AdamPower

User Manual

AR57

MODBUS-RTU

Stepper Motor Controller

SHENZHEN ADAM TECHNOLOGY CO LTD

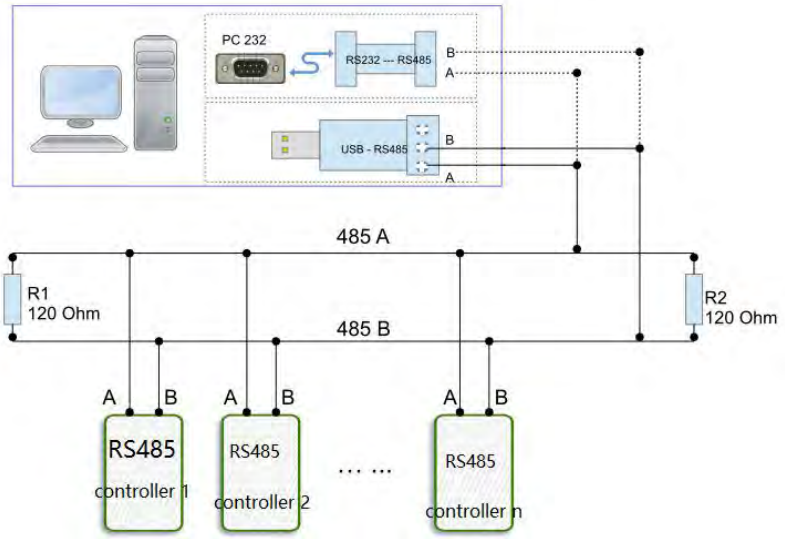
1. Product introduction

1.1. Overview

AR57 is a high-integrated and compact size stepper driver. It adopts standard RS485 communication protocol, can be connected with PLC, HMI, industrial computer and other upper computer with only two communication lines. Up to 32 axes of motion platform networking can be achieved with its built-in motion control commands.

Smooth operation, low noise and controllable temperature of the motor can be ensured by its new control algorithms such as vibration suppression and low heat, with a built-in 32-bit DSP digital chip, and its external dimensions is similar with a 57mm motor(NEMA23).

The maximum output current is 2.2A, which can meet the needs of applications for stepper motor 57 mm(NEMA23) and smaller size. The driver uses micro-segmentation technology to achieve high microstep effects through internal algorithms even under low microstep conditions. The motor works with better performance after optimizing the operating parameters automatically by automatic matching function of theAR57. The drive can be integrated with the NEMA23 stepper motor as an integrated product, helping to miniaturize and reduce wiring of the device.



Network layout

1.2. Features

- Standard RS485 communication protocol compatible with Modbus RTU protocol.
- Multi-axes control, extending up to 32 axes for simultaneous control.
- DC input voltage 20~50VDC, recommended working voltage 24/36VDC.
- Continuous output current 4.0A max, max peak current5.6A.
- Integrated design, mounted with 57/60/86 mm stepper motor.
- Low vibration, low noise, stable operation, low motor heating.
- 24V differential input signal ports(2 limits and 1 stop) 1OC output(peak current100mA).
- Protection functions such as overvoltage, undervoltage and overcurrent.
- Built-in automatic matching function of motor parameter.
- Can be set between 1-256 subdivisions, with uniform motor step spacing; Stable output at 1/12 rpm

1.3. Application

Particularly suitable for small volume, small space, high immunity requirements of various

automated devices and instruments.

For example: electronic processing equipment, electronic assembly equipment, laser equipment, automatic grabbing equipment, packaging equipment and industrial robots. It is especially effective when the user expects a high-stationary, low-noise device.

2. Electrical, Mechanical & Environmental Specifications

2.1. Electrical specifications

Parameters	AR57 (DC24V)			
	min	normal	max	unit
Continuous output current	0	-	5.6	A
Power supply voltage (DC)	+20	+24/36	+50	VDC
Control signal input current	6	10	16	mA
Overvoltage protection voltage	36	38	40	VDC
Insulation resistance	100	-	-	MΩ

2.2. Application environment and parameters

Cooling method		Natural cooling or forced air cooling
Application Environment	environment	Cannot be placed next to other hot devices. Avoid dust, oil mist, corrosive gases, humidity and strong vibration. Forbidden to have flammable gas and conductive dust.
	temperature	-5℃~ +45℃
	humidity	40~90%RH
	vibration	10~55Hz/0.15mm
Storage temperature		-20℃~+65℃

Use altitude	≤1000m
Weight	appr. 60g (incl.the motor)

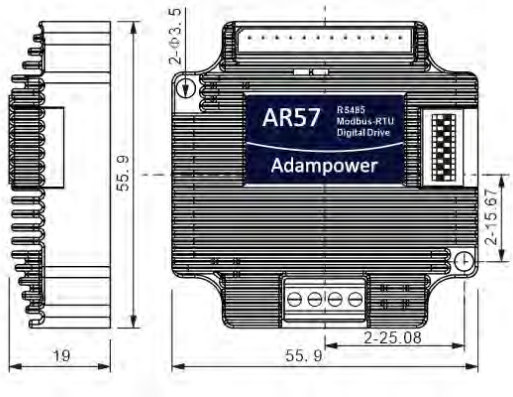
2.3. Product dimension and motor matching

The AR57 driver can be integrated with the 57/60 mm stepper motor. ADAM POWER provides1.0Nm, 2.0Nm, 3.0Nm and other integrated machine products.

The motor parameters can be directly written into the control algorithm, and the motor performance is superior. If only the AR57 driver is required and the equipment has requirements for low-speed vibration, it is recommended to contact us for parameter matching.

Standard integrated stepper motor parameters:

Model	Holding Torque(Nm)	Length(mm)	Features
AR5710	1.0	57-56	1. Save wiring;
AR5720	2.0	57-76	2. Motor parameters
AR5730	3.0	60-90	are written into
			control algorithm;



AR57 driver outline drawing

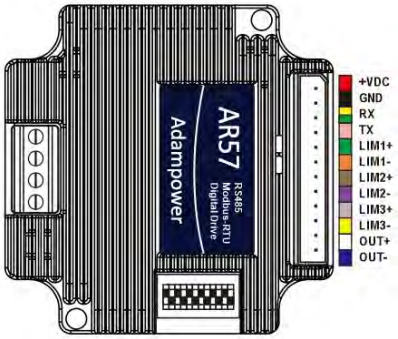
2.4. Heat dissipation precautions

The reliable working environment temperature of the drive is between -5~ 45°C, the drive is within 60°C, the motor is within 70°C. If necessary, install a fan near the drive to ensure that the drive operates within a reliable operating temperature range.

When the driver is integrated with the motor, an insulating flange is recommended to reduce the influence of motor heating on the driver.

3. Drive Interface & Wiring Introduction

3.1 Host computer control signal port

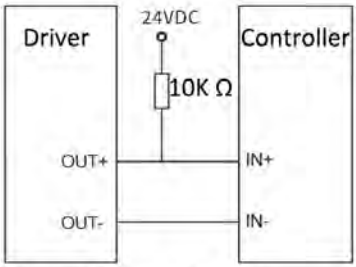


Use 8Pin 2.0mm spacer terminal

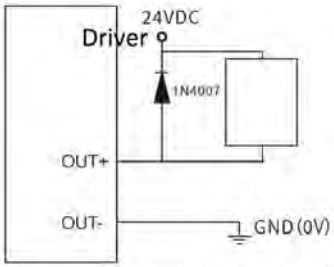
PIN	Definition	Remarks
1	VDC	Positive power input: DC voltage 20-50VDC
2	GND	Negative power input: DC voltage GND
3	RX	RS485 RX
4	TX	RS485 TX
5 6	LIM1+ LIM1-	Positive limit / Forward to 0 signal port, valid for rising edge High level: 24V, Low Level: 0~ 0.5V
7 8	LIM2+ LIM2-	Negattive limit / Reverse to 0 signal port, valid for rising edge High level: 24V, Low Level: 0~ 0.5V
9 10	LIM3+ LIM3-	IO port 3, valid for rising edge, trigger Stop signal. High level: 24V, Low Level: 0~ 0.5V
11 12	OUT+ OUT-	Alarm/In-place/Brake output port, OC circuit, Max. receive 24V, Instantaneous output current of 100mA, continuous output current of 50mA

OUT+/OUT- as defferential output port, Max.receive voltage is DC24V, and instaneous ouput current is 100mA, continuous output current is 50mA.

For protect the port when used to connect the brake,solenoid valve or realy, the Current diodes must be connected at both ends of the device:



Alarm/In-place Output



solenoid valve/relay/brake Output

3.2 Stepper motor ports

Use 4Pin 3.5 spacer screw terminal

PIN	Definition	Remarks
1	A+	Two-phase stepper motor A+ phase
2	A-	Two-phase stepper motor A-phase
3	B+	Two-phase stepper motor B+ phase
4	B-	Two-phase stepper motor B-phase

Note: If the motor lead of A+/A- or B+/B- is exchanged, the initial steering of the motor will be replaced.

3.3 LED status indication

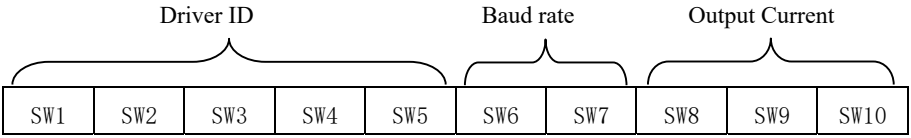
The green LED is the power indicator.

When the drive is powered on, the LED is on.

When the drive is powered off, the LED is off..

4. DIP Switch Setting

The AR57 driver uses a10-digit DIP switch to set the driver ID, communication baud rate and output current. The details as below:



4.1. ID address setting

ID	SW1	SW2	SW3	SW4	SW5
Reserved	ON	ON	ON	ON	ON
1	OFF	ON	ON	ON	ON
2	ON	OFF	ON	ON	ON
3	OFF	OFF	ON	ON	ON
4	ON	ON	OFF	ON	ON
5	OFF	ON	OFF	ON	ON
6	ON	OFF	OFF	ON	ON
7	OFF	OFF	OFF	ON	ON
8	ON	ON	ON	OFF	ON
9	OFF	ON	ON	OFF	ON
10	ON	OFF	ON	OFF	ON
11	OFF	OFF	ON	OFF	ON
12	ON	ON	OFF	OFF	ON
13	OFF	ON	OFF	OFF	ON
14	ON	OFF	OFF	OFF	ON
15	OFF	OFF	OFF	OFF	ON
16	ON	ON	ON	ON	OFF
17	OFF	ON	ON	ON	OFF
18	ON	OFF	ON	ON	OFF
19	OFF	OFF	ON	ON	OFF
20	ON	ON	OFF	ON	OFF
21	OFF	ON	OFF	ON	OFF
22	ON	OFF	OFF	ON	OFF
23	OFF	OFF	OFF	ON	OFF
24	ON	ON	ON	OFF	OFF
25	OFF	ON	ON	OFF	OFF
26	ON	OFF	ON	OFF	OFF
27	OFF	OFF	ON	OFF	OFF
28	ON	ON	OFF	OFF	OFF
29	OFF	ON	OFF	OFF	OFF
30	ON	OFF	OFF	OFF	OFF
31	OFF	OFF	OFF	OFF	OFF

Note: The formula for calculating the ID table is: ID=1*SW1+2*SW2+4*SW3+8*SW4+16*SW5.

The default ID is 0, 0 means broadcast address for global control.

4.2. Communication baud rate setting

Baud Rate	SW6	SW7
9600	ON	ON
38400	OFF	ON
57600	ON	OFF
115200	OFF	OFF

Note: When the communication baud rate in the table cannot meet the usage requirements, the baud rate of the bit can be customized by the host computer when SW6 and SW7 are turned ON.

Output peak current	Output Mean current	SW8	SW9	SW10
Default 1.5A	1.1A	ON	ON	ON
2.1A	1.5A	OFF	ON	ON
2.7A	1.9A	ON	OFF	ON
3.2A	2.3A	OFF	OFF	ON
3.8A	2.7A	ON	ON	OFF
4.3A	3.1A	OFF	ON	OFF
4.9A	3.5A	ON	OFF	OFF
5.6A	4.0A	OFF	OFF	OFF

Default output current: 1.5A, via MODBUS-RTUC command to set any value within range.

5. Communication

The built-in trapezoidal acceleration/deceleration curve generator, which trapezoidal acceleration and deceleration, fixed length operation through communication commands, continuous operation, decelerate to stop, and stop immediately can be realize by. Internal operation supports absolute position mode and relative position mode control, and built-in common zero return function for simplify development. The internal pulse generator uses 32-bit speed, acceleration, and travel to achieve a wide range of trajectories.

5.1. Communication protocol

The communication uses the standard MODBUS protocol and supports 0x03 (read register), 0x06 (write single register), 0x10 (16) (write multiple registers). Serial communication format: baud rate 9600 ~ 115200, 8 data bits, no parity, 1 stop bit.

5.2. MODBUS register address

Add	Item	Details	Default Value	Range	Remarks
0	Peak current	R/W/S	2700	1 ~ 5600	Unit:mA
1	Subdivision	R/W/S	1600	200 ~ 51200	The number of pulses required for the motor to run one revolution.
2	Standby time	R/W/S	300	100 ~ 10000	The time the drive enters standby, unit: ms
3	Standby current percentage	R/W/S	50	0 ~ 100	Unit: %
4	DIP status	R			
5	Reserved	R			
6	Enable level		0	0~1	0: high level enable; 1 Low level enable
7	Enable Motor		0	0~1	0: Disable; 1 Enable
9	Enable FIR filtering		0	0~1	0: Disable; 1 Enable
10	Filtering time	R/W/S	4000	50 ~ 25600	Set the filter filter time: us
11	Encoder feedback	R		0~65535	Closed Loop works only
12	Power-on current	R/W/S	4000	0 ~ 65535	To reduce the vibration of the rotor, unit: 50 us

Add	Item	Details	Default Value	Range	Remarks
13	Current loop auto-tuning enable	R/W/S	1	0/1	Open loop Current loop PI power-on automatic tuning function: 0: not enabled 1: enabled
14	Read Servo mode	R			Closed loop only
15	Current loop Kp	R/W/S	1000	10 ~ 32767	This item is read-only when auto-tuning is enabled; the user can rewrite when it is not enabled.
16	Current loop Ki	R/W/S	200	0 ~ 32767	This item is read-only when auto-tuning is enabled; the user can rewrite when it is not enabled.
17	Reserved	R			
18	Baud rate	R/W/S	96	96~1152	96 represents 9600
19	Broadband		0	0~500	KHZ(0: Don't set broadband)
20	Motor Resistance			0~32767	unit: ohm
21	Motor Inductance			0~32767	unit: mh
24	Control options	S	0	0~2	0: DIP option; 1: Open Loop; 2: Closed Loop
25	Control mode	S	0	0~10	0: DIP option; 1: Lead; 2: PM; 3:FOC
26	Lock shaft current	R/W	50	0~100	Lock shaft current percentage, unit: %
27	current loop gain	R/W	50	0~100	current loop gain adjustment, unit: %
28	Encoder broadband	R/W	0	0~500	KHZ(0: Don't set broadband)
29	Line of encoder	R/W	1000	200~65535	1000 line, means 4000pulses/r
31	Device ID number	R		0~100	Device ID
35	FOC bit position loop Kp	R		0~32766	
36	FOC bit position loop Ki	R		0~32766	
37	FOC bit position loop Rigidity	R		0~32766	
38	FOC bit position loop Kaff	R		0~32766	
39	Total number of pulses low 16bit	R		0~65535	The number of external pulses received; low 16bit
40	Total number of pulses high 16bit	R/W		0~65535	The number of external pulses received, high 16bit, and write 1 clear datas
41	Encoder recorded pulses Low 16bit	R/W		0~65535	Write 1 clear datas
42	Encoder recorded pulses high 16bit	R/W		0~65535	
43	Grating ruler direction	R/W	1	0/1	1: Forward; 0: Reverse
44	Speed Loop Kaff	R		0~32766	
46	Speed Loop Kp	R		0~32766	
47	Speed Loop Ki	R		0~32766	
48	bus voltage	R			Return to bus voltage, 10 means 1V
49	Pulse options	R	0	0/1	0: Pulse& direction; 1: twin pulse
50	Edge options	R	0	0/1	0: rising edge; 1: falling edge
51	Motor running direction	R/W/S	1	0/1	0:CW; 1:CCW
56	Fault detection	R/W		0~65535	Bit0: Overcurrent detection Bit1: Overvoltage detection Bit2: Undervoltage detection Bit7: Position out of tolerance detection Bit11: Operational amplifier fault detection
57	clear fault signal	R	0	0/1	0: disable; 1: enable
58	enable signal current power-on	R/W	6000	0~65535	unit: 50us(1 means 50us)
59~61	Reserved	R			

Add	Item	Details	Default Value	Range	Remarks
62	Deceleration low 16bit	R/W/S	10176	0 ~ 65535	Unit: pulse/s^2
63	Deceleration high 16bit	R/W/S	9	0 ~ 65535	Unit: pulse/s^2
64	Speed Low 16bit	R/W/S	6000	0 ~ 65535	Unit: pulses/s
65	Speed high16bit	R/W/S	0	0 ~ 65535	Unit pulses/s
66	Accelerationlow 16bit	R/W/S	10176	0 ~ 65535	Unit: pulse/s^2
67	Acceleration high 16bit	R/W/S	9	0 ~ 65535	Unit: pulse/s^2
68	Displacement low 16bit	R/W/S	6000	0 ~ 65535	Unit: pulses
69	Displacement high 16bit	R/W/S	0	0 ~ 65535	Unit: pulseS
70	Motion Command	R/W	0	0~5	Trigger the corresponding motion, then the address becomes 6 0—Deceleration stop 1—Positive fixed length motion 2—reverse fixed length motion 3—forward continuous motion 4—reverse continuous motion 5—stop immediately 6—default value, meaningless
71	Zero return command	R/W	0	0~2	0—Exit zero return mode 1—zero return by positive limit signal 2—zero return by negative limit signal
72	Displacement control	R/W	0	0/1	0: incremental mode 1: absolute mode
73	Input port trigger method	R/W/S	67		bit0- LIM1 port bit1-LIM2 port bit6-Lim3 port 0-normally closed, High level trigger 1-normally opeon,low level trigger
74	Read Input port trigger polarity	R/W/S	0	0~1	0: ineffective; 1: effective
75	Register status	R		bitX	bit0-Overcurrent bit1-Overvoltage bit2-In place signal bit3-zero return completed bit4-Positive limit effective bit5-Negative limt effective bit7- internal pulse completed, see 2.2 table
76	Output port function	R/WS	0	0~3	0-Alarm output 1-In place output 2-brake control 3-Set as need
77	Output port polarity	R/WS	0	0~1	effective to #76: alarm/in-place output; 0-normally open; 1-normally closed
78	Output port level	R/WS	0	0~1	effective to#76 set as need, 0-low vel, disconnected; 1-high level, connected
82	Zero return Speed 1 low 16bit	R/W/S	12000	0 ~ 65535	Zero return mode, before reach **0**'s speed, Unit: pulses/s
83	Zero return Speed 1 high 16bit	R/W/S	0	0 ~ 65535	
84	Zero return Speed 2 low 16bit	R/W/S	100	0 ~ 65535	Zero return mode, after through **0**'s speed, Unit: pulses/s
85	Zero return Speed 2 high 16bit	R/W/S	0	0 ~ 65535	
86	Zero return acceleration low 16 bit	R/W/S	3200	0 ~ 65535	Unit: pulse/s^2
87	Zero return acceleration high 16 bit	R/W/S	4	0 ~ 65535	Unit: pulse/s^2
88	Zero return Limit filtering time	R/W/S	10	0~65535	unit: 50us(1 means 50us)
90	Save parameters	R/W	0	0/1	Write 1 to Save current parameters, return 0: Not saved; return 1: saved
91	Restore factory settings	R/W	0	0/1	Write 1 to Clear current parameters, return 0: unclear; return 1: cleared
93	Clear faults	R/W	0	0/1	Write 1 to Clear faults, (can't clear if currently faults state)
94~150	Reserved	R			

5.3. Drive Control Register

Bit definition	Name description	Default value	description
9~15	Reserved	0	
8	IO trigger level polarity	0	**Edge trigger mode:** 0: Optocoupler does not conduct ---> start when turned on Optocoupler conduction ---> stop when not conducting 1: The optocoupler does not conduct ---> stop when turned on Optocoupler conduction ---> start when not conducting Level mode: 0: The optocoupler is turned on and held up The optocoupler does not conduct and stops when held 1: The optocoupler is turned on and stopped when held The optocoupler does not conduct and is activated when it is held
7	IO trigger mode: edge/level selection	0	0——ENA port edge trigger mode 1——ENA port level trigger mode
6	IO trigger motion enable	1	0 - ENA port has no effect 1 - ENA port can trigger motion
2~5	Reserved	0	no
1	Negative limit signal level	1	0—Negative limit occurs when the optocoupler is turned off 1—The negative limit occurs when the optocoupler is turned on.
0	Positive limit signal level	1	0—The positive limit occurs when the optocoupler is turned off. 1—The positive limit occurs when the optocoupler is turned on.

#73 Input port trigger mode and definitions

Bit definition	Name description	Default value	description
7~15	Reserved	0	Reserved
6	LIM3 Status	1	1——Normally open, Low level trigger 0——Normally closed, high level trigger
2~5	Reserved	0	0
1	LIM2 Status	1	1——Normally open, Low level trigger 0——Normally closed, high level trigger
0	LIM1 Status	1	1——Normally open, Low level trigger 0——Normally closed, high level trigger

#75 Driver Registrer Status

Bit definition	Name description	Default value	description
8~15	Reserved	0	Reserved
7	Movement completed	1	1——Internal pulse transmission completed 0——internal pulse is not completed
6	Reserved	0	0
5	Negative limit	0	0——no negative limit signal 1——have negative limit signal
4	Positive limit	0	0——no negative limit signal 1——have negative limit signal
2~3	Reserved	0	
1	Overpressure	0	0 - no overpressure 1 - Overpressure occurs
0	Overcurrent	0	0 - no overcurrent 1 - Overcurrent occurs

5.5 Return to zero function

Return to zero with the positive limit signal as zero

The process of returning to zero after registering "1" to register address 71 (zero return command) as follows:

Runing trajectory A: limit signal is not triggered when you send zero-return command:

Step 1: Run forward to the positive limit with the zero-return speed 1,

(speed and acceleration set by regsiter add#82-83, 86-87)

Step 2: After detecting the positive limit signal, decelerate and run reverse.

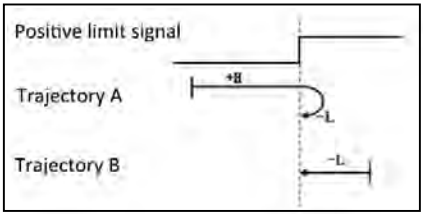
Step 3: Run revrse with zero-return speed 2(set by register84-85),

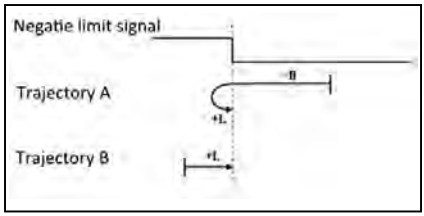
after detecting the positive limit falling edge, Stop, Zero return completed.

Runing trajectory B: limit signal has been triggered when you send zero-return command:

Start Zero return command, Motor run reverse with zero-return speed 2(set by register 84-85),

after detecting the positive limtit falling edge, Stop, Zero return completed.





Return to zero with the Negative limit signal as zero

The process of returning to zero after registering "2" to register address 71 (zero return command) as follows:

Runing trajectory A: limit signal is not triggered when you send zero-return command:

Step 1: Run forward to the negative limit with the zero-return speed 1,

(speed and acceleration set by regsiter add#82-83, 86-87)

Step 2: After detecting the negative limit signal, decelerate and run reverse.

Step 3: Run revrse with zero-return speed 2(set by register84-85),

after detecting the negative limit falling edge, Stop, Zero return completed.

Runing trajectory B: limit signal has been triggered when you send zero-return command:

Start Zero return command, Motor run reverse with zero-return speed 2(set by register 84-85),

after detecting the negative limtit falling edge, Stop, Zero return completed.

5.5.3 Exit back to zero:

After the "0" is written to the register address 71 (return to zero command), the drive exits the zero

return process and decelerates to a stop.

After completing the zero return, the customer can clear the pulse counter by writing a 1 to the register address 40 as needed (as in absolute position mode).

5.4 MODBUS Common function code

5.4.1 Read Holding Registers command 0x03

Host->slave data

Device address	function code	Register address		Number of read registers		CRC check	
01	03	00	00	00	01	85	0A

Slave->host data

Device address	function code	Return bytes	Number of registers		CRC check	
01	03	02	0A	8C	BF	41

The slave return current value (register address 00) is 2700 mA.

5.4.2 Write a single register command 0x06

Host->slave data

Device address	Function-code	Register add		Data input		CRC check	
01	06	00	40	06	40	8A	4E

Slave->host data

Device address	Function-code	Register add		Data input		CRC check	
01	06	00	40	06	40	8A	4E

Write 1600 pulses/s to the slave's speed of 16 bits, register address 64(0x0040).

5.4.3 Write multiple register commands 0x10

Host -> slave data

Device add	Function code	Starting add		Input no.		bytes no.	Input contents		Input contents		CRC check	
01	10	00	44	00	02	04	38	80	00	01	3B	24

Host -> slave data

Device add	Function code	Starting add		Input no.		CRC check	
01	10	00	44	00	02	01	DD

Write 0x3880 (14464) to the lower 16bit register address 0x0044(64), and write 0x0001 to the 16-bit high register address 0x0045(65), that is, the total displacement is 14465+65536=80000 pulses

5.5 CRC check routine

The following routine calculates the CRC in C language

```
Uint16 Funct_CRC16(unsigned char * puchMsg, Uint16 DataLen)
{
Uint16 i,j,tmp;
Uint16 crcdata=0xFFFF;
for(i=0;i<DataLen;i++)
{
crcdata=(*puchMsg)^crcdata;
puchMsg++;
for(j=0;j<8;j++)
{
tmp=crcdata&0x0001;
crcdata=crcdata>>1;
if(tmp){
crcdata=crcdata^0xA001;
}
}
}
returncrcdata;
}
```

5.6 Communication error codes

There are four possible situations in the communication process:

1. The communication is normal, the drive can receive and return information normally.

2. The driver cannot receive the information of the host normally due to communication error. At this time, the host performs timeout processing.

3. The drive receives the data, but an error is detected (such as a CRC error, the frame length is incorrect), the drive does not return information, and the host does timeout processing.

4. The driver receives the normal MODBUS frame, but the driver cannot handle it correctly (such as unsupported function code, unsupported register address, etc.), at which point the drive returns the corresponding fault information.

Format of returning the fault information: slave address + function (0x80 + function code) + fault code + CRC low + CRC high.

Error code	Name	Remarks
01	Illegal function code	This drive only supports 0x03, 0x06, 0x10 function code
02	Illegal register address	If the written register address is out of range. In addition to the listed registers, some addresses are reserved for testing, and customers should not operate other registers.
03	Illegal data	If the 03 function reads more than 100 data at a time, the drive reports this fault. There are restrictions on the data range of some registers inside the drive. Please follow the instructions.

Feedback:

More question or requirement about the integrated stepper motors, please contact us directly.

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