

Voice Coil Actuator Series Drive User Guide



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1 Installation

1.1 Dimension





Fig. 1-1 Dimension (unit: mm)

1.2 Assembly and Disassembly

Before installation, please check the product package:

- Servo drive
- Connector corresponding to the servo drive
- User manual (scan the QR code card to access to the official website for download).

Please note the following during disassembly:

- Careful remove the box.
- Make sure the product is free of cosmetic damage. If there are such damages, please contact us.
- Check the model on the housing of the product and make sure the product is your desired one.
- Check if the rated voltage meets your demands.

1.3 Mechanical Installation

This servo is a pedestal type servo amplifier and failures may occur if installed in the wrong way.

1.3.1 Installation Site

- Please do not use this product in the vicinity of corrosive and flammable gas environments such as hydrogen sulfide, chlorine, ammonia, sulfur, chlorinated gases, acids, alkalis, salts, and combustible materials.
- Please do not install this product in the environments with high temperature, humid places and lots of dust and iron powder.
- Please do not use this product in a closed environment where will cause high temperature of the servo and shorten the service life.
- Please note the following:
 - ✓ For servo drives with 200W and below, there is no special requirements for installation.
 - \checkmark For servo drives with 400W, please make sure that the temperature of the secondary

cooling installation surface is below 55°C.

 \checkmark For servo drives with 750W, please make sure the temperature of the installation

surface is below 55°C, and make sure at least 3 m/s wind convection with wind

direction along the horizontal direction of PCB.

1.3.2 Environmental Condition

Projects	Description		
	• 0: 0°C - +50°C		
Ambient temperature	• 1: -40°C - +50°C		
Amplent temperature	• 2: -55°C - +50°C		
	• 3: -70°C - +50°C		
Environmental humidity	< 95% RH (no condensation)		
Storago tomporaturo	• -40°C - +85°C (no freezing)		
	• 7-0°C - +85°C (no freezing)		
Storage humidity	0% - 95% RH (no condensation)		
Vibration	< $5 \mathrm{m/s^2}$		

 Table 1-1 Environmental conditions

1.3.3 Installation Steps

Note: The servo drive should be vertically installed on the wall and M3 screws must be tightened. For other requirements.

- On the back of the mounting plate, mark the position of screw hole. The hole spacing is shown as in Figure 2-1, and the specification of heat sink hole is M3,.
- Tap threads according to the mark, and make sure threads have full contact.
 Note: The metal surface of the mounting plate should not be coated or painted, and if so, please scrape it off. Otherwise the electromagnetic compatibility will deteriorate.
- Vertically mount the servo drive on the back of the mounting plate.
 Note: Please pay attention to the installation spacing, and make sure the mounting surface is in good contact.

2 System Wiring

2.1 Interface Definition

There are 6 interfaces on the servo drive. Among them, the following interfaces are external:

- J10-J11: EtherCAT communication interface
- J5: USB communication interface
- J6: IO interface
- J7: Motor encoder feedback interface
- J9: Power input and output interface

The pin definition of each interface is shown in Figure 2-1:



Figure2 -1 Interface definition

2.1.1 Pin Definition of J10 and J11

Interface	Pin	Pin Name
	1	TX+
J10/J11-EtherCAT	2	TX-
(J11-IN; J10-	3	RX-
OUT)	5	RX+
	4、6	PE

2.1.2 Pin Definition of J5

You can communicate with the servo drive for parameter settings and debugging via the standard Micro-USB cable.

2.1.3 Pin Definition of J6

Interface	Pin	Pin Name
	1	+24V_OUT
	2	GND-OUT
	3	DO2_OUT
	4	DO3_OUT
	5	DO0_OUT
	6	DO1_OUT
	7	DI4_IN
	8	DI5_IN
J6-IO interface	9	DI2_IN
	10	DI3_IN
	11	DI0_IN
	12	DI1_IN
	13	STO0
	14	GND-IN
	15	STO1
	16	STO_RET

Table 2-2 Pin definition of J6

2.1.4 Pin Definition of J7

Interfa	Din	Pin name				
се	ce Abs		Incremental	Hall	Analog	Power supply
	1					PE
	2					GND
	3		INC_A+			
	4		INC_A-			
	5		INC_B+			
J7-	6		INC_B-			
motor	7		INC_Z+			
encod	8		INC_Z-			
er	9					
feedba	10					
ck	11				AI1+	
ce	12				Al1-	
	13				Al2+	
	14				Al2-	
	15					
	16					
	17			HALL_U		
	18					5V
	19			HALL_W		
	20			HALL_V		

Table 2-3 Pin definition of J7

2.1.5 Pin Definition of J9

Interface	Interface	Pin Name			
	Pins				
	1	U			
	2	V			
J9-power input	3	W			
and output	4	PE			
interface	5	DC+			
	6	DC-			

Table 2-4	Pin defir	nition of	J9
-----------	-----------	-----------	----

Caution:

- 1. For voice coil motor or DC brush motor, please connect the power cable to UV phase.
- 2. For two-phase four-wire stepping motor, please connect A+ and B+ of the power cable respectively to U phase and W phase, A- and B- to V phase.

2.2 IO wiring

2.2.1 DI wiring

• When the upper unit uses relay to output (taking DI0 as an example)



• When the upper unit uses open collector to output **PNP connection**



NPN connection



Note: The mixing case of PNP and NPN input is not supported.

2.2.2 DO Wiring

• When the upper unit uses relay to input (taking DO1 as an example).



• When the upper unit uses optocoupler to input (taking DO1 as an example).



Note:

- 1. DO_OUT needs a pull-up resistor and current limiting resistor (it is optional. Please decide whether to use it according to the optocoupler specifications of the upper unit).
- 2. The maximum voltage and current of the internal optocoupler output is as follows.
 - Voltage: 30 V DC
 - Current: 400 mA DC

2.3 AI Wiring



Note:

- 1. The servo drive has 2 analog input circuits, i.e. Al1 and A12.
 - Input voltage: -10 +10 V
 - AD accuracy: 12 bits
- 2、Please make sure the input voltage is within -12 +12 V. Otherwise, damage to the circuit may occur.
- 3, Input impedance: $3.74 \text{ k}\Omega$.
- 4、 The upper unit can read values of 0x2413 (Al1) and 0x2414 (Al2) for external analog closed loop control.

2.4 Cables

Table 2-5 Cables

Name	Description	Length/m	Model
		1	SP-075-010-A
	Power cable between motor and servo	3	SP-075-030-A
	drive with connector	5	SP-075-050-A
	(for servo system ≤5 A)	X (non- standard)	SP-075-XXX-A
		1	SP-150-010-A
	Power cable between motor and servo	3	SP-150-030-A
Power cables ^{*1}	drive with connector	5	SP-150-050-A
	(for 10 A servo system)	X (non- standard)	SP-150-XXX-A
		1	SP-250-010-A
	Power cable between motor and servo	3	SP-250-030-A
	drive with connector	5	SP-250-050-A
	(for 20 A servo system)	X (non- standard)	SP-250-XXX-A
	Encoder signal cable between motor and servo drive with connector (For incremental encoders)	1	SDE15-010-A
		3	SDE15-030-A
		5	SDE15-050-A
Epocdor ophios*1		X (non- standard)	SDE-15-XXX-A
Encoder cables	Encoder signal cable between motor	1	SDE08-010B-A
	and servo drive with connector and	3	SDE08-030B-A
	battery (3.6 V, it is recommended to	5	SDE08-050B-A
	replace it every 15 - 24 months) (For absolute encoders)	X (non- standard)	SDE08-XXXB-A
		1	SDD16-010
	Digital I/O cable (6 inputs 4 outputs)	3	SDD16-030
Digital I/O cables ^{*1}	2-way STO, with connector	5	SDD16-050
		X (non- standard)	SDD16-XXX
Communication	EtherCAT communication cable 1 between the servo drive and upper unit PLC	Х	SDC0X0-CC
cables*2	EtherCAT communication cable 2 between servo drives	Х	SDC0X0-CD

Note:

- 1. It is recommended to purchase a set of cables for direct use. Otherwise, you need to purchase J2-J7 connectors separately.
- 2. It is recommended to purchase a set of bus communication cable, because the CAN / EtherCAT communication interface is not a standard RJ45 connector. And you can purchase USB cables by yourself.
- 3. Cable can be customized. For special needs, please contact us.

3 Trial Run and Debugging

The iSMC software is used for trial run and debugging. For details, please refer to **User Manual of Servo Debugging Software ISMC**.

Debugging steps:



Figure 3-1 Parameter debugging steps

3.1 Communication Connection

- 1. Install the SMC software and USB driver.
- 2. Connect the upper computer and the servo drive via a USB cable (Mirco Type B).
- 3. Run ISMC software, enter the main interface, and select submenu "Configuration":

Application Studio 1 (1.6.6.16)	- o ×
Configuration App Tools Setting Help	
Condition monitor aton with Motor&Feedback Limits&Protections Identification functions	Module control #
Real-time Monitor	Three-ring Debug Motion control
Realized Load motor	Save motor Inner source effect 3 - Curr *
Poston reedback(m) 0	Controller parameters
Poston emotion 1. Click to open the	Current Inco Kn[0.001] 1000 *
Speed Feedback(pm) 0 Max Torque[Nm] 2,400	Current into K(0.001) Son *
Current Feedback(A) 0. Rotation Inetta[kgrom^2] 0.407	Eead Environ Method O - N - *
402 SV Not Real COMMUNICATION INTERTACE Motor max speed(rom) 3200	TorForward/oefficient/0.0011 500 *
Last Fault 0x Motor max current[A] 25.600	TorqueFilterRC[0.001] 10
	:
Motor D axis inductance[mH] 2.100 Motor Q axis inductance[mH] 2.100	Automatically download Download
Motor stator phase resistance[Q] 0.150	Function generator parameters
Self-defined parameters Montor Motor pole pairs number 1	inner source type 1 - squ *
Paraltame * Value Unit Encoder	Current amplitude(A) 0.000 \$
Control \ 0 Encoder Type 2 - Incremental Encoder-Otto O Communication Setting	Inner source frequency[Hz] 0.000
Status = 0	Inner source number 0 C
Modes 0 n Mesoucarter 1 1000 Communication Mode USB -	• Start Stop
N3 vec. 10 hardborect 0 house US8	Enabled Oscilloscope
C28 ver \ 0 Port Name COM6 *	Auti-tum Clear
Refrech Connect Disconnect	
Edt	
Fault display Digital 10 monitor	
No. faut	
	. and j
approx	
CONNECL	
Measures	
Communication Statushiot connected Drive State:Disabled Servo State:Normal Anived Target:Not arrived Motion State:Stop Motion Model/Unknown User Right: Normal_User Servo Type:EtherCAT	

Figure 3-2 Open the communication interface

- 4. Click "Refresh", and select the port connected to the servo drive in drop-down box "Port".
- 5. Click **"Connect"**. The result shows as in Figure 3-3.

Contraction Application	Tools Setting Help							
dition montor	* Configuration with	Motor&Feedback Limits&Protects	ns dentification function	5			Module control	
Real-tope Monitor							Three-ring Debug	Notion control
Dix 34	Motor&Feedback	Motor					Inner source effect	3 - Curr
ition Feedback[cnt] 0	Lineball Deckardines	Motor model		Load motor	Save motor		Controler ascentare	
ition Emor[cnt] 0	Umcsaprocections	Mator type	1 - Rotary Brushless Motor	Servo Motor			Concroller parameters	
ed Feedback(rpm) 0000		Motor rated power[Watt]	19			-	Current loop Kp[0.001]	1500
rent Feedback(A) -0.04	entification functio	Rated Torque[Nm]	0.014	Max Torque[N·m]	0.056	\$	Current loop K[0.001]	1000 \$
SV Fault	-	Torque Coefficient[N:m/A]	0.031	Rotation Inertia[kgrcm^2]	0.260	-	Feed Forward Method	0 - N *
Ends Avenue		Motor rated speed[rpm]	1000	C Motor max speed[rpm]	2000	\$	TorForwardCoefficient[0.001]	500 \$
000020	N	Motor rated current[A]	0.600	C Motor max current[A]	2.000	0	TorqueFilterRC[0.001]	10 🛟
		Motor back EMF[mV/rpm]	2.000			\$	T Automatically developed	
		Motor D axis inductance[mH]	0.600	Motor Q axis inductance[rnH]	0.595	\$		Download
		Motor stator phase resistance[Q]	10.000			;	Function generator paramete	rs.
Self-defined parameters Monitor		Motor pole pairs number	2			÷	Inner source type	1 - squ
ParaName * Value L	int	Encoder					Current amplitude[A]	0.000
Control 6		Encoder Type	2 - Incremental Encoder-	🕐 Communication Setting			Inner source frequency[Hz]	0.000
Status \ 1544		Basel Man (another land)	CETTO CONTRACTOR CONTRACTOR	Communities Made (1978)			Inner source number	0
Modes \ 0	-	wsepropul conuctions	03330	Contraction Hole (cost			Start	
V0C \ 24251 m	W	HalModeSelect	0 - None	USB			Fashind	Occlassona
N3 Vers 1 1.6.1.1.2.0.1.0	_			Port Name COMD T			Enabled	Uscauscope
E	dr		1	14				
Fault display Digital IO monito	¢.		1					
8020 Rotor does not move during A								
OutDOD Notor does not nove during Angle identification		Successful	connecti	on feedback				
1.Parameters such as current are incorrectly set 2.Heavy load, mechanical study, missigned wiring		/						
1.Set the appropriate parameter values 2.Check whether the equipment, kad, and cable connection are correct	Î							
-								

Figure 3-3 Communication connection succeeded

3.2 Parameter Writing

Parameter settings includes the settings of parameters about startup, motor feedback, limit protection and user unit.

3.2.1 Startup Parameters

Click "Start Configuration" in submenu "Configuration", select the corresponding communication mode, and click "OK".

3.2.2 Motor Feedback Parameters

Motor feedback parameters includes motor parameters and encoder parameters.

- 1. Select "Motor Feedback" in submenu "Configuration".
- 2. Set motor parameters and encoder parameters.
- 3. Click "Download" after settings are completed.



Figure 3-5 Settings of motor feedback parameters

Note: Please restart the servo drive after saving successfully, and reconnect the communication after restarting.

Motor parameters

1) To conveniently configure motor parameters, SMC supports motor database in which you can directly call the motor parameters of known models and save the motor parameters of new models.

Note: The database only supports saving and loading motor feedback parameters. "**Import**" command is used to import all servo parameters and "**Export**" command is used to export all servo parameters.



2) Please input the values of target motor parameters into the software according to the motor nameplate and the motor parameter manual provided by the manufacturer, as shown in Figure 3-7:

Motor type	1 - Rotary Brushless Motor/Servo Motor			•
Motor type	1 - Kotary brusiness Mocor/Servo Mocor			÷
Motor rated power[Watt]	19			÷
Rated Torque[N·m]	0.014	Max Torque[N·m]	0.056	÷
Torque Coefficient[N·m/A]	0.031	Rotation Inertia[kg·cm^2]	0.260	÷
Motor rated speed[rpm]	1000	Motor max speed[rpm]	2000	÷
Motor rated current[A]	0.600	Motor max current[A]	2.000	÷
Motor back EMF[mV/rpm]	2.000			÷
Motor D axis inductance[mH]	0.600	Motor Q axis inductance[mH]	0.595	÷
Motor stator phase resistance[Ω]	10.000			÷
Motor pole pairs number	2			÷



- The motor types include rotary brushless motor, linear brushless motor, rotary DC brush motor and voice coil motor. The parameters and units may vary with the motor type.
- **Note:** Please pay attention to parameter unit when writing.

• Encoder parameters

According to the actual encoder type, in the encoder parameter interface, please select the encoder type and input the resolution.

Encoder Type 2 - Incremental Encoder-Orthotropy	•
Resolution[counts/rev] 65536	\$
HalModeSelect 0 - None	•
Encoder	
Encoder Type 3 - Absolute Encoder-Tamagawa	•
Encoder single turn resolution[Bit] 17	\$
Encoder multi turn resolution[Bit] 16	¢
Communication rate[Mbps] 2.5	
HallModeSelect 0 - None	

Rotary encoder

Linear encoder

Figure 3-8 Motor parameters-3

Encoder parameters are as shown in Table 3-1.

Table 3-1 Encoder parameters

Name	Unit	Definition
Absolute single-turn resolution	Bit	The pulse value output by one rotation of the encoder.
Absolute multi-turn resolution	Bit	The maximum number of turns recorded by the encoder.
Encoder multi-turn value reset		To clear the absolute encoder multi- turn value to zero.
Resolution	 Rotary: counts/revolution Linear: counts/nm, um, mm 	 The pulse value output by one rotation of the encoder. The pulse value output by the grating ruler per unit distance.
Communication rate	М	The clock frequency at which data is sent to or received from the encoder.

3.2.3 Limit Protection

- 1. In "Configuration" submenu, select "Limit Protection".
- Set the peak current and the duration of the peak current.
 To protect motor i2t, please set the values according to the maximum current of the motor. Otherwise, damage to the motor may occur.



3.2.4 User Unit

- 1. In "Configuration" submenu, select "User Unit".
- 2. Set parameter unit for motion control parameters, including position unit and velocity unit, and configure mechanical gear ratio, as shown in Figure 3-9:

Control unit			
Load type	Rotate		
Position unit	cnt		•
Speed unit	rpm		•
Mechanical parameter			
Number of turns of moto	or shaft= 1	Number of turns of drive shaft= 1	\$
			Apply

Figure 3-9 User units

3. After settings, click "Apply". The settings takes effect immediately.

In the debugging mode and motion mode, the unit will be the same as the set unit. Please set user units for position and velocity modes according to the load type, as shown in Table 4-2.

Table 3-2 User units

Load Type Motion Unit	Lir	near		Rotary
	cnt	pulses	cnt	number of pulses
	um	microns	deg	angle
Position unit	mm	mm	rad	radian
	cm	centimeter	rev	Turn
	uu	customize	uu	customize
	cnt/s	pulses/sec	cnt/s	Pulses/sec
	um/s	μm/s	deg/s	angle/sec
Valaaityuunit	mm/s	mm/s	rad/s	radians/sec
	cm/s	cm/s	rpm	rpm
	uu	customize	rps	rev/sec
	-	-	uu	customize

3.3 Magnetic Pole Calibration

3.3.1 Phase Sequence Steering Detection

Phase sequence and motion direction of the incremental motors is required before motion control. With the phase sequence detection, the servo drive will automatically recognize UVW wire, and reverse the phase sequence and rotation direction according to the positive direction.

3.3.2 Hall Detection

When using the Hall sensor, the servo drive needs to automatically recognize the Hall angle. After that, the motor can be directly started with the Hall angle, which makes the motor start more smoothly, for it avoids the shock of magnetic pole identification when the incremental motor is powered on each time.

3.3.3 Commutation Offset Detection

Before motion control, detection of the magnetic pole zero is required. After calibration, the motion control can be performed normally. Otherwise, motor runway may occur.

Commutation offset detection is required after the phase sequence steering detection. Otherwise, calibration may fail. In this case, when the motion is enabled or started, the current feedback value observed in the motion monitoring is pretty large, the motor rotor is locked, or there is a risk of motor runaway. At this time, please set "2002" to "1" in "Parameter Editor-PID", to switch the phase sequence.

Parameter	Description
2002 Three-phase seq switch enable	The function of switching phase sequence. 0-no
	switching; 1-switching

The steps are as follows:

1. After setting parameters, in the parameter configuration interface, click "**Electric-degree Identify**":

Commutation current ratio1[0.001]	800		
Electric-degree			
Commutation offset	44022		
PoleIdentifyMode	1 - jogging		
PoleIdentifyElectricAngle[deg]	107		
AutoCalibrateAngle	M		
	Download	Phase-sequence Identify	
		Ongoing	

Figure 3-10 Automatic commutation detection

2. Wait for about 5 -10 seconds. The status turns green, as shown in figure 3-11, which indicates that the zero point calibration is completed.

Commutation current ratio1[0.001]	800		
Electric-degree			
Commutation offset	64373		\$
PoleIdentifyMode	1 - jogging		•
PoleIdentifyElectricAngle[deg]	337		
AutoCalibrateAngle	N.		
	Download	Phase-sequence Identify	
		Electric-degree Identify	

Figure 3-11 Completion of automatic commutation offset detection

Description:

- 1. For an absolute encoder, an accurate calibration is required at the first time. After that, motion control can be performed directly after the servo drive is powered on.
- 2. For an incremental encoder (without Hall signal), the calibration is required every time the servo drive is powered on. Otherwise, motion control is not allowed.

Calibration can be done by sending calibration commands and enable commands (see note 2 for logic) or manually clicking automatic commutation offset detection.

During calibration, please do not perform other motion control related operations. Otherwise, the servo drive will report the corresponding error.

The servo drive owns the function of automatic calibration after power-on. With it enabled, you can check AutoCalibrateAngle or set 0x2120 to 1. As a result, after saving, the servo drive will automatically start calibration every time it is powered on. After calibration, the servo is disabled, and the sign indicating the completion of calibration shows. At this time, please set 0x2121 to 1.

- 3. For an incremental encoder (with Hall signal), configuring HALL start (0x2103=1) and recognizing HALL angle are required at the first time. After that, motion control can be performed directly after the servo drive is powered on.
- 4. Setting of calibration current
 - a. Gradually increase 0x2105 until the motor shaft can be fixed in a certain position quickly and stably.
 - b. Rotate the shaft.
 - c. Start calibration again several times until the position is basically the same (i.e. the value of 0x2102 is almost the same).

Note:

- If the calibration current is not adjusted properly or the load of motor shaft is too large, the calibration will fail. For the error handling, please refer to *Chapter 5 Troubleshooting*.
- 2. After 0x6060 (control mode) is set to 0, 0x2101 is written to 1, 0x6040 (control word)

is executed according to the enable logic of 6 -> 7 -> 15, the servo enters calibration status. When 0x2101 turns to 0, it means the calibration process is completed.

Commutation	offset	related	parameter	S
				_

parameter	Description	
2101 Calibrate commutation offset	The sign of manual zero calibration enable.	
2102 Commutation offset	The value of zero calibration.	
2103 HallModeSelect	Hall mode selection. 0: disable Hall;1: enable Hall.	
	D-axis calibration current amplitude	
2105 Commutation current ratio_1	= 2105 / 1000 * Rate current.	
	Frequency: constant value	
213E Hall_Angle	Hall calibration angle.	
2120 AutoCalibrateAngle	Automatic calibration after power-on. 0-OFF; 1-	
	ON.	
	The sign whether automatic calibration after	
2121 AutoCalibrateAngleFinish	power-on is completed. 0-Incomplete; 1-	
	Complete.	
	Q-axis calibration current amplitude	
2402 Commutation current ratio_2	= 2402 / 1000 * 2105	
	Frequency: high frequency	

3.4 PID Adjustment

If PID parameters are not set properly, the motor may vibrate or make abnormal noise. Thus, to achieve a better control effect, it is necessary to adjust PID parameters before controlling the motor.

The upper software SMC provides a function generator, which can output the given mode, wave form and step signal, and capture the given waveform and the feedback waveform for response analysis with an oscilloscope.

The whole debugging steps is as follows:

Adjustment for current loop \rightarrow Adjustment for velocity loop \rightarrow Adjustment for position loop

3.4.1 Current Loop

The first debugging is for the current loop.

1. Select "Current Loop", and then click "Tool" in the main menu,select "Oscilloscope". The debugging interface of the current loop shows as in Figure 3-12:

	Configuration Application	Tools Setting Help					
	dition monitor Realtime Monitor	Configuration wits	Motor&Feedback Limits&Protections Ide	entification functions Mode	ule control Three-ring Debug	a Motion control	
	Ended	Motor&Feedback		less less less less less less less less	er source effect	3 - Curr *	
	on Feedback[ont] -70440	Limits&Protections	Commutation current rabio1[0.001]	900 · Co	ntroller paramete	rs 2 - Speed loop	
	d Feedback[rpm] 0.000		Commutation offset	64373	ment koop Kp[0.0	1 - Position loop 700 -	
	ent Feedback[A] -0.004	entification functio	PoleIdentifyMode	1-joggng *	ment loop Ki(0.00	01] 1000 0	
	SV Switch on disab	lec	PoleIdentfyElectricAngle[deg]	339 To	eo Porward Mech rForwardCoefficie	ent[0.001] 500 \$	
	ox0000		AutoCalbrateAngle	2 To	ngueFilterRC[0.01	10 0	
				Downbad Phase sequence Identify	Automatically dov	emicad Download	
				Electric-degree Johnsty Ful	nction generator	parameters	
	Self-defined parameters Monitor ParaName * Value Un	18			er source type	1 - squ *	
	Control / 0			Inn	er source frequer	ncy(Hz) 0.000 0	
	Status 1600 Nodes 0	-		In	er source number	r 0 0	
	/dc 24251 m/	(Start	Stop	
	28 ver \ 1.6.1.1.2.0.1.0				C. Harrison		
	Ed	t					
	ult display Digital ID monitor						
	No fault						
	otion						
	ption						
	ns						
	11es						
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Figure 3-12 Current loop debugging interface

2. Adjust Kp.

Main function: to increase the bandwidth with the increase of Kp. If it is too large, the motor makes noise, and if it is too small, the bandwidth is lowered.

a. Set Ki to 0 and Kp to 100, and click "**Download**":

Generally, you only need to slightly adjust the default values.

Controller parameters	
Current loop Kp[0.001]	100 🗘
Current loop Ki[0.001]	0 🗘
Feed Forward Method	0 - None 🔻
TorForwardCoefficient[0.001]	500 🗘
TorqueFilterRC[0.001]	10 🗘
Automatically download	Download

Figure 3-13 Control parameters of current loop

b. Set the function type to sine wave, current amplitude to 25% of the motor rated current (the following takes 1 A as an example) and frequency to 1500 Hz.

Function generator parameters			
Inner source type	2 - sine-wave 🔻		
Current amplitude[A]	1.000 🗘		
Inner source frequency[Hz]	1500.000 🗘		
Inner source number	0		
Start	Stop		
Enabled	Oscilloscope		

Figure 3-14 Function generator parameters of current loop

c. Turn on oscilloscope again, set the sampling channel to Id/Iq reference (current given value) and Id/Iq feedback (current feedback value), set the sampling period to 50 us, and check continuous sampling.

Continuous	Trigger	Trigger Channel	1 ~
Id reference	e v	Trigger Level[mA]	0
Id feedback	. v	Pretrigger	0 ~
	~	Trigger Edge	Rising-edge \sim
		Start	Stop
Sample Period 2	00 µs 🛛 🗸	Offina	Carro
Sample Time 0.	.819 s 🛛 🗸	Online	Save

Figure 3-15 Oscilloscope sampling parameters of current loop

- d. Enable the servo, start function generator, and click "Start Acquisition".
- e. Keep increasing Kp until the amplitude of Id/Iq feedback is between (0.707~1) of the amplitude of Id/Iq reference and the phase lag does not exceed 90°:



Figure 3-16 Current sampling waveform after adjusting Kp

3. Adjust Ki.

Main function: to eliminate the steady-state error. If it is too large, it will lead to overshoot and the motor will make noise.

a. Set the function type to square wave, current amplitude to 25% of the motor rated current (the following takes 1 A as an example) and frequency to 10 Hz.

Function generator parameters	
Inner source type	1 - square-wave 🔻
Current amplitude[A]	1.000 🗘
Inner source frequency[Hz]	10.000 🗘
Inner source number	0 🗘

Figure 3-17 Function generator parameters of current loop

b. Gradually increase Ki, (generally increase 100 each time), and repeat step c and d of adjusting Kp until the steady-state error is eliminated, the waveform of Id/Iq feedback almost coincides with that of Id/Iq reference waveforms, and the overshoot is within 5%:



Figure 3-18 Current sampling waveform after adjusting Ki

Note: When adjusting the current loop, if the motor is a rotary brushless/linear motor, please select id for adjustment, and if the motor is DC brush/voice coil motor, please select iq for adjustment.

3.4.2 Velocity Loop

The second debugging is for the velocity loop.

Select "Velocity Loop". The debugging interface of the velocity loop shows as in Figure 3-19:

🔊 🐐 o 🗙 👄	Application Studie I (1.6.6.16)		- 0
Configuration Application To	s Setting Help		
ndition monitor #	Osciloscope[Stop]	Module control	
Real-time Monitor	Training Market	Three-ring Debug	Motion control
Disalet	- 10 reference - 31 feedback	Inner source effect	2 - Speed loop
ition Feedback[cnt] -70440	13 M	Controller parameters	
stion Error[cnt] 0	0.45	Schudidha	0 - Napa
ed Feedback[rpm] 0.000	64		
rent Feedback[A] 0.000		Velocity loop Kp[0.001]	240
SV Not Ready to Swite		Velocity loop Ki[0.001]	0
Fault 0x0000		Feed Forward Method	0 - None
	0.25	VelForwardCoefficient[0.001]	800
	62 ·	SpeedFilterRC[0.001]	20
		[Speed feedback filter]	
Self-defined parameters Monitor	0.0	[Speed error fiter]	
ParaName * Value Unit	1.0	[Speed error filter 2]	
Control \ 0	0.05	Automatically download	Download
Status 1600			
Vdr 24251 mV		Function generator parameters	
M3 versi 1.6.1.1.2.0.1.0	-0.05	Inner source type	3 - step-wave
C28 ver 1.6.1.1.2.0.1.0	41	Speed amplitude(rpm)	300.000
	0.15	Inner source time[ms]	500
		Start	Stop
	74	Enabled	Osciloscope
	0.3		
	-43		
	0.35		
Edit	44		
Fault display Digital 30 monitor			
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scription			
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×	🖂 🖬 Id feedback 🗸 Pretrigger 0		
	Tripper Edge Raing-edge		
sasures	Crut Drm		
	Sample Period 200 us		
	Sample Time 0.819 s V Offine Save		

Figure 3-19 Velocity loop debugging interface

- Do the following preparation works:
- a. Set the inertia ratio to 0X2422.
- b. Set the following parameters to 0:
 - ✓ 0x2020:01 Filter type of measured speed
 - ✓ 0x2021:01 Filter type of speed error filter
 - ✓ 2022:01 Filter type of speed error second filter
 - ✓ 2006 Feed forward method
- 3. Adjust Kp.

2.

a. Set Ki to 0 and Kp to 10, and click "Download":

Controller parameters	
Scheduling	0 - None 🔻
Velocity loop Kp[0.001]	10 ‡
Velocity loop Ki[0.001]	0 🗘
Feed Forward Method	0 - None 🔻
VelForwardCoefficient[0.001]	800 🗘
SpeedFilterRC[0.001]	20 🗘

Figure 3-20 Control parameters of velocity loop

b. Set the function type to step signal and velocity amplitude to 300 rpm, and set the duration according to the limit of running distance, i.e 500 ms.

Function generator parameters	
Inner source type	3 - step-wave 🔻
Speed amplitude[rpm]	300.000 🗘
Inner source time[ms]	500 ‡

Figure 3-21 Function generator parameters of velocity loop

c. Turn oscilloscope again, set the sampling channel to velocity loop reference (speed given value) and velocity loop feedback (velocity feedback value), set the sampling period to 200 us, check "Trigger Acquisition", set the trigger edge to rising edge, set trigger channel to velocity loop reference, set trigger level to 10 rpm, and set pretrigger to 20%.

Continuous	🗹 Trigger		Trigger Channel	1	~
Id refere	nce	~	Trigger Level[mA]	0	
Id feedb	ack	~	Pretrigger	0	\sim
		\sim	Trigger Edge	Rising-edge	\sim
		\sim	Start	Stop	
Sample Period	50 µs	~	Offling	Covo	
Sample Time	0.205 s	~	Online	Save	

Figure 3-22 Oscilloscope sampling parameters of velocity loop

- d. Enable the servo, start function generator, and click "Start Acquisition".When the function type is set to step signal, there will be a delay of 4 5 seconds, to make sure that there is enough time for the oscilloscope to start acquisition.
- e. Keep increasing Kp (generally increase 10 digits each time) and observe the waveform of velocity loop reference (speed given value) and velocity loop feedback (speed feedback value) until the critical oscillation shows in the velocity waveform:

ja 🛎 🗸 🗸 🗕	Application Studio 1 (1.6.6.16)		- 0
Configuration Application To	e Setting Help		
ndition monitor	0sci	Module control	
Real-time Monitor	350.2	Three-ring Debug	Motion control
tion Feedback(cot) -20440		Inner source effect	2 - Speed loop
tion Freedback(cnt) -70440	269.2	Controller parameters	
ed Feedback(mm) 0.000		Scheduling	0 - None
ant Feedback[A] 0.000	188.1	Velocity Inco Ko[0,001]	240
W Not Ready to Switz	107, 1	Velocity loop K[0.001]	0
ault 0x0000		Feed Forward Method	0 - None
	26.1	VelForwardCoefficient[0.001]	800
		SpeedFilterRC[0.001]	20
	-54.9	[Sneed feedback fiter]	
Self-defined narameters Monitor	0.0000 0.1057 0.2113 0.3170 0.4228 0.5283 0.6339 0.7398 0.8452	[Speed error filter]	
araName * Value Unit		[Speed error filter 2]	
lortro		Automatically download	Download
tatus 1600	350.2		DOWINDBU
odes 0		Function generator parameters	
3 versi 1.6.1.1.2.0.1.0	276.1	Inner source type	3 - step-wave
28 ver 1.6.1.1.2.0.1.0		Speed amplitude(rpm)	300.000
	202.0	Inner source time[ms]	500
		Start	
	120.0	Enabled	Oscilloscope
	53.9		
64	-20.2		
EUL	0.1464 0.1550 0.1635 0.1721 0.1807 0.1892 0.1978 0.2064 0.2150		
the department of the second sec			
Digital to monitor			
No fault	N		
No fault	-a5 ¹ 2 → 45 1 15 2 25 3 35 4 45 5 55 6 65 7 75 8 45 9		
No fault	45 ^[1] 0 85 1 85 2 25 3 25 4 45 5 55 6 65 7 75 8 85 9 Time(s)		
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No fault	4.5 1 − − − − − − − − − − − − − − − − − −		
No fault	43 H 0 55 1 153 2 25 3 35 4 55 53 6 65 7 75 8 65 9 Time(s) Controved □ Pager Carried 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		
bit days Dogta p montor	4.5 0 1 1 1 1 1 1 1 1 1 1		
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No fault of monitorial potential and the second sec	43 1 0 43 1 15 2 23 3 33 4 45 5 53 6 6.5 7 73 8 45 9 Time(s) 55 6 6.5 7 73 8 45 9 Continues Trapper Trapper Care(m) 0 Continues Trapper Care(m) 0 0 10 feedback → Protoger 0 7 Top Care(m) 0 0 Carell Manum Manum Average StartPort EndPort X		
Like Group Digitar jo monitorio No fault ^ rpppon ^ Jres ^ Jres ~	4.3		

Figure 3-23 Velocity sampling waveform after adjusting Kp

- f. Take 70% 80% of the value of Kp, and stop the oscilloscope acquisition and function generator.
- 4. Adjust Ki.

Gradually increase Ki, and repeat step **c** and **d** of adjusting Kp until the steady-state error of velocity loop feedback is eliminated and the overshoot is within 30%:



Figure 3-24 Velocity sampling waveform after adjusting Ki

To reduce the velocity deviation during acceleration, you can do debugging for torque feed forward as follows:

- 1. To enable the feed forward function, set 2006 to 2.
- 2. Set 2019 Torque feed forward time constant to a fixed value, and keep increasing 2016 Speed feed forward coefficient until a good result of velocity feed forward shows at a certain value.
- 3. Repeatedly adjust 2019 and 2016 to find a balance.

Note: Improper debugging will cause system oscillation. If oscillation or mechanical resonance occurs during debugging, you can set 0x2021 / 0x2022 Filter type of speed error filter to eliminate the oscillation frequency:

Parameter	Description
200C:01 Measured speed filter	The filter value of measured speed
200F:01 Speed error filter	The filter value of speed error
2010:01 Speed error second filter	The filter value 2 of speed error
2020:01 Filter type of measured speed filter	The filter type of measured speed
2020:02 Frequency of measured speed filter	The filter frequency of measured speed
2020:03 Quality factor of measured speed	The filter quality factor of measured speed
filter	
2021:01 Filter type of speed error filter	The filter type 1 of measured speed
2021:02 Frequency of speed error filter	The filter frequency 1 of measured speed
2021:03 Quality factor of speed error second	The filter quality factor 1 of measured
filter	speed
2022:01 Filter type of speed error filter	The filter type 2 of measured speed
2022:02 Frequency of speed error filter	The filter frequency 2 of measured speed
2022:03 Quality factor of speed error second	The filter quality factor 2 of measured
filter	speed
2421 Velocity Average Filtering	Velocity average filter (internal use)

3.4.3 Position Loop

The third debugging is for position loop.

1. Select **"Position Loop"**. The debugging interface of the position loop shows as in Figure 3-25.



Figure 3-2 5 Debugging interface of position loop

- 2. Adjust Kp.
 - a. Set Kp, and click "Download".

It is recommended to use the default value 10 at first, and modify it after obtain the position curve.

Controller parameters	
Scheduling	0 - None 🔻
Position loop Kp[0.001]	10
Automatically download	Download

Figure 3-26 Control parameters of position loop

b. Set the function type to square wave signal, position amplitude to 1000 cnt (the current position is zero, the motion amplitude is 1000 cnt. Please pay attention to the mechanical stroke), and signal frequency to 5 Hz.

Function generator parameters	
Inner source type	1 - square-wave 🔻
Position amplitude[cnt]	1000 🗘
Inner source frequency[Hz]	5.000 🗘
Inner source number	0 🗘

Figure 3-27 Function generator parameters of position loop

c. Turn on oscilloscope, set the sampling channel to position loop reference (position given value) and position loop feedback (position feedback value), set the sampling period and duration to proper values, and check continuous acquisition.

Continuous 🗌 Trigger		Trigger Channel	1 ~
Position loop reference	~	Trigger Level[mA]	0
Position loop feedback	~	Pretrigger	0 ~
	\sim	Trigger Edge	Rising-edge \sim
	\sim	Start	Stop
Sample Period 200 µs	\sim	Offina	Cauc
Sample Time 0.819 s	~	Online	Save

Figure 3-28 Oscilloscope sampling parameters of position loop

- d. Observe the waveform of position loop reference (position given value) and position loop feedback (position feedback value), and adjust Kp as follows until the result of waveform is good with unsaturated current:
 - \checkmark Increase Kp when the position follow-up error is large or the response is slow.



 \checkmark Reduce Kp when the position overshoot or jitter occurs.

Figure 3-29 Position sampling waveform after adjusting Kp

In actual application, if not satisfied with the position follow-up error, you can carry out debugging for torque feed forward and speed feed forward as follows:

- 1. To enable the feed forward function, set 0x2006 to 2.
- 2. Set 0x2019 Torque feed forward time constant to a fixed value, and keep increasing 2016 velocity feed forward coefficient until a good result of velocity feed forward shows at a certain value.
- 3. Repeatedly adjust 0x2019 and 0x2016 to find a balance.

After adjusting the position loop gain, the motor makes low-frequency audible noise in the

enabled but not running state, which will reduce the velocity loop Kp or the current loop Kp. If the value of position loop Kp is too small, the rigidity is weak.

3.4.4 Grouping Gain

Grouping gain can be set in the situation where the inertia load changes and a group of fixed gain parameters of velocity loop and position loop cannot satisfy high, medium and low speed. Its principle is as follows:



Take the velocity loop as an example: when setting the grouping gain, you can set the actual speed or the given speed:

Actual Speed / Given Speed:	Gain Parameter				
0 - zero speed	Kp and Ki at zero speed				
Zero speed - low speed	• Kp increases with the slope (Kp at low speed - Kp at				
	zero speed) / (low speed - zero speed).				
	• Ki increases with the slope (Ki at low speed - Ki at				
	zero speed) / (low speed - zero speed)				
Low speed - high speed	• Kp increases with the slope (Kp at high speed - Kp				
	at low speed) / (high speed - low speed).				
	• Ki increases with the slope (Ki at high speed - Ki at				
	low speed) / (high speed - low speed)				
> High speed	Kp and Ki at high speed				

3.5 Motion Control

After setting motor parameters, encoder parameters and control parameters, the motor can be simply driven. The modes that the software controls the servo drive to drive the motor include the following:

- Position mode
- Speed mode
- Homing mode

• Torque mode

3.5.1 Position Control Mode

The process of motion control in position mode is as follows:

1. Click "**Motion**" in the main menu, and click "**Position Mode**". The interface of motion control in position mode shows as in Figure 4-31.

Module control			д	
Three-ring Debug		Motion control		
Move Model	Positio	Position Model		
Position Model				
Reciprocate				
Target position[cnt]	0			
Profile velocity[rpm]	0.000		÷	
Profile acceleration[rpm/s]	16670	.000	‡	
Profile deceleration[rpm/s]	16670.000			
Quick stop deceleration[rpm/s]	50000.000			
Order Type	absolute			
Motion profile type	0 - Lin	ear ramp	•	
		(Download	
	Start		Start+Collecting	
	Enable	d	Stop	

Figure 3-31 Interface of motion control in position mode

- 2. Set the following parameters:
 - Motion mode: to set the position motion as unidirectional motion or reciprocating motion.
 - ✓ Target position: to control the distance of motor movement. When the motion mode is set to reciprocating motion, you need to set two target positions.
 - ✓ Speed: the movement speed of the motor.
 - ✓ Acceleration: the acceleration to start the motor.
 - \checkmark Deceleration: the deceleration to stop the motor.
 - ✓ Deceleration for quick stop: the deceleration to stop the motor when the motor is directly disabled.
 - Command type: absolute, to start movement with zero point of the encoder as the start point; relative, to start movement with current position of the encoder as zero point.
 - ✓ Curve type: including linear ramp (straight line) and Jerk-limited ramp (S-shaped curve).
 - ✓ Waiting time: the waiting delay time for the arrival of the target position when the motion mode is set to reciprocating motion.
 - \checkmark Cycle times: the number of reciprocating cycles when the motion mode is set to

reciprocating motion. Infinite cycle means cycle will continue all the time.

- 3. To enable the servo drive, click "Enable".
- 4. To start motion control in position mode and start acquisition oscilloscope, click "**Start**" and **"Start Acquisition**".

3.5.2 Velocity Control Mode

The process of motion control in position mode is as follows:

1. Select **"Velocity Mode".** The interface of motion control in velocity mode shows as in Figure 3-32.

🔊 🔌 Q 💥 🖨		Application Studio I (1.6.6.16)			- 0
Configuration Application Tools	Setting Help				
ondition monitor #	Osciloscope[Stop]		Module control		
Real-time Monitor			Three-ring Debug	Mot	ion control
Directed and the second	1006		Move Model P	osition Model	
sition Feedback[ont] -70440			Position Model S	ipeed Model	
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irrent Feedback[A] 0.000	1001	and shared in the real case that and the share that the share of a station of the share-	Profile velocity[rpm] 0	.000	
2 SV Not Ready to Swite			Profile acceleration[rpm/s] 1	6670.000	
ist Fault 0x0000	999	ht a bhaile 116 116 116 116 117 117 117 117 117 117	Profile deceleration(rpm/s) 1	6670.000	
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Self-defined parameters Monitor		0.0000 0.2113 0.4226 0.6339 0.8452 1.0565 1.2678 1.4791 1.6904			Download
ParaName * Value Unit				Start	Start+Collecting
Control \ 0			B	nabled	Stop
Modes 0	1006				
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Jeasures	Carrola Daviad	Start Stop			
~	Sample Penod	Zou pa Offine Save			
	dample Time	0.019 5			

Figure 3-32 Interface of motion control in velocity mode

- 2. Set the following parameters:
 - ✓ Target speed: the movement speed of the motor.
 - \checkmark Acceleration: the acceleration to start the motor.
 - \checkmark Deceleration: the deceleration to stop the motor.
 - ✓ Deceleration for quick stop: the deceleration to stop the motor when the motor is directly disabled.
- 3. To enable the servo drive, click "Enable". Servo Enable shows in the interface.
- 4. To control the motor to move in the positive direction, click "**Forward**", to control the motor to move in the opposite direction, click "**Reverse**".
3.5.3 Homing Mode

The process of motion control in homing mode is as follows:

1. Select **"Homing Mode".** The interface of motion control in homing mode shows as in Figure 3-33.

adition monitor	nyy case in roo	s Setting Help							
		Configuration with	Motor&Feedback Limits&Protection	ons Identification functions				Module control	
Real-time I	Monitor	and the second second	Motor					Three-ring Debug	Motion control
Disabled		MOTORAPEEGDACK	Nator model		Land	Imator	Cruce methor	Move Model	Homing Model
ion Feedback[cnt]	-70440	Limits&Protections	Hotor model	L. Batan Brukhar Makado	Loso	motor	Save motor	Homing Model	Position Model
ion Error[cnt]	0	V	Motor type	1 - Kocary Brushless Mocor/Se	STVO MOCOF			Homing method	Homing Model
f Feedback(rpm)	0.000		Motor rated power[Watt]	10				 Speed during search for switching 	am] 30.021
nt Feedback[A]	0.000	entification functio	Kated Torque[Nm]	0.010		Max Torque[N·m]	0.022	 Speed during search for zero[rpn 	1 18.311
V	Not Ready to Swite		Torque coemcient(N-m/A)	0.018	-	kotation inertia(kg·cm··2)	0.005	Home offset[cnt]	0
ault	0x0000		Motor rated speed(rpm)	2000		Motor max speed(rpm)	5000	 Homing acceleration[rpm/s] 	5000.000
			Motor faced current[A]	0.670	•	Motor max current[A]	1.300	 ZokusPosErrimt[cnt] 	0
			Motor back EMF[mV/rpm]	0.100			(· ·	
			Motor D axis inductance[mH]	0.530	•	Motor Q axis inductance[mH]	0.530		
			Motor stator phase resistance[[2]	9.200				;	
ielf-defined parar	meters Monitor		Hotor pole pars number	1				·)	
attame *	Value Unit	Encoder						9	
tut - 16			Encoder Type	2 - Incremental Encoder-Orthotropy					→
vies - 0			Resolution[counts/rev]	65536				:	
lc - 243	251 mV		HalModeSelect	0 - None					
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Figure 3-3 3 Interface of motion control in homing mode

- 2. Set the following parameters:
 - ✓ Homing method: there are 35 homing methods. When starting, the motor moves according to the selected homing method.
 - High speed for homing: when starting, the motor starts to find the zero point at high speed.
 - ✓ Low speed for homing: when starting, the motor moves to the zero point at low speed after it finds the zero point.
 - Zero offset: after setting the zero offset, the motor finally stops at the position behind the offset.
 - Acceleration and deceleration for homing: when starting, the acceleration and deceleration for homing.
- 3. To enable the servo drive, click "Enable". Servo Enable shows in the interface.
- 4. To make the motor move with the set homing method, click "**Start**", to stop the motor, click "**Stop**".

Homing

1. Homing method

- ✓ When using an incremental encoder, and when the servo does not know the position of the motor when it is powered on, homing is required every time it is powered on.
- ✓ When using an absolute encoder or incremental + Hall signal, homing is required only when the servo is powered on for the first time.

Note: The zero point calibration is the initial angle identification of the motor. If the initial angle identification is not performed, the motor may reverse or even run away. When

using an incremental encoder, zero point calibration is required each time the power is on; when using an absolute encoder or incremental + Hall signal, zero point calibration is required only when the power is on for the first time.

2. Related concepts

Origin and zero point

- Home position: machine origin, which can represent origin switch or motor Z signal.
- Zero position: the position after homing finishes.

During homing, the motor stops at the home position. If the position deviation 607C is set, the motor stops at the zero position.

Zero position = Home position + 607C Home offset:



Figure 3-34 Relationship between origin and zero point

Speed

- High speed: the speed during finding the limit switch (different according to the origin mode). (6099-01h).
- Low speed: the speed during finding the origin after finding the limit switch. (6099-02h).
- Acceleration and deceleration: acceleration and deceleration during homing. (609A).

Direction

The direction in which the encoder value increases is the positive direction, and the direction in which the value decreases is the negative direction.

3.5.3.1 Homing Method

Note:

1. The numbers in the figure correspond to the corresponding homing methods. The same

numbers indicates two ways of this homing method. For example, two ③ in the figure

of method 3 indicates two different ways of the homing method 3.

- 2. The index pulse is the Z signal.
- 3. The bold color indicates homing at high speed.

3.5.3.2 Method 1: Homing on negative limit switch (falling edge) and index pulse





When homing starts, the motor moves at a high speed (6099-01) in the negative direction. When the negative limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the negative limit switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.



Figure 3-36 Speed-time curve of method 1

3.5.3.3 Method 2: Homing on positive limit switch (falling edge) and index pulse





When homing starts, the motor moves at a high speed (6099-01) in the positive direction. When the positive limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the positive limit switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.



Figure 3-38 Speed-time curve of method 2

3.5.3.4 Method 3: Homing on positive home switch (falling edge) and index pulse



Figure 3-39 Method 3

- When homing starts, if the home switch signal is low level, the motor moves at a high speed (6099-01) in the positive direction. After the home switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the positive home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- When homing starts, if the home switch signal is high level, the motor moves at a low speed (6099-02) in the negative direction. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.



Figure 3-40 Speed-time curve of method 3

3.5.3.5 Method 4: Homing on positive home switch (rising edge) and index pulse



Figure 3-41 Method 4

原点开关: Home switch Z 信号: Z signal

- When homing starts, if the home switch signal is low level, the motor moves at a low speed (6099-02) in the positive direction. After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A) and finally return to the Z pulse latch position. The status word Target reached is set to 1 when the motor stops.
- When homing starts, if the home switch signal is high level, the motor moves at a high speed (6099-01) in the negative direction. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A) and finally return to the Z pulse latch position. The status word Target reached is set to 1 when the motor stops.



Figure 3-42 Speed-time curve of method 4

3.5.3.6 Method 5: Homing on negative home switch (falling edge) and index pulse



Figure 3-43 Method 5

- When homing starts, if the home switch signal is low level, the motor moves at a high speed (6099-01) in the negative direction. After the home switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A) and finally returns to the Z pulse latch position. The status word Target reached is set to 1 when the motor stops.
- When homing starts, if the home switch signal is high level, the motor moves at a low speed (6099-02) in the positive direction. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A) and finally returns to the Z pulse latch position. The status word Target reached is set to 1 when the motor stops.



Figure 3-44 Speed-time curve of method 5

3.5.3.7 Method 6: Homing on negative home switch (rising edge) and index pulse



Figure 3-45 Method 6

- When homing starts, if the home switch signal is low level, the motor moves at a low speed (6099-02) in the negative direction. After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- When homing starts, if the home switch signal is high level, the motor moves at a high speed (6099-01) in the positive direction. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.



Figure 3-46 Speed-time curve of method 6

3.5.3.8 Method 7: Homing on negative home switch (falling edge) and index pulsepositive limit switch detection





- When homing starts, if the home switch signal is low level, the motor moves at a high speed in the positive direction.
 - ✓ After the home switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
 - ✓ After the positive limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a high speed (6099-01), and keeps moving in the negative direction at the high speed. After the home switch signal becomes high level, the motor decelerates with homing deceleration (609A) to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- When homing starts, if the home switch signal is high level, the motor moves at a low speed (6099-02) in the negative direction. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the

motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.



Figure 3-48 Speed-time curve of method 7

3.5.3.9 Method 8: Homing on positive home switch (rising edge) and index pulsepositive limit switch detection





• When homing starts, if the home switch signal is low level, the motor moves at a low

speed (6099-02) in the positive direction.

- ✓ After the home switch signal becomes high level, the motor keeps moving at a low speed (6099-02) in the positive direction. After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- ✓ After the positive limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a high speed (6099-01), and keeps moving in the negative direction at the high speed. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), move in the positive direction to accelerate to a low speed (6099-02) with the homing acceleration (609A), and keeps moving in the positive direction at the low speed. After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- When homing starts, if the home switch signal is high level, the motor moves at a high speed (6099-01) in the negative direction. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.



Figure 3-50 Speed-time curve of method 8

3.5.3.10 Method 9: Homing on negative home switch (rising edge) and index pulse-



positive limit switch detection



- When homing starts, if the home switch signal is low level, the motor moves at a high speed (6099-01) in the positive direction.
 - ✓ After the home switch signal becomes high level, the motor keeps moving at a high speed (6099-01) in the positive direction. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal changes from low level to high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
 - ✓ After the positive limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- When homing starts, if the home switch signal is high level, the motor moves at a high speed (6099-01) in the positive direction. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal becomes high level and the first Z signal shows, the status word Homing

attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.



Figure 3-52 Speed-time curve of method 9

3.5.3.11 Method 10: Homing on positive home switch (falling edge) and index pulsepositive limit switch detection



Figure 3-53 Method 10

• When homing starts, if the home switch signal is low level, the motor moves at a high speed (6099-01) in the positive direction.

- ✓ After the home switch signal becomes high level, the motor moves with the homing deceleration (609A) to decelerate to a low speed (6099-02), and keeps moving at the low speed in the positive direction. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- ✓ After the positive limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a high speed (6099-01), and keeps moving in the negative direction at the high speed. After the home switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), move in the positive direction to accelerate to a low speed (6099-02) with the homing acceleration (609A), and keeps moving in the positive direction at the low speed. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- When homing starts, if the home switch signal is high level, the motor moves at a low speed (6099-02) in the positive direction. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.



Figure 3-54 Speed-time curve of method 10

3.5.3.12 Method 11: Homing on positive home switch (falling edge) and index pulse-



negative limit switch detection

Figure 3-55 Method 11

- When homing starts, if the home switch signal is low level, the motor moves at a high speed (6099-01) in the negative direction.
 - ✓ After the home switch signal becomes high level, the motor moves with the homing deceleration (609A) to decelerate to 0, and moves in the positive direction to accelerate to a low speed (6099-02) with the homing acceleration (609A), and keeps moving at the low speed in the positive direction. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
 - ✓ After the negative limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a high speed (6099-01), and keeps moving in the positive direction at the high speed. After the home switch signal becomes high level, the motor decelerates to a low speed (6099-02) with the homing deceleration (609A), and keeps moving in the positive direction at the low speed. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- When homing starts, if the home switch signal is high level, the motor moves at a low speed (6099-02) in the positive direction. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.





3.5.3.13 Method 12: Homing on negative home switch (rising edge) and index pulsenegative limit switch detection





- When homing starts, if the home switch signal is low level, the motor moves at a low speed (6099-02) in the negative direction.
 - ✓ After the home switch signal becomes high level, the motor keeps moving in the negative direction at a low speed (6099-02). After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status

word Target reached is set to 1 when the motor stops.

- ✓ After the negative limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a high speed (6099-01), and keeps moving in the positive direction at the high speed. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), moves in the negative direction to accelerate to a low speed (6099-02) with the homing acceleration (609A), and keeps moving in the negative direction at the low speed. After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- When homing starts, if the home switch signal is high level, the motor moves at a high speed (6099-01) in the positive direction. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.



Figure 3-58 Speed-time curve of method 12

3.5.3.14 Method 13: Homing on positive home switch (rising edge) and index pulse-

negative limit switch detection





- When homing starts, if the home switch signal is low level, the motor moves at a high speed (6099-01) in the negative direction.
 - ✓ After the home switch signal becomes high level, the motor keeps moving in the negative direction at the high speed. After the home switch signal becomes low level, the motor moves with the homing deceleration (609A) to decelerate to 0, and moves in the positive direction to accelerate to a low speed (6099-02) with the homing acceleration (609A), and keeps moving at the low speed in the positive direction. After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
 - ✓ After the negative limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the home switch signal becomes high level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- When homing starts, if the home switch signal is high level, the motor moves at a high speed (6099-01) in the negative direction. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the home switch signal becomes high level and the first Z signal shows, the status word Homing





Figure 3-60 Speed-time curve of method 13

3.5.3.15 Method 14: Homing on negative home switch (falling edge) and index pulsenegative limit switch detection





- When homing starts, if the home switch signal is low level, the motor moves at a high speed (6099-02) in the negative direction.
 - ✓ After the home switch signal becomes high level, the motor moves with the homing deceleration (609A) to decelerate to a low speed (6099-02), and keeps moving in the negative direction at a low speed. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

- ✓ After the negative limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a high speed (6099-01), and keeps moving in the positive direction at the high speed. After the home switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), moves in the negative direction to accelerate to a low speed (6099-02) with the homing acceleration (609A), and keeps moving in the negative direction at the low speed. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- When homing starts, if the home switch signal is high level, the motor moves at a low speed (6099-01) in the negative direction. After the home switch signal becomes low level and the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.



Figure 3-62 Speed-time curve of method 14

3.5.3.16 Method 15: Reserved

3.5.3.17 Method 16: Reserved

3.5.3.18 Method 17: Homing on negative limit switch (falling edge)



Figure 3-63 Method 17

When homing starts, the motor moves at a high speed (6099-01) in the negative direction. When the negative limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the negative limit switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.



Figure 3-64 Speed-time curve of method 17

3.5.3.19 Method 18: Homing on positive limit switch (falling edge)



Figure 3-65 Method 18

When homing starts, the motor moves at a high speed (6099-01) in the positive direction. When the positive limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the positive limit switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.



Figure 3-66 Speed-time curve of method 18

3.5.3.20 Method 19: Homing on negative home switch (falling edge)

Home switch



Figure 3-67 Method 19

- When homing starts, if the home switch signal is low level, the motor moves at a high speed (6099-01) in the positive direction. After the positive home switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the positive home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- When homing starts, if the home switch signal is high level, the motor moves at a low speed (6099-02) in the negative direction. After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.



Figure 3-68 Speed-time curve of method 19

3.5.3.21 Method 20: Homing on positive limit switch (rising edge)



Figure 3-69 Method 20

- When homing starts, if the positive home switch signal is low level, the motor moves at a low speed (6099-02) in the positive direction. After the positive home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- When homing starts, if the positive home switch signal is high level, the motor moves at a high speed (6099-01) in the negative direction. After the positive home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the positive home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.



Figure 3-70 Speed-time curve of method 20

3.5.3.22 Method 21: Homing on negative home switch (falling edge)



Figure 3-71 Method 21

- When homing starts, if the home switch signal is low level, the motor moves at a high speed (6099-01) in the negative direction. After the home switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- When homing starts, if the home switch signal is high level, the motor moves at a low speed (6099-02) in the positive direction. After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.



Figure 3-72 Speed-time curve of method 21

3.5.3.23Method 22: Homing on negative home switch (rising edge)



Figure 3-73 Method 22

- When homing starts, if the home switch signal is low level, the motor moves at a low speed (6099-02) in the negative direction. After the home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- When homing starts, if the home switch signal is high level, the motor moves at a high speed (6099-01) in the positive direction. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.



Figure 3-74 Speed-time curve of method 22

3.5.3.24 Method 23: Homing on negative home switch (falling edge) -positive limit switch detection





- When homing starts, if the home switch signal is low level, the motor moves at a high speed (6099-01) in the positive direction.
 - ✓ After the home switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
 - ✓ After the positive limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a high speed (6099-01), and keeps moving in the negative direction at the high speed. After the home switch signal becomes high level, the motor decelerates to a low speed (6099-01) with the homing deceleration (609A), and keeps moving in the negative direction at the low speed. After the home switch becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- When homing starts, if the home switch signal is high level, the motor moves at a low speed (6099-02) in the negative direction. After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.



Figure 3-76 Speed-time curve of method 23

3.5.3.25 Method 24: Homing on positive home switch (rising edge)-positive limit switch detection





- When homing starts, if the home switch signal is low level, the motor moves at a low speed (6099-02) in the positive direction.
 - ✓ After the home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

- ✓ After the positive limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a high speed (6099-01), and keeps moving in the negative direction at the high speed. After the home switch signal becomes low level, the motor decelerates to 0 with the homing acceleration (609A), and moves in the positive direction with the homing acceleration (609A), and moves in the positive direction with the homing acceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- When homing starts, if the home switch signal is high level, the motor moves at a high speed (6099-01) in the negative direction. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.



Home switch signal is high level when homing starts

Figure 3-78 Speed-time curve of method 24

3.5.3.26 Method 25: Homing on negative home switch (rising edge)-positive limit switch detection





Regardless of the high level or low level of the home switch signal, the motor moves in the positive direction.

When homing starts, the motor moves in the positive direction at a high speed (6099-01). After the home switch signal becomes low level or the positive limit switch becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to

decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.



Figure 3-80 Speed-time curve of method 25







- When homing starts, if the home switch signal is low level, the motor moves at a high speed (6099-01) in the positive direction.
 - ✓ After the home switch signal becomes high level, the motor decelerates to a low speed (6099-02) with the homing deceleration (609A), and keeps moving in the

positive direction at the low speed (6099-02). After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

- ✓ After the positive limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a high speed (6099-01), and keeps moving in the negative direction at the high speed. After the home switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A), and moves in the positive direction with the homing acceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- When homing starts, if the home switch signal is high level, the motor moves at a low speed (6099-02) in the positive direction. After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.



Figure 3-82 Speed-time curve of method 26

3.5.3.28 Method 27: Homing on positive home switch (falling edge)-negative limit switch detection



Figure 3-83 Method 27

- When homing starts, if the home switch signal is low level, the motor moves at a high speed (6099-01) in the negative direction.
 - ✓ After the home switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), moves in the positive direction with the homing acceleration to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed (6099-02). After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
 - ✓ After the negative limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a high speed (6099-01), and keeps moving in the positive direction at the high speed. After the home switch signal becomes high level, the motor moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- When homing starts, if the home switch signal is high level, the motor moves at a low speed (6099-02) in the positive direction. After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.





3.5.3.29 Method 28: Homing on negative home switch(rising edge)-negative limit switch detection





- When homing starts, if the home switch signal is low level, the motor moves at a low speed (6099-02) in the negative direction.
 - After the home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
 - ✓ After the negative limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a high speed (6099-01), and keeps

moving in the positive direction at the high speed. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

• When homing starts, if the home switch signal is high level, the motor moves at a high speed (6099-01) in the positive direction. After the home switch signal becomes low level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.



Figure 3-86 Speed-time curve of method 28

3.5.3.30 Method 29: Homing on positive home switch(rising edge)-negative limit switch detection



Figure 3-87 Method 29

Regardless of the high level or low level of the home switch signal, the motor moves in the negative direction.

When homing starts, the motor moves in the negative direction at a high speed (6099-01). After the home switch signal becomes low level or the negative limit switch becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the positive direction at the low speed. After the home switch signal becomes high level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.


3.5.3.31 Method 30: Homing on negative home switch (falling edge)-negative limit switch detection





- When homing starts, if the home switch signal is low level, the motor moves at a high speed (6099-01) in the negative direction.
 - ✓ After the home switch signal becomes high level, the motor moves with the homing deceleration (609A) to decelerate to a low speed (6099-02), and keeps moving in the negative direction at the high speed. After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
 - ✓ After the negative limit switch signal becomes high level, the motor decelerates to 0 with the homing deceleration (609A), and moves in the positive direction with the homing acceleration (609A) to accelerate to a high speed (6099-01), and keeps moving in the positive direction at the high speed. After the home switch signal becomes high level, the motor decelerates to 0 with the homing acceleration (609A), and moves in the negative direction with the homing acceleration (609A), and moves in the negative direction with the homing acceleration (609A), and moves in the negative direction with the homing acceleration (609A) to accelerate to a low speed (6099-02), and keeps moving in the negative direction at the low speed. After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.
- When homing starts, if the home switch signal is high level, the motor moves at a low speed (6099-02) in the negative direction. After the home switch signal becomes low level, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.



Figure 3-90 Speed-time curve of method 30

3.5.3.32 Method 31: Reserved

3.5.3.33 Method 32: Reserved

3.5.3.34 Method 33: Homing on index pulse in negative direction





When homing starts, the motor moves at a low speed (6099-02) in the negative direction. After the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.



Figure 3-92 Speed-time curve of method 33

3.5.3.35 Method 34: Homing in index pulse in positive direction



Figure 3-93 Method 34

When homing starts, the motor moves at a low speed (6099-02) in the positive direction. After the first Z signal shows, the status word Homing attained is set to 1, and the motor starts to decelerate with the homing deceleration (609A). The status word Target reached is set to 1 when the motor stops.

3.5.3.36 Method 35: Current position

In this method, the current position shall be taken to the home position.

3.5.3.37 Method -1: Guard position as home point in negative direction



When homing starts, the motor moves in the negative direction, and the locked rotor torque reaches the set value of 0x2138 when the guard is touched. The motor stops after the time set by 0x2137:

 \checkmark If the retraction distance is not set, the current position is set as the home point.

✓ If the retraction distance is set, the motor will retract the corresponding distance and set the current position as the home point.

3.5.3.38 Method -2: Guard position as home point in positive direction



When homing starts, the motor moves in the positive direction, and the locked rotor torque reaches the set value of 0x2138 when the guard is touched. The motor stops after the time set by 0x2137:

- \checkmark If the retraction distance is not set, the current position is set as the home point.
- ✓ If the retraction distance is set, the motor will retract the corresponding distance and set the current position as the home point.

3.5.3.39 Method -3: C pulse as home point after guard is touched in negative

direction



When homing starts, the motor moves in the negative direction, and the locked rotor torque reaches the set value of 0x2138 when the guard is touched. After the time set by 0x2137, the motor moves in the positive direction. The first C pulse is home point.

3.5.3.40 Method -4: C pulse as home point after guard is touched in positive direction



When homing starts, the motor moves in the positive direction, and the locked rotor torque reaches the set value of 0x2138 when the guard is touched. After the time set by 0x2137, the motor moves in the negative direction. The first C pulse is home point.

3.5.4 Torque Control Mode

Torque mode is generally used for servo to act as loading.

The process of motion control in torque mode is as follows:

1. Select **"Torque Mode".** The interface of motion control in torque mode shows as in Figure 3-96.

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Figure 4-96 Interface of motion control in torque mode

- 2. Set the following parameters:
 - ✓ Target torque: the torque output by the motor. (unit: permillage of rated torque)
 - ✓ Torque Ramp: The acceleration when the motor starts to output torque. (unit: permillage of rated torque / second)
- 3. To enable the servo drive, click "Enable". Servo Enable shows in the interface.
- 4. To control the motor to move with a positive given torque, click "**Forward**", to control the motor to move with a negative given torque, click "**Reverse**".

3.5.5 Pulse Control Mode

• External wiring of the servo drive

Currently Diamond Plus series is supported only with CANopen communication mode. You can control it in one of the following pulse modes:

- 1. A/B-phase quadrature pulse control: respectively connect pulse signal A/B to J2 (3, 4, 5, 6) of the incremental encoder.
- 2. Direction + pulse control: connect direction signal to J2 (5, 6) of the incremental encoder and the position pulse signal to J2 (3, 4).

Encoder_2A+	PULSE+
Encoder_2A-	PULSE-
Encoder_2B+	SIGN+
Encoder_28-	SIGN-
	Encoder_2A+ Encoder_2A- Encoder_2B+ Encoder_2B-

Note: The voltage of differential pulse input signal is ± 5 V. Due to the best anti-noise ability of this signal transmission method, it is recommended to use this connection method first; if the upper unit is 24 V output, it needs to be converted to 5 V input with a conversion module.

• Configuration of the upper computer

To configure the upper computer, do the following:

- 1. Correctly set the motor and encoder parameters.
- 2. Carry out debugging for the motor and PID parameters. Please refer to the relevant debugging manual for details.
- Open the upper computer, click "Tools" → "Parameter Editor" → "AI, pulse control parameters", and set the following parameters:

No	Name	Description	Set
110.	Nume	Description	Value
0x2023	PulseControlEnable	Pulse control enable	1
0x2024	InputResolution	 Input resolution: ✓ Rotary motors: it corresponds to one rotation of the motor. ✓ Linear / voice coil motors: it corresponds to a magnetic pole pitch. 	1000
0x2025	PositionControlLPFFreq	-	0
0x2026	PulseControlMode	 Selection of pulse control mode: ✓ 1: A/B-phase quadrature pulse control. ✓ 2: Direction + pulse control ✓ 3: not support. 	1

After the above parameters are set and the motor debugging is finished, it can directly receive the pulse input signal for position control.

3.5.6 Analog Control Mode

The servo drive supports receiving analog quantities to control the position, speed and current of the motor. The relevant parameters are as follows:

No.	Name	Description	
		 ✓ 0: not used 	
		 ✓ 1: position control 	
		 ✓ 2: velocity control 	
0x201B	Analog control mode	 ✓ 3: current control 	
		 ✓ 4: position feedback 	
		✓ 5: speed feedback	
		 ✓ 6: current feedback 	
0x 201C	Analog input offset	Set according to the initial 0 drift	
0x201D	Al 1 input dead-time	Default: 0	
0x201E	All input low-pass filter cutoff	Default: 3000	
		Unit: position-cnt/V, speed-rpm/V,	
0x201F	Al1 control gain	current-mA/V. (Please set it	
		according to specific control range.)	
0,2112		Unit: mv (Currently this group is used	
UXZ413		by default)	
0x2414	AI2 analog input value	Unit: mv (Reserved)	

Please refer to the relevant documents of analog control for details.

3.6 Troubleshooting

If an error occurs during debugging, please troubleshoot the error by following the error description, possible causes and troubleshooting methods displayed by the upper computer software, as shown in Figure 3-98.



Figure 3-96 Fault Display

After the error is successfully troubleshooted, click "Clear Alarm" in the toolbar.

Debugging can be continued after the system shows no error.

Note: If you have any questions during debugging, please seek technical support. Please do not arbitrarily modify the parameters, so as to avoid damages to personnel and property.

4 Troubleshooting

When an error occurs, the LED on the Diamond Plus servo panel will flash red in rhythm. After connecting the upper computer software, the error code based on the CiA402 standard will be displayed in the error handling interface.

When the servo alarms, please refer to the following table to check the servo, and solve the servo error according to the corresponding solution.

Error Code	Name	Cause	Solution
0x2230	Bus overcurrent	 DC bus with excessive voltage. Short circuit at periphery. Encoder failure. Internal components of the servo are damaged. 	 Check power supply and whether high inertia loads leads to rapid stop without dynamic braking. Check whether the servo and the output wiring are short circuit, whether earthing is short circuit, and whether the braking resistor is short circuit. Check whether the encoder is damaged or the wiring is correct; check whether the shielding layer of the encoder cable is well grounded, and whether there is strong interference near the cable.
0x2310	U-phase overcurrent	 U-phase output is short circuit. High load. Cable insulation is damaged. Poor motor insulation. Failure of U- phase current detecting circuit. 	 Check U-phase wiring. Lower the load. Check U-phase cable and replace it if necessary. Measure the motor insulation, repair and replace it if necessary; Repair or replace the drive.
0x2311	V-phase overcurrent	 V-phase output is short circuit; High load. Cable insulation is damaged. Poor motor insulation. Failure of V- phase current detecting circuit. 	 Check V-phase wiring. Lower the load. Check V-phase cable and replace it if necessary. Measure the motor insulation, repair and replace it if necessary. Repair or replace the drive.

Table 4-1 Fault description

Error Code	Name	Cause	Solution
0x2320	Hardware short circuit	 DC bus with excessive voltage. Short circuit at periphery. Encoder failure. Internal components of the servo are damaged. 	 Check power supply and whether high inertia loads leads to rapid stop without dynamic braking. Check whether the servo and the output wiring are short circuit, whether earthing is short circuit, and whether the braking resistor is short circuit. Check whether the encoder is damaged or the wiring is correct; check whether the shielding layer of the encoder cable is well grounded, and whether there is strong interference near the cable.
0x3220	Servo undervoltage	 Low input voltage of the power circuit. Poor insulation of DC bus. High load. Poor insulation of the driver cable. Failure of DC bus undervoltage detecting circuit. Basic power module failure. 	 Check the power circuit. Check the DC bus insulation. Lower the load. Check the drive cable. Repair or replace the drive. Repair or replace the basic power module.
0x3210	Servo overvoltage	 Insufficient capacity of brake circuit. Insufficient capacity of braking resistor. Basic power module failure 	 Reduce the start-stop frequency; increase the acceleration/deceleration time constant; lower the load inertia; increase the drive and motor capacity. Increase the power of the braking resistor. Repair or replace the basic power module;
0x4110	Ambient temperature overheating	 1.High ambient temperature. 2.Abnormal cooling system. 3.Temperature detecting circuit failure. 	 Lower the ambient temperature and strengthen ventilation and heat dissipation. Check the cooling fan speed and air volume. If they are abnormal, replace the fan with the same model. Check whether the servo cooling channel is blocked by foreign objects.
0x4120	Ambient	1.Low ambient	1. Check whether the ambient

Error Code	Name	Cause	Solution
	temperature underheating	temperature. 2.Temperature detecting circuit failure.	temperature is too low; 2. Check the value of parameter minimum ambient temperature.
0x4310	Power module overheating	 High ambient temperat ure. Abnormal cooling system. Temperature detecting circuit failure. 	 Lower the ambient temperature and strengthen ventilation and heat dissipation. Check the cooling fan speed and air volume. If they are abnormal, replace the fan with the same model. Check whether the servo cooling channel is blocked by foreign objects.
0x8482	Exceed maximum speed	 Motor run away. Wrong encoder parameters. Encoder failure Instruction error Load mutation 	 Check the phase sequence of the motor power cable. Check the settings of encoder parameter. Check whether the encoder is damaged or the wiring is correct; check whether the shielding layer of the encoder cable is well grounded, and whether there is strong interference near the cable. Check the position / speed / torque command. Check whether the load is mutated and related cause. Correct the phase zero again. Adjust PID parameters.
0x8483	Large speed tracking error	 The encoder wiring is wrong or the connector is in poor contact. The gain does not match. Large external load fluctuations or interference. 	 Check the encoder wiring; Adjust the servo gain again. Increase anti-interference measures.

Error Code	Name	Cause	Solution
0x8611	Large position deviation	 The encoder wiring is wrong or the connector is in poor contact. The gain does not match. Large external load fluctuations or interference. 	 Check the encoder wiring; Adjust the servo gain again. Increase anti-interference measures.
0x7380	Encoder connection error	 Wrong encoder parameters. Encoder cable failure. The encoder cable is not connected. The internal components of the servo are damaged. 	 Check the settings of encoder parameters. Check the line sequence of encoder cable. Connect the encoder cable.
0x7383	Encoder multi-turn info error	Internal encoder error.	Power off and restart the servo. If the fault cannot be cleared, replace the encoder.
0x7385	Encoder count error	Internal encoder error.	Power off and restart the servo. If the fault cannot be cleared, replace the encoder.
0x7389	Encoder count overflow error	Internal encoder error.	Clear the encoder multi-turn value, power off and restart the servo. If the fault cannot be cleared, replace the encoder.
0x738A	Encoder communicati on CRC error	1.Wrong encoder parameters. 2.Encoder cable failure.	 Check the settings of encoder parameters. Check whether the encoder is damaged or the wiring is correct; check whether the shielding layer of the encoder cable is well grounded, and whether there is strong interference near the cable.
0x738B	Encoder delimiter error	Internal encoder error.	Power off and restart the servo. If the fault cannot be cleared, replace the encoder.
0x3221	PWM drive abnormal	PWM drive +15 V undervoltage.	Check whether the control power +24V is connected properly.
0x8612	Exceed	Given position or	1.Check the setting of limit position.

Error Code	Name	Cause	Solution
	position limit	actual position exceeds position limit.	2.Check the settings of given position.3.Check whether the limit switch is triggered.
0x7384	Encoder overheating	The working temperature of the encoder exceeds 95℃.	 Test again after the motor has cooled down. Improve the heat dissipation conditions and check whether the motor overheats during running. Internal encoder error.
0x6280	Wrong profile value	There is a zero value in the set value of the profile track, which makes the planned track unsuccessful.	 Make sure the set speed is not zero. Make sure the set acceleration is not zero.
0x6281	Termination speed setting error	The termination speed is greater than the profile speed, which makes the planned track unsuccessful.	1. The set termination speed must be less than or equal to the profile speed.
0x6282	Termination speed setting error	The target position is too close to the current position to reach the termination speed.	1. Check whether the set termination speed is too large.
0x6283	Software limit setting error	When the minimum / maximum software limit is not set to 0, the minimum value is greater than or equal to the maximum value; or exceed the position limit.	 Set the minimum value greater than the maximum when the minimum / maximum software limit is not set to 0. Check whether the maximum value is too large. Check whether the minimum value is too small.
0x6284	Wrong position limit	When the minimum / maximum position limit is not set to 0, the minimum value is greater	1. Set the minimum value greater than the maximum when the minimum / maximum position limit is not set to 0.

Error Code	Name	Cause	Solution
		than or equal to the maximum value.	
0x6285	Wrong planned curve type	The set planned curve type is not supported.	1. Set the planned curve type to 0 (Linear ramp)
0x6286	Wrong planned curve type	The set planned curve type is not supported.	1. Set the planned curve type to 0 (Linear ramp) or 3 (Jerk-limited ramp).
0x6287	Wrong planned torque curve	The set planned torque type is not supported.	1. Set the planned torque curve type to 0 (Linear ramp).
0x6288	Wrong homing method	The limit switch was accidentally triggered.	1. Start homing again after setting a suitable homing method.
0x6289	Wrong homing method	The set homing method is not supported.	1. Start homing again after setting a suitable homing method.
0x628B	Homing process timed out	The zero point was not found during homing.	 Check the lower limit switch or the origin switch. Set a suitable homing method.
0x628C	Initial speed not zero when planning Jerk-limited ramp	When the planned curve type is Jerk- limited ramp, the initial speed is not zero.	1. Make sure the motor is still before enabling the curve planning of the Jerk- limited ramp.
0x6180	Execution time of planned curve less than 0	The settings of position, speed, or acceleration / deceleration are incorrect.	Reset position, speed, acceleration and deceleration.

Error Code	Name	Cause	Solution
0x6181	Stop speed greater than initial speed	Stop speed is not set to 0	Set stop speed to 0.
0x6182	Position, speed, acceleration and deceleration not set for continuous motion of multiple points	The position, speed, acceleration and deceleration are not set for continuous motion of multiple points	Reset the target position, speed, acceleration and deceleration.
0x6184	Internal state transition error in homing	Jump exception of the internal homing state.	Execute homing again.
0x7124	Motor overtheating	The motor temperature is detected by the external temperature sensor and then connected to the servo through the DI port, and its upper limit is determined by the external temperature sensor.	 High load. Lack of phase. Fault related to motor machinery, including lack of lubricating grease, improper assembly of bearings and end caps, eccentricity of inner holes, etc.

Error Code	Name	Cause	Solution
0x3130	Lack of phase	UVW phases have open circuit.	Check the wiring of UVW phases.
0x8700	Sync error	Bus synchronization error.	Restart the servo.
0x738C	Hall error	Hall signal is disconnected.	Check the wring of Hall.
0x6551	Wrong target speed	The target speed is 0 in position control.	Check the value of 0x6081 and make sure it is not 0.
0x6552	Wrong acceleration and deceleration in position and velocity control	The track planning is unsuccessful when acceleration and deceleration is set to 0.	Make sure acceleration or deceleration is not 0.
0x6553	Wrong position track planning period	The position track planning is set to 0.	Make sure the set period is not 0.
0x7320	Z pulse repetition positioning position error	The difference of adjacent Z pulses exceeds 0x2001.	 Check the scale installation or accuracy. Check the Z pulse positioning deviation.
0x8620	Failed to enable auto calibration	Failed to enable automatic calibration.	 Check whether the motion control mode is 0. Check whether the device is stuck, the frictional resistance increases or the load is abnormal, etc. Check whether there is an open circuit or short circuit in the three-phase wiring. Check whether the settings of 0x2105 and 0x2402 are proper. Check whether the phase sequence of the UVW wiring and the setting of 0x2002 are correct. Check the encoder wiring.

Error Code	Name	Cause	Solution
0x6542	Planned deceleration or quick stop deceleration in the position mode is 0	The planned deceleration or quick stop deceleration in the position mode is 0.	Check the deceleration or quick stop deceleration and make sure it is not 0.
0x6572	Planned deceleration or quick stop deceleration in the position mode is 0	The planned deceleration or quick stop deceleration in the position mode is 0.	Check the deceleration or quick stop deceleration and make sure it is not 0.
0x9100	DI external input alarm	DI external input condition triggers an alarm.	Check the external input conditions.
0x8900	l2T protection alarm	Exceed the I2T setting threshold	 Adjust limiter protection peak current. Adjust limiter protection peak current duration. Note: The alarm takes effect when 0x2017 bit1 is set to 1.
0x8901	Alarm of no calibration	Operation is enabled without performing angle identification.	Enable operation after If Hall is connected and angle identification is finished.
0xB010	Position feedback jitter during angle identification	Wrong encoder wiring. Abnormal load or external disturbance.	Check the encoder wiring. Check the load or external disturbance.
0xB020	Rotor not moving during angle identification	Parameter settings such as current are incorrect. High load. The machine is stuck, or the wiring is wrong.	Set appropriate parameter values. Check device, load and wiring.

Error Code	Name	Cause	Solution
0xB030	Large action of angle identification	Large setting of current. Fault, including device, load, wiring (phase sequence), etc.	Set appropriate parameter values. Check device, load and wiring (phase sequence).
0xB040	Angle identification timed out	Software exception	Check the upper computer software, M3 and C28. Check each parameter setting. Check device, load and wiring.
0xB102	Motor hardly rotates during phase sequence detection	Wrong encoder wiring. High load or friction. Problem with current loop configuration The commutation current ratio 1 is too small.	Check the encoder wiring. Increase commutation current ratio 1.
0xB104	Hall status feedback abnormal	Wrong wiring of Hall sensor. Wrong Hall mode.	Check the wring of Hall Sensor. Make sure 0x2103 is set to 0.

5 Debugging Software ISMC

Stone Motion Control (ISMC) is a servo debugging software independently developed by our company. Through USB serial communication, you can configure and modify servo parameters, debug controller parameters, realize motion control, monitor system status in real time, diagnose faults, check error logs, and realize update and maintenance.

This chapter only focuses on software download and setup. For software operations, please refer to "*Servo Debugging Software ISMC User Manual*'.

5.1 Software Download

5.1.1 System Requirements

System environment requirements:

- Memory: 1 GB or more (1.5 GB or more for running on a virtual machine)
- Display: above 800x600
- System type: 32-bit or 64-bit Windows 7 / Windows 8 / Windows 10
- Processor: above 1.6 GHZ

5.1.2 Software Installation

The setup process of SMC is as follows:

- 1. Download the setup package from the official website.
- 2. Double click the .exe application file, and wait for the decompression. After decompression, the setup wizard pops up, as shown in Figure 6-1.

Stone Motion Control V1.00 InstallShield Wizard				
ع.	Welcome to Stone Motion Control InstallShield Wizard			
	The InstallShield(R) Wizard will install StoneMotion Control V1.00 on your computer. To continue, click Next.			
	Warning: This program is protected by copyright laws and international treaties.			
	< previous The next step N > cancel			

Figure 5-1 SMC installation wizard

3. Click "Next". The agreement dialog box pops up, as shown in Figure 5-2.

🛃 Stone Motion Control V1.00 InstallShield Wizard	×			
License Agreement Please read the license agreement below carefully.	と			
To add your own license text to this dialog, specify your license agreement file in the	Dialog editor.			
1. Navigate to the User Interface view. 2. Select the LicenseAgreement dialog. 3. Choose to edit the dialog layout. Once in the Dialog editor, select the Memo ScrolableText control. 5. Set FileName to the name of your license agreement RTF file. After you build your release, your icense text will be displayed in the License Agreement dialog.				
 I accept the terms of this license agreement (A)∘ I de the terms of this license agreement (D) 	o not accept Print (P)			
InstallShield <	t step (N) > cancel			

Figure 5- 2 Installation agreement

4. Select "I Agree", click "Next" and enter the user information, as shown in Figure 5-3.

Stone Motion Control V1.00 InstallShield Wizard User information Please enter your information.	×
User name U: David	_
Unit (O) : test	-
InstallShield	next step N > cancel

Figure 5-3 User information

 Click "Next", and select the setup type, as shown in Figure 5-4. Generally, please use the default type.



Figure 5-4 Setup type

6. Click "**Next**", and click "**Finish**" after the setup is finished to exit the setup interface and complete the setup, as shown in Figure 6-5.

Stone Motion Control V1.00 InstallShield Wizard Stone Motion Control V1.00 is installing the program features of your choice		-	-	Ì	×
	InstalShield WizardE please wait while Stone Motion Control V minutes. Status: New documents are being made in summer	'1.00 is insta	alled. Thi	s should	I take a few
InstallShield	< previous step. The r	next step ((N) >	cance	el

Figure 5-5 Installing

- After setup, check the shortcut of SMC software by accessing "Desktop" → "Start" → "All Programs" on your computer, as shown in Figure 5-6.
 - Stone Motion Control v1.00 最近添加 Stone Motion Control 最近添加 Figure 5-6 Start menu

5.2 Driver Installation

When using USB communication for the first time, you need to install the USB driver.

Note: The driver will be automatically installed on Windows 10 after connecting the USB data cable.

Taking Windows 7 as an example, the process of driver installation is as follows:

1. Connect the upper computer and the servo drive via the USB data cable. A prompt that the driver cannot be installed automatically, as shown in Figure 6-7.



Figure 5-7 Failed to install the driver

2. Open the Windows main menu, and right click "Computer".



Figure 5-8 Windows main menu

3. To open the computer management, click "Manage":

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新計算程度第二元回 前、用作工具 (○ 4月51138日年) 総 単有量価値) 総 単有量価値) 総 単有量価値) 総 単有量価値 (○ 4月51138日年) 総 単有量価値 (○ 4月51138日年) 総 単有量価値 (○ 4月51138日年) 総 単有量価値 (○ 4月51138日年) 総 単一型(○ 4月51138日年) 総 単 単 第(○ 4月51138日年) 総 単 単 (○ 4月51138日年) 総 単 (○ 4月51138日年) 総 単) 総 単 (○ 4月51138日年) 総 単) 総 単 (○ 4月51138日年) 総 単) 総 単) 総 単) 総 単 (○ 4月51138日年) 総 単) 総 単) 総 単) 総 単) 総 単) 総 (○ 4月51138日年) 総 単) 総 単) 総 (○ 4月51138日年) 総 単) 総 (○ 4月51138日年) 総 (○ 4月51138日年) (○ 4月51138日年) (○ 4月51138日年) (○ 4月511381) (○	Re INALE BAR Defactor Click "Manage"	(1) 2013年(王元) 王(1) 2411 王(1) 2411	

Figure 5-9 Computer management window

4. Select "Device Manager" → "Others", and find the unrecognized device Virtual COM Port.

唐 计算机管理(本地)	4 BJZ	12/5
* [] 系统工具	Bluetooth 无线电投发器	设备被理器
 基本的名称量 基本的图片的组 基本的图片的组 管理 基礎常常 基礎常常 基礎考問 基礎考問 基礎考問 	Constant Constant	2.516rs

Figure 5-10 Device manager

5. Right click "Virtual COM Port", and select "Update Driver Software".

◆ ↔ 2 (() () () () () () () () () () () () ()	0 980(H)] 전 (고 전 전	
 計算机管理(本地) 第60工具 任务计划程序 日 事件音看器 前 共享文件夫 香 本地用户和组 	▲	操作 初编量理题 — 更多地作)
 ○ 代規 高学経電理測 ▲ 25 伊坡 副: 宣言推測 副: 宣言推測 ■ 服务和应用程序 	· 计算机 · 计算机 · 世校 · 世校 · 世校 · 世校 · 世校 · サバロシ · ・ · ・ · ・ · ・ · ・ · ・ · ・ · ・ · ・	Update Driver Software

Figure 5-11 Update driver software

6. Select "Browse my computer for driver software".

80	1 2 8 5	×
• ۱	更新驱动程序软件 · Virtual COM Port	
您想	如何搜索驱动程序软件?	
•	自动搜索更新的驱动程序软件(S) Windows 將在鄉計算明目 Internet 上查找用于相关。 非在设备安装设备中就用点功能。	会員的最新版力程序软件,除
*	浏览计算机以查找驱动程序软件(R) 手应直进用会等驱动框件软件。	
	Browse the computer	
	driver software	取消

Figure 5-12 Find driver software

7. Click **"Browse"**, find and select the driver folder **"windows_drivers"** in the SMC installation directory.

Default path: C:\Program Files(x86)\SMC\Files\windows_drivers.

🚱 🔯 更新驱动程序软件 - TI USB serial port (COM3)	×
浏览计算机上的驱动程序文件	
在以下位置援委援动程序软件: CNProgram Files (x80)(CSC)Files)windcows_drivers ・ 図 包括子文件夫(1)	
→ 从计算机的设备被动程序列表中选择(L) 此列表#显示与该设备着自的已安装的范却图字软件,以及与该设备处于同一类别下的 所有驱动图字软件。	
下一步(N) 取	清

Figure 5-13 Browse the driver installation path

8. Click "Next" to start installation, and select "Always install this driver software" in the pop-up security warning window.



Figure 5-14 Security warning pop-up

9. Finish driver installation.

更新能动型体软件 - TLUSB serial port (COM3)	
Windows 已经成功地更新威动程序文件 Windows 已经完成安装武设备的策动程序软件:	
TI USB serial port	Successful Installation
	TERICO
	关闭(C)

Figure 5-15 Finish driver installation

Note: If the driver fails to be installed successfully, please contact the technician.

5.3 Firmware Upgrade

You can burn and upgrade the M3 and C28 files in the servo through SMC. The process of firmware upgrade is as follows:

1. Select "Setting" in the main menu, and click "Firmware Updata" to open the firmware upgrade interface, as shown in Figure 5-16.



Figure 5-16 Firmware upgrade

- 2. Click "Select File" to open the folder and select the M3 or C28 file to be upgraded.
- 3. Click **"Upgrade"** to start upgrading. After the upgrade is successful, SMC software and the servo are restarted.
- 4. After reconnecting, repeat the above steps to upgrade the next program until all programs are upgraded.

Note:

- 1. For firmware upgrade, please contact our technical team.
- 2. Servo DC+/DC- power supply is required when upgrading, and 24 V power supply is recommended.
- 3. The names of the upgraded files are fixed, i.e. C28-APP.bin and M3-APP.bin.
- 4. For the first time, please flash M3-APP.bin first, and then flash C28-APP.bin.

6 Communication

6.1 EtherCAT Communication

6.1.1 Principle

6.1.1.1 CoE reference model

The internal CANopen over EtherCAT (CoE) network model of Stone servo is shown in Figure 7-30.



Figure 6-30 COE reference model

The EtherCAT (CoE) network model consists of two parts:

• Data link: mainly responsible for EtherCAT communication protocol

• Application: it embeds the CANopen drive Profile (DS402) communication protocol.

The object dictionary in CoE includes parameters, application data, and PDO mapping information.

Process data object (PDO) consists of objects in the object dictionary that can do PDO mapping, and the content in PDO data is defined by PDO mapping. The read and write of PDO data is periodic with no need to look up the object dictionary; while the mailbox communication (SDO) is non-periodic communication with a need to look up the object dictionary.

6.1.1.2 EtherCAT slave information

The EtherCAT slave information file (XML file) is read by the master and used to construct the configuration of the master and slave. The XML file contains the necessary information for EtherCAT communication. STONE provides the "Stone_E XML.xml" file for the servo drive to construct the configuration of the master and slave.

6.1.1.3 EtherCAT State Machine

It is used to describe the states and state changes of the slave. The state change request is usually initiated by the master and the slave responds. The details is shown in Figure 6-31.





The status of state machine is shown in Table 6-31.

Status	Description
Deet	♦ Firmware update.
ROOL	 Drive can transit to Init state.
loit	Initialize the communication.
ITTIL	 Unable to communicate with SDO and PDO.
	• The master configures the link address and SM channel to start
	mailbox communication.
Init > Dro OD	 The master initializes DC clock synchronization.
Init->Pre-OP	• The master requests a transition to the Pre-Op state.
	• The master sets the AL control register.
	• The slave checks if mailbox is normally initialized.
	 Mailbox communication is activated.
PIE-OP	 Unable to communicate with PDO.
	• The master configures the Sync Manager channel and FMMU
	channel for PDO.
	• The master configures PDO data mapping and Sync Manager
Dro OD Safo OD	PDO parameters through SDO.
FIE-OF->Jale-OF	 The master requests transition to Safe-Op state.
	• The slave checks if the Sync Manager responsible for the PDO
	data is correctly configured, and check the distributed clock
	when the slave sends a request to start synchronization.
	• The slave application will transfer the actual input data and will
Safe-OP	not respond to the output.
	 Output is set to "safe state".
Safa OD SOD	 The master sends valid output data.
Sale-OP-2OP	 The master requests a transition to the Op state.
	Mailbox communication is available.
UP	 PDO communication is available.

Table 6-31 Status

6.1.1.4 PDO mapping

ISD-A5-E-01 servo has 4 configurable PDOs, including 2 RxPDOs (0x1600 and 0x1601) and 2 TxPDOs (0x1A00 and 0x1A01). When you need to change the default PDO mapping, you can change the xml file and configure it into the servo.

Note: When using EtherCAT communication, it is necessary to set the communication cycle of the upper computer to be the same as that of the lower servo (default: 4 ms).

The default PDO mapping of STONE servo is as follows: RxPDO

(sub) index	Name	Object Type	Default
		REC	
0x1600	1st Receive PDO	Data type	-
		-	
0x00	Number of mapped objects	UINT8	10
0x01	Mapped object 1	UINT 16	0x6040 Control word
0x02	Mapped object 2	UINT32	0x607A Target position
0x03	Mapped object 3	UINT32	0x60B1 Velocity offset
0x04	Mapped object 4	UINT 16	0x60B2 Torque offset
0x05	Mapped object 5	UINT32	0x60FF Target velocity
0x06	Mapped object 6	UINT 16	0x6071 Target torque
0x07	Mapped object 7	UINT 8	0x6060 Modes of operation
0x08	Mapped object 8	UINT 8	0x0000
0x09	Mapped object 9	UINT32	0x0000
0x0A	Mapped object 10	UINT32	0x0000

Table 6-32 RxPDO

Table 6-33 RxPDO

(sub) index	Name	Object Type	Default
		REC	
0x1601	2st Receive PDO	Data type	-
		-	
0x00	Number of mapped objects	UINT8	12
0x01	Mapped object 1	UINT32	0x0000
		UINT32	0x0000
0x0C	Mapped object 12	UINT32	0x0000

TxPDO

Table 6-34 TxPDO

(sub) index	Name	Object Type	Default
		REC	
0x1A00	1st Transmit PDO	Data type	-
		_	
0x00	Number of mapped objects	UINT8	12
0x01	Mapped object 1	UINT 16	0x6041 Statusword
0x02	Mapped object 2	UINT32	0x6064 Position actual value
0x03	Mapped object 3	UINT32	0x 606C Velocity actual value
0x04	Mapped object 4	UINT 16	0x 6077 Torque actual value
0x05	Mapped object 5	UINT 8	0x 6061 Modes of operation

(sub) index	Name	Object Type	Default
			display
0x06	Mapped object 6	UINT 8	0x0000
0x07	Mapped object 7	UINT32	0x0000
0x08	Mapped object 8	UINT32	0x 0000
0x09	Mapped object 9	UINT32	0x0000
0x0A	Mapped object 10	UINT32	0x 0000
0x0B	Mapped object 11	UINT32	0x0000
0x0C	Mapped object 12	UINT32	0x0000

Table 6-35 TxPDO

(sub) index	Name	Object Type	Default
		REC	
0x1A01	2 st Receive PDO	Data type	-
		-	
0x00	Number of mapped objects	UINT8	12
0x01	Mapped object 1	UINT32	0x0000
		UINT32	0x0000
0x0C	Mapped object 12	UINT32	0x0000

Note: You can query detailed PDO mapping information in the xml file

6.1.2 EtherCAT

6.1.2.1 Communication Interface



Pin	Name	Definition	Direction
1	TX+	Send data+	Output
2	TX-	Send data-	Output
3	RX+	Receive data+	Input
4	RX-	Receive data-	Input
5	PE	Shield	-

Figure 6-32 Definition of EtherCAT communication interface

6.1.2.2 Communication Wiring



Figure 6-33 Communication wiring

6.1.2.3 Software Settings

1. Configure the motor parameters, and make sure that the servo motor can be operated normally with the ISMC software.

For the trial run, please refer to "Diamond Plus Servo User Manual".

- 2. Select master type (0x2005):
 - ✓ 0: support the 402 state machine of most masters, including Beckhoff.
 - ✓ 1: specially support the 6061 state machine of Omron PLC.

Set servo communication cycle, set 0x60C2 to 01.
 Communication cycle range is within 1 - 4 ms (default value: 4 ms).
 The communication cycle of controller and servo should be the same. Otherwise, a synchronization error will occur during running.

The master triggers DC mode in the CSP mode. Otherwise, it will not operate normally. **Note:**

- 1. The transferring and receiving PDOs can be dynamically configured by the master, but the maximum number for each PDO parameter is 10. If the range is exceeded, the slave will be unable to enter the op state.
- 2. The sequence of network cables is $IN \rightarrow OUT$. Otherwise, some nodes may be unable to enter the op state.

6.1.3 Communication with Beckhoff PLC

1. Connect hardware and check configuration

Refer to chapter 1 and 2 and complete the hardware and basic configuration between the servo and PLC.

2. Place the configuration file

Place file Stone_E XML.xml under the TwinCAT directory as follows:

* 个 - 此电脑 > Windows (C:) >	TwinCAT > 3.1 > Cor	nfig > lo >	EtherCAT
名称 ^	修改日期	英型	大小
Beckhoff EPP2xxx	2017/4/4 13:07	XML 文档	1,375 KB
Beckhoff EPP3xxx	2017/1/24 14:32	XML 文档	1,840 KB
Beckhoff EPP4xxx	2016/12/22 11:57	XML 文档	500 KB
Beckhoff EPP5xxx	2016/12/22 11:57	XML 文档	736 KB
Beckhoff EPP6xxx	2017/4/5 15:46	XML 文档	1,272 KB
Beckhoff EPP7xxx	2016/12/22 11:57	XML 文档	1,466 KB
Beckhoff EQ1xxx	2015/11/12 15:24	XML 文档	22 KB
Beckhoff EQ2xxx	2016/11/23 11:42	XML 文档	73 KB
Beckhoff EQ3xxx	2016/11/22 12:22	XML 文档	1,386 KB
Beckhoff ER1xxx	2016/11/21 16:46	XML 文档	165 KB
Beckhoff ER2xxx	2016/11/21 15:32	XML 文档	259 KB
Beckhoff ER3xxx	2017/1/24 14:32	XML 文档	982 KB
Beckhoff ER4xxx	2016/11/22 13:58	XML 文档	318 KB
Beckhoff ER5xxx	2016/3/14 12:52	XML 文档	273 KB
Beckhoff ER6xxx	2016/3/14 12:52	XML 文档	494 KB
Beckhoff ER7xxx	2016/11/22 13:14	XML 文档	1,503 KB
Beckhoff ER8xxx	2016/3/14 12:52	XML 文档	207 KB
Beckhoff EtherCAT EvaBoard	2015/2/4 13:57	XML 文档	72 KB
Beckhoff EtherCAT Terminals	2015/2/4 13:57	XML 文档	53 KB
Beckhoff FB1XXX	2017/5/24 13:26	XML 文档	49 KB
Beckhoff FCxxxx	2015/2/4 13:57	XML 文档	21 KB
Beckhoff ILxxxx-B110	2015/2/4 13:57	XML文档	8 KB
Stone -E XML_3.43(PC)	2019/2/27 6:54	XML 文档	272 KB

Figure 6-34 Directory of file Stone_E XML.xml

3. Establish project and connection

Run TwinCAT software, create a project, modify the IP address of the computer and the controller in the same local area network, and select the target system to be connected:

THE EDIT VIEW PROJECT	BUILD DEBUG TWINCAT PLC TO	DOLS SCOPE WINDOW HELP	
	a al al 9 - C - F Attach •	Kelease +	TwinCAT RT (x86) +
Solution Explorer Search Solution Explorer (Ctrl+2) Solution Test' (1 project) Solution Test' (1 project) Solu	CX-1370426 (5.19.212.38.1.1) CX-1370426 (5.19.212.38.1.1) CX-1370426 (5.19.212.38.1.1) CX-1370426 (5.19.212.38.1.1) CX-1370426 (5.19.212.38.1.1) CX-1570518 (5.31.15.24.1.1) CX-1570512 (169.254.1.1.1.1) Choose Target System 3 Add Route Dialog Enter Host Name Connected Visud-P-61053 192.16 Select Adapter(s) VDU/501 Wrebes-N W.ANH Hof Man TC389/H & UM(a) TL/3g/s	Refeath Status ss AMS Netd TwirCAT Q 81.18 192.168.131.65 211.2249 V 4 10.199.164.20 255.255.255.192 V 9 (Gigabri) 192.168.1.118 255.255.255.0 网卡选择,可以输小缆索范围 到TC2系统	Broadcast Search IS Version Comment Yn XP
	AmsN	ОК	Cancel
	Transport Type: ILP_IP Address Info: VirtualXP-61053 Host Name IP Address	Static Temporary	 Static Temporary
	Connection Timeout (s): 5	A	

Figure 6-35 Modify IP address in TwinCAT

4. Scan the slave and automatically configure NC axis Right click on "I/O", select "Scan", scan EtherCAT slave, click "Scan boxes" after scanning the slave, and click "Automatically add NC axis".

FILE EDIT VIE	ew T	PROJECT	BUILD	DEBUG 合 ウ・	TWINCAT	TWINSAFE	E PLC	TOOLS
Solution Explorer	ā	¥ -		→ ₽	×			
Search Solution ES	oplo nCA Proje M N	rer (Ctrl+;) T Project81' (1 ect81	project)	,				
*∎ D. \$} M		Add New Iter Add Existing Export EAP C Scan	n Item onfig File	Ins Shif	t+Alt+A			
	5	Paste Paste with Lin	ks	Ctrl	+V			

Figure 6-36 Automatic scanning and configuration of slaves in TwinCAT

After scanning is successful, icon StoneLOGO appears as shown in the below, and the servo status is in the OP state.

ELE EDIT VIEW PROJECT BUILD DEBUG TWINCAT TWINCAT PLC IOOLS SCOPE WINDOW HELP Image: Solution Explorer Ima	* q
Image: ControlWord Solution Explorer Image: ControlWord Image: ControlWord Solution Explorer Image: ControlWord Image: Control Image:	- Q
Solution Explorer • • • • • • • • • • • • • • • • • • •	
Image: Control Explorer Image: Control Project39 Image: Control P	
Solution Explorer • # × Construction TwincAT Project89 Process Data Startup CoE - Online Online Search Solution TwincAT Project89 P P Solution TwincAT Project89 P P State Machine Init Bootstrap P SystEM Pre-Op Safe-Op P NC Task 1 SAF OP OP Op Clear Error OP	
Search Solution Explorer (Ctrl+:) P Solution TwinCAT Project89' (1 project) F Image: Solution TwinCAT Project89' (1 project) State Machine Image: Solution TwinCAT Project89' (1 project) Image: State Machine Image: Solution TwinCAT Project89' (1 project) Image: State Machine Image: Solution TwinCAT Project89' (1 project) Image: State Machine Image: Solution TwinCAT Project89' (1 project) Image: State Machine Image: Solution TwinCAT Project89' (1 project) Image: State Machine Image: Solution TwinCAT Project89' (1 project) Image: State Machine Image: Solution TwinCAT Project89' (1 project) Image: State Machine Image: Solution TwinCAT Project89' (1 project) Image: State Machine Image: Solution TwinCAT Project89' (1 project) Image: State Machine Image: Solution TwinCAT Project89' (1 project) Image: State Machine Image: Solution TwinCAT Project89' (1 project) Image: State Machine Image: Solution TwinCAT Project89' (1 project) Image: State Machine Image: Solution TwinCAT Project89' (1 project) Image: State Machine Image: Solution TwinCAT Project89' (1 project) Image: State Machine Image: Solution TwinCAT Project89' (1 project) Image: State Machine	
Search Solution Explorer (Ctrl+:) State Machine State Machine State Machine State Machine State Machine State Machine Init Bootstrap Current State: OP Pre-Op Safe-Op Requested State: OP Op Clear Error	
Image: Solution TwinCAT Project89' (1 project) State Machine Image: State Machine Init Image: State Machine Image: State Machine Image: State Machine	
Imit Bootstrap Imit Imit	
▷ @ SYSTEM Current State: ○P ▲ MOTION Pre-Op Safe-Op ▷ M NC-Task 1 SAF ○p Clear Error ○ SAFETY ○p Clear Error	
▲ MOTION Pre-Op Safe-Op Requested State: OP Op Clear Error SAFETY Op Clear Error	
> Max No.Task 1 SAF Op Clear Error SAFETY	
DN L++	
A 📴 I/O	
Port A: Carrier / Open	
A Device 4 (EtherCAT) Port B: No Carrier / Closed	
inage	
Port C: No Carrier / Closed	
▶ Since and the second sec	
Outputs	
InfoData	
Drive 1 (Sapphire - E)	
P GreedBack process data mapping Name Online Type Size >Add In/Out User Linked to	
P Statusword X 576 UINT 2.0 39.0 Input 0 nState1, nState2	
▶ 👜 InfoData 🤔 Position actual X 0 DINT 4.0 41.0 Input 0 nDataIn1.In.Inputs	
A 🚰 Mappings 🚰 Velocity actual X 0 DINT 4.0 45.0 Input 0 nDataIn7. In . Inputs	
📫 NC-Task 1 SAF - Device 4 (EtherCAT) 1 📑 Torque actual X -3 INT 2.0 49.0 input 0 nDatain3[0] . nDatain	
From List	
Error List Output	

Figure 6-37 Successfully scan stone servo

Note: When scanning slave, please make sure TwinCat is in Config Mode.

5. Read COE data from Stone servo

As shown in Figure 7-39, you can read and write the data of the servo slave through SDO. Or you can call the COE command function module through the EtherCAT function library in the PLC program (Please refer to "TwinCat User Manual" for details). **Note:** If the data is configured as PDO, write is invalid. To check if read and write are successful, you can monitor and compare data through the SMC software.



Figure 6-39 Configure SDO in TwinCAT

6. Read and configure PDO mapping

TwinCAT will automatically read the default PDO configuration of the lower computer when scanning the XML file of the slave. The default PDO mapping object and configuration are shown in Figure 7-40.

C C G To - II - O C G C C C	General EtherCAT DC Process Data Startup CoE - Online Online						
Search Solution Explorer (Ctrl+;)							
🔺 🗮 Device 4 (EtherCAT) 🔷	Sync Manager: PDO List:						
🛟 Image	SM Size Type Flags Index Size Name Flags	SM SU					
👯 Image-Info	0 128 Mbx 0x1400 14.0 FeedBack process data ma	3 0					
SyncUnits	1 128 Mbyln Ov1A01 0.0 FeedBack text signal	0					
Inputs	2 20 Outp	3 0					
Outputs	2 20 Outp Ox1000 200 Reference process data m	2 0					
InfoData	3 14 Inputs 0x1001 0.0 KXPdo1	0					
Drive 1 (Sapphire - E)							
 FeedBack process data mapping 							
Statusword							
Valasity actual value							
Torque actual value	PDO Assignment (0x1C12): PDO Content (0x1A00):						
Modes of operation display	Index Size Offs Name	Type Default (h					
A 📑 Reference process data mapping	0x1601 0x6041 2.0 0.0 Statusword	UINT					
Secontrolword	0x6064 4.0 2.0 Position actual value	DINT					
Target position	0x606C 40 60 Velocity actual value	DINT					
Velocity offset	0x6077 2.0 10.0 Torous actual value	INT					
Torque offset	aver fill 20 10.0 Torque actual value						
🗫 Target velocity	Download Predefined PDO Assignment: (none)						
Target torque	PDO Assignment						
Modes of operation	Land DDO info from davies						
Trive 1 (Sapphire - E) GerdBack process data mapping Statusword Position actual value Velocity actual value Modes of operation display Reference process data mapping Forque position Velocity offset Torque offset Torque velocity Target velocity Forque ve	PDO Assignment (0x1C12): PDO Content (0x1A00): Index Size Offs Name Ox6064	Type Default (h UINT DINT DINT INT					

Figure 6-40 Configure PDO in TwinCAT

If the target PDO parameter is not in the default PDO configuration, you can add PDO parameter mapping through TWinCAT. For example, if you would like to add DI (0X2701) status when transferring PDO (1600):



Figure 6-41 Add PDO parameters in TwinCAT

- 7. Configure NC control
 - Configure NC TASK cycle: set "Cycle ticks" in NC-Task 1 SAF to "4" (unit: ms). NC determines generation and calculation of position, velocity, acceleration and the direction.

Solution Explorer 👻 🕂 🗄	C TwinCAT Project83 ↔ ×	
○ ○ ☆ [™] - ₱ <i>⊭</i> -	Task Settings Online	
Search Solution Explorer (Ctrl+;)	•	
Solution 'TwinCAT Project83' (1 project) Solution 'TwinCAT Project83 MortioN Mor	Name: NC-Task 1 SAF Auto start Auto Priority Management Priority: 4 Cycle ticks: 4 Start tick (modulo): 0	Port: 501 ÷ Object Id: 0x05000010 Options Disable Create symbols
▶ ﷺ Axes 9 PLC 3 SAFETY 5 C++ 2] 2]/O	Separate input update Pre ticks: Warning by exceeding	
 ↓ Devices ▶ ➡ Device 4 (EtherCAT) ▲ Mappings ▲ NC-Task 1 SAF - Device 4 (EtherCAT) 1 	Message box Watchdog Cycles: 0 👘	

Figure 6-42 a. Configure NC TASK cycle in TwinCAT

b. Configure the synchronization clock: enable distributed clock.
 Please note that the setting of Cycle Time should be the same with the synchronization period (4 ms) of the servo drive. Otherwise, the servo may vibrates during running.
Figure 6-43 Check synchronization clock in TwinCAT

Advanced Settings		~
	Distributed Clock	
	Cyclic Mode	
	Operation Mode: DC-Synchron V	
	Enable Sync Unit Cycle (µs): 4000	
	SYNC 0	
	Cycle Time (µs):	
	● Sync Unit Cycle x 1 ∨ User Defined 0	
	○ User Defined + SYNC0 Cycle	
	4000 × 0 ~ 0	
	Based on Input Reference	
	+	
	Enable SYNC 0 =	
	SYNC 1	
	O Sync Unit Cycle Cycle Time (μs):	
	SYNC 0 Cycle x 1 Shift Time (μs): 0	
	☑ Enable SYNC 1	
	Use as potential Reference Clock	

Figure 6-44 Set cycle time in TwinCAT

- c. Set the following in the NC axis:
 - Set Scaling Factor: the distance corresponding to the encoder pulse of each position feedback.

e.g. If one turn of the servo motor is 10000 pulses, and each turn is 1 mm, the scaling factor should be set to 1/10000 = 0.0001 mm/Inc; if the target position increases by 10 mm, the actual servo position should increase by 100000 INC. Generally,

• Set the speed of NC control. Otherwise, an alarm will occur.

olution Explorer 🔹 म 🗙	er + + × TwinCAT Project89 + ×									
○ ○ 습 To - @ 🖌 💻	Gener	al NC-Encoder Parameter Time Compensatio	n Online							
earch Solution Explorer (Ctrl+;)	Control									
🛱 Routes 🔺					1 Unit 📤					
Type System	-	Encoder Evaluation:								
TcCOM Objects		Invert Encoder Counting Direction	FALSE	1	E					
 Morrow NC-Task 1 SAF 		Scaling Factor Numerator	0.0001		F mm/INC					
💼 NC-Task 1 SVB		Scaling Factor Denominator (default: 1.0)	1.0		F					
Image		Position Bias	0.0		Fmm					
Objects		Modulo Factor (e.g. 360.0°)	360.0		Fmm					
⊿ ≩a Axes		Tolerance Window for Modulo Start	0.0		Fmm					
A 🖨 Axis 1		Encoder Mask (maximum encoder value)	OxFFFFFFF		C					
P Inputs		Encoder Sub Mask (absolute range maximum v	. 0x000FFFFF		C					
Outputs		Reference System	'INCREMENTAL'		E					
⊿ ⇒∥ Drive	-	Limit Switches:								
P 🔄 Inputs		Soft Position Limit Minimum Monitoring	FALSE		е					
ti⊾ Ctrl		Minimum Position	0.0		Fmm					
🕨 🛄 Inputs		Soft Position Limit Maximum Monitoring	FALSE]	e					
		Maximum Position	0.0		F mm					

Figure 6-45 Set scaling factor in TwinCAT

d. To prevent the PLC from reporting a following error, set "Following Error Calculation" to "Extern".

🗄 🔛 🧧 🎜 🌾 🎯 🗽 🔍 <local> 🗸 🗸</local>	.	· · · · · · · · · · ·	€ 6.	6 c = 0 4 4 2) . C C C			
Solution Explorer 👻 👎 🗙	TwinCA	AT Project89 👳 🗙							
C O G で・副 / ター Search Solution Explorer (Ctrl+;)	Gene	ral NC-Drive Parameter Time Comper	isation						
🗟 Routes 🔺								Unit	
Type System	•	Output Settings:							
		Invert Motor Polarity		FALSE	•		В		
NC-Task 1 SAF		Reference Velocity		2200.0 1.0			F	mm/s	
NC-Task 1 SVB Image Image		at Output Ratio [0.0 1.0]				F			
	+	+ Position and Velocity Scaling:							
Objects	+	Torque and Acceleration Scaling:							
⊿ anthe Axes	+	Optional Position Command Output Smo	oothing						
A 📑 Axis 1	•	Other Settings:							
▶ ⇒ Unive		Drive Mode		'STANDARD'	-		E		
Ling Ctrl		Drift Compensation (DAC-Offset)		0.0			F	mm/s	
Inputs		Following Error Calculation		'Extern'	-	[E		
P U Outputs									
SAFETY									
964 C++									
4 🖾 1/0									
▲ Devices ▲ T Device 4 (EtherCAT)									
t Image									

Figure 6-46 Set following error calculation in TwinCAT

e. To reverse the motor control polarity, set "Invert Encoder Counting Direction" to "TRUE" and "Invert Motor Polarity" to "TRUE".

General NC-Encoder Parameter Time Compensation	Online								
	ral NC-Encoder Parameter Time Compensation Online								
Parameter Encoder Evaluation: Invert Encoder Counting Direction Scaling Factor Numerator Scaling Factor Numerator Scaling Factor Chemoninator (default 1.0) Position Bias Modulo Factor (e.g. 360.0*) Tolerance Window for Modulo Start Encoder Mask (maximum encoder value) Encoder Sub Mask (absolute range maximum v Reference System Limit Switches: Soft Position Limit Minimum Monitoring Minimum Position Kaximum Position Filter:	Offline Value TRUE ▼ 0.0001 1 1.0 0.0 360.0 0 0.0 0.0 0.4FFFFFF 0.0000FFFF 'INCREMENTAL' ▼ FALSE ▼ 0.0 0	Online Value	1 Unit 8 F 9 F 9 F 9 F 9 F 9 F 10 F 11 F 12 F 13 F 14 F 15 F 16 F 17 F 18 F 19 F 10 F 10 F 11 F 12 F 14 F 15 F 16 F 17 F 18 F 19 F 10 F <						
	Encoder Evaluation: Invert Encoder Counting Direction Scaling Factor Numerator Scaling Factor Denominator (default 1.0) Position Bias Modulo Factor (e.g. 360.0*) Tolerance Window for Modulo Start Encoder Mask (maximum encoder value) Encoder Sub Mask (absolute range maximum v Reference System Limit Switches: Soft Position Limit Minimum Monitoring Minimum Position Soft Position Imit Aximum Position Filter:	Encoder Evaluation: Invert Encoder Counting Direction IRUE Invert Encoder Counting Direction Scaling Factor Numerator 0.0001 Scaling Factor Denominator (default: 1.0) 1.0 Position Bias 0.0 Modulo Factor (eg., 360.0°) 360.0 Tolerance Window for Modulo Start 0.0 Encoder Mask (maximum encoder value) 0xFFFFFFFF Encoder Sub Mask (absolute range maximum v 0x000FFFF Reference System 'INCREMENTAL' V Limit świtches: Soft Position Limit Minimum Monitoring FALSE Minimum Position 0.0 Kosimu Limit Maximum Monitoring FALSE Maximum Position 0.0	- Encoder Evaluation: Invert Encoder Counting Direction TAUE Scaling Factor Numerator 0.0001 Scaling Factor Denominator (default: 1.0) 1.0 Position Bias 0.0 Modulo Factor (eg. 360.0°) 360.0 Tolerance Window for Modulo Start 0.0 Encoder Sub Mask (maximum encoder value) 0xFFFFFF Encoder Sub Mask (absolute range maximum v 0x000FFFFF Reference System 'INCREMENTAL' Limit Switches:	- Encoder Evaluation: ■ ■ ■ ■ Invert Encoder Counting Direction T ■					

Figure 6-47 Set invert encoder counting direction in TwinCAT

Solution Explorer	▼ ₽× Tw	winCAT	Project89 + ×								
○ ○ 습 io - i ≠ -		Gener	eral NC-Drive Parameter Time Compensation								
Search Solution Explorer (Ctrl+;)	ρ- q.										
alla Routes	^		Parameter	Offline Value	Online Value		Unit				
Type System		-	Output Settings:								
MOTION			Invert Motor Polarity	TRUE	▼	в					
NC-Task 1 SAF			Reference Velocity	2200.0		F	mm/s				
DC-Task 1 SVB			at Output Ratio [0.0 1.0]	1.0		F					
i⊽ Image Tables		+	Position and Velocity Scaling:								
Objects		+	Torque and Acceleration Scaling:								
⊿ ≝a Axes		+	Optional Position Command Output Smoothing								
A Axis 1	- 11	-	Other Settings:								
Þ ≇⊈ Drive			Drive Mode	'STANDARD'	•	E					
🔤 Ctrl			Drift Compensation (DAC-Offset)	0.0		F	mm/s				
Inputs			Following Error Calculation	'Extern'	→	E					
PLC SAFETY C++											

Figure 6-48 Set invert motor polarity in TwinCAT

f. Activate the configuration, control the servo working via the NC debugging interface, use Online function to simulate the servo working in the running mode (Make the servo lock the shaft, and click the button to make the servo run).



Figure 6-49 NC debugging interface in TwinCAT

当前速度: Current speed 当前位置: Current position 目标位置: Target position 目标速度: Target speed 故障代码: Error code 使能按钮: Enable button 使能状态: Enable button 使能状态: Enable status 参考速度: Reference speed 目标速度: Target speed 复位: Reset 停止: Stop 启动: Start 快速正向手动: Fast positive debugging 慢速正向手动: Slow positive debugging 快速反向手动: Fast negative debugging 目标位置: Target position 控制环 P 参数: Control loop P parameter NC 轴的状态: NC axis Status 速度比例: Speed rate 跟随误差: Follow-up error 运动标志: Movement sign

8. Create a PLC project

a. Create a new PLC project.



Figure 6-50 Create a new PLC project in TwinCAT



Figure 6-51 Set cycle ticks of PLC task in TwinCAT

9. Use of CoeSDO

CoeSDO is similar to SDO in CANOPEN. It can be used to read and write some objects whose exchange is not frequent or that are not supported by PDO communication. The steps are as follows:

a. Add "Tc2_EtherCAT.lib" in TwinCAT PLC library manager.



Figure 6-52 Add "Tc2_EtherCAT.lib" to the TwinCAT PLC library manager

 After adding, declare the CoeSDO read and write in the program.
 Taking read of status word 60410010 and write of homing mode 60980008 as examples, both of which have no symbols.

1	PROGRAM MAIN
⊒ 2	VAR
3	<pre>sNetId : T_AmsNetId := '169.254.110.127.5.1';</pre>
4	<pre>bExecute : BOOL:=FALSE;</pre>
5	bExe : BOOL:=FALSE;
e	nSlaveAddr : UINT := 1001;
7	nIndex : WORD := 16#6041;
8	nSubIndex : BYTE :=0;
9	nIndex1 : WORD := 16#6098;
10	nSubIndex1 : BYTE :=0;
11	bError : BOOL;
12	nErrId : UDINT;
13	fbSdoRead : FB_EcCoESdoRead;
14	fbSdoWrite : FB_EcCoESdoWrite;
15	statuword: UINT;
16	<pre>Homing_mode: INT:= 7;</pre>
17	
18	END VAR
19	-

Figure 6-53 Add CoeSDO function to program in TwinCAT

c. Set the T_AmsNetId of the EtherCAT master.

olution Explorer	• • ×	IVIAIIN	T WIT	ICAT Projectes	7 ^					
ວ ວ ຝ ວັ - ฮิ ዶ 🗕 earch Solution Explorer (Ctrl+;)	- م	General	Adapte	r EtherCAT (Online	CoE - O	nline			
 itest Project image: External Types image: References image: DUTs 	^	NetId:		169.254.110.1	27.5.1		A. Expo	dvanced Set	tings ation File	
GVLs ▲ ➢ POUs 圖 MAIN (PRG) ■ VISUs ▷ PIcTask (PIcTask)							Syr	nc Unit Assig Topolog	gnment y	
test.tmc	- 11	Fra	Cmd	Addr	Len	WC	Sync Unit	Cycle (Utilization (Size / Du
SAFETY	- 1		LRD LRW	0x09000000 0x01000000	1 20	3	<default></default>	4.000 4.000		
	-1	o	BRD	0x0000 0x0	2	1		4.000	0.20 0.20	75 / 7.92



d. Set the slave's address SlaveAddr.

	General EtherCAT	DC	Process Data	Startup	CoE - Onlin	e Online	NC: Or	nline N	IC: Fu
arch Solution Explorer (Ctrl+;)		_							
MAIN (PRG)	Type:	Sap	ohire EtherCAT	Drive					
🗀 VISUs ▷ 뤍 PlcTask (PlcTask)	Product/Revision:	3745	58 / 1						
test.tmc	Auto Inc Addr:	0							
SAFETY	therCAT Addr:] 1001			Advar	nced Setti	ngs		
₩ C++ ▲ ☑ I/O	Identification	0	•						
	Previous Port:	Mas	ter					\sim	
Inputs	Name	Onli	ne	Туре	Size	>Add	In/Out	User	Lin
Outputs	📌 Statusword	545		UINT	2.0	39.0	Input	0	nSt
🕨 🛄 InfoData	📌 Position actual 🕽	0		DINT	4.0	41.0	Input	0	nDa
Interpretation of the second secon	🛃 Velocity actual 🕽	(0		DINT	4.0	45.0	Input	0	nDa

Figure 6-55 Set slave's address SlaveAddr in TwinCAT

e. Call the read and write function in the program, e.g. trigger read 0X6041 status word as 545, and write homing mode 0X6098 as 7.



Figure 6-56 Trigger read of 0X6041 as 545 in TwinCAT



Figure 6-57 Trigger write of homing mode 0X6098 as 7 in TwinCAT



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