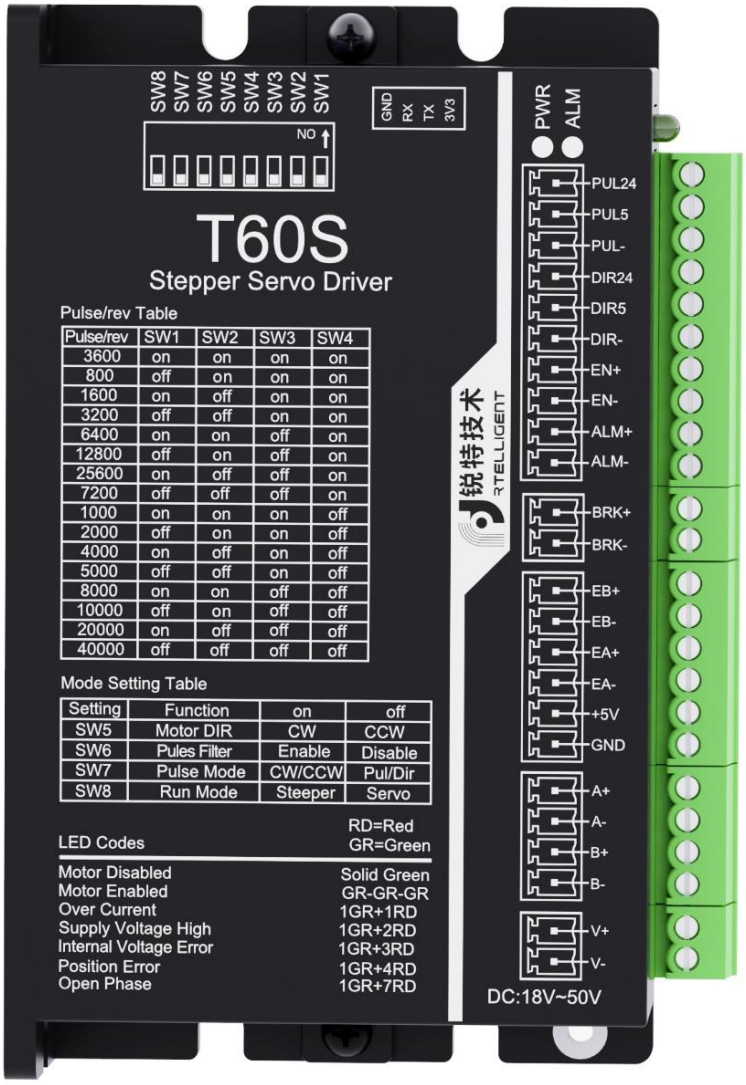
# T60S/T86S Closed Stepper Driver User Manual




## Shenzhen Rtelligent Technology Co., Ltd

# Revision History

| Date | Version | Description |
|---|---|---|
| 2024.09.10 | V4.0 | Version 4 product update |
| 2024.10.12 | V4.1 | Chapter 4: Modify table title in 4.4.1 |

# 1. Feature

- New generation closed loop control algorithm
- Three pulse command forms: pulse + direction, double pulse, orthogonal pulse
- Independent 5V, 24V control signal interface
- Brake interface: direct connection
- Isolated input and output
  - 3 isolated inputs
  - 1 isolated output

# 2. Product Comparison

| Feature | T60S | T86S |
|---|---|---|
| **Voltage range** | 18~50VDC | 28~110VDC |
| **AC Input** | Not Supported | 20~80VAC |
| **Maximum current** | 6000mA | 8000mA |
| **Brake interface** | Brake direct connection | |
| **Debugging Interface** | Serial port TTL 3.3V | |
| **Extension DIP switch** | 8-bit | |
| **Alarm output** | 1 | |
| **Pulse command voltage** | 5V, 24V independent interface | |
| **Pulse bandwidth setting** | Software setting | |
| **Reverse direction** | DIP setting | |
| **Command filtering** | DIP setting | |
| **Pulse mode setting** | DIP setting: PUL+DIR, CW+CCW | |
| **Working mode** | DIP setting: Open loop/closed loop | |

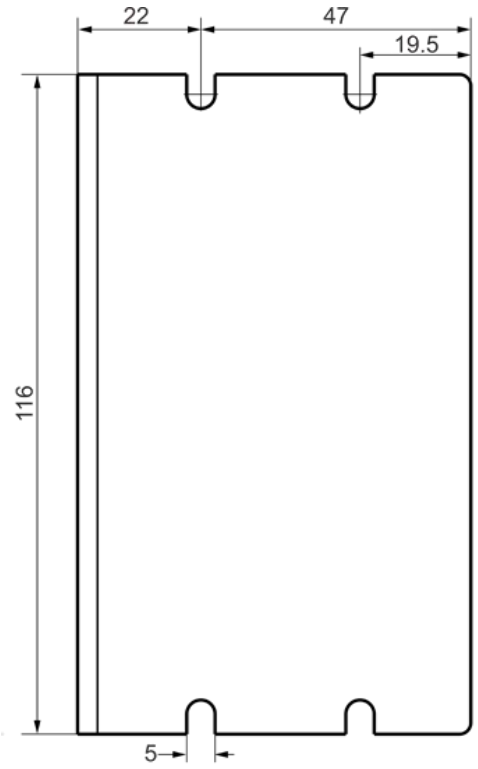
# 3. Installation

## 3.1. Installation Requirement

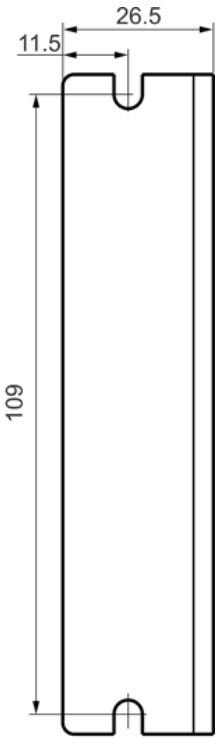
- When installing, please place the driver vertically or horizontally, with the front facing forward and the top facing upward to facilitate heat dissipation.
- During assembly, be careful to prevent drilling shavings and other foreign matter from falling into the driver
- Please use M3 screws to fix during installation.
- When there is a vibration source near the installation (such as a drilling machine, etc.), please use a vibration absorber or install an anti vibration rubber gaske.
- When multiple drivers are installed in the control cabinet, please pay attention to leaving enough space for placement to achieve sufficient heat dissipation; If necessary, a cooling fan can be configured to ensure good cooling conditions inside the control cabinet.

## 3.2. Installation Dimension

### 3.2.1. T60S Installation Dimension

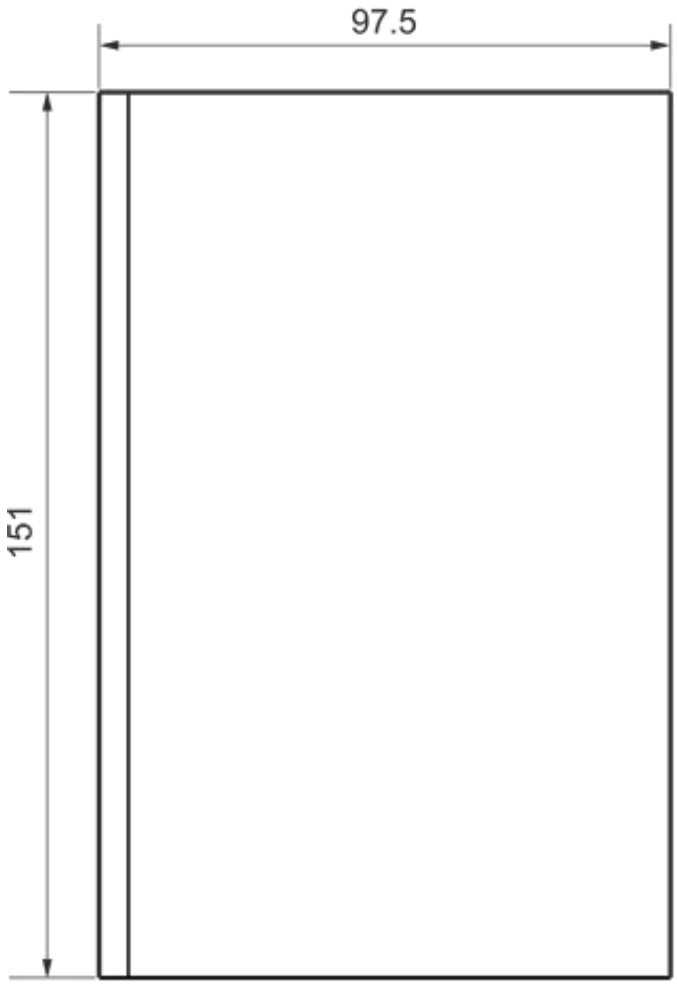



**Front**

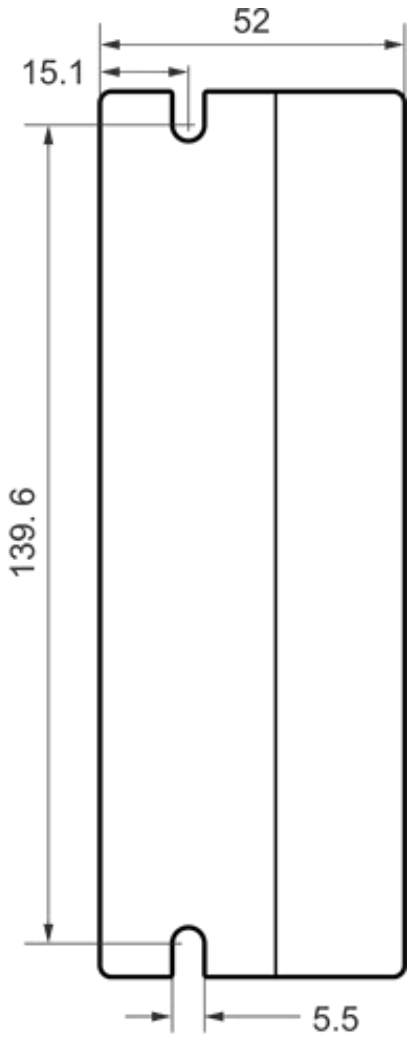



**Side**

### 3.2.2. T86S Installation Dimension




**Front**

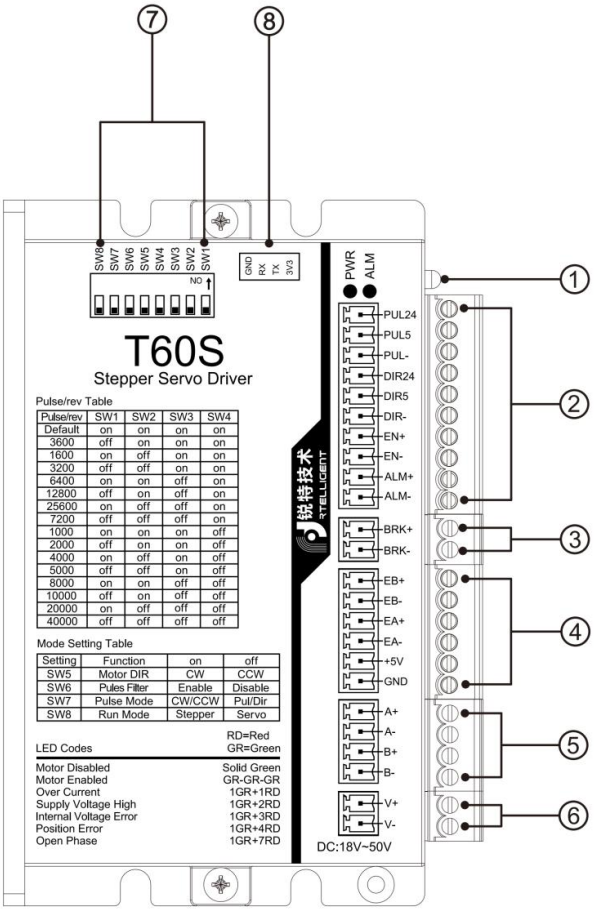



**Side**

# 4. Port, Wiring & Setting

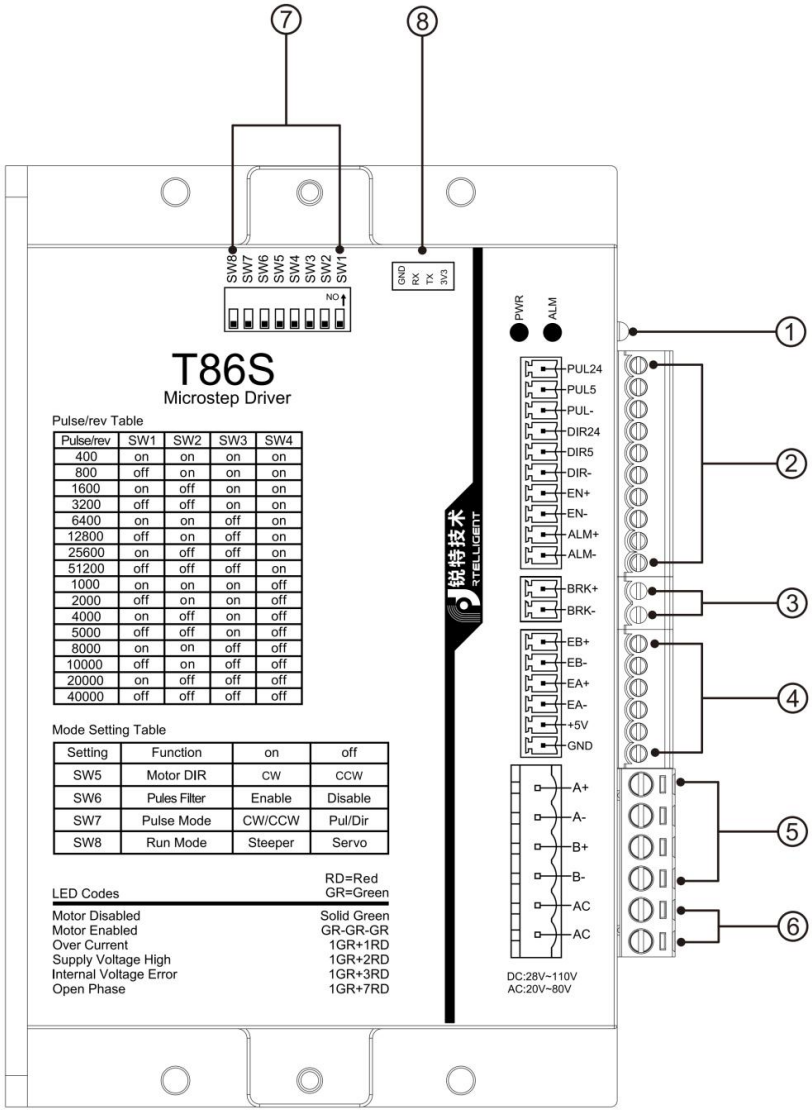
## 4.1. Port Function Description

### 4.1.1. T60S




| Number | Part Name | Description |
|---|---|---|
| ① | Status indicator | LED lights are used to display the operating status and fault status of the driver |
| ② | Control signal interface | Pulse, direction, enable signal inputs and alarm signal output interface |
| ③ | Brake Interface | For connecting the brake cable |
| ④ | Encoder cable Interface | For connecting the encoder cable |
| ⑤ | Motor power cable interface | Connect A+, A-, B+, B- phases |
| ⑥ | Power supply input interface | Input DC voltage 18~50V |
| ⑦ | DIP switch | Used to set common parameters such as pulse/revolution, pulse mode, motor running direction, etc |
| ⑧ | Debugging interface | Used to connect to the debugging software for parameter debugging |

## 4.1.2. T86S

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| ② | Control signal interface | Pulse, direction, enable signal inputs and alarm signal output interface |
| ③ | Brake Interface | For connecting the brake cable |
| ④ | Encoder cable Interface | For connecting the encoder cable |
| ⑤ | Motor power cable interface | Connect A+, A-, B+, B- phases |
| ⑥ | Power supply input interface | Input voltage 28~110VDC or 20V~80VAC |
| ⑦ | DIP switch | Used to set common parameters such as pulse/revolution, pulse mode, motor running direction, etc |
| ⑧ | Debugging interface | Used to connect to the debugging software for parameter debugging |

## 4.2. Power Supply & Motor

<table>
<tr><th rowspan="2"></th><th colspan="2">Identification</th><th rowspan="2">Name</th><th rowspan="2">Description</th></tr>
<tr><th>T60S</th><th>T86S</th></tr>
<tr><td rowspan="2">Power supply</td><td>V+</td><td>AC</td><td>Power positive pole</td><td rowspan="2">1. The polarity of the T60S product cannot be reversed, otherwise the product will be damaged.<br>2. The T86S products can be connected to both AC and DC.</td></tr>
<tr><td>V-</td><td>AC</td><td>Power negative pole</td></tr>
<tr><td rowspan="4">Motor</td><td colspan="2">B-</td><td>Two phase stepper motor B- (Black)</td><td rowspan="4">Wiring according to the color of the motor wire.</td></tr>
<tr><td colspan="2">B+</td><td>Two phase stepper motor B+ (Green)</td></tr>
<tr><td colspan="2">A-</td><td>Two phase stepper motor A - (Blue)</td></tr>
<tr><td colspan="2">A+</td><td>Two phase stepper motor A+ (Red)</td></tr>
<tr><td rowspan="6">Encoder</td><td colspan="2">GND</td><td></td><td rowspan="6">+5V is only for encoder use and should not be used for other loads, otherwise it may damage the driver. The maximum output current is 100mA.</td></tr>
<tr><td colspan="2">+5V</td><td>RS485 B</td></tr>
<tr><td colspan="2">EA-</td><td>Encoder differential A-</td></tr>
<tr><td colspan="2">EA+</td><td>Encoder differential A+</td></tr>
<tr><td colspan="2">EB-</td><td>Encoder differential B-</td></tr>
<tr><td colspan="2">EB+</td><td>Encoder differential B+</td></tr>
<tr><td rowspan="2">Brake</td><td colspan="2">BRK-</td><td>Brake negative pole</td><td rowspan="2">The brake is directly connected to the driver without the need for additional relay control, making closed-loop control more reliable</td></tr>
<tr><td colspan="2">BRK+</td><td>Brake positive pole</td></tr>
</table>

# 4.3. Control Signal Interface

| | T60S/T86S identification | Name | Description |
|---|---|---|---|
| Control signal | PUL24 | 24V pulse positive pole interface | 1. Separate interfaces for 5V and 24V pulse, direction control signals.<br>2. Maximum voltage for 24V interface is 28V.<br>3. The maximum voltage for the 5V interface is 7V.<br>4. EN+and EN - are compatible circuits with voltage levels of 5~24V.<br>5. ALM+and ALM - are optocoupler isolated collector open circuits. |
| | PUL5 | 5V pulse positive pole interface | |
| | PUL- | Pulse negative pole | |
| | DIR24 | 24V direction positive pole interface | |
| | DIR5 | 5V direction positive pole interface | |
| | DIR- | Direction negative pole | |
| | EN+ | Enable positive pole | |
| | EN- | Enable negative pole | |
| | ALM+ | Alarm output positive pole | |
| | ALM- | Alarm output negative pole | |

## 4.3.1. Wiring Requirements

To prevent interference with the driver, it is recommended to use shielded cables for control signals, and short-circuit the shielding layer to the ground cable. Unless otherwise specified, the shielding cable of the control signal cable should be grounded at one end: the upper computer end of the shielding cable should be grounded, and the driver end of the shielding cable should be suspended.

Only grounding at the same point is allowed within the same machine. If it is not real grounding, it may cause serious interference, and the shielding layer should not be connected at this time.

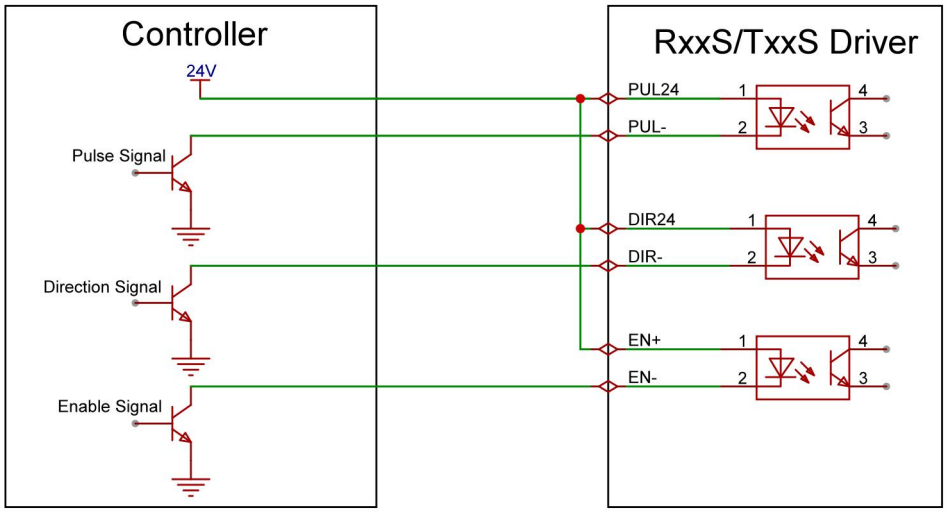
Pulse and direction signal lines are not allowed to be wrapped side by side with motor cables. It is better to separate them by at least 10cm, otherwise motor noise can easily interfere with pulse direction signals, causing inaccurate motor positioning, system instability, and other faults

## 4.3.2. Pulse & Direction Signal

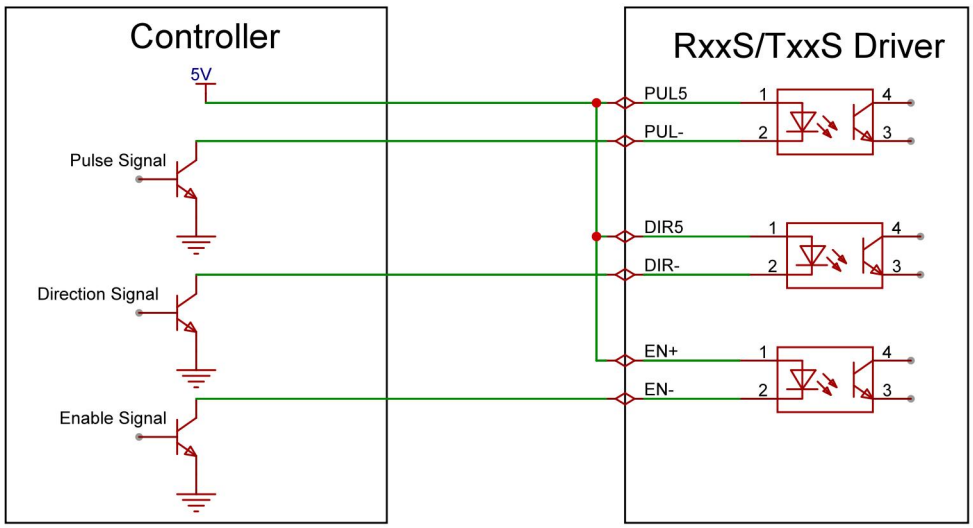
Different from the 5~24V pulse control signal interface circuit or single 5V, single 24V control signal interface used in previous stepper drivers. The T60S and T86S drivers use independent 5V and 24V pulse control signal interfaces to match most control systems on the market. At the same time, it avoids the trouble of connecting additional current limiting resistors.

When the running direction of the motor is inconsistent with the system design, it can be adjusted by extended DIP switch SW5.

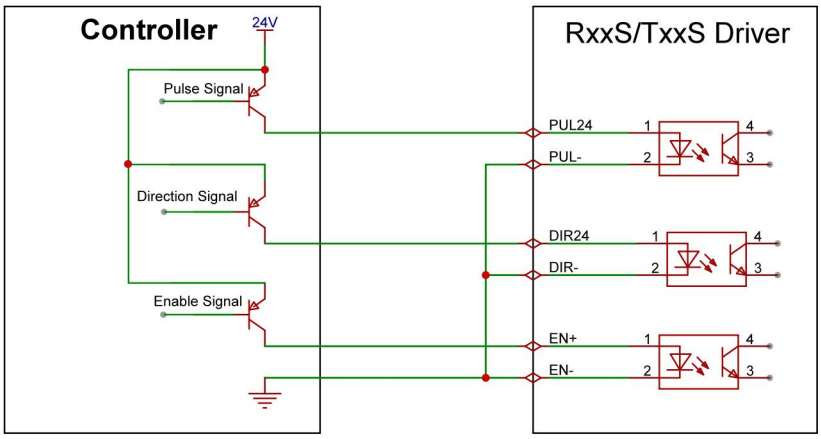
### 4.3.2.1. NPN single-ended 24V common anode connection



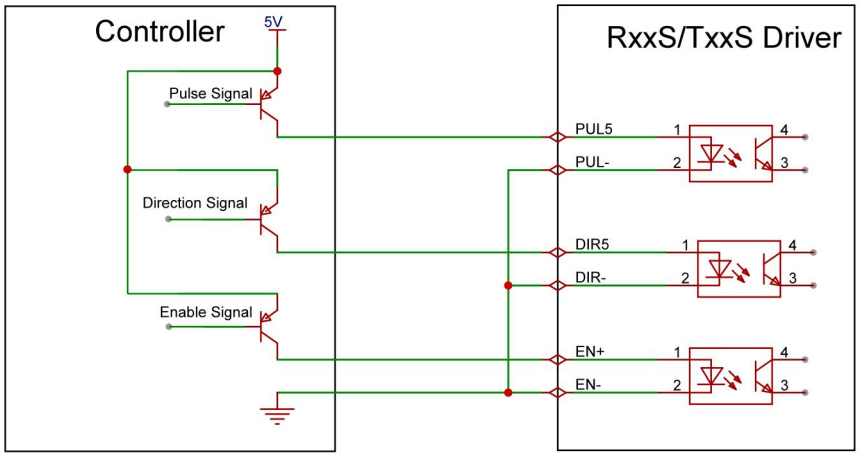

### 4.3.2.2. NPN single-ended 5V common anode connection



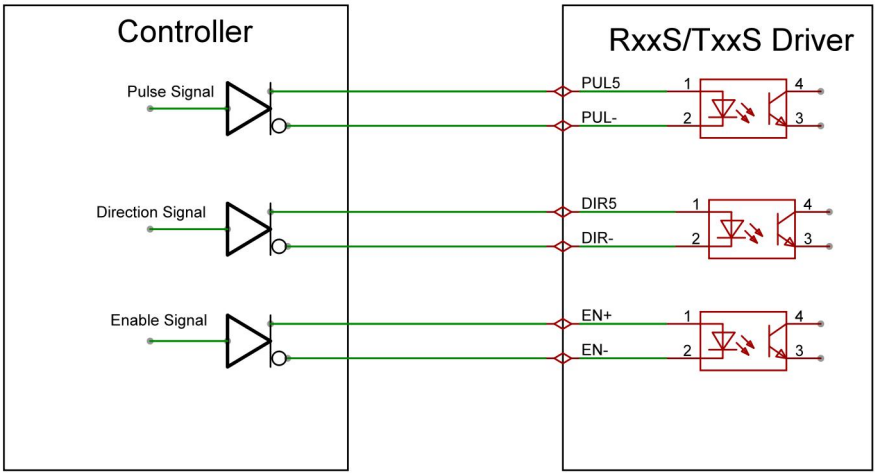
### 4.3.2.3. PNP single-ended 24V common cathode connection method




### 4.3.2.4. PNP single-ended 5V common cathode connection



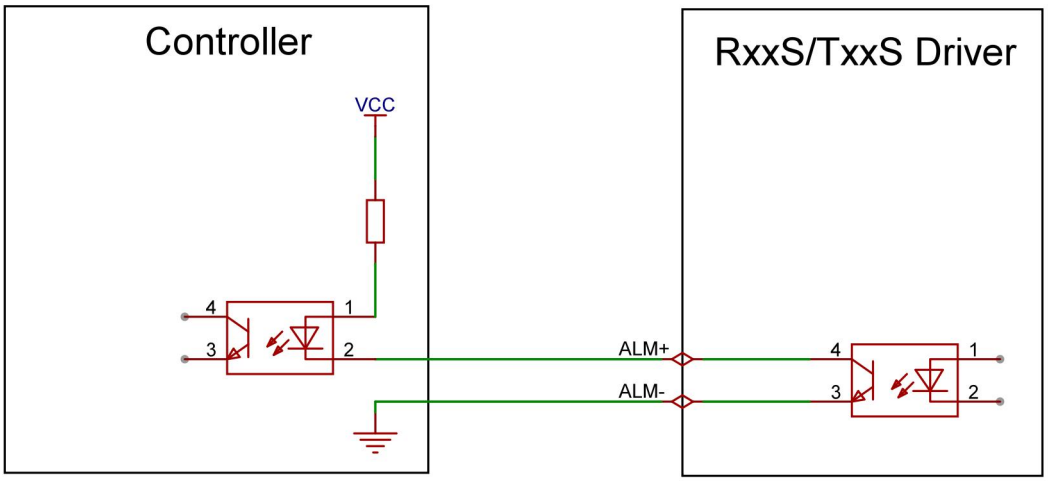

### 4.3.2.5. Differential connection



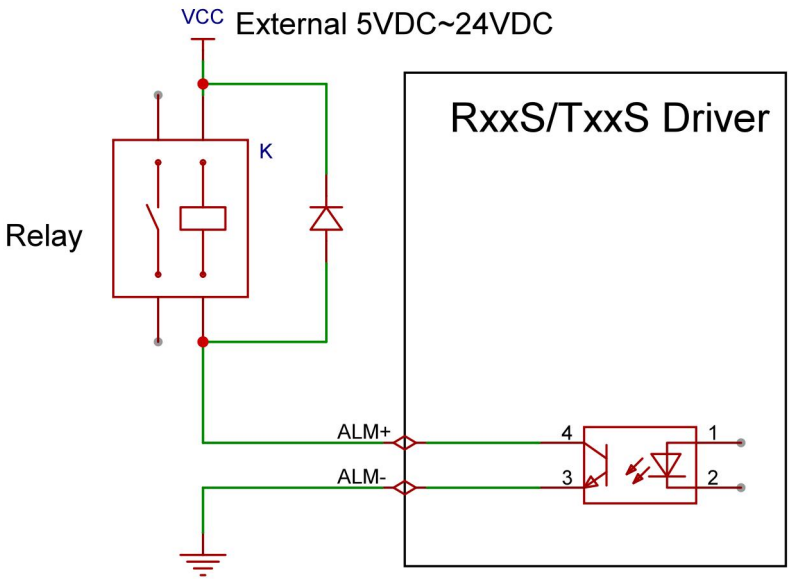
## 4.3.3. Alarm Signal

ALM+, ALM- is an optoelectronic isolated collector open circuit (OC) output, capable of withstanding a maximum voltage of 30VDC and a maximum saturation current of 100mA. When the driver is working normally, the output optocoupler is not conducting.

### 4.3.3.1. Optocoupler connection




### 4.3.3.2. Relay connection



## 4.4. Running Parameters Setting

The T60S and T86S actuators include 8 DIP switches, which are used to set the operating parameters of the stepper motor. Among them, SW1-SW4 are used to set pulse/revolution parameters, SW5 is used to set running direction, SW6 is used to set command smoothing filtering, SW7 is used to set pulse mode, and SW8 is used to set motor running mode.

| SW1 | SW2 | SW3 | SW4 | SW5 | SW6 | SW7 | SW8 |
|---|---|---|---|---|---|---|---|
| Pulse/revolution setting | | | | Running direction | Command smoothing filter | Pulse mode | Motor running mode |

### 4.4.1. Pulse/revolution Setting [SW1~SW4]

| Subdivision (pulse/rev) | | SW1 | SW2 | SW3 | SW4 |
|---|---|---|---|---|---|
| T60S | T86S | | | | |
| 3600 | | on | on | on | on |
| 800 | | off | on | on | on |
| 1600 | | on | off | on | on |
| 3200 | | off | off | on | on |
| 6400 | | on | on | off | on |
| 12800 | | off | on | off | on |
| 25600 | | on | off | off | on |
| 7200 | | off | off | off | on |
| 1000 | | on | on | on | off |
| 2000 | | off | on | on | off |
| 4000 | | on | off | on | off |
| 5000 | | off | off | on | off |
| 8000 | | on | on | off | off |
| 10000 | | off | on | off | off |
| 20000 | | on | off | off | off |
| 40000 | | off | off | off | off |

### 4.4.2. Running Direction Setting [SW5]

Without changing the stepper motor winding connection and control signal settings, the motor's running direction can be changed by setting SW5 to on or off.

The factory default is off.

### 4.4.3. Command Smoothing Filter [SW6]

DIP SW6 is used to set whether the pulse filtering function of the driver is turned on.

On indicates that the pulse filtering function is turned on.
Off indicates that the pulse filtering function is turned off.

The pulse filtering function is the filtering effect of the driver on the input command. When the filtering function is turned on, the driver will smooth the input pulse command, which can make the motor run more smoothly in acceleration and deceleration, but this will also cause a certain delay in the pulse command

Actual command filtering time = set value * 50us, and the filtering setting value can be changed through software (default is 512).

### 4.4.4. Pulse Mode Setting [SW7]

Set DIP switch SW7 to select pulse mode. When switch SW7 is set to on, it is in dual pulse mode, and when it is set to off, it is in pulse&direction mode. After changing the pulse mode, please power on the driver again for the settings to take effect

SW7=on: CW & CCW mode
SW7=off: Pulse & Direction mode (factory default)

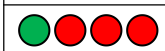
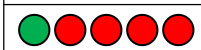
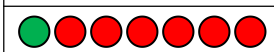
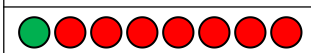
### 4.4.5. Motor Running Mode Setting [SW8]

DIP SW8 is used to set the control mode of the driver.

“On” indicates that the input driver is operating in open-loop mode and can be used to test motors.
“Off” indicates a closed-loop mode with normal input.

## 4.5. Status & Alarm Indicator Lights

- T60S and T86S drivers include an integrated red and green indicator light for displaying status and errors
- When the motor is in the enabled state, the green indicator light flashes slowly. When the green light is on for a long time, the motor is not enabled
- If an error occurs when the red LED flashes, it will be displayed by a combination of flashing red and green lights, as follows:

| LED status | | Driver status |
|---|---|---|
|  | Steady green light | Driver is not enabled |
|  | Flashing green light | Driver works fine |
|  | 1 green, 1 red | Driver overcurrent |
|  | 1 green, 2 red | Driver input power overvoltage |
|  | 1 green, 3 red | Driver internal voltage error |
|  | 1 green, 4 red | Encoder out-of-voltage alarm |
|  | 1 green, 6 red | Parameter check error |
|  | 1 green, 7 red | Motor phase loss |

# 5. Communication Protocol

## 5.1. Modbus/RTU Configuration

- The serial communication parameters are as follows:
  (1) Baud rate: 115200
  (2) Data bits: 8 bit
  (3) Stop bit: 1 bit
  (4) Check bit: None
- TxxS series products currently support the following Modbus function codes:
  (1) 0x03: Read holding register
  (2) 0x06: Write single register
  (3) 0x10: Write multiple registers
- MODBUS registers start with 0, while in touch screen and PLC, register addresses are typically represented as 400x type, starting with 1.
  So: PLC address=MODBUS address + 1
- Register operation type:
  (1) R: Rad only
  (2) W: Write only
  (3) R/W: Read or write
- Data type:
  (1) SHORT —— 16bit
  (2) LONG —— 32bit
- MODBUS defaults to a 16 bit register. Two consecutive registers form a 32-bit data, with low 16-bit data at the beginning and high 1-bit data at the end.

# 5.2. Register Explanation

## 5.2.1. Driver Flag Register [0～1]

### 5.2.1.1. Alarm Flag Register [0]

Defined all alarm flags for the driver. MODBUS address: 0

| 15 | | | | | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|---|
| Reserve | | | | | | | | ECDE1 |
| R-0 | | | | | | R-0 | | |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| POSE | MPE | MEM | OT | UV | OV | OC | IVE | |
| R-0 | R-0 | R-0 | R-0 | R-0 | R-0 | R-0 | R-0 | |

| BIT | Name | Description |
|---|---|---|
| 9～15 | Reserve | **Read always returns 0** |
| 8 | ECDE1 | **Encoder failure**<br>0: Encoder signal is normal<br>1: Encoder signal is abnormal |
| 7 | POSE | **Tracking error alarm**<br>No tracking error alarm<br>1: Tracking error alarm occurs, the motor cannot follow the encoder normally<br>◆ The possible impacts of a tracking error alarm are as follows:<br>① Position deviation alarm threshold<br>② Encoder cable<br>③ Motor power cable<br>④ Check whether the setting of parameters such as speed and acceleration is reasonable |
| 6 | MPE | **Motor phase loss alarm**<br>No alarm<br>1: Alarm occurs<br>◆ When a phase loss alarm occurs, the driver cannot detect the current of the motor winding normally<br>① Need to check motor wiring and motor type |
| 5 | MEM | **Parameter check error**<br>0: Parameter check is correct<br>1: Parameter check error |

| | | |
|---|---|---|
| 4 | OT | **Over temperature alarm sign**<br>0: Driver temperature is normal<br>1: The temperature of the internal components of the driver is too high |
| 3 | UV | **Undervoltage alarm flag**<br>0: No undervoltage alarm<br>1: Driver experiencing undervoltage |
| 2 | OV | **Overvoltage alarm sign**<br>0: No overvoltage alarm<br>1: Driver overvoltage occurs<br>◆ Drive overvoltage occurs, check the following:<br>① Check the input power supply<br>② Check the pump voltage during motor deceleration |
| 1 | OC | **Overcurrent alarm flag**<br>0: No overcurrent alarm<br>1: The driver has triggered an overcurrent alarm<br>◆ The driver has experienced an overcurrent alarm, and the possible reasons are as follows<br>① Short circuit occurs in the motor winding<br>② The current set by the driver is too large, causing the motor to burn out<br>③ Internal components of the driver are damaged |
| 0 | IVE | **Internal voltage error alarm flag**<br>0: No internal voltage error<br>1: Internal voltage error<br>◆ The internal voltage error alarm of the driver is usually caused by damage to the internal components of the driver |

### 5.2.1.2. Driver Status Register [1]

Defined some status flags inside the driver. MODBUS Address: 1

| 15 | | | | 11 | 10 | 9 | 8 |
|---|---|---|---|---|---|---|---|
| Reserve | | | | TC | POW | NL | PL |
| | | | | R-0 | | | |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| CLAMP | ARRSPD | RDY | HOME | MOV | INPOS | ALM | ENA |
| R-0 | R-0 | R-0 | R-1 | R-0 | R-0 | R-0 | R-1 |

| BIT | Name | Description |
|---|---|---|
| 12～15 | Reserve | **Read always returns 0** |
| 11 | TC | **Torque reaching state**<br>0: The torque has not reached the set value<br>1: The torque reaches the set value |
| 10 | STALL | **Stall detection**<br>0: During open-loop operation, the motor runs normally<br>1: During open-loop operation, the motor experiences stalling |
| 9 | NL | **Negative limit effective state**<br>0: Not in the negative limit position<br>1: In the negative limit position |
| 8 | PL | **Positive limit effective state**<br>0: Not in the positive limit position<br>1: In the positive limit position |
| 7 | CLAMP | **Motor mechanical brake status**<br>0: The brake is not opened, mechanically locking the motor shaft<br>1: The brake has been opened and the motor can run |
| 6 | ARRSPD | **Whether the motor is running to the set speed**<br>0: Speed not reached<br>1: The speed has reached<br>◆ In the internal pulse command mode, it is used to indicate whether the motor has reached the set speed |
| 5 | RDY | **Driver ready sign**<br>0: Not ready<br>1: Ready<br>◆ Usually, when the driver is in the enabled state, it is in the ready state. But during the transition from disable to enable of the motor, it takes 100ms to enter the ready state. In addition, automatic parameter recognition and current step testing during power on can cause the motor to be in an unprepared state. |
| 4 | HOME | **Homing sign**<br>0: Homing not completed<br>1: Homing completed |
| 3 | MOV | **Motor running sign**<br>0: Motor stopped state<br>1: The motor is running<br>◆ When the motor is in operation, it cannot respond to new motion commands and can only respond to stop commands. |

| | | |
|---|---|---|
| 2 | INPOS | **Motor positioning completion sign in closed-loop mode**<br>0: Positioning not completed<br>1: Positioning Completed |
| 1 | ALM | **Driver alarm flag**<br>0: Driver without alarm<br>1: The driver has triggered an alarm, please check the register REG_LMCODE (address 0) |
| 0 | ENA | **Driver enable flag**<br>0: Driver not enabled<br>1: The driver has been enabled<br>◆ The default driver is already enabled when powered on |

## 5.2.2. Input/output status register [2～7]

### 5.2.2.1. Input Port Value Register [2]

Used to indicate the value of the current input port. Due to the optoelectronic isolation of the input port, for ease of understanding, the article uses whether the optocoupler is conducting to indicate the status of the input port. MODBUS Address: 2

| 15 | | | | | | | 8 |
|---|---|---|---|---|---|---|---|
| Reserve | | | | | | | |
| R-0 | | | | | | | |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| Reserve | | IN6 | IN5 | IN4 | IN3 | IN2 | IN1 |
| R-0 | | R-0 | R-0 | R-0 | R-0 | R-0 | R-0 |

| BIT | Name | Description |
|---|---|---|
| 6～15 | Reserve | **Read always returns 0** |
| 5 | IN6 | **Level status of input port IN6**<br>0: Input port 6 is not conducting<br>1: Input port 6 is conducting |
| 4 | IN5 | **Level status of input port IN5**<br>0: Input port 5 is not conducting<br>1: Input port 5 is conducting |
| 3 | IN4 | **Level status of input port IN4**<br>0: Input port 4 is not conducting<br>1: Input port 4 is conducting |

| | | |
|---|---|---|
| 2 | IN3 | **Level status of input port IN3**<br>0: Input port 3 is not conducting<br>1: Input port 3 is conducting |
| 1 | IN2 | **Level status of input port IN2**<br>0: Input port 2 is not conducting<br>1: Input port 2 is conducting |
| 0 | IN1 | **Level status of input port IN1**<br>0: Input port 1 is not conducting<br>1: Input port 1 is conducting |

### 5.2.2.2. Current Output Port Value [3]

Output port value register. MODBUS Address: 3

| 15 ~ 8 | 7 ~ 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|
| Reserve | Reserve | OUT4 | OUT3 | OUT2 | OUT1 |
| R-0 | R-0 | R-0 | R-0 | R-0 | R-0 |

| BIT | Name | Description |
|---|---|---|
| 4～15 | Reserve | **Read always returns 0** |
| 3 | OUT4 | **Level status of output port 4 (used by other products)**<br>0: Output port 4 is not conducting<br>1: Output port 4 is conducting |
| 2 | OUT3 | **Level status of output port 3 (used by other products)**<br>0: Output port 3 is not conducting<br>1: Output port 3 is conducting |
| 1 | OUT2 | **Level status of output port 2**<br>0: Output port 2 is not conducting<br>1: Output port 2 is conducting |
| 0 | OUT1 | **Level status of output port 1**<br>0: Output port 1 is not conducting<br>1: Output port 1 is conducting |

### 5.2.2.3. Input Port Conduction Edge Latch Register [4]

Every time the port changes from off state to on state, the driver will latch this change. MODBUS Address: 4

| 15 … 8 |
|---|
| Reserve |
| R-0 |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| Reserve | | IN6 | IN5 | IN4 | IN3 | IN2 | IN1 |
| R-0 | | R-0 | R-0 | R-0 | R-0 | R-0 | R-0 |

| BIT | Name | Description |
|---|---|---|
| 6～15 | Reserve | **Read always returns 0** |
| 5 | IN6 | **Input port IN6 conduction edge latch flag**<br>0: Input port 6 has not experienced any conduction edge<br>1: Input port 6 has a conductive edge |
| 4 | IN5 | **Input port IN5 conduction edge latch flag**<br>0: Input port 5 has not experienced any conduction edge<br>1: Input port 5 has a conductive edge |
| 3 | IN4 | **Input port IN4 conduction edge latch flag**<br>0: Input port 4 has not experienced any conduction edge<br>1: Input port 4 has a conductive edge |
| 2 | IN3 | **Input port IN3 conduction edge latch flag**<br>0: Input port 3 has not experienced any conduction edge<br>1: Input port 3 has a conductive edge |
| 1 | IN2 | **Input port IN2 conduction edge latch flag**<br>0: Input port 2 has not experienced any conduction edge<br>1: Input port 2 has a conductive edge |
| 0 | IN1 | **Input port IN1 conduction edge latch flag**<br>0: Input port 1 has not experienced any conduction edge<br>1: Input port 1 has a conductive edge |

### 5.2.2.4. Input Port Shutdown Edge Latch Register [5]

Every time the port changes from on to off, the driver will latch this change. MODBUS Address: 5

| 15 | | | | | | | 8 |
|---|---|---|---|---|---|---|---|
| Reserve | | | | | | | |
| R-0 | | | | | | | |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| Reserve | | IN6 | IN5 | IN4 | IN3 | IN2 | IN1 |
| R-0 | | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 |

| BIT | Name | Description |
|---|---|---|
| 6～15 | Reserve | **Read always returns 0** |
| 5 | IN6 | **Input port IN6 shutdown edge latch flag**<br>0: Input port 6 did not experience any pass/fail edges<br>1: Input port 6 experienced a shutdown edge |
| 4 | IN5 | **Input port IN5 shutdown edge latch flag**<br>0: Input port 5 did not experience any pass/fail edges<br>1: Input port 5 experienced a shutdown edge |
| 3 | IN4 | **Input port IN4 shutdown edge latch flag**<br>0: Input port 4 did not experience any pass/fail edges<br>1: Input port 4 experienced a shutdown edge |
| 2 | IN3 | **Input port IN3 shutdown edge latch flag**<br>0: Input port 3 did not experience any pass/fail edges<br>1: Input port 3 experienced a shutdown edge |
| 1 | IN2 | **Input port IN2 shutdown edge latch flag**<br>0: Input port 2 did not experience any pass/fail edges<br>1: Input port 2 experienced a shutdown edge |
| 0 | IN1 | **Input port IN1 shutdown edge latch flag**<br>0: Input port 1 did not experience any pass/fail edges<br>1: Input port 1 experienced a shutdown edge |

### 5.2.2.5. Input Port Conduction Edge Clearing Register [6]

Used to clear the conduction edge flag of the latch. MODBUS Address: 6

| 15 ~ 8 |
|---|
| Reserve |
| R-0 |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| Reserve | | IN6 | IN5 | IN4 | IN3 | IN2 | IN1 |
| R-0 | | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 |

| BIT | Name | Description |
|---|---|---|
| 6～15 | Reserve | **Read always returns 0** |
| 5 | IN6 | **Clear the conduction edge latch status flag of IN6**<br>0: No effect<br>1: Clear the conduction edge latch flag of IN6 port |
| 4 | IN5 | **Clear the conduction edge latch status flag of IN5**<br>0: No effect<br>1: Clear the conduction edge latch flag of IN5 port |
| 3 | IN4 | **Clear the conduction edge latch status flag of IN4**<br>0: No effect<br>1: Clear the conduction edge latch flag of IN4 port |
| 2 | IN3 | **Clear the conduction edge latch status flag of IN3**<br>0: No effect<br>1: Clear the conduction edge latch flag of IN3 port |
| 1 | IN2 | **Clear the conduction edge latch status flag of IN2**<br>0: No effect<br>1: Clear the conduction edge latch flag of IN2 port |
| 0 | IN1 | **Clear the conduction edge latch status flag of IN1**<br>0: No effect<br>1: Clear the conduction edge latch flag of IN1 port |

### 5.2.2.6. Input Port Shutdown Edge Clearing Register [7]

Used to clear the off edge flag of the latch. MODBUS Address: 7

| 15 ~ 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Reserve | Reserve | | IN6 | IN5 | IN4 | IN3 | IN2 | IN1 |
| R-0 | R-0 | | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 |

| BIT | Name | Description |
|---|---|---|
| 6～15 | Reserve | **Read always returns 0** |
| 5 | IN6 | **Clear the off edge latch status flag of IN6**<br>0: No effect<br>1: Clear the shutdown edge latch flag of IN5 port |
| 4 | IN5 | **Clear the off edge latch status flag of IN5**<br>0: No effect<br>1: Clear the shutdown edge latch flag of IN5 port |
| 3 | IN4 | **Clear the off edge latch status flag of IN4**<br>0: No effect<br>1: Clear the shutdown edge latch flag of IN4 port |
| 2 | IN3 | **Clear the shutdown edge latch status flag of IN3**<br>0: No effect<br>1: Clear the shutdown edge latch flag of IN3 port |
| 1 | IN2 | **Clear the latch status flag of IN2's turn off edge**<br>0: No effect<br>1: Clear the shutdown edge latch flag of IN2 port |
| 0 | IN1 | **Clear the off edge latch status flag of IN1**<br>0: No effect<br>1: Clear the shutdown edge latch flag of IN1 port |

## 5.2.3.Current position and speed related registers of the motor [8～16]

| MODBUS address | Attribute | Default value | Range | Description |
|---|---|---|---|---|
| 8 | R | 0 | [0,65535] | Internal pulse mode, current absolute position, low 16-bit |
| 9 | R | 0 | [0,65535] | Internal pulse mode, current absolute position, high 16-bit |
| 10 | R | 0 | [-3000,3000] | Current command speed, signed 16-bit data<br>Unit: RPM |
| 11 | R | - | [0,100] | Current bus voltage value<br>Unit: mV |
| 12 | R | 0 | [0,65535] | Closed-loop mode, motor tracking error, low 16-bits<br>Unit: Encoder Resolution |
| 13 | R | 0 | [0,65535] | Closed-loop mode, motor tracking error, high 16-bits |
| 14 | R | 0 | [0,65535] | External pulse counter, low 16-bit |
| 15 | R | 0 | [0,65535] | External pulse counter, high 16-bit |
| 16 | R/W | 0 | [0,1] | Clear external pulse counter<br>Writing 0 has no effect, reading always returns 0<br>Writing 1 will clear the external pulse counter, and the values of registers 14 and 15 will become 0. Then this register will become 0. |

## 5.2.4. Driver control mode setting [17～23]

| MODBUS address | Attribute | Default value | Range | Description |
|---|---|---|---|---|
| 17 | R/W | 0 | [0,1] | Command mode setting register, set the source of pulse commands for the driver<br>0: Internal pulse command<br>1: External pulse command |
| 18 | R/W | 0 | [0,6] | 0: Waiting state<br>The driver will restore the bit waiting state after processing any control instructions received.<br>1: Fixed length forward rotation<br>In relative position mode, the motor runs forward according to the 70-74 register parameters.<br>In absolute position mode, the operating status is |

| | | | | |
|---|---|---|---|---|
| | | | | determined based on the current position and the absolute position set at 70-74.<br>2: Fixed length reversal<br>In relative position mode, the motor operates in reverse according to the 70-74 register parameters.<br>In absolute position mode, the operating status is determined based on the current position and the absolute position set at 70-74.<br>3: Speed mode, continuous forward rotation<br>The motor accelerates forward according to registers 75 and 77<br>4: Speed mode, continuous reverse<br>The motor accelerates in reverse according to registers 75 and 77<br>6: Slow down and stop<br>Position mode, the motor decelerates and stops according to the 71 register<br>Speed mode, the motor decelerates and stops according to the 76 register<br>9: Trigger homing<br>This register only works when the value of the internal pulse mode register 20 is 0 |
| 19 | R/W | 0 | [0,2] | External pulse command mode setting register<br>0: PUL+DIR mode: PUL is the pulse input port, DIR is the direction input port<br>1: Reserved<br>2: CW+CCW mode: PUL is the CW input signal, DIR is the CCW input signal<br>3: Orthogonal input mode: |
| 20 | R/W | 0 | [0,5] | Preset application selection for internal pulse mode<br>0: Communication control: responds to instructions from register 18<br>1: Reserved, do not use<br>2: Preset IO control mode 1 start stop + direction<br>3: Preset IO control Mode 2: forward rotation + reverse rotation<br>4: Preset IO control mode 3: speed table<br>5: Preset IO control mode 4: internal position table |
| 21 | R/W | 0 | [0,1] | Motor type setting register<br>0: Two phase stepper motor |

| | | | | |
|---|---|---|---|---|
| | | | | 1: Three phase stepper motor<br>2: Five phase stepper motor<br>◆ The TxxS series is a two-phase motor, please do not make any other settings |
| 22 | R/W | 0 | [0,2] | Motor operation mode setting register<br>0: Open loop operation<br>1: Servo operation |
| 23 | R | 0 | [0,1] | Motor direction reverse setting register<br>0: Default running direction<br>1: Reverse the direction of motor operation<br>◆ Due to the direction of the TxxS series being set through SW5, this register is used to display the current settings |

## 5.2.5. Open Loop Operating Parameters [24～29]

| MODBUS address | Attribute | Default value | Range | Description |
|---|---|---|---|---|
| 24 | R | 4000 | [200,65535] | Display the pulse/revolution of driver runtime<br>Unit: Pulse/rev |
| 25 | R | 1500 | [0,6000] | Display the maximum operating current of the driver<br>Unit: mA |
| 26 | R/W | 50 | [0,100] | Standby current percentage<br>Set the percentage of current relative to operating current when the driver enters standby mode in open-loop operation mode.<br>Unit:% |
| 27 | R/W | 500 | [10,65535] | Standby time setting<br>Set the time after the pulse stops for a certain period of time when the driver enters standby mode during open-loop operation.<br>Unit: ms |
| 28 | R/W | 512 | [1,1024] | Pulse command filter<br>Used for smoothing pulse commands (including internal and external pulses), filtering time = set value * 50us |
| 29 | Reserve | - | - | - |

## 5.2.6. Motor & Current Loop Parameters [30～39]

| MODBUS address | Attribute | Default value | Range | Description |
|---|---|---|---|---|
| 30 | R/W | 0 | [0,1] | Auto-PI enable function<br>Driver built-in parameter recognition and gain optimization algorithm. Usually, good results can be achieved. If the customer needs optimization, this feature can be disabled.<br>0: Do not use auto-PI function<br>1: Use the auto-PI function |
| 31 | R | - | [100,65535] | Automatically recognized resistance value<br>Read the motor winding resistance value automatically recognized by the driver.<br>Unit: mOhm |
| 32 | R | - | [1,65535] | Automatically recognized inductance value<br>Read the motor winding inductance value automatically recognized by the driver.<br>Unit: mH |
| 33 | R/W | 1000 | [100,10000] | User set resistance value<br>When the automatic PI function is cancelled, the resistance value set by the user takes effect.<br>Unit: mOhm |
| 34 | R/W | 1 | [1,10] | User set inductance value<br>When the automatic PI function is disabled, the inductance value set by the user takes effect.<br>Unit: mH |
| 35 | R/W | 200 | [0,1000] | Motor torque constant<br>The parameters are only valid when the motor control mode is servo mode two |
| 36 | R/W | 1000 | [200,10000] | Proportional gain of current loop<br>KP in the current loop PI algorithm.<br>When the auto-PI function is enabled, ILOOPKP is automatically generated.<br>When the auto-PI function is disabled, users can modify ILOOPKP. |

| | | | | |
|---|---|---|---|---|
| 37 | R/W | 200 | [0,2000] | Current loop integral gain<br>KI in the current loop PI algorithm.<br>When the auto-PI function is enabled, ILOOPKI is automatically generated.<br>When the automatic PI function is disabled, users can modify ILOOPKI |
| 38 | R/W | 256 | [0,1024] | KC in Current Loop PI Algorithm |
| 39 | R/W | 0 | [0,1] | Current step test<br>Writing 0 is no effect, reading always returns 0.<br>Writing 1 will initiate the current loop step test. At this point, the current of the motor winding will first be zero and then increase to 1000mA. Users can view step response through NTConfigurator, manually adjust ILOOPKP and ILOOPKI, and optimize motor response. |

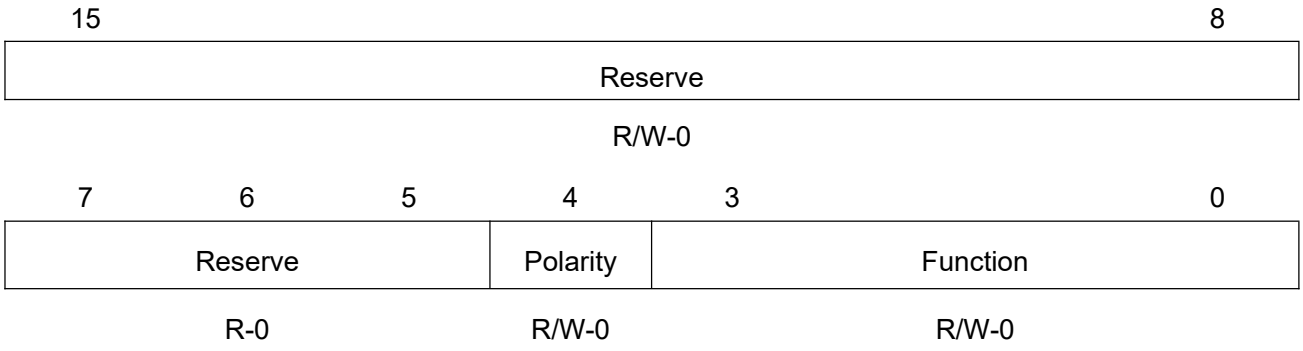
## 5.2.7. Closed Loop Motor Parameters [40～49]

| MODBUS address | Attribute | Default value | Range | Description |
|---|---|---|---|---|
| 40 | R/W | 4000 | [256,65535] | Encoder resolution<br>The driver is capable of receiving input signals from orthogonal encoders and performing 4th harmonic processing.<br>Encoder resolution = number of encoder lines * 4 |
| 41 | R/W | 2000 | [100,65535] | Positioning completion detection mode<br>0: Immediate mode, at any time as long as the position error is less than the value set in register 42 and continues for the time set in register 43, it is considered to be in place<br>1: The command stop mode only judges the error after the motor motion instruction stops for more than the time set in register 44. |
| 42 | R/W | 10 | [1,65535] | Positioning completion accuracy<br>Unit: Encoder resolution |

| | | | | |
|---|---|---|---|---|
| 43 | R/W | 50 | [1,65535] | Positioning completion duration<br>Set the duration after the motor enters the completion accuracy.<br>Duration = Set value * 50us |
| 44 | R/W | 100 | [1,65535] | The time when the positioning is completed and the detection begins<br>After the driver stops receiving pulses for a set period of time, it begins to determine whether the positioning is complete.<br>Set time = set value * 50us |
| 45 | R/W | 4000 | [0,65535] | Out of tolerance alarm threshold, low 16-bit |
| 46 | R/W | 0 | [0,65535] | Out of tolerance alarm threshold, high 16-bit<br>When both registers 45 and 46 are 0, cancel the out of tolerance alarm. |
| 47 | R/W | 0 | [0,1] | Encoder signal A, B exchange<br>It is possible to match motors from other manufacturers without changing the wiring of the motor and encoder. |
| 48 | R | 0 | [0,65535] | Encoder single-turn count value |
| 49 | - | - | - | - |

## 5.2.8. Output Port Parameters [50～59]

T60S/T86S products do not have output ports, and corresponding setting registers are reserved here for compatibility with other products.



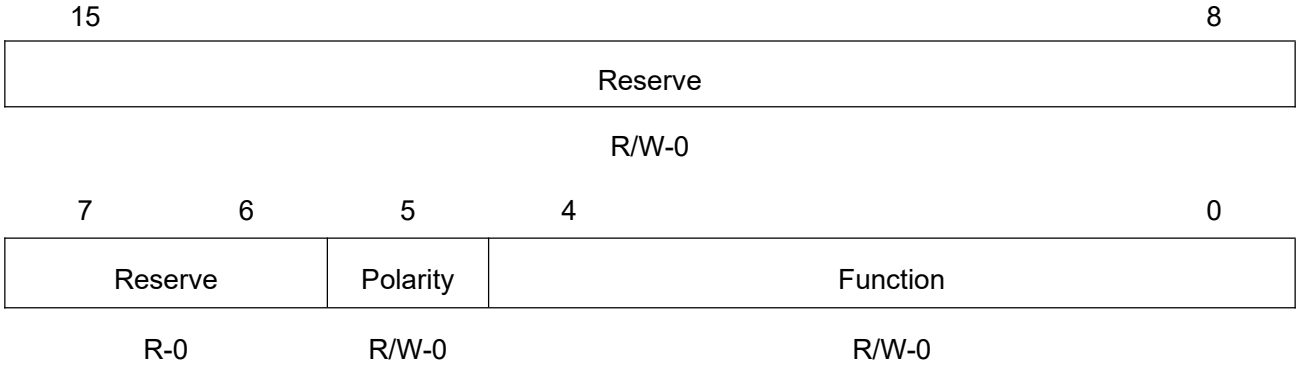
| BIT | Name | Description |
|---|---|---|
| 5～15 | Reserve | **Read always returns 0** |
| 4 | Polarity | **Output port polarity**<br>0: Normally close<br>1: Normally open (default value) |
| 0～3 | Function | **Output port function selection**<br>0: Normal output, user controlled<br>1: Alarm output, default value for OUT1<br>2: Brake signal output<br>3: In place signal output<br>4: Speed reaches output, OUT2 default value<br>5: Homing completed output<br>6: Driver ready for output<br>7: Motor stop state output<br>8:: Positive limit output<br>9: Negative limit output<br>10: Power indicator output<br>11: Torque reaches output<br>Other: The input port is not functional and only serves as a regular input port |

Homing completed output:

| MODBUS address | Attribute | Default value | Range | Description |
|---|---|---|---|---|
| 50 | R/W | 1 | [0,11] | Output port 1 setting register (other products) |
| 51 | R/W | 4 | [0,11] | Output port 2 setting register (other products) |
| 52 | R/W | 1 | [0,11] | Output port 3 setting register (other products) |
| 53 | R/W | 4 | [0,11] | Output port 4 setting register (other products) |

## 5.2.9. Input Port Parameters [60～69]

The T60S/T86S product includes 3 input ports, each with the same setting method.




| BIT | Name | Description |
|---|---|---|
| 6～15 | Reserve | **Read always returns 0** |
| 5 | Polarity | **Effective voltage level of input port**<br>0: Normally close<br>1: Normally open (default value) |
| 0～4 | Function | **Input port function selection**<br>0: Pulse Inputs<br>1: Direction input<br>2: Orthogonal encoder A-phase input<br>3: Orthogonal encoder B-phase input<br>4: Motor offline<br>5: Clear fault<br>6: Emergency stop<br>7: Jog forward / start stop<br>8: Jog reverse / direction<br>9: Positive limit input<br>10: Negative limit input<br>11: Zero point signal<br>12: Start homing<br>13: Reverse the direction of motor operation<br>14: Multi-segment speed control 0<br>15: Multi-segment speed control 1 |

| | | |
|---|---|---|
| | | 16: Multi-segment speed control 2<br>17: Multi-segment speed control 3<br>18: Multi-segment position control 0<br>19: Multi-segment position control 1<br>20: Multi-segment position control 2<br>21: Multi-segment position control 3<br>22：USER1<br>23：USER2<br>24：USER3<br>25：USER4<br>26：USER5<br>27：USER6<br>28：USER7<br>29：USER8<br>30：USER9<br>31：USER10<br>Other: The input port is not functional and only serves as a regular input port |

| MODBUS address | Attribute | Default value | Range | Description |
|---|---|---|---|---|
| 60 | R/W | 0 | [0,31] | Input port 1 setting register |
| 61 | R/W | 1 | [0,31] | Input port 2 setting register |
| 62 | R/W | 4 | [0,31] | Input port 3 setting register |
| 63 | R/W | 7 | [0,31] | Input port 4 setting register |
| 64 | R/W | 12 | [0,31] | Input port 5 setting register |
| 65 | R/W | 11 | [0,31] | Input port 6 setting register |

## 5.2.10. Homing Parameters [80～89]

| MODBUS address | Attribute | Default value | Range | Description |
|---|---|---|---|---|
| 80 | R/W | 200 | [1,3000] | Homing high speed<br>Unit: RPM |
| 81 | R/W | 40 | [1,3000] | Homing low speed<br>Unit: RPM |
| 82 | R/W | 100 | [0,1000] | Homing acceleration |
| 83 | R/W | 0 | [-32768,32767] | Zero point offset |
| 84 | R/W | 0 | [0,3] | Zero point offset mode setting |
| 85 | R/W | 0 | [17，35] | Homing mode selection |
| 86 | R/W | 0 | [0,1000] | Emergency stop deceleration |
| 87 | R/W | 50 | [0,1000] | Stop time of homing process<br>Unit: ms<br>◆ During the homing process, the driver will detect the status of the sensor and make corresponding deceleration stop actions. After the motor stops, after a set time, it will further act according to the homing method |
| 88 | R/W | 5000 | [0,65535] | Homing timeout time<br>Unit: ms<br>◆ After triggering the homing, if the set timeout period is exceeded and the homing is still not completed, the motor will slow down and stop. Waiting for the user's next trigger. |
| 89 | R/W | 0 | [0,1] | Enable automatic homing upon power on<br>0: It is prohibited to reset to homing after powering on<br>1: After the driver is powered on, it starts homing |

## 5.2.11. Auxiliary Function Register [90～99]

| MODBUS address | Attribute | Default value | Range | Description |
|---|---|---|---|---|
| 90 | R/W | 0 | [0,1] | Writing 0 is invalid, reading returns 0<br>Write 1 to save the current parameters |
| 91 | R/W | 0 | [0,1] | Writing 0 is invalid, reading returns 0<br>Write 1 to restore factory settings |
| 92 | - | - | - | Manufacturer reserves use, user prohibits writing data |
| 93 | R | - | - | Driver ID number |
| 94 | R | - | - | Driver version number |
| 95 | R | - | - | - |

## 5.2.12. Shaft Locking Time [105,106]

When the stepper motor is initially powered on, the position is at a random position, and the initial position between the stator and rotor of the motor needs to be determined by locking the shaft. Locking the shaft through a current ramp can reduce the vibration of the motor during power on and enable.

| MODBUS address | Attribute | Default value | Range | Description |
|---|---|---|---|---|
| 105 | R/W | 16000 | [0,65535] | Lock shaft ramp time; unit: 62.5us |
| 106 | R/W | 4000 | [0,65535] | Lock shaft duration; unit: 62.5us |

## 5.2.13. Current & Pulse/revolution Parameters [110~114]

| MODBUS address | Attribute | Default value | Range | Description |
|---|---|---|---|---|
| 110 | R/W | 1500 | [0,1500] | Unit mA; The maximum current of T60S/T86S is 1500<br>When in open-loop mode, this register is used to set the current for open-loop operation mode.<br>In closed-loop mode, this register is used to set the maximum current for closed-loop operation mode. |
| 111 | R/W | 4000 | [200,65535] | Set the pulse required for one rotation of the motor |
| 112 | Reserve | | | |
| 113 | R/W | 30 | [0,100] | Current compensation percentage |
| 114 | R/W | 30 | [0,100] | Current loop gain compensation percentage |

## 5.2.14. Phase Loss Detection [115,116]

Phase loss refers to an abnormality in the winding of a stepper motor, such as a broken wire in the motor winding

The TxxS series products include the connection between the motor winding and the driver circuit board, which monitors the motor winding status through a current detection circuit to ensure that the corresponding current is fed back normally. When a phase loss alarm occurs, the driver shuts off power output and the motor is in a free state.

In some cases, it is impossible to detect phase loss, such as when the driver is powered on for the first time, the current reference value of the B-phase winding is zero. If the B-phase winding breaks, the current detected by the driver is also zero, and the driver cannot give an alarm signal at this time. If a command is sent to make the motor run for more than 2 full steps, the driver can determine the phase loss state of the B-phase winding

| MODBU address | Attribute | Default value | Range | Description |
|---|---|---|---|---|
| 115 | R/W | 0 | [0,1] | Enable phase loss detection function<br>0: Disable phase loss detection function<br>1: Enable phase loss detection function |
| 116 | R/W | 50 | [0,1500] | Phase loss detection current threshold: mA |

## 5.2.15. PP & PV Mode Motion Parameters [70～79]

| MODBU address | Attribute | Default value | Range | Description |
|---|---|---|---|---|
| 70 | R/W | 200 | [10,1000] | Acceleration during point-to-point motion, unit: R/S ^ 2 |
| 71 | R/W | 200 | [10,1000] | Deceleration during point-to-point motion, unit: R/S ^ 2 |
| 72 | R/W | 300 | [0,3000] | Maximum speed during point-to-point movement, unit: RPM |
| 73 | R/W | 2000 | [-16777216,16777216] | Pulse command during point-to-point movement, unit: number of pulses<br>P73 is low 16-bit data, P74 is high 16-bit data |
| 74 | | | | |
| 75 | R/W | 60 | [10,1000] | Jog acceleration, unit: R/S ^ 2 |
| 76 | R/W | 60 | [10,1000] | Jog deceleration, unit: R/S ^ 2 |

| | | | | |
|---|---|---|---|---|
| 77 | R/W | 300 | [0,3000] | Jog speed, unit: RPM |
| 78 | R/W | 0 | [0,1] | Absolute motion (ABS) / relative motion (INC) motion settings |
| 79 | W | 0 | 1 | Write 1 to clear position counter (registers 8, 9) |

- The 73 and 74 registers form a 32-bit signed register.
- In incremental operation mode, the absolute values of 73 and 74 represent the distance traveled, and register 18 is used to write 1 or 2 to control whether the motor runs in the forward or reverse direction.
- In absolute position mode, the signed data consisting of 73 and 74 represents the target position, and the motor runs to the set distance by writing 1 through 18.

### 5.2.16. Stall Detection [117~119]

The TxxS series products can operate in open-loop mode, and the driver is equipped with a sensorless stall detection function. Stall refers to the inability of a stepper motor to rotate normally due to external reasons, which can cause the stepper motor to overload, even burn out, and damage mechanical components of the equipment.

The TxxS series products collect real-time current feedback from the motor, estimate the load torque changes of the motor through an observer, and then determine whether the motor is experiencing stalling. Once motor stalling is detected, corresponding protective measures can be taken.

Using sensorless technology for locked rotor detection, the accuracy of the detection depends on the recognition of motor parameters and the correct setting of relevant observer parameters. The default parameter recognition of the driver is usually sufficient for this task. When a misjudgment occurs in practical testing applications, users can turn off this function.

When a stall condition is detected, even if the controller continues to send commands to the driver, the driver will stop running, but the motor will remain in full current state and lock the shaft. At the same time, the red alarm indicator light will remain on, and the alarm output port will output an alarm signal. When the user stops sending pulses, the driver will automatically clear the alarm state and respond to subsequent command signals.

The related registers are as follows:

| MODBUS address | Attribute | Default value | Range | Description |
|---|---|---|---|---|
| 117 | R/W | 0 | [0,1000] | Stall detection enable<br>0--- Disable the stall detection function<br>0--- Enable the stall detection function |
| 118 | R/W | 180 | [0,3000] | Starting speed for stall detection: RPM |
| 119 | R/W | 2 | [0,65535] | Stall detection position error alarm threshold |

## 5.2.17. Low-speed Resonance [120~129]

The TxxS series products provide a harmonic injection algorithm to effectively reduce the low-speed resonance of two-phase stepper motors when operating in open-loop mode.

Usually, the first resonance point speed V1 of a two-phase stepper motor is around 60 RPM, and the second resonance point speed V2 is around 120 RPM. The specific resonance speed of a motor is directly related to its inertia, current, etc., and requires testing to discover the resonance point under different conditions.

The speed relationship between the two resonance points is V2 = 2 * V1. To debug the resonance, the following steps need to be completed:

The first step is to identify two resonance points and determine the velocity range of the resonance region. External pulses or internal pulses can be used to compare and identify the first resonance point, and then maintain the current speed.

Step two, adjust the amplitude and phase of the first resonance point to significantly reduce the resonance of the motor.

Step three, run the motor at the second resonance point and maintain the current speed.

Step four, adjust the amplitude and phase of the second resonance point to significantly reduce the resonance of the motor.

| MODBUS address | Attribute | Default value | Range | Description |
|---|---|---|---|---|
| 120 | R/W | 0 | [0,1500] | The amplitude of the first resonance point |
| 121 | | 0 | [0,1024] | Phase of the first resonance point |
| 122 | | 0 | | Reserve |
| 123 | | 0 | [0,1500] | The amplitude of the second resonance point |
| 124 | | 0 | [0,1024] | The amplitude of the second resonance point |
| 125 | | 0 | | Reserve |
| 126 | | 0 | [0,600] | The initial velocity of the first vibration point |
| 127 | | 0 | [0,600] | The speed of the first vibration point has ended |
| 128 | | 0 | [0,600] | Starting speed of the second vibration point |
| 129 | | 0 | [0,600] | The speed of the second vibration point ends |

## 5.2.18. Closed Loop Control Parameters [130~159]

| MODBUS address | Attribute | Default value | Range | Description |
|---|---|---|---|---|
| 130 | R/W | 300 | [1,5000] | First order speed filtering bandwidth |
| 131 | | 900 | [1,5000] | Second order speed filtering bandwidth |
| 132 | | 2000 | [1,5000] | Second order speed filtering bandwidth |
| 133~149 | | | | Reserve |
| 150 | | 3500 | [500,20000] | Position loop Kp |
| 151 | | 0 | [0,65535] | Position loop Kd |
| 152 | | 40 | [10,500] | Speed loop Kp |
| 153 | | 100 | [0,600] | Speed loop KI |
| 154 | | 0 | [0,65535] | Acceleration feedforward |
| 155 | | 3000 | [0,5000] | Position loop output filtering bandwidth |
| 156 | | 3000 | [0,5000] | Position loop differential output filtering bandwidth |
| 157 | | 500 | [0,5000] | Speed loop output filtering bandwidth |
| 158 | | 80 | [0,100] | Proportion of first-order speed feedback |
| 159 | | Reserve | Reserve | Reserve |

By adjusting the parameters of the position loop and speed loop, it is possible to achieve rigid adjustment of position tracking

## 5.2.19. Speed Table Parameters Setting [205～220]

| MODBUS address | Attribute | Default value | Range | Description |
|---|---|---|---|---|
| 205 | R/W | 0 | [-3000,3000] | Speed table 1, unit: RPM |
| 206 | R/W | 20 | | Speed table 2, unit: RPM |
| 207 | R/W | 30 | | Speed table 3, unit: RPM |
| 208 | R/W | 50 | | Speed table 4, unit: RPM |
| 209 | R/W | 60 | | Speed table 5, unit: RPM |
| 210 | R/W | 80 | | Speed table 6, unit: RPM |
| 211 | R/W | 100 | | Speed table 7, unit: RPM |
| 212 | R/W | 150 | | Speed table 8, unit: RPM |
| 213 | R/W | 200 | | Speed table 9, unit: RPM |
| 214 | R/W | 250 | | Speed table 10, unit: RPM |
| 215 | R/W | 300 | | Speed table 11, unit: RPM |
| 216 | R/W | 400 | | Speed table 12, unit: RPM |
| 217 | R/W | 500 | | Speed table 13, unit: RPM |
| 218 | R/W | 600 | | Speed table 14, unit: RPM |
| 219 | R/W | 700 | | Speed table 15, unit: RPM |
| 220 | R/W | 800 | | Speed table 16, unit: RPM |

# 6. Application Instructions for Motion Control

## 6.1. Pulse Control Mode

T60S/T86S series products use pulse + direction control by default when they leave the factory. The related register settings are as follows:

| Step | Register address | Unit | Value | Parameter description |
|---|---|---|---|---|
| 1 | 17 | --- | 1 | Command mode setting register, set the source of pulse commands for the driver<br>0: Internal pulse command<br>1: External pulse command |
| 2 | 19 | --- | 0 | External pulse command mode setting register<br>0: PUL+DIR mode: PUL is the pulse input port, DIR is the direction input port<br>1: Reserved<br>2: CW+CCW mode: PUL is the CW input signal, DIR is the CCW input signal<br>3: Orthogonal input mode |
| 3 | 110 | mA | 1500mA | \The current of T60S series drivers has been comprehensively optimized by default. Users can further optimize based on this. |
| 4 | 111 | Pulse/rev | 4000 | Default control using 4000 pulses per revolution |

For details, see section 4.3.2

## 6.2. Communication Control Mode

In this mode, users can perform homing, positioning, and speed control movements of the motor through communication

Parameter settings for communication control mode:

| Step | Register address | Unit | Value | Parameter Description |
|---|---|---|---|---|
| 1 | 17 | --- | 0 | Command mode setting register, set the source of pulse commands for the driver<br>0: Internal pulse command<br>1: External pulse command |
| 2 | 20 | --- | 0 | Preset application selection for internal pulse mode<br>0: Communication control: responds to instructions from |

| | | | | |
|---|---|---|---|---|
| | | | | register 18<br>1: Reserved, do not use<br>2: Preset IO control mode 1: start stop + direction<br>3: Preset IO control mode 2: forward rotation + reverse rotation<br>4: Preset IO control mode 3: speed table<br>5: Preset IO control mode 4: position table |
| 3 | 18 | --- | | 0: Waiting state.<br>The driver will restore the bit waiting state after processing any control commands received.<br>1: Fixed length forward rotation.<br>In relative position mode, the motor runs forward according to the 70-74 register parameters.<br>In absolute position mode, the operating status is determined based on the current position and the absolute position set at 70-74.<br>2: Fixed length reverse.<br>In relative position mode, the motor operates in reverse according to the 70-74 register parameters.<br>In absolute position mode, the operating status is determined based on the current position and the absolute position set at 70-74.<br>3: Speed mode, continuous forward rotation.<br>The motor accelerates forward according to registers 75 and 77<br>4: Speed mode, continuous reverse.<br>The motor accelerates in reverse according to registers 75 and 77<br>6: Slow down and stop.<br>Position mode, the motor decelerates and stops according to the 71 register<br>Speed mode, the motor decelerates and stops according to the 76 register<br>9: Trigger homing<br>◆ This register only works when the value of the internal pulse mode register 20 is 0 |

### 6.2.1. PP Position Control Mode

The TxxS series products have the function of communication control motor operation with specified pulse stroke. The specific modes and parameters that need to be set are as follows (register addresses are decimal numbers unless otherwise specified or indicated):

Set the value of register address 20 (preset application selection in internal pulse mode) to 0 (communication control, responding to commands at register address 18);

Set the functions of digital input and output ports according to application needs and actual wiring terminals;

(1) Set motion parameters:

| Address | Unit | Parameter Description |
|---|---|---|
| 70 | R/S^2 | Acceleration of position mode |
| 71 | R/S^2 | Deceleration of position mode |
| 72 | RPM | Speed of position mode |
| 73 | Command Pulse | Number of command pulses for position mode, low 16-bit register |
| 74 | Command Pulse | Number of command pulses for position mode, high 16-bit register |
| 78 | R/S^2 | Set position operation mode:<br>0: Incremental<br>1: Absolute |
| 79 | - | Write 1 and clear the position counter (registers 8 and 9) |

(2) Communication given operation command: start point-to-point movement by writing values 1 (fixed length forward rotation) and 2 (fixed length reverse rotation) to register 18 (for detailed commands on this register, please refer to register 18 in "Driver Control Mode Settings [17-23]");

(3) During operation, if shutdown is required, the value 6 can be written to register 18 (deceleration stop, deceleration is set to the value in register 71)

◆ Attention: Changing the acceleration (register 70), deceleration (register 71), and speed (register 72) during the operation of the motor will not immediately respond to these set values by the driver. It is necessary to trigger them by writing the corresponding commands again to register 18.

### 6.2.2. PV Speed Control Mode

The TxxS series products have the function of controlling the motor's jog operation through communication. The specific modes and parameters that need to be set are as follows (register addresses are decimal numbers unless otherwise specified or indicated):

(1) Set the value of register address 20 (preset application selection in internal pulse mode) to 0 (communication control, responding to instructions at register address 18);

(2) Set the functions of digital input and output ports according to application needs and actual wiring terminals;

(3) Set motion parameters:

| Address | Unit | Parameter Description |
|---|---|---|
| 75 | R/S^2 | Acceleration of Jog motion |
| 76 | R/S^2 | Deceleration of jog motion |
| 77 | RPM | Speed of jog motion |

(4) Communication given operation command: start point-to-point movement by writing values 3 (continuous forward rotation) and 4 (continuous reverse rotation) to register 18 (for detailed instructions on this register, please refer to register 18 in "Driver Control Mode Settings [17-23]");

(5) During operation, if shutdown is required, the value 6 can be written to register 18 (deceleration stop, deceleration is set to register 76).

◆ Attention:

(1) The motor is in operation and only responds to stop commands (deceleration stop or emergency stop). If it is necessary to change the direction of motor operation through instructions, a stop command needs to be sent to wait for the motor to stop before sending a start signal in the other direction.

(2) During the operation of the motor, the speed can be changed (register 77), and the driver will immediately respond, that is, the motor will immediately run at the set speed value without the need to stop and restart before responding.

### 6.2.3. Homing

The TxxS series closed-loop stepper driver products have three working modes: automatic power on homing, communication triggered homing, and IO triggered homing. They support the 17~30 and 35 homing methods defined in CANOPEN

## 6.3. Preset IO Control Mode 1: Start Stop+Direction

The TxxS series closed-loop stepper driver products can control the operation of the motor using two IN ports through this mode. One IN terminal is used to control the start/stop of the motor, and the other IN terminal is used to control the direction of operation of the motor. The specific settings are as follows:

| Step | Register address | Unit | Value | Parameter Description |
|---|---|---|---|---|
| 1 | 17 | --- | 0 | Command mode setting register, set the source of pulse commands for the driver<br>0: Internal pulse command<br>1: External pulse command |
| 2 | 20 | --- | 2 | Preset application selection for internal pulse mode<br>0: Communication control: responds to instructions from register 18<br>1: Reserved, do not use<br>2: Preset IO control mode 1: start stop + direction<br>3: Preset IO control mode 2: forward rotation + reverse rotation<br>4: Preset IO control mode 3: speed table<br>5: Preset IO control mode 4: position table |
| 3 | 60 | --- | 39 | PUL- port (IN1) is set to "7-jog forward rotation / start stop" and normally open;<br>Set to 7 when normally closed. |
| | 61 | --- | 40 | DIR- port (IN2) is set to "8-jog reverse / direction" and normally open;<br>Set to 8 when normally closed. |
| 4 | 75 | R/S^2 | 60 | Acceleration of jog motion |
| | 76 | R/S^2 | 60 | Deceleration of jog motion |
| 5 | 205 | RPM | 100 | Speed of motor operation |

- The acceleration (register 75), deceleration (register 76), and speed (register 205) can be dynamically changed during the operation of the motor, and the driver will immediately respond to these set values.
- The direction signal can be switched during the operation of the motor. At this time, the motor will slow down and stop at the deceleration set in register 76, and then accelerate in the opposite direction to the set speed.

Under the above register settings, connecting 24V to the COM port and controlling the status of PUL-, DIR-, EN- can control the operation of the motor:

| PUL- level | DIR- level | EN- level | Motor status |
|---|---|---|---|
| / | / | 0V | Offline |
| 0V | 24V | 24V | Forward |
| 0V | 0V | | Reverse |
| 24V | 24V | | Not run |
| 24V | 0V | | Not run |

## 6.4. Preset IO Control Mode 2: Forward Rotation+Reverse Rotation

The TXXS series products can control the operation of the motor using two IN ports through this mode. One IN terminal is used to control the start/stop of the motor, and the other IN terminal is used to control the direction of operation of the motor. The specific settings are as follows:

| Step | Register address | Unit | Value | Parameter Description |
|---|---|---|---|---|
| 1 | 17 | --- | 0 | Command mode setting register, set the source of pulse commands for the driver<br>0: Internal pulse command<br>1: External pulse command |
| 2 | 20 | --- | 3 | Preset application selection for internal pulse mode<br>0: Communication control: responds to instructions from register 18<br>1: Reserved, do not use<br>2: Preset IO control mode 1: start stop + direction<br>3: Preset IO control mode 2: forward rotation + reverse rotation<br>4: Preset IO control mode 3: speed table<br>5: Preset IO control mode 4: position table |
| 3 | 60 | --- | 39 | PUL- port (IN1) is set to "7- jog forward/start stop" and normally open;<br>Set to 7 when normally closed. |
| | 61 | --- | 40 | DIR- port (IN2) is set to "8- jog reversel/direction" and normally open;<br>Set to 8 when normally closed. |
| 4 | 75 | R/S^2 | 60 | Acceleration of jog motion |
| | 76 | R/S^2 | 60 | Deceleration of jog motion |
| 5 | 205 | RPM | 100 | Speed of motor operation |

- The acceleration (register 75), deceleration (register 76), and speed (register 205) can be dynamically changed during the operation of the motor, and the driver will immediately respond to these set values.
- The direction signal can be switched during the operation of the motor. At this time, the motor will slow down and stop at the deceleration set in register 76, and then accelerate in the opposite direction to the set speed.

Under the above register settings, connecting 24V to the COM port and controlling the status of PUL-, DIR-, EN- can control the operation of the motor:

| PUL- Level | DIR- Level | EN- Level | Motor status |
|---|---|---|---|
| / | / | 0V | Offline |
| 0V | 24V | 24V | Forward |
| 24V | 0V | | Reverse |
| 24V | 24V | | Not run |
| 0V | 0V | | Not run |

## 6.5. Preset IO Control Mode 3: Speed Table Mode

The TxxS series products can control up to 8 speeds through up to 3 IOs. Usually, the first gear speed is set to 0, indicating that the motor stops when there is no signal input. The relevant register settings are as follows:

| Step | Register address | Unit | Value | Parameter Description |
|---|---|---|---|---|
| 1 | 17 | --- | 0 | Command mode setting register, set the source of pulse commands for the driver<br>0: Internal pulse command<br>1: External pulse command |
| 2 | 20 | --- | 4 | Preset application selection for internal pulse mode<br>0: Communication control: responds to instructions from register 18<br>1: Reserved, do not use<br>2: Preset IO control mode 1: start stop + direction<br>3: Preset IO control mode 2: forward rotation + reverse rotation<br>4: Preset IO control mode 3: speed table<br>5: Preset IO control mode 4: position table |
| 3 | 60 | --- | 46 | PUL- port (IN1) is set to "14- Multi segment speed 0" and normally open;<br>Set to 14 when normally closed. |

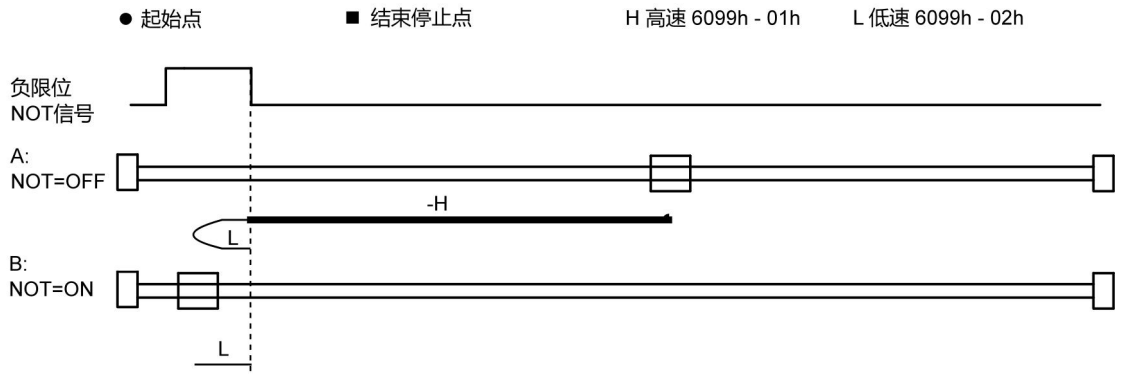
| | | | | |
|---|---|---|---|---|
| | 61 | | 47 | DIR- port (IN2) is set to "15- Multi-segment Speed 1" and normally open;<br>Set to 15 when normally closed. |
| | 62 | | 48 | EN- port (IN3) is set to "16- Multi-segment Speed 2" and normally open;<br>Set to 16 when normally closed. |
| 4 | 75 | R/S^2 | 60 | Acceleration of jog motion |
| | 76 | R/S^2 | 60 | Deceleration of jog motion |
| 5 | 205 | RPM | 0 | Speed table 1 |
| | 206 | | 200 | Speed table 2 |
| | 207 | | -200 | Speed table 3 |
| | 208 | | 300 | Speed table 4 |
| | 209 | | -300 | Speed table 5 |
| | 210 | | 400 | Speed table 6 |
| | 211 | | -400 | Speed table 7 |
| | 212 | | 500 | Speed table 8 |

- The value of the speedometer register is signed 16-bit data, which can be used to achieve forward and reverse operation of the motor by setting the positive and negative values of the speed.

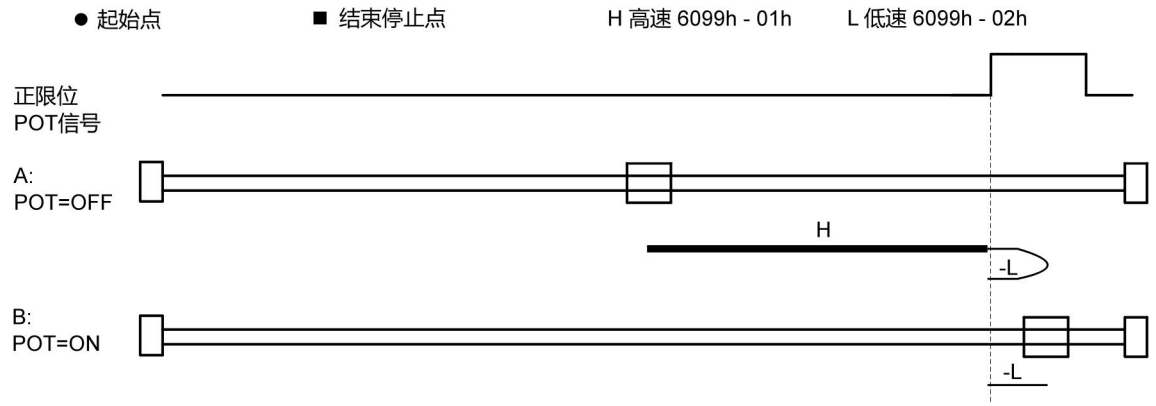
## 6.6. Homing Method

The TxxS series closed-loop stepper driver products have three working modes: power on automatic homing, communication triggered homing, and IO triggered homing. They support the 17~30 and 35 homing modes defined in CANOPEN. The specific process of the homing method is described below.

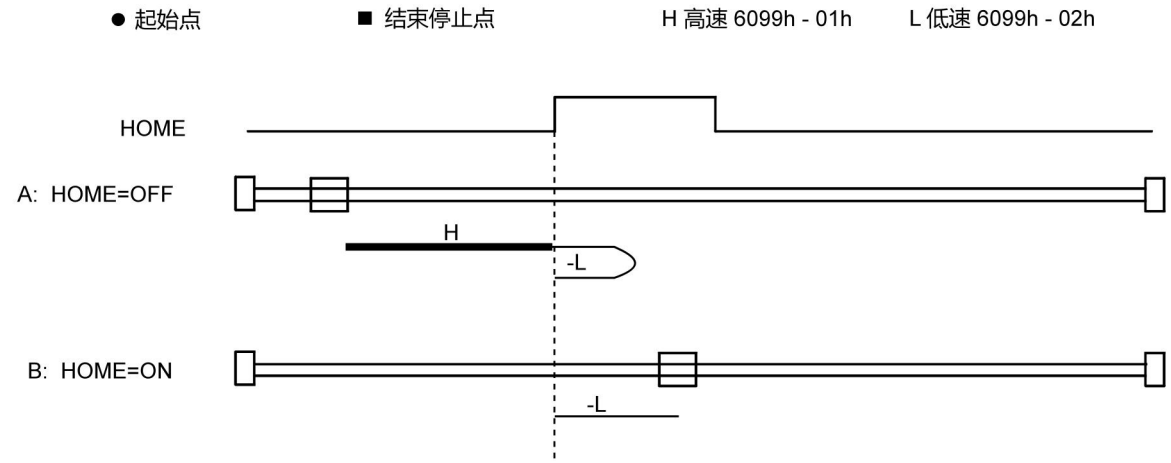
### 6.6.1. Method 17



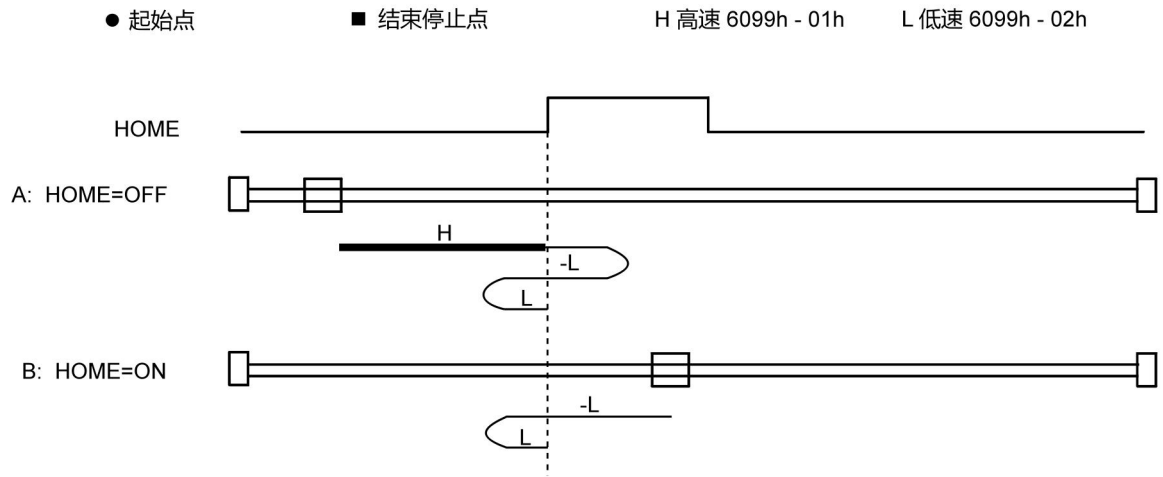
## 6.6.2. Method 18



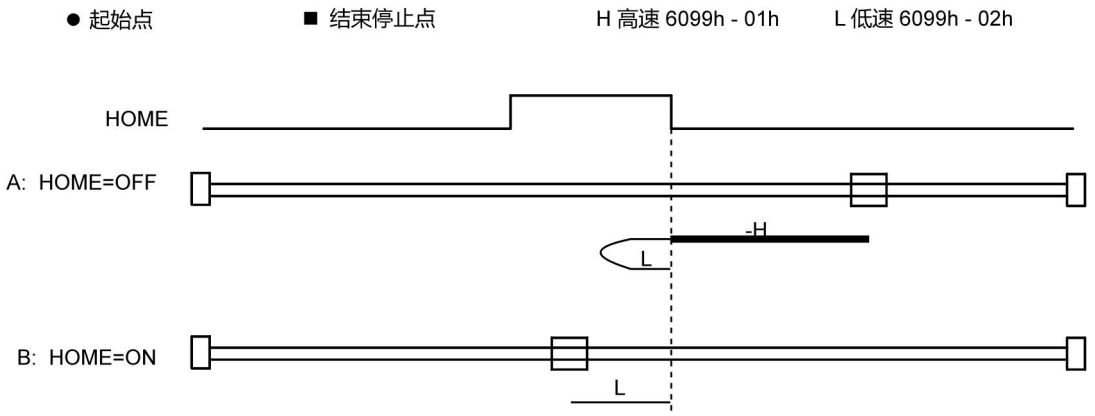

## 6.6.3. Method 19



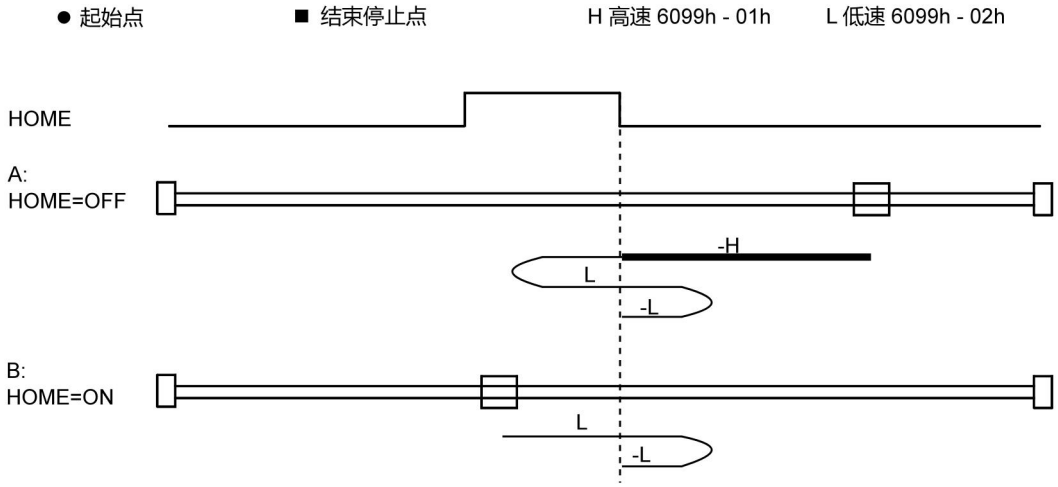

## 6.6.4. Method 20



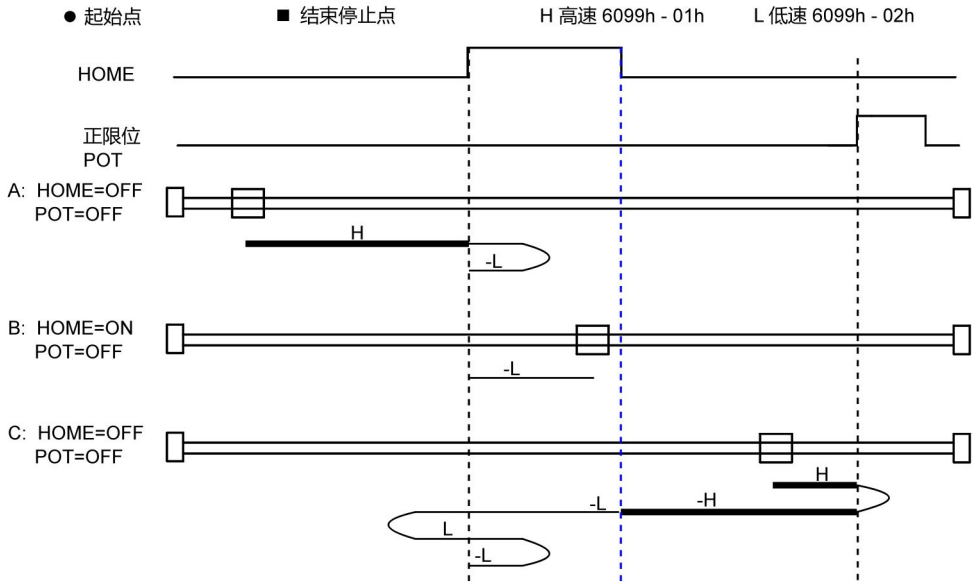
## 6.6.5. Method 21



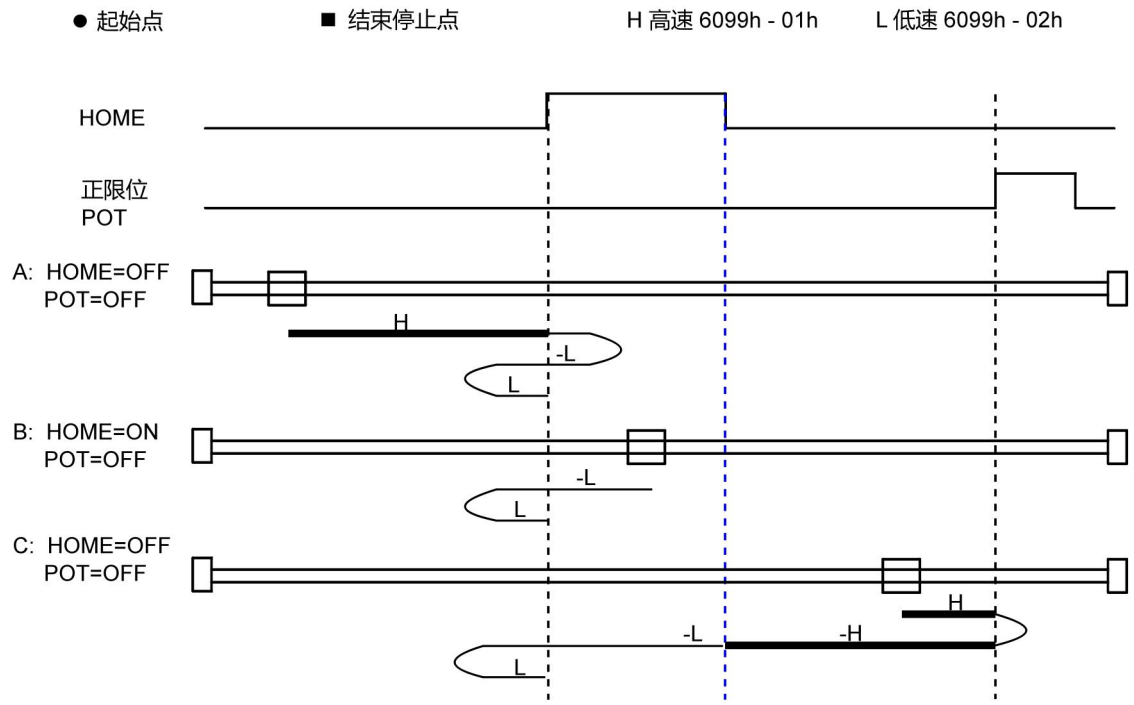

## 6.6.6. Method 22



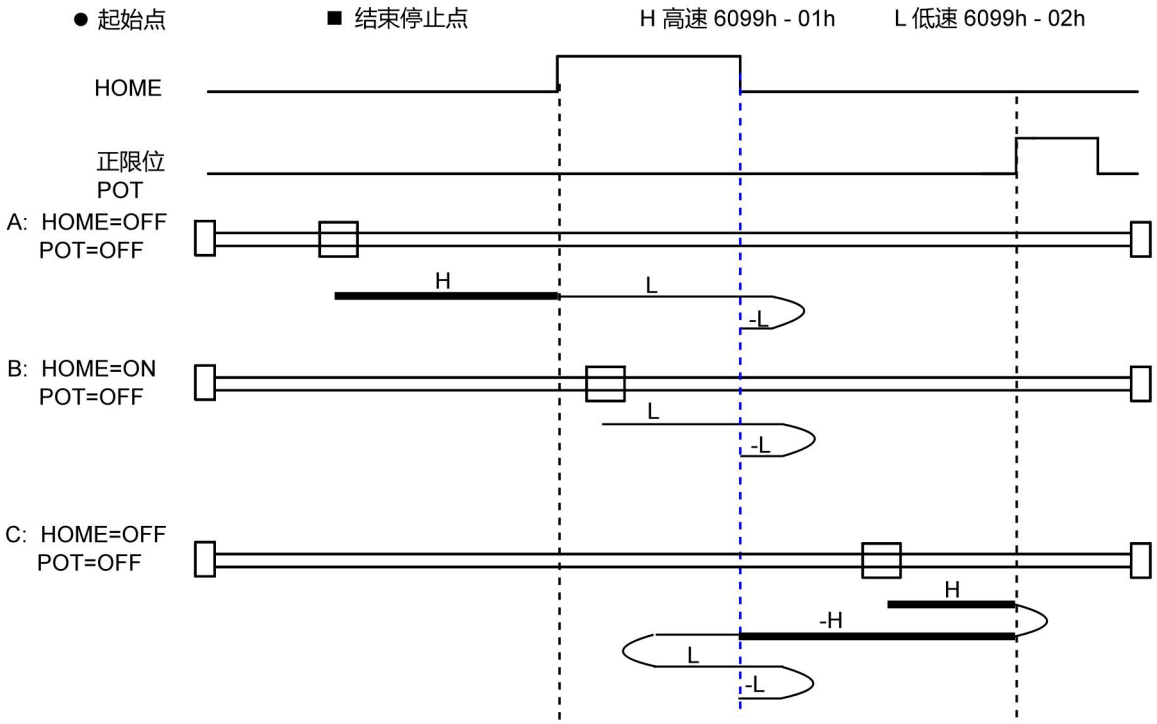

## 6.6.7. Method 23



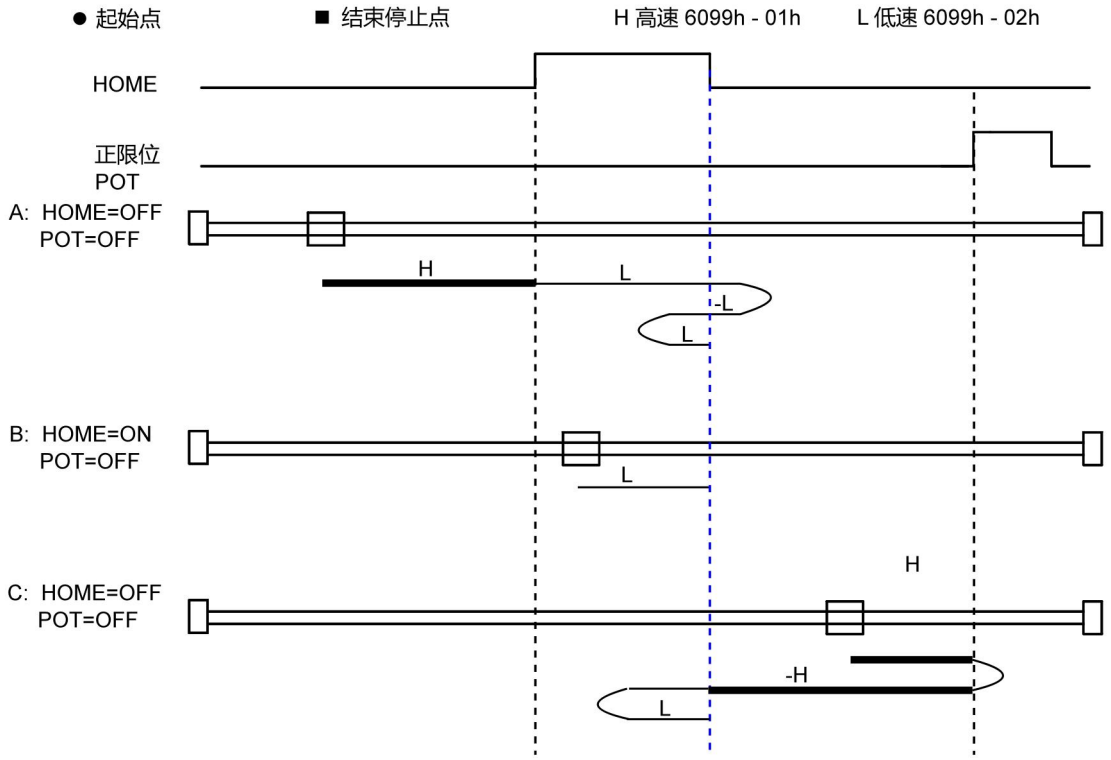
## 6.6.8. Method 24



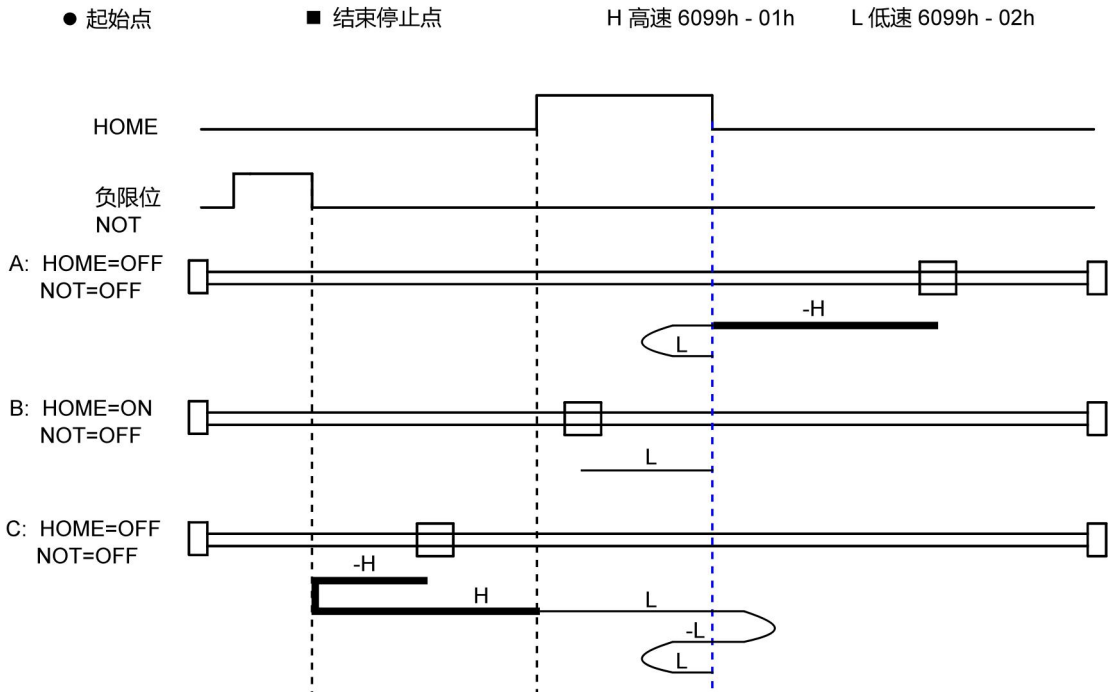

## 6.6.9. Method 25



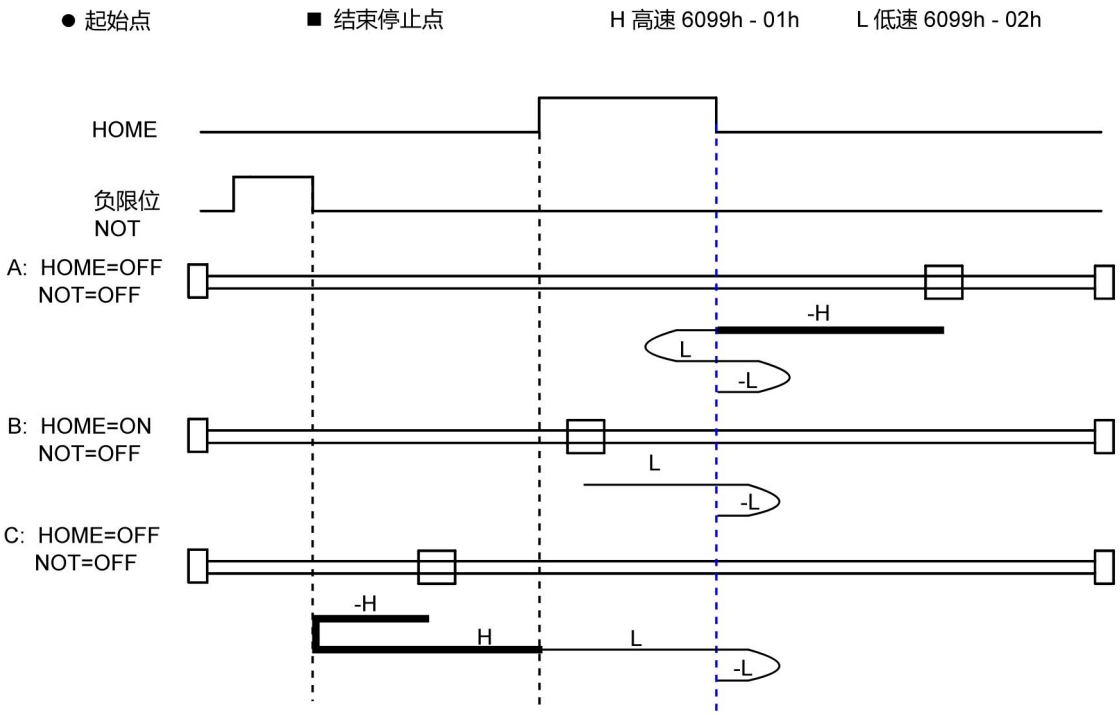
## 6.6.10. Method 26



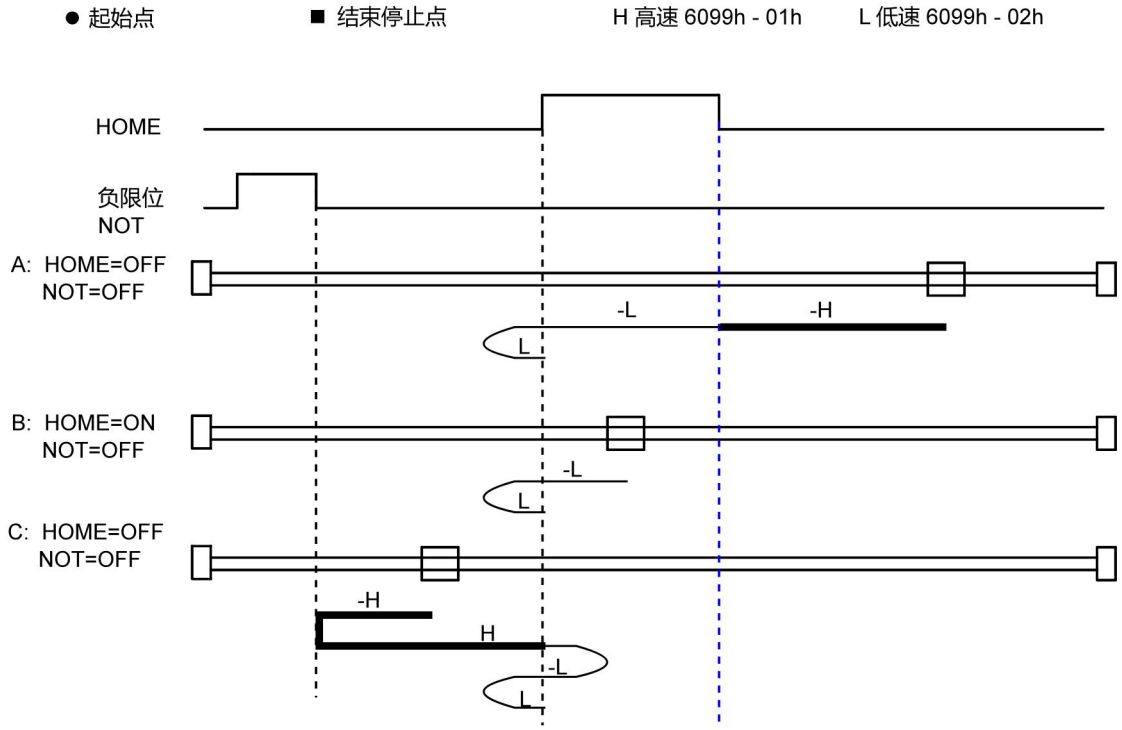

## 6.6.11. Method 27



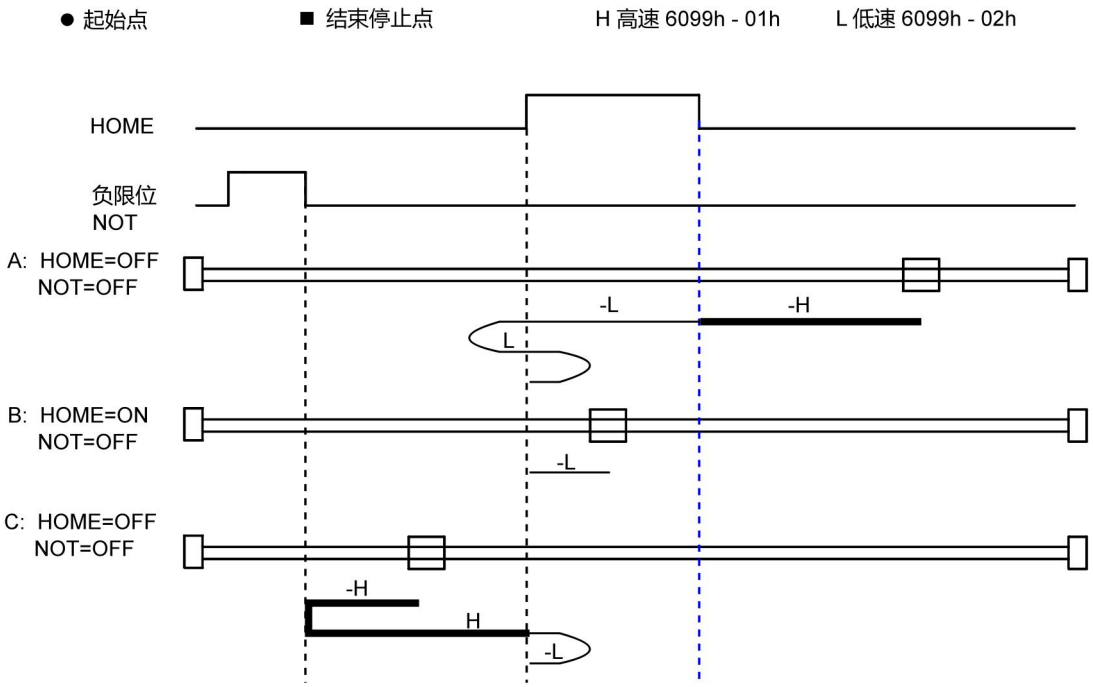
## 6.6.12. Method 28



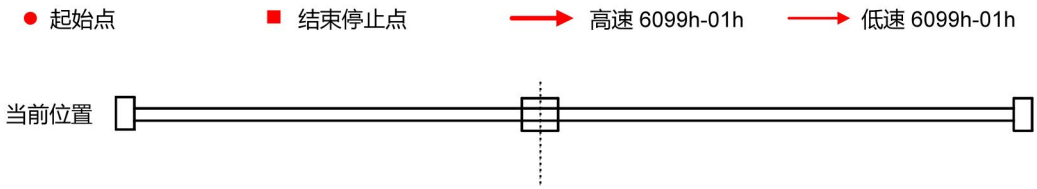

## 6.6.13. Method 29



## 6.6.14. Method 30




## 6.6.15. Method 35



# Appendix A Function Code Message Format

## 1. Function 03: Read and hold register

Query message:

| QUERY | Example(Hex) |
|---|---|
| Field Name | |
| Slave address | 01 |
| Function code | 03 |
| Start address, high 8bit | 00 |
| Start address, low 8-bit | 00 |
| Data length, high 8bit | 00 |
| Data length, low 8-bit | 05 |
| CRC check, low 8-bit | 85 |
| CRC check, high 8-bit | C9 |

Response message:

| RESPONSE | Example(Hex) |
|---|---|
| Field Name | |
| Slave address | 01 |
| Function code | 03 |
| Number of bytes returned | 0A |
| Data, high (Register 40001) | 00 |
| Data, low (Register 40001) | 00 |
| Data, high (Register 40002) | 00 |
| Data, low (Register 40002) | 01 |
| Data, high (Register 40003) | 00 |
| Data, low (Register 40003) | 00 |
| Data, high (Register 40004) | 00 |
| Data, low (Register 40004) | 03 |
| Data, high (Register 40005) | FF |
| Data, low (Register 40005) | FF |
| CRC check, low 8-bit | C5 |
| CRC check, high 8-bit | C6 |

## 2. Function 06: write to a single register

Query message: 01 06 00 12 00 00 29 CF

| QUERY | Example(Hex) |
|---|---|
| Field Name | |
| Slave address | 01 |
| Function code | 06 |
| Address, high 8-bit | 00 |
| Address, low 8-bit | 12 |
| Data, high 8-bit | 00 |
| Data, low 8-bit | 00 |
| CRC check, low 8-bit | 29 |
| CRC check, high 8-bit | CF |

Response message:

| QUERY | Example(Hex) |
|---|---|
| Field Name | |
| Slave address | 01 |
| Function code | 06 |
| Address, high 8-bit | 00 |
| Address, low 8-bit | 12 |
| Data, high 8-bit | 00 |
| Data, low 8-bit | 00 |
| CRC check, low 8-bit | 29 |
| CRC check, high 8-bit | CF |

## 3. Function 16(10 HEX): Write to multiple registers

Query message: 01 10 00 4B 00 04 08 00 64 00 64 02 58 01 F4 86 EC

| QUERY | Example(Hex) |
|---|---|
| Field Name | |
| Slave address | 01 |
| Function code | 10 |
| Start address, high 8-bit | 00 |
| Start address, low 8-bit | 4B |
| Data length, high 8-bit | 00 |
| Data length, low 8-bit | 04 |
| Number of bytes | 08 |
| Data high, (Register 40076) | 00 |
| Data, low (Register 40076) | 64 |
| Data, high (Register 40077) | 00 |
| Data, low (Register 40077) | 64 |
| Data, high (Register 40078) | 02 |
| Data, low (Register 40078) | 58 |
| Data, high (Register 40079) | 01 |
| Data, low (Register 40079) | F4 |
| CRC check, low 8-bit | 86 |
| CRC check, high 8-bit | EC |

Response message:

| QUERY | Example(Hex) |
|---|---|
| Field Name | |
| Slave address | 01 |
| Function code | 10 |
| Start address, high 8-bit | 00 |
| Start address, low 8-bit | 4B |
| Data length, high 8-bit | 00 |
| Data length, low 8-bit | 04 |
| CRC check, low 8-bit | B1 |
| CRC check, high 8-bit | DC |

# Appendix B: Modbus/RTU Abnormal Response and Code

Response and code of NT60 when communication is abnormal

```
// exception code
#define ILLEGAL_FUNCTION  0x01
#define ILLEGAL_DATA_ADD  0x02
#define ILLEGAL_DATA_VAL  0x03
#define DEVICEFAIL        0x04
```

# Appendix C: Modbus/RTU 16-bit CRC Check Routine

The CRC routine is written using the C language specification, making it easy for users to port to various platforms. The CRC_Checksum.c file contains two functions for calculating CRC.

**Using computational CRC method:**

```
    unsigned short CalcCRCbyAlgorithm(unsigned char* pDataBuffer, unsigned long usDataLen)
    {
        /* Use the Modbus algorithm as detailed in the Watlow comms guide */

        const unsigned short POLYNOMIAL = 0xA001;
        unsigned short wCrc;
        int iByte, iBit;

        /* Initialize CRC */
        wCrc = 0xFFFF;

        for (iByte = 0; iByte < usDataLen; iByte++)
        {
            /* Exclusive-OR the byte with the CRC */
            wCrc ^= *(pDataBuffer + iByte);

            /* Loop through all 8 data bits */

            for (iBit = 0; iBit <= 7; iBit++)
            {
                /* If the LSB is 1, shift the CRC and XOR the polynomial mask with the CRC */

                /* Note - the bit test is performed before the rotation, so can't move the << here */
                if (wCrc & 0x0001)
                {
                    wCrc >>= 1;
                    wCrc ^= POLYNOMIAL;
                }
                else
```

```
            {
                /* Just rotate it */
                wCrc >>= 1;
            }
        }
    }

    return wCrc;
}
```

**CRC is calculated using table lookup:**

```
/* Table Of CRC Values */
const unsigned short TABLE_CRC16[] =
{
    0x0000, 0xC0C1, 0xC181, 0x0140, 0xC301, 0x03C0, 0x0280, 0xC241,
    0xC601, 0x06C0, 0x0780, 0xC741, 0x0500, 0xC5C1, 0xC481, 0x0440,
    0xCC01, 0x0CC0, 0x0D80, 0xCD41, 0x0F00, 0xCFC1, 0xCE81, 0x0E40,
    0x0A00, 0xCAC1, 0xCB81, 0x0B40, 0xC901, 0x09C0, 0x0880, 0xC841,
    0xD801, 0x18C0, 0x1980, 0xD941, 0x1B00, 0xDBC1, 0xDA81, 0x1A40,
    0x1E00, 0xDEC1, 0xDF81, 0x1F40, 0xDD01, 0x1DC0, 0x1C80, 0xDC41,
    0x1400, 0xD4C1, 0xD581, 0x1540, 0xD701, 0x17C0, 0x1680, 0xD641,
    0xD201, 0x12C0, 0x1380, 0xD341, 0x1100, 0xD1C1, 0xD081, 0x1040,
    0xF001, 0x30C0, 0x3180, 0xF141, 0x3300, 0xF3C1, 0xF281, 0x3240,
    0x3600, 0xF6C1, 0xF781, 0x3740, 0xF501, 0x35C0, 0x3480, 0xF441,
    0x3C00, 0xFCC1, 0xFD81, 0x3D40, 0xFF01, 0x3FC0, 0x3E80, 0xFE41,
    0xFA01, 0x3AC0, 0x3B80, 0xFB41, 0x3900, 0xF9C1, 0xF881, 0x3840,
    0x2800, 0xE8C1, 0xE981, 0x2940, 0xEB01, 0x2BC0, 0x2A80, 0xEA41,
    0xEE01, 0x2EC0, 0x2F80, 0xEF41, 0x2D00, 0xEDC1, 0xEC81, 0x2C40,
    0xE401, 0x24C0, 0x2580, 0xE541, 0x2700, 0xE7C1, 0xE681, 0x2640,
    0x2200, 0xE2C1, 0xE381, 0x2340, 0xE101, 0x21C0, 0x2080, 0xE041,
    0xA001, 0x60C0, 0x6180, 0xA141, 0x6300, 0xA3C1, 0xA281, 0x6240,
    0x6600, 0xA6C1, 0xA781, 0x6740, 0xA501, 0x65C0, 0x6480, 0xA441,
    0x6C00, 0xACC1, 0xAD81, 0x6D40, 0xAF01, 0x6FC0, 0x6E80, 0xAE41,
    0xAA01, 0x6AC0, 0x6B80, 0xAB41, 0x6900, 0xA9C1, 0xA881, 0x6840,
    0x7800, 0xB8C1, 0xB981, 0x7940, 0xBB01, 0x7BC0, 0x7A80, 0xBA41,
    0xBE01, 0x7EC0, 0x7F80, 0xBF41, 0x7D00, 0xBDC1, 0xBC81, 0x7C40,
    0xB401, 0x74C0, 0x7580, 0xB541, 0x7700, 0xB7C1, 0xB681, 0x7640,
    0x7200, 0xB2C1, 0xB381, 0x7340, 0xB101, 0x71C0, 0x7080, 0xB041,
```

```
    0x5000, 0x90C1, 0x9181, 0x5140, 0x9301, 0x53C0, 0x5280, 0x9241,
    0x9601, 0x56C0, 0x5780, 0x9741, 0x5500, 0x95C1, 0x9481, 0x5440,
    0x9C01, 0x5CC0, 0x5D80, 0x9D41, 0x5F00, 0x9FC1, 0x9E81, 0x5E40,
    0x5A00, 0x9AC1, 0x9B81, 0x5B40, 0x9901, 0x59C0, 0x5880, 0x9841,
    0x8801, 0x48C0, 0x4980, 0x8941, 0x4B00, 0x8BC1, 0x8A81, 0x4A40,
    0x4E00, 0x8EC1, 0x8F81, 0x4F40, 0x8D01, 0x4DC0, 0x4C80, 0x8C41,
    0x4400, 0x84C1, 0x8581, 0x4540, 0x8701, 0x47C0, 0x4680, 0x8641,
    0x8201, 0x42C0, 0x4380, 0x8341, 0x4100, 0x81C1, 0x8081, 0x4040
};

unsigned short CalcCRC_TAB(unsigned char* pDataBuffer, unsigned long usDataLen)
{
    unsigned char nTemp;
    unsigned short wCRCWord = 0xFFFF;

    while (usDataLen--)
    {
        nTemp = wCRCWord ^ *(pDataBuffer++);
        wCRCWord >>= 8;
        wCRCWord ^= TABLE_CRC16[nTemp];
    }

    return wCRCWord;
}
```