DINGS'
Precision Motion Specialist

VER 1.0

DS-CLS9-FETC-1A

Technical Manual

DINGS
Precision Motion Specialist

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1. Preface

1.1 Product Quality Warranty

- If a product quality issue occurs within one year of purchase (excluding cases of improper operation by the customer or use under conditions not conforming to specifications), the defective product may be returned to us for handling after our confirmation.
- For failures caused by improper operation or use under non-conforming conditions, or for any failure occurring more than one year after purchase, a reasonable repair fee will be charged. If the product is used in a critical application, we strongly recommend keeping an adequate quantity of spare units to ensure continuous, stable system operation.
- When returning a product for repair by mail, please ensure the return item is properly packaged. We cannot be held responsible for failures caused by other damage occurring during transport.
- Repairs typically take several working days; your understanding is appreciated.
- The following situations are not covered by the product quality warranty:

  A) Failures caused by conditions, environment, or operation not conforming to those specified in our user manual;

  B) Failures caused by modification, repair, or self-disassembly performed by parties other than our company;

  C) Failures caused by using the product with methods outside its specifications;

  D) Failures caused by reasons that could not be reasonably predicted given the scientific and technical level at the time of shipment;

  E) Failures caused by other force majeure causes (e.g., natural disaster, war).

1.2 Precautions for Use

- Use this product within its rated values and in the environment stated in this manual.
- This product is not designed or manufactured for use in situations or environments concerning life safety. Therefore, if the product is to be purchased for a special application, please inform our sales staff and confirm through discussion.
- We continuously pursue higher quality and greater customer trust; however, when using our products, be sure to consider safety designs such as redundant/backup design, fire-prevention design, and malfunction-prevention design, so as to avoid personal injury, fire, or other social harm caused by system design faults.
- The product specifications and technical parameters listed in this manual are for reference only.
- For continuous improvement of characteristics, this product may be subject to specification changes or upgrades without prior notice in the future.

1.3 Safety Precautions

So that all users can operate this driver safely, the following safety precautions are listed in this manual.

DANGER	Indicates that a mistake may cause a hazardous situation resulting in death or serious injury.
CAUTION	Indicates that a mistake may cause a hazardous situation resulting in moderate personal injury or minor injury. Material damage may also occur.
PROHIBITED	Indicates an action that must not be performed.
MANDATORY	Indicates an action that must be completed.

DANGER

- Do not touch the terminals or their interior by hand while energized. Risk of electric shock.
- Do not forcibly pull or twist the cables, and do not place heavy objects on the cables. Risk of electric shock and fire.
- Do not touch any rotating parts while the motor is running. Risk of being caught by the rotating shaft and injured.
- Do not touch the interior of the driver by hand while energized. Risk of electric shock.
- Do not touch the wiring terminals within 5 minutes after the power is turned off. Risk of electric shock.
- Be sure to ground the grounding terminals of the driver and motor. Risk of electric shock.
- Perform operations such as moving, wiring, maintenance, and inspection only after confirming the power is off and the display indicators on the panel have fully gone out. Risk of electric shock.

CAUTION

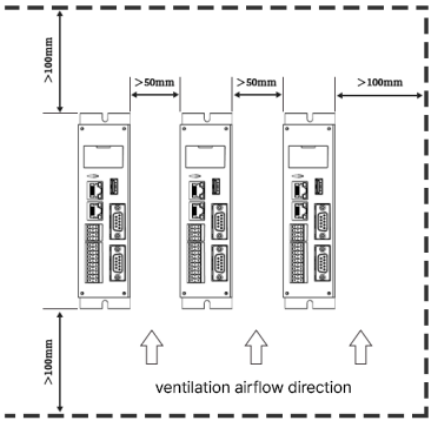
- Do not use this product in locations where it may be exposed to water, oil, or chemical splashes, or in locations with corrosive or flammable gases.
- Strictly observe the requirements in the product manual. Otherwise there is a risk of product damage or personal injury.
- The driver, motor, and peripheral equipment rise in temperature during operation; do not touch them. Risk of burns.
- Use the motor and driver in the specified combination. Otherwise there is a risk of fire.
- During energization or shortly after power-off, the driver heatsink, motor, etc. may still be at high temperature; do not touch them. Risk of burns.
- Do not apply excessive pressure to the edges of the enclosure. Risk of deformation.
- Install the driver in a well-ventilated location that is easy to maintain and inspect.
- When the ambient temperature of the driver exceeds 40°C, check the ventilation or exhaust equipment.

PROHIBITED

- Do not use or store this product in locations exposed to direct sunlight.
- Do not use or store this product in locations where the ambient temperature or humidity exceeds the specified range.
- Do not use or store this product in locations with a lot of dust or debris.
- Do not use or store this product in locations subject to direct vibration or shock.
- Do not disassemble, repair, or modify the internal or external structure of this product yourself.
- Do not place machinery with high heat generation or strong electromagnetic interference around the driver.

MANDATORY

- Before starting operation, confirm that an emergency stop can be triggered at any time.
- Maintain at least the following installation clearances between drivers and between the driver and other equipment. Ensure as much installation clearance as possible; otherwise the performance and service life of the driver may be impaired.

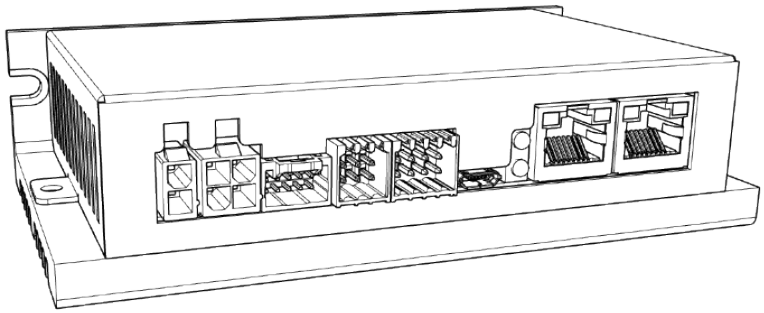


2. Overview

2.1 Product Introduction

This fieldbus stepper motor driver supports the EtherCAT protocol and adopts advanced algorithms, combining the low-speed high-torque characteristics of stepping with the closed-loop technology of servo systems to truly realize the features of no addressing, no step loss, and high cost-performance.

The product also supports the STO function, providing a hardware-level safety protection device with simple wiring for greater safety and reliability. Such products are widely used in cutting-edge industrial applications such as 3C electronics packaging, LCD product manufacturing, inspection and analysis equipment, lithium-battery equipment, and solar photovoltaic equipment, and are well received by a broad range of users.



2.2 Features

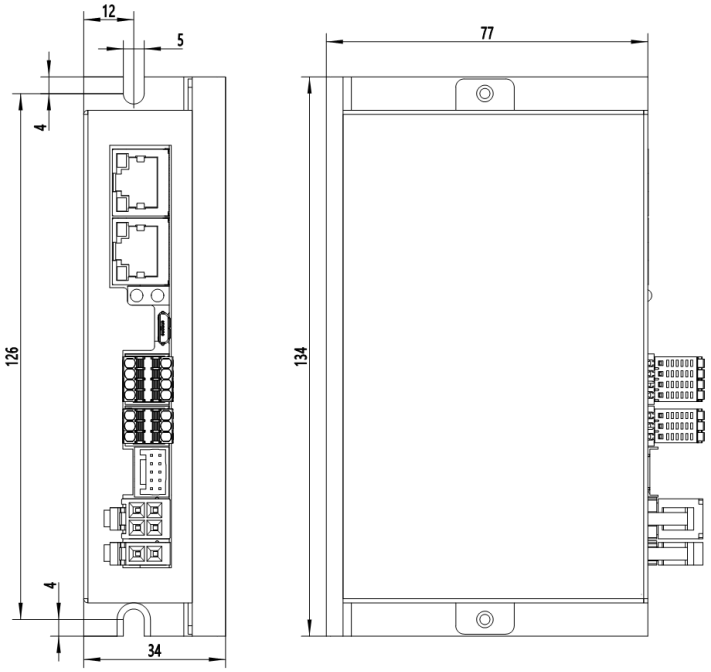
- Input power: DC 24V ~ 48V
- Maximum output phase current (peak): 6.5A
- EtherCAT communication control, supporting control modes PP, PV, HM, CSP, CSV
- Absolute-value stepper motor and driver; no homing required;
- Encoder uses BiSS-C communication
- Optocoupler-isolated input function
- Motor short-circuit protection, undervoltage protection, overvoltage protection, overcurrent protection, and other functions
- Integrated STO (Safe Torque Off) function; no additional relay is required to cut the driver power. Reduces the number of safety devices on the machine, reduces wiring, lowers cost, and improves safety.

2.3 Technical Parameters

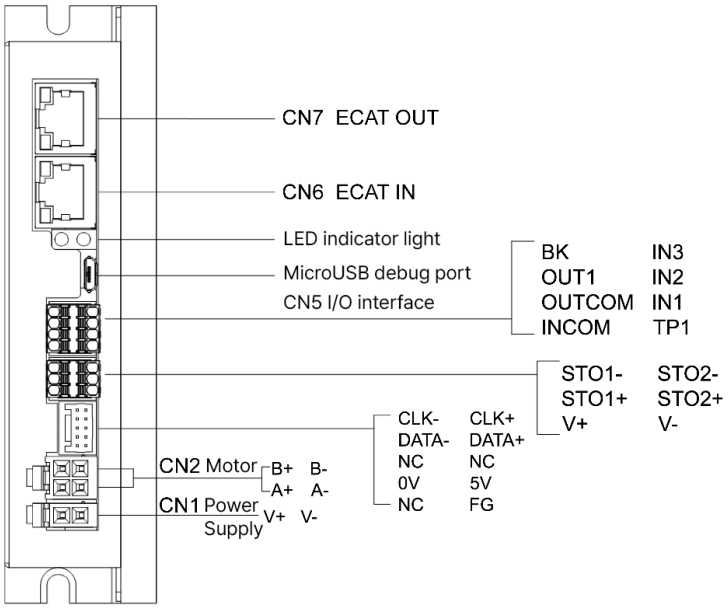
Project		Remarks
Drive model		DS-CLS9-FETC-1A
Adapted motor		Two-phase hybrid ABS encoder stepping motor
Output current		0.4 A ~ 6.5 A / phase
Drive mode		Full-bridge bipolar PWM drive
Overvoltage protection		DC 53V
Undervoltage protection		DC 15V
Initialization time		2 sec
Input signal	1 touch-probe input signal	Optocoupler input voltage 18~24V Conduction current 5~8mA
	3 universal input signals	
Output signal	1 universal output signal	Optocoupler-isolated output Max. withstand voltage 30VDC Max. saturation current 50mA
	1 brake output signal	
Size (excl. connectors)		134 × 77 × 34 mm
Weight		Approx. 311 g
Environmental Specifications	Surrounding air conditions	Avoid dust, oil mist, and corrosive gases
	Humidity	<85%RH, no condensation
	Operating temperature	0 ~ 40 °C
	Heat dissipation	Install in a ventilated environment

2.4 Dimensions

Outline dimensions: 134 × 77 × 34 mm. Refer to the original manual for the detailed drawing.



3. Description of Interface



3.1 Power Interface Definition CN1 (Power)

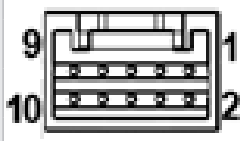
Connector No.	Diagram	Pin No.	Signal name
CN1		2	Power V+
		1	Power V-

Notes	1. Connect power and motor correctly and observe power polarity. Never insert or remove terminals while energized, especially while the driver is connected to a PC via the USB debug cable. 2. Maintain a safe distance between the supply power and other equipment. It is recommended to place the circuit breaker (air switch) at the input side of the switching power supply, not at its output side.

3.2 Motor Interface Definition CN2 (Motor)

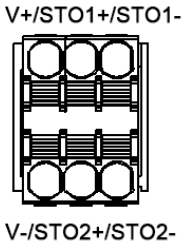
Connector No.	Diagram	Pin No.	Signal name
CN2		4	Motor A+
		3	Motor B+
		2	Motor A-
		1	Motor B-

3.3 Encoder Interface Definition CN3 (Encoder IN)

Connector No.	Diagram	Pin No.	Signal name
CN3		1	CLK-
		2	CLK+
		3	DATA-
		4	DATA+
		5	NC
		6	NC
		7	0V
		8	5V
		9	NC
		10	FG

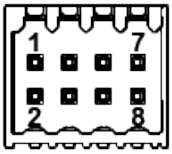
Notes	3. Connect power correctly and observe power polarity. 4. The driver outputs a 5V signal for the encoder, with a maximum current of 200mA.

3.4 STO Interface Definition CN4

Connector No.	Diagram	Signal Name	Description
CN4		V+	Power output from the driver
		V-	For applications that do not use the STO function and do not wish to connect input signals
		STO1+	Input 1 that triggers the STO function
		STO1-	To trigger the STO function, set the optocoupler of this input circuit to the OFF (cut-off) state
		STO2+	Input 2 that triggers the STO function
		STO2-	To trigger the STO function, set the optocoupler of this input circuit to the OFF (cut-off) state

Notes	5. Wire correctly. (See9 “Wiring Requirements“ for the specific wiring method.)

3.5 I/O Interface Definition CN5 (I/O)

Connector No.	Diagram	Pin	Signal Name	Description
CN5		1	IN_COM	Common terminal for single-ended input signals; compatible with common-cathode/common-anode (24VDC)
		2	TP1	High-speed input port, max. input frequency 100KHz
		3	OUT_COM	Output common-cathode common terminal (0V)
		4	IN1	Universal input port, 18~24V active, max. input frequency 1KHz, signal definition configurable
		5	OUT1	Single-ended output signal, common-cathode connection, max. output current 50mA, max. withstand voltage 30VDC. Output function configurable
		6	IN2	Universal input port, 18~24V active, max. input frequency 1KHz, signal definition configurable
		7	OUT_BR	Single-ended output signal, common-cathode connection, max. output current 50mA, max. withstand voltage 30VDC. Output function fixed to brake (holding) function; an external relay is required
		8	IN3	Universal input port, 18~24V active, max. input frequency 1KHz, signal definition configurable

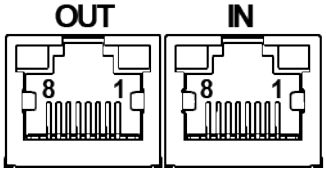
Notes 6. Wire correctly. (See "9 Wiring Requirements" for the specific wiring method.)

3.6 MicroUSB Debug Interface CN6

Connector No.	Diagram	Description
CN6		The USB-to-MicroUSB debug cable must not exceed 2 meters.

3.7 EtherCAT Communication Interface Definition CN7(IN)/CN8(OUT)

3.7.1 Interface Definition

Connector No.	Diagram	Pin	Signal Name	Description
CN7/CN8		1	E-TX+	EtherCAT data transmit positive
		2	E-TX-	EtherCAT data transmit negative
		3	E-RX+	EtherCAT data receive positive
		4	NC	——
		5	NC	——
		6	E-RX-	EtherCAT data receive negative
		7	NC	——
		8	NC	——
		Connector shell	PE	Shielding ground

	Notes	
		7. The terminals use standard RJ45 type ×2. This illustration shows the pin positions from the front (mating) view. 8. Current is set via communication: 0.4~6.5A (peak), default 1.0A. 9. Microstepping is set via communication: 200~102400, default 4000

3.7.2 RJ45 Network Port LED Definitions

LED ID	Name	Color	State	Description
LED1	Link/Activity IN	Green	Off	No physical-layer link established
			On	Physical-layer link established
			Blinking	Data exchange after link established
LED2	RUN	Green	Off	Init state
			Blinking	Pre-Operational state
			Single flash	Safe-Operational state
			On	Operational state
LED3	Link/Activity OUT	Green	Off	No physical-layer link established
			On	Physical-layer link established
			Blinking	Data exchange after link established
LED4	ERR	Red	Off	No error
			Slow blink	Communication configuration error
			Single flash	Sync error or communication data error
			Double flash	Watchdog timeout request
			Fast blink	Bootstrap error

4. LED Indicators

This product has one red and one green LED indicator to display status.

4.1 Status Display

Method: The indicator blinks (0.5s on, 0.5s off), completing one round of the "indicator states" corresponding to the various conditions, and then cyclically displays that state.

Status Function	Indicator State	Comm Code	Description
Enable off	Green blinking	1	Enable off, driver offline, motor can rotate freely
Motor stopped	Green blinking	2	Enable on, no pulse input, motor phase-locked, not running
Motor running	Green steady on	3	Pulse input present, motor running

4.2 Alarm Display

Method: The indicator blinks (0.5s on, 0.5s off), completing one round of the "indicator states" corresponding to the various conditions, and then cyclically displays that state.

Status Function	Indicator State	Comm Code	Description
Motor overcurrent	1 Green + 1 Red	10	Motor phase overcurrent or driver fault
Motor phase loss	1 Green + 2 Red	11	Motor not connected
Undervoltage	1 Green + 4 Red	13	Power input below 15V
Overvoltage	1 Green + 3 Red	14	Power input above 53V
Position deviation exceeded	1 Green + 5 Red	25 or 26	25: Position deviation exceeds set value 26: Motor overload, current sustained at 1.5× for more than 2 s
Other faults		Other	

	Notes	10. The lower 8 bits are alarm codes, only one at the same moment, the higher 8 bits are warnings, warnings can be more than one at the same time

5. STO Function

5.1 STO Function Description

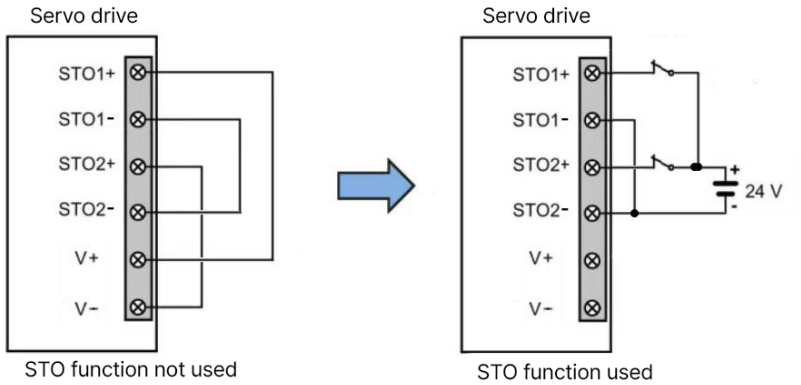
Safe Torque Off (STO) is a hardware-level safety protection function.

When the STO function operates, the driver's hardware circuit is triggered to forcibly shut off the internal power transistors, thereby cutting the motor power without damaging the driver or the surrounding motor components, preventing motor operation and placing the driver in a disabled state. It is a hardware-level safety protection device that can protect personnel and equipment safety in emergency situations.

5.2 STO Function Features

- Improves machine safety
- Reduces the cost and time of machine certification
- Reduces safety devices on the machine
- Simplifies wiring and lowers cost
- A driver with the integrated STO function does not require an additional relay to cut the driver power, because the power is cut directly by the STO input.

5.3 STO Wiring Diagram



Notes	11. The STO wiring above represents a general case and is for reference only; the actual wiring method should follow the actual situation.

5.4 Logic Relationship Between STO Function and Input Signals

STO1 Input State	STO2 Input State	STO Function State
ON	ON	Not triggered
ON	OFF	Triggered
OFF	ON	Triggered
OFF	OFF	Triggered

Notes	12. The "ON" (conducting) input voltage requires 24VDC (each input signal must provide at least 5mA of current). 13. The "OFF" (cut-off) input voltage requires 0~3VDC, or open (unconnected).

5.5 Precautions

- If the STO function is not needed, make sure the mating STO plug supplied at the factory is correctly inserted into the port.
- If using the STO function, make sure you understand the STO working mechanism and safety precautions.
- After the STO function is triggered, the motor may rotate due to external force (e.g., a vertical-axis load). Therefore, in such cases use a stepper/stepper-servo motor with a brake and correctly connect the brake control circuit.
- After the STO function is triggered, the motor stops freely, so note that the stopping distance increases due to inertia.
- After the STO function is triggered, the internal power transistors of the driver stop output, but the driver power is not cut. Therefore, when troubleshooting, confirm whether the power needs to be cut.
- After the STO function is triggered, the driver is in an alarm state and the motor is disabled.
- After the STO input signal returns to normal, the driver still remains in the alarm/disabled state.

6. Power Supply

6.1 Voltage

The maximum allowable operating voltage range of the driver is 24~48V DC, and a 24~48V DC supply is recommended.

A regulating capacitor can absorb current spikes on the power line and prevent false protection of the driver. When the driver is used at low voltage, it is recommended to connect a large regulating capacitor in parallel at the power input to prevent driver undervoltage alarms caused by unstable supply voltage. It is not recommended to use the driver when the supply voltage is below 15V, as the driver operation may be unreliable.

When the driver is powered by a regulated supply and the supply voltage is close to 48V, it is recommended to take voltage-clamping measures at the power input to avoid a situation where the supply voltage exceeds 53V and the driver stops due to an overvoltage alarm.

When the driver is powered by an unregulated supply, ensure the no-load output voltage of the supply does not exceed 34V DC. Because the rated current of an unregulated supply is the full-load current, when the load is light (e.g., when the motor is not running) the actual voltage can rise to a maximum of 1.4 times the rated supply voltage. For smooth and quiet motor operation, choose a lower voltage.

6.2 Current

The maximum supply current should be the sum of the two phase currents. Generally, the current you need depends on the motor model, voltage, speed, and load conditions. The actual power current value is much lower than this maximum, because the driver uses a switching amplifier that converts a high-voltage, low-current signal into a low-voltage, high-current signal through power switching. The rated voltage of the motor windings is usually very small; the higher the driver's supply voltage is above the rated voltage of the motor windings, the smaller the power input current required by the driver.

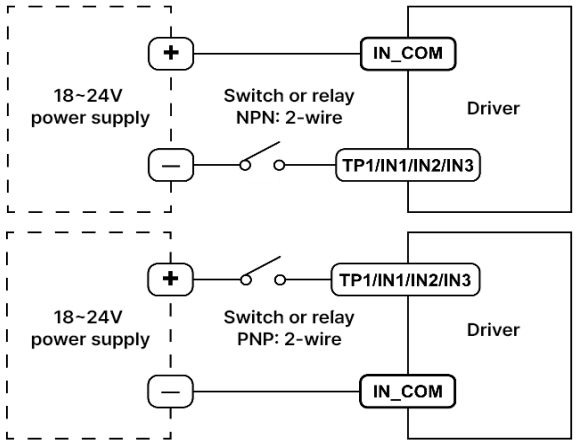
6.3 Regenerative Current

When the motor decelerates, it acts like a generator, converting the kinetic energy of the load into electrical energy. Some of this energy is dissipated by the driver and motor. If your application has a large load running at high speed, a considerable amount of kinetic energy is converted into electrical energy. A simple linear power supply usually has a large capacitor to absorb this energy without damaging the system. However, a switching power supply tends to shut down under overvoltage conditions, and the excess energy is fed back to the driver, which can easily cause a driver alarm (overvoltage) or even damage the driver.

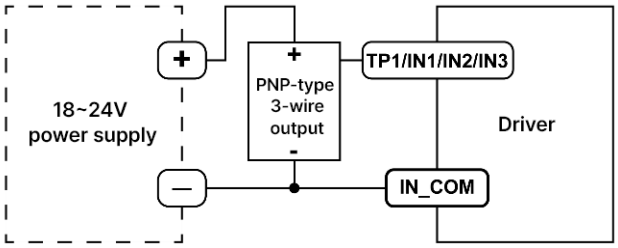
7. Typical Signal Connections

7.1 Signal Input Circuit

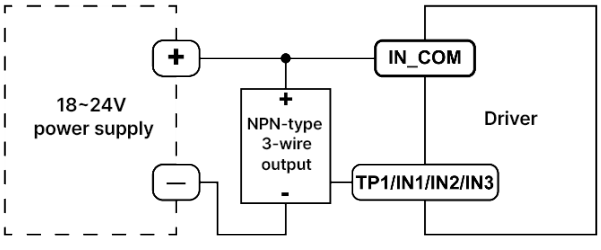
Switch or relay input diagram



PNP input diagram

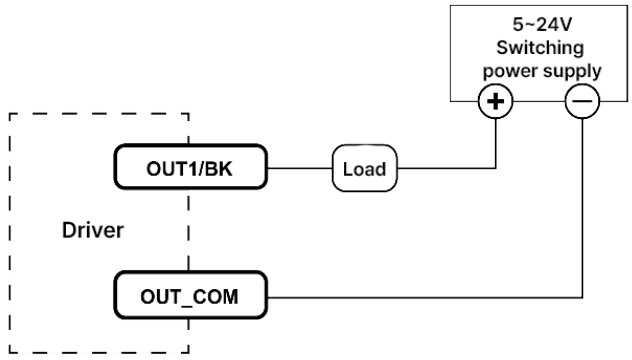


NPN input diagram

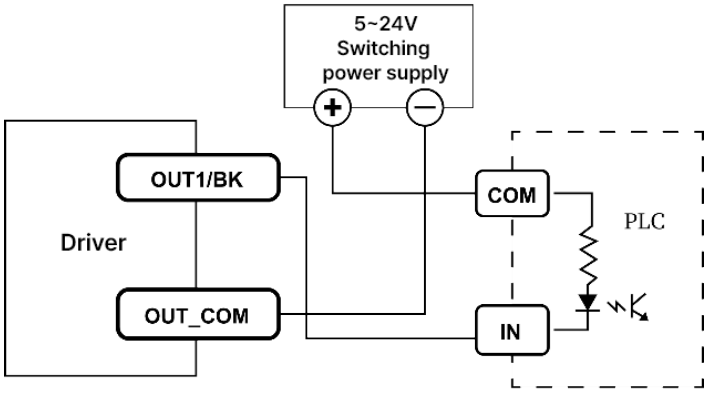


7.2 Output Circuit Diagram

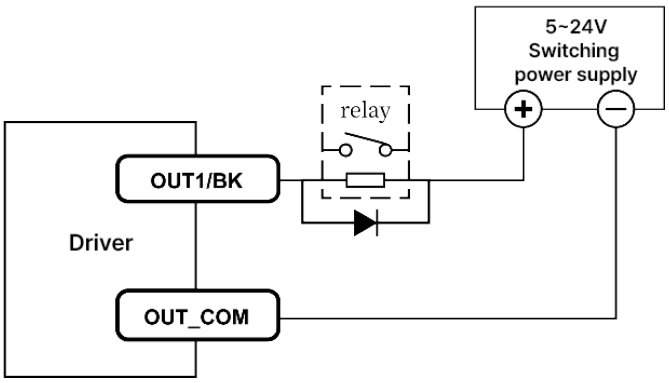
PNP-type output diagram



PNP-Type Output Connected to a PLC Input



Output signal connected to a relay



Notes

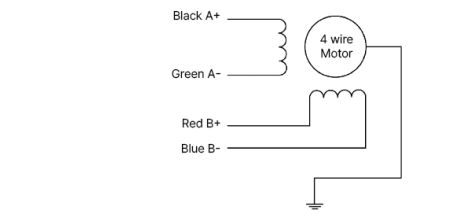
14. Do not connect the output terminal to a DC voltage above 30V, and do not allow the current flowing into the output terminal to exceed 50mA.

8. Motor Connection

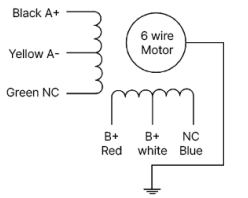
WARNING: Before connecting the motor to the driver, confirm the driver power is off. Confirm that unused motor leads are not short-circuited to other objects. The motor must not be disconnected while the driver is energized.

8.1 Motor Connection Methods

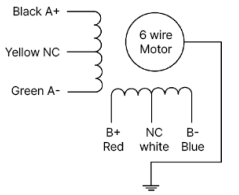
Wiring diagram



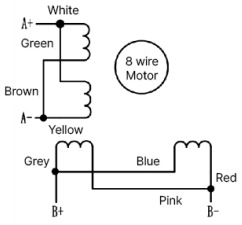
4-wire bipolar motor



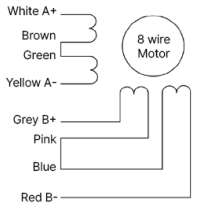
6-Wire Center-Tap Connection



6-Wire Series Connection



8-Wire Bipolar – Parallel



8-Wire Bipolar – Series

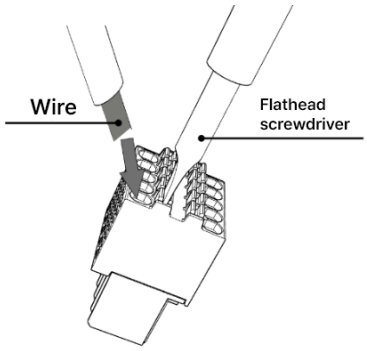
8.2 Motor Connection

- A 4-wire motor can be connected in only one way.
- A 6-wire motor can be connected in two ways: full winding or half winding. In full-winding mode, the motor has greater torque at low speed but cannot run as fast as in half-winding mode. When running in full winding, the motor must run at 30% of the half-winding current to avoid overheating.
- An 8-wire motor can be connected in two ways: series or parallel. The series method provides greater torque at low speed but less torque at high speed. When running in series, the motor must run at 50% of the parallel current to avoid overheating.
- Phases are relative, but windings of different phases must not be connected to the same phase terminals of the driver (A+ and A- form one phase; B+ and B- form the other phase). If the motor direction differs from the desired direction, simply swap the positions of A+ and A-.
- Method to check whether the series/parallel connection of a stepper motor is correct: without connecting the driver, turn the motor shaft directly by hand. If it turns easily and evenly, the wiring is correct; if it meets large or uneven resistance accompanied by a certain sound, the wiring is incorrect.
- This driver can only drive two-phase hybrid absolute-value stepper motors; it cannot drive three-phase or five-phase stepper motors.
- The wiring colors in the motor connection methods above represent a general case and are for reference only; refer to the motor specification manual for the specific wiring method.

9. Wiring Requirements

9.1 Wiring Method

Press the terminal with a flat-blade screwdriver; after stripping the wire, insert it into the terminal until it touches the terminal block, then release the screwdriver to fix the wire.

Wiring diagram


	Notes	15. Wire correctly. Also note that when inserting the terminal into the driver, it should insert smoothly; when your finger feels the terminal engage with a click and the terminal emits a "click" sound, insertion is successful. Otherwise wiring may fail.

9.2 Precautions

- Connect the power correctly, observe power polarity, and confirm the motor and power connectors are correct before energizing!
- When stripping wires, do not first tin the wire ends, as this may make normal wiring impossible.
- When wiring, be careful not to twist the strands, and do not let strands protrude, so as to avoid conductor short circuits.
- Connect the strands directly; do not solder them. Otherwise the wire may break due to vibration.
- It is strictly forbidden to tin the wire ends before inserting them into the wiring terminals; otherwise contact resistance may increase and overheat, damaging the terminal.
- The wire ends must not be exposed outside the terminal, to prevent accidental short circuits that could damage the driver.
- It is strictly forbidden to insert or remove the driver's high-power (motor and power) terminals while energized. A large current still flows through the coil even when the energized motor is stopped; inserting or removing the high-power (motor and power) terminals will produce a huge instantaneous induced EMF that will burn out the driver.
- Use a dedicated tool to tighten the wiring terminals.
- Do not apply pressure to the wires after wiring.
- To prevent interference, it is recommended to use shielded cable for the control signals and to short the shield layer to the ground wire. Unless otherwise required, ground the shield of the control-signal cable at one end only: ground the host-controller end of the shield and leave the driver end floating. Within the same machine, grounding is allowed at only one point; if it is not a true earth ground, interference may be severe, in which case the shield layer should not be connected.
- If one power supply feeds multiple drivers, use a parallel connection at the power source; daisy-chaining from one driver to the next is not allowed.

10. Parameter Description and Settings

- The fieldbus closed-loop stepper driver is a standard EtherCAT slave device that complies with the EtherCAT standard protocol and can communicate with any standard master that supports this protocol.
- The PC software and the driver interact via the MODBUS protocol. The PC software can modify/read all driver parameters and alarm information, and control trial operation of the driver.

10.1 SDO Parameter List

10.1.1 Configuration Parameters

Object Dict.	Name	Attr.	Word	Range	Default	Unit	Remarks
2064	Composite current	RO	1	--	--	0.1%A	
2065	Bus voltage	RO	1	--	--	1%V	
206C	Error code	RO	1	--	--		
206D	Operating status	RO	1	--	--		
206E	Hardware version	RO	1	--	--		
206F	Software version	RO	1	--	--		
20C8	Current loop Kp	RW	1	50~30000	800		
20C9	Rotation direction	RW	1	0~3	0		Selects motor rotation direction and encoder direction: bit1=0 encoder direction unchanged, bit1=1 encoder direction reversed; bit0=0 running direction unchanged, bit0=1 running direction reversed
20CE	Control command	RW	1	0~5	0		
20D5	Idle (stop) current	RW	1	10~120	50		Stop current as a percentage of the running current
20D7	Current loop Ki	RW	1	50~30000	800		
20D9	Motor mode setting	RW	1	0~2	0		0: open loop, 1: closed loop
20DE	Current loop Kp max.	RW	1	50~30000	800		
20E0	Filter coefficient	RW	1	0~500	50		The smaller the value, the smoother the motor runs, but the greater the delay
20E1	Current proportion max.	RW	1	1000~2000	1000		
20E4	Current loop Ki max.	RW	1	50~30000	800		
20F1	Current setting	RW	1	400~6500	1000	0.1%A	
20F5	Idle (stop) current	RW	1	1~30000	200	ms	Delay time (ms) before entering half-current state after the motor stops

20F7	In-position range	RW	1	1~1000	5		
20F8	Field-weakening limit	RW	1	0~1000	500		
20FB	Speed loop Kp	RW	1	0~30000	1000		
20FC	Speed loop Ki	RW	1	0~30000	50		
20FD	Speed loop Kd	RW	1	0~30000	0		
20FF	Position loop Kp	RW	1	0~30000	500		
2100	Position loop Ki	RW	1	0~30000	1000		
2101	Position loop Kd	RW	1	0~30000	0		
210B	Encoder type	RW	1	10~11	—		10: multi-turn 16bit, single-turn 16bit / 11: multi-turn 16bit, single-turn 17bit
2127	Auto-detect parameters	RW	1	0~1	1		In open-loop mode, whether to auto-detect and update motor parameters. 0: manual setting, 1: auto-detect
2144	Memory control switch	RW	1	0~65535	0		bit0: enable forward soft-limit function. bit1: enable reverse soft-limit function.
2190	IN1 function selection	RW	1	0~11	0		0: port disabled 1: absolute motion 2: relative motion 3: constant-speed run 4: forward jog 5: reverse jog 6: decelerate stop 7: emergency stop (immediate stop output + warning) 8: set position 9: positive limit signal 10: negative limit signal 11: home signal
2191	IN2 function selection	RW	1	0~11	0		Same settings as IN1
2192	IN3 function selection	RW	1	0~11	0		Same settings as IN1
21A4	OUT1 function selection	RW	1	100~109	101		
21AD	Input port logic	RW	1	0~15	0		
21AE	Output port logic	RW	1	0~3	0		

Notes

16. Object-dictionary 2xxx parameters are automatically saved to EEPROM when written via SDO operations. The number of writes is limited to a maximum of 1,000,000.

10.1.2 Motion Parameters

Object Dict.	Name	Attr.	Word	Range	Default	Unit	Remarks
603F	Error register	R	1	--	0	--	
6040	Control word	RW	1	0~65535	0	--	
6041	Status word	R	1	--	0	--	
605A	Quick stop option code	RW	1	0~65535	0	--	
6060	Operation mode	RW	1	0~255	1	--	1=PP 3=PV 6=Home 8=CSP 9=CSV
6061	Operation mode display	R	1	--	0	--	
6064	Actual position	R	2	--	0	pulse	
606C	Actual speed	R	2	--	0	0.01RPS	
607A	Target position	RW	2	-2147483647 ~2147483647	0	pulse	PP mode 1 target position command
607D+1	Negative soft limit	RW	2	-2000000000 ~2000000000	-2000000000	pulse	
607D+2	Positive soft limit	RW	2	-2000000000 ~2000000000	2000000000	pulse	
6080	Max. limit speed	RW	2	-2147483647 ~2147483647	3000	0.01RPS	
6081	Profile velocity	RW	2	1~5000	100	0.01RPS	PP mode 1 max. speed
6083	Profile acceleration	RW	2	1~5000	50	RPS^2	PP/PV mode 1/3 acceleration
6084	Profile deceleration	RW	2	1~5000	50	RPS^2	PP/PV mode 1/3 deceleration
6085	Quick stop deceleration	RW	2	5~10000	500	RPS^2	Quick-stop deceleration (PP/PV/Home)
6098	Homing method	RW	1	0~100	21	--	
6099+1	Homing approach speed	RW	2	1~5000	200	0.01RPS	
6099+2	Homing creep speed	RW	2	1~5000	100	0.01RPS	
609A	Homing acceleration	RW	2	5~10000	50	RPS^2	
607C	Home offset	RW	2	-2147483647 ~2147483647	0	pulse	
60B8	Touch-probe control word	RW	1	0~65535	0	none	Sets the touch-probe function
60B9	Touch-probe status word	R	1	--	0	none	Touch-probe action status
60BA	Touch-probe data 1	R	2	--	0	P	probe1 rising-edge captured data
60BB	Touch-probe data 2	R	2	--	0	P	probe1 falling-edge captured data
60BC	Touch-probe data 3	R	2	--	0	P	probe2 rising-edge captured data
60BD	Touch-probe data 4	R	2	--	0	P	probe2 falling-edge captured data

60FD	Input IO status	R	2	--	0	--	bit0: negative limit bit1: positive limit bit2: home bit16~18: corresponds to IN1~IN3 status bit19: TP1 signal
60FE+1	Physical outputs	RW/S	2	0 ~4294967295	0	--	Master output signal control word
60FE+2	Bit mask	RW/S	2	0 ~4294967295	0	--	Output bit mask
60FF	Target velocity	RW	2	-5000~5000	0	-	Target velocity in CSV mode
6502	Supported drive modes	R	2	0 ~4294967295	421	--	Control modes supported by the driver (PP, PV, HM, CSP, CSV)

11. Common Functions

11.1 Control Word and Operation Modes

In synchronous motion mode, the master performs trajectory planning and outputs cyclic commands. The driver receives the planned commands according to the synchronization cycle, making this mode suitable for multi-axis synchronous motion. This product supports Cyclic Synchronous Position (CSP) mode and Cyclic Synchronous Velocity (CSV) mode.

In Cyclic Synchronous Position (CSP) mode, trajectory planning is performed by the master. The driver receives position commands from the master according to the synchronization cycle and sends them to the drive for immediate execution when the synchronization signal arrives.

In Cyclic Synchronous Velocity (CSV) mode, trajectory planning is performed by the master. The driver receives target velocity commands from the master according to the synchronization cycle and sends them to the drive for immediate execution when the synchronization signal arrives.

This product supports synchronization cycles of 1000 μs, 2000 μs, and 4000 μs.

In non-synchronous motion modes, the master only sends motion parameters and control commands. After receiving a motion start command from the master, the closed-loop stepper driver performs trajectory planning based on the motion parameters sent by the master. Each motor axis operates asynchronously. The supported non-synchronous motion modes are Profile Position (PP), Profile Velocity (PV), and Homing (HM).

Regardless of the control mode, data is exchanged between the EtherCAT master and slave through the object dictionary. Data can generally be transferred using either PDO or SDO. Based on the real-time requirements and importance of the data, the transfer priority is classified into three levels: Required > Recommended > Optional.

“Required” means that the corresponding object dictionary must be configured for PDO transfer in that mode. “Recommended” means that PDO transfer is recommended to maintain real-time performance and provide better control. If the control requirements are not demanding, SDO communication may also be used. “Optional” means that the corresponding object dictionary is generally transferred through SDO and does not need to be configured for PDO transfer. The object dictionaries associated with each control mode are shown in the following table.

Object dictionaries associated with each control mode							
Control Mode	Index+Sub	Name	Data Type	Attr.	Unit	PDO	SDO
CSP mode (8)	6040-00h	Control word	U16	RW	—	Required	-
	607A-00h	Target position	I32	RW	P	Required	-
	6041-00h	Status word	U16	RO	—	Required	-
	6064-00h	Actual position	I32	RO	P	Required	-
	606C-00h	Actual speed	I32	RO	0.01RPS	Optional	Optional
CSV mode (9)	6040-00h	Control word	U16	RW	—	Required	-
	6041-00h	Status word	U16	RO	—	Required	-
	6064-00h	Actual position	I32	RO	P	Required	-
	606C-00h	Actual speed	I32	RO	0.01RPS	Required	-
	60FF-00h	Target speed	I32	RW	0.01RPS	Required	-
	60B1-00h	Velocity offset	I32	RW	—	Optional	Optional
	60B2-00h	Velocity limit	U32	RW	0.01RPS	Optional	Optional
PP mode (1)	607A-00h	Target position	I32	RW	P	Recommended	Optional
	6081-00h	Profile velocity	U32	RW	0.01RPS	Optional	Optional
PV mode (3) PP mode (1) PV mode (3) shared	60FF-00h	Target speed	I32	RW	0.01RPS	Recommended	Optional
	6040-00h	Control word	U16	RW	—	Recommended	Optional
	6083-00h	Profile acceleration	U32	RW	RPS^2	Optional	Optional
	6084-00h	Profile deceleration	U32	RW	RPS^2	Optional	Optional
HOME mode (6)	6040-00h	Control word	U16	RW	—	Recommended	Optional
	6098-00h	Homing method	I8	RW	—	Optional	Optional
	6099-01h	Homing approach speed	U32	RW	0.01RPS	Optional	Optional
	6099-02h	Homing creep speed	U32	RW	0.01RPS	Optional	Optional
	609A-00h	Homing acceleration	U32	RW	RPS^2	Optional	Optional
	607C-00h	Home offset	U32	RW	P	Optional	Optional
PP/PV/ HOME Shared	6041-00h	Status word	U16	RO	—	Recommended	Optional
	6064-00h	Actual position	I32	RO	P	Recommended	Optional
	606C-00h	Actual speed	I32	RO	0.01RPS	Optional	Optional
Shared all modes	60B8-00h	Touch-probe function	U16	RW	—	Recommended	Optional
	60B9-00h	Touch-probe status	U16	RO	—	Recommended	Optional
	60BA-00h	Probe 1 capture value	I32	RO	P	Optional	Optional
	60FD-00h	Digital inputs	U32	RO	—	Recommended	Optional
	603F-00h	Latest error code	U16	RO	—	Recommended	Optional

Other related params	6060-00h	Operation mode	I8	RW	—	Optional	Optional
	60B0-00h	Position offset	I32	RW	—	Optional	Optional
	6082-00h	Start (kick-off) speed	U32	RW	0.01RPS	Optional	Optional
	6085-00h	Quick stop deceleration	U32	RW	RPS^2	Optional	Optional
	6061-00h	Operation mode display	I8	RO	—	Optional	Optional

Regardless of which control mode is used to drive the actuator, read/write of the control word 6040h and status word 6041h is indispensable; the master and slave use these two object dictionaries as the medium to issue commands and monitor status. The following focuses on the bit definitions of these two object dictionaries.

The control word (6040h) is defined in the table below. The left half of the table describes bit4~6 and bit8, whose meaning depends on the operation mode and mainly governs the run/stop execution of each mode. The right half describes bit0~3 and bit7; the combination of these bits manages the state transitions of the CiA 402 state machine to meet complex and varied control needs. The status word (6041h) is defined in the status-word definition table. bit0~bit7 mainly display the 402 state-machine transition state; bit8~bit15 mainly display the run/stop status of motion in each control mode. The typical enable state transition is as follows:

Initial (00h) → Power on (06h) → Start (07h) → Enable (0fh) → Run or pause (depending on the operation mode, combining bit4~6 and bit8 to issue the relevant control command).

Controlword (6040h) bit definitions												
Mode/ Bit	**15 ~9**	**8**	**6**	**5**	**4**	**7**	**3**	**2**	**1**	**0**	**Typ.**	**Action**
Shared	-	Pause	Depends on op. mode			Fault reset	Op. enable	Quick stop	Voltage out	Switch on		
CSP mode 8	-	N/A	N/A	N/A	N/A	0	0(x)	1	1	0	06h	Power on
CSV mode 9	-	N/A	N/A	N/A	N/A	0	0(x)	1	1	0	06h	Power on
PP mode 1	-	Decel stop	Abs/Rel	Immediate trig	New setpoint	0	0	1	1	1	07h	Start
PV mode 3	-	Decel stop	N/A	N/A	N/A	0	0(x)	0	1	0(x)	02h	Quick stop
HM mode 6	-	Decel stop	N/A	N/A	Start motion	0	1	1	1	1	0fh	Enable
none						1	0(x)	0(x)	0(x)	0(x)	80h	Clear fault
none						0	0	0	0	0	0	Initial

Additional notes on other bits:

- The bit2 quick-stop trigger logic is active at 0; note this differs from the logic of other triggers.
- The bit7 fault-reset trigger logic is rising-edge active.
- The bit5 immediate-trigger logic is rising-edge active.

Status word (6041h) bit definitions								
Mode Low 8 bits	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Shared	Reserved	Not started	Quick stop	Power on	Fault	Op. enabled	Switched on	Ready to switch on

Mode High 8 bits	15	14	13	12	10	8	11	9
Shared	Depends on op. mode						Limit active	Remote
CSP mode 8	N/A	N/A	N/A	Following active	N/A	Reserved	(Set when HW limit active)	(0 below Pre-OP)
CSV mode 9	N/A	N/A	N/A	Velocity following active	N/A	Reserved		
PP mode 1	Reserved	Reserved	N/A	New setpoint ack	Position reached	Reserved		
PV mode 3	Reserved	Reserved	N/A	Speed = 0	Speed reached	Reserved		
HM mode 6	Reserved	Reserved	Homing error	Homing done	Position reached	Reserved		

Additional notes on other bits:

- bit4 is set once power is applied to the driver.
- bit5 quick-stop active is only valid at logic 0, which is opposite to the logic of the other bits.
- bit9 remote displays the communication state-machine status; it is 0 below Pre-OP, in which case the control word (6040h) commands cannot be executed.
- bit11 limit is set when a hardware limit is active.
- bit8 abnormal stop is generally valid under hardware-limit, decelerate-stop, and quick-stop trigger states.
- bit12 following master: under CSP, if the driver is disabled or no longer follows the master's commands, this bit is set to 0.

State transitions for control operation in each mode										
	Step	0	1	2	3	4	5	6	7	8
Mode	Action	Preparation	Initial	Power On	Start	Enable	Run	Reposition	Stop	Fault
CSP 8	6040	Establish comm, OP state, activate NC axis	00h	06h	07h	0fh	1fh (master sends command)	Master control	Master stop position command	-
	6041		250h	231h	233h	1237h	1237h	1237h	1237h	238h
CSV 9	6040	Establish comm, OP state, activate NC axis	00h	06h	07h	0fh	1fh (master sends commands)	Master control	Master stop velocity command	-
	6041		250h	231h	233h	1237h	1237h	1237h	1237h	238h
PP 1	6040	Establish comm, OP state, set motion params	00h	06h	07h	0fh	-	2fh→3fh	10fh	-
	6041		250h	231h	233h	8237h	1237h	1637h →1237h	1737h	1238h
PV 3	6040	Establish comm, OP state, set motion params	00h	06h	07h	0fh	Runs immediately after enable	Change speed immediately	10fh	-
	6041		250h	231h	233h	1637h	1637h	1637h	1737h	1638h
HM 6	6040	Establish comm, OP state, set motion params	00h	06h	07h	0fh	1fh	N/A	10fh	-
	6041		250h	231h	233h	8337h	237h	237h	737h	238h

Additional note: When changing the position in PP mode, a rising edge must be applied to bit5 of the control word to start the new position motion.

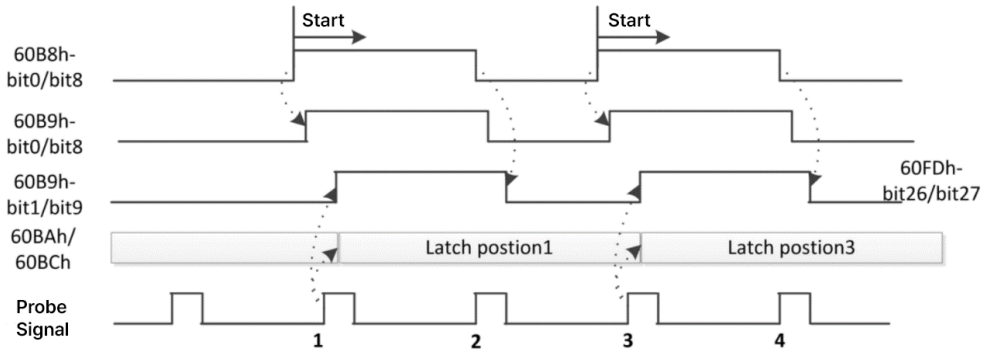
11.2 Touch-Probe Capture Function

The touch-probe function uses an input signal with probe capability to capture and record the actual motor position. The driver has two input IO signals that support the probe function and can be enabled simultaneously. The object dictionaries related to the probe function are shown in the table below.

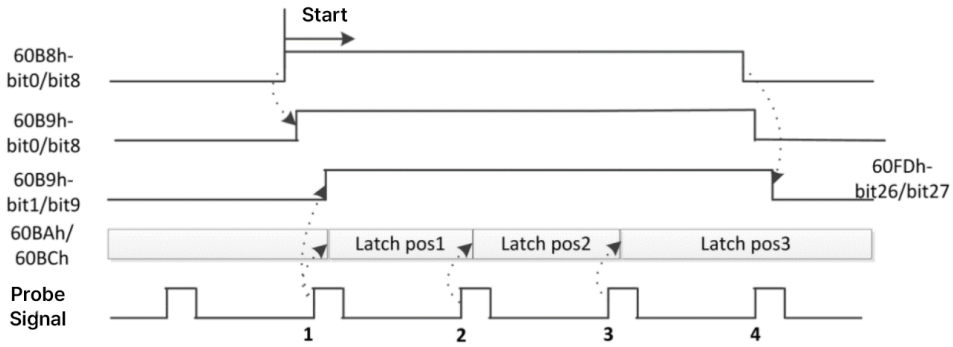
<table>
<tr><th colspan="7">Touch Probe Function–Related Object Dictionary</th></tr>
<tr><th>Object Dictionary</th><th colspan="6">Bit/Object Meaning</th></tr>
<tr><td rowspan="4">60B8h</td><td>7~6</td><td>5</td><td>4</td><td>3~2</td><td>1</td><td>0</td></tr>
<tr><td>-</td><td>Probe1 falling-edge trigger</td><td>Probe1 rising-edge trigger</td><td>-</td><td>Probe1 mode</td><td>Probe1 enable</td></tr>
<tr><td>15~14</td><td>13</td><td>12</td><td>11~10</td><td>9</td><td>8</td></tr>
<tr><td>-</td><td>Probe2 falling-edge trigger</td><td>Probe2 rising-edge trigger</td><td>-</td><td>Probe2 mode</td><td>Probe2 enable</td></tr>
<tr><td rowspan="4">60B9h</td><td>7</td><td>6</td><td>5~3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>Probe2 actual level</td><td>Probe1 actual level</td><td>-</td><td>Probe1 falling-edge trigger done</td><td>Probe1 rising-edge trigger done</td><td>Probe1 in action</td></tr>
<tr><td colspan="3">15~11</td><td>10</td><td>9</td><td>8</td></tr>
<tr><td colspan="3">-</td><td>Probe2 falling-edge trigger done</td><td>Probe2 rising-edge trigger done</td><td>Probe2 in action</td></tr>
<tr><td>60BAh</td><td colspan="6">Probe1 rising-edge captured data value register</td></tr>
<tr><td>60BBh</td><td colspan="6">Probe1 falling-edge captured data value register</td></tr>
<tr><td>60BCh</td><td colspan="6">Probe2 rising-edge captured data value register</td></tr>
<tr><td>60BDh</td><td colspan="6">Probe2 falling-edge captured data value register</td></tr>
<tr><td>60FDh</td><td colspan="6">bit26 state is the AND of 60B9 bit1 and bit2; bit27 state is the AND of 60B9 bit9 and bit10</td></tr>
<tr><td>2152h</td><td colspan="6">Writing 17 or 18 to its sub-indexes 01h and 02h configures probe 1 or probe 2 function</td></tr>
</table>

Additional notes on other bits:

- 60B8h bit0 and bit8: the enable/stop control bits for probe 1 and probe 2 respectively; rising-edge active.
- 60B8h bit1 and bit9: the probe mode is divided into single-shot mode and continuous mode.
- Single-shot mode: after the probe starts, it captures only on the first trigger signal. To capture a new position value again, a rising edge must be applied to bit0/bit8 of object 60B8 to restart the probe action.
- Continuous mode: after the probe starts, a capture action is performed on every trigger signal.
- Refer to the original manual for the detailed timing waveforms (single-shot mode rising-edge trigger, continuous mode rising-edge trigger).



Rising-Edge Trigger in Single Mode



Rising-Edge Trigger in Continuous Mode

11.3 Output Peak Current

If the matched motor is of frame size 42 or smaller, before connecting the motor for the first time you must first modify the driver's output peak current to prevent excessive output current from burning out the motor.

The output peak current can be modified via the object dictionary of the master PLC (object dictionary: 0×20F1), and can also be modified via the host-computer debugging software:

Object Dict.	Name	Attr.	Word	Range	Default	Unit	Remarks
20F1	Current setting	RW	1	400~6500	1000	0.1%A	

11.4 603F Fault Codes

603F Object	Fault Description
0×2211	Overcurrent fault
0×7120	Motor open circuit
0×3220	Undervoltage
0×3210	Overvoltage
0×8611	Excessive position error
0xFF23	Emergency stop
0xFF19	Position following error
0xFF18	Motor overspeed
0xFF32	Unstable communication

12. Revision History

Version	Date	Change Description
V1.0	26. 09	——

DINGS
Precision Motion Specialist

ENG Web

Partners Web

YouTube

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