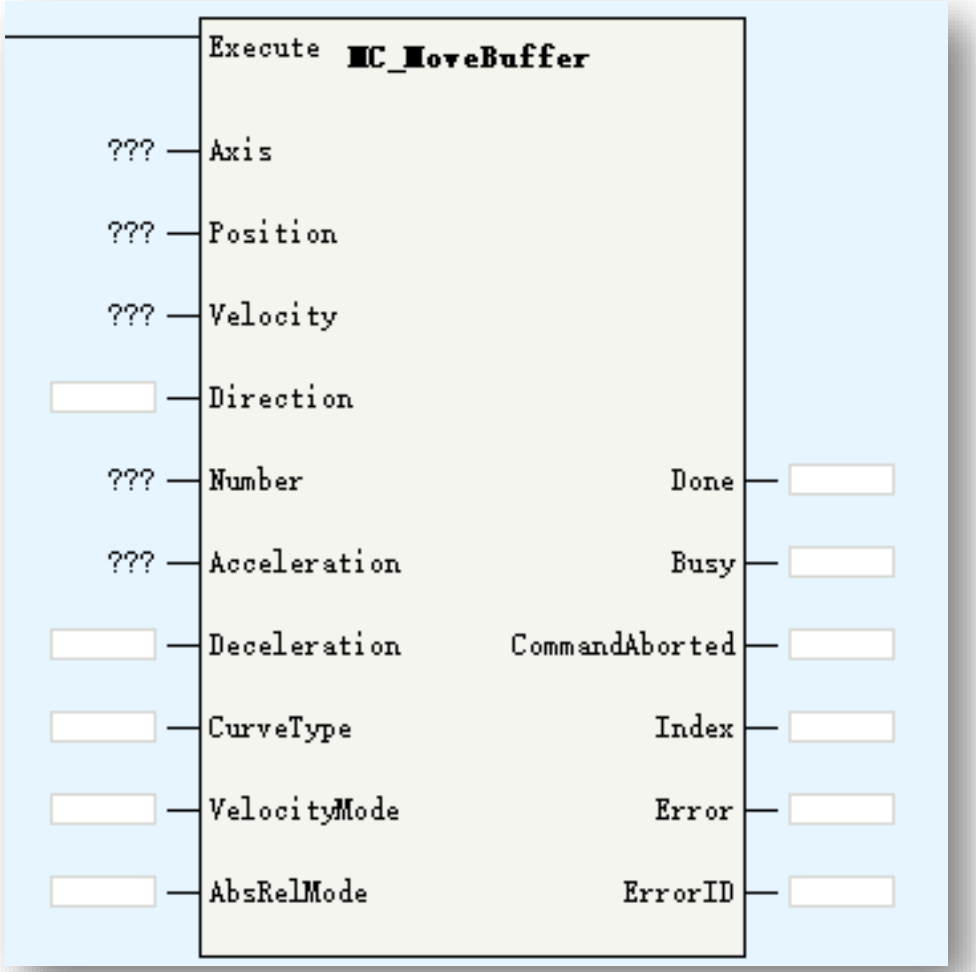
Be noted if there is no interruption signal triggered during this process, the FB will report an error according to the parameters <ErrorMode>. The output parameter <Infeed> will indicate is there an interruption signal during this process.

While executing this command, axis get into discrete motion status, can be aborted by other motion FBs according to PLCopen state machine.



Relative/Absolute mode, interruption signal triggered

➢ MC_MoveBuffer



Parameters	Description
Axis	Axis ID/Axis name
Position	Target position
Velocity	Target velocity
Direction	Rotation mode absolute position direction: 0:pos 1:neg 2:shortest 3:current
Number	Buffer data quantity(up to 16)
Acceleration	Acceleration
Deceleration	Deceleration
CurveType	Velocity ACC/DEC curve: 0: T curve 1: S curve
VelocityMode	0: decrease to 0 then get into next position stage 1: keep current speed to get into next stage
AbsRelMode	0:abs 1:rel
Index	Index of current position stage

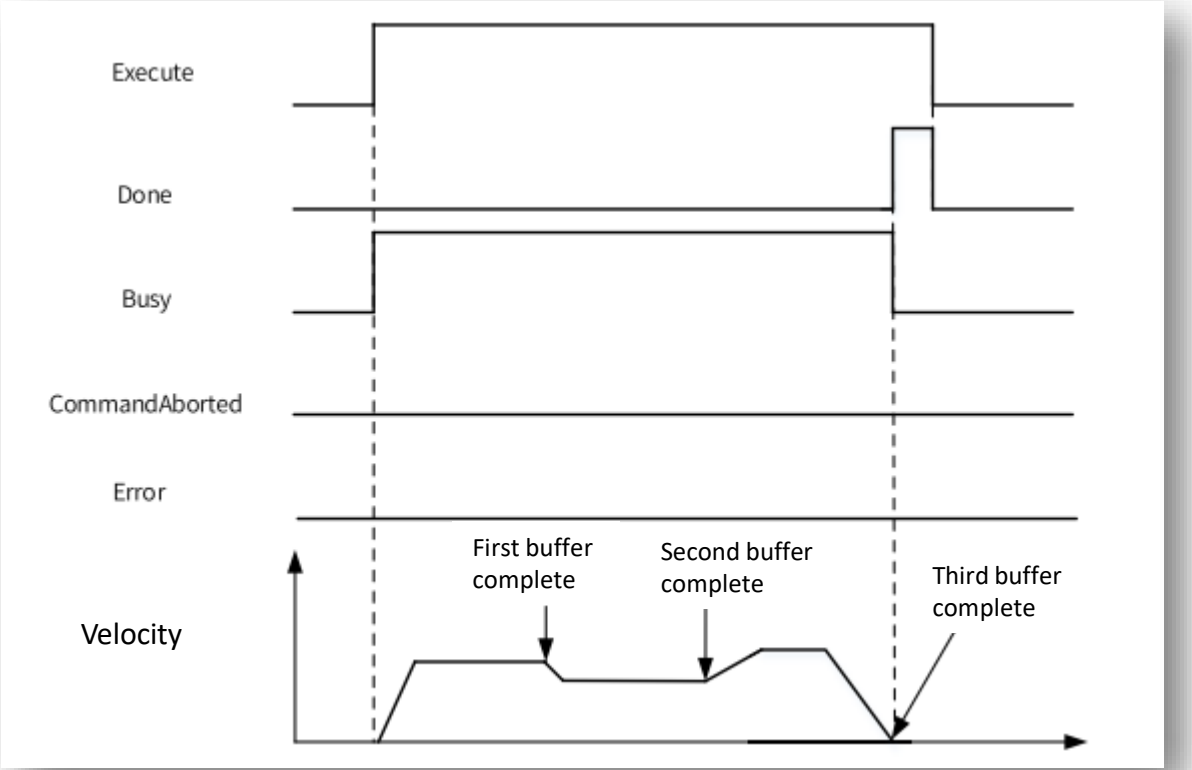
➢ MC_MoveBuffer

MC_MoveBuffer is used for multi-position function. It can support up to 16 position segment.

Be noted the <Position>/<Velocity>/<Direction> are array type parameters, the length is depend on the buffer <Number>. The first position segment parameters is <Position>[0]/<Velocity>[0]/<Direction>[0], and so on for other segments.

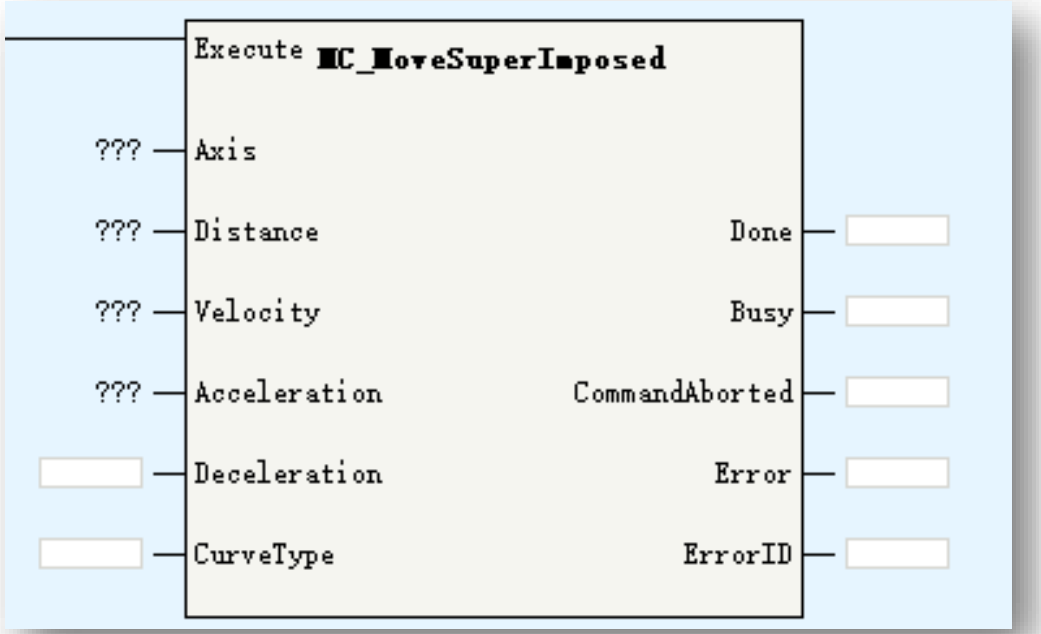
This command works while axis in standstill/discrete motion/continuous motion status.

While executing this command, axis get into discrete motion status, can be aborted by other motion FBs according to PLCopen state machine.



3 position buffers, VelocityMode = 1

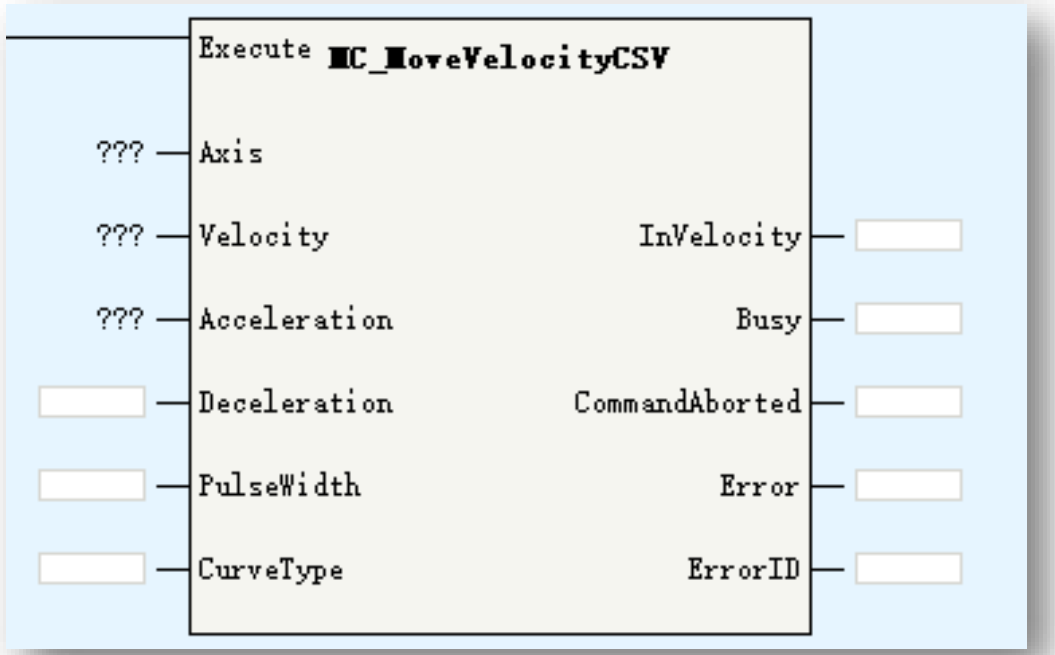
➢ MC_MoveSuperImposed



Parameters	Description
Axis	Axis ID/Axis name
Distance	Compensation position
Velocity	Target velocity
Acceleration	Acceleration
Deceleration	Deceleration
CurveType	Velocity ACC/DEC curve: 0: T curve

MC_MoveSuperImposed is used to superimposed a distance based on current motion.
Not work when MC_Halt, axes group commands are using.
Works only in CSP mode.
Applicable to CAM/GEAR command. MC_CamOut/MC_GearOut can stop this command.
After executing this command, axis get into discrete motion, can be aborted by other motion FBs.

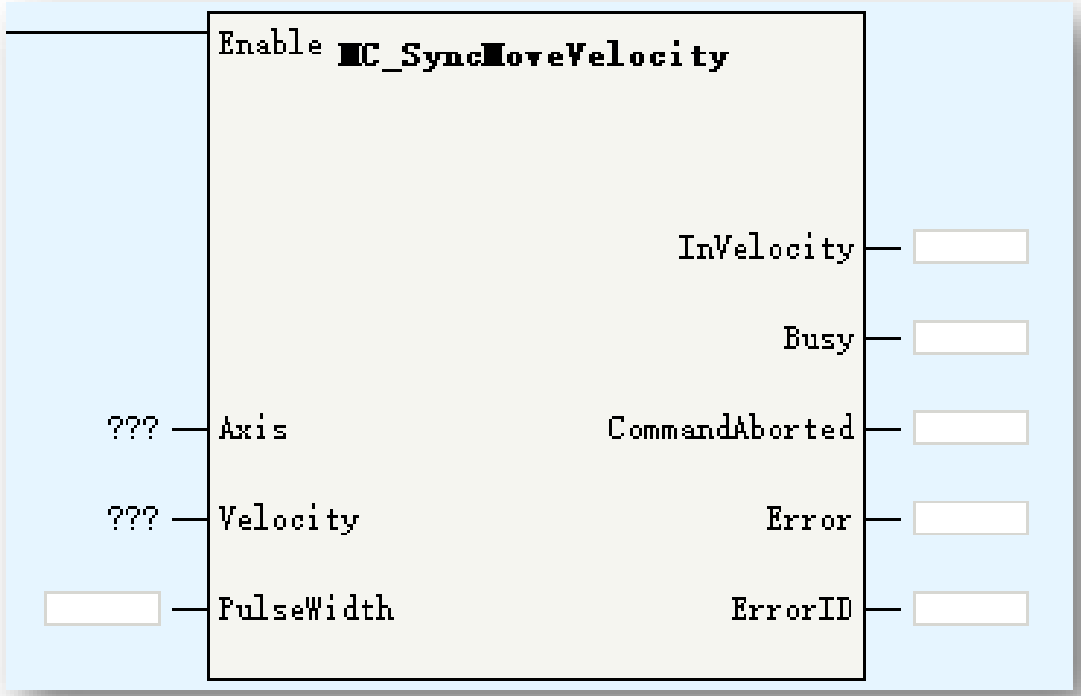
➢ MC_MoveVelocityCSV



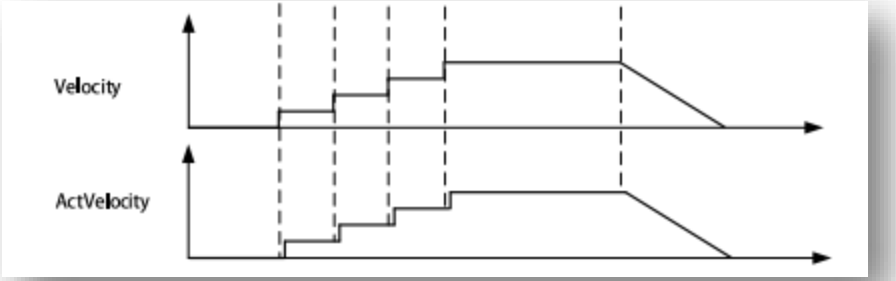
Parameters	Description
Axis	Axis ID/Axis name
Velocity	Target velocity
Acceleration	Acceleration
Deceleration	Deceleration
PulseWidth	Pulse width, unit: 0.01%
CurveType	Velocity ACC/DEC curve: 0: T curve 1:S curve
InVelocity	Get into target velocity

This command control axis in CSV mode.
While using with EtherCAT axis, same function with MC_MoveVelocity.
While using with pulse control axis, this FB can control hardware to output PWM curve, the <PulseWidth> is used to control the output pulse width.

MC_SyncMoveVelocity

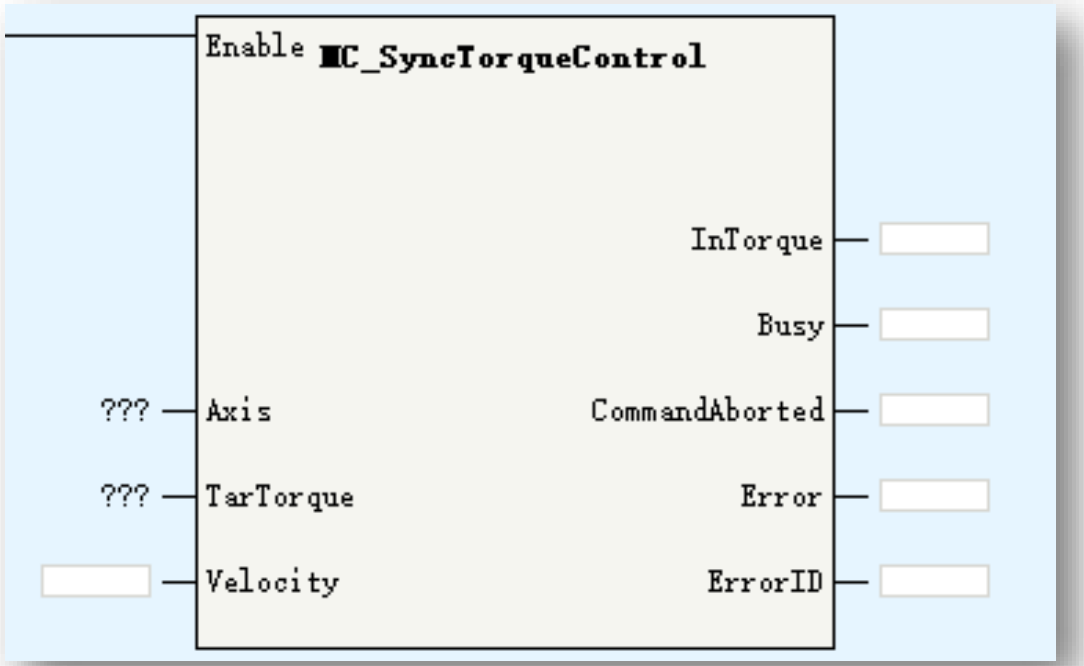


Parameters	Description
Axis	Axis ID/Axis name
Velocity	Target velocity
PulseWidth	Pulse width, unit: 0.01%
InVelocity	Get into target velocity



This command control axis in CSV mode.
Almost same with MC_MoveVelocityCSV, the difference is this command have no acceleration and deceleration.

➢ MC_SyncTorqueControl



Parameters	Description
Axis	Axis ID/Axis name
TarTorque	Target torque(1%)
Velocity	Velocity limit
InTorque	Get into target torque

Work in CST mode.
Same with MC_TorqueControl.

➢ MC_SetAxisConfigPara

Parameters	Description
Axis	Axis ID/Axis name
ParameterIndex	-1: All parameters valid, works on disabled state 0: All parameters invalid 100: Modify gear ratio 200: Modify pos/neg software limit 300:modify linear/rotation mode 400: modify encoder mode 500:modify homing mode 600: modify hardware limit and origin signal 700: modify pulse output format 800: modify revert setting 900: modify virtual axis mode 1000: modify touch probe signal 1100: modify software limit variable

This command is used to modify axis configuration parameters.
Parameters modifications may cause the position mutation, please execute homing operation after modifying these parameters if necessary.

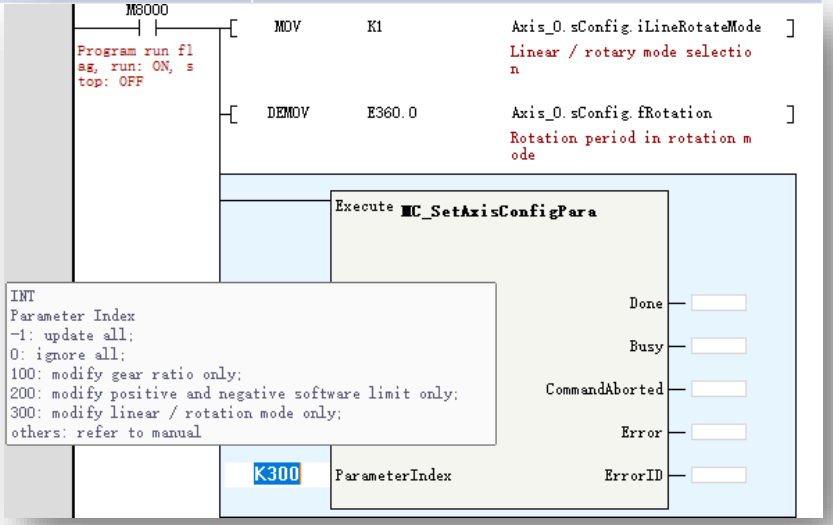
MC_SetAxisConfigPara

ParameterIndex	Description	Work state
100	Gear ratio: dPulsePreCycle: pulse of 1 revolution fDistancePreCycle: displacement of workbench per round dNumerator: gear ratio numerator dDenominator: gear ratio denominator	Disabled
200	bSoftLimitEnable: enable software limit fPLimit: positive limit value (linear mode) fNLimit: negative limit value (linear mode)	Disabled/Standstill
300	iLineRotateMode: 0-linear mode 1-rotation mode fRotation: cycle of rotation mode	Disabled
400	iEncoderMode: 0-absolute 1-relative	Disabled
500	fHomeMethod: homing method fHomeVelocity: homing velocity fHomeApproachVelocity: homing approach velocity fHomeAcceleration :homing acceleration dHomeTimeOut: homing timeout dHomePositionMode: homing position mode selection	Disabled/Standstill
600	bPLimitTerminalPolarity: positive limit polarity: OFF-positive ON-negative bNLimitTerminalPolarity: negative limit polarity: OFF-positive ON-negative bHomeTerminalPolarity: origin point polarity: OFF-positive ON-negative dPLimitTerminalID: positive limit signal ID(Modbus address) dNLimitTerminalID negative limit signal ID(Modbus address) dHomeTerminalID origin signal ID(Modbus address)	Disabled
700	iPulseMethod: pulse output format 3-AB phase 4-pulse + direction 5-CW/CCW	Disabled
800	bDirection: OFF-positive ON-Negative	Disabled

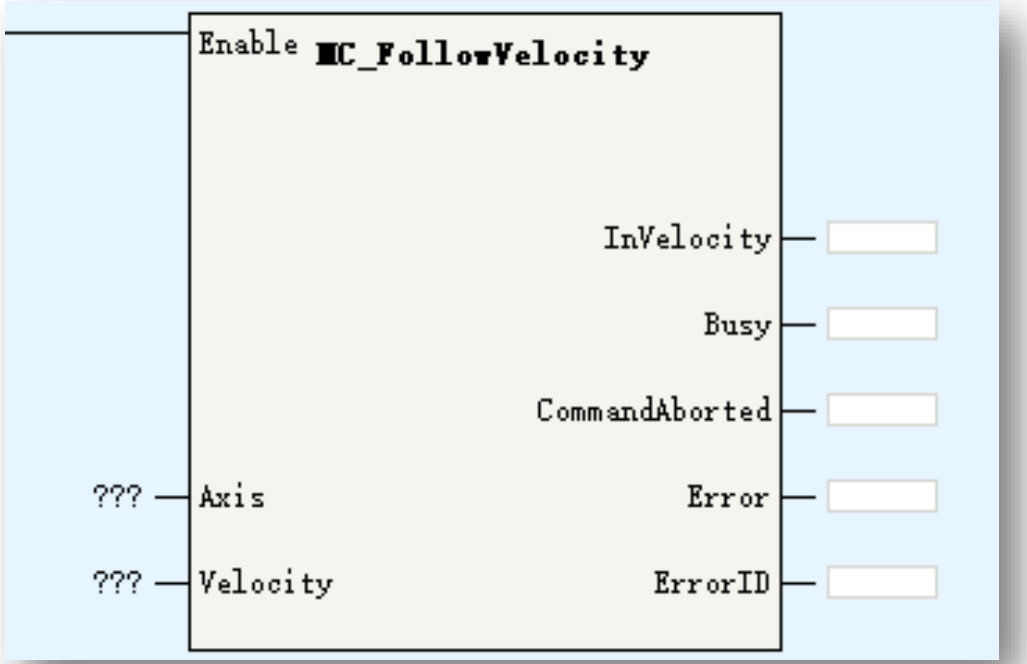
➢ MC_SetAxisConfigPara

ParameterIndex	Description	Work state
900	bVirtualMode: OFF-virtual mode invalid ON-virtual mode valid	Disabled
1000	dTouchProbeID1: touch probe 1 ID dTouchProbeID2: touch probe 2 ID	Disabled
1100	fLimitDeceleration fErrorStopDeceleration fFollowErrorWindow fInvelocityWindow fMaxVelocity fMaxJogVelocity fMaxAcc fMaxPTorque fMaxNTorque bEtherErrorStop: get into <errorstop> state while axis in error: OFF-invalid ON-valid	Disabled/Standstill

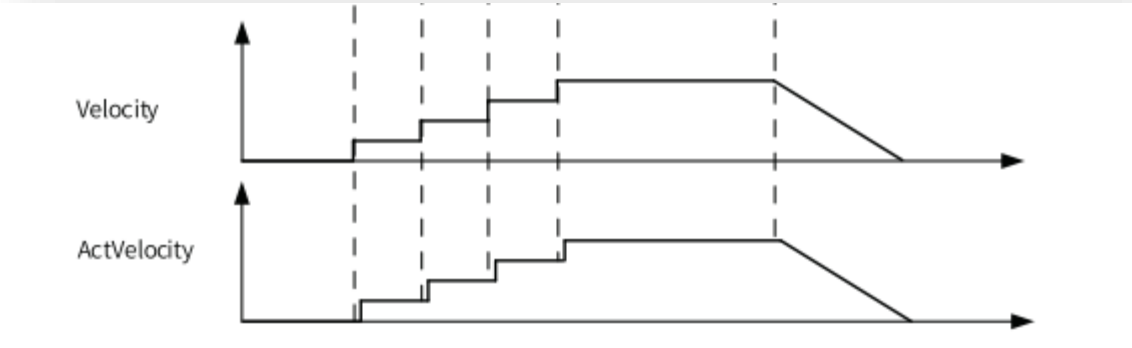
Modify axis linear/rotation mode configuration in program. All these configuration parameters are in the structure _scfgAxis. User can access these parameters by <AxisName>.sConfig.<ParameterName>.



➢ MC_FollowVelocity



Parameters	Description
Axis	Axis ID/Axis name
TarTorque	Target torque(1%)
Velocity	Velocity limit
InTorque	Get into target torque



This command almost same with MC_SyncVelocity.
The difference is this command works in CSP mode, can used with the MC_SuperImposed.
While <Enable> =ON, the modification of <Velocity will effect immediately without acceleration/deceleration delay.
While executing this command, axis get into synchronized motion state.

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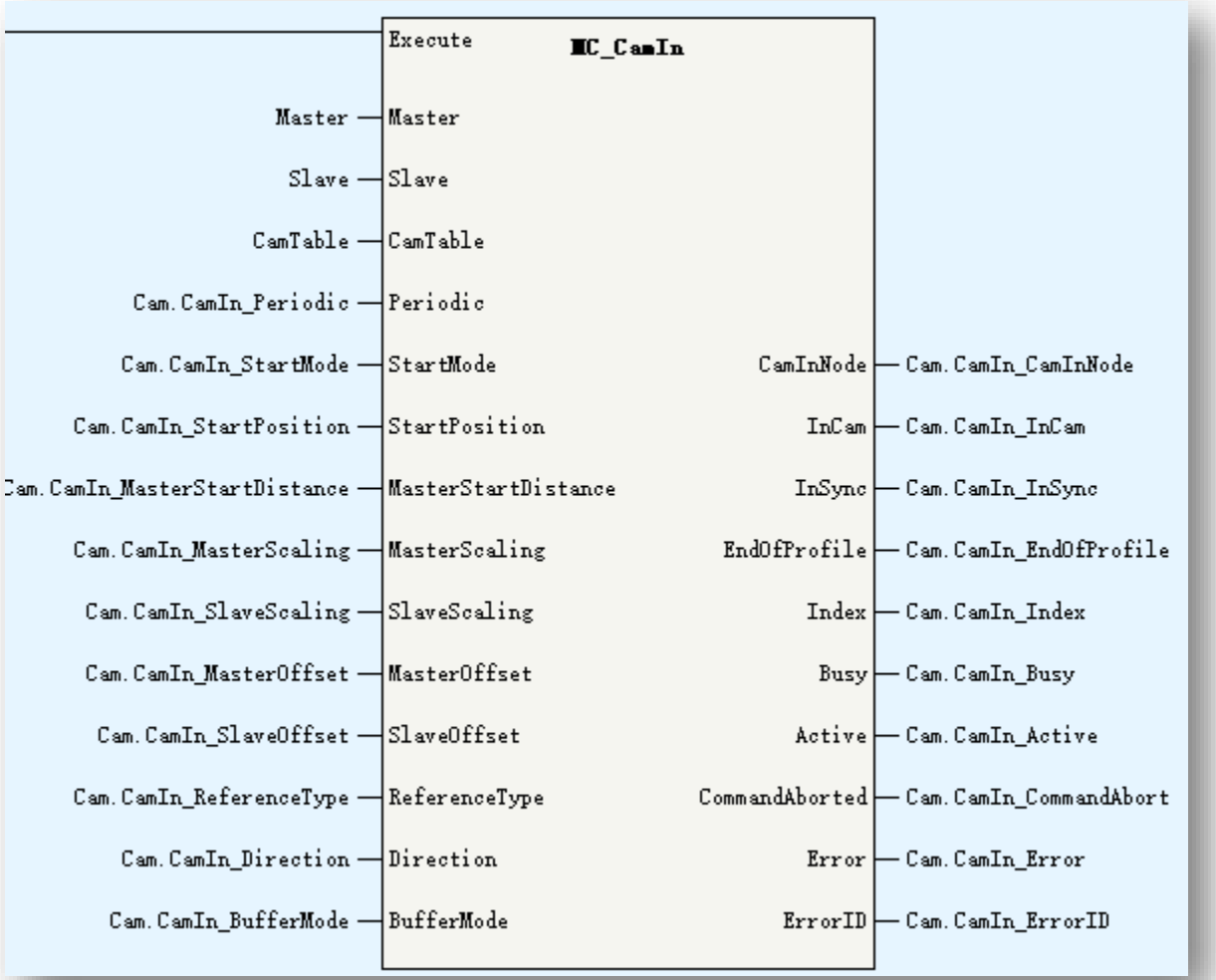
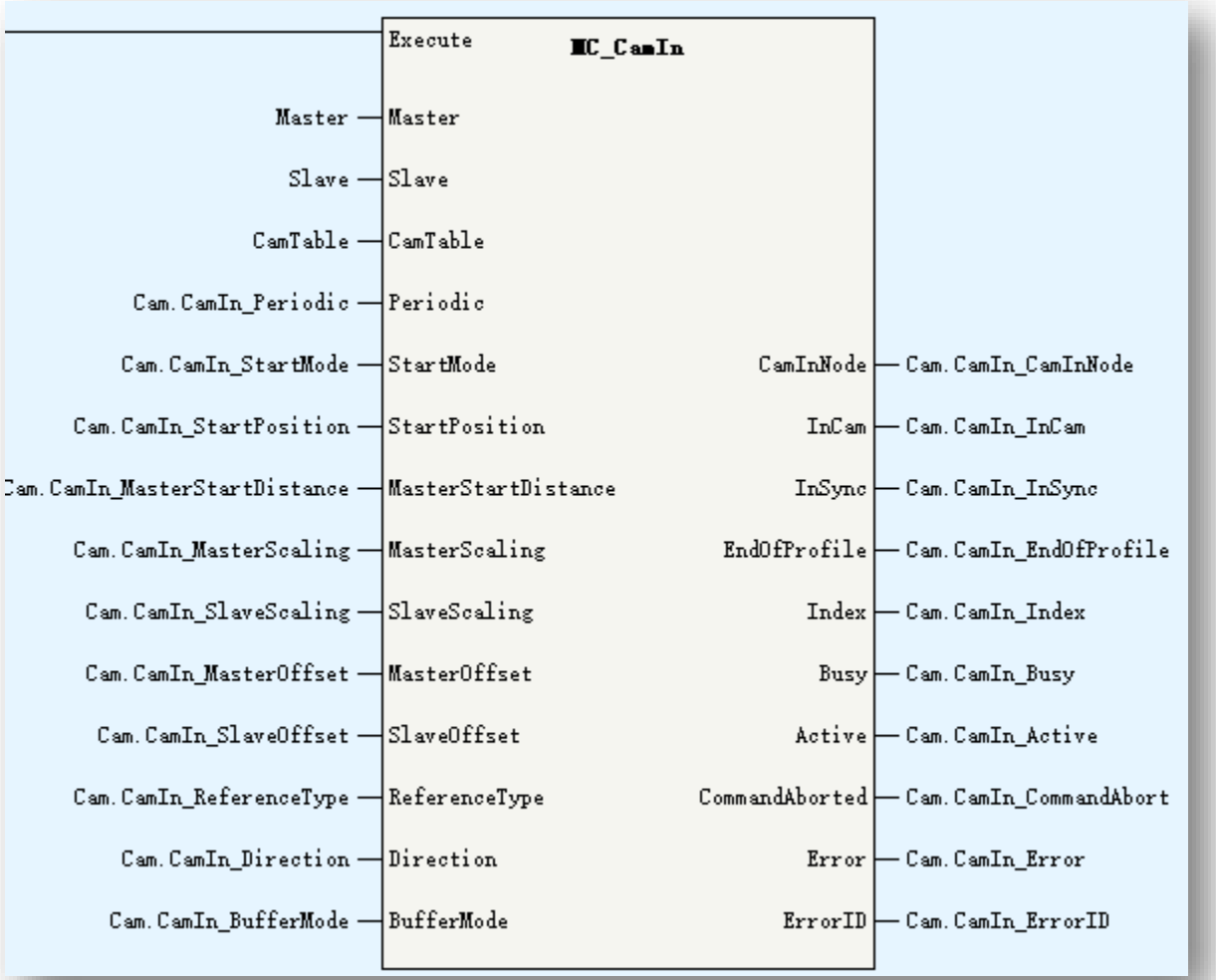
CAM and GEAR	Function
MC_CamIn	Enable CAM
MC_CamOut	Disable CAM
MC_GetCamTablePhase	Get CAM phase(master position)
MC_GetCamTableDistance	Get CAM distance(slave position)
MC_GearIn	Enable GEAR
MC_GearOut	Disable GEAR
MC_Phasing	Master phase offset
MC_SaveCamTable	Save CAM table
MC_GenerateCamTable	Update CAM table
MC_DigitalCamSwitch	CAM tappet function

➢ MC_CamIn



Parameters	Description
Master	Master axis: support EtherCAT axis, pulse control axis, Fieldbus encoder axis and local encoder axis
Slave	Slave axis: support EtherCAT axis and pulse control axis
CamTable	Cam table selection
Periodic	CAM cycle mode: 0:periodic Other: specified certain cycle numbers
StartMode	Master distance mode: 0:abs 1:rel 2:immediate
StartPosition	Start position of CAM table
MasterStartDistance	Master start distance
MasterScaling	Master scale factor
SlaveScaling	Slave scale factor
MasterOffset	Master offset
SlaveOffset	Slave offset
ReferenceType	Reference position: 0: last cycle set position 1: current cycle set position 2:current cycle feedback position

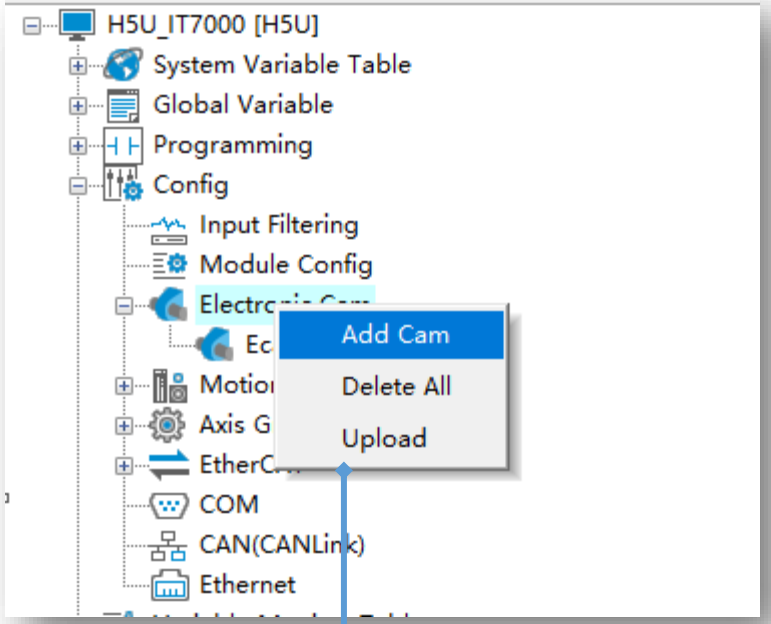
➢ MC_CamIn

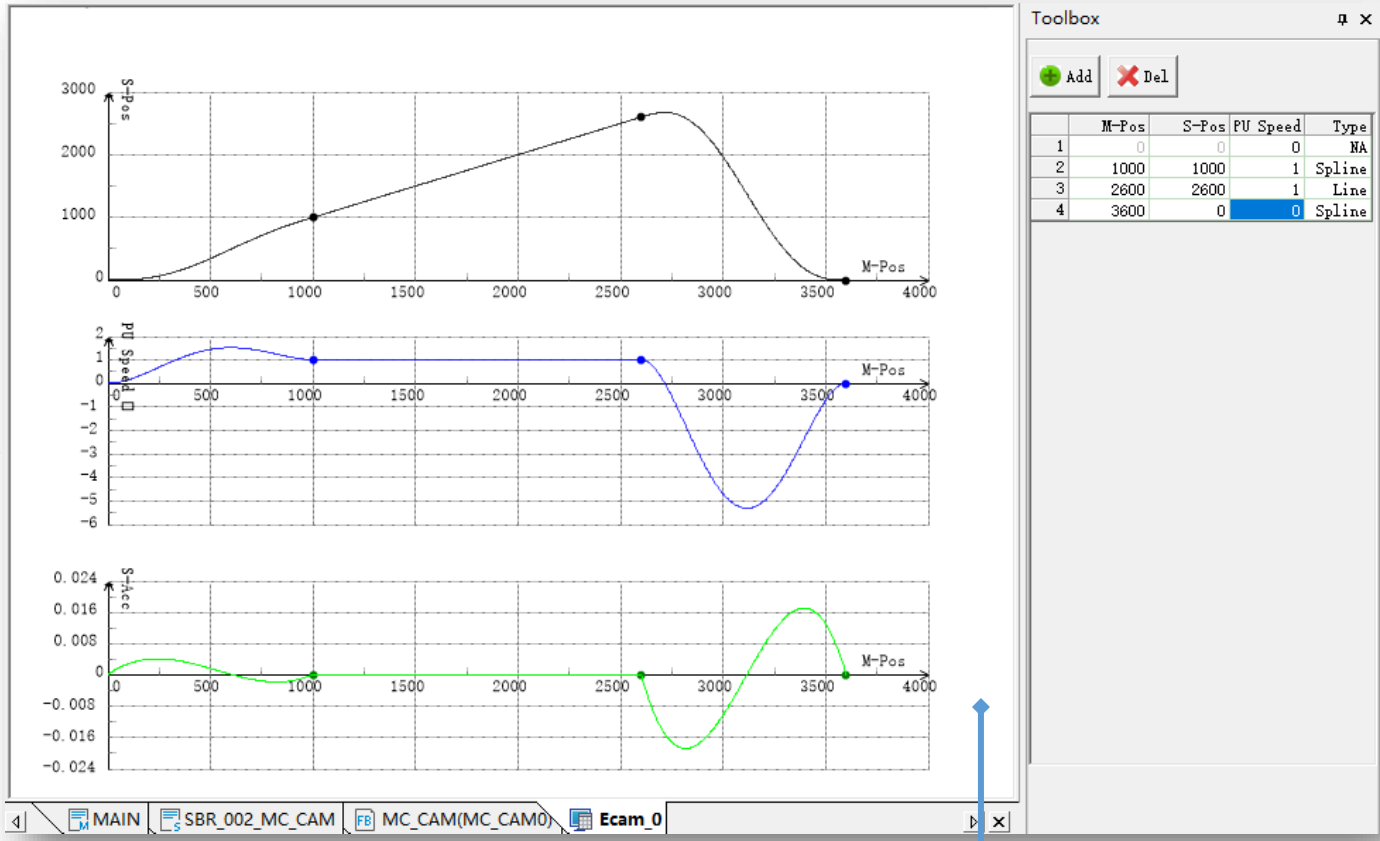


Parameters	Description
Direction	0:positive 1:negative 2:none
BufferMode	0:wait last motion complete Others: reserved
CamInNode	CamIn node(data structure)
InCam	In CAM motion
InSync	In sync motion
EndOfProfile	CAM cycle complete
Index	Index
Active	FB executing

MC_CamIn command can start from standstill, discrete motion, continuous motion and synchronized motion state.

➢ MC_CamIn-CamTable



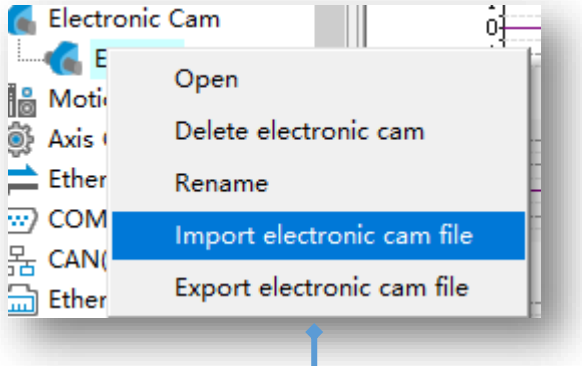


<Config>→<ElectricCam>→right click <Add Cam> to add a CAM table. AutoShop support up to **16** CAM tables, and the H5U PLC support up to **8** CAM running at the same time. Each CAM table support **361** key points

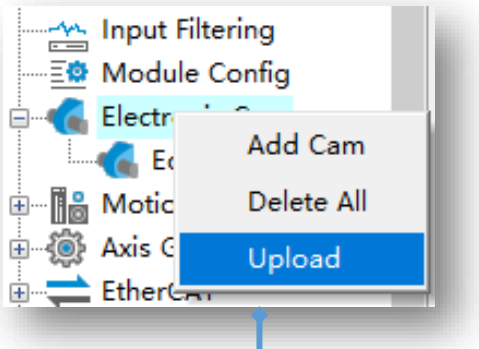
Drag and drop the key point in the left CAM wiring or modify the key point data in the right table

CAM table is data collection of master position and slave distance. It describe the position relation ship between master and slave. In a CAM motion, controller calculate the slave position according to the CAM table. CAM table can only created by configuration.

➢ MC_CamIn-CamTable Operation



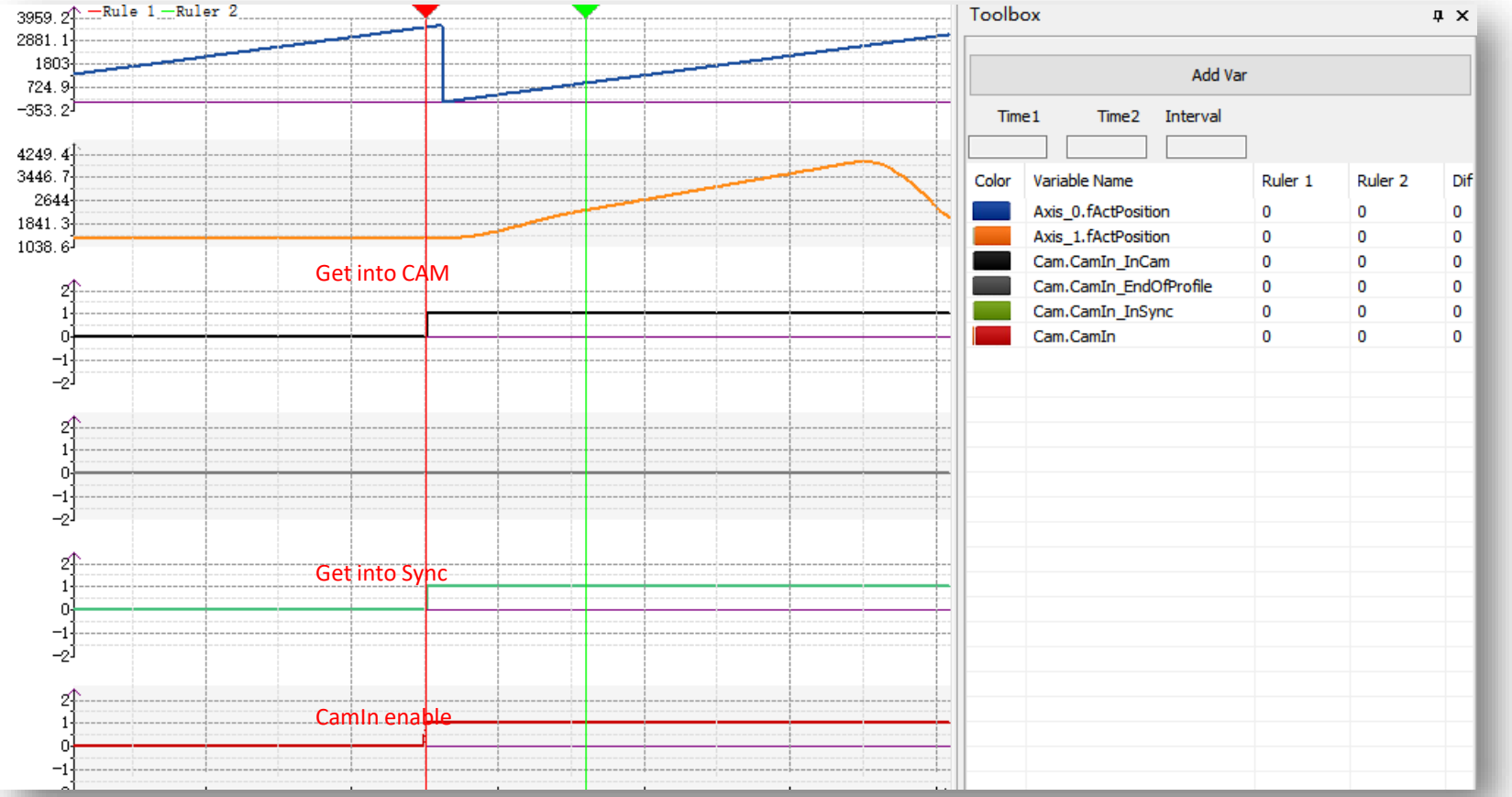
Right click to import/Export CAM file with .CSV format.



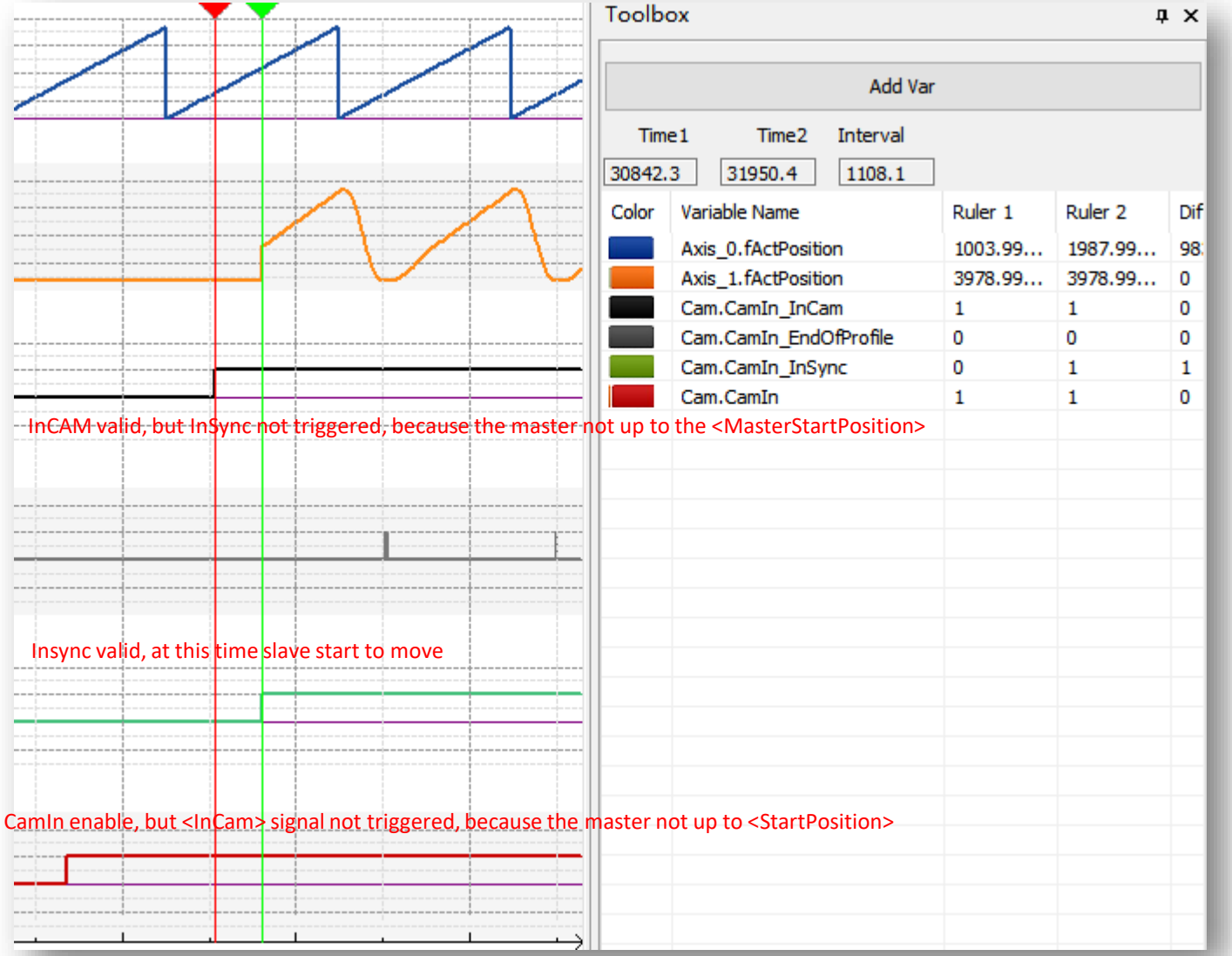
Right click to upload CAM table from PLC

➢ MC_CamIn-StartMode

StartMode=2, CAM start immediately.
From below trace curve, while CamIn enabled, slave get into CAM motion(at this time, slave position is decided by master position, and slave is in synchronized state), at the same time, slave start to move according to CAM table relationship(Insync signal) without delay.



➢ MC_CamIn-StartMode



StartMode=0(absolute), CAM start in a specified position. To understand this function, there are 2 parameters need to clarify:

StartPosition: while master position up to startPosition, get into CAM. Be noted <Get into CAM> not mean the slave have to move, it means the slave already create CAM relationship with master.

MasterStartPosition: While master position up to MasterStartPosition, get into Sync. <Get into Sync> means the slave will motion with master according to CAM table(master position).

See left trace curve.

While talking about <StartPosition> and <MasterStartPosition>, the value is affected by the <StartMode>, while StartMode=0, the real value:

StartPosition=<StartPosition>

MasterStartPosition=<MasterStartPosition>

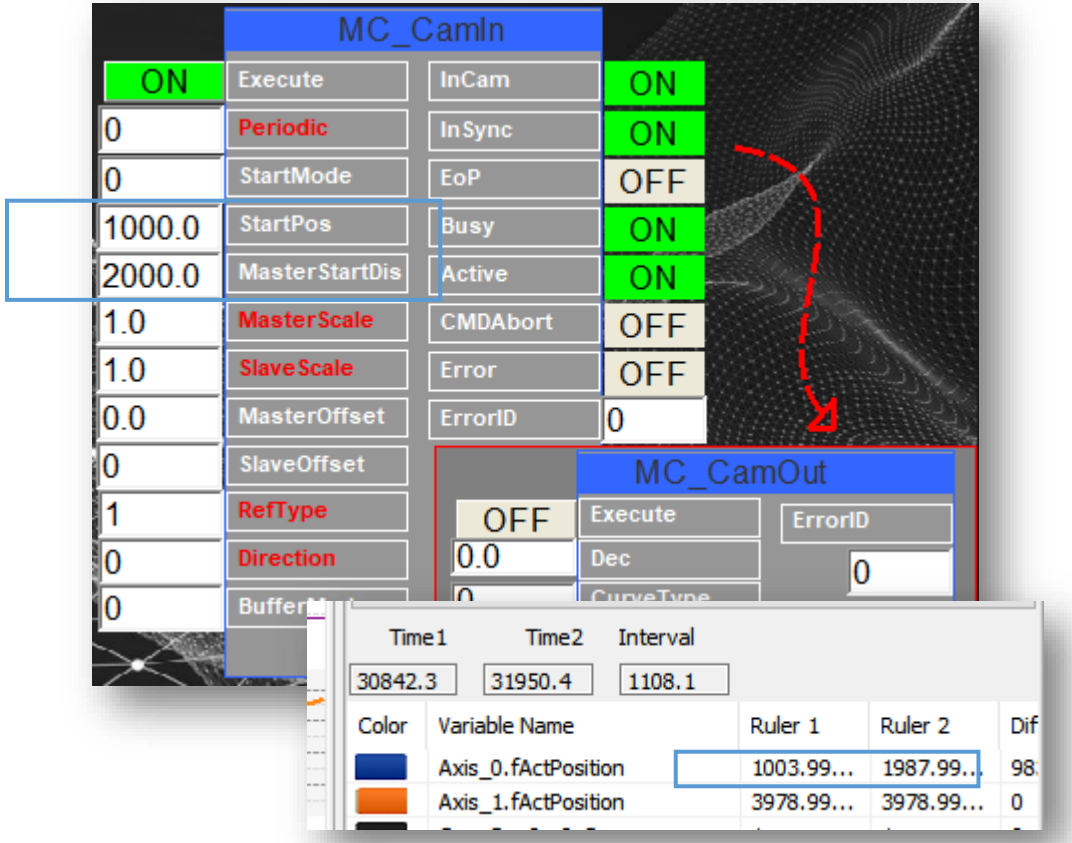
While StartMode=1, the real value:

StartPosition=<StartPosition>

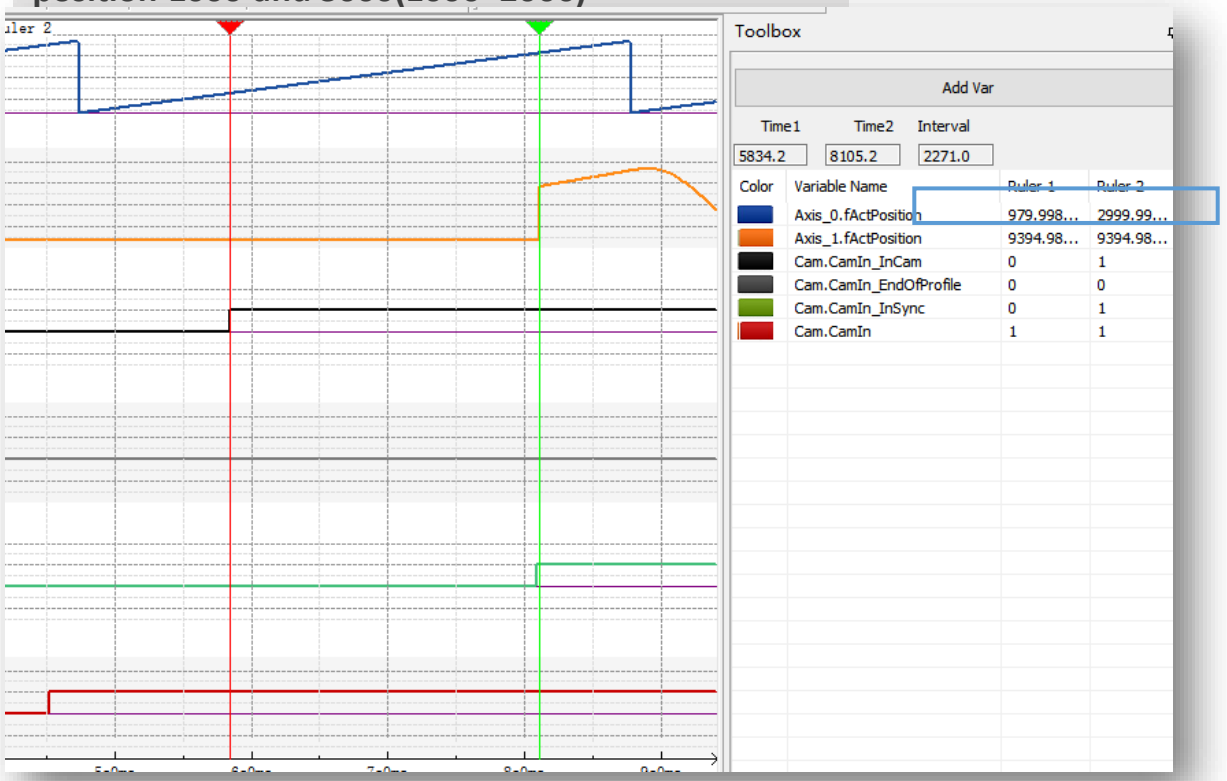
MasterStartPosition=<StartPosition> + <MasterStartPosition>

➢ MC_CamIn-StartMode

Below is the parameters of the former curve, you can see the <InCam> and <InSync> triggered in master position 1000 and 2000:

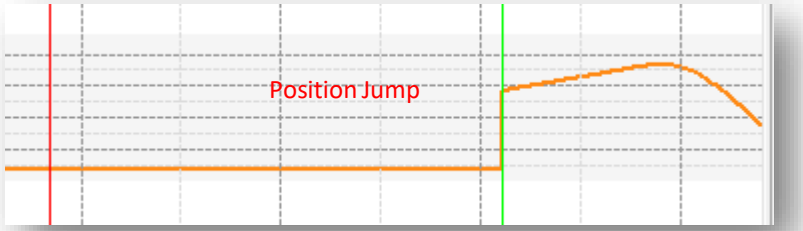


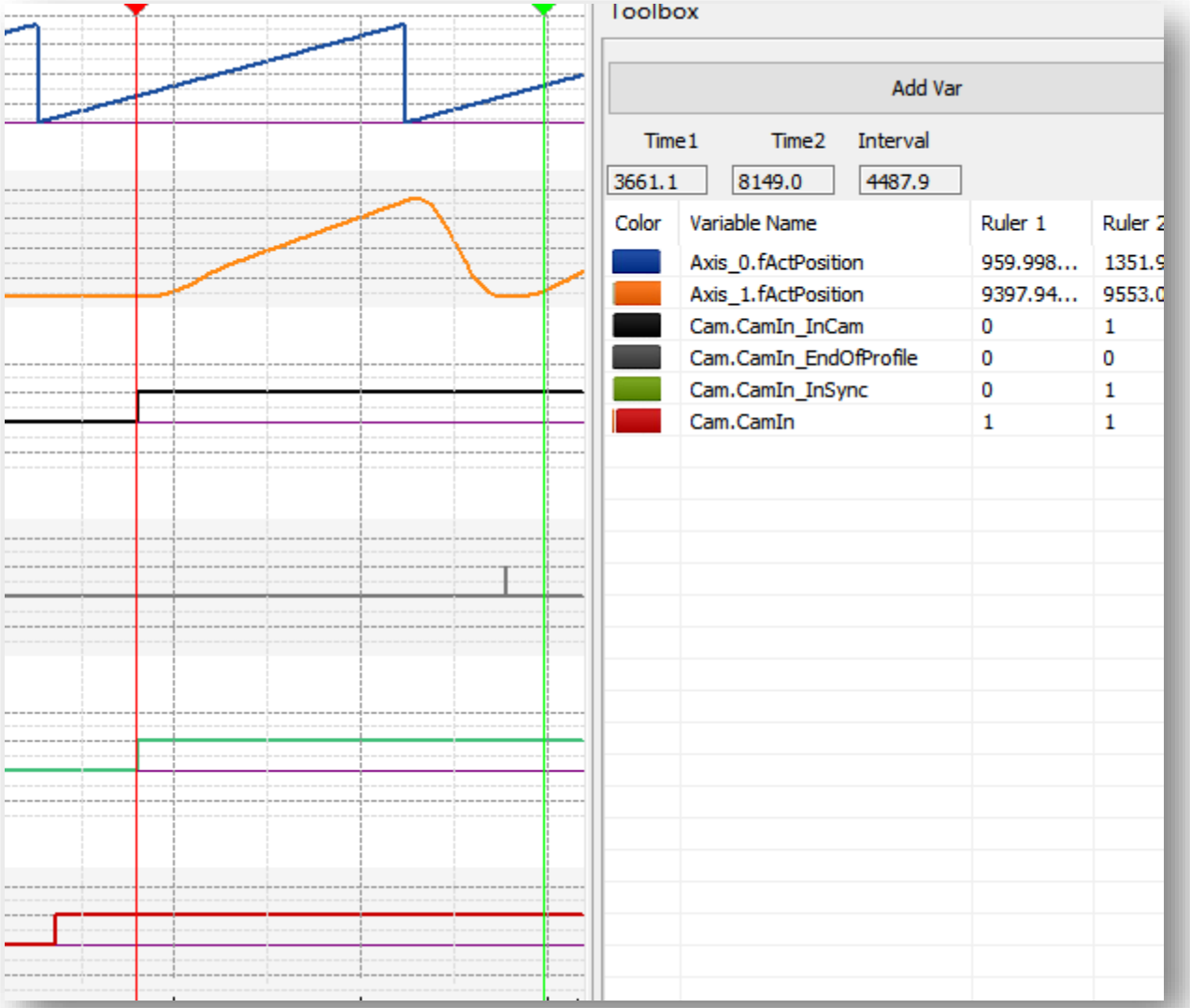
If we modify the StartMode=1(relative), other parameters not change, the effect show as below, the <InCam> and <InSync> triggered in master position 1000 and 3000(1000+2000)



➢ MC_CamIn-StartMode

Be noted while <InCam> position(StartPosition) and <InSync> position(MasterStartPosition) is different, there could be a position jump of slave. If don't want this jump, please make sure the StartPosition=MasterStartPosition(in other word, the <InCam> and <InSync> triggered at the same time). For example, while StartMode=0(absolute) and StartPostion = MasterStartPosition=1000, the effect show as right, the slave position no jump(right image, yellow curve).

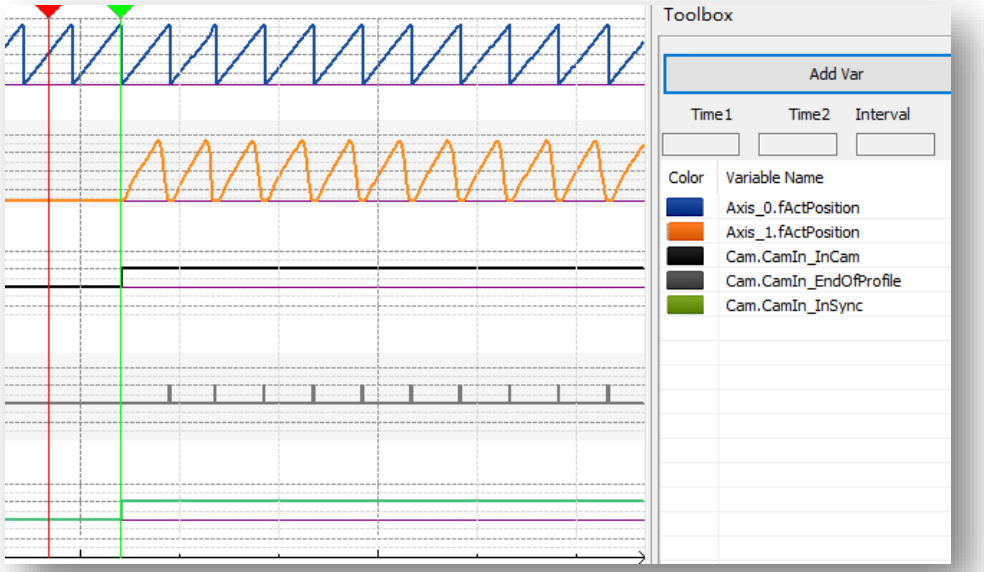




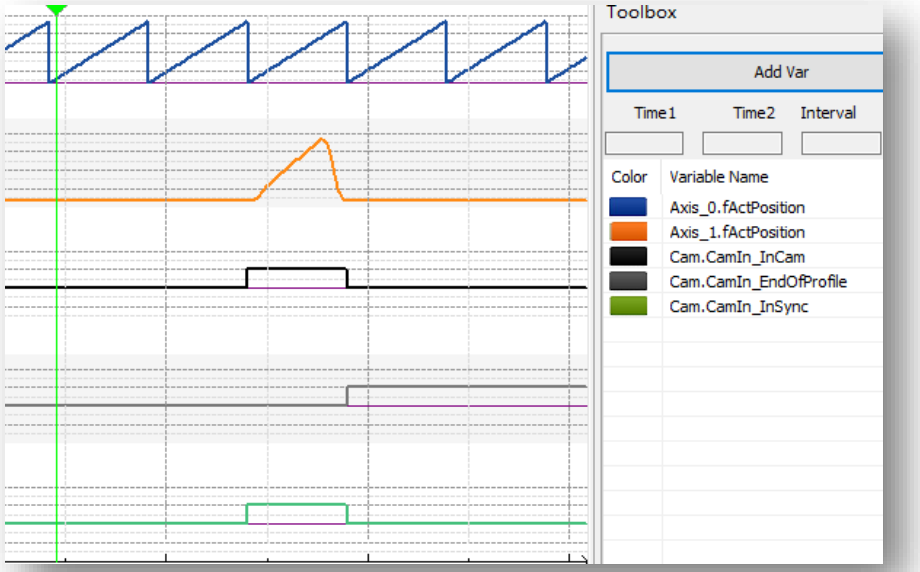
➢ MC_CamIn-Periodic

While Periodic=0, slave axis execute CAM motion repeatedly. <EndofProfile> will triggered and be valid for one cycle time while CAM cycle complete.

While Periodic=N(N>0), axis execute CAM motion N times. <EndofProfile> will triggered and be valid for one cycle time while CAM cycle complete. At the last CAM cycle, <EndOfProfile> will keep valid if Execute is ON.



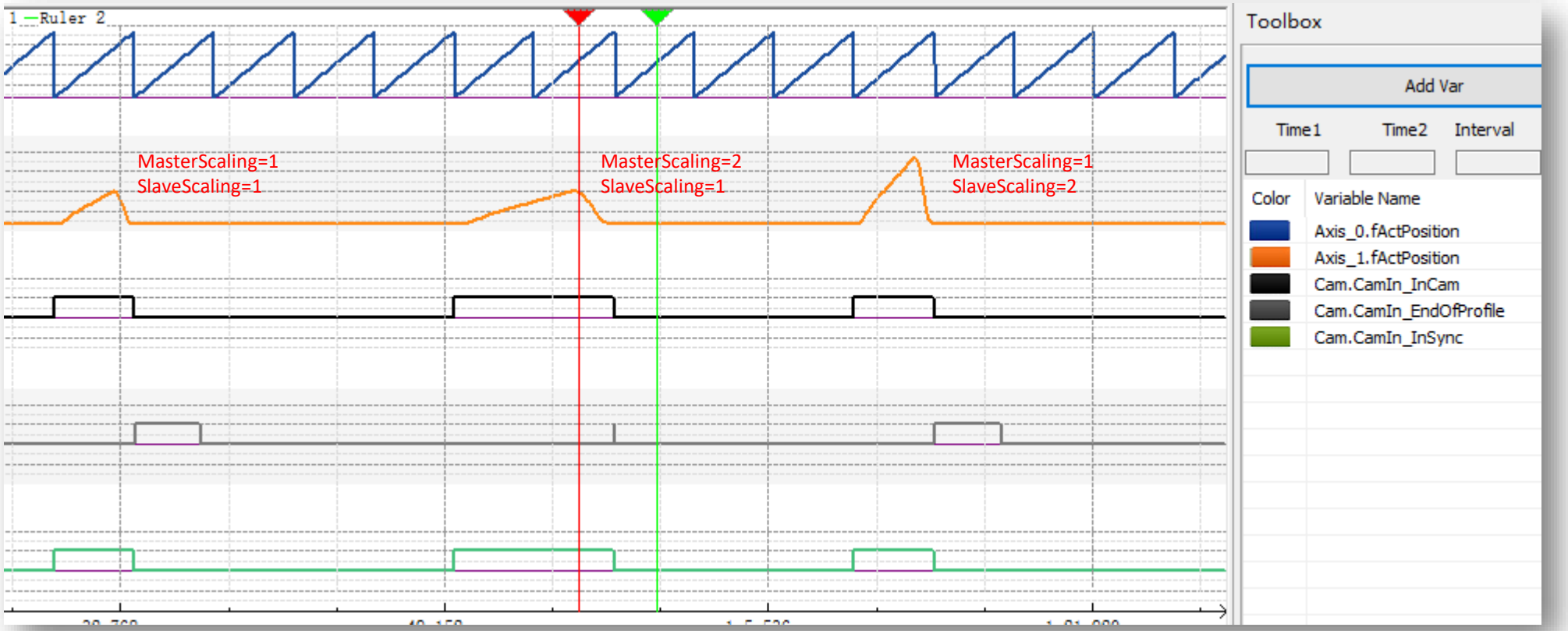
Periodic=0



Periodic=1

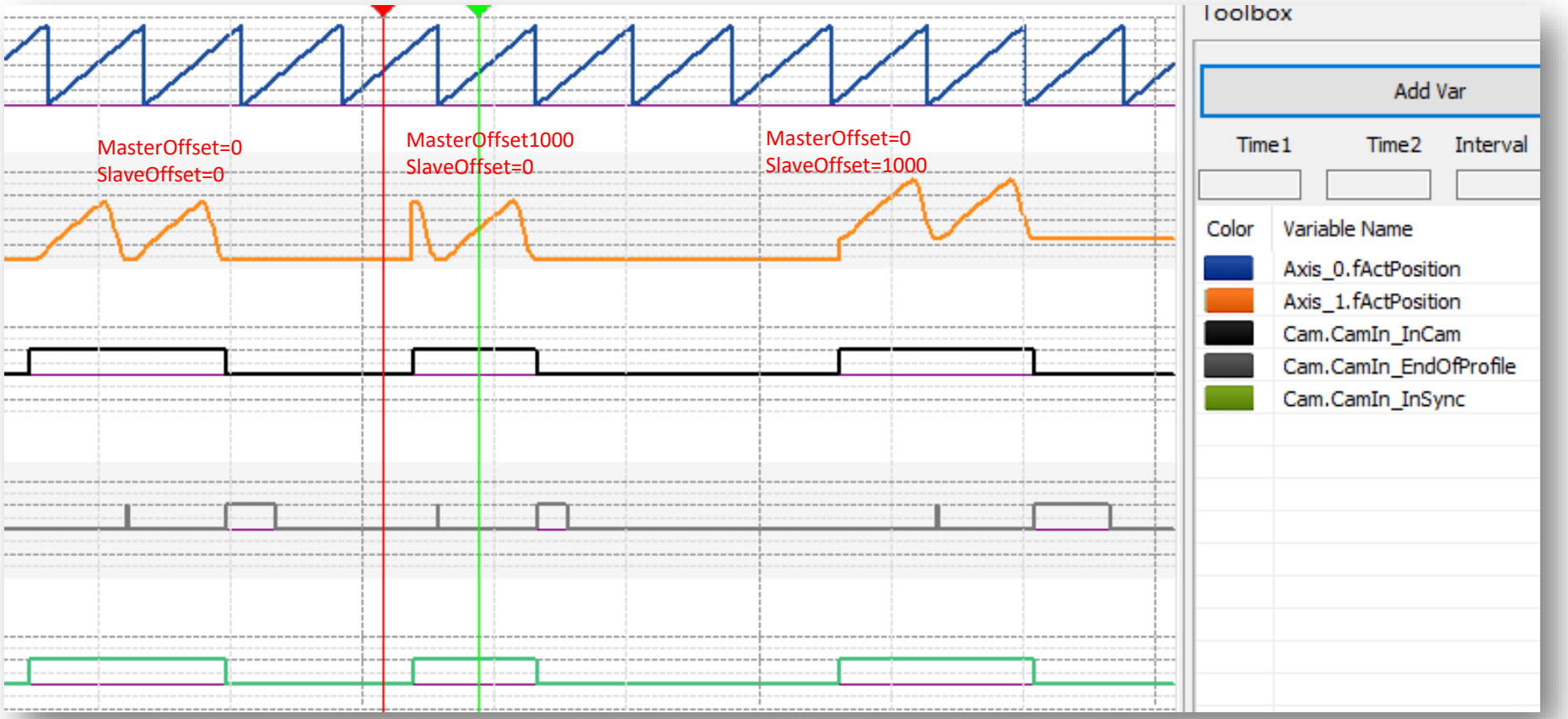
➢ MC_CamIn-Scale

Scale is used to scale up and down the master position and slave position.
The parameter <MasterScaling> and <SlaveScaling> used to set the ratio.



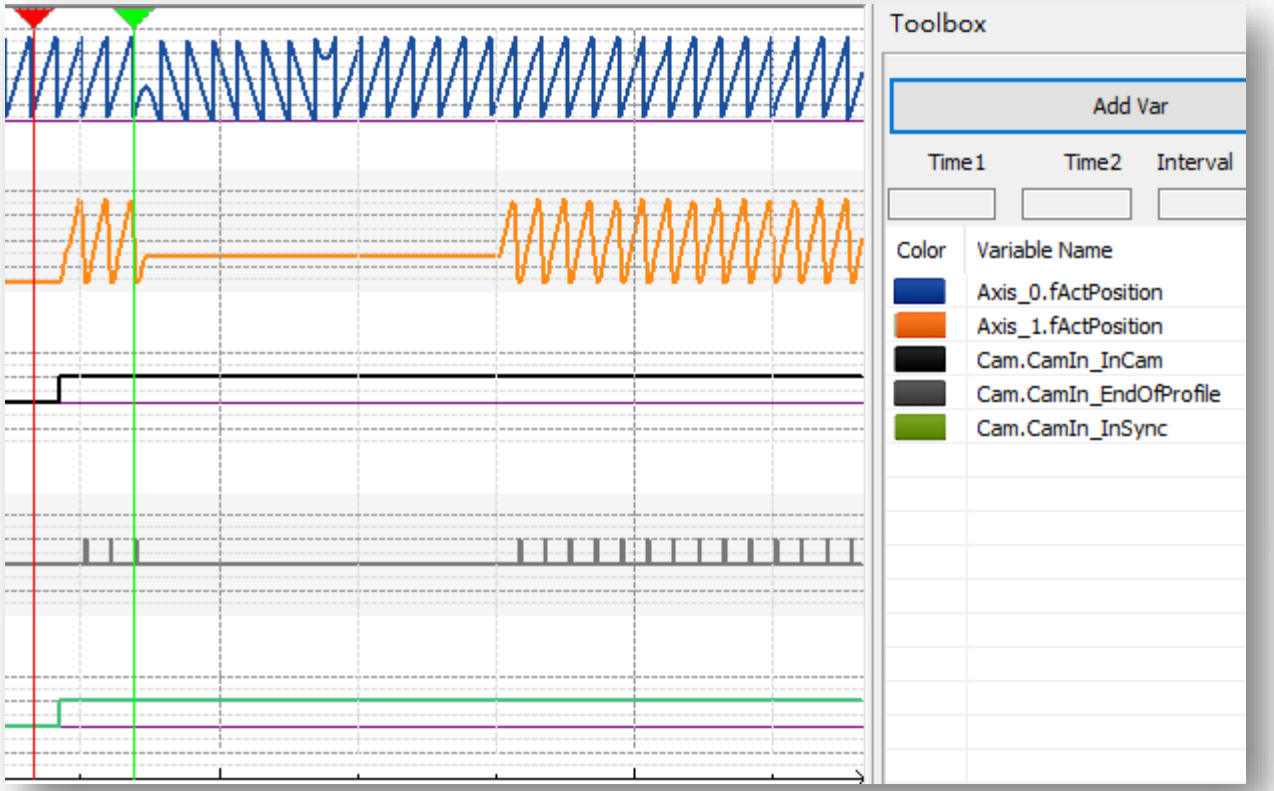
➢ MC_CamIn-Offset

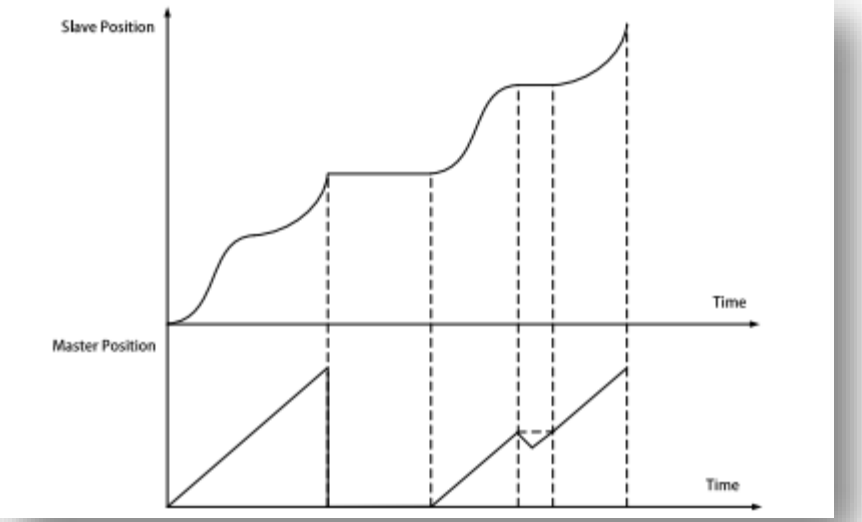
Offset is used to set offset distance for master position and slave position.
The parameter <MasterOffset> and <SlaveOffset> used to set the value.



➢ MC_CamIn-Direction

Only when master motion direction same as <Direction>, the slave CAM motion can be enabled. If the master motion direction reversed, the slave will stop motion, until master restore the former direction and position, the slave will continue to move.
If there is no specified direction(Direction=2), CAM support move in both direction.

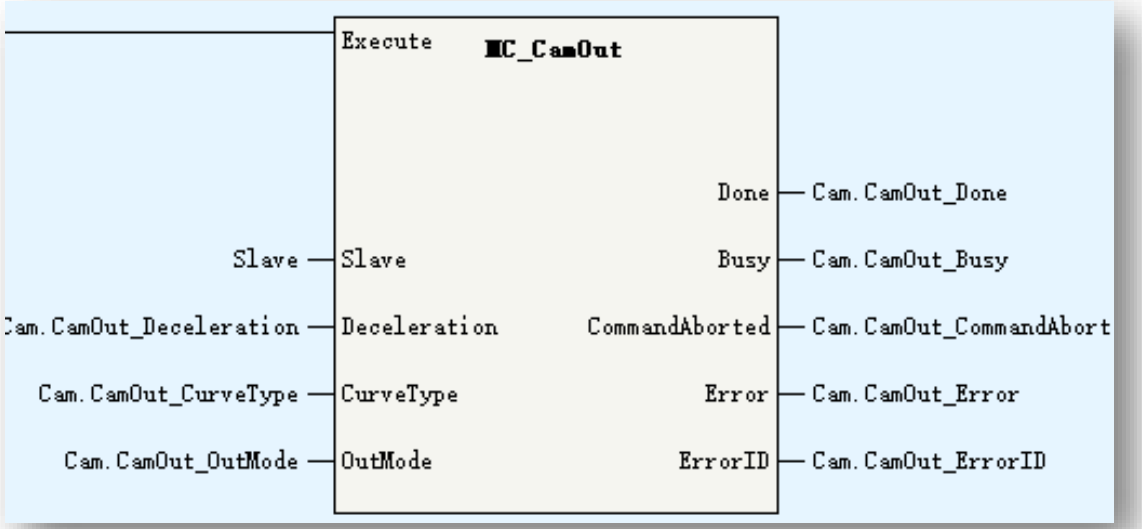




➢ MC_CamIn-Restart and Multi-Start

Re-execute MC_CamIn during FB busy period, <Periodic>/<MasterScaling>/<SlaveScaling>/<ReferenceType>/<Direction> will be refresh and valid in next CAM cycle.
Multi execute MC_CamIn command, the second command busy signal will be valid, but active will not be triggered immediately, need wait the current running CAM cycle complete, the new command active become valid. Then, the second CAM will work and <Periodic>/<MasterScaling>/<SlaveScaling>/<ReferenceType>/<Direction> parameters will follow the newer command.

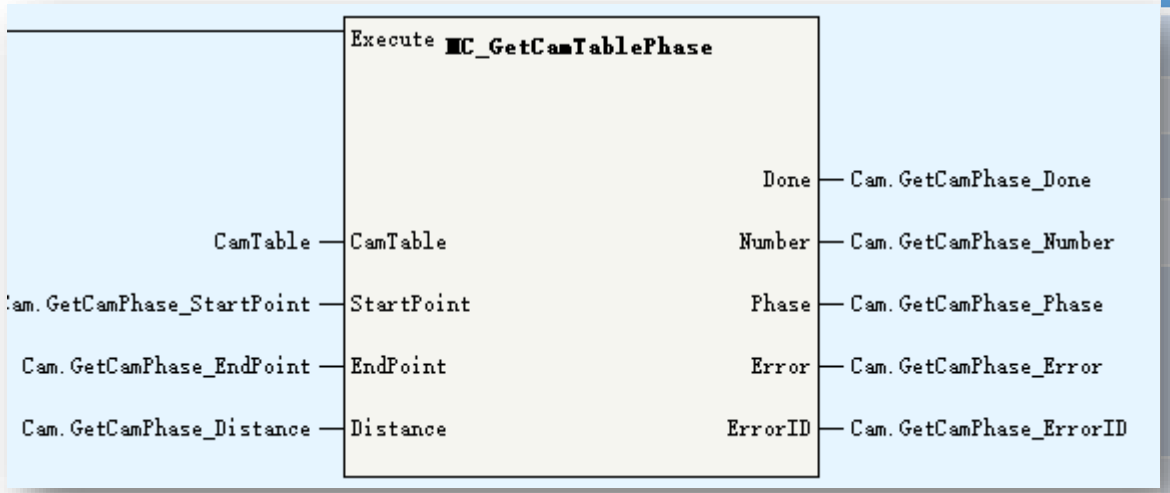
MC_CamOut



Parameters	Description
Slave	Slave Axis Name
Deceleration	Deceleration
CurveType	Velocity ACC/DEC curve: 0: T curve
OutMode	0: deceleration to stop 1: after current CAM cycle complete, stop immediately

MC_CamOut is used to release the CAM motion of slave.
If OutMode=0, while execute this FB, slave axis will get into continuous motion and deceleration to stop(standstill)
If OutMode=1, while execute this FB, slave will still in CAM motion(synchronized motion state) until current CAM cycle complete, after that, slave stop immediately.

MC_GetCamTablePhase

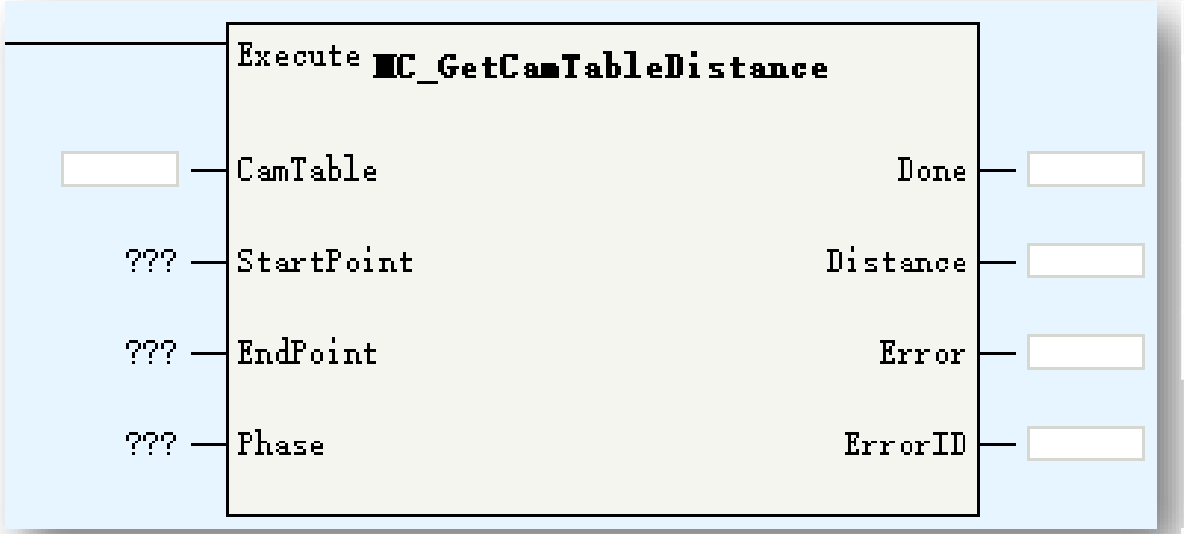


Parameters	Description
CamTable	Cam table
StartPoint	Start Point (_sMC_CAM_NODE)
EndPoint	End Point (_sMC_CAM_NODE)
Distance	Slave position in CAM
Number	Corresponding master position -1: infinite same position 0:None Greater than 0: the actual position quantities
Phase	The actual master position(array)

sMC_CAM_Node	Description
fPhase	Master phase
fDistance	Slave distance
fVel	Connection velocity
fAcc	Connection acceleration(reserved)
iCurve	Curve Type 0: reserved 1: linear 2: quintic curve

MC_GetCamTablePhase is used to calculate the master position according to slave position within 2 CAM key points(sMC_CAM_NODE).

MC_GetCamTableDistance

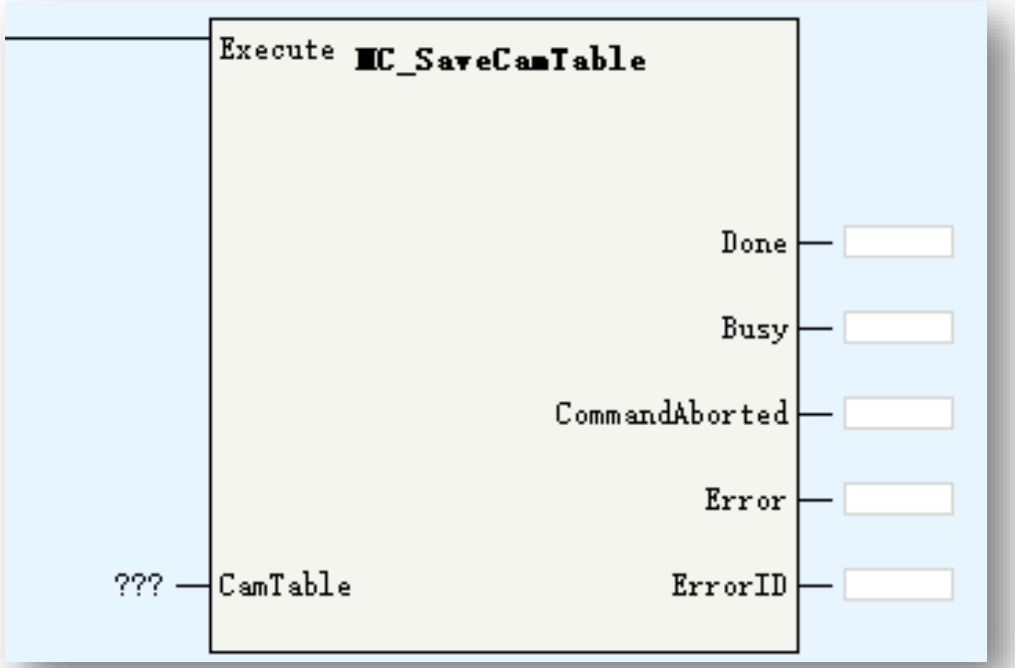


Parameters	Description
CamTable	Cam table
StartPoint	Start Point (_sMC_CAM_NODE)
EndPoint	End Point (_sMC_CAM_NODE)
Phase	Master position in CAM
Distance	Slave position in CAM

sMC_CAM_Node	Description
fPhase	Master phase
fDistance	Slave distance
fVel	Connection velocity
fAcc	Connection acceleration(reserved)
iCurve	Curve Type 0: reserved 1: linear 2: quintic curve

MC_GetCamTableDistance is used to calculate the slave position according to master position within 2 CAM key points(sMC_CAM_NODE).

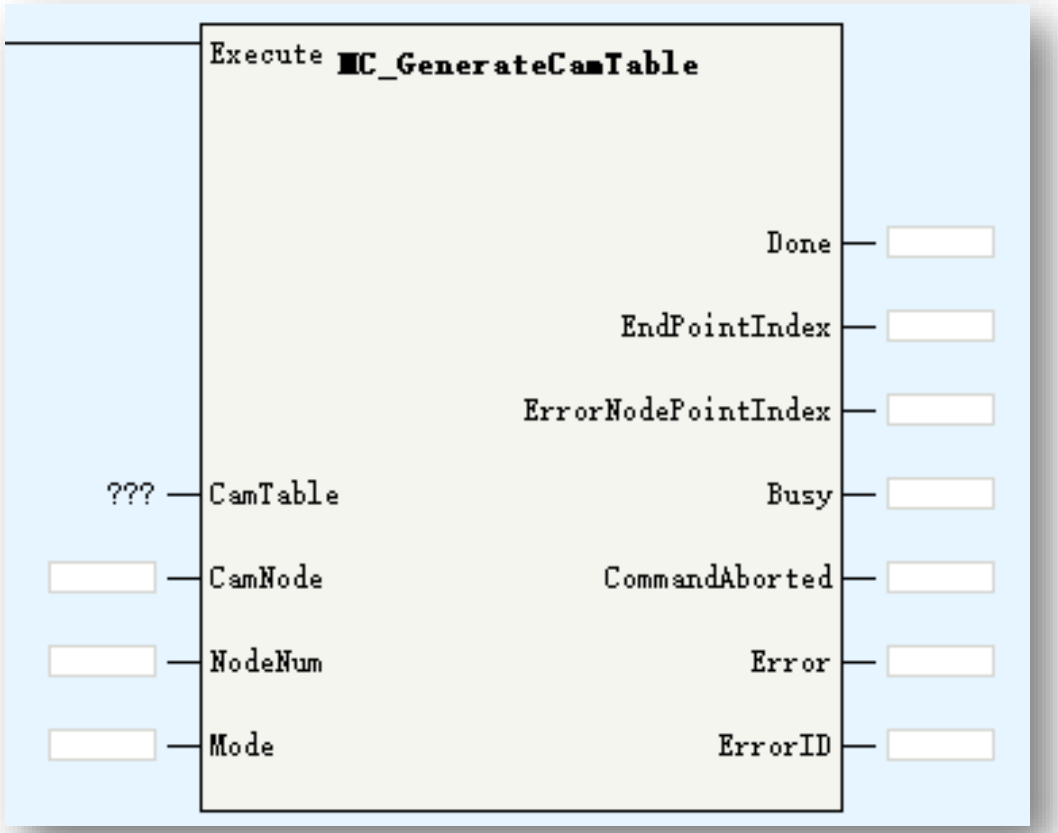
MC_SaveCamTable



Parameters	Description
CamTable	Cam table

MC_SaveCamTable is used to save the specified CAM table to flash. Be noted while this command executing, cannot power off the controller, or the CAM data will lost.

➢ MC_GenerateCamTable



MC_GenerateCamTable is used to update the specified CAM table data according to <CamNode> and <NodeNum>, the updated CAM table will effect in next CAM cycle.

Parameters	Description
CamTable	Cam table
CamNode	CAM node array (_sMC_CAM_NODE)
NodeNum	CAM node number, 2~361. While this parameter is empty, using the mode number of current CAM table
Mode	0: valid in next CAM cycle
EndPointIndex	End point index
ErrorNodePointIndex	Error point index

sMC_CAM_Node	Description
fPhase	Master phase
fDistance	Slave distance
fVel	Connection velocity
fAcc	Connection acceleration(reserved)
iCurve	Curve Type 0: reserved 1: linear 2: quintic curve

➢ MC_GenerateCamTable-CamNode

<CamNode> is used to specify if the new CAM point array will be used. While <CamNode> is empty, the former CAM point array will be used and user only modify the key points value. While <CamPoint> is not empty(and range is 2~361), the new CAM point array will be used and users have to set all key points value.

Below table show the process while <CamNode> is empty:

Master	Slave
0	0
500	500
2600	2600
3600	0

Modify key point(s) in same node array

Master	Slave
0	0
1000	1000
2600	2600
3600	0

```
DEMOV    E1000          Ecam_0.sCamnode[1].fPhase
                        Spindle Phase (Writable)
DEMOV    E1000          Ecam_0.sCamnode[1].fDistance
                        Displacement from axis (writa
                        ble)
DEMOV    E0             Ecam_0.sCamnode[1].fVel
                        Connection speed (writable)
MOV      K4             Cam.GenCamTable_NodeNum
SET      Cam.GenCamTable
```

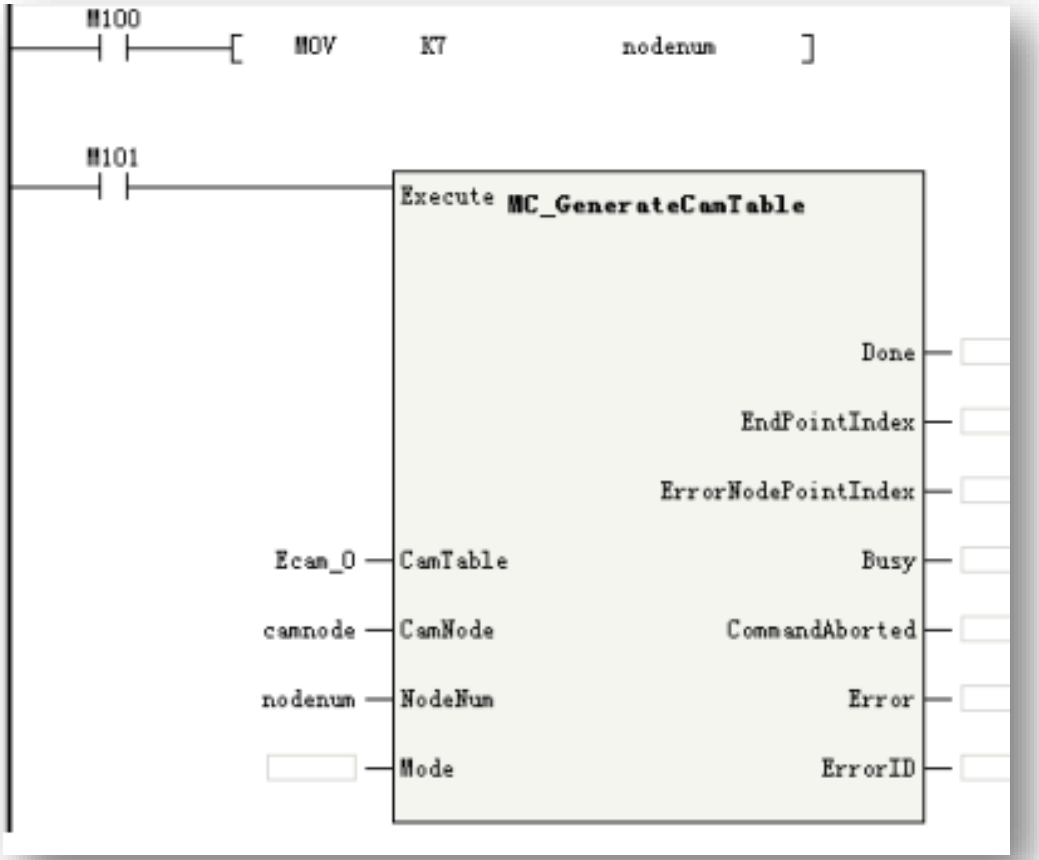
➢ MC_GenerateCamTable-CamNode

Below table show the process while <CamNode> is not empty:

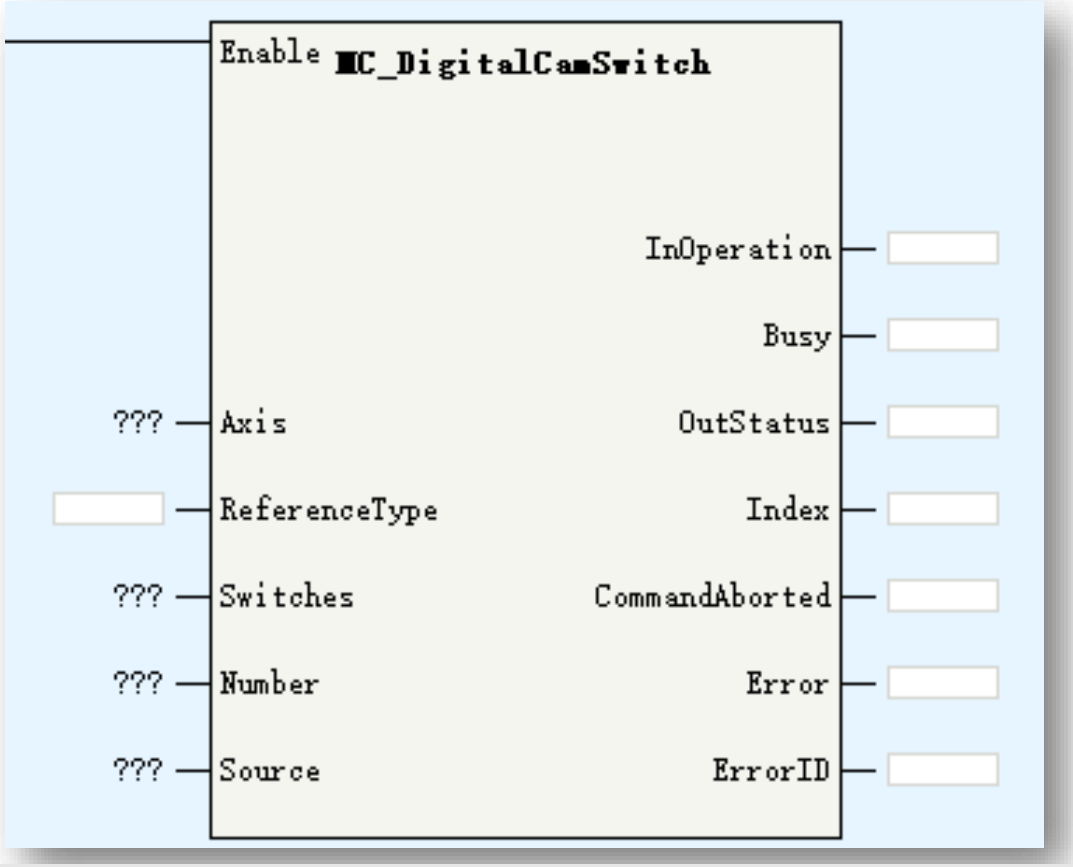
Master	Slave
0	0
500	500
2600	2600
3600	0

Create a new node array

Master	Slave
0	0
500	500
1000	1000
2600	2600
3000	3000
3300	3200
3600	0



➢ MC_DigitalCamSwitch



Parameters	Description
Axis	Axis ID/Axis name
ReferenceType	Reference position: 0: last cycle set position 1: current cycle set position 2:current cycle feedback position 3: while <Axis> as CAM slave, the master position
Switches	Tappet switch(_sMC_DigitalSwitch[1..32])
Number	Tappet switch number
Source	Tappet source: 0~13 is the physical output 1000~1007 is the virtual output
InOperation	In tappet
OutStatus	Out status
Index	Index of comparison point to be executed, 0~31

MC_DigitalCamSwitch used to reality CAM tappet function. The <Switch> used to set the configuration of tappet switch and the <Source> used to set the output tappet signal.

➢ MC_DigitalCamSwitch

_sMC_DigitalSwitch	Description
fPosition	Start absolute position of tappet valid range
iMode	Switch mode: 0: disabled 1: position type 2: time type
iDirection	Master direction 0:positive 1:negative 2:none
fParameter	Positon type: end position of tappet valid range Time type: time(ms) for output valid, not over 10000ms

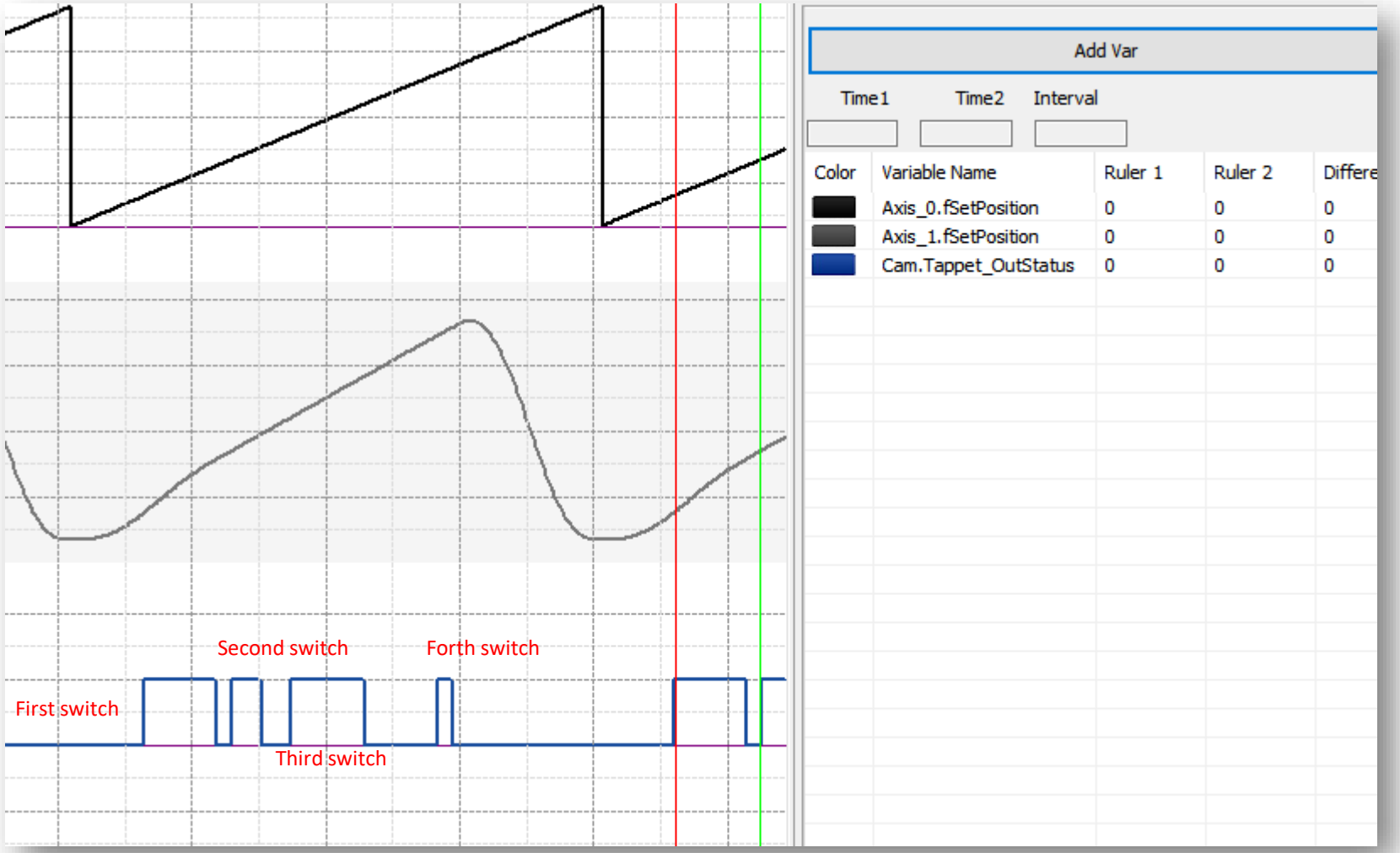
fPosition	iMode	iDirection	fParameter
500	1	0	1000
1100	1	0	1300
1500	1	0	2000
2500	2	0	100

Take note:
iMode=0, do not use current comparison point
iMode=1, while master up to <fPosition>, output valid, and while master up to <fParameter>, output invalid
iMode=2, while master up to <fPosition>, output valid, after <fParameter> ms, output invalid
The start position have to be different with end position
In the switch array, the <fPosition>(start position) of each switch is unique, which means, if over 2 switch share same start position, the error will occur.

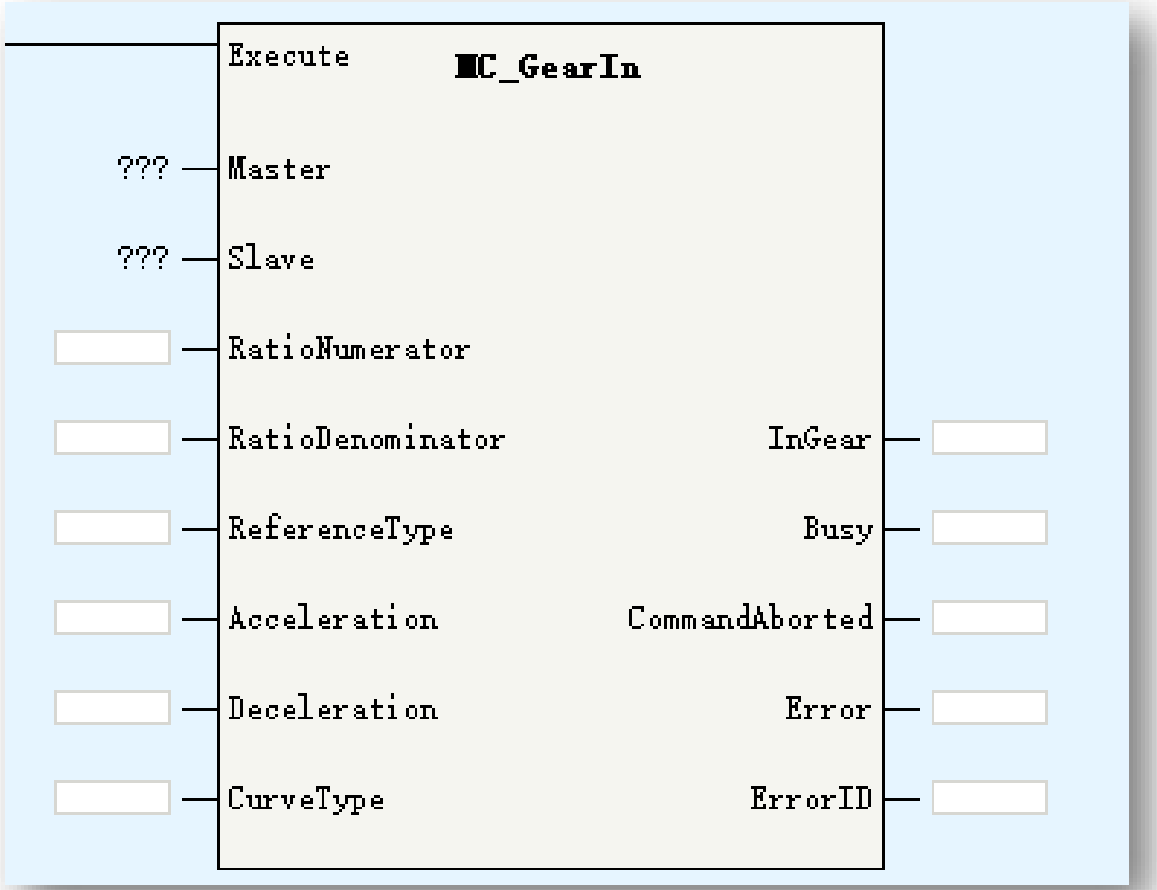
In the right table, we set the switches.

➢ MC_DigitalCamSwitch

The real effect in trace curve.



MC_GearIn

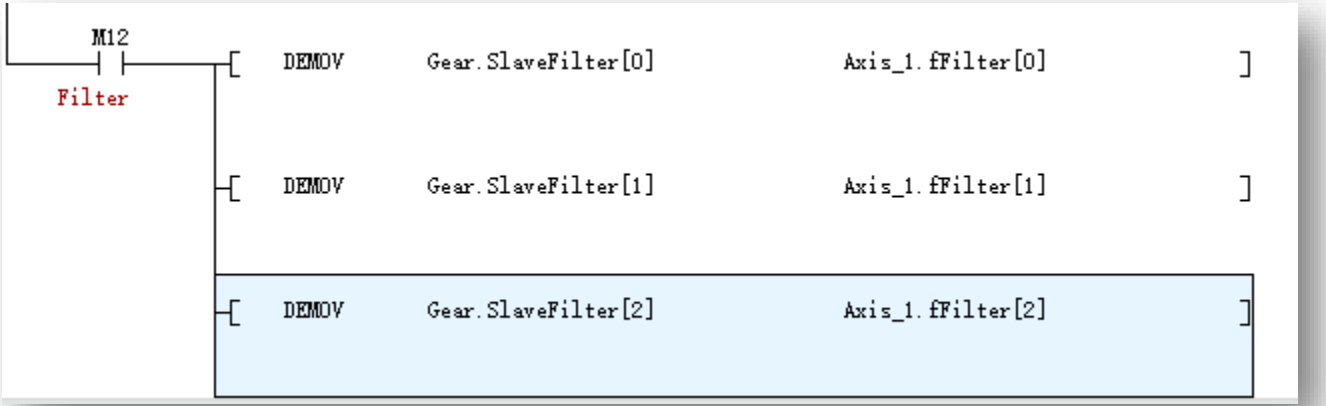


Parameters	Description
Master	Master axis: support EtherCAT axis, pulse control axis, Fieldbus encoder axis and local encoder axis
Slave	Slave axis: support EtherCAT axis and pulse control axis
RatioNumerator	Numerator of gear ratio
RatioDenominator	Denominator of gear ratio
ReferenceType	0: last cycle set position 1: current cycle set position 2:current cycle feedback position
Acceleration	Acceleration
Deceleration	Deceleration
CurveType	Curve type 0: T type curve
InGear	In gear

MC_GearIn is used to establish velocity relationship between 2 axis. The slave axis velocity will follow the master axis velocity according to the gear ratio. MC_GearIn support restart or multi start to update gear ratio.

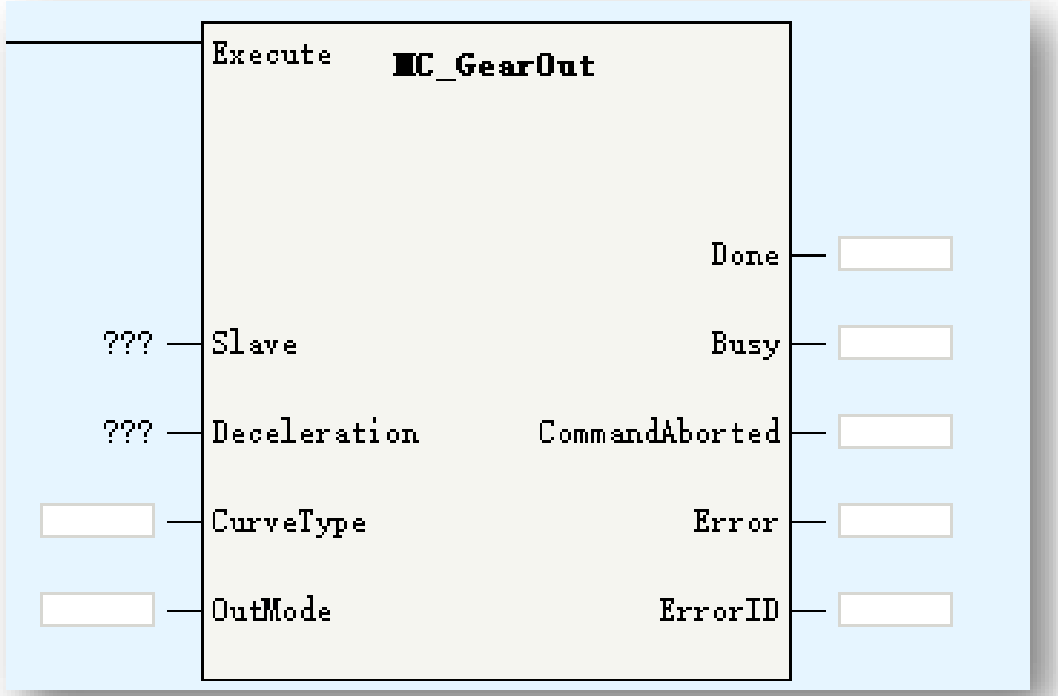
➢ MC_GearIn

Take note:
To get stable slave velocity, H5U provide filter function for MC_GearIn function to filter the master velocity. The calculation principle as below:
Filter Master velocity=fFilter[0]*CurrentCycleMasterVelocity + fFilter[1]*LastCycleMasterVelocity + fFilter[2]*TheTimeBeforeLastCycleMasterVelcity. In other word, it is a weighted calculation of recent 3 cycles master velocity.
The fFilter[0..2] parameters is in axis structure, users can invoke these parameters by <AxisName>.fFilter[0..2] to set the filter parameters. Make sure the summary of fFilter[0..2] is 1.



fFilter	REAL[3]		Set the filter factor for the spindle (power-on ini..
fFilter[0]	REAL	Dec	
fFilter[1]	REAL	Dec	
fFilter[2]	REAL	Dec	

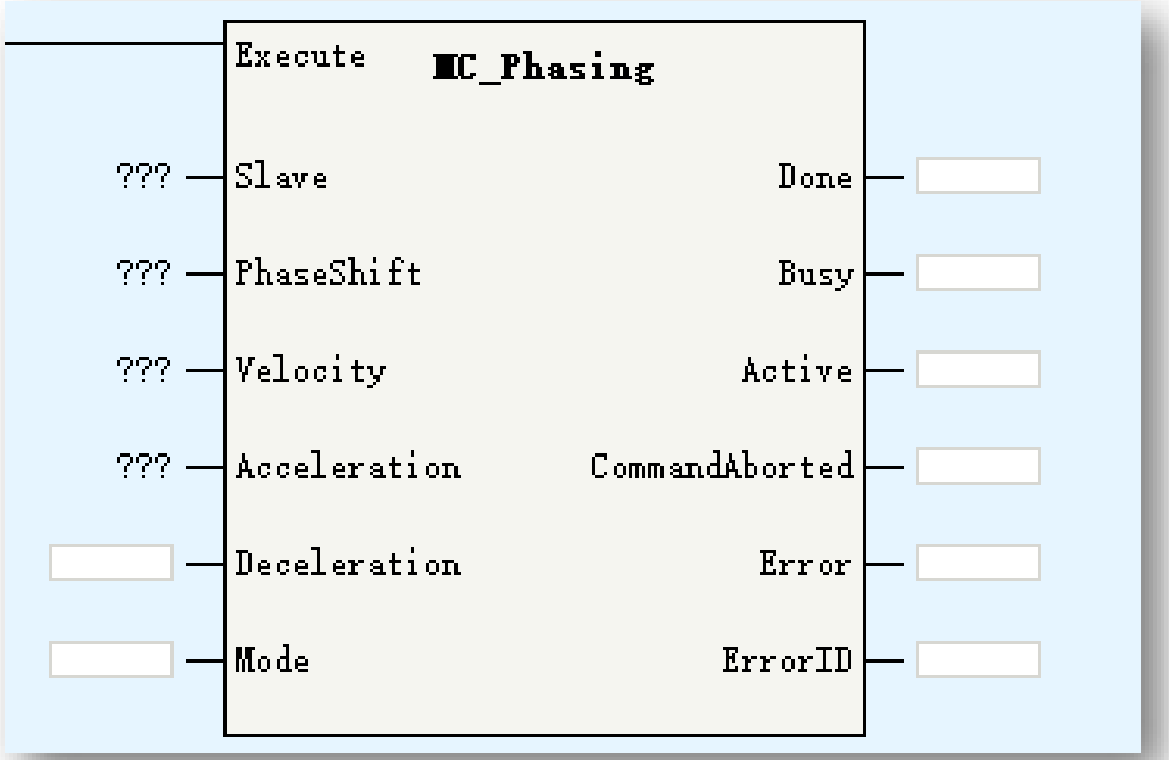
MC_GearOut



Parameters	Description
Slave	Slave axis: support EtherCAT axis and pulse control axis
Deceleration	Deceleration
CurveType	Curve type 0: T type curve
OutMode	0: Deceleration to stop

MC_GearOut is used to release the gear motion of slave.

MC_Phasing

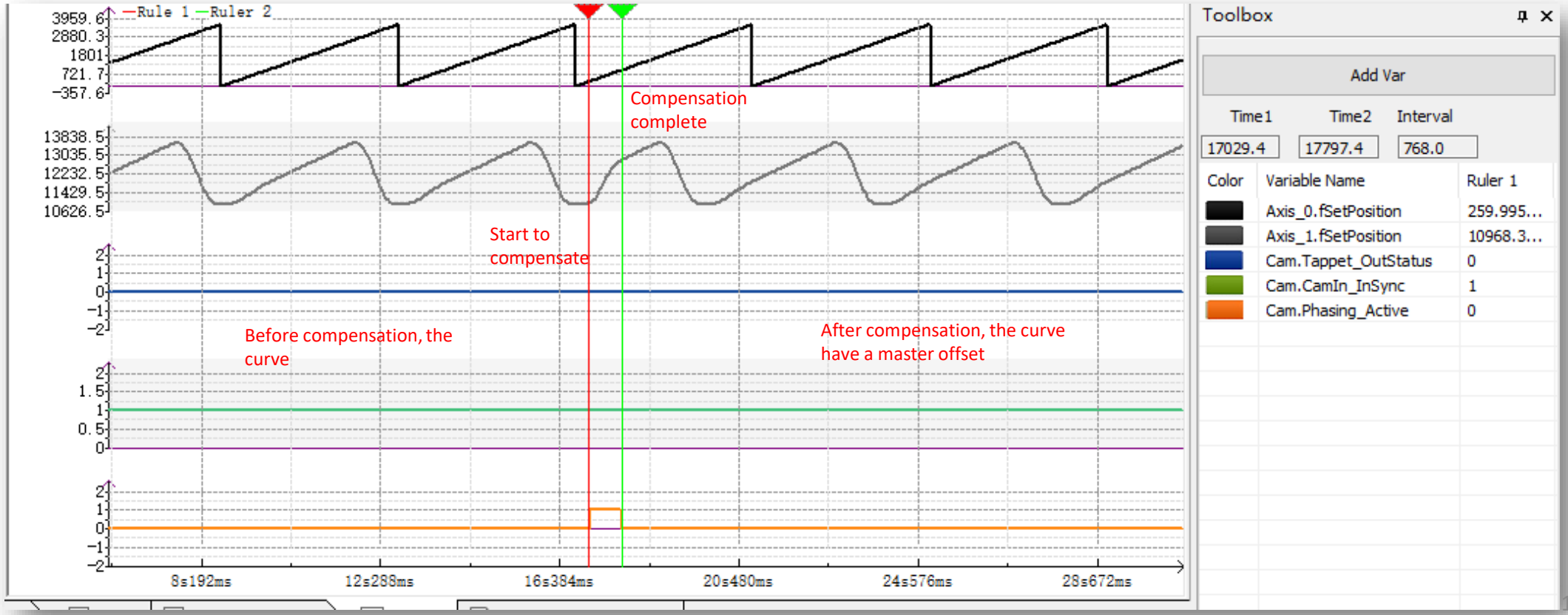


Parameters	Description
Slave	Slave Axis ID/Axis name
PhaseShift	Master offset value
Velocity	Target velocity
Acceleration	Acceleration
Deceleration	Deceleration
Mode	Mode: 0: reserved 1: Stop phase shift while master velocity is 0
Active	Compensation executing

MC_Phasing is used to set the master offset in CAM or GEAR motion. Be noted this command will not impact the position of master, but impact the position(origin set position + calculated offset position) of slave.

➢ MC_Phasing-while using with CAM motion

While using with MC_CamIn, if MC_Phasing enabled before MC_CamIn.Insync signal, it will stay in buffer mode and wait the Insync siganl turn ON.
The master position curve will not impact by this command by slave position will change to new position (corresponding position of master position + offset)

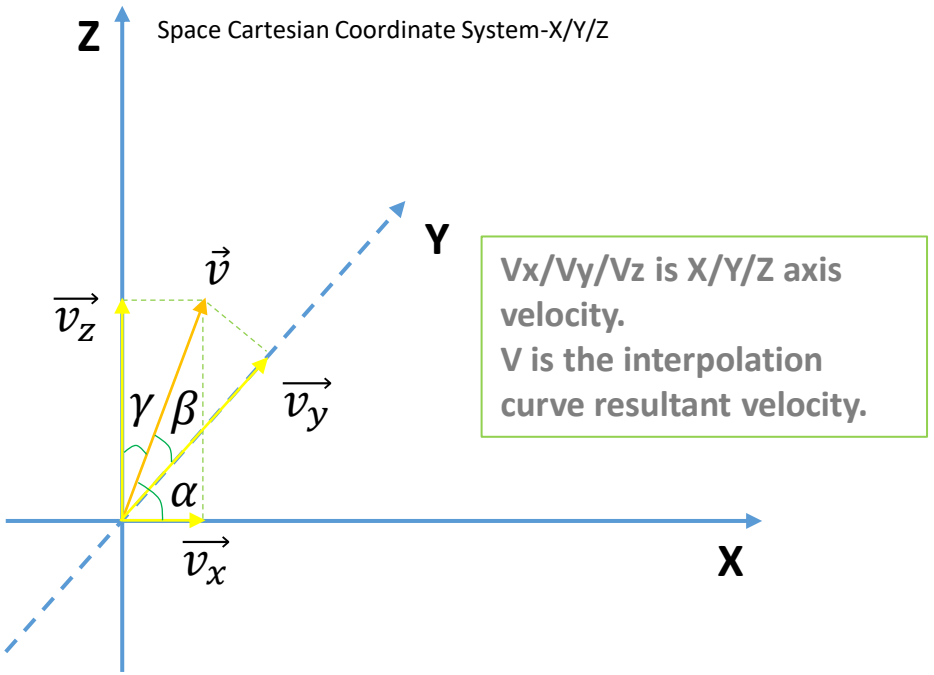


Axes Group	Function
MC_MoveLinear	Axes group move linear curve
MC_MoveCircular	Axes group move circular curve
MC_GroupStop	Axes group stop
MC_GroupPause	Axes group pause

Interpolation Introduction

H5U support linear interpolation and circular interpolation in a space Cartesian coordinate system. The interpolation function is realized in the form of axes group.
>Each axes group support up to 4 axes(EtherCAT axis or local pulse axis), include X/Y/Z (coordinate axis) and A (auxiliary axis);
>H5U support up to 8 axes group, each axes group support 2 axes(X/Y), 3 axes(X/Y/Z) and 4 axes(X/Y/Z/A);
>Interpolation support buffer mode, each axes group support up to 8 buffer curve, the transition mode is settable.

Space Cartesian Coordinate System-X/Y/Z

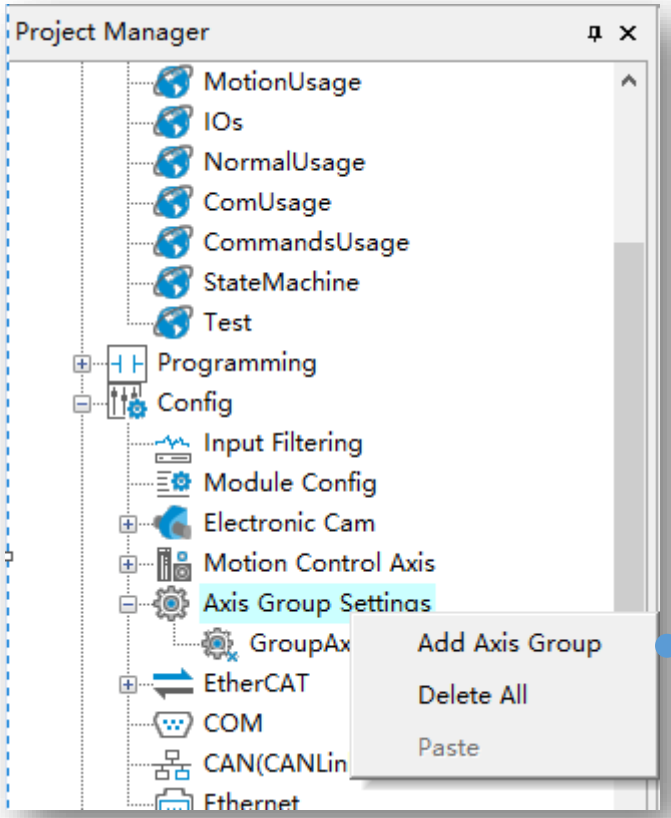


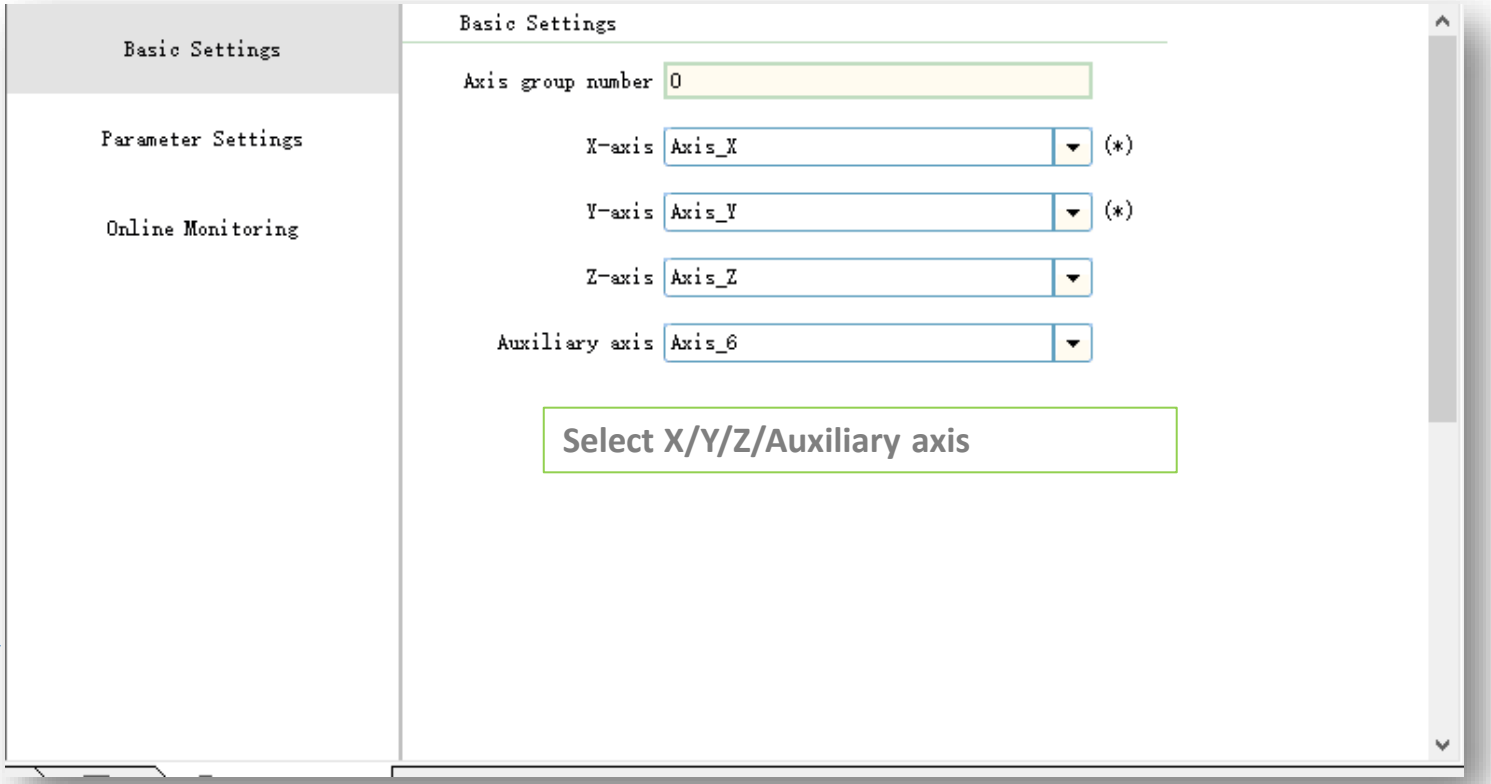
Vx/Vy/Vz is X/Y/Z axis velocity.
V is the interpolation curve resultant velocity.

Linear Coordinate System-A

While linear interpolation, X/Y/Z motion in coordinate direction, auxiliary axis move linearly from start point to end point.
While circular interpolation, select XY/YZ/XZ plane as circular interpolation, other axis move linearly form start point to end point.

➢ Axes Group Configuration-Basic Settings

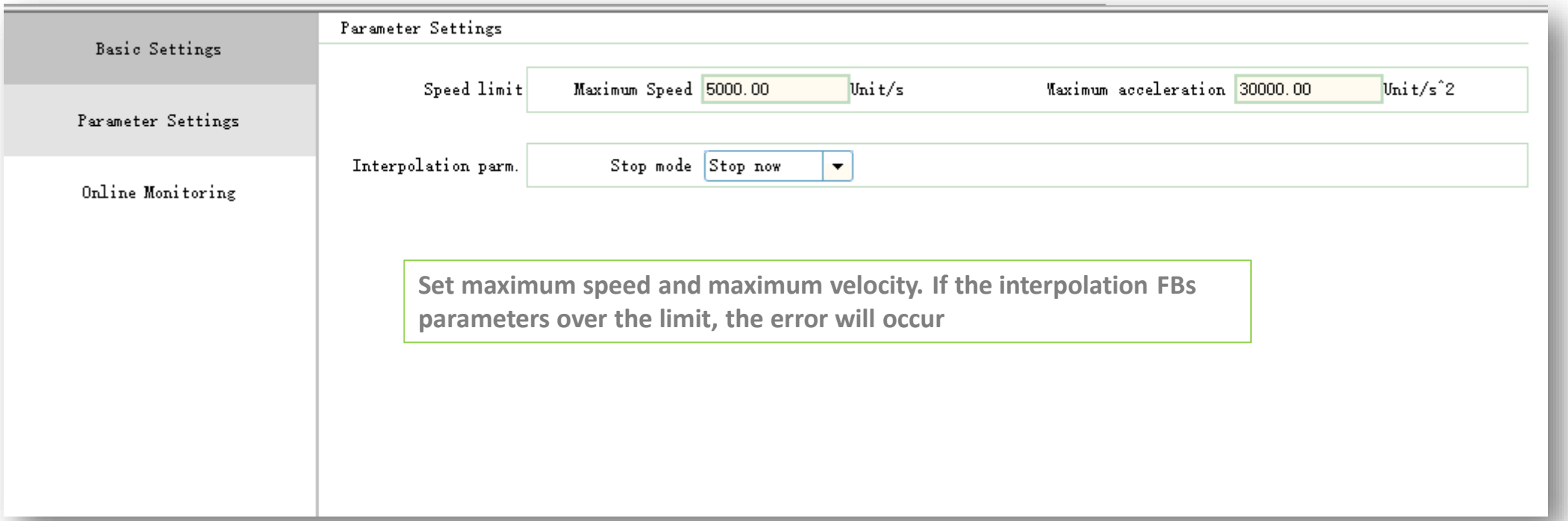




Select X/Y/Z/Auxiliary axis

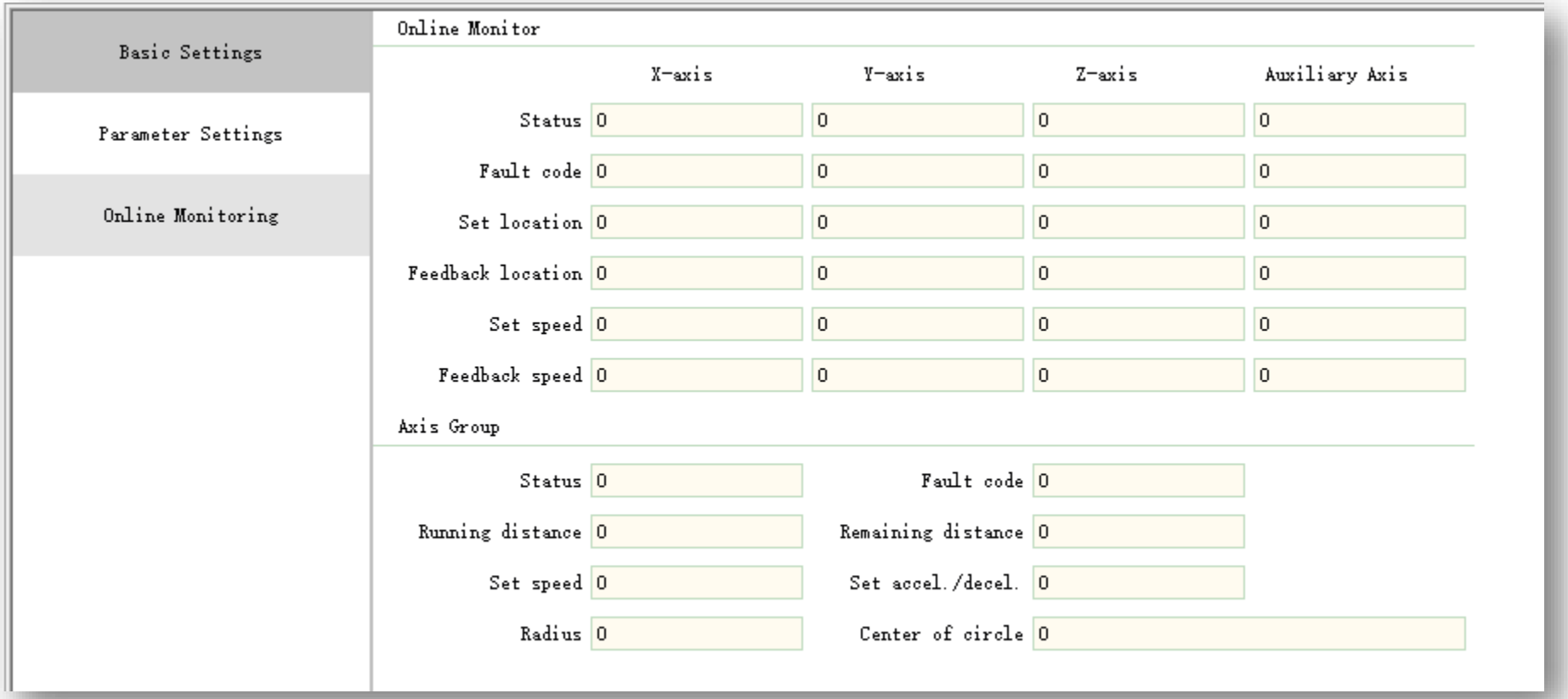
<Project Manager>→<Config>→<Axis Group Settings> right click to <Add Axis Group>

➢ Axes Group Configuration-Parameter Settings



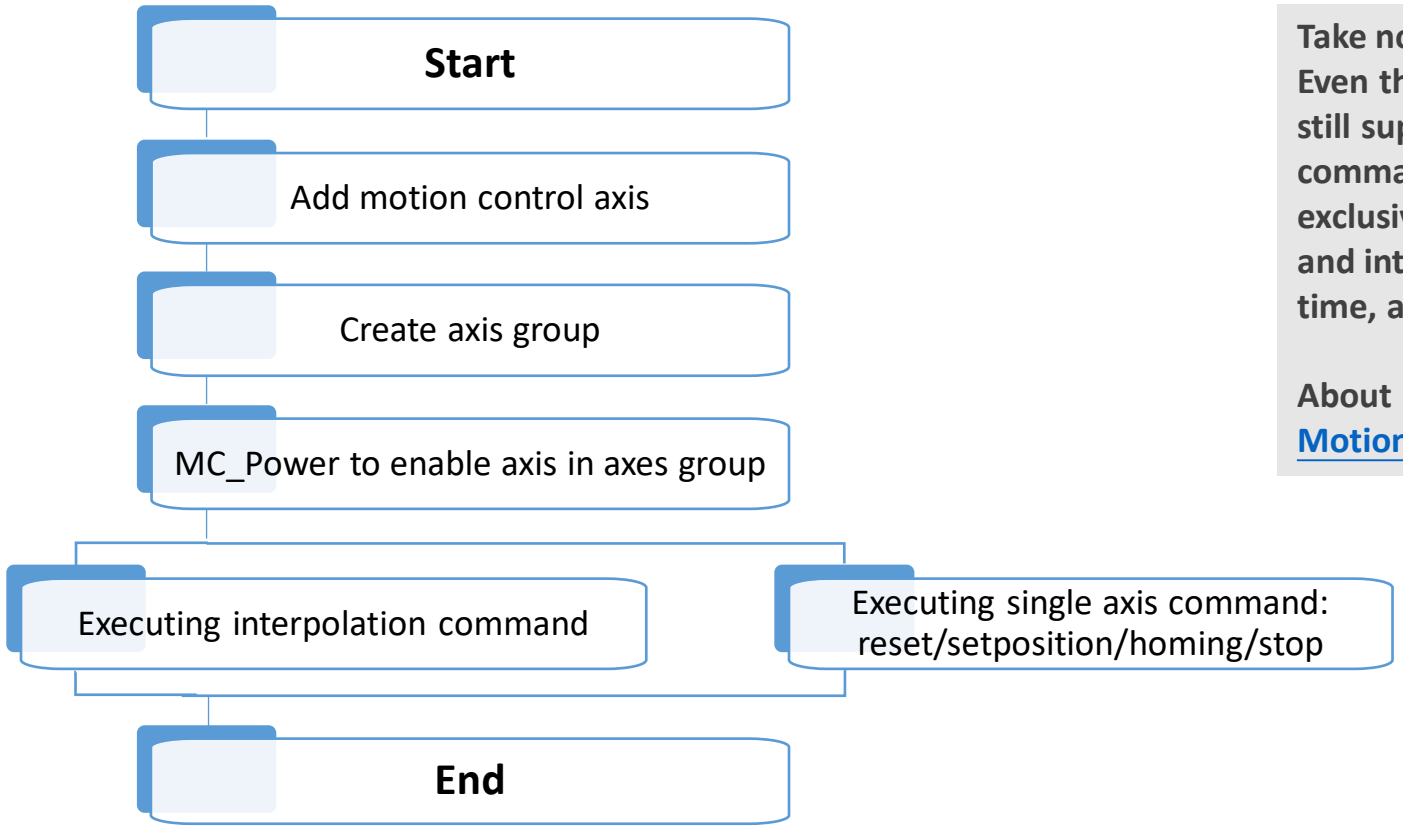
Set maximum speed and maximum velocity. If the interpolation FBs parameters over the limit, the error will occur

Axes Group Configuration-Online Monitoring



To check the parameters and error information for each axis in group

Interpolation Process



Take note：
Even though an axis is added to an axes group, the axis still support single axis motion. However, the single axis commands and interpolation commands are mutually exclusive, which means, single axis motion commands and interpolation commands will not effect at the same time, and at the same time, they cannot abort each other.

About how to add motion control axis, please refer to Motion control axis configuration.

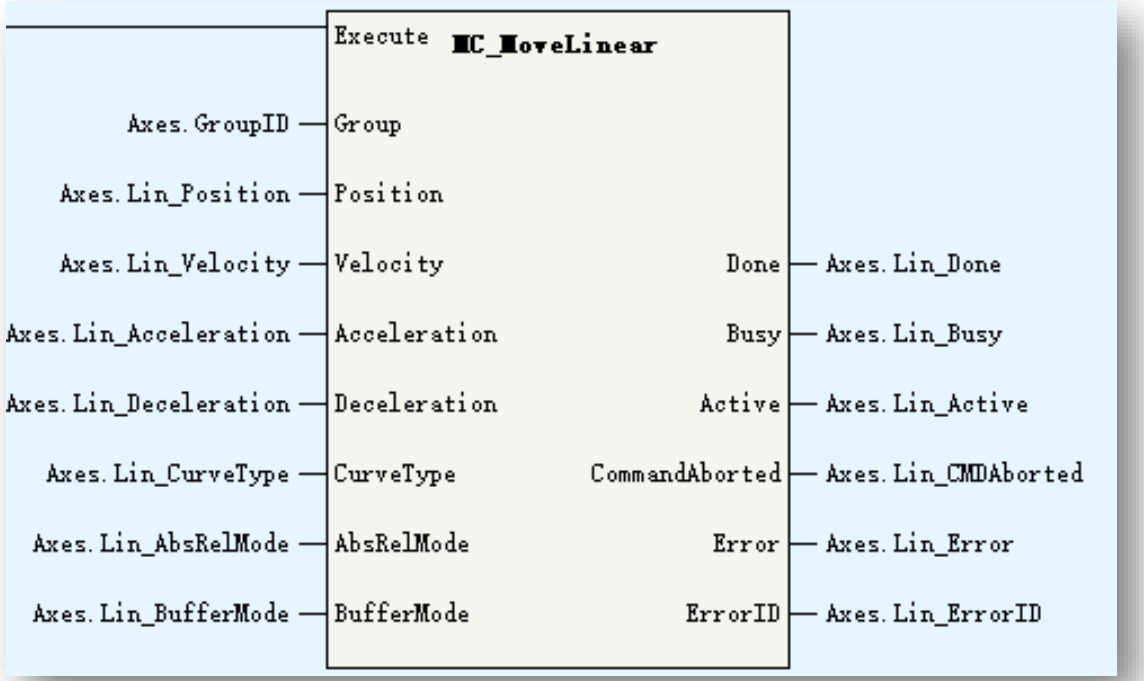
➢ Axes Group System Variable

While create an axes group in project configuration, a system structure _sMC_GroupInfo will be created automatically. In this data structure, users can monitoring and check the axes group status. Below table only show the <wState> definition, more details please refer to AutoShop software.

wState	Definition
0	Initialization
1	Disabled
2	Single Stop
3	Single Homing
4	Single Motion
5	Error Stop
6	Standstill
7	Stopping
8	Synchronous Motion

GroupAxes_0	_sMCGROUP_INFO		
wRingPos	INT	Dec	Configuration Number (Read Only, Monitoring)
wGroupID	INT	Dec	Axis Group Number (Read Only, Monitoring)
wState	INT	Dec	Status (read-only, monitoring)
wErrorCode	INT	Dec	Failure Code (Read-Only, Monitoring)
bMotionState	BOOL	Bin	Exercise Status (Read Only, Monitoring)
bHaltValid	BOOL	Bin	Pause state (read-only, monitoring)
wBufNum	INT	Dec	Number of buffers (read-only, monitoring)
sAxis_x	_sGROUPAXIS_INFO		X-axis status (read-only, monitoring)
wAxisID	INT	Dec	Axis number (read-only, monitoring)
wState	INT	Dec	Status (read-only, monitoring)
wErrorCode	INT	Dec	Failure Code (Read-Only, Monitoring)
fsetpos	REAL	Dec	Set location (read-only, monitoring)
factpos	REAL	Dec	Feedback location (read-only, monitoring)
fsetvel	REAL	Dec	Set Speed (Read Only, Monitor)
factvel	REAL	Dec	Feedback speed (read-only, monitoring)
sAxis_y	_sGROUPAXIS_INFO		Y-axis status (read-only, monitoring)
sAxis_z	_sGROUPAXIS_INFO		z-axis status (read-only, monitoring)
sAxis_a	_sGROUPAXIS_INFO		Auxiliary Axis Status (Read Only, Monitoring)
fSetvel	REAL	Dec	Set Speed (Read Only, Monitor)
fSetacc_dec	REAL	Dec	Set the plus (minus) speed (read-only, monitoring)
fSetvel_buf	REAL	Dec	Buffer Curve Set Speed (Read Only, Monitor)
fSetacc_d...	REAL	Dec	Buffer curve setting plus (minus) speed (read-only...
fSetdis	REAL	Dec	Set Distance (Read Only, Monitor)
fLeftdis	REAL	Dec	Remaining distance (read-only, monitoring)
fCenter_x	REAL	Dec	Coordinates of the x-point at the center of the ci...
fCenter_y	REAL	Dec	Coordinates of the Y-axis of the center of the cir...
fCenter_z	REAL	Dec	Coordinates of the z-axis of the center of the cir...
fRadius	REAL	Dec	Radius of circle for arc interpolation (read-only,...
fStartAng	REAL	Dec	Arc interpolation start angle (read-only, monitoring)
fSetAng	REAL	Dec	Circular Interpolation Moving Angle (Read Only, Mo...

➢ MC_MoveLinear



Parameters	Description
Group	Axes group ID
Position	Target position
Velocity	Target velocity
Acceleration	Acceleration
Deceleration	Deceleration
CurveType	Velocity Curve: 0: T type curve
AbsRelMode	0: absolute mode 1: relative mode
BufferMode	0: abort + no transition 1: buffer + no transition 2: former velocity + no transition 3: additional angle transition
Active	Executing current interpolation curve

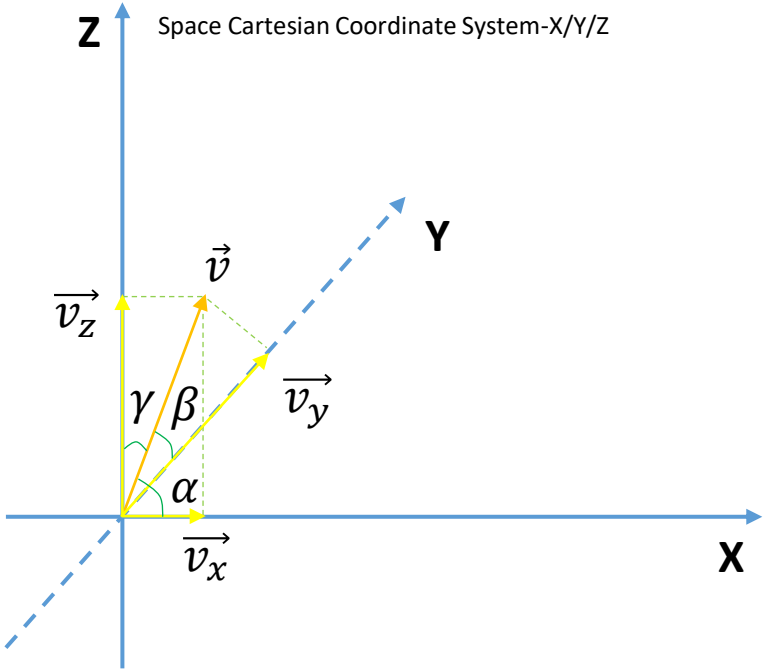
MC_MoveLinear is used to move axes group linearly. While <Execute> triggered, input parameters will update and the FB will start to run.
Take note:
Only when all axis in group is standstill status, this command can execute, or there will be an error occur.
After this command executing, all axis in group will in synchronous motion state and cannot be aborted by single motion command.
After interpolation done, all axis in group will back to standstill state, at this time single motion command can be executed.
Don't support restart, if re-execute this command while <Busy> is ON, an error 9421 will occur.

➢ MC_MoveLinear-Position/Velocity

<Position> is an array data type, <Position[0]> set the X axis target position, <Position[1]> set Y axis target position, and so on for other axes.

Vx=V*cosα Vy=V*cosβ Vz=V*cosγ V=$\sqrt[2]{v_x^2+v_y^2+v_z^2}$

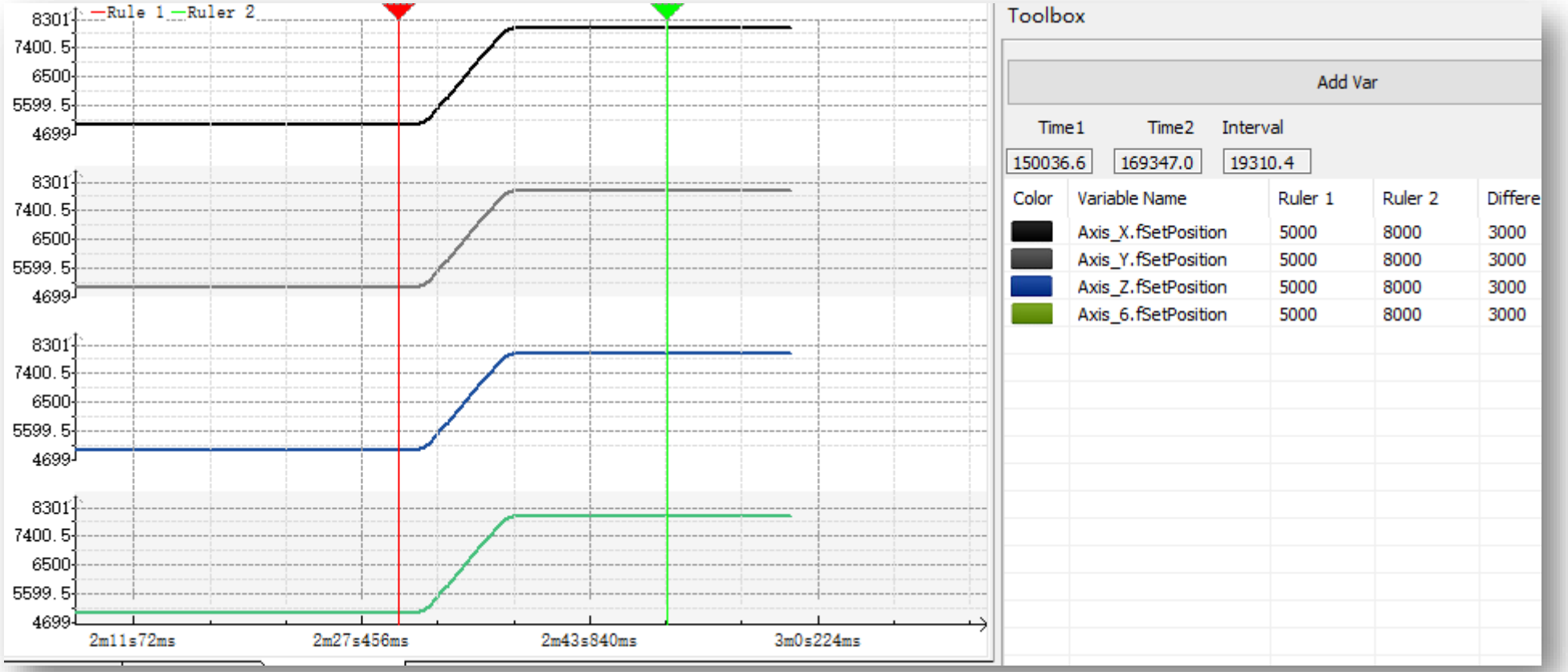
The auxiliary axis velocity is:
While X/Y/Z don't move, A axis will move follow the parameter <Velocity>
While X/Y/Z move, A axis will get into target position with X/Y/Z at the same time. For example, if displacement of X is L1, displacement of A is L2, then Va=Vx*L2/L1



➢ MC_MoveLinear-Mode

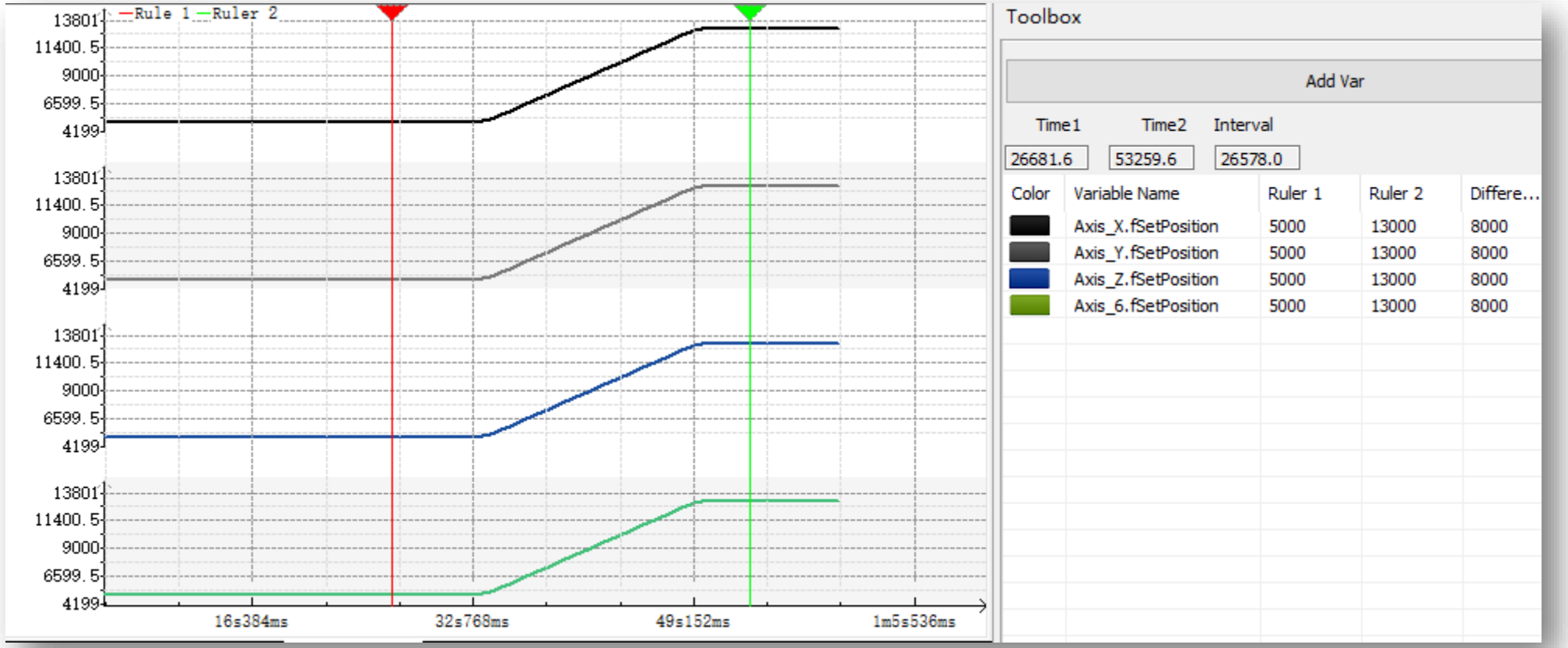
<AbsRelMode>=0, absolute mode, X/Y/Z/A move to <Position[0]>/<Position[1]>/<Position[2]>/<Position[3]>

<AbsRelMode>=1, relative mode, X/Y/Z/A move to Px + <Position[0]>/ Py + <Position[1]>/ Pz + <Position[2]>/ Pa + <Position[3]>, (Px, Py, Pz) is current coordinate system position, Pa is auxiliary axis position.



Start position is X/Y/Z(5000, 5000, 5000) + A(5000), target position is X/Y/Z(8000,8000,8000)+A(8000), absolute mode

➢ MC_MoveLinear-Mode



Start position is X/Y/Z(5000, 5000, 5000) + A(5000), target position is X/Y/Z(8000,8000,8000)+A(8000), relative mode

➢ MC_MoveCircular

Parameters	Description
Group	Axes group ID
CircAxes	Circular motion base on: 0: x-y plane 1:y-z plane 2:x-z plane
CircMode	Circular interpolation mode: 0: 3 pass points 1: center point + start point + end point 2: radius + start point + end point
AuxPoint	Auxiliary points(array[0..3] of real)
EndPoint	End points(array[0..3] of real)
Velocity	Target velocity
Acceleration	Acceleration
Deceleration	Deceleration
PathChoice	0:CW 1:CCW
CurveType	Velocity curve 0: T type curve
AbRelMode	0: absolute mode 1: relative mode
BufferMode	0: abort + no transition 1: buffer + no transition 2: former velocity + no transition 3: additional angle transition
Active	Executing current interpolation curve

MC_MoveCircular

MC_MoveCircluar is used to move axes group circularly. While <Execute> triggered, input parameters will update and the FB will start to run.

Take note:
Only when all axis in group is standstill status, this command can execute, or there will be an error occur.

After this command executing, all axis in group will in synchronous motion state and cannot be aborted by single motion command.

After interpolation done, all axis in group will back to standstill state, at this time single motion command can be executed.
Don't support restart, if re-execute this command while <Busy> is ON, an error 9421 will occur.

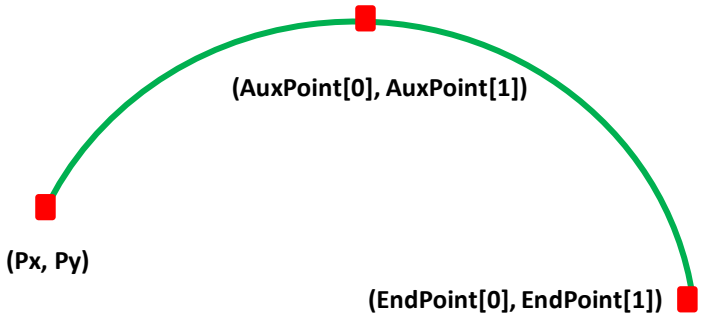
<CircAxes> specified coordinate plane. For example, while <CircAxes>=0, select X-Y coordinate plane. X axis and Y axis do circular interpolation motion, Z axis and A axis as auxiliary axes, do linear motion.

➢ MC_MoveCircular-Circle Mode

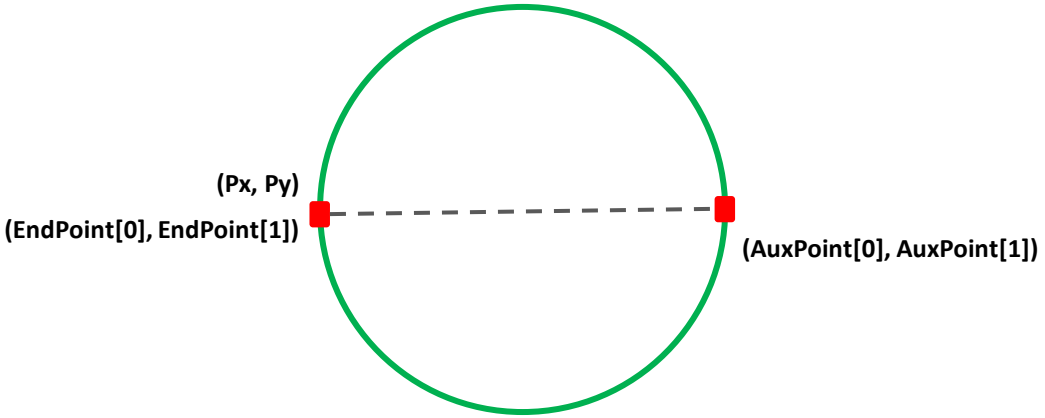
<CircMode>=0: 3 pass points mode. The circular(or arc) will generate according the given 3 points: start point, pass(middle) point and end point.
Start point is current position of axes group, the middle point is specified by <AuxPoint>, the end point is specified by <EndPoint>:
While select X-Y plane: start point is (Px, Py), middle point is (<AuxPoint[0]>, <AuxPoint[1]>), end point is (<EndPoint(0)>, <EndPoint(1)>)
While select Y-Z plane, start point is (Py, Pz), middle point is (<AuxPoint[1]>, <AuxPoint[2]>), end point is (<EndPoint(1)>, <EndPoint(2)>)
While select X-Z plane, start point is (Px, Pz), middle point is (<AuxPoint[0]>, <AuxPoint[2]>), end point is (<EndPoint(0)>, <EndPoint(2)>)

While start point is same as end point, the curve is a circle with a diameter as <start point←→middle point> distance. In this case, <PathChoice> will specified the motion direction of the circle, 0 is clockwise direction, 1 is counterclockwise direction.

Take note: except start point is same as end point, while 3 points in a line, the 3 points cannot form a circle.



*Select X-Y plane, and start point <> end point

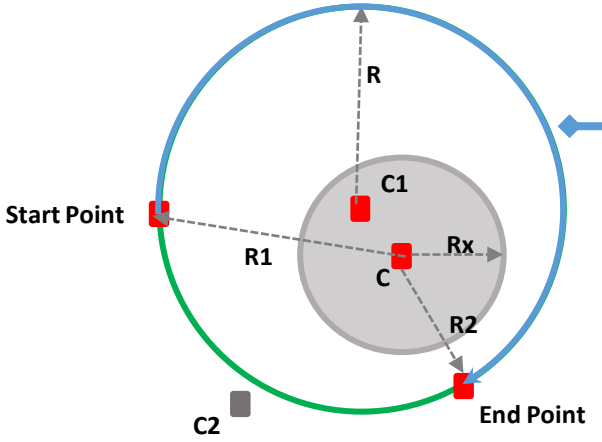


*Select X-Y plane, and start point = end point

MC_MoveCircular-Circle Mode

<CircMode>=1: center point + start point + end point. The circular(or arc) will generate according the given 3 points: circle center, start point and end point.
Start point is current position of axes group, the center point is specified by <AuxPoint>, the end point is specified by <EndPoint>:
While select X-Y plane: start point is (Px, Py), center point is (<AuxPoint[0]>, <AuxPoint[1]>), end point is (<EndPoint(0)>, <EndPoint(1)>)
While select Y-Z plane, start point is (Py, Pz), center point is (<AuxPoint[1]>, <AuxPoint[2]>), end point is (<EndPoint(1)>, <EndPoint(2)>)
While select X-Z plane, start point is (Px, Pz), center point is (<AuxPoint[0]>, <AuxPoint[2]>), end point is (<EndPoint(0)>, <EndPoint(2)>)

Take note: While the distance between center and star point(R1) and distance between center and end point(R2) is different, interpolator will calculate the mean value R(R=(R1+R2)/2), then calculate the new center point according to R. There could 2 center points calculated, at this time, the center point(C1) which is close to preset center point(C) will be selected, and, the new center point have to be in the circle of preset center(C) as circle center and Rx<AuxPoint[3]> as radius.

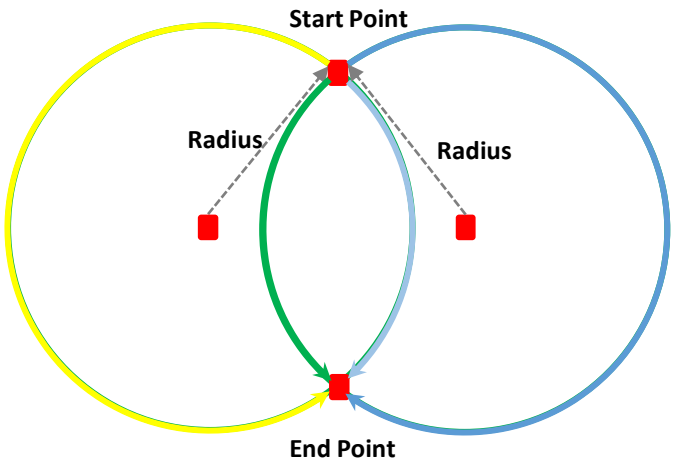


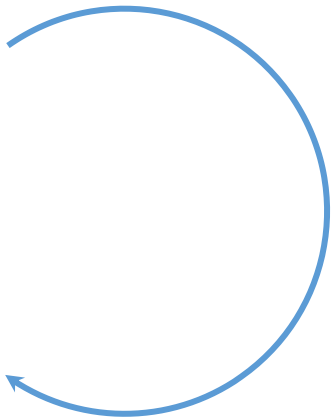
<Path Choice> to decide the interpolation direction, 0 is clockwise direction, 1 is counterclockwise direction

MC_MoveCircular-Circle Mode

<CircMode>=2: radius + start point + end point. The circular(or arc) will generate according the given 3 parameters: radius, start point and end point.
Start point is current position of axes group, the radius is specified by <AuxPoint[0]>, the end point is specified by <EndPoint>:
While select X-Y plane: start point is (Px, Py), end point is (<EndPoint(0)>, <EndPoint(1)>)
While select Y-Z plane, start point is (Py, Pz), end point is (<EndPoint(1)>, <EndPoint(2)>)
While select X-Z plane, start point is (Px, Pz), <AuxPoint[2]>), end point is (<EndPoint(0)>, <EndPoint(2)>)

Take note: if radius value is negative, will generate the longer arc, if radius value is positive, will generate the shorter arc. The interpolation direction is set by <PathChoice>, 0 is clockwise direction, 1 is counterclockwise direction.





*<PathChoice>=0;
Radius value is negative

*<PathChoice>=0;
Radius value is positive

*<PathChoice>=1;
Radius value is negative

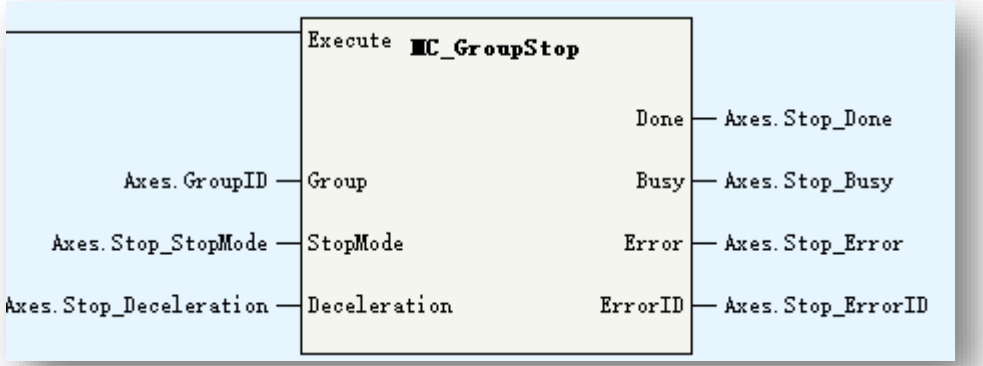
*<PathChoice>=1;
Radius value is Positive

➢ MC_MoveCircular-AbsRelMode

<AbsRelMode>=0, absolute mode, <AuxPoint> and <EndPoint> specified absolute position of axis.

<AbsRelMode>=1, relative mode, <AuxPoint> and <EndPoint> specified relative position of axis.

➢ MC_GroupStop



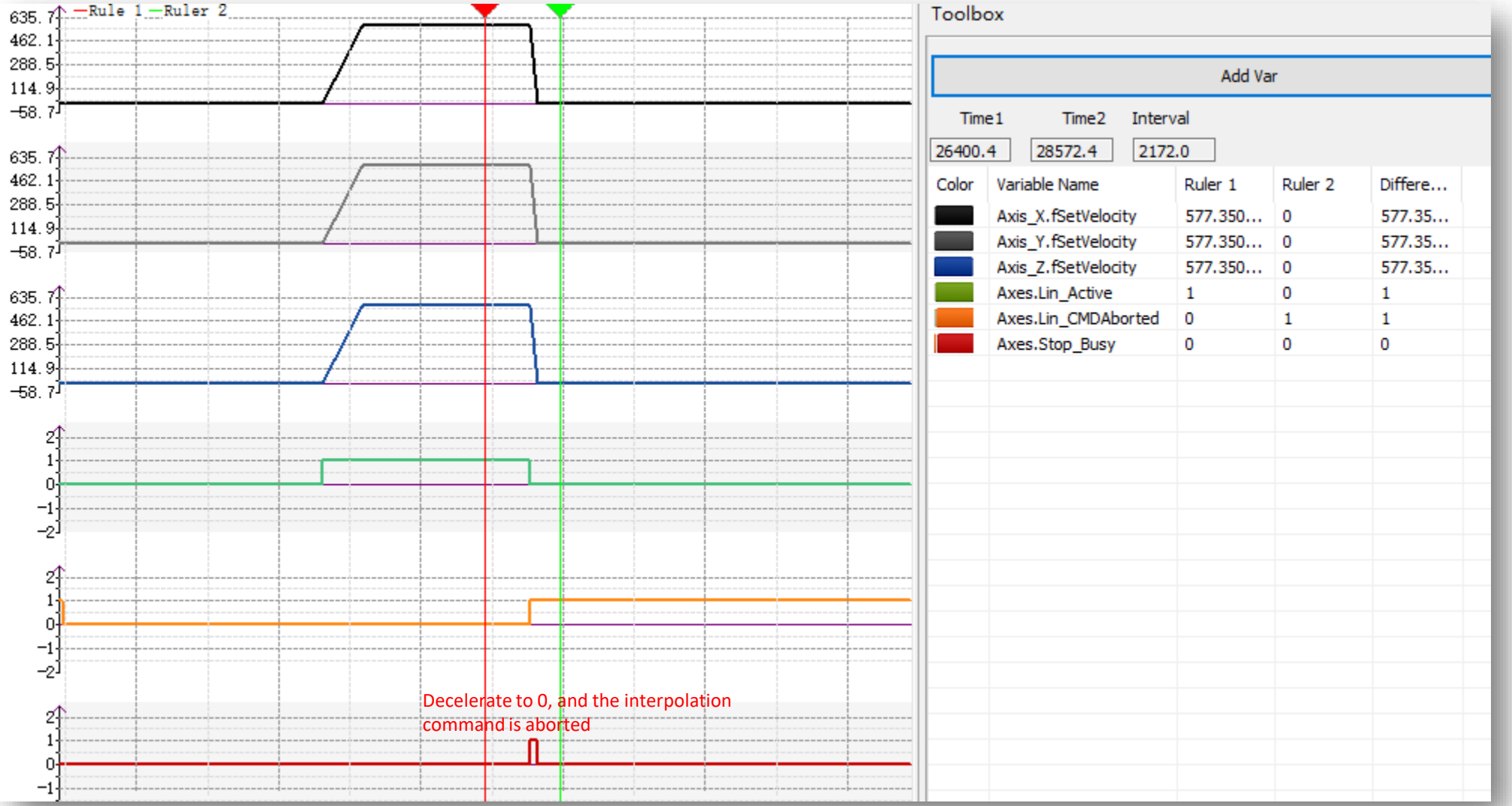
Parameters	Description
Group	Axes Group ID
StopMode	0: decelerate to stop 1: stop immediately
Deceleration	Deceleration

MC_GroupPause is used to stop the axes group motion.

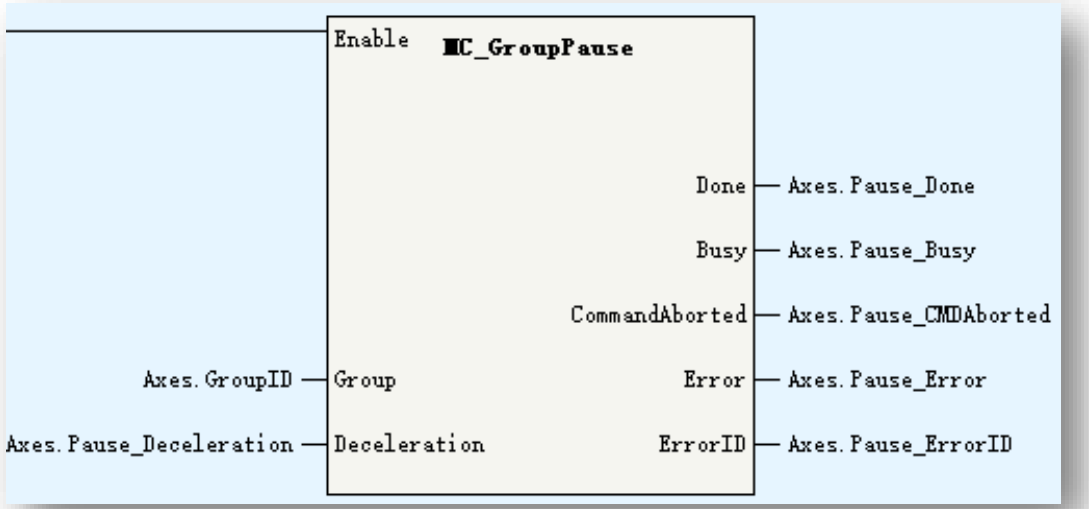
After executing this command, axes group will decelerate to stop or stop immediately. When the axes group stopped and <Execute> enabled, the <Done> signal will valid and the axes group will keep in sync motion status. When the <Execute> signal disabled, the axes group will get into standstill status, at this time, can re-execute new interpolation motion or single axis motion.

Take note:
MC_GroupStop only works for interpolation commands(MC_MoveLinear, MC_MoveCircular).
Support restart, the deceleration follow the latest command.
Don't support multi commands, if over 1 MC_GroupStop commands execute at the same time, the error 9441 will occur.

➢ MC_GroupStop



➢ MC_GroupPause

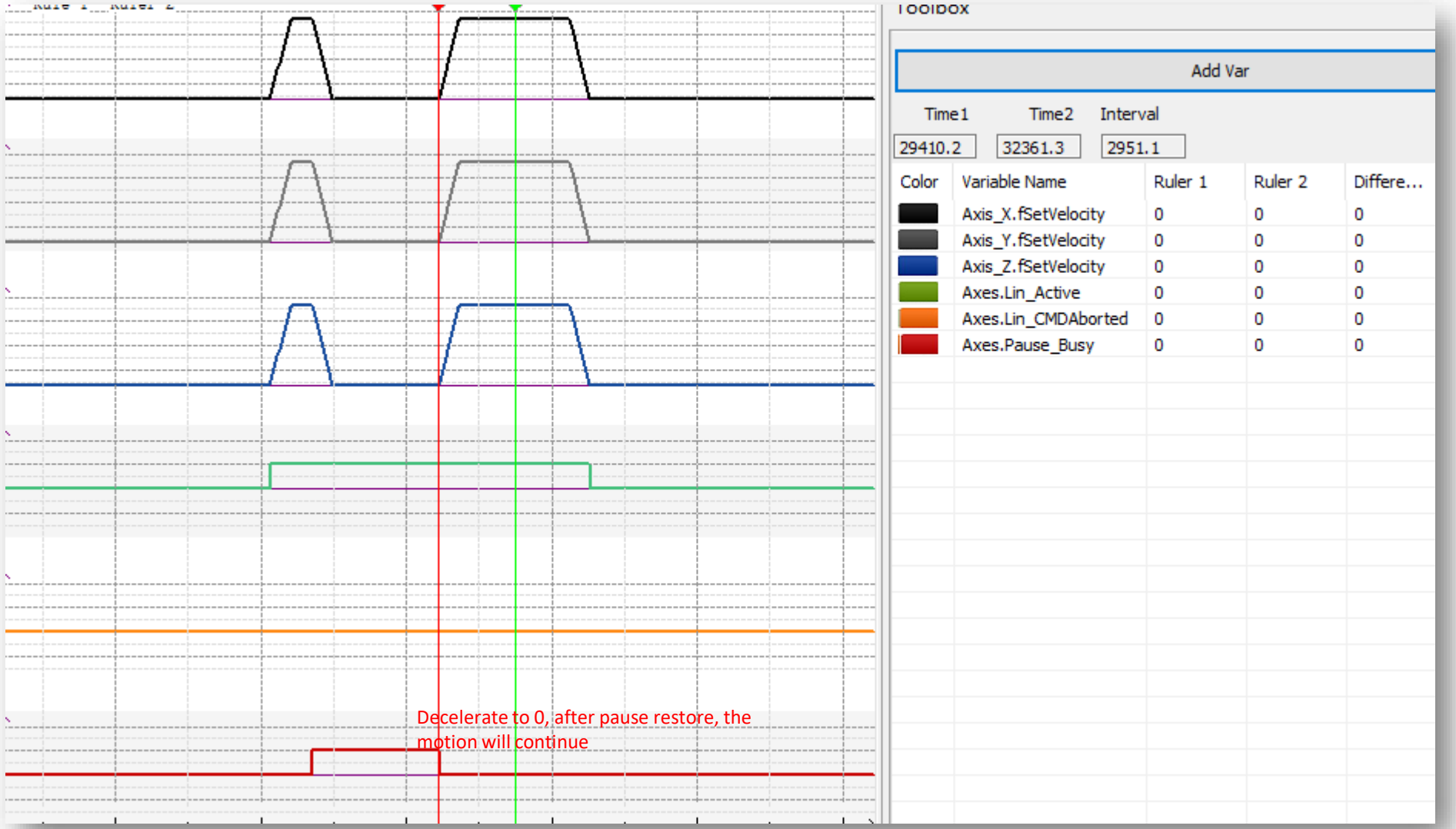


Parameters	Description
Group	Axes Group ID
Deceleration	Deceleration

MC_GroupPause is used to stop the axes group motion. Different from MC_GroupStop, this command will not change the motion state machine and will not stop the interpolation.
If the axes group in standstill status, after executing MC_GroupPause, axes group still in standstill, at this time if an interpolation FB execute, the interpolation will not execute immediately, but while disabled the MC_GroupPause FB, the interpolation motion will start.
If the axes group in sync motion status, after executing MC_GroupPause, axes group will decelerate to 0 speed and still be in sync motion status, while disabled the MC_GroupPause FB, the interpolation motion will continue.

Take note:
MC_GroupPause only works for interpolation commands(MC_MoveLinear, MC_MoveCircular).
Support restart and multi start, the deceleration follow the latest command.

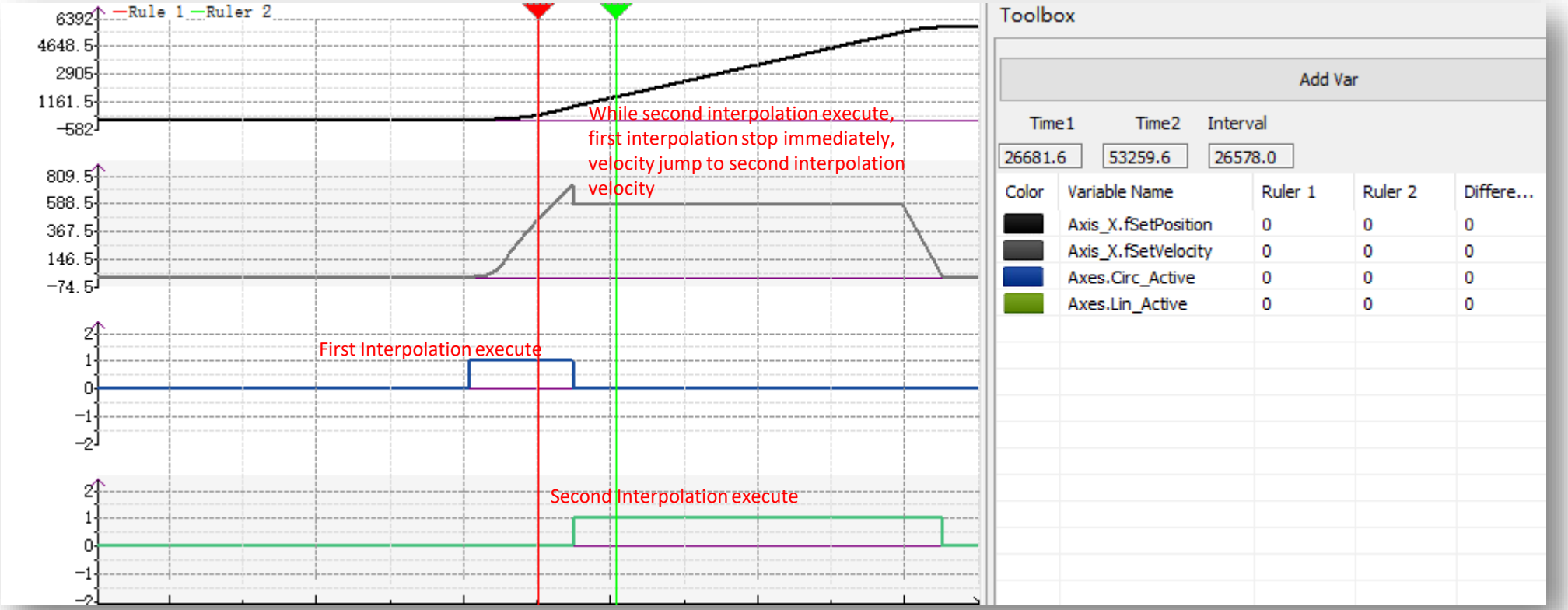
➢ MC_GroupPause



➢ BufferMode

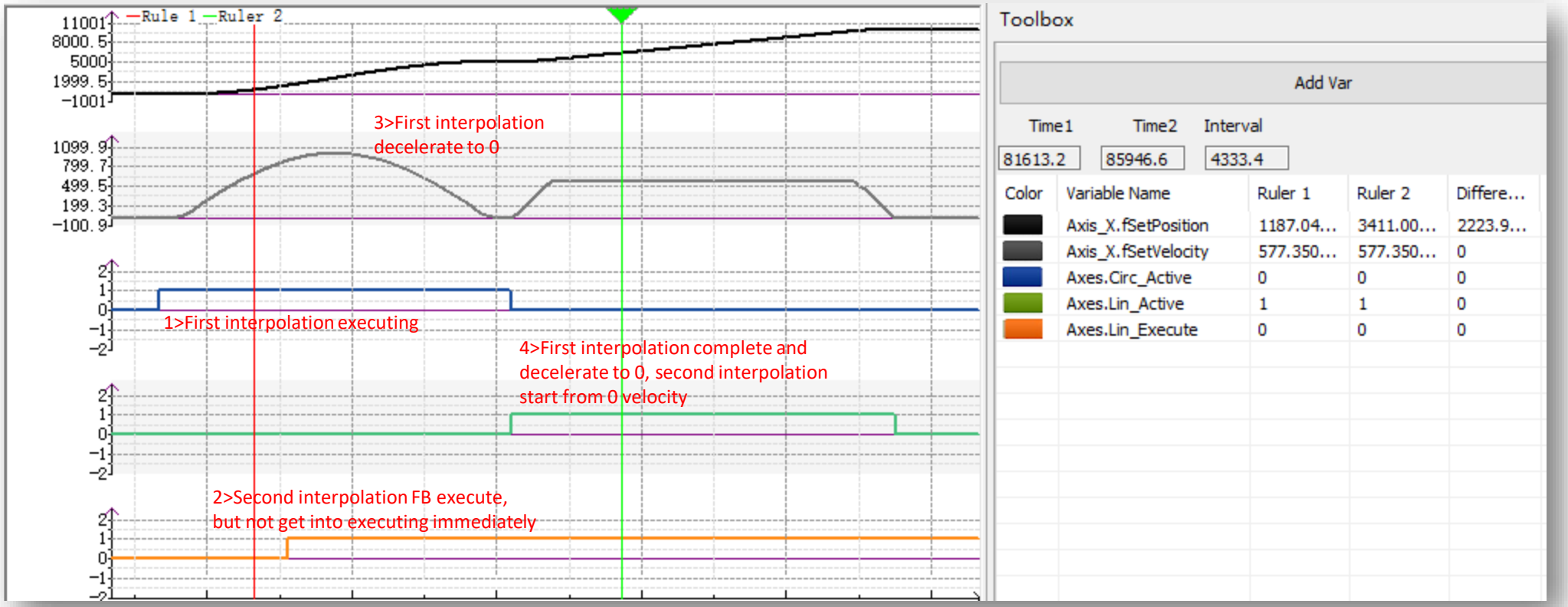
MC_MoveLinear/MC_MoveCircular support 4 buffer modes.
0: abort + no transition: change to another interpolation curve immediately, no transition
1: buffer + no transition: after current interpolation complete and decelerate to 0, execute the next interpolation curve, no transition
2: former velocity + no transition: interpolator will try to complete current interpolation with current velocity, and start the second interpolation with current velocity, no transition
3: additional angle transition, with transition curve: when current interpolation deceleration and next interpolation acceleration executing at the same time.

➢ BufferMode



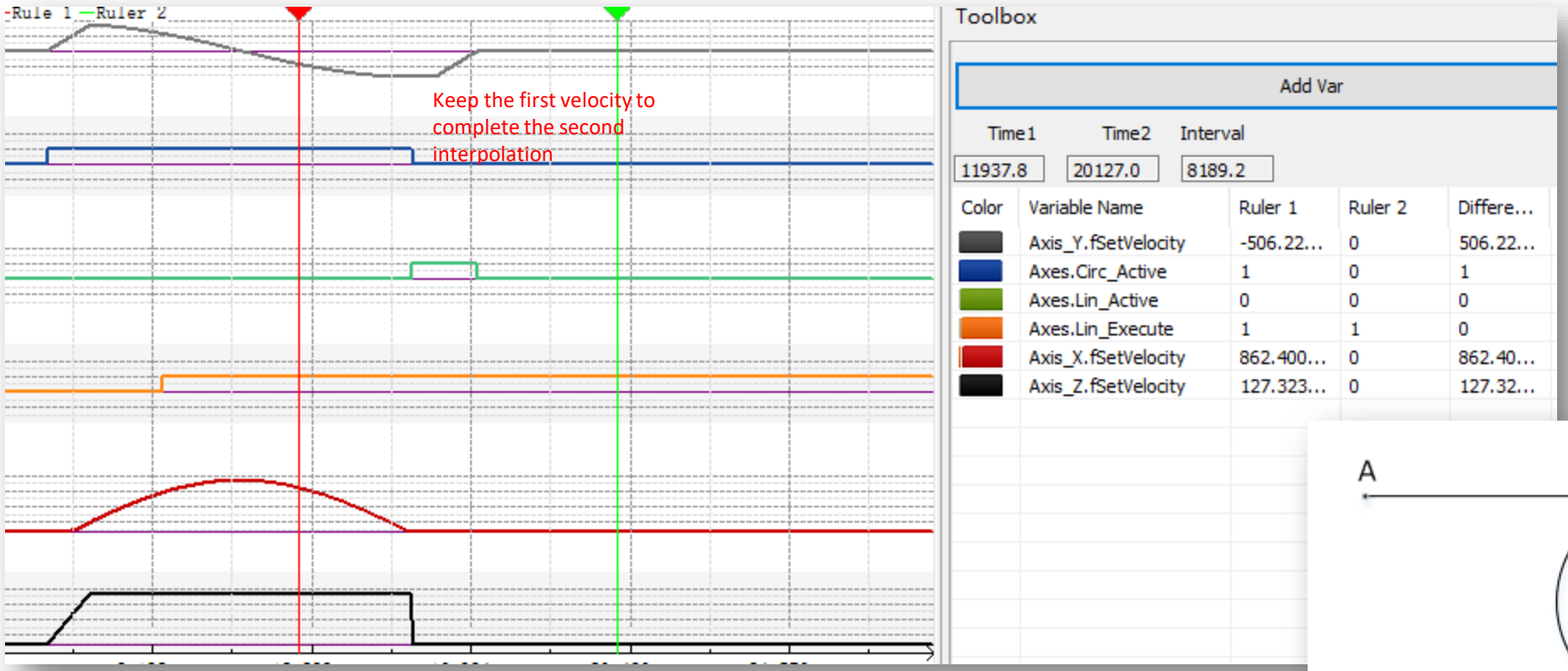
Buffer Mode = 0, **abort + no transition**

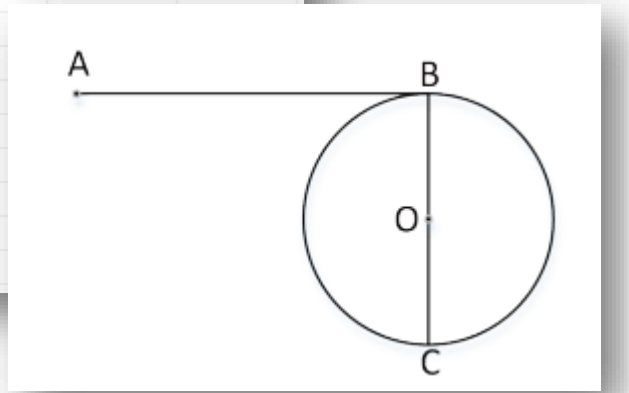
➢ BufferMode



Buffer Mode = 1, **buffer + no transition**

➢ BufferMode



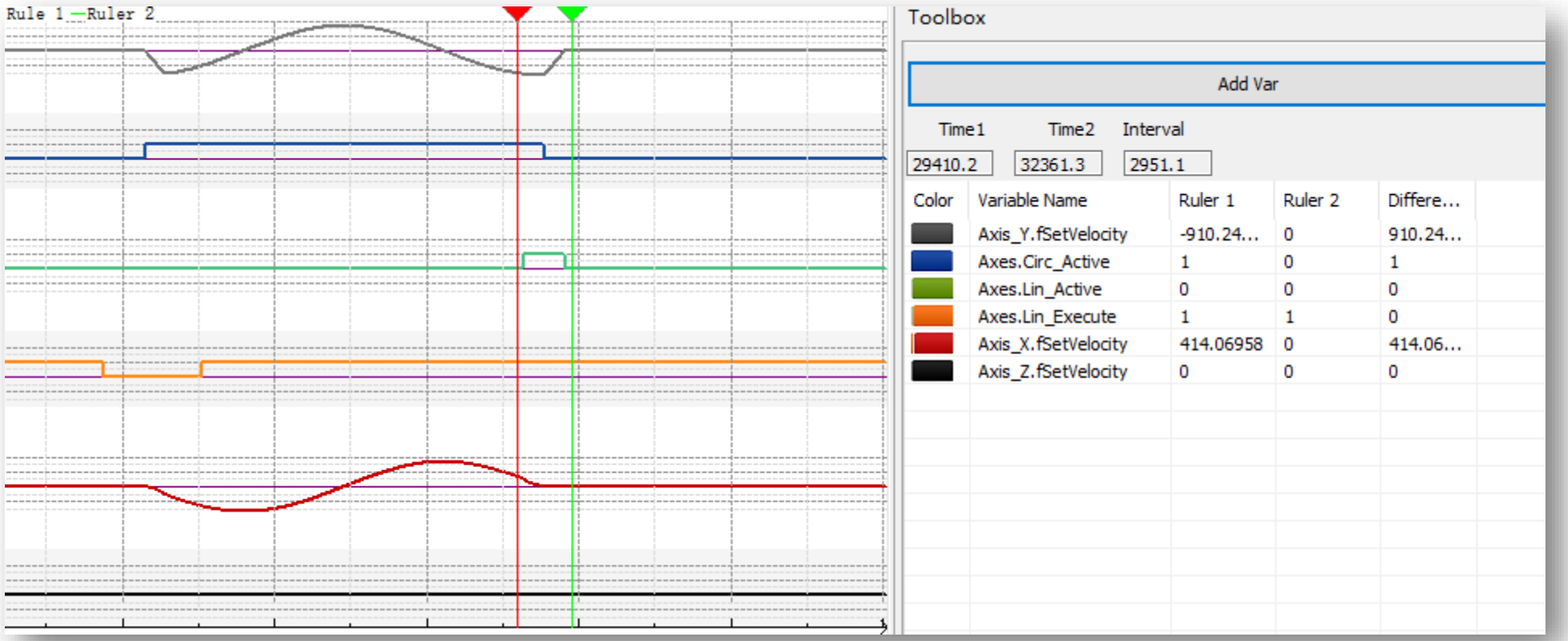


Buffer Mode =2, former velocity + no transition

Take note：

Buffer mode=2 will try to keep first interpolation velocity to execute second interpolation. But it not means the velocity is static. For example, if the first interpolation is circular motion, some axis end velocity is 0, and while execute the second interpolation, there could be a velocity jump. To make the velocity constant(or continuous), need consider the real motion situation.

➢ BufferMode



Buffer Mode =3, additional angle transition, with transition curve

Take note：

Buffer Mode =3. While interpolator detect that first interpolation start to decelerate, the second interpolation will start to execute. Each axis velocity equal to the summary of velocity components of first interpolation and second interpolation. The velocity curve will be continuous.

AxesGroup Reset

If axes group in error status, users can check the status of axis in group with single axis command(MC_ReadStatus), using axes group data structure or monitoring function in axes group configuration view, also need check the error code of the error reported function block. After confirm (and solved) the error, users can using MC_Reset FB to reset corresponding axis.

Take note:
Only when all axis in group in standstill status, the axes group will get into standstill status.

Single axis configuration in axes group

Single axis setting	In axes group
Gear ratio	Follow the single axis <unit conversion setting>
Encoder mode	Follow the single axis encoder mode(absolute or incremental)
Mode setting	Axes group only support linear mode, so need set the mode as linear mode in single axis configuration
Limit	Axis in group support the limit setting in single axis configuration
Following error threshold	Axis in group support the following error setting
Velocity limit	Axis in group limited by the velocity limit setting in single axis configuration, but the maximum acceleration will not follow single axis configuration
Torque limit	None

Motion Control(CANopen)

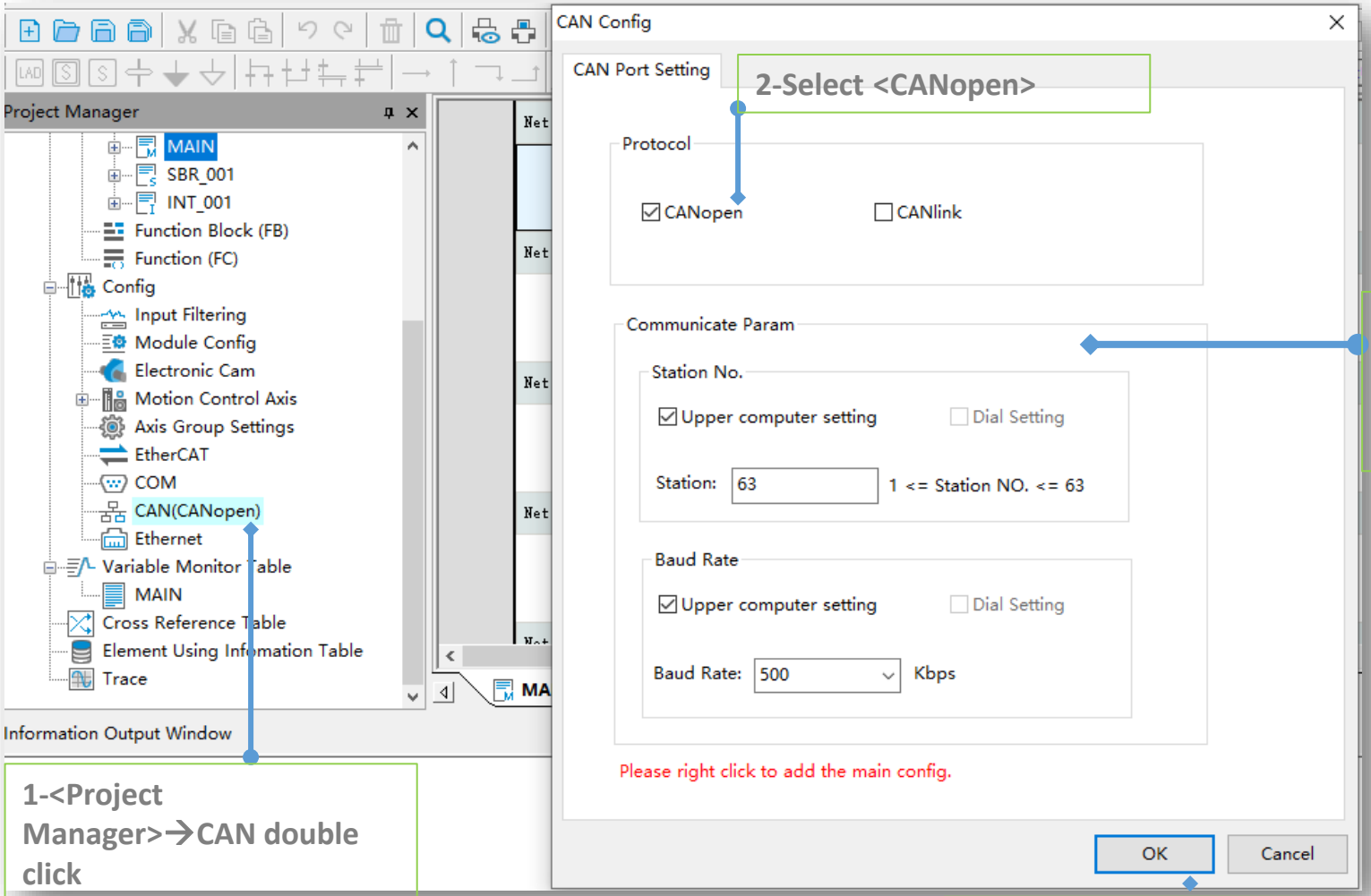
INOVANCE

Back to Contents

CANopen Motion Control	Function
MC_Power_CO	Axis enable control
MC_Reset_CO	Axis error reset
MC_ReadActualVelocity_CO	Read axis velocity
MC_ReadActualPosition_CO	Read axis position
MC_Halt_CO	Stop axis
MC_Stop_CO	Emergency stop axis
MC_MoveVelocity_CO	Axis move in velocity
MC_MoveRelative_CO	Axis move relatively
MC_MoveAbsolute_CO	Axis move absolutely
MC_Home_CO	Axis homing
MC_Jog_CO	Axis jog
MC_WriteParameter_CO	Write parameter
MC_ReadParameter_CO	Read parameter

CANopen motion commands is used to control inovance CANopen servo, which support up to 16 axes.

➢ CANopen Configuration



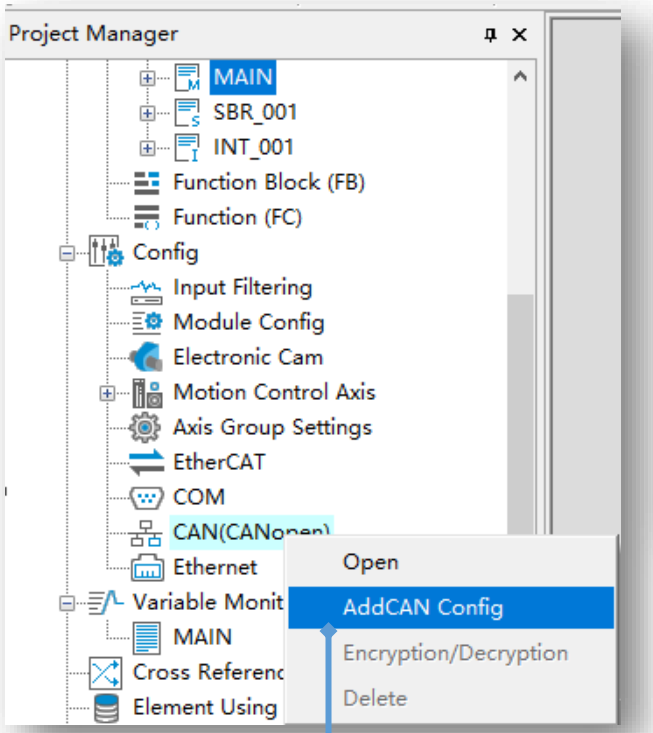
1-<Project Manager>→CAN double click

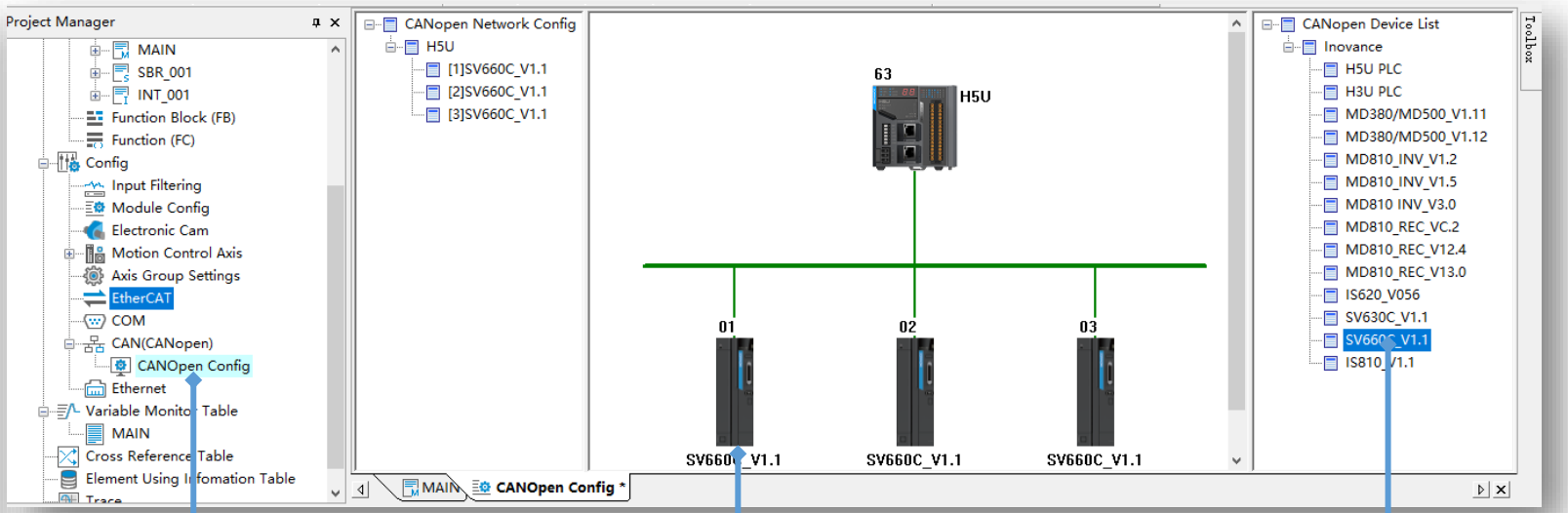
2-Select <CANopen>

3-Communication Parameter using default:
Station No. 63
Baud rate 500 kbps

4-Click <OK>

➢ CANopen Configuration





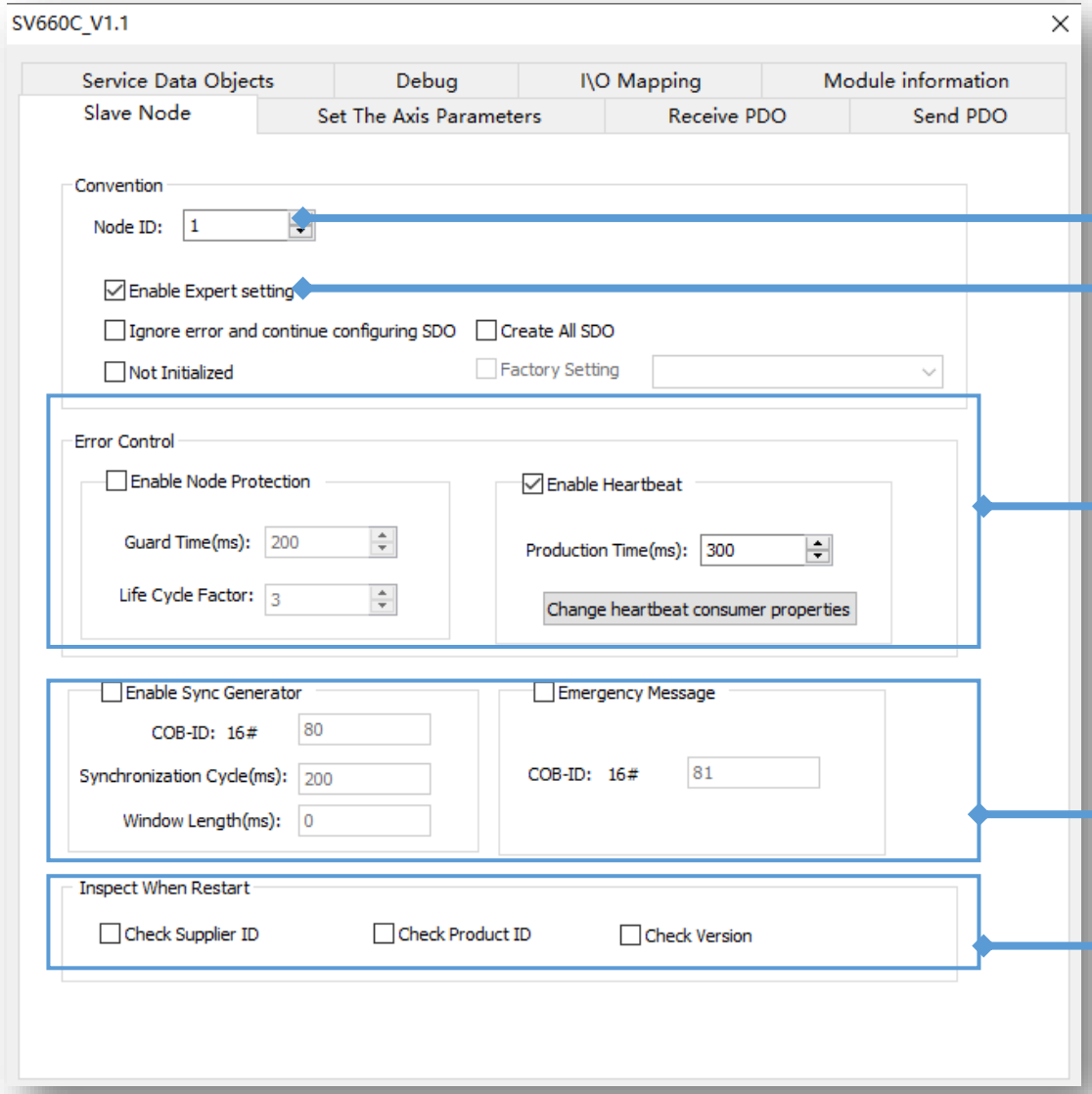
6-Click <CANopen Config> to open the configuration view

5-<Project Manager>→CAN Right click to add CAN configuration

8-Click the device to get into device configuration view(next slide)

7-Click from the device list to add the device

CANopen Configuration



Node ID will automatically generated, the range is 1~63

Check the <Enable Expert setting> to enable CANopen communication setting, normally use the default set.

Error Control:
Node protection and heart beat cannot selected at the same time. Recommend to use node protection. The difference is node protection is sent-receive confirmation mechanism, the heart beat only sent heart beat frame periodically but slave no reply.

Error Control:
Enable sync production and emergency frame.

Restart parameters.

➢ CANopen Configuration

SV660C_V1.1

Slave Node | Set The Axis Parameters | Receive PDO | Send PDO

Service Data Objects | Debug | I\O Mapping | Module information

Number	Index	Subindex	Name	Value	Bit Length	Download
1	16#1000	16#00	Device type	0x00020192	32	*
2	16#1018	16#01	Vendor ID	0x000003B9	32	
3	16#1018	16#02	Product code	0x000D010C	32	
4	16#1018	16#03	Revision number	0x00020001	32	
5	16#1400	16#01	Disable PDO	0x80000201	32	*
6	16#1401	16#01	Disable PDO	0x80000301	32	*
7	16#1402	16#01	Disable PDO	0x80000401	32	*
8	16#1403	16#01	Disable PDO	0x80000501	32	*
9	16#1600	16#00	Clear PDO mapping	0x00	8	*
10	16#1601	16#00	Clear PDO mapping	0x00	8	*
11	16#1602	16#00	Clear PDO mapping	0x00	8	*
12	16#1603	16#00	Clear PDO mapping	0x00	8	*
13	16#1800	16#01	Disable PDO	0xC0000181	32	*
14	16#1801	16#01	Disable PDO	0xC0000281	32	*
15	16#1802	16#01	Disable PDO	0xC0000381	32	*
16	16#1803	16#01	Disable PDO	0xC0000481	32	*
17	16#1A00	16#00	Clear PDO mapping	0x00	8	*
18	16#1A01	16#00	Clear PDO mapping	0x00	8	*
19	16#1A02	16#00	Clear PDO mapping	0x00	8	*
20	16#1A03	16#00	Clear PDO mapping	0x00	8	*
21	16#1400	16#02	Set transmission type	0x01	8	*
22	16#1401	16#02	Set transmission type	0x01	8	*
23	16#1600	16#01	1st receive PDO mapping	0x60400010	32	*
24	16#1600	16#02	1st receive PDO mapping	0x60FF0020	32	*
25	16#1600	16#03	1st receive PDO mapping	0x60600008	32	*
26	16#1601	16#01	2nd receive PDO mapping	0x607A0020	32	*
27	16#1601	16#02	2nd receive PDO mapping	0x60810020	32	*

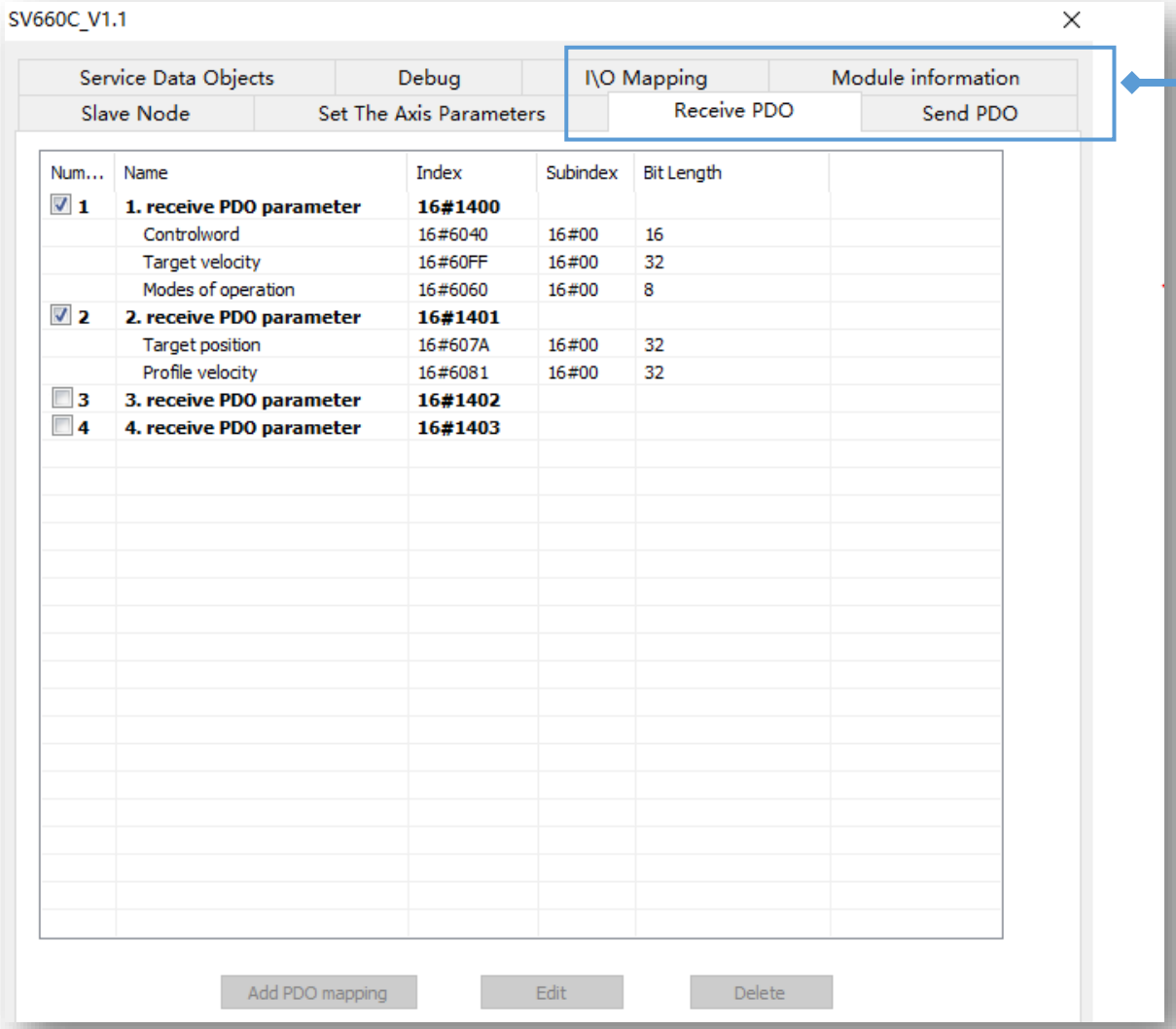
SDO Timeout: 500 ms

SDO Edit

Add | Edit | Delete

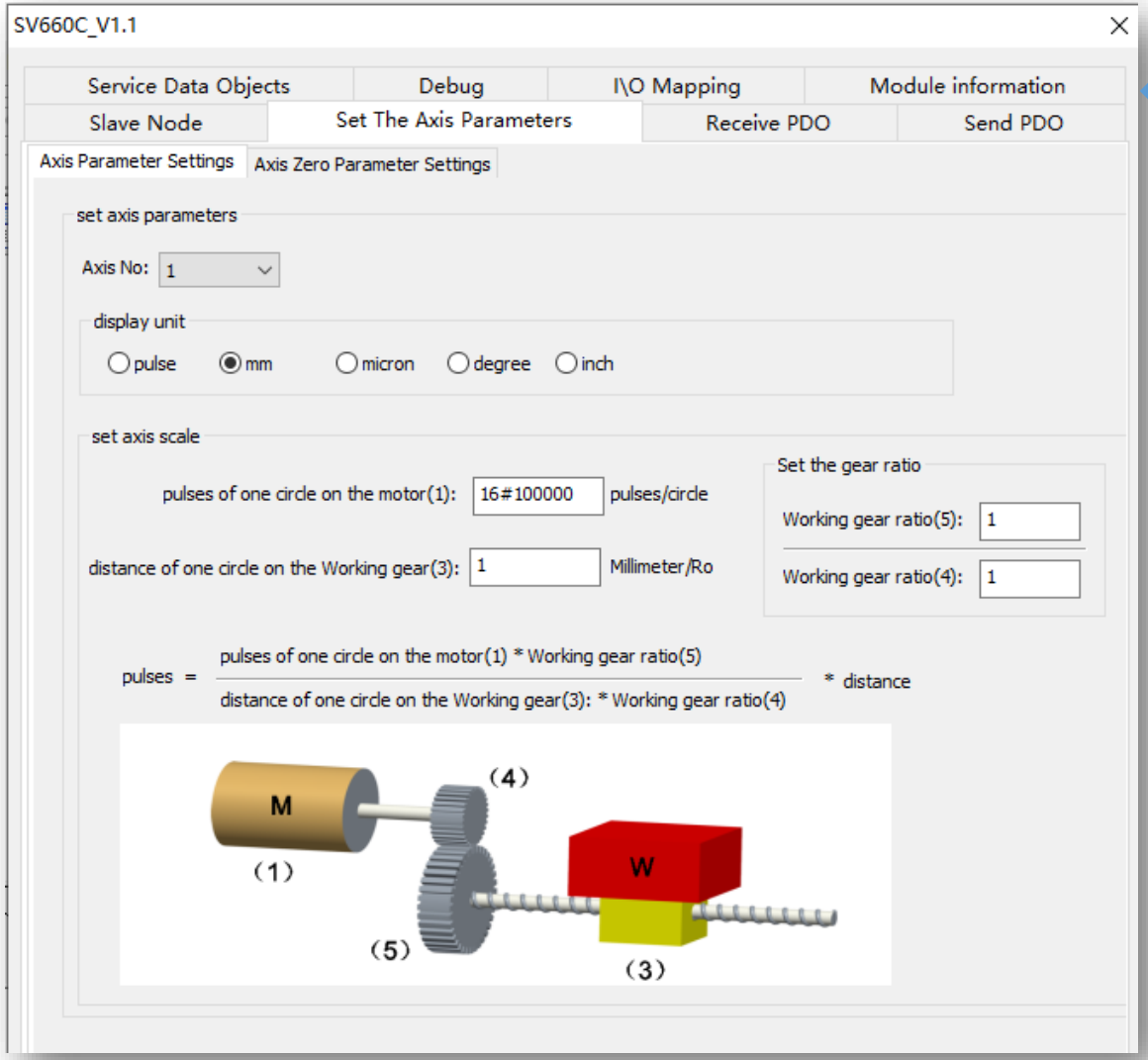
When select <Enable expert setting> in <Slave Node>, users can manually add SDO in this page. All SDO will update in CANopen field bus start process(pre-operational status).

➢ CANopen Configuration



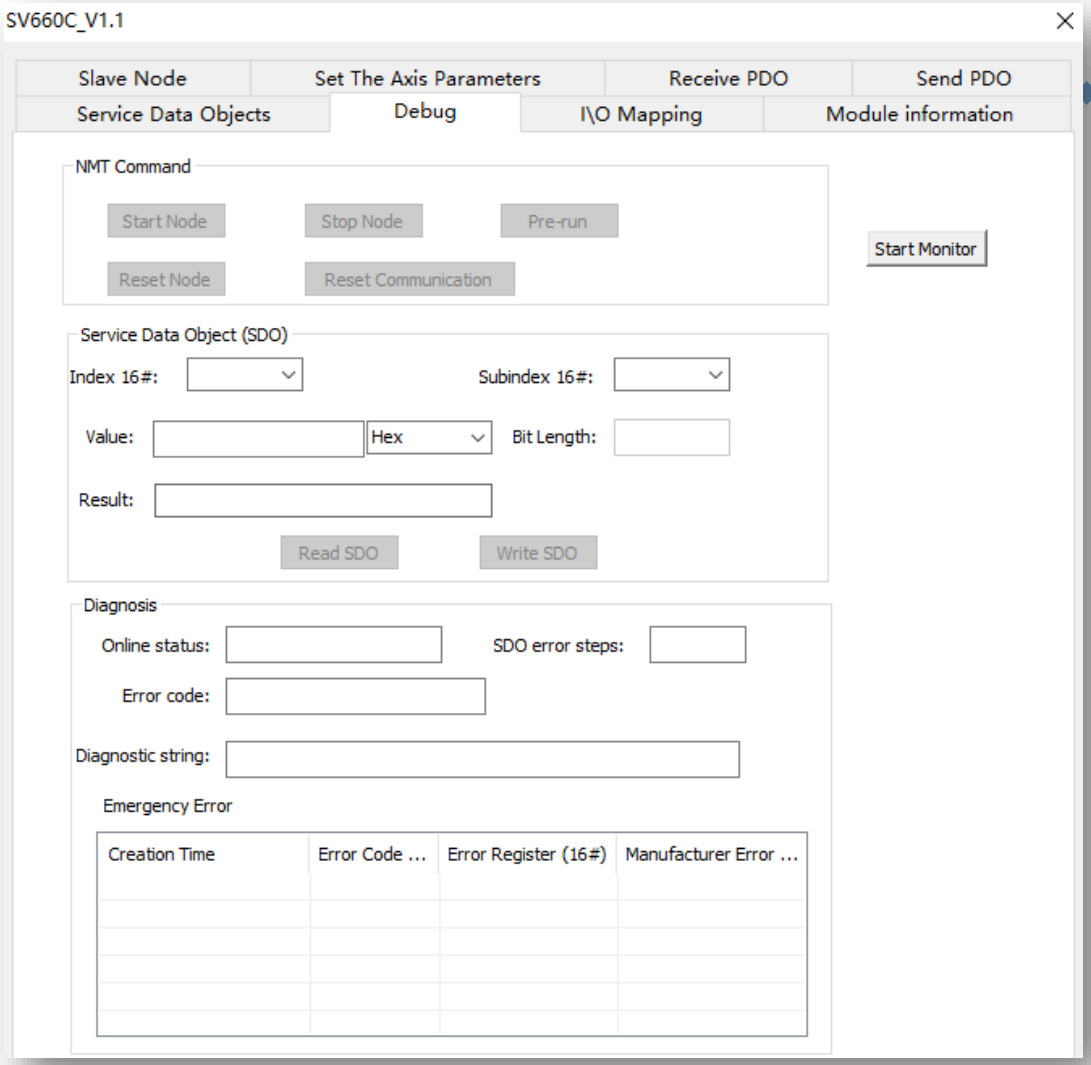
<Receive PDO>, <Send PDO> using default setting.
if need add PDO just select the corresponding PDO and click <Add PDO mapping>. Be noted each PDO support up to 8 byte data.
<I/O mapping> will generated automatically, also support manually configuration, users can modify according to real demands.

➢ CANopen Configuration



<Set the axis parameters> used to set the gear ratio and conversion ratio between user unit and encoder unit.

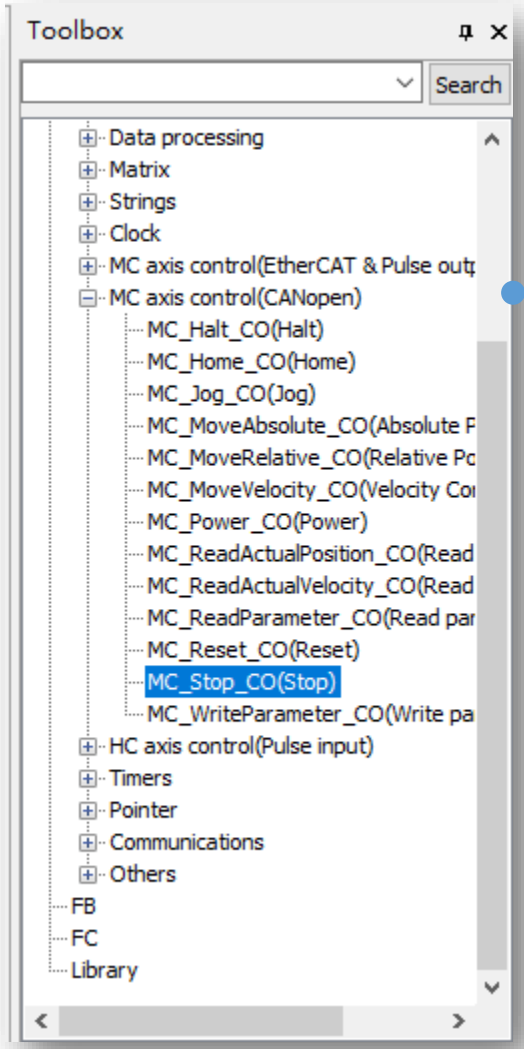
CANopen Configuration



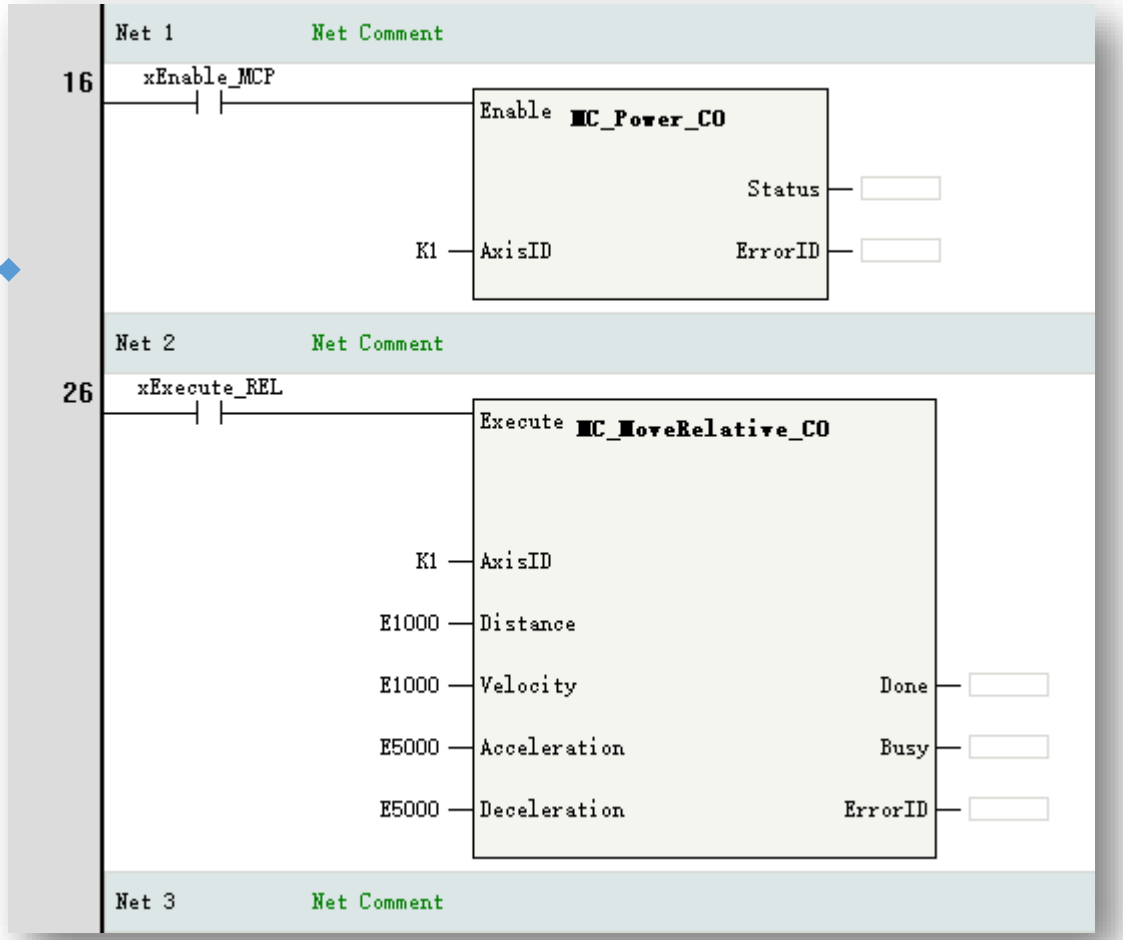
<Debug> is used to monitoring CANopen bus status and support SDO reading.

Take note:
H5U share same CANopen configuration with H3U, for more details of CANopen configuration, users can refer to H3U manual.

Motion Control Function Block



Select the CANopen motion FBs from toolbox to LD diagram.



High Speed Input

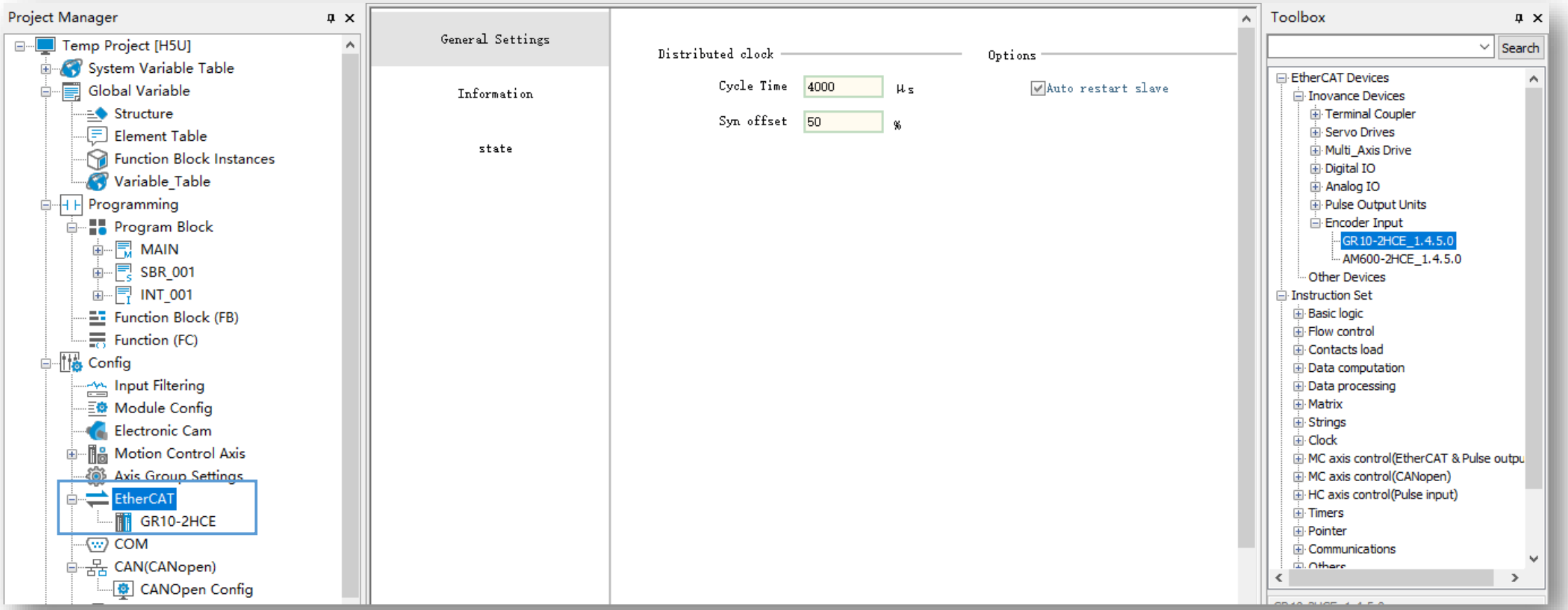
INOVANCE

Back to Contents

Field bus encoder	Function
ENC_Counter	Encoder enable
ENC_Reset	Encoder reset
ENC_Preset	Encode value preset
ENC_TouchProbe	Encoder touch probe
ENC_ArrayCompare	Encoder array comparison
ENC_StepCompare	Encoder step(certain distance) comparison
ENC_GroupArrayCompare	Encoder array comparison(2 dimension array)
ENC_ReadStatus	Read encoder status
ENC_DigitalOutput	Encoder digital output control
ENC_ResetCompare	Encoder reset comparison output

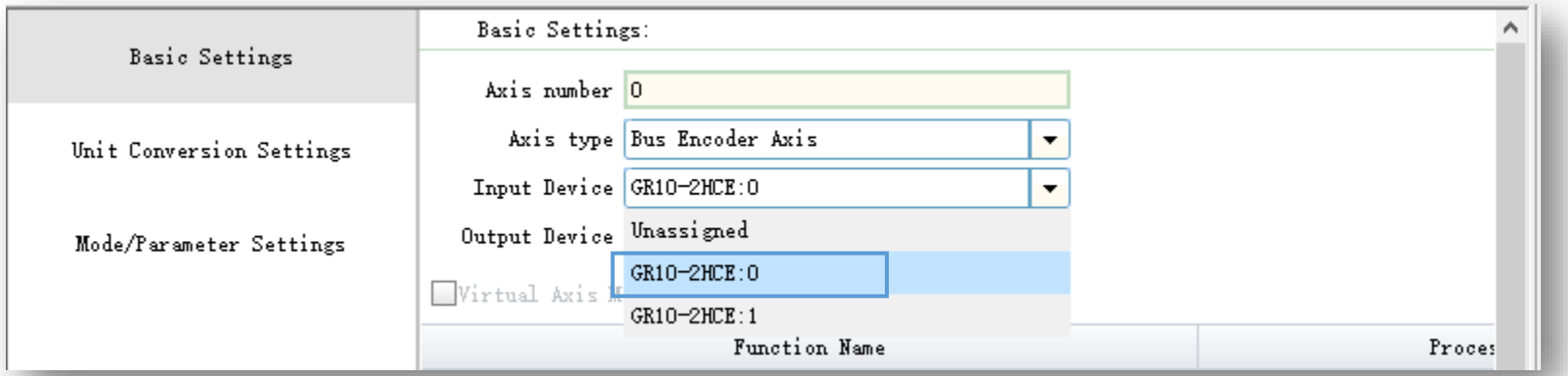
HS counter	Function
HC_Counter	Enable high speed counter
HC_Preset	HS counter value preset
HC_TouchProbe	HS counter touch probe
HC_Compare	HS counter comparison
HC_ArrayCompare	HS counter array comparison
HC_SetCompare	HS counter step(certain distance) comparison

Add encoder axis

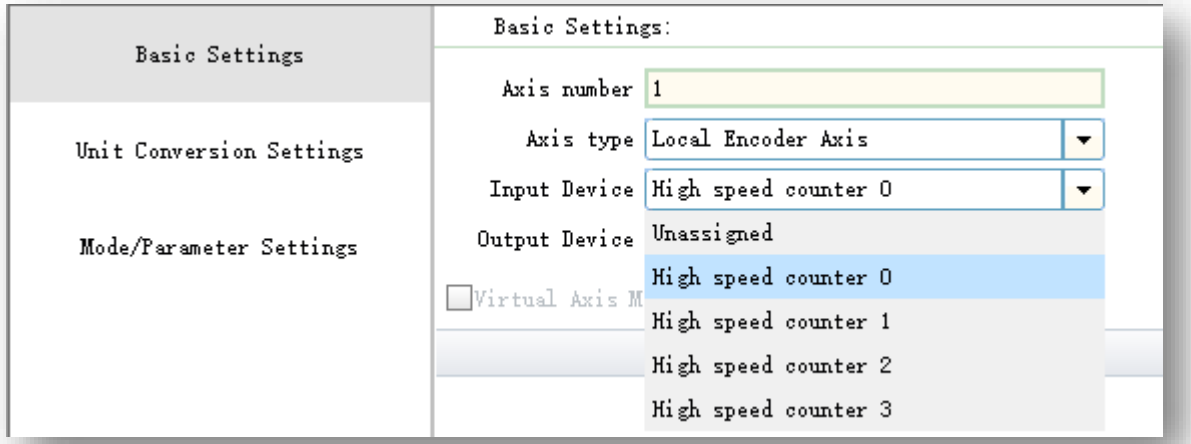


1> Open <Config>→<EtherCAT>, select GR10-2HCE model to add to EtherCAT device list.

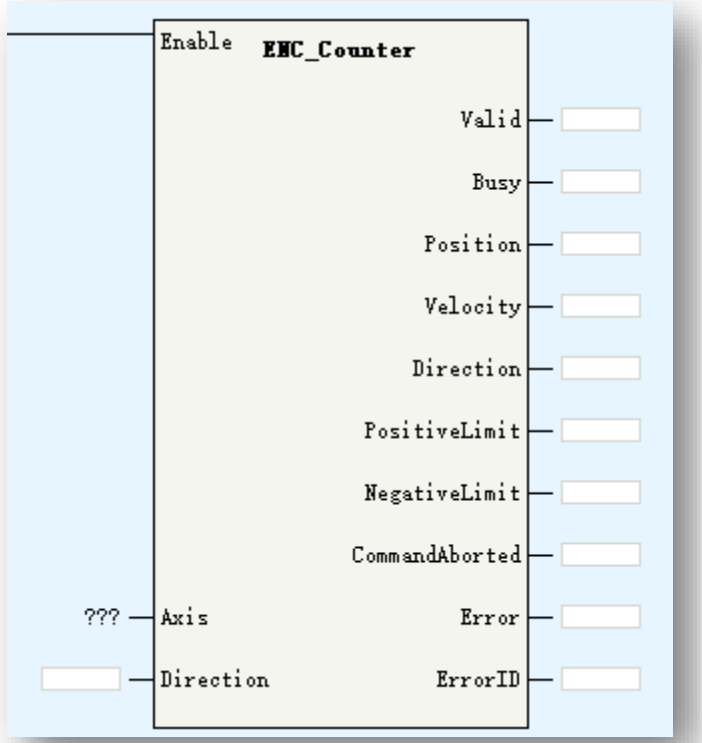
Add encoder axis



2> add a motion control axis, select <Bus Encoder Axis> and assign the <Input Device>, then the bus encoder axis can be used in program.
For local encoder axis, select <Local Encoder Axis> assign the <Input Device>, H5U support up to 4 built in local counter.
For more motion axis configuration, please refer to [Motion Control Axis Configuration]



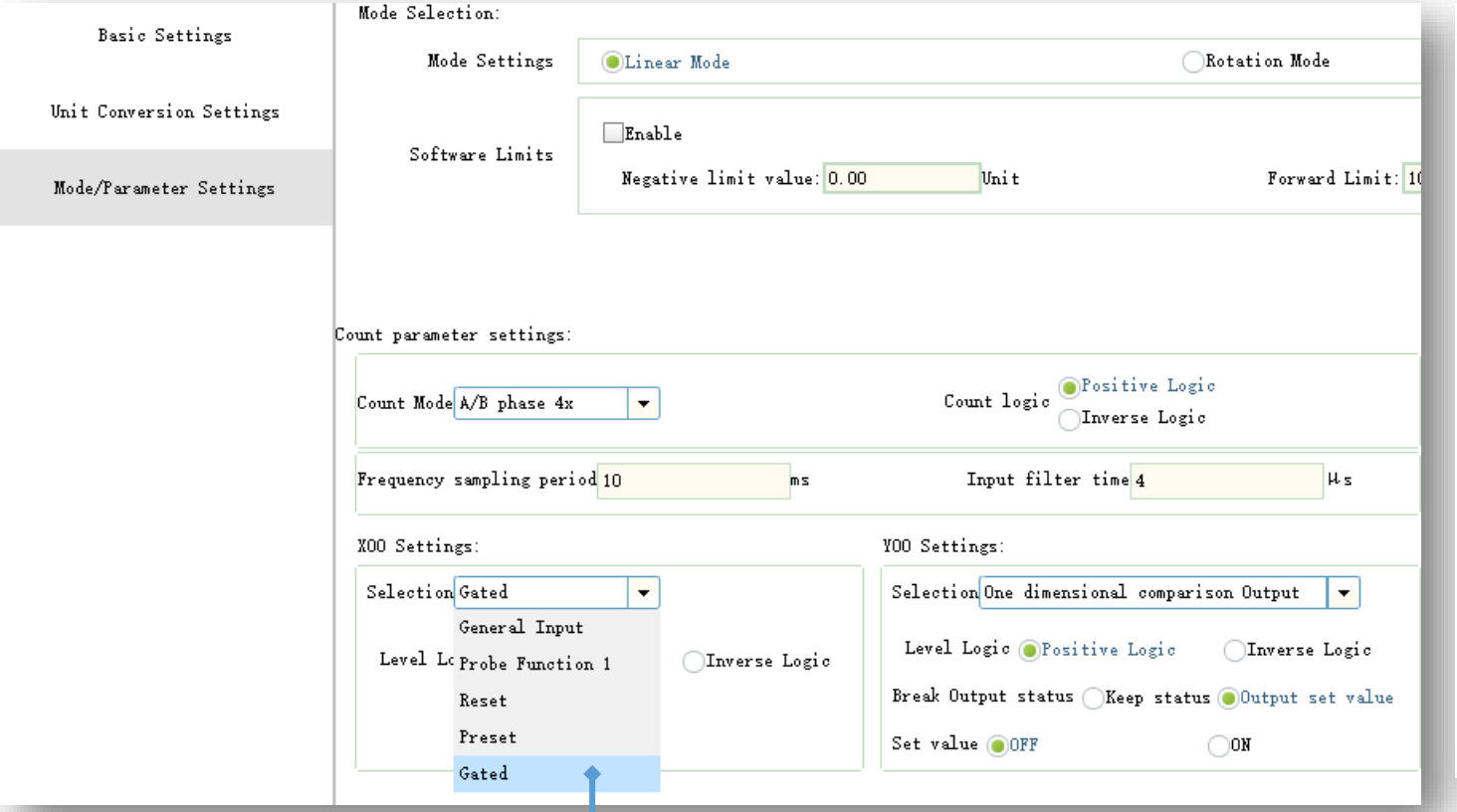
➢ ENC_Counter

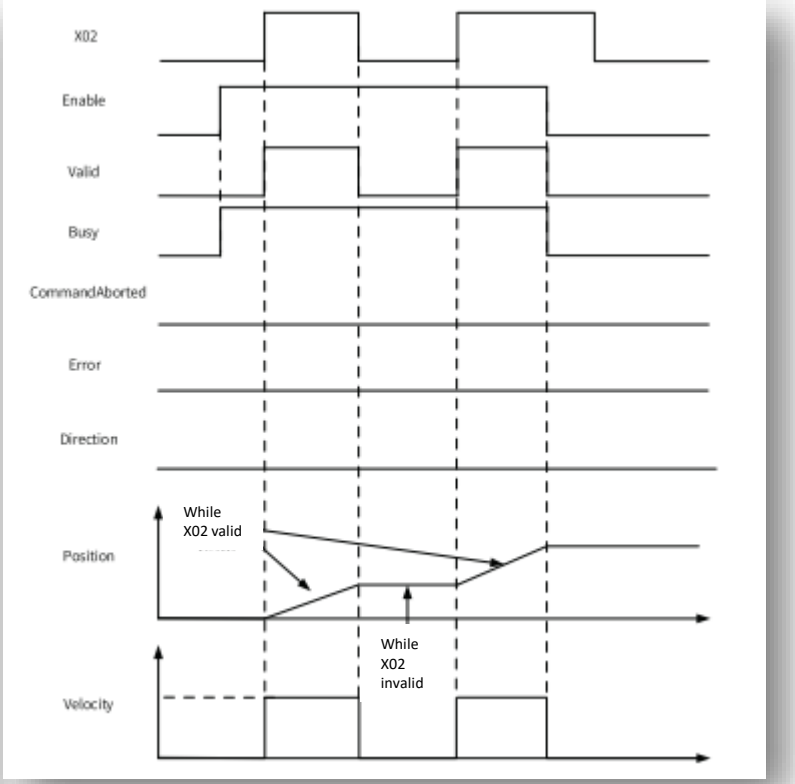


Parameters	Description
Axis	Encoder Axis name (bus encoder axis)
Direction	reserved
Valid	Encoder input valid
Position	Current position
Velocity	Current velocity
Direction	Current direction
PositiveLimit	Positive limit valid in linear mode
NegativeLimit	Negative limit valid in linear mode

ENC_Counter is used to enable the bus encoder axis.
When <Enable> is ON, <Busy> will be valid, when counter start to count, <Valid> will turn ON. The <Position>/<Velocity>/<Direction> will display current counter specifications.
While axis works in linear mode and counter up to positive or negative limit, <PositiveLimit> and <NegativeLimit> will be valid and counter stop counting.

➢ ENC_Counter

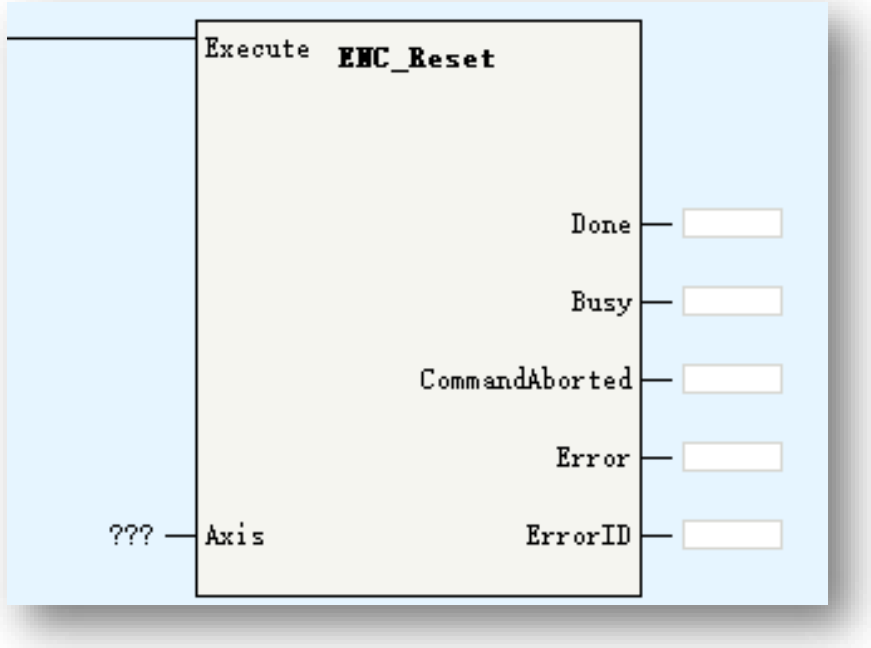




*X02(2HCE model) selected as <Gated> input for bus encoder counter

If select <Gated> in digital input setting, the corresponding input signal will control the encoder count, and the <Valid> will be ON when the gated signal valid(encoder counting), <Valid> will be OFF when the gated signal invalid(encoder not counting

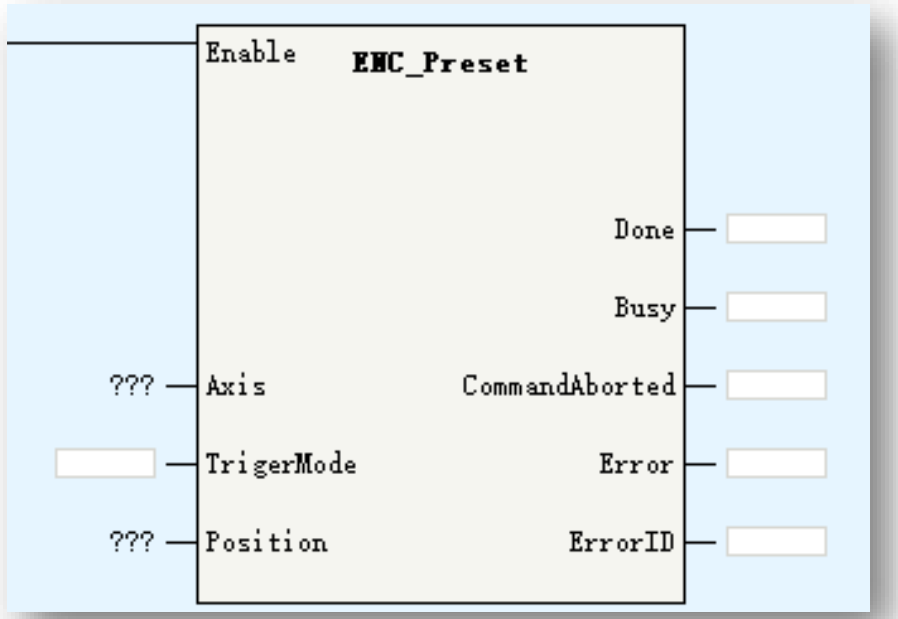
ENC_Reset



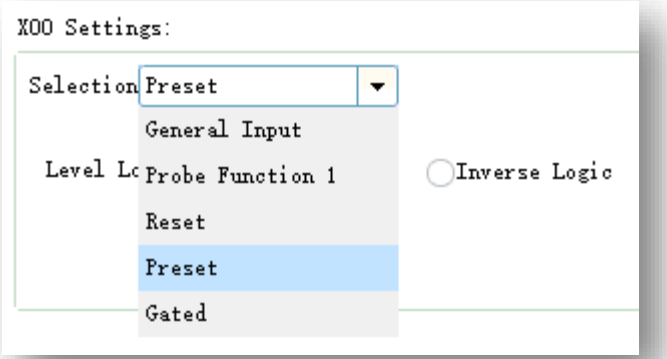
Parameters	Description
Axis	Encoder Axis name (bus encoder axis)

ENC_Reset is used to reset bus encoder axis when axis is in error.

➢ ENC_Preset



Parameters	Description
Axis	Encoder Axis name (bus encoder axis)
TriggerMode	0: trigger in command rising edge 1: digital input rising edge 4: Z signal
Position	Preset position

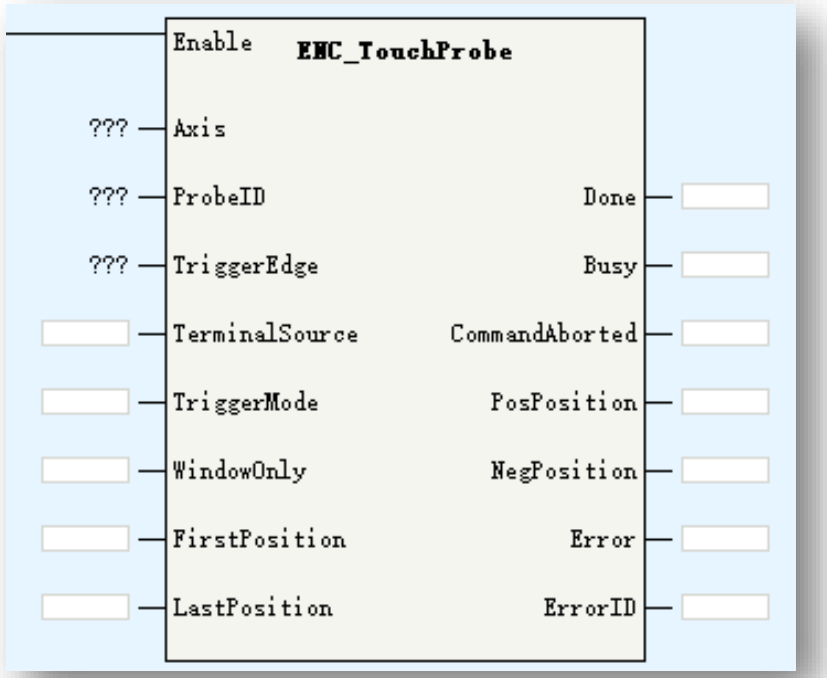


*Select DI as <Preset> functionality in axis configuration view.

ENC_Preset is used to set bus encoder current position as <Position>(input parameter).

While <TriggerMode>=0, position set when FB enabled;
While <TriggerMode>=1, position set when digital input(of remote encoder model) signal triggered;
While <TriggerMode>=4, position set when detected Z signal(of remote encoder model).

➢ ENC_TouchProbe

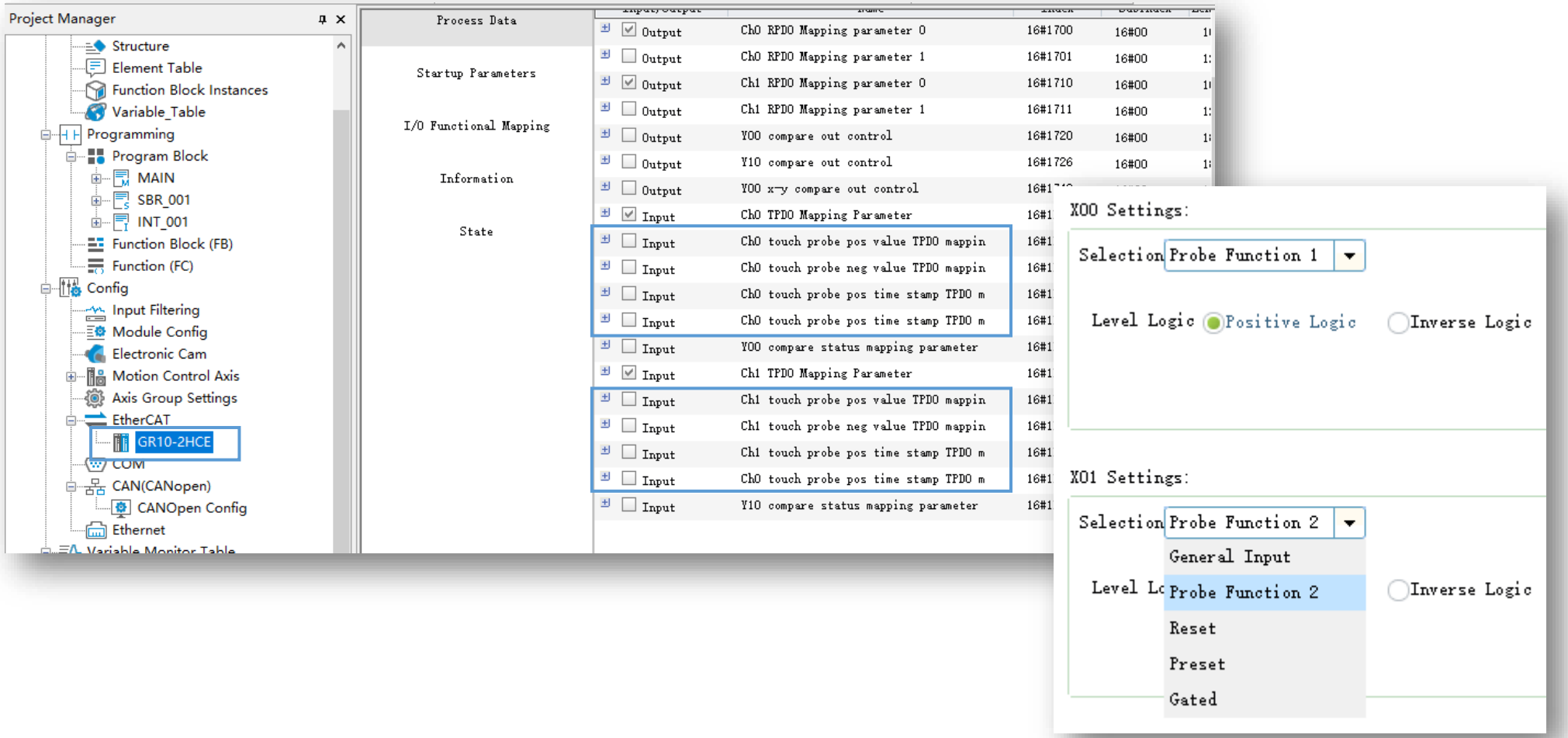


Parameters	Description
Axis	Encoder Axis name (bus encoder axis)
ProbeID	0: TP1 1:TP2
TriggerEdge	0: rising edge 1:falling edge 2:both of rising and falling edge
TerminalSource	TP trigger source: 0:DI 1:encoder Z signal
TriggerMode	0: single 1: continuous
WindowOnly	0: disabled window function, detect TP signal in any position 1: enable window function, detect TP signal in <FirstPosition, LastPosition> range
FirstPosition	TP window start position
LastPosition	TP window last position
PosPosition	Positive(rising edge) latch value
NegPosition	Negative(falling edge) latch value

ENC_TouchProbe is used to read the locked position value of external encoder while signal triggered without software delay, which means the latch position will not impacted by EtherCAT cycle and data transmission time.

➢ ENC_TouchProbe

To using touch probe function, need select corresponding PDO in EtherCAT slave configuration(GL10-2HCE) and set the DI as touch probe input in axis configuration view.

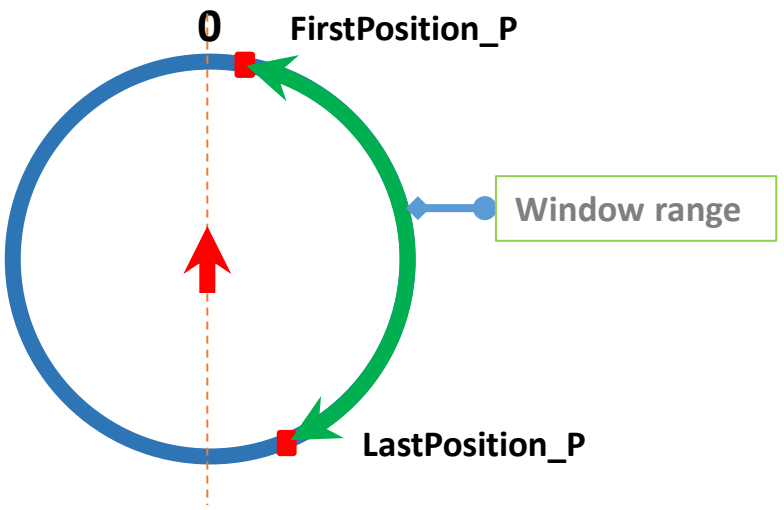


➢ ENC_TouchProbe

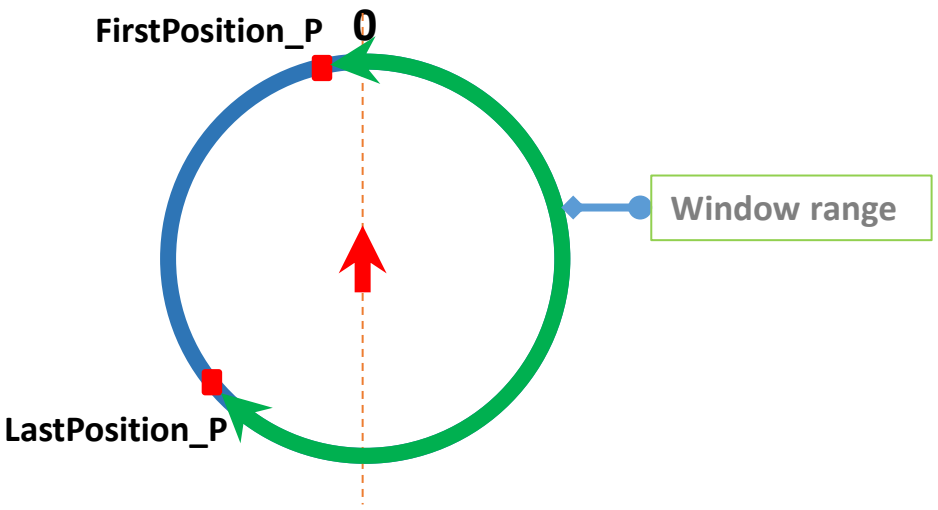
While <Enable>=ON(rising edge), FB will lock the input parameters.

If <WindowOnly>=OFF, the window detection function will not work, the touch probe in full position range.

If <WindowOnly>=ON, the window detection function will be enabled, in this case:
While axis is in linear mode, only when the touch probe triggered in <FirstPosition> and <LastPosition> range, the position value will be latched.
While axis is in rotation mode, firstly do modulo operation to the <FirstPosition> and <LastPosition> based on the rotation cycle. For example, if <FirstPosition> is set as 540, the rotation cycle is 360, then the <540 Mod 360> = 180. After modulo operation, we get the modulo value FirstPosition_P and LastPosition_P.

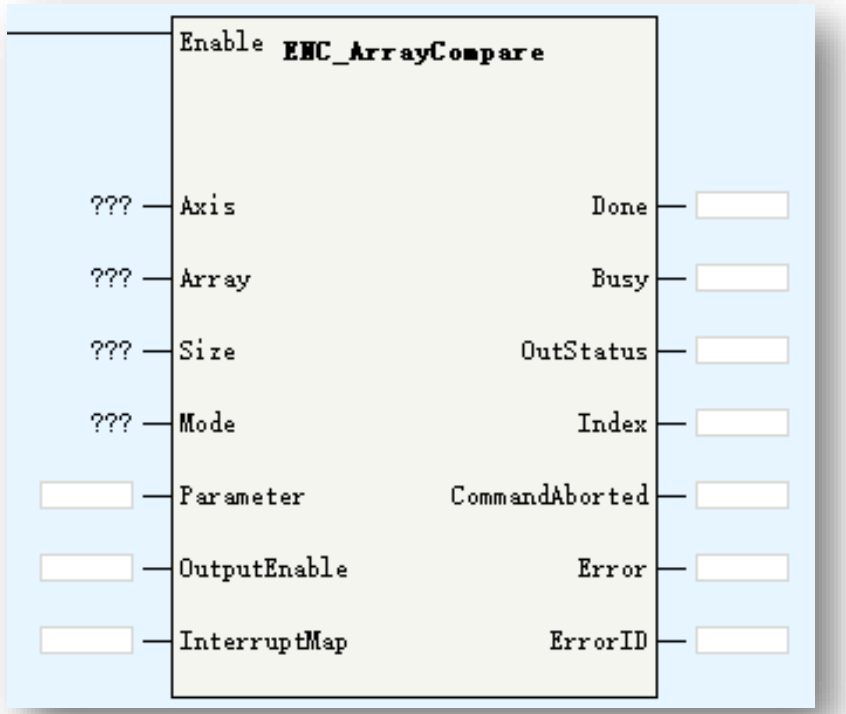


*While FirstPosition_P < LastPosition_P



*While FirstPosition_P > LastPosition_P

➢ ENC_ArrayCompare



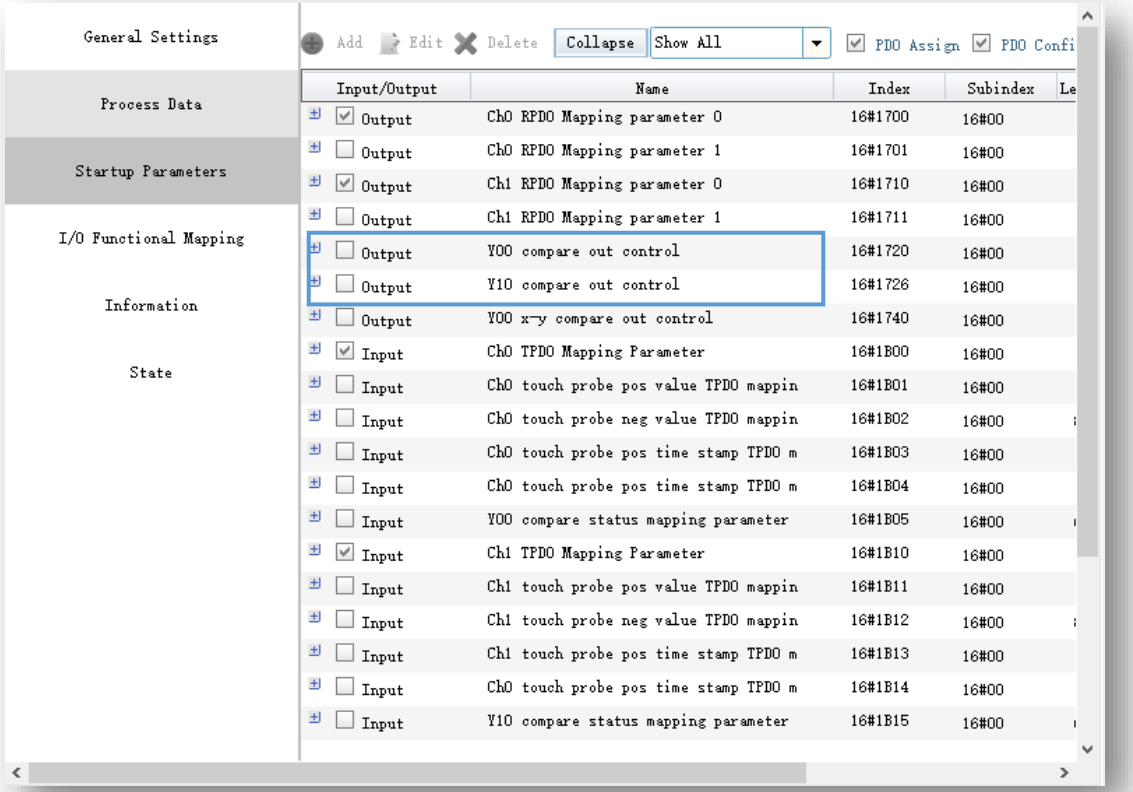
Parameters	Description
Axis	Encoder Axis name (bus encoder axis)
Array	Comparison array
Size	Comparison value quantities
Mode	0: reserved 1: time 2: pulse 3: electrical level
Parameter	Time mode: output valid time, unit: us Pulse mode: output pulse quantities Electrical level mode: original voltage level, 0 is low voltage, 1 is high voltage, every time up to comparison point, the output status will revert
OutputEnable	Reserved
InterruptMap	Reserved
OutStatus	Output signal status
Index	The upcoming comparison index

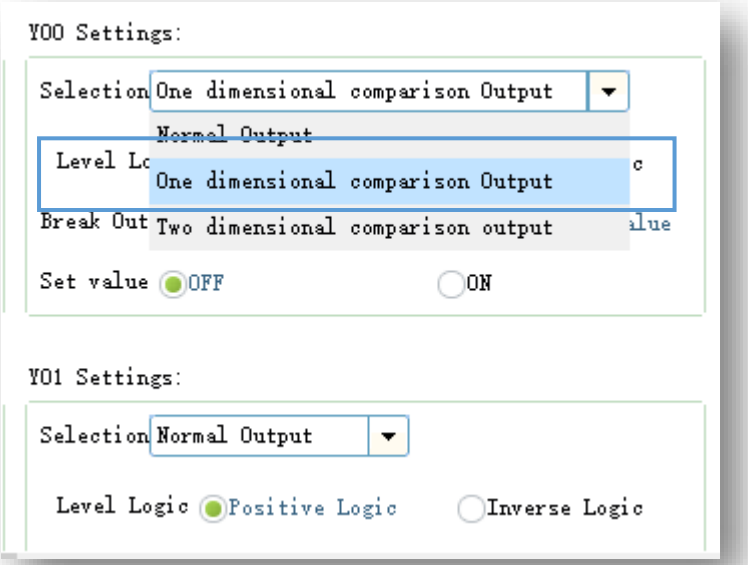
ENC_ArrayCompare is used to compare multi points and set corresponding output. The multi points are set in the array, and the comparison point quantities is set by the <Size>, be noted the <Size> value have to be less than the array length, or there could be array overflow(out of bound) when programming executing.

➢ ENC_ArrayCompare

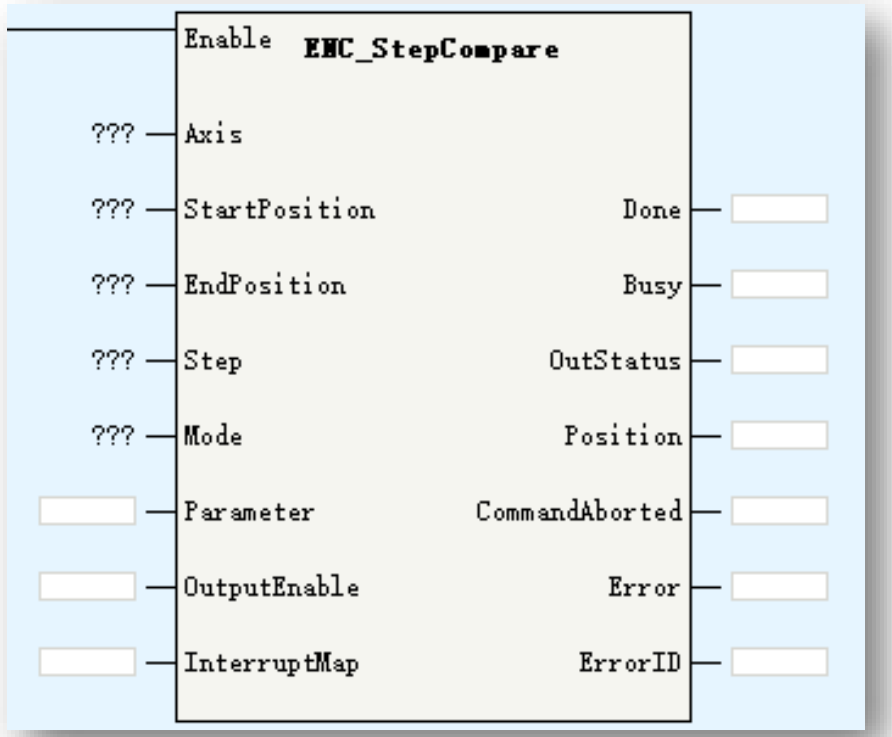
To use array comparison functionality, need select corresponding PDO in EtherCAT slave configuration(GL10-2HCE) and set the DO as <One dimensional comparison Output> in axis configuration view.

Take note: Y00 is used for channel 0, and Y10 is used for channel 1.





➢ ENC_StepCompare

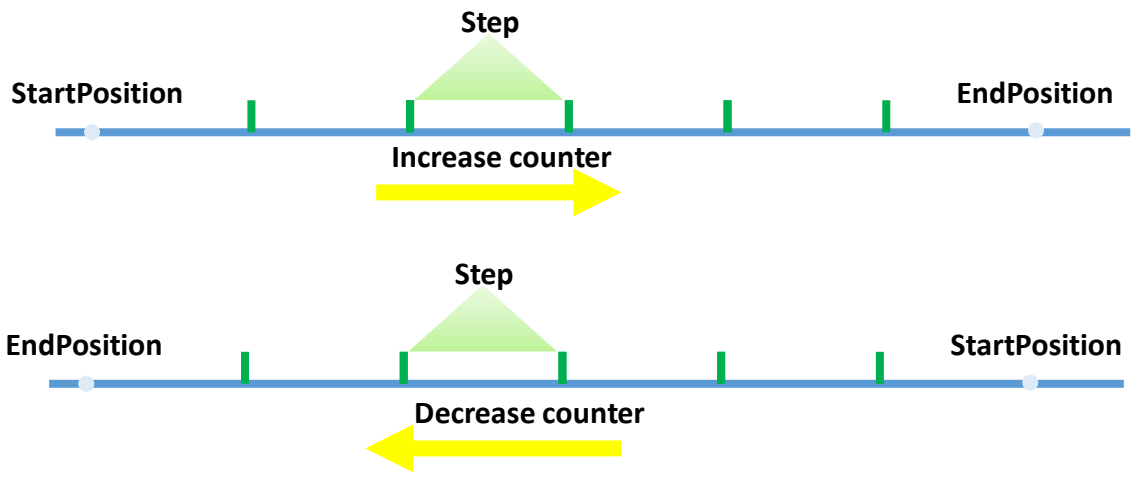


Parameters	Description
Axis	Encoder Axis name (bus encoder axis)
StartPosition	Comparison start position
EndPosition	Comparison end position
Step	Step
Mode	Comparison mode: 0: reserved 1: time mode 2: pulse mode 3: electrical level mode
Parameter	Time mode: output valid time, unit: us Pulse mode: output pulse quantities Electrical level mode: original voltage level, 0 is low voltage, 1 is high voltage, every time up to comparison point, the output status will revert
OutputEnable	Reserved
InterruptMap	Reserved
OutStatus	Output signal status
Position	The upcoming comparison value

ENC_Counter is used to compare multi position in a certain position range. The comparison space is set by the <Step>, the comparison range is set by the <StartPosition> and <EndPosition>.

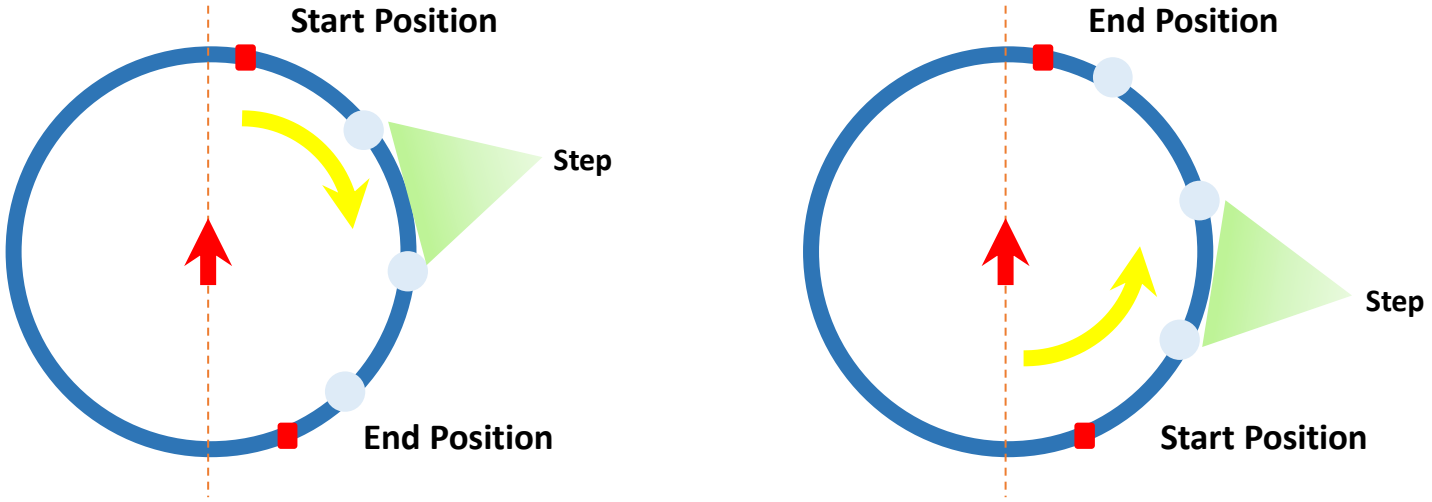
➢ ENC_StepCompare

In linear mode:
While <StartPosition> less than <EndPosition>, <Step> should be positive number, and while <StartPosition> is greater than <EndPosition>, <Step> should be negative number.



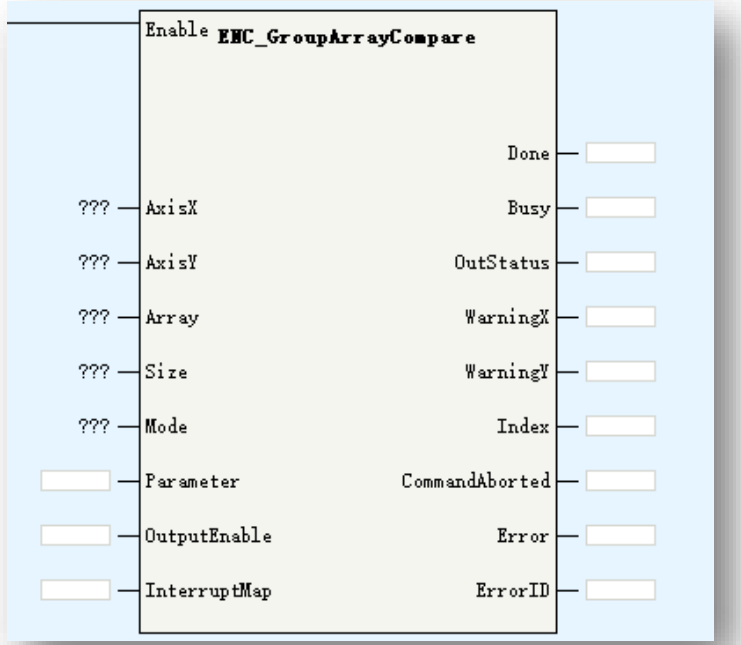
In rotation mode, same logic with linear mode:
While <StartPosition> less than <EndPosition>, <Step> should be positive number, and while <StartPosition> is greater than <EndPosition>, <Step> should be negative number.

➢ ENC_StepCompare



To use ENC_StepCompare, need select corresponding PDO in EtherCAT slave configuration(GL10-2HCE) and set the DO as <One dimensional comparison Output> in axis configuration view.
The sets is same with ENC_ArrayCompare.

➢ ENC_GroupArrayComapre



ENC_GroupArrayCompare is 2 dimension multi points comparison function block. It need be used with GR10-2HCE mode, and select channel 0 as X axis, channel 1 as Y axis.

The multi points are set in the array, and the comparison point quantities is set by the <Size>, be noted the <Size> value have to be less than the array length, or there could be array overflow(out of bound) when programming executing.

Parameters	Description
AxisX	Encoder Axis X name (bus encoder axis)
AxisY	Encoder Axis Y name (bus encoder axis)
Array	Comparison array(2 dimension array)
Size	Comparison value quantities
Mode	Comparison mode: 0:reserved 1:time mode 2:reserved 3: electrical level mode
Parameter	Time mode: output valid time, unit:us Electrical level mode: original voltage level, 0 is low voltage, 1 is high voltage, every time up to comparison point, the output status will revert
OutputEnable	Reserved
InterruptMap	Reserved
OutStatus	Output signal status
WarningX	X axis warning output
WarningY	Y axis warning output
Index	The uncoming comparison index

➢ ENC_GroupArrayComapre

To use 2 dimension array comparison functionality, need select corresponding PDO in EtherCAT slave configuration(GL10-2HCE) and set the DO as <Two dimensional comparison Output> in axis configuration view.

Take note: Y00 is used for channel 0, and Y10 is used for channel 1.

General Settings
Process Data
Startup Parameters
I/O Functional Mapping
Information
State

Add | Edit | Delete | Collapse | Show All | PDO Assign | PDO Config | PDO Data Size | Output(Byte):20 Input(Byte):32

Input/Output	Name	Index	Subindex	Length	Sign	SM	Type
Output	Ch0 RPDO Mapping parameter 0	16#1700	16#00	10	Editabl	2	
Output	Ch0 RPDO Mapping parameter 1	16#1701	16#00	12	F		
Output	Ch1 RPDO Mapping parameter 0	16#1710	16#00	10	Editabl	2	
Output	Ch1 RPDO Mapping parameter 1	16#1711	16#00	12	F		
Output	Y00 compare out control	16#1720	16#00	18	F		
Output	Y10 compare out control	16#1726	16#00	18	F		
Output	Y00 x-y compare out control	16#1740	16#00	18	F		
Input	Ch0 TPDO Mapping Parameter	16#1B00	16#00	16	Editabl	3	
Input	Ch0 touch probe pos value TPDO mappin	16#1B01	16#00	10	F		
Input	Ch0 touch probe neg value TPDO mappin	16#1B02	16#00	8	F		
Input	Ch0 touch probe pos time stamp TPDO m	16#1B					
Input	Ch0 touch probe pos time stamp TPDO m	16#1B					
Input	Y00 compare status mapping parameter	16#1B					
Input	Ch1 TPDO Mapping Parameter	16#1B					
Input	Ch1 touch probe pos value TPDO mappin	16#1B					
Input	Ch1 touch probe neg value TPDO mappin	16#1B					
Input	Ch1 touch probe pos time stamp TPDO m	16#1B					
Input	Ch0 touch probe pos time stamp TPDO m	16#1B					
Input	Y10 compare status mapping parameter	16#1B					

To set the comparison range. See next slide.

Y00 Settings:

Selection: Two dimensional comparison output

Level Logic: Positive Logic / Inverse Logic

Break Output status: Keep status / Output set value

Set value: OFF / ON

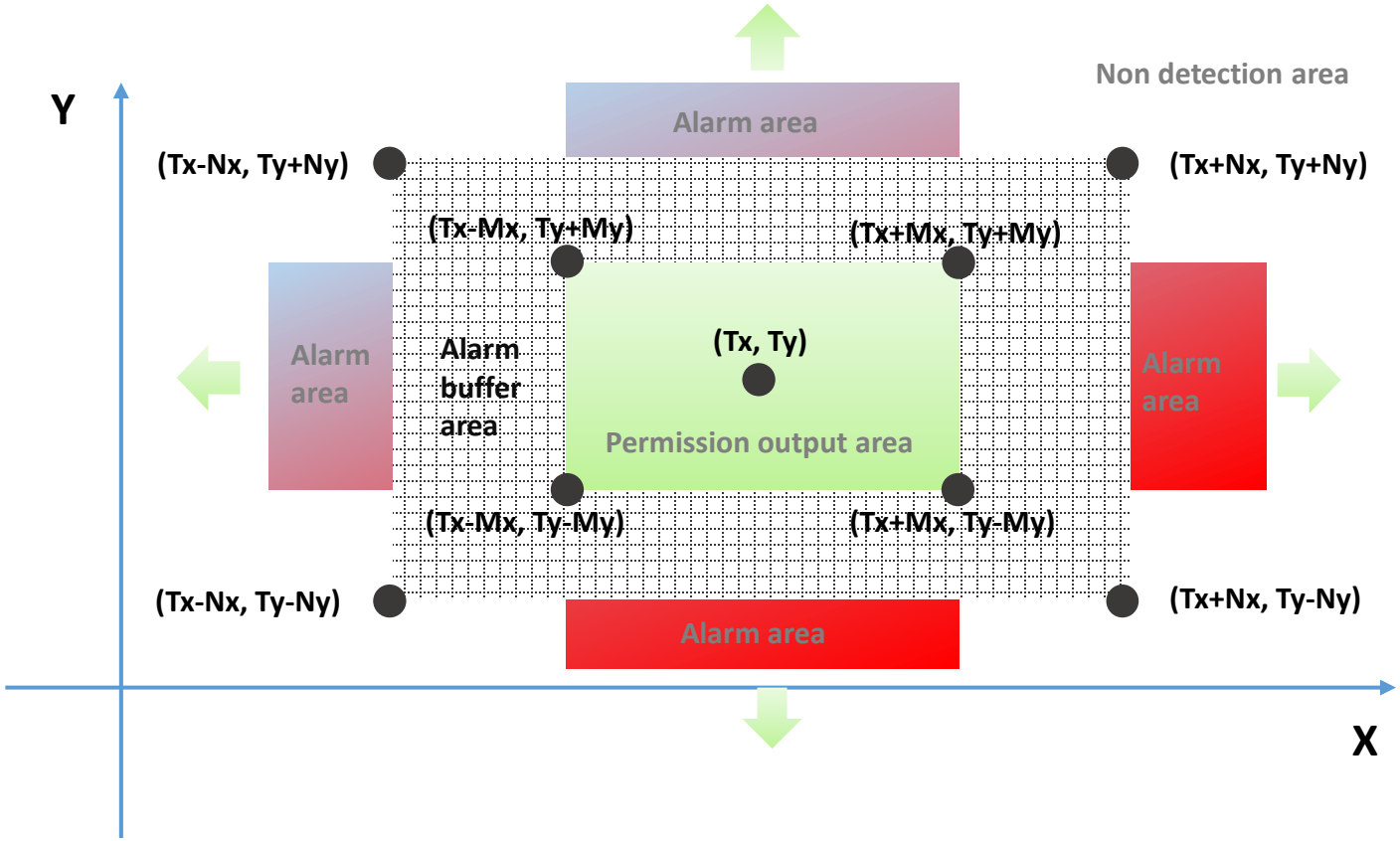
Two dimensional comparison output:

X Axis permissible error	1.00	Unit
Y Axis permissible error	1.00	Unit
X Axis alarm deviation	2.00	Unit
Y Axis alarm deviation	2.00	Unit

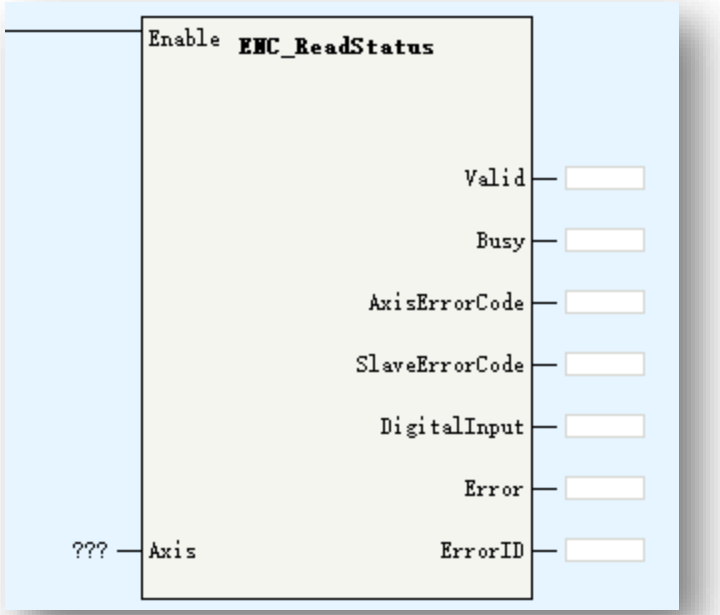
Permissible error must less than alarm deviation

➢ ENC_GroupArrayComapre

(Tx, Ty) is the target comparison point, (Mx, My) is the permission error, (Nx, Ny) is the alarm deviation.
If one axis already get into permission output area but the other axis not get into alarm buffer area, the corresponding of <WarningX> or <WarningY> will be valid until the other axis get into alarm buffer area.
If the point is in non detection area or alarm buffer area, there is no signal output(alarm output or comparison output)



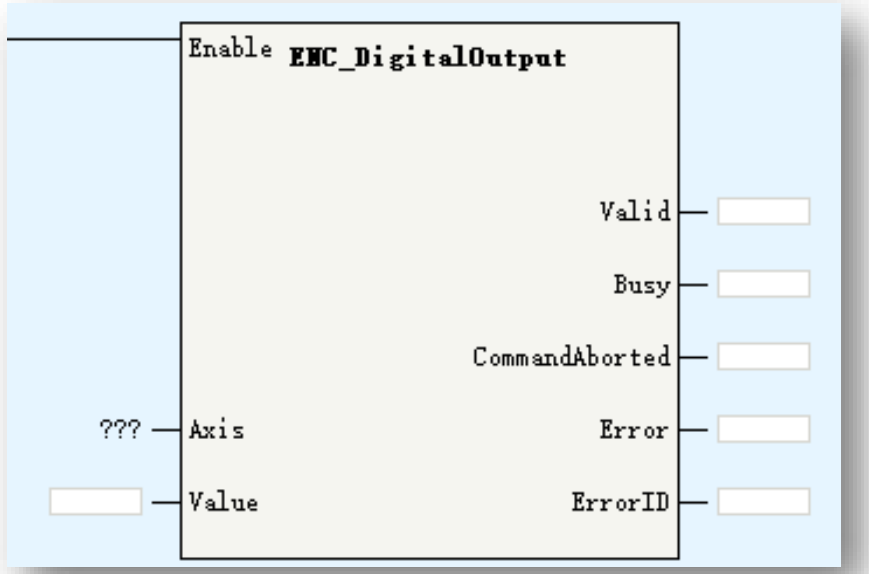
➢ ENC_ReadStatus



Parameters	Description
Axis	Encoder Axis name (bus encoder axis)
Valid	Valid
AxisErrorCode	Axis error code
SlaveErrorCode	Drive error code
DigitalInput	Bit0: CHn-X0 Bit1:CHn-X1 Bit2: CHn-X2 Bit3:CHn-X3

ENC_ReadStatus is used to read bus encoder axis status.
<AxisErrorCode> is bus encoder axis error code, refer the H5U error code.
<DriveErrorCode> is GR10-2HCE model error code, refer GR10-2HCE application manual.

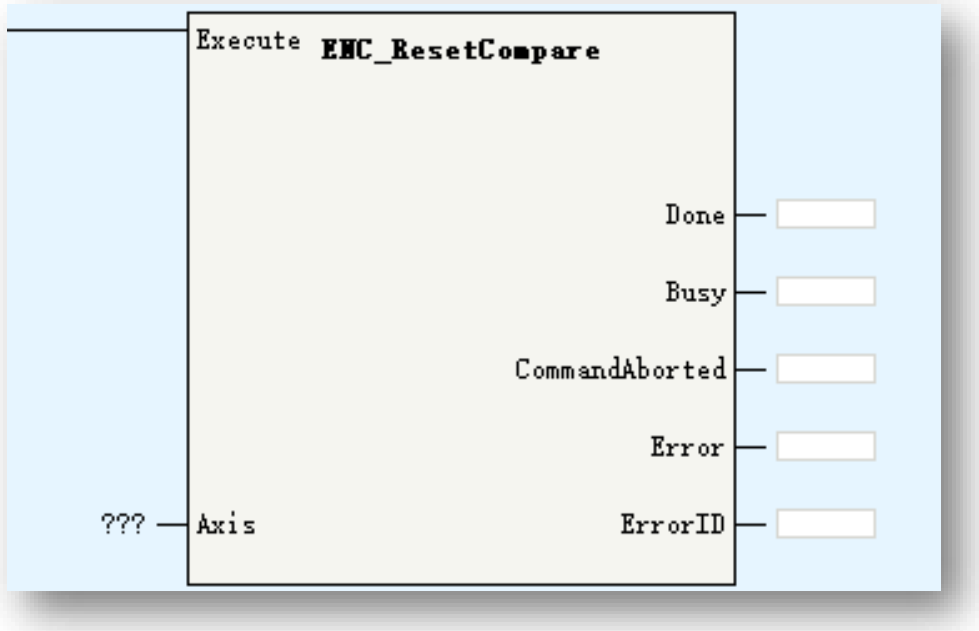
➢ ENC_DigitalOutput



Parameters	Description
Axis	Encoder Axis name (bus encoder axis)
Value	Bit0:CHn-Y0 Bit1:CHn-Y1 Bit2:CHn-Y2
Valid	Output valid

ENC_DigitalOutput is used to set GR10-2HCE output.
While the axis is bind with CH0, the output is Y0/Y1/Y2,
While the axis is bind with CH1, the output is Y10/Y11/Y12.

ENC_ResetCompare

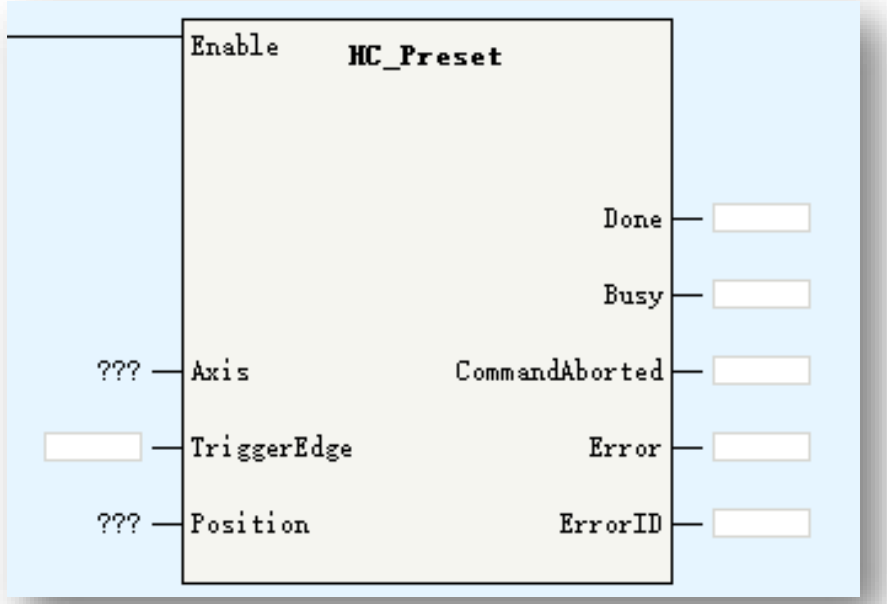


Parameters	Description
Axis	Encoder Axis name (bus encoder axis)

ENC_ResetCompare is used to reset comparison output of ENC_StepCompare/ENC_ArrayCompare/ENC_GroupArrayCompare. While ENC_ResetCompare executing, if ENC_StepCompare/ENC_ArrayCompare/ENC_GroupArrayCompare not complete, the command will be aborted, the the comparison output will be reset.

Take note:
If the comparison mode is electrical level mode, the comparison output will keep in a certain status(could be ON) even though corresponding comparison command already done, at this time, using ENC_ResetCompare to reset output status to OFF.

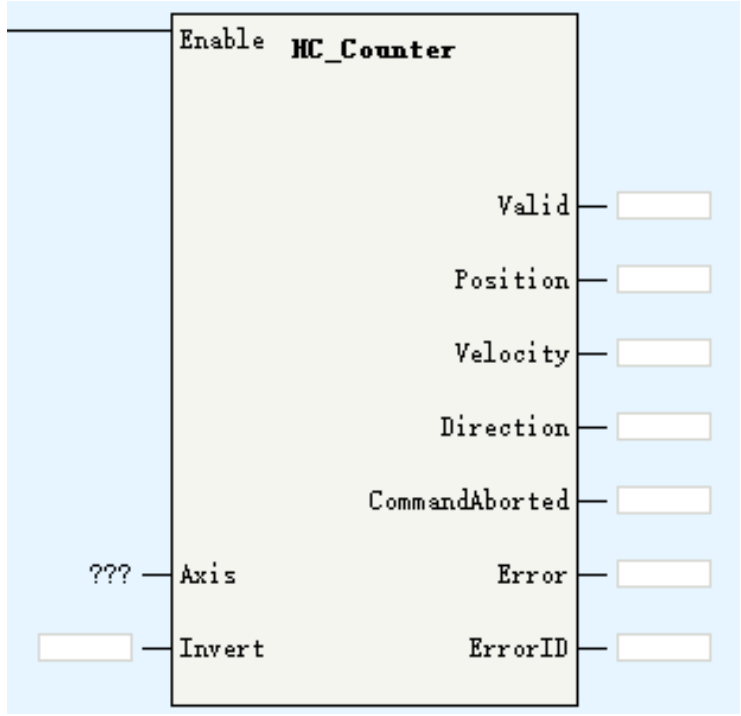
HC_Preset



Parameters	Description
Axis	Encoder Axis name/ID (local encoder axis)
TriggerEdge	0: trigger in FB rising edge 1: Input signal rising edge 2: input signal falling edge 3: input signal rising or falling edge
Position	Preset value

HC_Preset is used to set preset value for local encoder counter.
Take note:
If <TriggerEdge> is not 0, need configure <Preset Setting> in axis configuration view.

HC_Counter

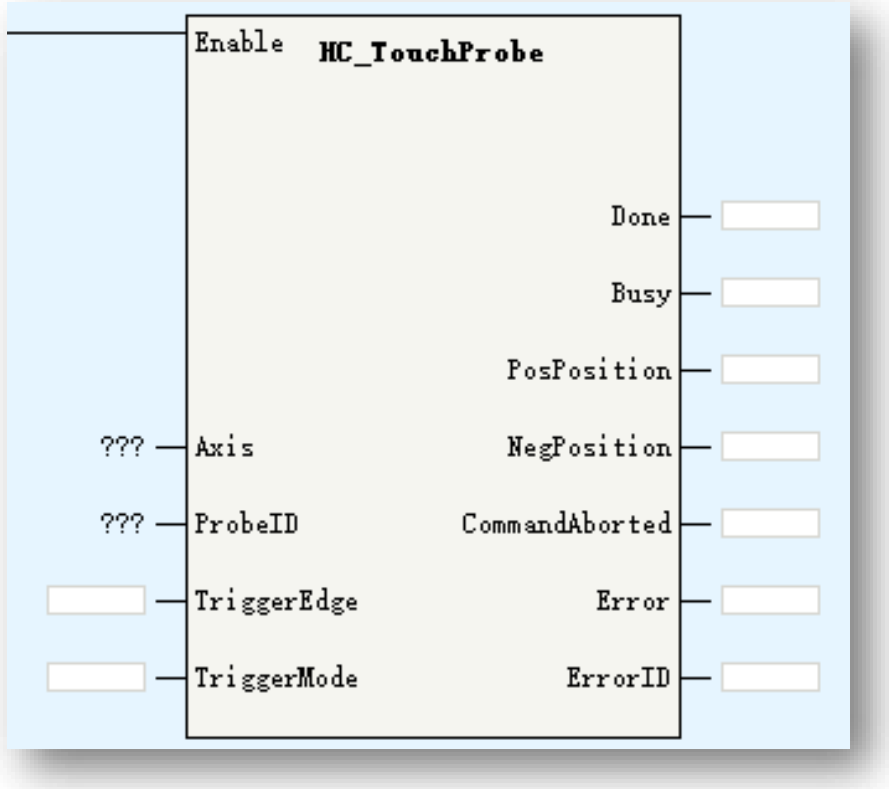


Parameters	Description
Axis	Encoder Axis name/ID (local encoder axis)
Invert	Invert count direction
Valid	Encoder input valid
Position	Current position
Velocity	Current velocity
Direction	Current direction

HC_Counter is used to enable the bus encoder axis.
The invert definition in different signal format show in the table.

Invert	A/B	Pulse/Direction	CW/CCW	Single source
0	Increase: phase A overtakes phase B Decrease: phase B overtakes phase A	Increase: Direction high level Decrease: Direction low level	Increase: Phase A Decrease: Phase B	Increase
1	Increase: phase B overtakes phase A Decrease: phase A overtakes phase B	Increase: Direction low level Decrease: Direction high level	Increase: Phase B Decrease: Phase A	Decrease

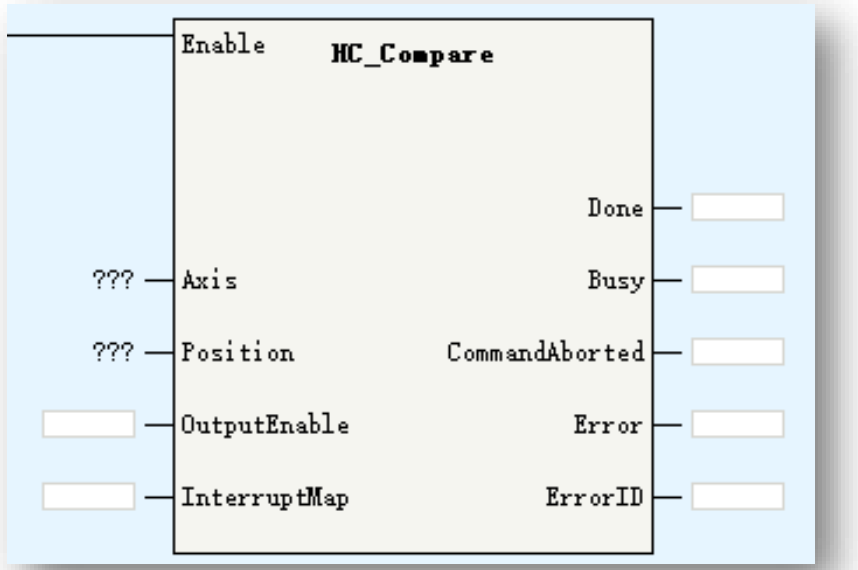
➢ HC_TouchProbe



Parameters	Description
Axis	Encoder Axis name/ID (local encoder axis)
ProbeID	Touch probe ID: 0: TP1 1:TP2
TriggerEdge	1: rising edge 2: falling edge 3: rising edge and falling edge
TriggerMode	0: single trigger 1: continuous trigger
PosPosition	Rising edge latch position
NegPosition	Falling edge latch position

HC_TouchProbe is used to read the locked position value of local encoder while signal triggered without software delay.

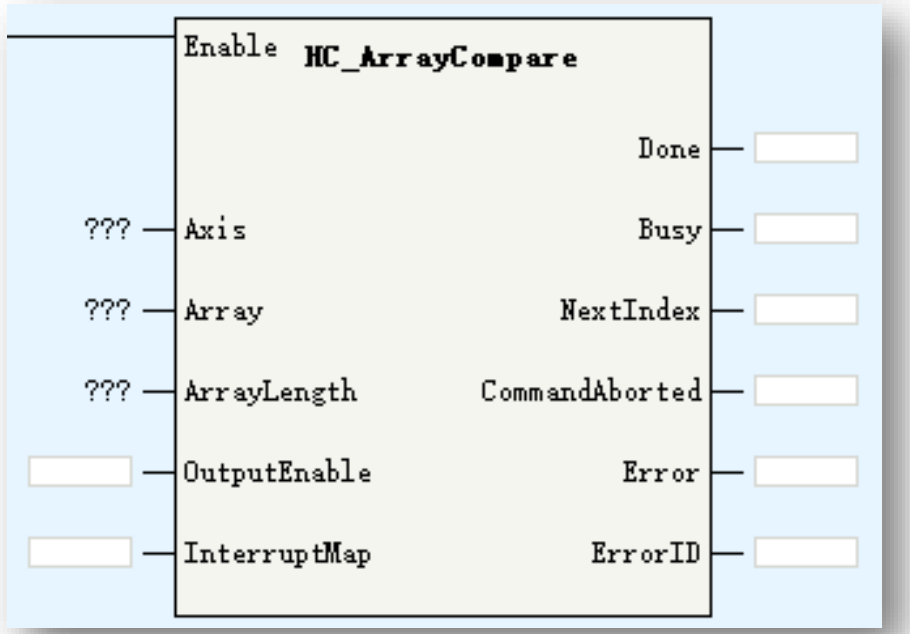
HC_Compare



Parameters	Description
Axis	Encoder Axis name (bus encoder axis)
Position	Comparison position
OutputEnable	0: don't use hardware output 1: use hardware output
InterruptMap	While up to comparison value: 0: no interruption 1: interruption 1 triggered 2: interruption 2 triggered … 16: interruption 16 triggered

HC_Compare is used to set comparison value for local encoder axis and it support comparison output(map to hardware output) and trigger an interruption event.

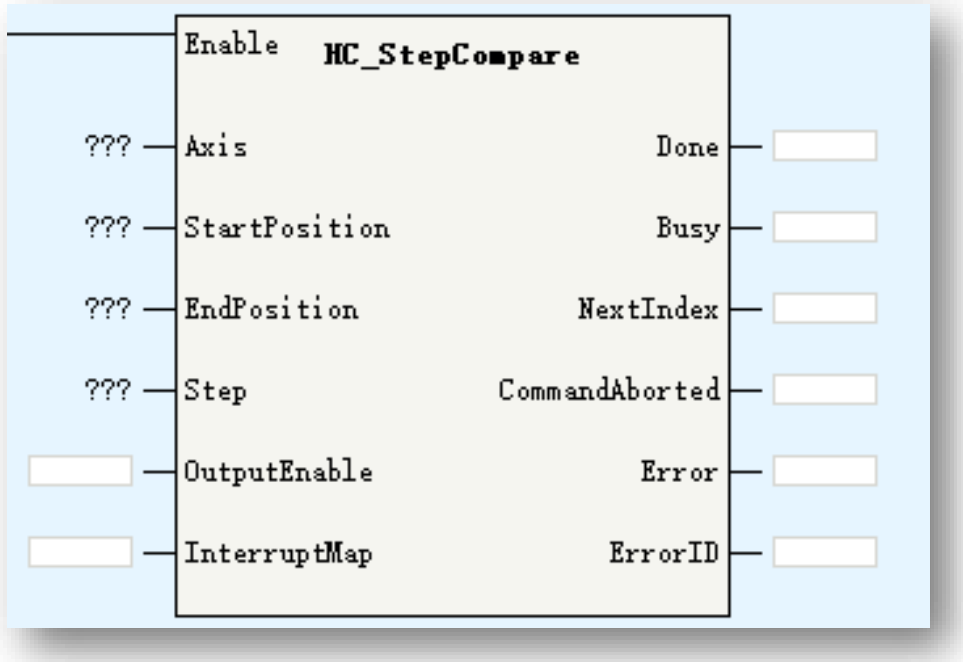
➢ HC_ArrayCompare



Parameters	Description
Axis	Encoder Axis name (bus encoder axis)
Array	Comparison position array
ArrayLength	Comparison position array length
OutputEnable	0: don't use hardware output 1: use hardware output
InterruptMap	While up to comparison value: 0: no interruption 1: interruption 1 triggered 2: interruption 2 triggered … 16: interruption 16 triggered
NextIndex	The upcoming comparison index

HC_ArrayCompare is used to set multi comparison value for local encoder axis and it support comparison output(map to hardware output) and trigger an interruption event.

HC_StepCompare



Parameters	Description
Axis	Encoder Axis name (bus encoder axis)
StartPosition	Comparison start position
EndPosition	Comparison end position
Step	Comparison step
OutputEnable	0: don't use hardware output 1: use hardware output
InterruptMap	While up to comparison value: 0: no interruption 1: interruption 1 triggered 2: interruption 2 triggered … 16: interruption 16 triggered
NextIndex	Positive limit valid in linear mode

HC_StepCompare is used to compare multi position in a certain position range. The comparison space is set by the <Step>, the comparison range is set by the <StartPosition> and <EndPosition>. Besides, it support comparison output(map to hardware output) and trigger an interruption event.
For more parameters introduction, please refer to ENC_StepCompare.

Functionality Features

IT7000 & H5U simulation

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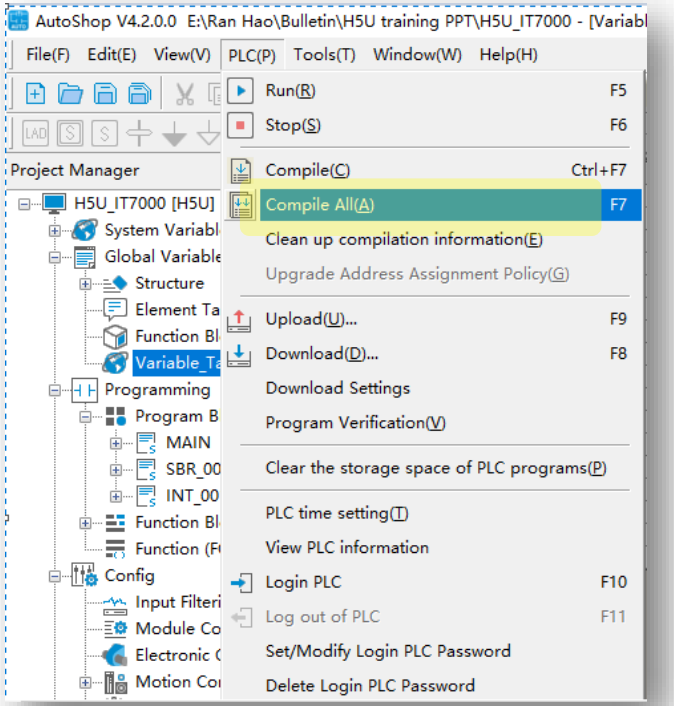
IT7000 support simulation with inovance H5U series PLC without hardware connection. This functionality will help users to improve project development/commissioning efficiency.

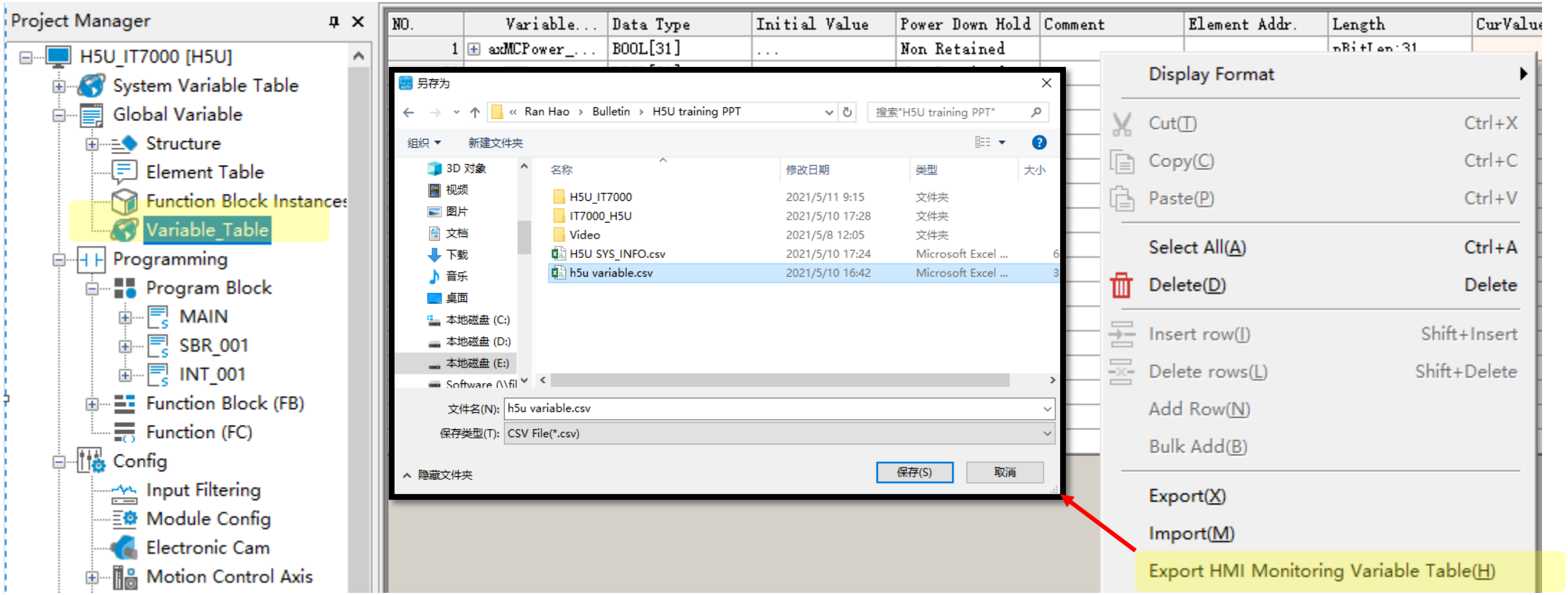
➢ H5U

Software: Autoshop V4.2.0.0(or above): https://www.inovance.com/hc/allResult?key=Autoshop
Step1: Create a new project and compile all without error.



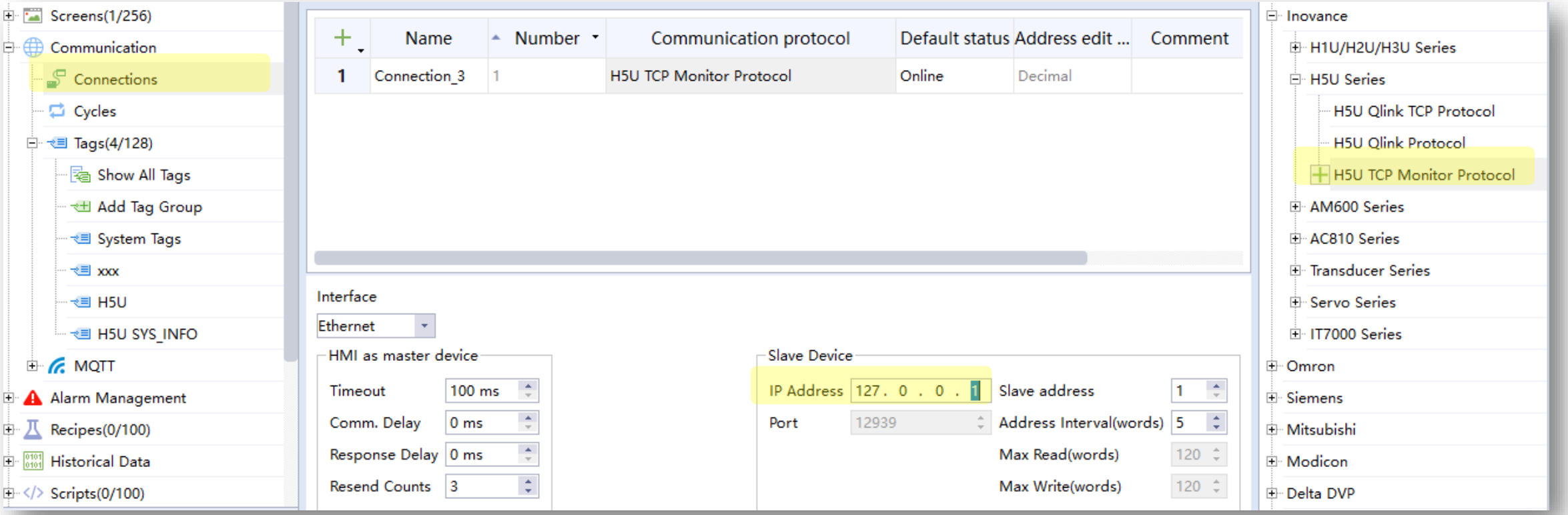
➢ H5U

Step2: Open the variable table and right click to export HMI variables. The export variable table should be .csv format.



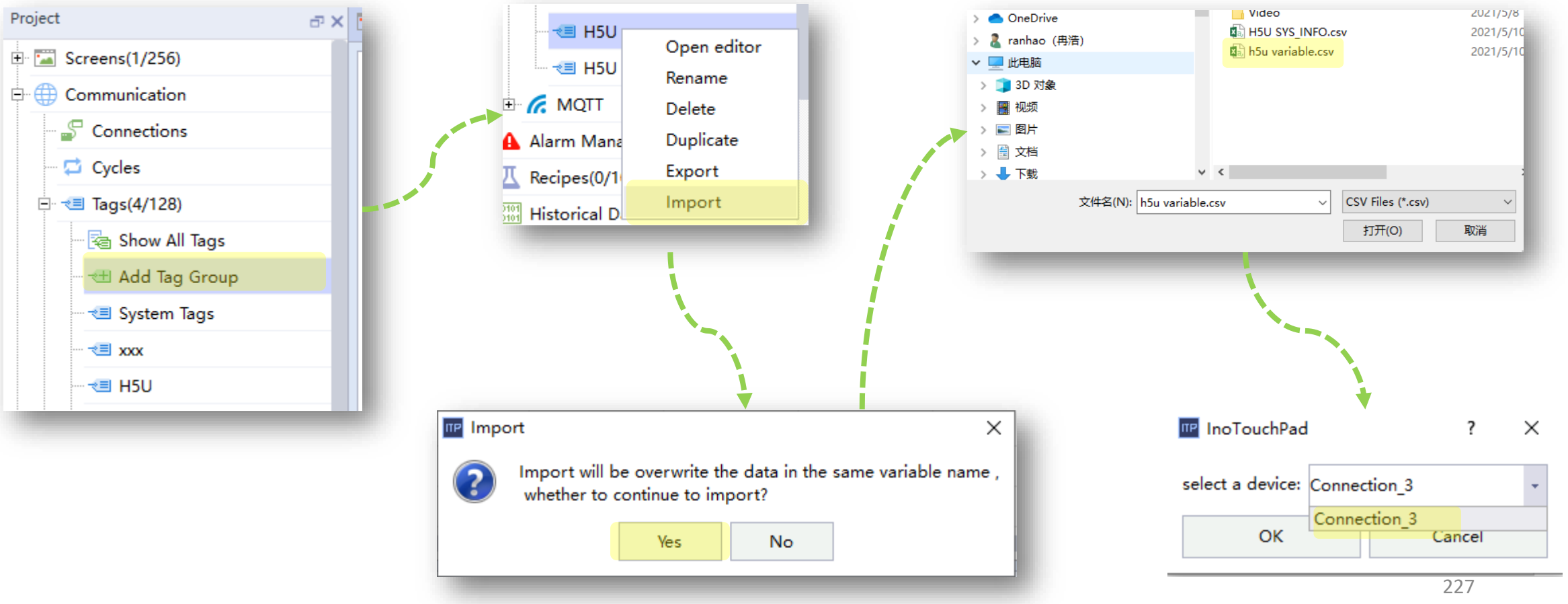
➢ IT7000

Step1: Add a new connection, select 'H5U TCP Monitoring Protocol' and set the slave device IP address as 127.0.0.1.



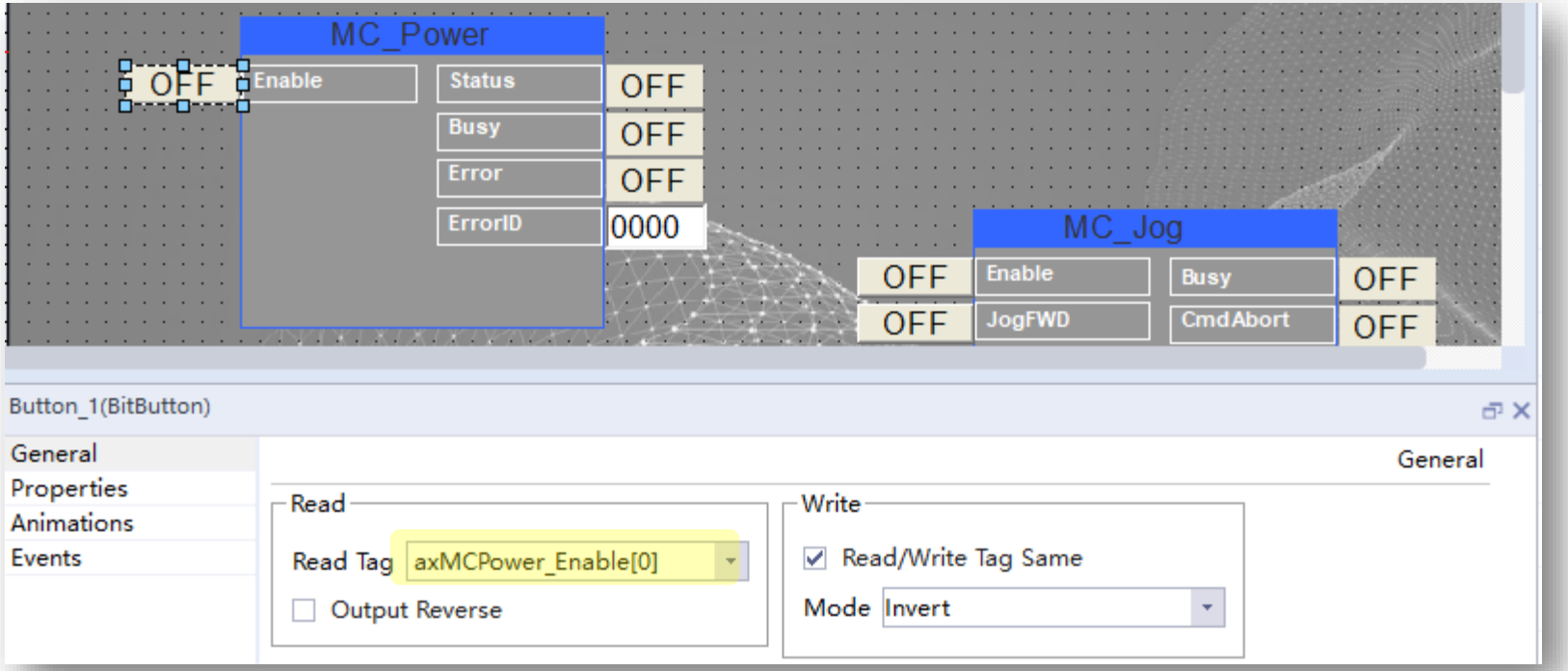
➢ IT7000

Step2: Add a new tag group, select and right click to import variables.



➢ IT7000

Step3: Configure/or map H5U variable to HMI controls



IT7000 & H5U simulation

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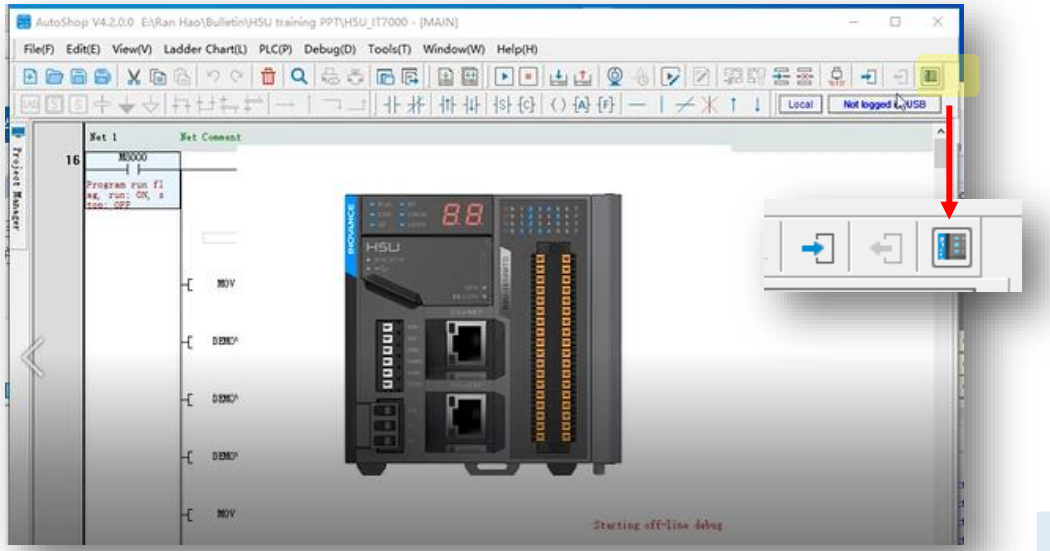
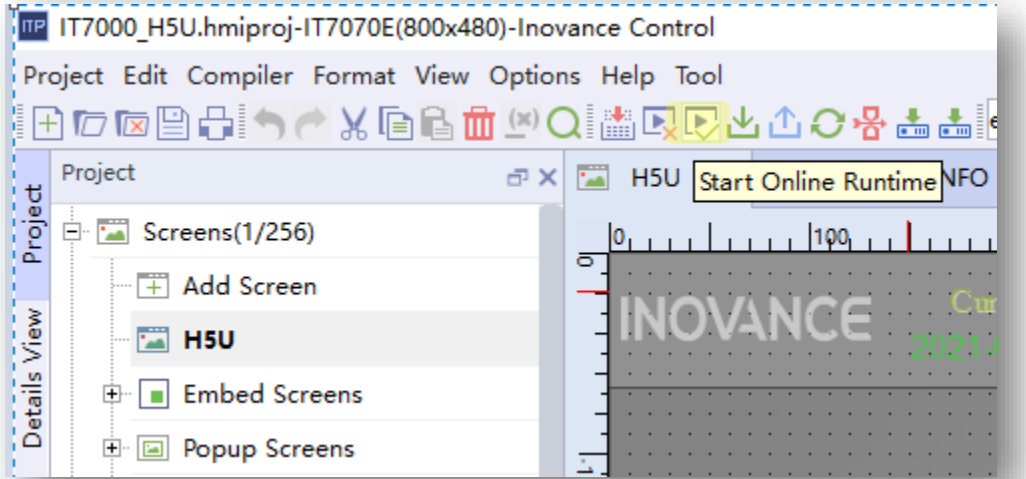
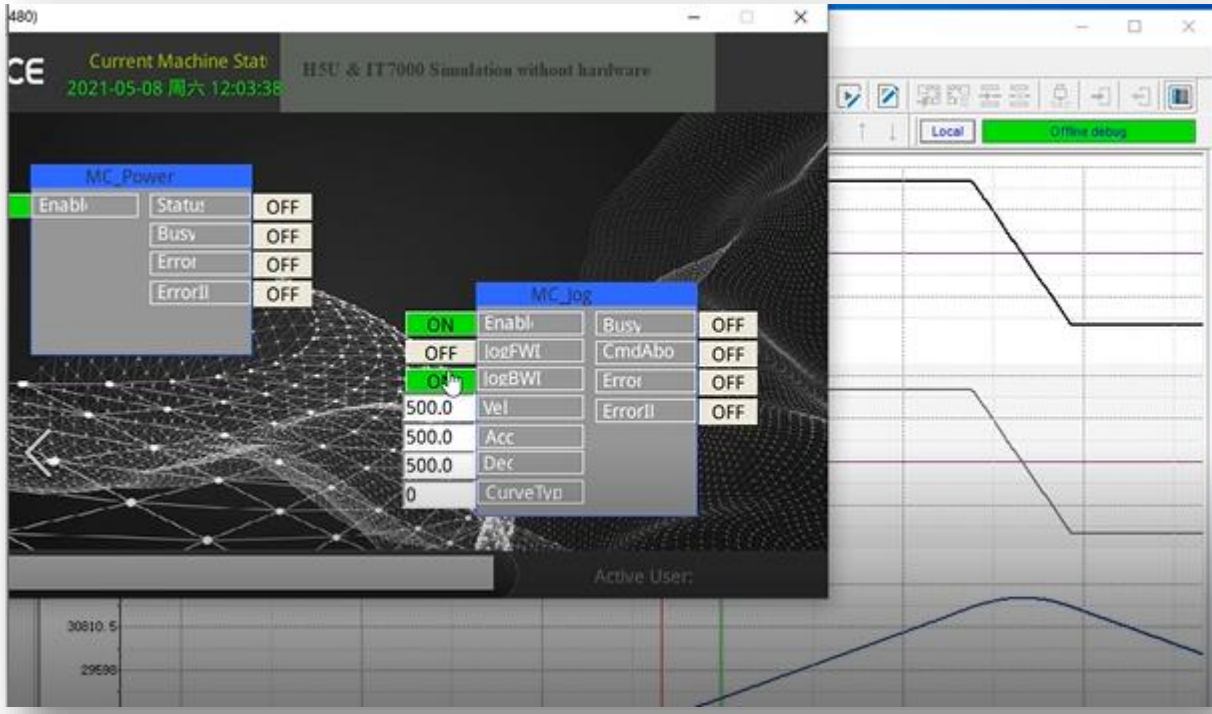
Start to simulation.





effect



Online Modification

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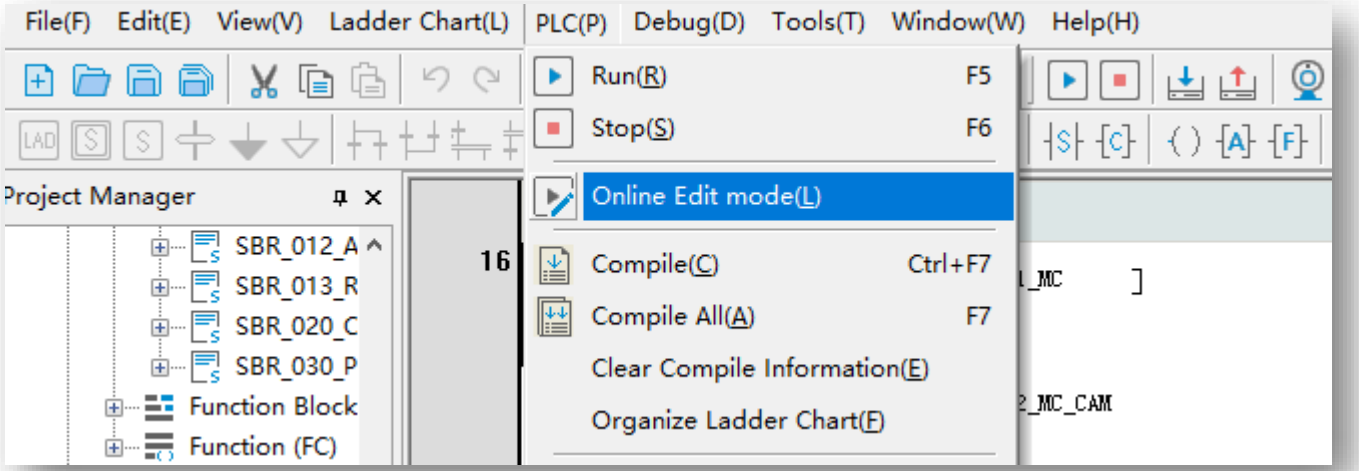
H5U support online modification, which allows users to modify program while the PLC is running. The online modification will not impact the PLC status.
Before using this function, make sure the connection between PC and PLC is good.
The operation process show as below:
1> Select <PLC> → <Online Edit Mode>



Online Modification

INOVANCE

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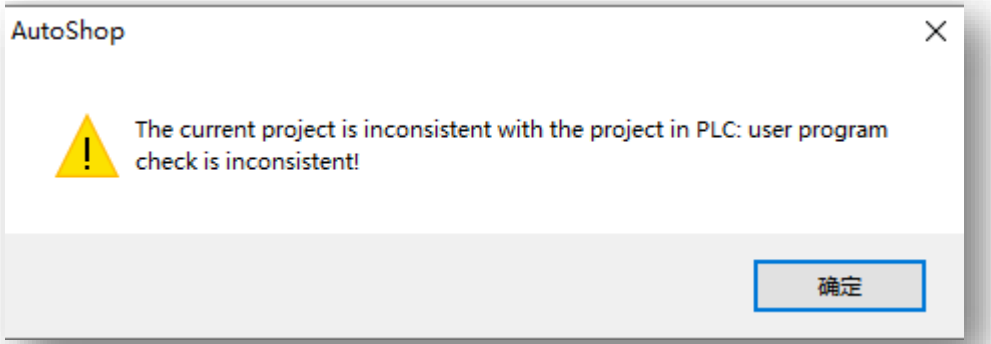
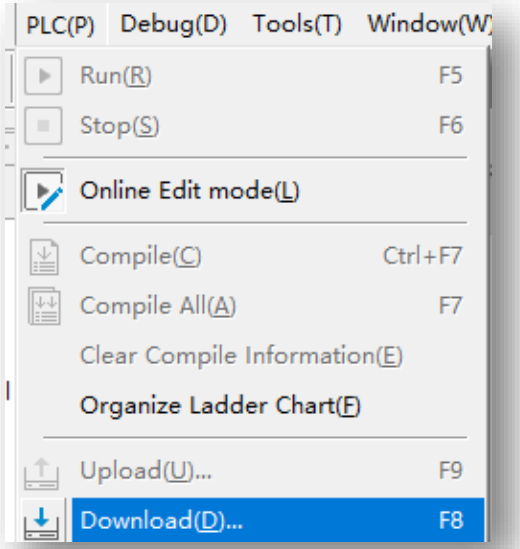
2> While get into <Online Edit Mode>, it the current opened project is different than the project in controller, the indication dialog box will pop up, at this time, users need to check if they open the correct project.



3> Modify the project according to real demands, after that, click download button to download the modified program to PLC. Take note, the PLC will not stop running during this process.



Online Modification

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4> Check the output window to check if the online modification succeed.

Information Output Window

```
AutoShop: Communication Message
Information(2021-11-02 15:04:00)  Download successful!
Information(2021-11-02 15:04:00)  Online Modification command executed correctly
```

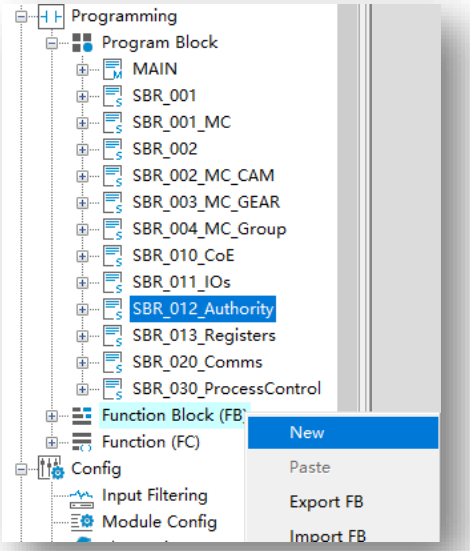
FB

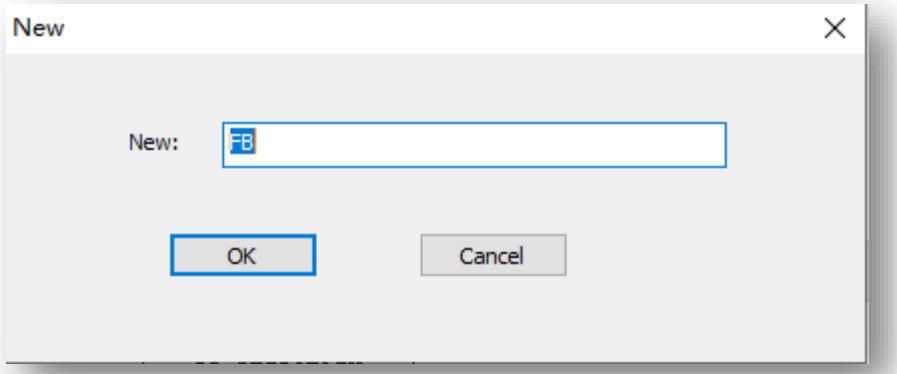
FB is function block which used to build specified program as a general program block and can be re-used in program. Using the encapsulated function block, users can save the development time and improve the programming efficiency and quality.

While a FB execute, there could be some variables used in FB, system will assign internal memory for these variables, and these internal variables will decide the FB status or features. For the same input parameters, there could be different output parameters, the output result depends on the FB status(or the internal variables).

The usage of FB show as below:

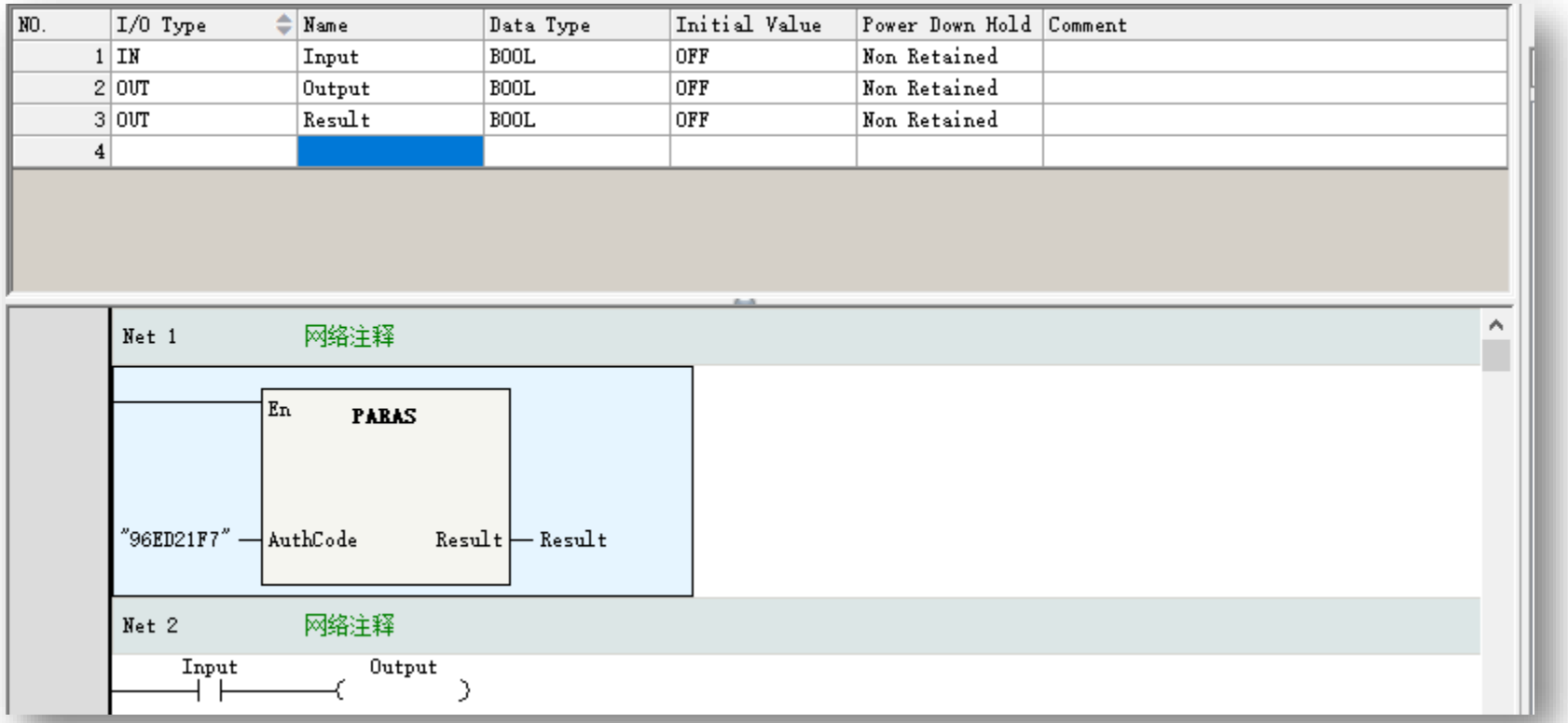
1> Create a new function block--<Programming>→<Function Block> right click and select <New>, then set the function block name in the pop up window.





➢ FB

2> Develop function block program.
FB support VAR/IN/OUT/INOUT type variable. VAR is internal usage variable, IN/OUT/INOUT is the input/output parameter of FB, besides, FB can use H5U soft elements(D/M/R…) as global variable, and at the same time, FB support <Retained> type variable.



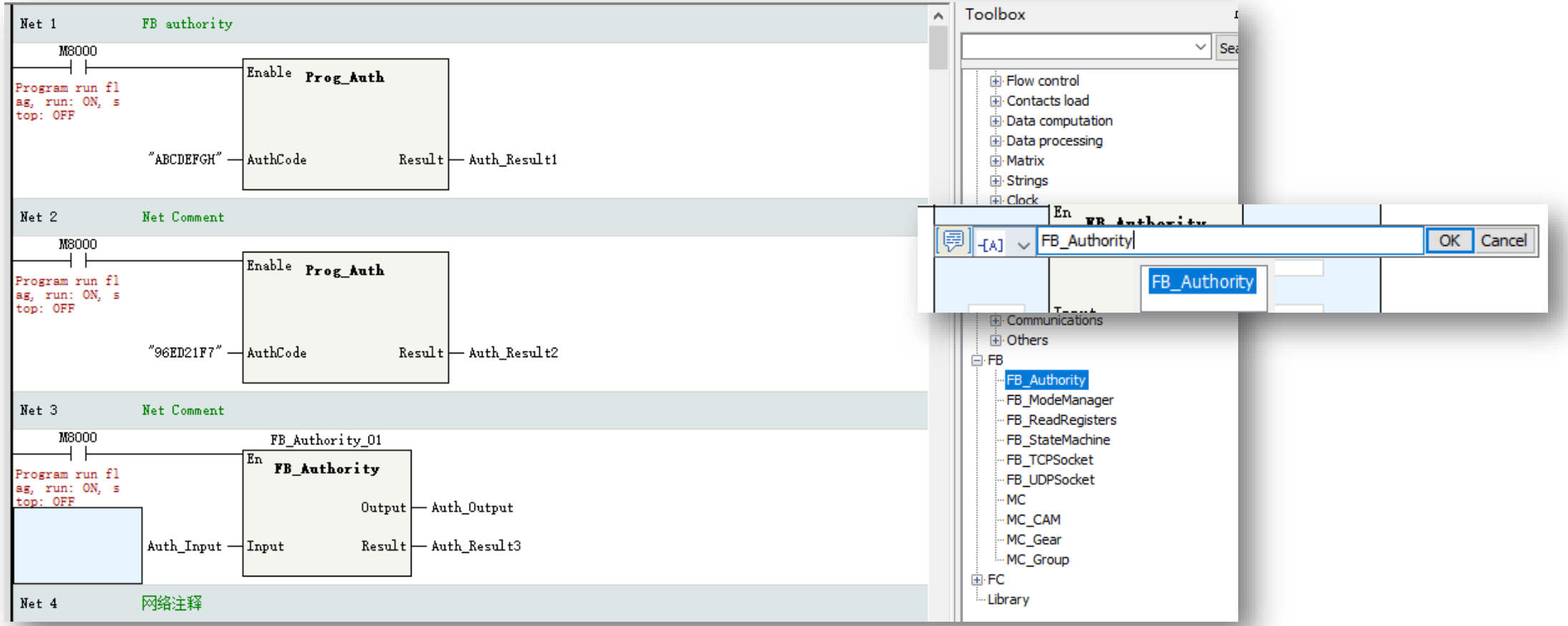
NO.	I/O Type	Name	Data Type	Initial Value	Power Down Hold	Comment
1	IN	Input	BOOL	OFF	Non Retained	
2	OUT	Output	BOOL	OFF	Non Retained	
3	OUT	Result	BOOL	OFF	Non Retained	
4						

FB

3> Using FB in program

FB can be used in program by selecting from tool box <FB>, or directly input FB name in input box.

Take note FB also support to be used in another FB, H5U FB support multistage nested(up to 8 stages).

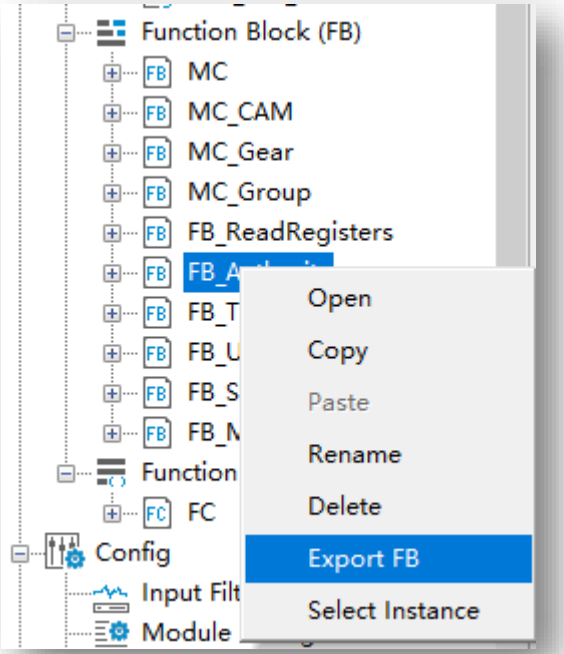


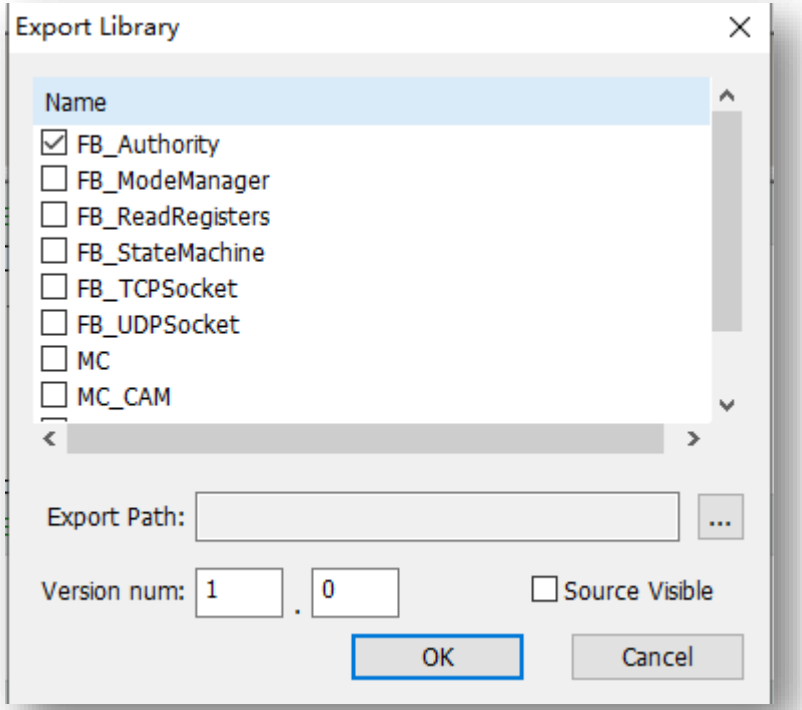
FB

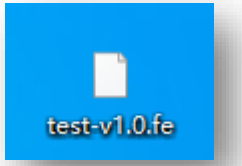
4> FB encapsulation

After a FB tested and verified that it works well, users can encapsulate the FB as a library and export, in this way, the FB can be used in another project, improve the development efficiency.

Select the FB and right click to <Export FB>, select the corresponding FBs and export path, user can defined the library version and select if the source code be visible. After click <OK> button, a library file with .fe suffix will generated in specified path.



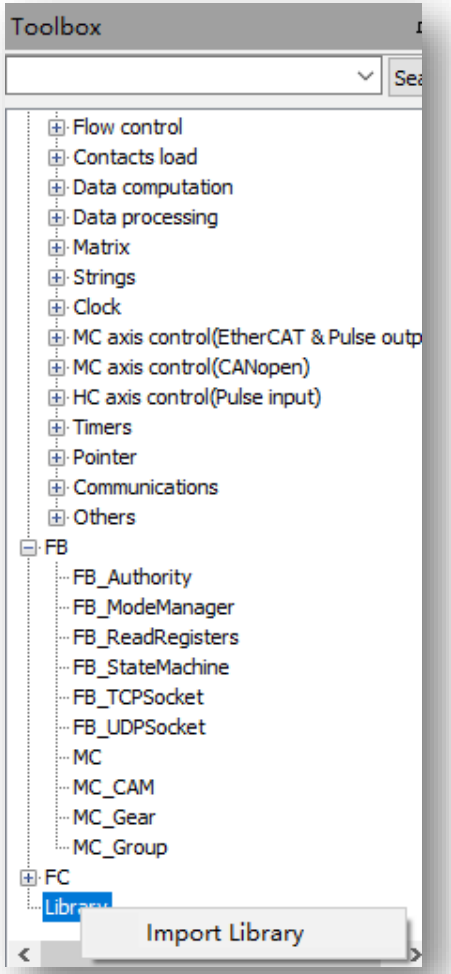


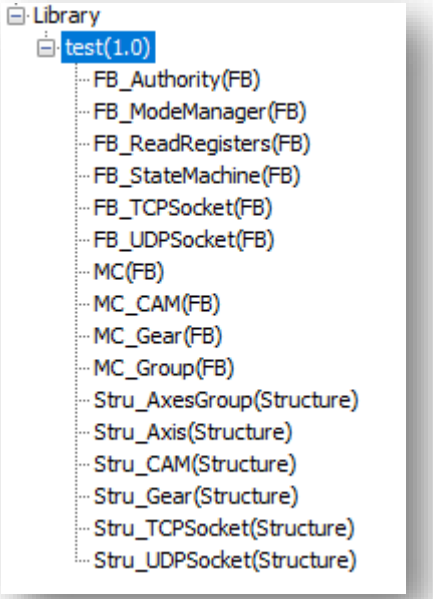


FB

4> FB encapsulation

In tool box, select <Library> right click to <Import Library>, select the library file, and then the library will be added in the tool box.

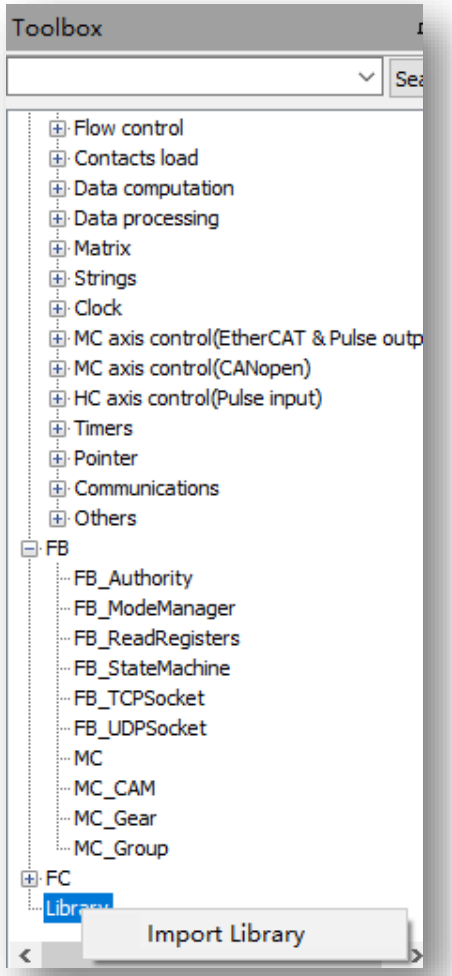


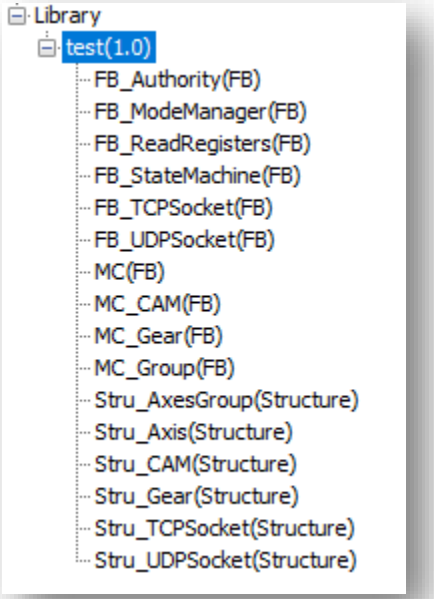


FB

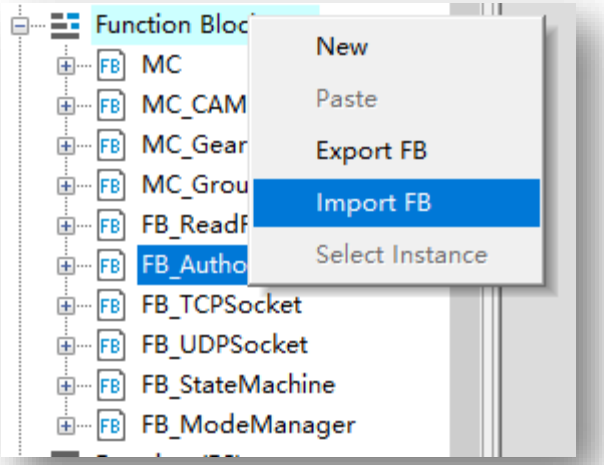
4> FB encapsulation

In tool box, select <Library> right click to <Import Library>, select the library file, and then the library will be added in the tool box.





Take note:
There is another way to import library.
In the device tree <Function Block>, right click and select <Import FB> . This way can only import the library with source code visible, and the exported library can only used in current project.



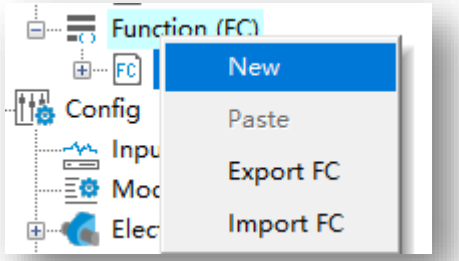
➢ FC

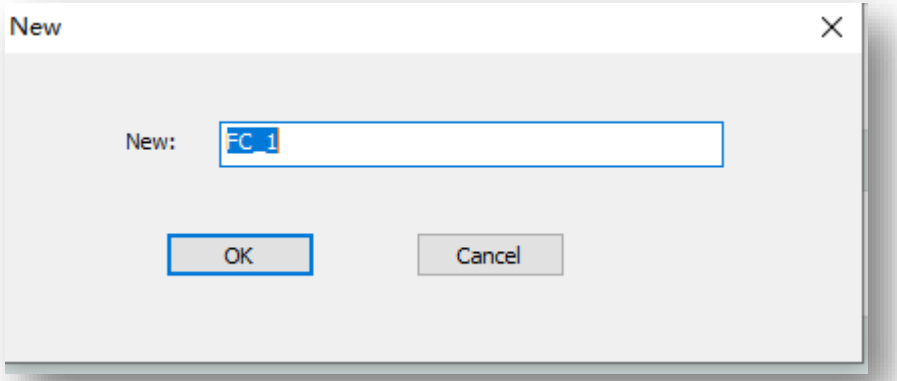
FC is function which used to build specified program as a general program block and can be re-used in program. Using the encapsulated function block, users can save the development time and improve the programming efficiency and quality.

The difference compare with FB:
>FC can only use static internal variable, which means there is no internal memory assigned for these variable and the variable value cannot be stored, in this case, variables in a FC don't support <Retain> property
>For same inputs, the outputs of a FC is a certain value, for example, sin<x>/cos<x> are very common math function, for a certain variable, the output value is certain. MC_MoveAbsolute/MC_MoveRelative are function block, in these block there are internal memory to store the process information, and every time the FB executing, the output value could be update.

The usage of FC show as below:
Create a new FC--<Programming>→<Function> right click and select <New>, then set the function name in the pop up window. Other operation please refer to FB introduction(use in program/export/import)

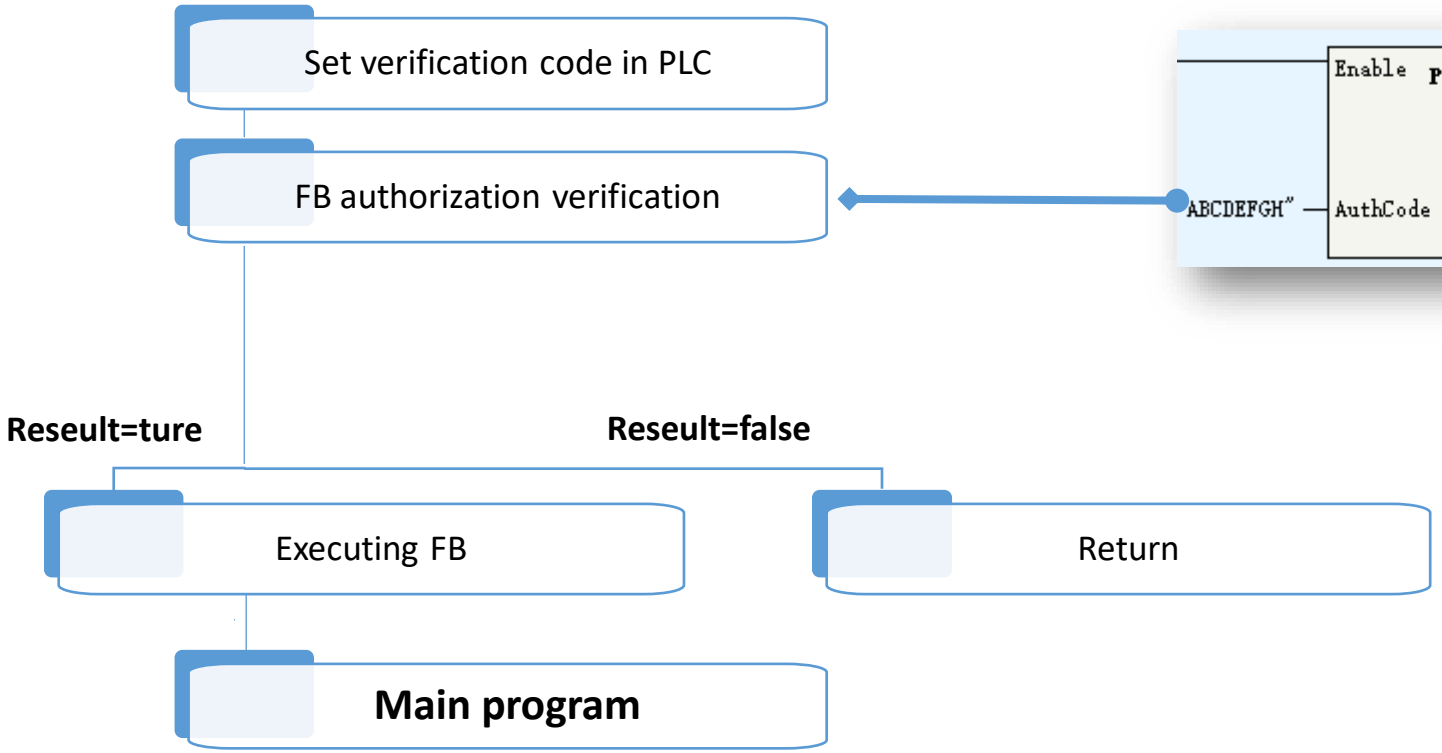
Take note: Do not use multi cycle instructions or state related instructions(like motion control/LD*) in FC!

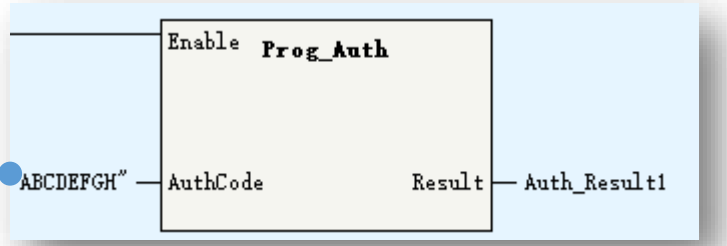


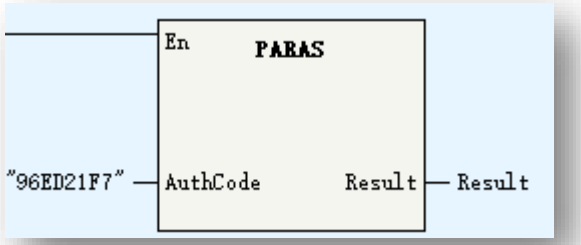


FB Authority

H5U use function Prog_Auth to set function blocks/library authority, only specified controller with authorization can use specified library. In this case, OEM can protect the intellectual property. The authority mechanism working process show as below:



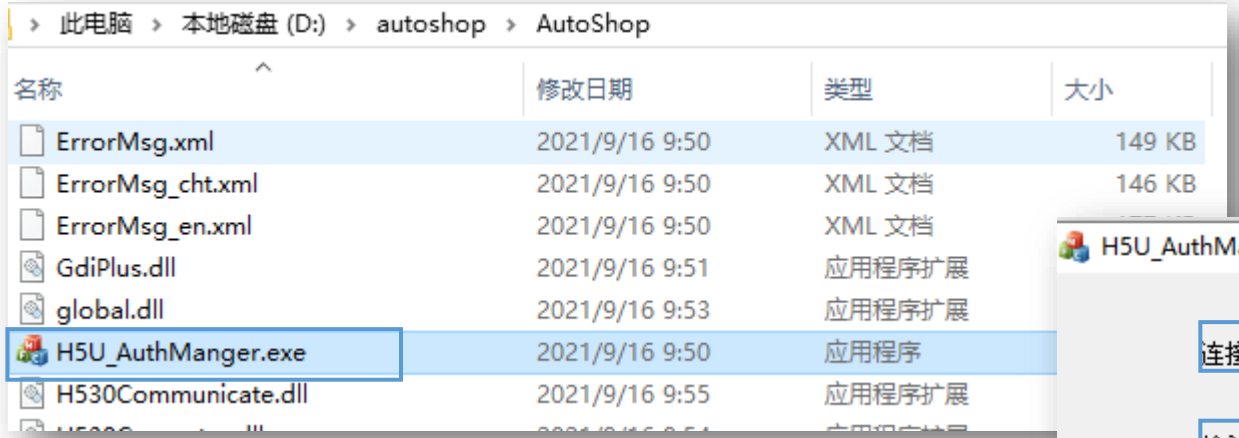




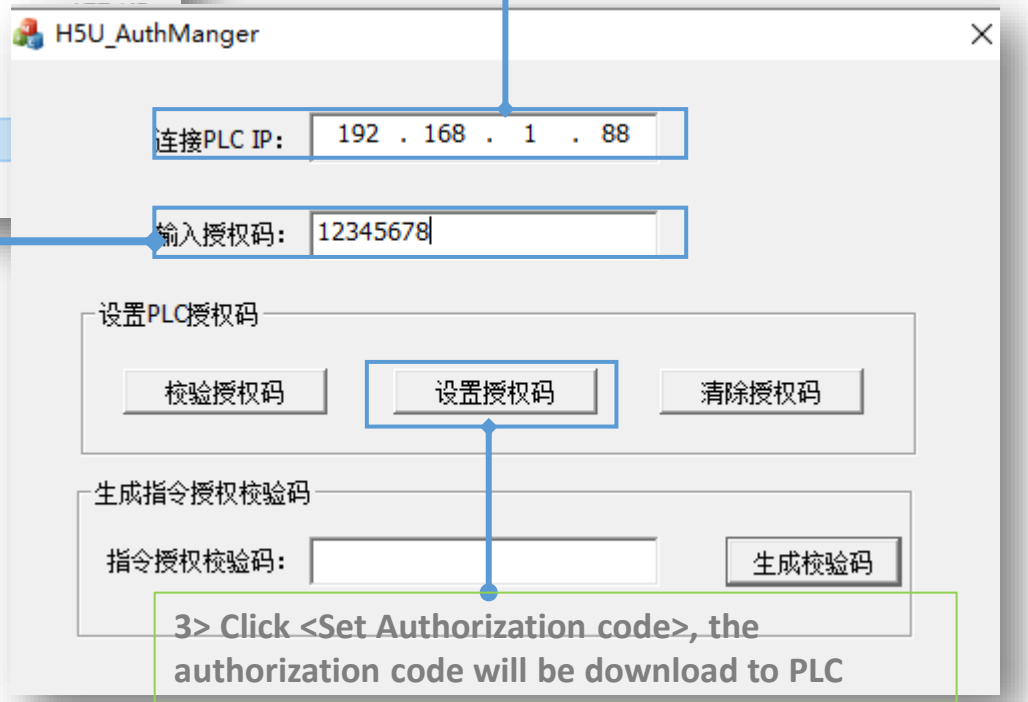
Verification function
AuthCode: Verification code
Result: ON: valid OFF:failed

➢ FB Authority

To set the FB authorization, need use a tool called <H5U_AuthManager>, users can find this tool in AutoShop installation directory



1>Input PLC IP address. Make sure the PLC is connected well with Ethernet cable

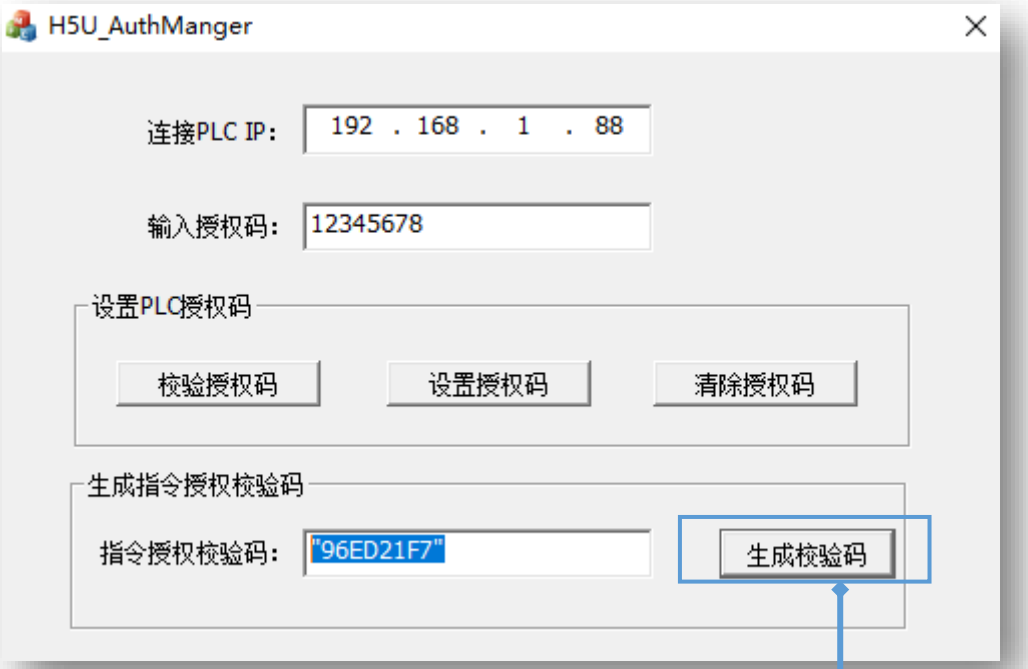


2>Input authorization code, it is a 8 digits numbers set by users

3> Click <Set Authorization code>, the authorization code will be download to PLC

FB Authority

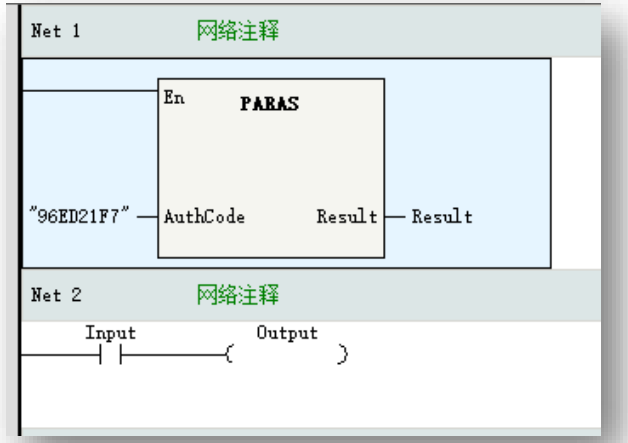
After download the authorization code into controller, users need generate a verification code which will be used in the function block.



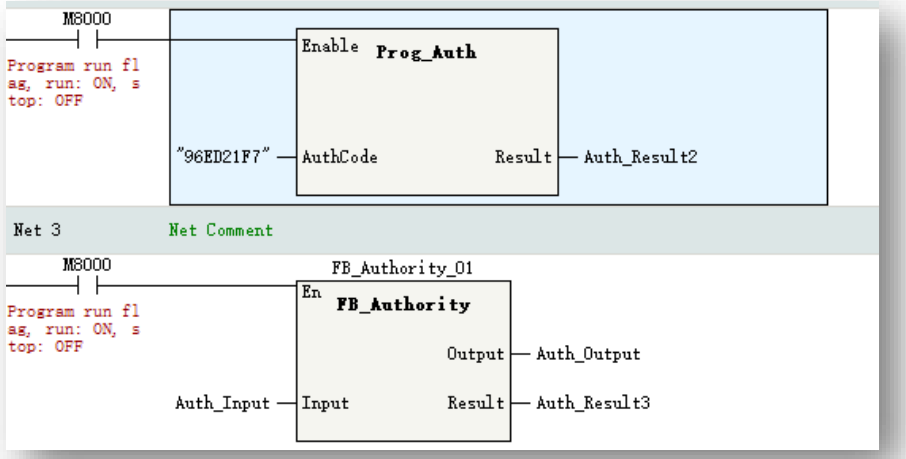
Click <Generate verification code>, then the verification code will be generated, in this case, the verification code is '96ED21F7'.

FB Authority

Open the function block, add the verification function PARAS, the <AuthCode> set as the verification code('96ED21F7').



Open the program, add function PROG_AUTH. If the verification code not match with the controller, the FB will not execute.

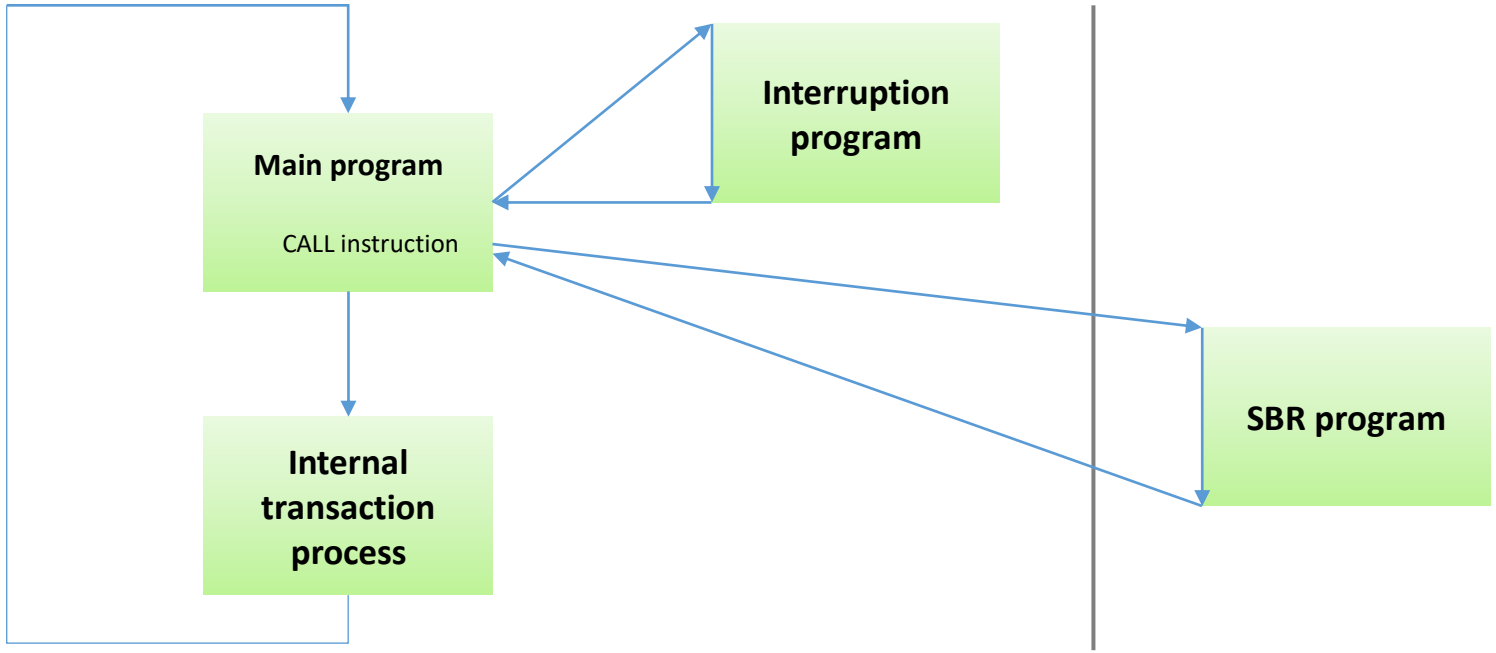


Sub Program

Sub routine category:

Prefix	Meaning	Description
SBR	Common sub routine	Support up to 1024 sub programs, and the sub program can be encrypted.
INT	Interruption routine	External interruption: X0~X3 input interruption, include rising edge, falling edge and rising/falling edge Timing interruption: 4 channel (time base=1ms) Comparison interruption: 1~16

Sub routine executing mechanism:



Sub Program

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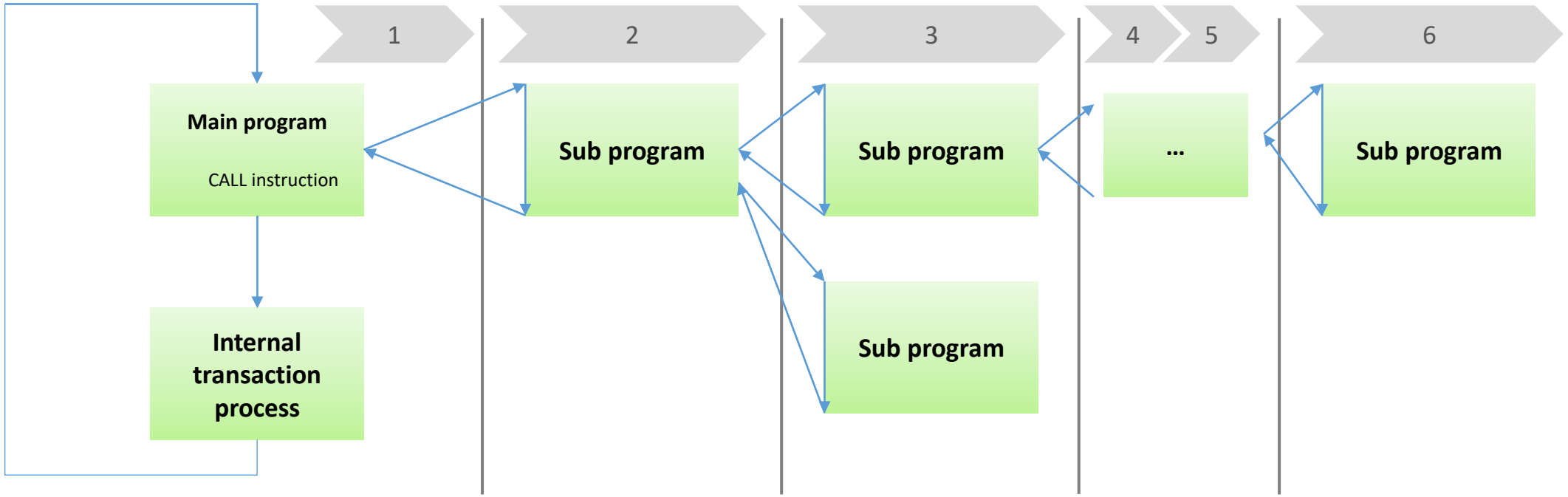
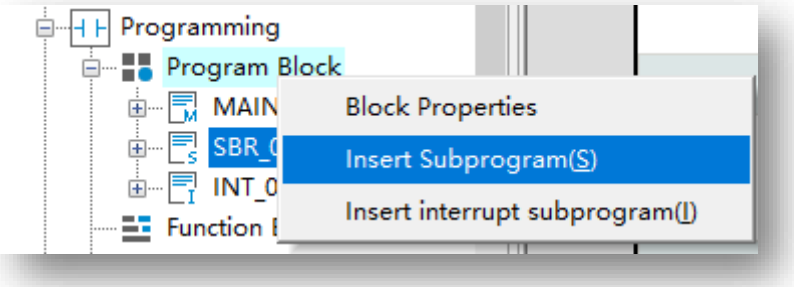
H5U support up to 6 stage sub routine nested. Main program invoke the sub program as the first nested stage, and the invoking in first sub program as the second nested stage, and so on for other nested stages.

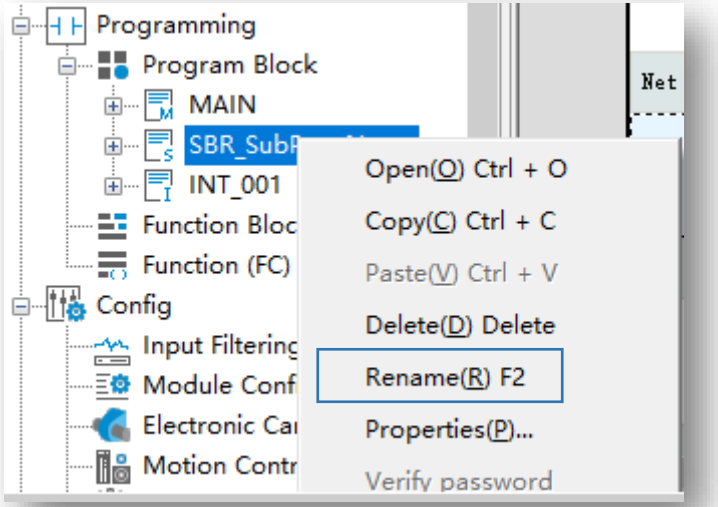


Common Sub Program

In the device tree <Programming>→<Program Block>, right click to <Insert Subprogram>

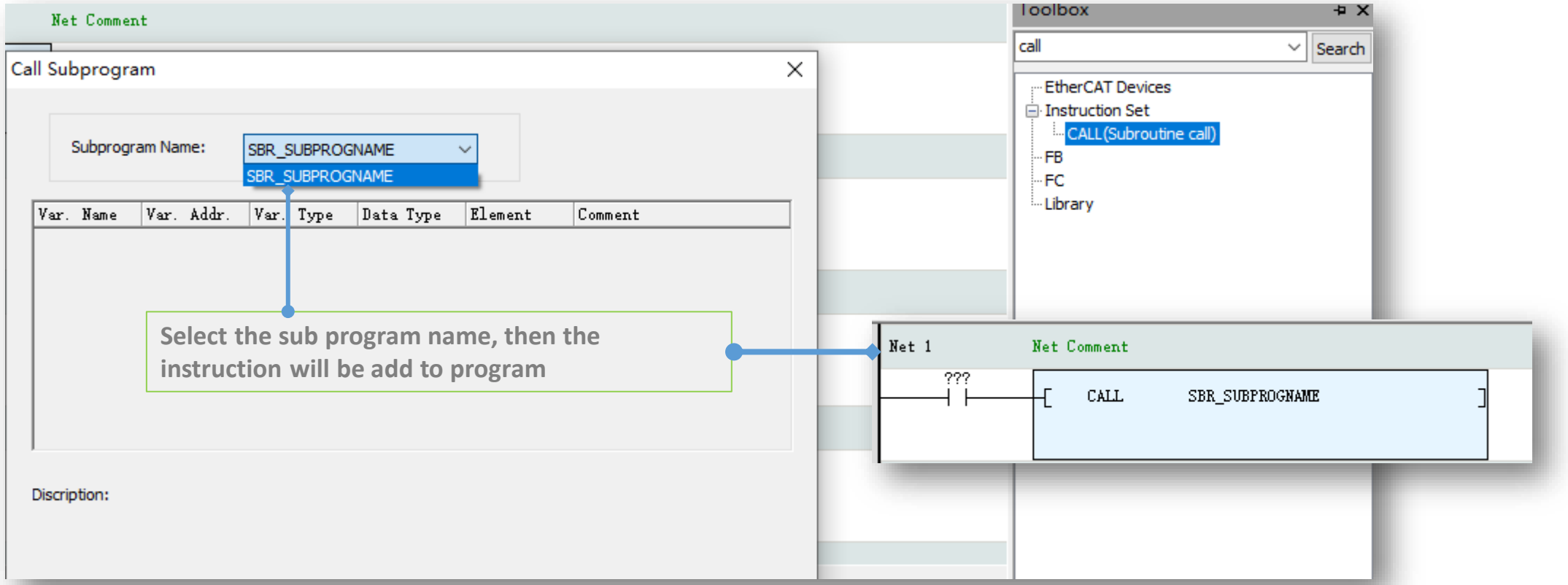


Select the new add sub program, right click <Rename> to modify the program name



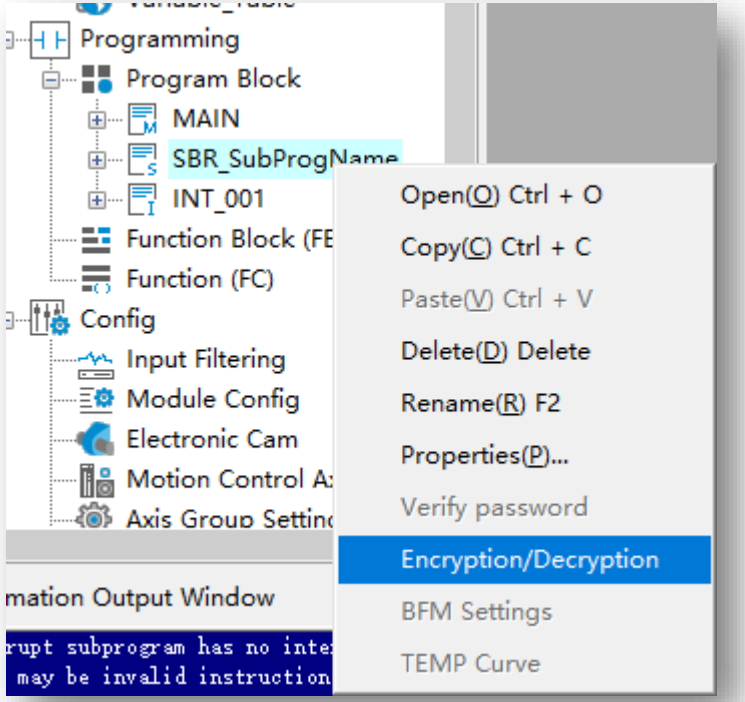
Call Sub Program

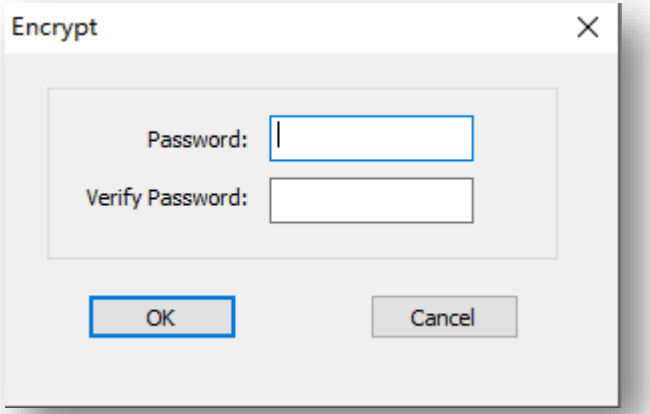
Using <Call> instruction to invoke the sub program. Select <Call> in tool box, then the instruction configuration assistant window will pop up, select the corresponding sub program.



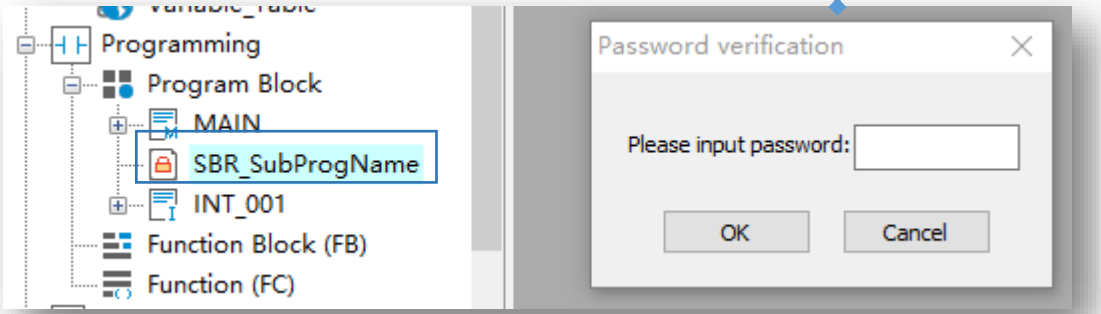
Encryption Sub Program

To encrypt a sub program, users need to right click to select the <Encryption/Decryption>, then set the sub program password in the pop up setting view.



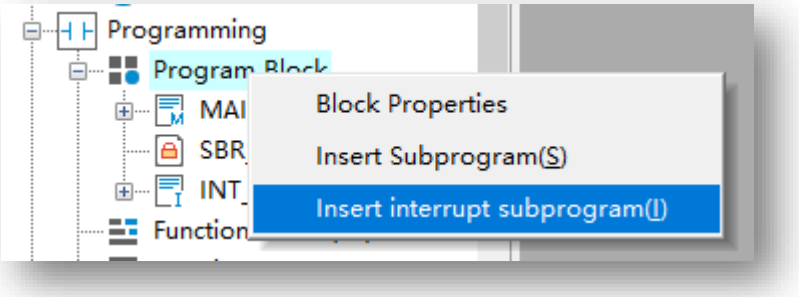


An encryption sub program looks different with non-encrypted program, and it have to enter the password to check the program details.

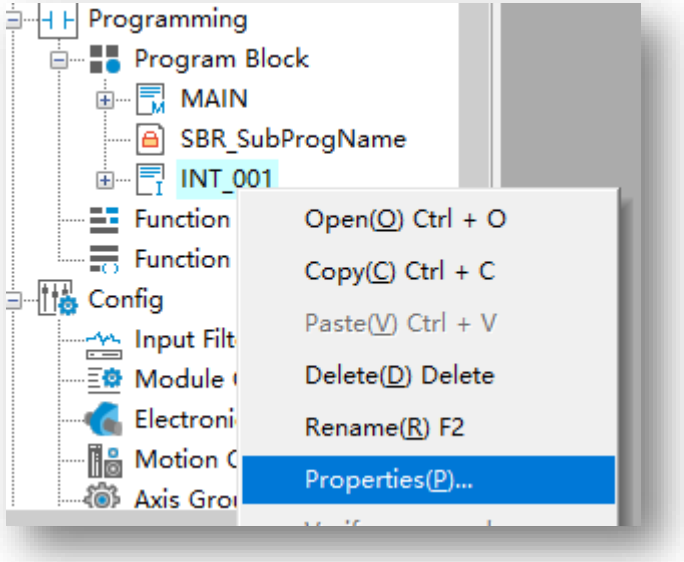


➢ Interruption Sub Program—External interruption

1>In device tree <Programming>→<Program Block>, select <Insert Interrupt subprogram>

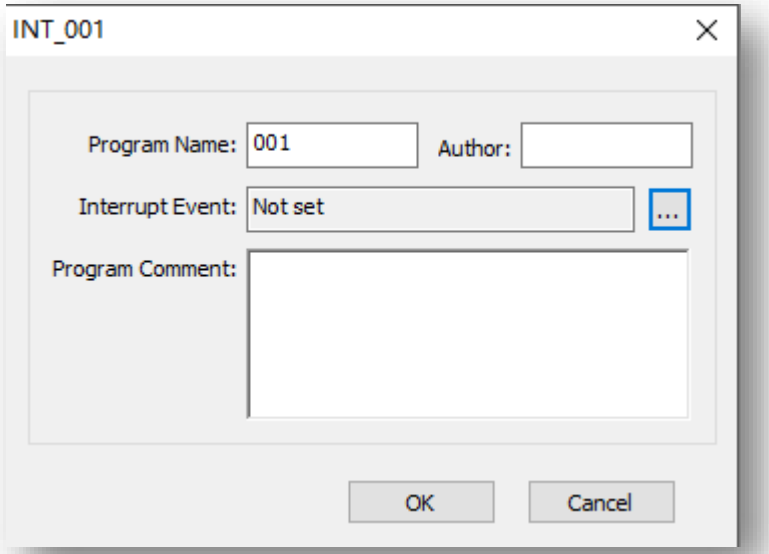


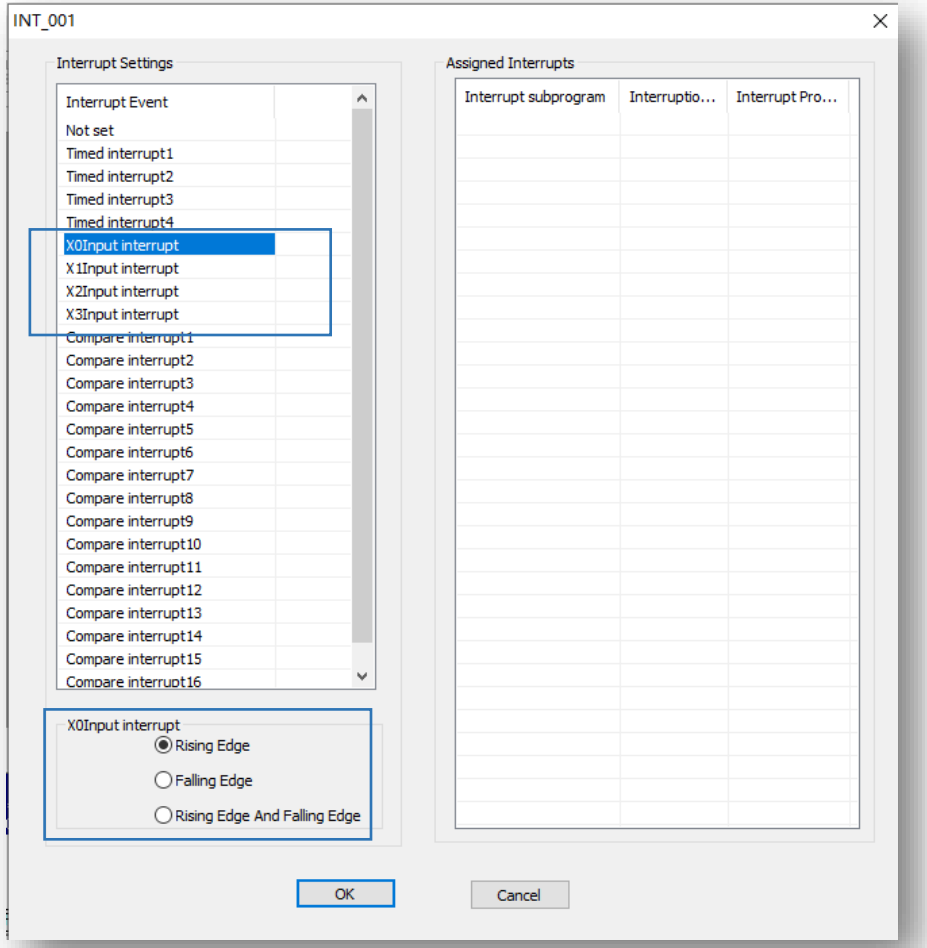
2>Select the interruption sub program, right click <Properties> to open the configuration view



Interruption Sub Program—External interruption

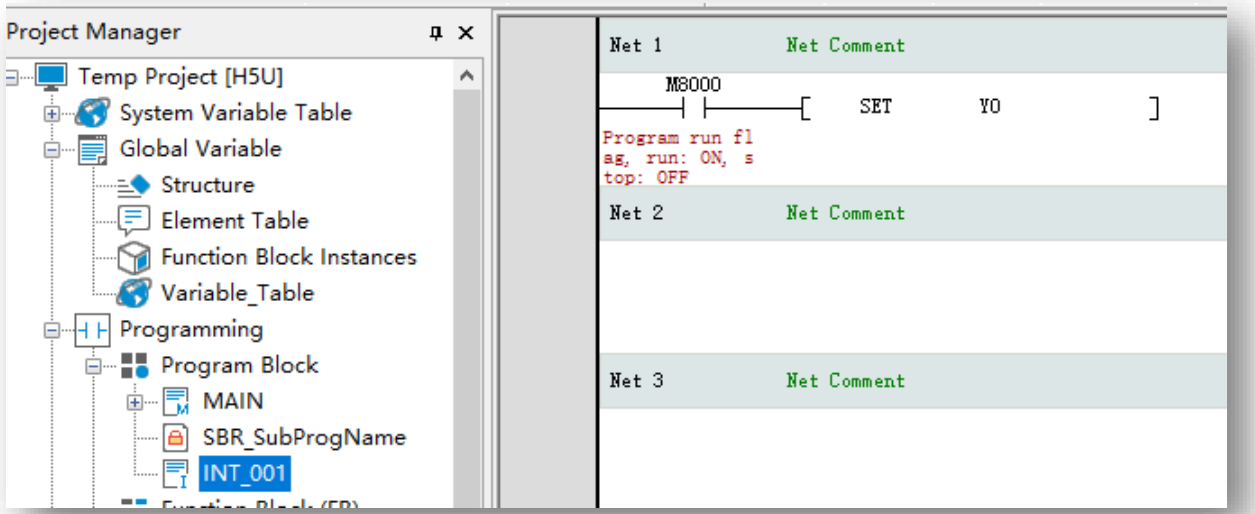
3>In the configuration view, click <…> to enter the interruption event selection view, select <X0(/1/2/3) interrupt> and set the trigger signal type.



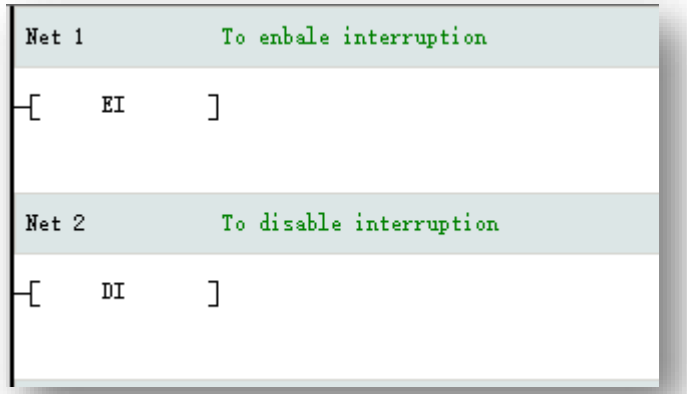


Interruption Sub Program—External interruption

4>Edit program in interruption sub program

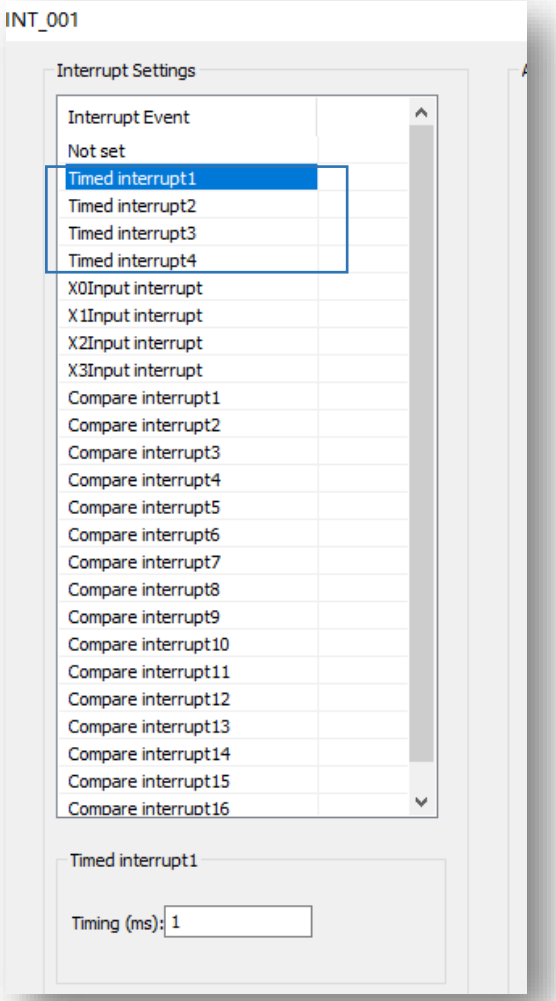


5>Use <EI> command in main program to enable interruption, <DI> to disable interruption



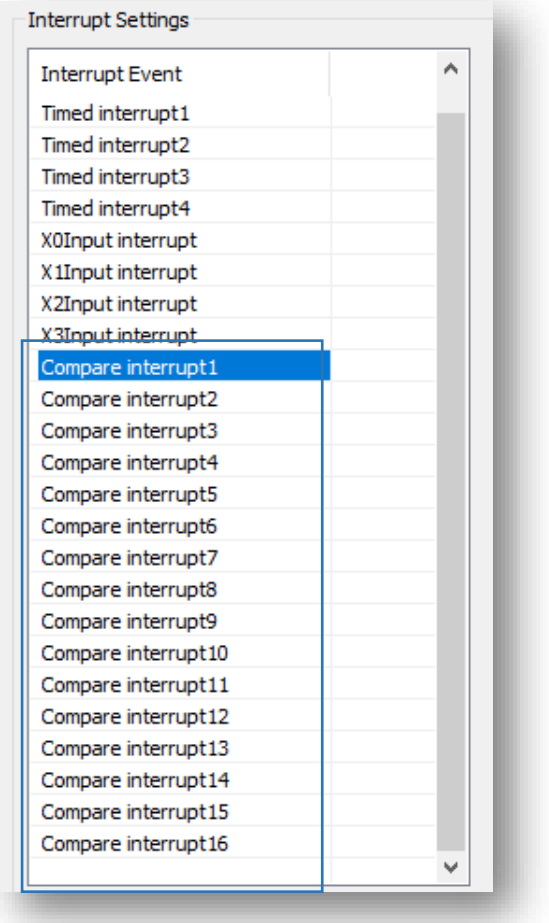
Interruption Sub Program—Timing interruption

Please follow the <External Interruption> configuration steps, the only difference is in Step3, select <Timed interrupt*>, the time base is 1ms, and the range of timing time is 1~1000ms.



➢ Interruption Sub Program—Comparison interruption

Please follow the <External Interruption> configuration steps, the only difference is in Step3, select <Compare interrupt*>, H5U support up to 16 comparison interruption.
Take note, to use comparison interruption, need using specified function block to set the comparison interruption, please refer the instruction <High speed inputs>.



H5U Error Code

H5U Error Code—Program Error

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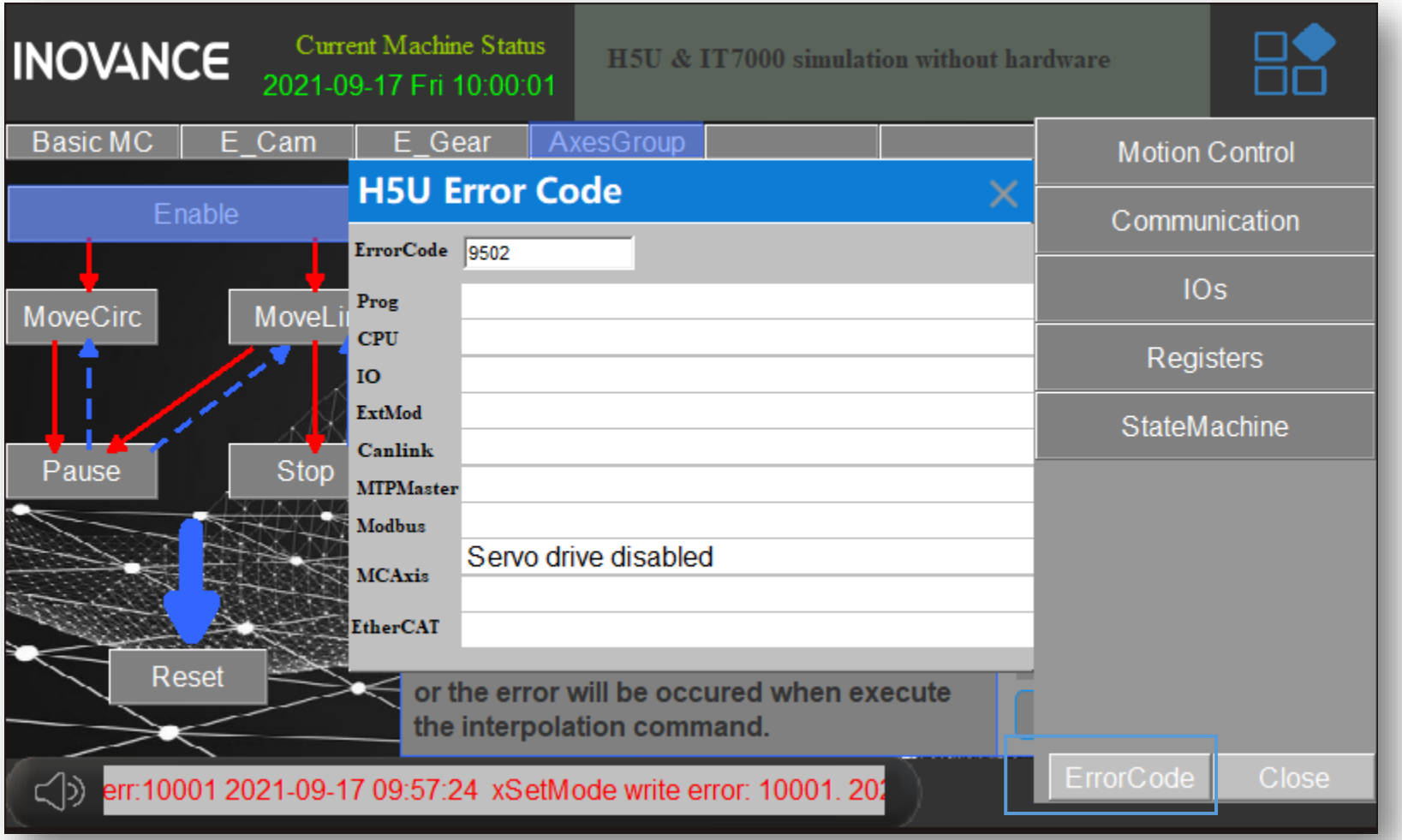
H5U English application manuals are not ready, Users can check the error code of H5U in the IT7000-H5U application example, or check in this document(next slides).



H5U Error Code—Program Error

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1500	WatchDog Overtime
1501	Undifiend Command
1502	Un-complete Program
1503	Authority Code Error
1504	Empty Program
1505	POU Error
1510	Sub Routine Error
1511	Sub Routine Type Error
1512	Sub Routine Number Error
1513	Sun Routine Address Error
1514	Interruption Routine Number Error
1515	Interruption Routine Address Error
1516	Interruption Routine Property Error
1517	Interruption Routine Timing Time Error
1520	Program Error
1521	Program Type Error
1522	Program Number Error
1523	Program Address Error
1524	Program Variable Quantity Error
1525	Program Variable Length Error
1526	Program Head Data Error
1530	CJ-LBL Label Number Error

1531	CJ-LBL Label address Error
5001	Program Abnormal, part of commands not executed
5010	CALL Command Error: Sub routine number error
5011	CALL Command Error: Sub routine not exist
5012	CALL command Error: Sub routine program nested over range
5013	CALL Command Error: Sub routine return error
5014	Sub Routine invoking and Return Not Match
5015	Interruption program not define
5016	Interuption program interuption quenes overflow
5020	FB/FC Program Number Error
5021	FB/FC Program Not Exist
5022	FB/FC Variable Not Exist
5023	FB/FC nested over range
5024	FB/FC Return Error
5025	Program invoke and return not match
5030	CJ-LBL command LBL Number Error
5031	CJ-LBL command LBL Not Exsit
5032	FOR/NEXT nested over range
5033	FOR/NEXT loop times over RANGE
5034	FOR/NEXT loop times equal to 0
5035	FOR/NEXT not match
5101	Command Parameters Address Error
5102	Command Parameters Over Range
5103	xxxx0001 Error
5104	Command Parameters Order Error
5105	String Command: String Error or Length Error
5110	Pointer Number Error

5111	Pointer Not Initiate
5112	Pointer point to Empty or over Range
5113	Pointer offset value over range
5114	Pointer point to Empty or over range after calculation
5120	Counter failed to instantiate
5121	Counter Command Comparison value error
5130	Timer failed to instantiate
5131	Timer Command Comparison value error
5140	SFC/STL branch over range
5150	FB command failed to instantiate
5160	Array Index Error: encoder error or not exist
5161	Array index Error: Over range
5600	SerialSR command failed to instantiate
5601	SerialSR command port number error
5602	SerialSR command protocol error
5603	SerialSR command port conflict
5604	SerialSR send data over range
5605	SerialSR send data buffer abnormal
5606	SerialSR receive data over range
5607	SerialSR receive data buffer abnormal
6580	CANopen Axis Command: Invalid Axis No.
6701	Invalid Memory Address
6705	Invalid Memory Size
6706	Data Error: Unreasonable or over range
6711	Invalid variable address
6712	invalid variable size
6713	invalid variable coding

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1011	FPGA initial failed
1012	Interruption initial failed
1013	Timing Interruption initial failed
5200	Non-volatile data error
5238	Alarm: 2038 is coming
5250	RTC not stable
5900	Ethernet IP address conflict

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5300	Initial failed
5301	invalid input filter

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5400	Hardware initial failed
5401	Config data analysis failed
5402	ExtMod slot initial failed
5403	ExtMod Not Found
5404	ExtMod and Config Not Match
5405	ExtMod Hardware Interface Abnormal
5406	ExtMod Software Interface Abnormal
5411	ExtMod No Power Supply
5412	ExtMod Hardware Fault
5413	ExTMod Temperature is too high
5419	ExtMod Input/Output Overflow(up)
5420	ExtMod Input/Output Overflow(low)
5421	ExtMod Input over up limit or output no connection
5422	ExtMod Input over lower limit or output short circuit
5423	ExtMod Input no connection or Output hardware fault

6300	Input device not assigned to Axis
6301	Axis scaling parameters error
6302	Software limit or rotory prameters invalid
6303	Invalid Axis Counter Mode or Input signal type
6304	invalid input for axis preset func
6305	Invalid input for touch probe 1
6306	Invalid input for touch probe 2
6307	invalid output for comparison output
6308	Invalid pulse width for comparison output
6400	Slave address conflict
6401	Slave offline
6411	Slave abnormal 1: undefined device code
6412	slave abnormal 2: PDO number over range
6413	slave abnormal 3: invalid register address
6415	slave abnormal 5: invalid register length
6416	slave feedback timeout
6421	slave sync abnormal 1: invalid command code
6422	slave sync abnormal 2: invalid register address
6423	slave sync abnormal 3: data over range
6424	slave sync abnormal 4: invalid operation under current status
6425	slave sync abnormal 5: invalid data length
6426	slave feedback timeout while sync

H5U Error Code—Modbus

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5500	Modbus-RTU data length have to be 8 bit
6001	Abnormal(01):invalid function code
6002	Abnormal(02):invalid data address
6003	Abnormal(03):invalid data value
6004	Abnormal(04):slave device fault
6128	different station No. between request and response frame
6129	different functoin code between request and response
6130	different data address between request and response
6131	different data value between request and response
6240	invalid map address
6255	request timeout

H5U Error Code—Modbus TCP Master

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6000	No Connection
6001	Abnormal(01):invalid function code
6002	Abnormal(02):invalid data address
6003	Abnormal(03):invalid data value
6004	Abnormal(04):slave device fault
6128	different station No. between request and response frame
6129	different function code between request and response
6130	different data address between request and response
6131	different data value between request and response
6240	invalid map address
6255	request timeout

H5U Error Code—Motion Control Axis

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9001	Local Axis Estop valid
9003	Over speed(pulse output over 200kHz)
9020	Homing Error: N-limit not mapped
9021	Homing Error: P-limit not mapped
9022	Homing Error: Origin not mapped
9023	Homing Error: pulse output over 200kHz
9024	Homing Error: timeout
9025	Homing Error: limit signal error
9030	Limit Valid
9031	sync error: target output pulse not match with actual output pulse
9101	Axis Type error or not exist
9102	axis config failed
9103	invoke MC_Reset when axis no error
9104	axis in unknow statuswhen invoking MC_ReadStatus
9105	Invoking MC_SetPosition while axis running
9106	Axis in fault stopping
9107	Unreasonable Parameters
9108	Unreasonable PLCopen state machine
9110	re-invoke MC_Stop
9111	Command linked list lost
9112	Axis No. Change
9113	MC_Reset Timeout
9114	0x6060 write failure
9115	Invoke MC_Halt when stopping
9116	Axis in online debug mode
9117	Command functionality not available
9118	Command acc/dec over range
9119	MC_Jog target velocity over range
9120	target velocity over range
9121	Jog command P/N siganals valid at same tiem

9122	EtherCAT axis without control word mapping
9123	EtherCAT axis without target position mapping
9124	EtherCAT axis without target torque mapping
9125	EtherCAT axis without status word mapping
9126	EtherCAT axis without actual position mapping
9127	EtherCAT axis without 0x60FD mapping
9128	EtherCAT axis without actual torque mapping
9129	EtherCAT axis without TP control word mapping
9130	EtherCAT axis without TP status word mapping
9131	EtherCAT axis without TP position mapping
9132	MC_MoveFeed occupied the probe channel
9133	Axis in virtual mode
9134	Virtual axis TP is on use
9135	No interruption detected while MC_MoveFeed done
9136	TP channel occupied while MC_MoveFeed on use
9137	Filed bus drive without 0x6060 mapping
9138	Filedbus drive without 0x6061 mapping
9139	Re-invoke MC_Home while homing
9140	Command target torque over limit
9141	Filed bus drive without max vel mapping
9142	Estop valid
9143	Re-invoke Estop Command
9144	Limit valid when jogging
9145	Target position over 9999999
9146	Target velocity over 9999999
9147	Target acceleration over 9999999
9148	Target deceleration over 9999999
9149	Axis in SYNC motion status
9150	MC_Halt valid
9151	MC_MoveVelocityCSV pulse width over range

H5U Error Code—Motion Control Axis

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9152	CSV mode without 0x60FF mapping
9153	TP terminal not configure
9200	Failed to get CAM configuration file
9201	Failed to get master axis
9202	Failed to get slave axis
9203	failed to get CAM table
9204	CAM quantities over range
9205	CAM key points not found
9206	Modify master axis while in CAM
9207	MC_CamIn StartMode over range
9208	MC_CamIn StartPosition over range
9209	MC_CamIn MasterStartDistance over range
9210	MC_CamIn MasterScaling over range
9211	MC_CamIn SlaveScaling over range
9212	MC_CamIn MasterOffset over range
9213	MC_CamIn SlaveOffset over range
9214	MC_CamIn MasterScaling is non-positive number
9215	MC_CamIn SlaveScaling is non-positive number
9216	MC_CamIn/MC_GearIn ReferenceType over range
9217	MC_CamIn Direction over range
9218	MC_CamIn BufferMode over range
9219	CAM table master position not in ascending order
9220	CAM table curve type over range
9221	MC_CamOut target deceleration over 9999999
9222	MC_CamOut target deceleration over range
9223	MC_Phasing target acceleration over 9999999
9224	MC_Phasing target acceleration over range
9225	MC_Phasing target velocity over 9999999
9226	MC_Phasing target velocity over range
9227	MC_CamOut curve type over range

9228	MC_CamOut mode over range
9229	MC_GenerateCamTable:CAM points array is empty
9230	MC_GenerateCamTable:CAM points over limit
9231	MC_GenerateCamTable:Mode over range
9232	MC_GenerateCamTable: Nodes less than 2
9233	MC_GearIn RatioNumberator equal to 0
9234	MC_GearIn RatioDenominator is non-positive number
9235	Invoke MC_SaveCamTable while MC_GenerateCamTable on use
9236	Invoke MC_GenerateCamTable while MC_SaveCamTable on use
9237	Failed to open CAM file while executing MC_SaveCamTable
9238	Failed to write points number while executing MC_SaveCamTable
9239	Failed to write data while executing MC_SaveCamTable
9240	First master position is not 0
9241	First slave position is not 0
9242	MC_GearOut Mode over range
9243	MC_Phasing deceleration over 9999999
9244	MC_GearIn deceleration over 9999999
9245	MC_CamIn Periodic over range
9246	CAM master position over 9999999
9247	CAM slave position over 9999999
9248	CAM speed over 9999999
9249	Gear Points is empty
9250	Master and slave map to same axis
9251	Master address greater than slave address
9252	Master fFilter[0] over range
9253	Master fFilter[1] over range
9254	Master fFilter[2] over range
9255	Sum of Master filter coefficients is not equal to 1
9256	MC_CamIn: unreasonable StarPosition and MasterStartPosition(positive direction)

H5U Error Code—Motion Control Axis

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9257	MC_CamIn: unreasonable StarPosition and MasterStartPosition(negative direction)
9258	MC_GearOut deceleration over 9999999
9259	MC_Phasing deceleration over range
9260	MC_GearIn deceleration over range
9261	MC_GearOut deceleration over range
9262	MC_GearIn acceleration over 9999999
9263	MC_GearIn acceleration over range
9264	MC_Phasing curve type over range
9265	MC_GearIn curve type over range
9266	MC_GearOut curve type over range
9267	Modify slave while in CAM
9268	MC_Phasing PhasingMode over range
9269	Axis not in CAM while invoking MC_CamOut
9270	Axis not in GEAR while invoking MC_GearOut
9271	Too much master position change in CAM/GEAR(1 EtherCAT cycle)
9272	MC_GetCamTableDistance Phase over range
9273	Modify slave while invoking MC_GearIn
9400	Axis number over limit(Axes up to 4)
9401	Axis in axes group in error status
9402	Buffer ITP commands over 8
9403	Axis reused in Aexs groups
9404	Lack of X/Y axis in Axes group
9405	Z axis not exist in axes group
9406	Axes group: auxiliary axis not exist
9407	Axes group: axes group ID reuse
9408	Axes group: failed to configure axis
9409	Axes group: ID less than 0
9410	Axes group not released
9411	MC_GroupStop aborted

9412	MC_MoveCircular: CircAxes over range
9413	MC_MoveCircular: CircMode over range
9414	MC_MoveCircular: PatchChoice over range
9415	MC_GroupStop: StopMode over range
9416	Axes group: X axis is in rotation mode
9417	Axes group: Y axis is in rotation mode
9418	Axes group: Z axis is in rotation mode
9419	Axes group: A axis is in rotation mode
9420	Re-trigger MC_MoveCircular
9421	Re-trigger MC_MoveLinear
9422	Failed to get axes group
9423	Axes group: failed to configure axis
9424	Axes group: axis in axes group not enabled
9425	Axes group: axis in axes group in single motion status
9426	Axes group: axis in axes group in stopping status
9427	Axes group in stopping status
9428	Axes group: axis in axes group in homing status
9429	Axes group: axis in axes group executing MC_SetPosition
9430	Axes group: axis in axes group in debug mode
9431	Axes group: axis in axes group get into debug mode while ITPing
9432	Axes group: Failed to get memory
9433	Axes group: Target Velocity is 0
9434	Axes group: Target acceleration is(or less then) 0
9435	Axes group: Target deceleration is(or less then) 0
9436	Axes group: CurveType over range
9437	Axes group: Unreasonable AbsRelMode
9438	Axes group: Unreasonable BufferMode
9439	Axes group: Unreasonable InsertMode
9440	Axes group: Axis in axes group in fault
9441	Axes group: re-invoke MC_GroupStop

H5U Error Code—Motion Control Axis

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9442	Axes group: Data Buffer is not empty
9443	Axes group: Cannot form an arc
9444	Axes group: Cannot form an circle
9445	Axes group: Command buffer is full
9446	Axes group: X axis speed over range
9447	Axes group: Y axis speed over range
9448	Axes group: Z axis speed over range
9449	Axes group: A axis speed over range
9450	Failed to get axes quantities
9451	Internal fault
9452	Cannot invoke this command in StandStill Status
9453	Speed over range
9454	ACC/DEC over range
9455	MC_MoveLinear error
9456	MC_MoveCicular error
9457	MC_GroupStop error
9458	MC_GroupPause error
9459	X axis is running in other group
9460	Y axis is running in other group
9461	Z axis is running in other group
9462	A axis is running in other group
9463	MC_GroupStop:axis in axes group in other sync motion(CAM or ITP)
9464	MC_MoveLinear/Circular:axis in axes group in other sync motion(CAM or ITP)
9465	MC_GroupPause:axis in axes group in other sync motion(CAM or ITP)
9501	EtherCAT servo error
9502	Servo drive disabled
9503	Limit valid
9505	Failed to modify control mode
9508	failed to homing

9509	Axis internal caculation error
9510	Fllowing error over range
9512	Servo disconnected during running
9513	Failed to homing caused by servo fault
9514	Failed to homing caused by offset over range
9515	Failed to homing caused by slave lost
9516	Failed to homing caused by SDO writing failure(0x607C)
9517	Failed to homing caused by SDO writing failure(0x6060)
9518	Failed to homing caused by SDO reading failure(0x6061)
9519	Failed to homing caused by SDO writing failure(0x6060=8)
9551	Failed to exchange control mode
9552	Target velocity is 0
9601	MC_MoveAbsolute pars abnormal
9602	MC_MoveRelative pars abnormal
9603	MC_MoveVelocity pars abnormal
9604	MC_Jog pars abnormal
9605	MC_MoveVelocityCSV pars abnormal
9606	MC_MoveBuffer pars abnormal
9607	MC_MoveFeed pars abnormal
9608	MC_Stop pars abnormal
9609	MC_MoveTorque pars abnormal
9610	MC_Halt pars abnormal
9611	MC_MoveSuperImposed pars abnormal
9612	MC_SyncMoveVelocity pars abnormal
9613	MC_SyncTorqueControl pars abnormal
9701	Failed to apply memory for encoder axis
9702	Invalid encoder axis type
9703	Axis config failure
9704	No config for 'Counter operation command' of encoder axis IO mapping
9705	No config for 'Counter status' of encoder axis IO mapping

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9706	No config for 'Encoder present position' of encoder axis IO mapping
9707	No config for 'Pulse rate' of encoder axis IO mapping
9708	Encoder axis: pos limit not greater than neg limit
9709	Encoder axis: pos limit over 2147483647(pulse unit)
9710	Encoder axis: neg limit below -2147483647(pulse unit)
9711	Encoder axis: rotation mode cycle over 2147483647(pulse unit)
9712	ENC_Counter: exchange axis mapping while command valid
9713	GR10-2HCE fault
9714	Encoder axis: failed to reset fault
9715	invoke ENC_Reset while there is no encoder axis error
9716	ENC_Preset: TriggerMode over range
9717	ENC_Preset: position over 9999999
9718	No config for 'Physical output command' of encoder axis IO mapping
9719	Encoder axis:Preset value or comparison output value over pos limit
9720	Encoder axis:Preset value or comparison output value below neg limit
9721	Encoder axis:Preset value or comparison output value over 2147482647 or below -2147483638(pulse unit)
9722	Encoder axis:Preset value or comparison output value over(or same as) cycle value(rotation mode)
9723	ENC_TouchProbe: ProbeID over range
9724	ENC_TouchProbe: TriggerEdge over range
9725	ENC_TouchProbe: TerminalSource over range
9726	ENC_TouchProbe: TriggerMode over range
9727	No config for probe statusword of encoder axis IO mapping
9728	No config for probe position feedback of encoder axis IO mapping
9729	No config for control word of encoder axis IO mapping
9730	Encoder axis: probe window first position greater(or equal to) than last position
9731	Xn0 not config as touch probe

9732	Xn1 not config as touchprobe
9742	No config for 'Compared mode' of encoder axis IO mapping
9743	No config for 'Compared pulse/time' of encoder axis IO mapping
9744	No config for 'Compared size/step' of encoder axis IO mapping
9745	No config for 'Compared point value 1' of encoder axis IO mapping
9746	No config for 'Compared point value 2' of encoder axis IO mapping
9747	No config for 'Physical output status' of encoder axis IO mapping
9748	No config for 'Compare error code' of encoder axis IO mapping
9749	No config for 'Current compare number/position' of encoder axis IO mapping
9750	Single axis array comparison command failed to get array address
9751	Axes array comparison command failed to get array address
9752	Fieldbus encoder axis not map to a slave
9753	Axes array comparison command not map to same slave
9754	Axes array comparison command X axis not map to ch0 of slave
9755	Axes array comparison command Y axis not map to ch1 of slave
9756	Yn0 not config as comparison output
9757	ENC_StepCompare:StartPosition over 9999999
9758	ENC_StepCompare:EndPosition over 9999999
9759	ENC_StepCompare:abs value of Step over 9999999
9760	Encoder comparison output command 'Parameter' over 9999999
9761	Encoder comparison output command 'Mode' over 9999999
9762	Encoder comparison output command time over range(time mode)
9763	ENC_StepCompare: Step is 0
9764	ENC_StepCompare: StartPosition is same as EndPosition
9765	ENC_StepCompare: Step is negative value while StartPosition < EndPosition
9766	ENC_StepCompare: Step is positive value while StartPosition > EndPosition
9767	ENC_ArrayCompare: Size over range

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9768	ENC_ArrayCompare:target position over 9999999
9769	Current axis is on single comparison process cannot aborted by array comparison command
9770	EtherCAT slave offline
9771	Fieldbus encoder axis is in offline debug mode
9772	Digital input not config as preset position functionality
9773	Comparasion commands: Parameter over range(pulse mode)
9774	2HCE model fault while invoke comparison commands
9775	Set position below 0 while in rotation mode
9776	Y00 not config as array comparison output
9777	Current axis is on array comparison process cannot aborted by single comparison command
9800	Cannot read the quantities of axes
9801	Axes quantities over range
9802	Axis internal memery assigned failure
9803	Axis failed to get parameters
9804	Failed to get slave

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8001	Failed to read master info
8002	Failed to read slave info
8003	EtherCAT start timeout
8004	Failed to apply master
8200	Failed to write SDO to slave
8201	Slave lost while fieldbus running
8202	Slave swith to non operational mode
8203	Slave state machine switch failure
8204	Slave type not match
8205	PDO address error
8206	PDO length error
8301	Failed to switch to INIT state
8302	Failed to switch to PreOP state
8304	Failed to switch to SafeOP state
8308	Failed to switch to OP state
8310	FMMU unit config error
8311	Mailbox config error
8400	ECTA config error
8401	ECTA hardware error
8402	ECTA extension module error

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