STM Series Integrated Stepper Motor

Modbus Communication User Manual (Closed Loop)

Version No.A

NiMotion Control Technology Co., LtdContent

Content

1 About the manual

1.1 Introduction

This manual explains how to program and operate the STM series integrated stepper motor manufactured by Beijing NiMotion Control Technology Co., Ltd.

1.2 Scope of Application

It is applicable to the STM series integrated stepper motors based on RS-485 communication.

2 Communications Network

2.1 Modbus Overview

The communication mode of the Modbus protocol is of the single-master/multi-slave type. Only the master station can send out queries (inquiries). The slave stations carry out the processing as required by the queries and reply with response messages.

2.2 Modbus-RTU Transmission Mode

When the device uses the RTU (Remote Terminal Unit) mode for Modbus serial link communication, each 8-bit byte in the message contains two 4-bit hexadecimal characters. The main advantage of this mode is a higher data density, with a higher throughput at the same baud rate compared to ASCII mode. Each message must be Sendted as a continuous stream of characters.

Frame Description:

Table2-1

Child Node Address	Function Code	Digital	CRC
1 byte	1 byte	0 to 252 bytes	2 bytes CRC low CRC High

The message frame is distinguished by an idle interval of at least 3.5 character time, called t3.5, and this module adopts the standard t3.5 as the idle interval distinction. the RTU frame transmission idle interval distinction diagram is shown in Figure 1.

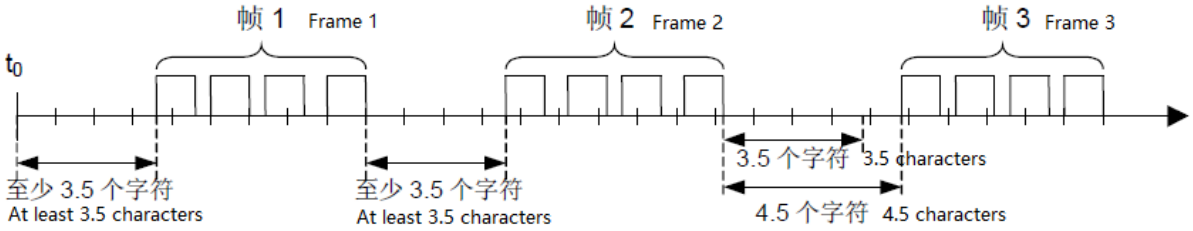

Figure 2-1

If the idle interval between two characters is greater than 1.5 character times, the message frame is considered incomplete and should be discarded by the receiving node. This idle time is called t1.5, and this module adopts the standard t1.5 time. The schematic diagram for determining abnormal frame idle intervals in RTU frame transmission is shown in Figure 2-2.

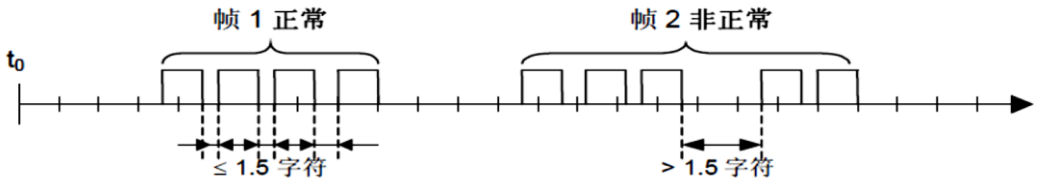

Figure 2-2

2.3 Data Type

Modbus is based on a series of data models on tables with different characteristics. The two basic tables are:

Table2-2

Basic Forms	Object Type	Type of Access	Element
Input register	16-bit	read-only	The I/O system provides this type of data
Holding register	16-bit	Read and write	Changing this type of data through the application

2.4 Modbus-RTU Function Code

Table 2-3

	Function Code Name	Function Code	Sub-function Code	Broadcast Message
16-bit access	Read Input Register	0x04	-	unsupported
	Read Holding Register	0x03	-	unsupported
	Write Single Register	0x06	-	supported
	Write multiple registers	0x10	-	supported
	Read Input Register	0x04	-	unsupported
Diagnosis	Return the query data	0x08	0x0000	unsupported
	Restart the communication options	0x08	0x0001	supported
	Forced only listening mode	0x08	0x0004	supported
	Clear the counter and diagnostic register	0x08	0x000A	supported
	Return the bus message count	0x08	0x000B	unsupported
	Return the bus communication error count	0x08	0x000C	unsupported
	Return the abnormal error count of the child node	0x08	0x000D	unsupported
	Return the message count of the child node	0x08	0x000E	unsupported
	Return the count of no response from the child node	0x08	0x000F	unsupported
	Return the NAK count of the child node	0x08	0x0010	unsupported
	Return the busy count of the child node	0x08	0x0011	unsupported
	Return the bus character overflow count	0x08	0x0012	unsupported
	Error register (Manufacturer's custom)	0x08	0x0015	unsupported
	The number of alarms for incorrect memory (Manufacturer's custom)	0x08	0x0016	unsupported

	Error memory (Manufacturer's custom)	0x08	0x0017	unsupported
	Clear the error memory (Manufacturer's custom)	0x08	0x0018	unsupported
	The current error alarm value (Manufacturer's custom)	0x08	0x0019	unsupported
	Hardware self-check (Manufacturer's custom)	0x08	0x001A	supported

2.5 Modbus-RTU Common Function Code

2.5.1 Read Holding Register (0x03)

Read the current value of the baud rate $0x0001_h$.

request message

Table 2-4

Slave Address	Function Code	Register Address	Number of Registers	CRC Value
01	0x03	00 01	00 01	-

response message

Table 2-5

Slave Address	Function Code	Byte Count	Register Value	CRC Value
01	0x03	02	00 00	-

The current baud rate value is 0 (9.6kbps).

2.5.2 Read Input Register（0x04）

Read the value of input voltage 0x0017.

request message

Table 2-6

Slave Address	Function Code	Register Address	Number of Registers	CRC Value
01	0x04	00 17	00 01	-

response message

Table 2-7

Slave Address	Function Code	Byte Count	Register Value	CRC Value
01	0x04	02	00 18	-

The current input voltage value is 0x0018(24V).

2.5.3 Write Single Holding Register(0x06)

Set the baud rate 0x0001 of slave address to 0x01 (9.6kbps).

request message

Table 2-8

Slave Address	Function Code	Register Address	Register Value	CRC Value
01	0x06	00 01	00 01	-

Response message

Table 2-9

Slave Address	Function Code	Byte Count	Register Value	CRC Value
01	0x06	00 01	00 01	-

2.5.4 Write multiple holding registers(0x10)

Set the baud-rate of the hold register 0x0001 of slave address 0x01 to 0x01(9.6kbps) and the network data format of the hold register 0x0002 to 0x00(8 data bits, parity bit, 1 stop bit).

request message

Table 2-10

Slave Address	Function Code	Register Address	Number of Registers	Byte Count	Register Value	CRC Value
01	0x10	00 01	00 02	04	00 01 00 00	-

Response message

Table 2-11

Slave Address	Function Code	Register Address	Number of Registers	CRC Value
01	0x10	00 01	00 02	-

2.5.5 Write and read multiple holding registers(0x17)

Read the holding register of slave address 0x01 and write the holding register 0x0002 of slave address 0x01 to 0x02(8 data bits, parity bit, 1 stop bit).

Request message

Table 2-12

Slave Address	Function Code	Read the starting address	Read the number of registers	Write the starting address	Write the number of registers	Write the number of bytes	Write the register Value	CRC value
01	0x17	00 01	00 01	00 02	00 01	02	00 02	-

Response message

Table 2-13

Slave Address	Function Code	Byte count	Read the register Value	CRC Value

01	0x17	02	00 00	-

2.5.6 Diagnosis(0x08)

It is used to inspect the communication system between the master station and the slave station, or to check various internal error states in the slave station.

An example of diagnosing and restarting communication

Request message

Table 2-14

Slave Address	Function Code	Sub-function Code	Data	CRC Value
01	0x08	00 01	00 00	-

Note: Except for the diagnostic sub-function codes 0x0000 and 0x0001, the data part of other functions is fixed at 0x00000.

Response message

Table 2-15

Slave Address	Function Code	Sub-function Code	Data	CRC Value
01	0x08	00 01	00 00	-

List of supported diagnostic sub-function codes.

Table 2-16

	Name of Function Code	Function Code	Sub-function Code	Data length
Diagnosis	Return the query data	0x08	0x0000	Unlimited length
	Restart the communication options	0x08	0x0001	2 bytes
	Forced only listening mode	0x08	0x0004	2 bytes
	Clear the counter and diagnostic register	0x08	0x000A	2 bytes
	Return the bus message count	0x08	0x000B	2 bytes
	Return the bus communication error count	0x08	0x000C	2 bytes
	Return the abnormal error count of the child node	0x08	0x000D	2 bytes
	Return the message count of the child node	0x08	0x000E	2 bytes
	Return the count of no response from the child node	0x08	0x000F	2 bytes
	Return the NAK count of the child node	0x08	0x0010	2 bytes
	Return the busy count of the child node	0x08	0x0011	2 bytes
	Return the bus character overflow count	0x08	0x0012	2 bytes
	Error register (Manufacturer's custom)	0x08	0x0015	2 bytes
	The number of alarms for incorrect memory (Manufacturer's custom)	0x08	0x0016	2 bytes
	Error memory (Manufacturer's custom)	0x08	0x0017	32 bytes

	Clear the error memory (Manufacturer's custom)	0x08	0x0018	2 bytes
	The current error alarm value (Manufacturer's custom)	0x08	0x0019	2 bytes
	Hardware self-check (Manufacturer's custom)	0x08	0x001A	2 bytes

2.6 Communication Exception Response

When a master device sends a request to a slave device, the master expects a normal response. The master's query may result in one of the following four events:

- If the slave device receives the request without communication errors and can handle the query normally, then the slave device will return a normal response.
- If the slave does not receive the request due to a communication error, the response cannot be returned. The master program will process it as a timeout.
- If the slave receives a request but detects a communication error (parity, CRC...), then no response can be returned. The master program will be processed on timeout.
- If the slave device receives a request for no communication error, but cannot process the request (e.g., if requesting a read of a non-existent input register), then the slave will return an exception response informing the client of the cause of the error.

The exception response message has two fields that are different from the normal response message:

Function Code Field:

In a normal response, the slave assigns the function code of the original request in the function code field of the response. All function codes have an MSB of 0 (they all have values below hex 80). In an exception response, the slave sets the MSB of the function code to 1. This makes the function code value in the exception response hex 80 higher than the function code value in the normal response.

By setting the function code MSB, the master's application program recognizes the exception response and can detect the data fields of the exception code.

Data Fields:

In a normal response, the slave can return data or statistical values (any information requested in the request) in the Data field.

In an exception response, the slave returns an exception code in the data field. This indicates the reason for the exception.

The exception response message for all supported function codes is the function code plus 0x80.

All exception function codes are 0x83, 0x84, 0x86, and 0x90.

The exception response message corresponding to function code 0x06 is as follows:

Table 2-177

Slave Address	Function Code	Exception Code	CRC Value
01	0x86	01	-

Table2-188

Exception Code	Exception Name	Description
01	Illegal function code	Function code cannot be recognized, not within 0x00~0x0F.
02	Illegal data address	The data address exceeds the definition.
03	Illegal data value	Values outside of register storage
04	Slave equipment failure	Generate non-recapturable errors
05	Recognize	Slaves take longer to process, requiring frequent interrogation by the master
06	Slave equipment busy	Wait for the host to send a request while the slave device is idle
12	Slave equipment alarm	Alarm exists for current motor status.

2.7 Communication Parameter Configuration

2.7.1 Baud Rate Setting

The communication rate of the device can be changed by setting the communication baud rate register of the RS-485 communication interface, but the parameters need to be saved after setting the baud rate, and will take effect after the device is next powered on or rebooted.

The index corresponding to the baud rate parameter is 0x0001, and the function codes of the operable holding registers are 0x03, 0x06, 0x10 and 0x17. The factory baud rate default value is 115.2Kbps.

Example of setting the communication baud rate of the slave address to 115.2 Kbps.

Request messages sent

Table 2-19

Slave Address	Function Code	Register Address	Register Value	CRC Value
01	0x06	00 01	00 05	-

Response message

Table 2-20

Slave Address	Function Code	Register Address	Register Value	CRC Value
01	0x06	00 01	00 05	-

Saving the set communication baud rate parameter

Request messages sent

Table 2-21

Slave Address	Function Code	Register Address	Register Value	CRC Value
01	0x06	00 08	73 76	-

Response message

Table 2-22

Slave Address	Function Code	Register Address	Register Value	CRC Value
01	0x06	00 08	73 76	-

Table of setting values and correspondence with baud rate:

Table 2-23

Hexadecimal	Baud Rate
1	Baud rate adaptive (1 to 8)
2	19.2kbps
3	38.4 kbps
4	57.6kbps
5	115.2kbps
6	256kbps
7	500kbps
8	1Mbps
9	1.5Mbps

2.7.2 Node ID

The address of the device can be set by setting the slave address 0x0000, and the range of setting is 1~247. The factory default slave address is 0x01. After the successful setting of the slave address, it is necessary to save the parameter setting, and it will take effect after the device is powered on or rebooted next time.

2.7.3 Network Data Format

The network data format for device communication is changed by setting the network data format 0x0002. The corresponding table of setting values is shown in the table below.

Table 2-24

Hexadecimal	Descriptive
0	8 data bits, even parity, 1 stop bit
1	8 data bits, odd parity, 1 stop bit
2	8 data bits, no parity, 1 stop bit
3	8 data bits, no parity, 2 stop bits

After changing the network data format of the device communication, the saving parameter Settings need to be made, which will take effect after the device is powered on or restarted next time. For specific operations, refer to the baud rate Settings.

2.7.4 Terminal Resistance

During the network construction process, if the network is embedded and connected to other Modbus devices, a 120-ohm terminal matching resistor needs to be connected at the end of the network.

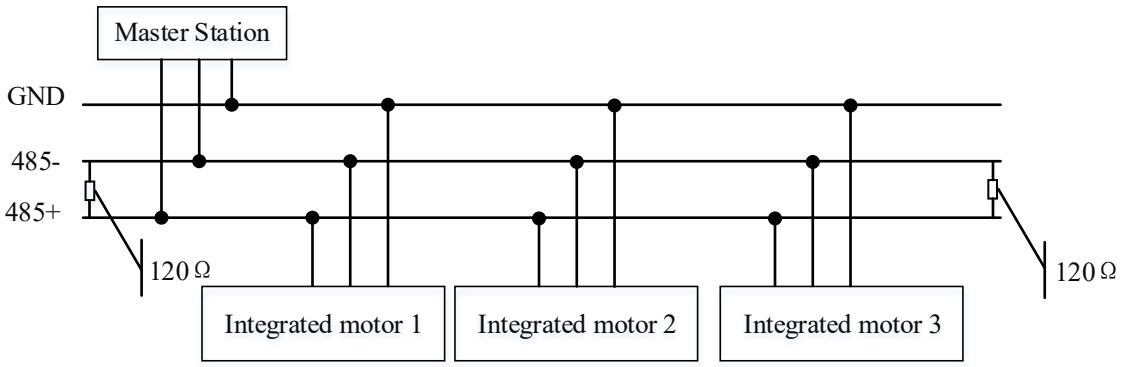

Figure 2-2

2.7.5 Factory parameter restoration

When the communication parameters of the motor are uncertain, the factory Settings can be restored by preemption through broadcast messages after power-off and restart. The broadcast preemption request message must be sent within one second before the motor is powered on. After a successful preemption, the RUN indicator light will flash. After successful preemption, the communication parameters of the motor are restored to factory Settings, that is, the slave address is equal to 1, the baud rate is equal to 115200, the parity bit is zero, there are 8 data bits and 1 stop bit. The motor serial number adopts a hexadecimal byte order with the higher byte first.

Table 2-25

Slave Address（1B）	Function Code（1B）	Motor Serial Number（4B）	CRC Value（2B）
0x00	0xC2	0x00 00 00 00	-

There is no response message for the broadcast message. It is necessary to determine whether the operation was successful by querying the status.

3 Motion control instructions

3.1 State Machine

The operating state of integrated low-voltage stepper motor is switched by a state machine. In Modbus, control words correspond to the hold register address 0x0051, and status words correspond to the input register address 0x001F.

Control Word

Request status changes through control words. The following table lists the bit combinations that cause the corresponding state transitions.

State Transition

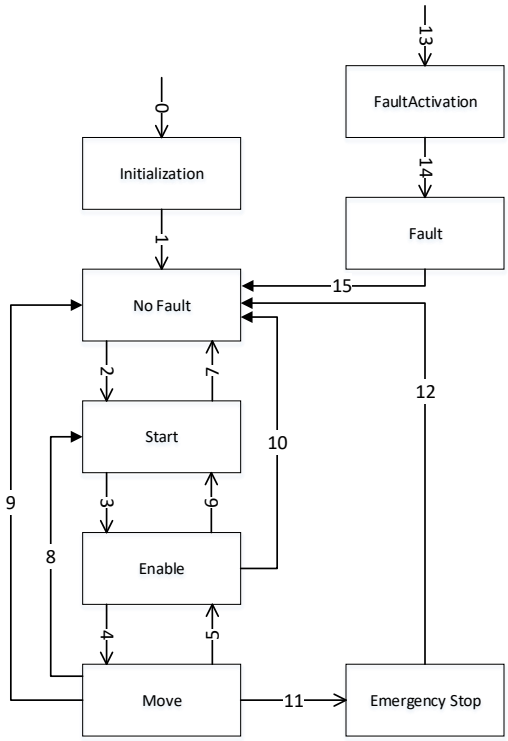

Figure 3-1

Each state corresponds to the motor as shown in the table below:

Table 3-1

State	Description
Initialization	The initialization and internal self-check of the motor driver have been completed.The parameters of the motor driver cannot be set, nor can the driving function be performed.
No Fault	No faults or errors in the motor driver have been ruled out.The driving parameters can be set.
Start	The motor driver starts up and the parameters can be set.
Enable	The motor driver outputs voltage to the motor, enabling it.
Move	The motor driver is operating normally. The drive function has been enabled for a certain operating mode, and the motor is controlled to complete the corresponding rotation through

State	Description
	instructions. The driver parameters cannot be set.
Emergency Stop	The emergency stop function has been activated, and the motor driver is executing the emergency stop function command. The driver parameters cannot be set.
Fault Activation	The motor driver has malfunctioned and is currently in the process of a shutdown due to a fault.The driver parameters cannot be set.
Fault	The fault shutdown has been completed. All drive functions have been disabled, and at the same time, driver parameters can be modified to troubleshoot. For resettable faults, after the parameters are changed, the fault can be reset by controlling the word 0x80.

The state transitions between control command words and state machines are as shown in the following table.

Table 3-2

State Transition		Control Word	State Word
0	To Initialization	Natural transition, no control instructions required.	—
1	Initialization→No Fault	Natural transition, no control instructions required.	—
2	No Fault→Start	0x06	0x0031
3	Start→Enable	0x07	0x0033
4	Enable→Move	0x0F	0x0037
5	Move→Enable	0x07	0x0033
6	Enable→Start	0x06	0x0031
7	Start→No Fault	0x00	0x0050
8	Move→Start	0x06	0x0031
9	Move→No Fault	0x00	0x0050
10	Enable→No Fault	0x00	0x0050
11	Move→Emergency Stop	0x02	0x0017
12	Emergency Stop→No Fault	For the rapid shutdown mode 0x003B, select 0 to 1. After the shutdown is completed, the transition will occur naturally without the need for control instructions	0x0050
13	→Fault Activation	Once the driver malfunctions, it will automatically switch to the fault shutdown state without the need for control instructions.	—
14	Fault Activation→Fault	After the fault shutdown is completed, a natural transition is made without the need for control instructions.	0x0018
15	Fault→No Fault	0x80 bit7 Effective rising edge; Bit7 remains at 1, and all other control instructions are invalid.	0x0050

3.2 Control Word

The bits of the control word, defined as follows:

Table 3-3

MSB			LSB					
15 …11	10 ,9	8	7	6 ,5 ,4	3	2	1	0
—	—	—	Fault reset	Special definition bit for operation mode	Enable	Quick stop	Enable voltage	Start

Bit4、5、6：

Table 3-4

Bit	Position Mode	Velocity Mode	HM
4	Set a new target position	x	The return to the origin begins
	0->1，It indicates a new action		0->1 ， It indicates a new action
5	x	x	x
6	0：GOTO Mode 1：MOVE Mode	x	x

Note：

It is meaningless to assign each bit of the control word individually,It must be combined with other bits to form a control instruction.

Bit 0 ~bit 3 and bit 7 have the same meaning in each mode, Only by sending commands sequentially can the motor drive be guided into the predicted state according to the switching process of the state machine,and each command corresponds to 1 definitive state.

3.3 Status Word

Data description

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
MSB															LSB

Table 3-5

Bit	Description
0	Start
1	Enable
2	Move
3	Fault
4	Voltage disconnection
5	Quick stop
6	No fault
7	Alarm
8	—
12	0— The operation action is completed 1— During operation

Bit	Description
9-15	—

Note：

It is meaningless to assign each bit of the status word individually,It must be combined with other control bits to form the current state feedback of the motor.

3.4 Stop Mode

There are two ways to stop the motor:

0 indicates no deceleration shutdown.

1 is to stop the machine at a certain deceleration.

There are various triggering methods for the motor when it stops moving：

1. Operation shutdown（0x003A）
   When the motor is in operation, performing state switching operations 5, 8 and 9 on the motor through control words will cause the motor to stop（move→enable 5，move→start 8，start→no fault 9）。
   The associated hold register is 0x003A.
2. Emergency stop（0x003B）
   When the motor is in a non-fault state and the control word value 0x0002 is sent, an emergency stop is executed.The associated hold register is 0x003B。
3. Fault stop（0x003C）
   Once the driver malfunctions, it will automatically switch to the fault shutdown state. The associated hold register is 0x003C。
4. The digital input DI special function triggers the shutdown
   Configure the special function of the corresponding port for digital input to immediately stop or decelerate stop. When the digital input changes and the special function becomes effective, the corresponding shutdown action will be executed. The configuration of DI special functions is detailed in Section 5.1.

4 Operation Mode

4.1 Operation Mode Selection

The integrated stepper motor supports operation modes including position mode, velocity mode and pulse mode. By setting the value of the register address 0x0039, you can choose to run in different mode.

Table 4-1

Hexadecimal	Description
1	Position mode
2	Velocity mode
3	Homing mode

4.2 Position Mode

The position mode is used to move from the current position to the target position. During the movement process, the maximum acceleration, maximum deceleration, maximum speed, minimum speed, etc. are all taken into account.

The motion-related parameters under position mode control are as shown in the following figure:

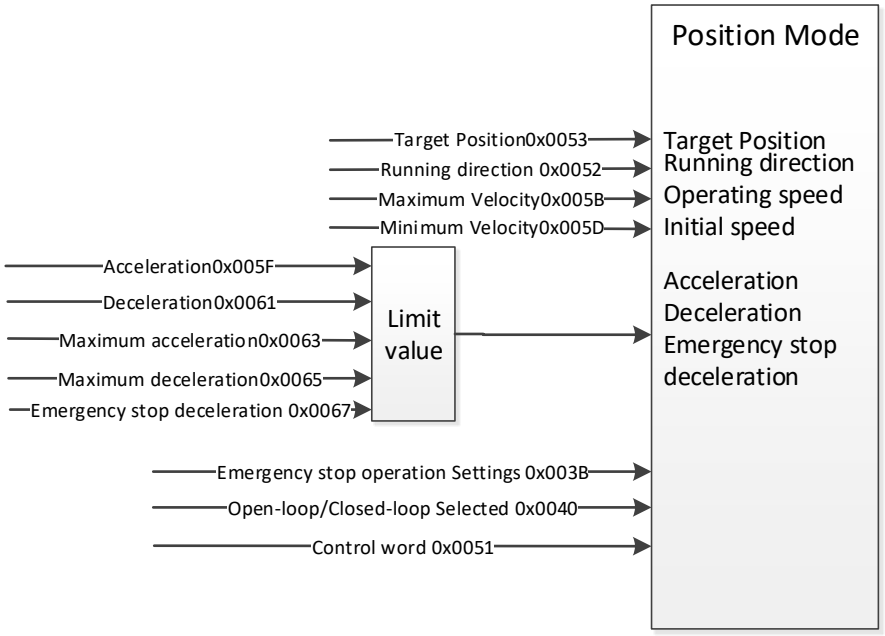

Figure 4-1

In position mode, the position range of the motor operation (position software limit value) can be set. Holding register 0x0059 to determine the maximum position value of the motion range, and holding register 0x0057 to determine the minimum position value of the motion range. If both the maximum and minimum position values are set to 0, there will be no software position limit value for the motor operation.

In position mode, positioning control is divided into absolute position positioning and relative position positioning. The bit4 and bit6 of the control word determine whether to perform absolute position positioning or relative position positioning.

Table 4-2

Modbus Address	Value	Description
0x0051	0F→1F	Absolute position operation, the target position parameter value is absolute position
	4F→5F	Relative position operation, the target position parameter value is relative position

4.2.1 Absolute Position Operation

For example, under the default value condition of the position mode association parameter, from Station 1 motor running to the absolute position 1000,000,000 pulses.The following message only contains the motor address, function code and data part, omitting the CRC part.

Table 4-3

Step	Request Message	Response Message	Note
1	01 10 00 53 00 02 04 3B 9A CA 00	01 10 00 53 00 02	Set the absolute target position 1,000,000,000
2	01 06 00 51 00 06	01 06 00 51 00 06	Start
3	01 06 00 51 00 07	01 06 00 51 00 07	Enable
4	01 06 00 51 00 0F	01 06 00 51 00 0F	Send control word F
5	01 06 00 51 00 1F	01 06 00 51 00 1F	Send control word 1F,and motor move as absolute position.

4.2.2 Relative Position Operation

For example, under the default value condition of the position mode association parameter, from Station 1 motor running to the relative position 200 pulses, and run 100 pulses each time. The following message only contains the motor address, function code and data part, omitting the CRC part.

Table 4-4

Step	Request Message	Response Message	Note
1	01 10 00 53 00 02 04 00 00 00 64	01 10 00 53 00 02	Set the target position 100
2	01 06 00 51 00 06	01 06 00 51 00 06	Start
3	01 06 00 51 00 07	01 06 00 51 00 07	Enable
4	01 06 00 51 00 4F	01 06 00 51 00 4F	Send control word 4F
5	01 06 00 51 00 5F	01 06 00 51 00 5F	Send control word 5F,and motor move as relative position.
6	01 06 00 51 00 4F	01 06 00 51 00 4F	Send control word 4F
7	01 06 00 51 00 5F	01 06 00 51 00 5F	Send control word 5F,and motor move as relative position.

4.3 Velocity Mode

Velocity mode is accelerate or decelerate from the current speed to the target speed and then run at a constant speed. During the movement process, the maximum acceleration, maximum deceleration, maximum

speed, minimum speed, etc. are all taken into account.The motion-related parameters under the velocity mode control are as shown in the following figure.

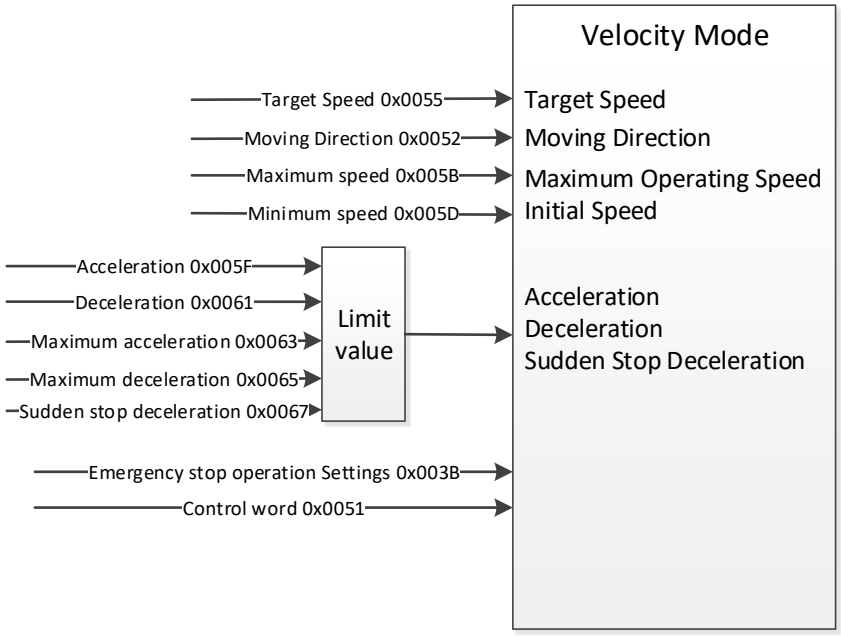

Figure 4-2

In velocity mode, the control word only needs to be set to the running state。

Table 4-5

Modbus Address	Value	Description
0x0051	0F	Compare whether the current speed is the same as the target speed a nd accelerate or decelerate accordingly.

Under the default value condition of the velocity mode associated parameters, switch from the motor running at 250 steps /s at Station 1 to running at 500 steps /s.The following message only contains the motor address, function code and data part, omitting the CRC part.

Table 4-6

Step	Request Message	Response Message	Note
1	01 10 00 55 00 02 04 00 00 00 FA	01 10 00 55 00 02	Set the target speed as 250step/s.
2	01 06 00 51 00 06	01 06 00 51 00 06	Start
3	01 06 00 51 00 07	01 06 00 51 00 07	Enable
4	01 06 00 51 00 0F	01 06 00 51 00 0F	The motor starts to accelerate until the speed reaches 250 steps /s.
5	01 10 00 55 00 02 04 00 00 01 F4	01 10 00 55 00 02	Set the target speed as 500step/s
6	01 06 00 51 00 0F	01 06 00 51 00 0F	The motor starts to accelerate until the speed reaches 500 steps /s.

Note：Speed（rpm）=60 x speed（step/s）/200

4.4 Homing Mode

The homing mode is used to move from the current position to the origin position of the device. During the movement process, the original point regression mode (holding register 0x6B), the origin offset value (holding register 0x69), the speed of finding the switch (holding register 0x6C), the speed of finding the zero position switch (holding register 0x6E), the acceleration of origin regression (holding register 0x70), etc. are all taken into account.

After the origin returns to zero, the position where the motor stops is the origin position of the machinery. By setting the origin offset object, the relationship between the mechanical origin and the mechanical zero point can be determined: mechanical origin = mechanical zero point + origin offset.

When the origin offset is 0, the mechanical origin coincides with the mechanical zero point.

The motion correlation parameters under the origin mode control are as shown in the following figure.

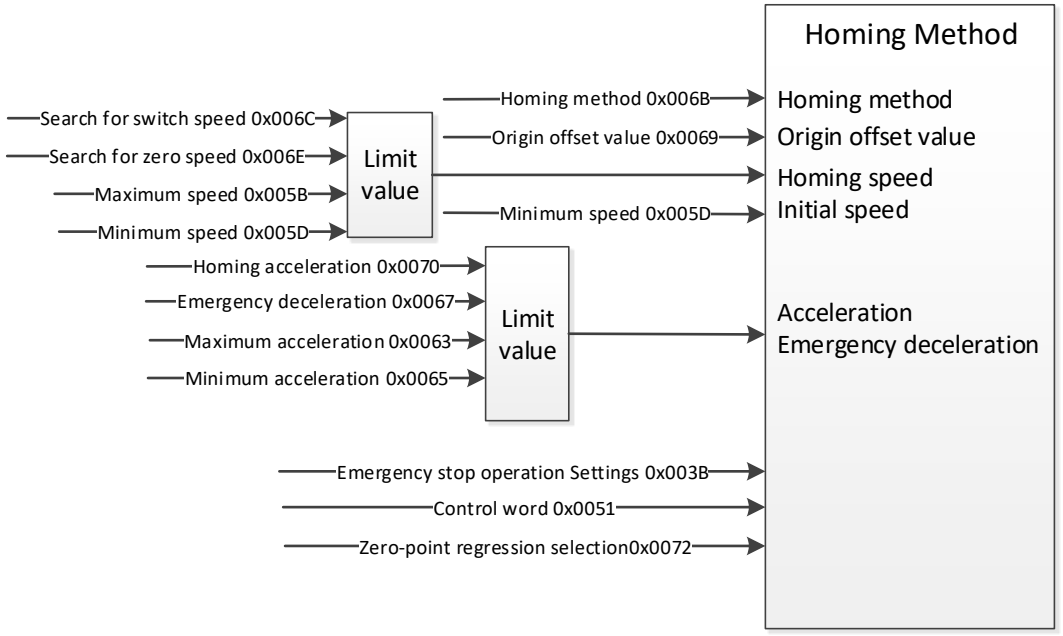

Figure 4-3

The Settings of the control words in the homing mode to start and run the homing are as follows.

Table 4-7

Modbus Address	Value	Description
0x0051	0F→1F	The motor begins to perform the homing action

The home return method is from 17 to 31. Among them, mode 31 is a quick return to zero method, and if the range of the selected home return mode is 17 to 30, then an origin switch or limit switch needs to be used. These special function switches need to be activated in the I/O configuration. For configuration details, please refer to section 5.

From the perspective of practical application requirements, we always need the motor to start working from zero point.Therefore, after the motor returns to zero from the origin, it needs to perform another action of "running to the zero point position".After setting the parameter 0x0072 (zero point regression) to a value of 1, the integrated motor will automatically return to the zero point position after the origin regression.

The switch relationships corresponding to homing methods 17 to 30 are as follows.

Table4-8

Homing Method	Switch Related
17	Negative Limit Switches
18	Positive Limit Switches
19	Home switch
20	Home switch
21	Home switch
22	Home switch
23	Home Switch, Positive Limit Switch
24	Home Switch, Positive Limit Switch
25	Home Switch, Positive Limit Switch
26	Home Switch, Positive Limit Switch
27	Home Switch, Negative Limit Switch
28	Home Switch, Negative Limit Switch
29	Home Switch, Negative Limit Switch
30	Home Switch, Negative Limit Switch

- Homing Method 17:

  Mechanical Home: Negative Limit Switch

  When the negative limit switch is invalid , start back to zero at high speed in reverse, decelerate, reverse, and run at low speed in forward direction when the negative limit switch is valid (along the change), and stop when the negative limit switch is invalid (along the change).

  When the negative limit switch is valid, the direct positive low speed starts back to zero and stops when it encounters the negative limit switch as invalid (along the change).

  The motion trajectory is shown below:

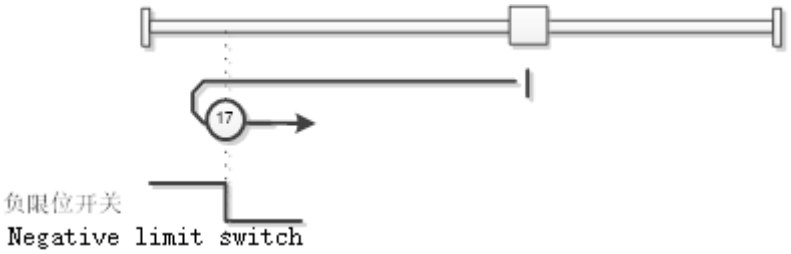

Figure4-3

- Homing Method 18:

  Mechanical Home: Positive Limit Switch

  When the positive limit switch is invalid, start back to zero at high speed in the positive direction, decelerate, reverse, reverse low speed when the positive limit switch is valid (along the change), and stop when the positive limit switch is invalid (along the change).

  When the positive limit switch is valid, it starts back to zero at low speed in direct reverse, and stops when it encounters a positive limit switch that is invalid (along the change).

  The motion trajectory is shown below:

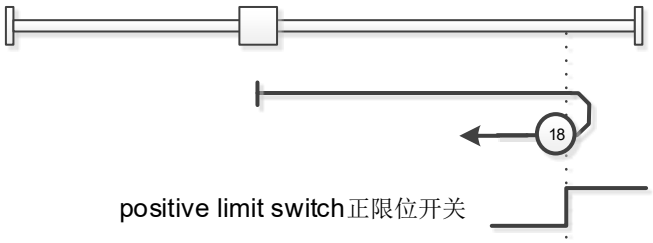

Figure4-45

- Homing Method 19 and 20:

Mechanical Home: Home Switch

Homing Method 19:

When the home switch is invalid , start back to zero with forward high speed, encounter the home switch is valid (along the change), decelerate, reverse, reverse low speed, encounter the home switch is invalid (along the change) to stop; when the home switch is valid, start back to zero with direct reverse low speed, encounter the home switch is invalid (along the change) to stop.

Homing Method 20:

When the home switch is invalid, start back to zero at low speed directly in the forward direction, and stop when the home switch is valid (along the change); when the home switch is valid, start back to zero at high speed in the reverse direction, and stop when the home switch is invalid (along the change), decelerate, reverse, and run at low speed in the forward direction, and stop when the home switch is valid (along the change).

The motion trajectory is shown below:

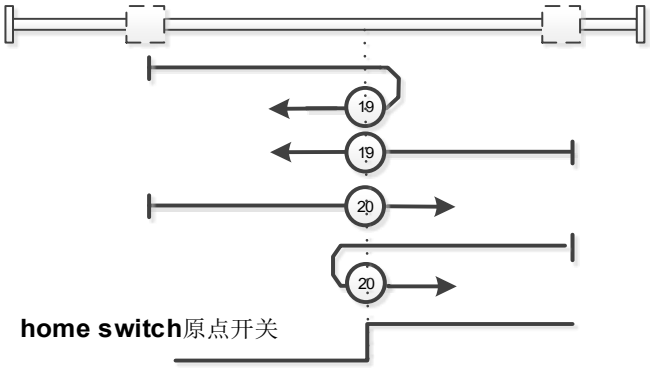

Figure 4-6

- Homing Method 21 and 22:

Mechanical Home: Home Switch

Homing Method 21:

When the home switch is invalid, start back to zero at high speed in reverse, decelerate, reverse, and run at low speed in forward direction when the home switch is invalid (along the change), and stop when the home switch is invalid (along the change); When the home switch is valid, start back to zero at low speed in forward direction directly, and stop when the home switch is invalid (along the change).

Homing Method 22:

When the home switch is invalid, start back to zero at low speed in direct reverse, and stop when the home switch is valid (along the change); when the home switch is valid, start back to zero at high speed in forward direction, and stop when the home switch is invalid (along the change), decelerate, reverse, and run at low speed in reverse direction, and stop when the home switch is valid (along the change).

The motion trajectory is shown below:

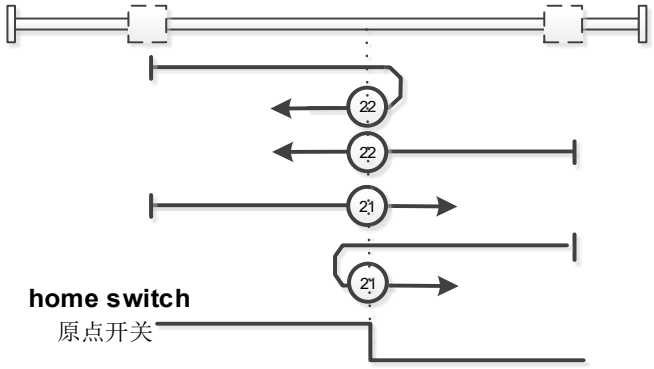

Figure 4-7

- Homing Method 23-26:

Mechanical Home: Home Switch

These are actually motors moving in one direction first to scan the home switch. The only time the home switch is active is when it is a shorter search trajectory.

Homing Method 23:

a. When the home switch is invalid, start back to zero at high speed in the positive direction without encountering the positive limit switch, decelerate, reverse, reverse low speed when the home switch is valid (along the change), and stop when the home switch is invalid (along the change);
b. When the home switch is invalid, start back to zero with positive high speed, encounter positive limit switch, reverse, reverse high speed, encounter home switch valid (along the change), decelerate, continue to reverse low speed, encounter home switch invalid (along the change) stop;
c. When the home switch is active, it starts back to zero at low speed in direct reverse and stops when it encounters the home switch is not active (along the change).

Homing Method 24 :

a. When the home switch is invalid, start back to zero at high speed in the forward direction without encountering a positive limit switch, when the home switch is valid (along the change), decelerate, reverse, run at low speed in the reverse direction, when the home switch is invalid (along the change), reverse, run at low speed in the forward direction, and stop when the home switch is valid (along the change);
b. When the home switch is invalid, start back to zero with positive high speed, encounter positive limit switch, reverse, reverse high speed, encounter home switch valid (along the change), decelerate, reverse low speed, encounter home switch invalid (along the change), reverse, positive low speed, encounter home switch valid (along the change) and stop;

c. When the home switch is valid, start back to zero at low speed directly in reverse, reverse when the home switch is invalid (along the change), run at low speed in forward direction, and stop when the home switch is valid (along the change).

Homing Method 25:

a. When the home switch is invalid, start back to zero at high speed in the forward direction without encountering a positive limit switch, decelerate and run at low speed in the forward direction when encountering a home switch that is valid (along the change), reverse and run at low speed in the reverse direction when encountering a home switch that is invalid (along the change), and stop when encountering a home switch that is valid (along the change);
b. When the home switch is invalid, start back to zero with positive high speed, encounter positive limit switch, reverse, reverse high speed, encounter home switch valid (along the change), decelerate, positive low speed, encounter home switch invalid (along the change), reverse, reverse low speed, encounter home switch valid (along the change) stop;
c. When the home switch is valid, direct forward low speed start back to zero, encounter the home switch is invalid (along the change), reverse, reverse low speed, encounter the home switch is valid (along the change) stop.

Homing Method 26:

a. When the home switch is invalid, start back to zero at a positive high speed without encountering a positive limit switch, decelerate and run at a positive low speed when the home switch is valid (along the change), and stop when the home switch is invalid (along the change);
b. When the home switch is invalid, start back to zero with positive high speed, encounter positive limit switch, reverse, reverse high speed, encounter home switch valid (along the change), decelerate, positive low speed, encounter home switch invalid (along the change) stop;
c. When the home switch is active, direct forward low speed starts back to zero and stops when it encounters a home switch that is not active (along the change).

The motion trajectory is shown below:

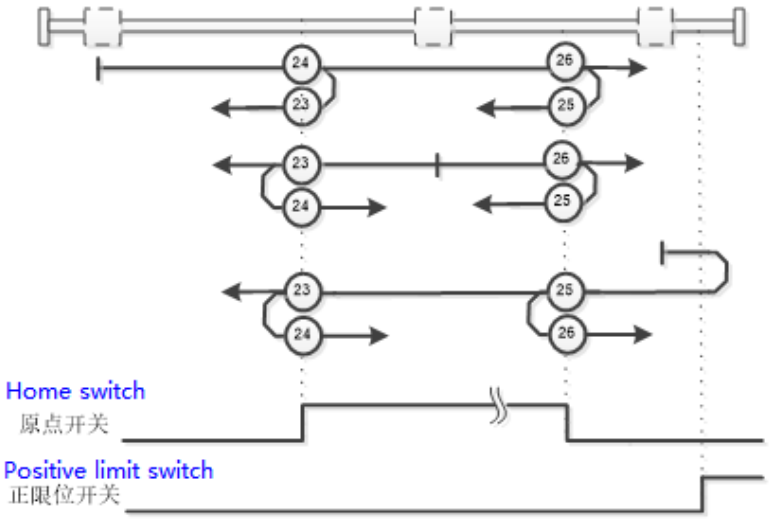

Figure44-8

- Homing Method 27-30:

  Mechanical Home: Home Switch

These are actually motors moving in one direction first to scan the home switch. The only time the home switch is active is when it is a shorter search trajectory.

Homing Method 27:

a. When the home switch is invalid, start back to zero at high speed in reverse without encountering a negative limit switch, decelerate, reverse, and run at low speed in forward direction when the home switch is valid (along the change), and stop when the home switch is invalid (along the change);
b. When the home switch is invalid, start back to zero at high speed in reverse, encounter the negative limit switch, reverse, run at high speed in the positive direction, encounter the home switch valid (along the change), decelerate, continue to run at low speed in the positive direction, and stop when encountering the home switch invalid (along the change);
c. When the home switch is active, direct forward low speed starts back to zero and stops when it encounters a home switch that is not active (along the change).

Homing Method 28:

a. When the home switch is invalid, start back to zero at high speed in reverse without encountering a negative limit switch, when the home switch is valid (along the change), decelerate, reverse, and run at low speed in the positive direction, when the home switch is invalid (along the change), reverse, and run at low speed in the reverse direction, and stop when the home switch is valid (along the change);
b. When the home switch is invalid, start back to zero with reverse high speed, encounter negative limit switch, reverse, positive high speed operation, encounter home switch valid (along the change), decelerate, positive low speed operation, encounter home switch invalid (along the change), reverse, reverse low speed operation, encounter home switch valid (along the change) stop;
c. When the home switch is valid, direct forward low speed start back to zero, encounter the home switch is invalid (along the change), reverse, reverse low speed, encounter the home switch is valid (along the change) stop.

Homing Method 29:

a. When the home switch is invalid, start back to zero at high speed in reverse without encountering a negative limit switch, when the home switch is valid (along the change), decelerate and run at low speed in reverse, when the home switch is invalid (along the change), reverse and run at low speed in positive direction, and stop when the home switch is valid (along the change);
b. When the home switch is invalid, start back to zero with reverse high speed, encounter negative limit switch, reverse, positive high speed operation, encounter home switch valid (along the change), decelerate, reverse low speed operation, encounter home switch invalid (along the change), reverse, positive low speed operation, encounter home switch valid (along the change) stop;
c. When the home switch is valid, start back to zero at low speed directly in reverse, reverse when the home switch is invalid (along the change), run at low speed in forward direction, and stop when the home switch is valid (along the change).

Homing Method 30:

a. When the home switch is invalid, start back to zero at high speed in reverse without encountering the negative limit switch, decelerate when the home switch is valid (along the change), run at low speed in reverse, and stop when the home switch is invalid (along the change);
b. When the home switch is invalid, start back to zero with reverse high speed, encounter negative limit switch, reverse, positive high speed operation, encounter home switch valid (along the change), decelerate, reverse low speed operation, encounter home switch invalid (along the change) stop;
a. When the home switch is active, it starts back to zero at low speed in direct reverse and stops when it encounters the home switch is not active (along the change).

The motion trajectory is shown below:

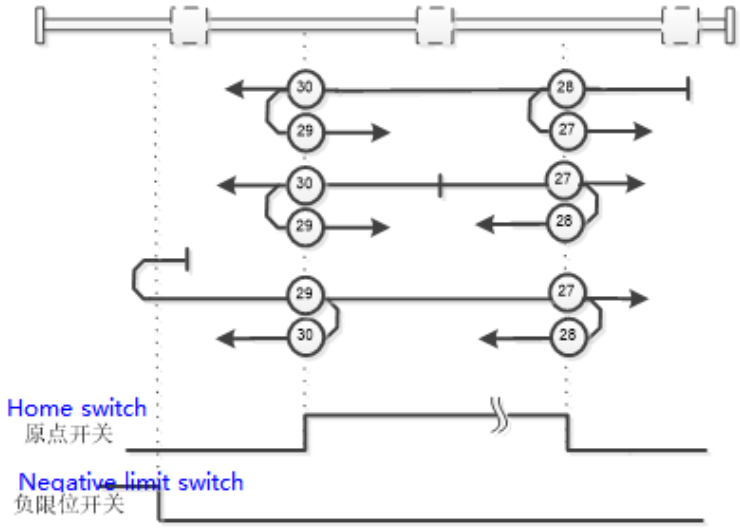

Figure 4-9

- Homing Method 31:

Method 31 is the rapid homing mode. Suppose that after sending the run command in this method, the motor will automatically and quickly return to the origin position based on the absolute position.

Example:

Under the default value conditions of the associated parameters in the homing mode, the homing method is 17, and the special function of the digital input DI1 is a negative limit switch. The following message only contains the motor address, function code and data part, omitting the CRC part .

Table 4-9

Step	Request Message	Response Message	Note
1	01 06 00 6B 00 11	01 06 00 6B 00 11	Set homing method is 17.
2	01 10 00 2C 00 02 04 00 00 00 01	01 10 00 2C 00 02	Set the function of DI1 is 1.
3	01 06 00 51 00 06	01 06 00 51 00 06	Start
4	01 06 00 51 00 07	01 06 00 51 00 07	Enable
5	01 06 00 51 00 0F	01 06 00 51 00 0F	Send 0F to control word .
6	01 06 00 51 00 1F	01 06 00 51 00 1F	Send 1F to control word .

5 Special Features

5.1 Digital inputs and outputs

The integrated stepper motors have input and output interfaces.The integrated digital input function is used to connect sensors for auxiliary motion control, such as limit microswitches, photoelectric switches, Hall sensors, etc.

For the connection and port definitions of digital input and digital output,please refer to the instruction manual of product.

5.1.1 Digital Input

This device has two types of digital input parameters. One is fixed as inputs DI1 to 3, and the other can be configured as digital inputs DX1 and DX2.For example, when the 0th bit of the DX1 configuration parameter 0x0034 is set to 0, the DX1 port is configured as input. When set to 1, the port is configured as output.

The following figure shows the input associated parameters and internal flowchart involved in DI：

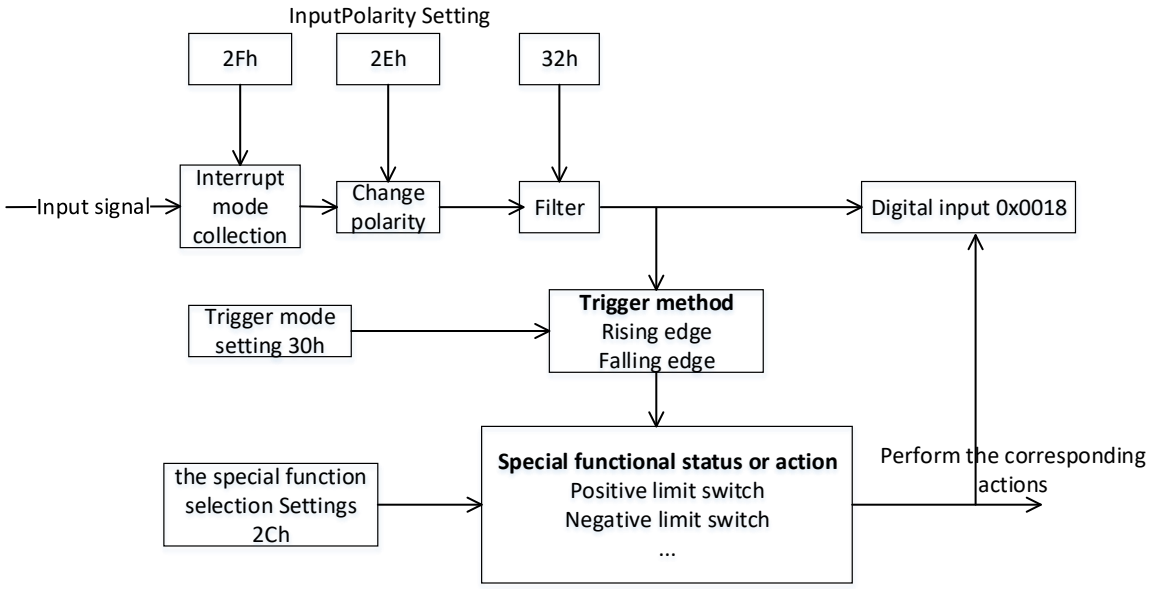

Figure 5-1

Detailed description of associated parameters：

- **Interrupt enable 0x002Fh**

  The 16-bit parameter data is defined as follows：

Table 5-1

Bit	15~8	7	6	5	4	3	2	1	0
Description	—	—	—	—	DX2	DX1	DI3	DI2	DI1

When each value is 1, the corresponding port enables the interrupt mode to collect the signal status

- **Input polarity parameters 0x002Eh**

The 16-bit parameter data is defined as follows：

Table 5-2

Bit	15~8	7	6	5	4	3	2	1	0
Description	—	—	—	—	DX2	DX1	DI3	DI2	DI1

When each value is 1, perform the inversion operation on the input level of the corresponding port.

- **Input filter parameter settings 0x0032h**

A total of 4 bytes. DI1 is from bit0 to bit3. Each DI occupies 4 bits. The unit is ms.

Table 5-3

Bit	31…16	19…16	15…12	11…8	7…4	3…0
Description	—	DX2	DX1	DI3	DI2	DI1

- **Trigger method 0x0030h**

A total of 4 bytes. DI1 is from bit0 to bit3. Each DI occupies 4 bits.The triggering mode of the signal can be set.

Table 5-4

Bit	31…16	19…16	15…12	11…8	7…4	3…0
Description	—	DX2	DX1	DI3	DI2	DI1

The meaning of the value corresponding to each DI：

0：Invalid.
1：Rising edge trigger.
2: Falling edge trigger.
3: Rising/Falling edge trigger.

- **Special functions 0x002Ch**

A total of 4 bytes. DI1 is from bit0 to bit3. Each DI occupies 4 bits.

Table 5-5

Bit	31…16	19…16	15…12	11…8	7…4	3…0
Description	—	DX2	DX1	DI3	DI2	DI1

The value of each DI：After the operation mode is set to pulse input, DI1-DI3 will be automatically set to the corresponding functions without the need for manual setting.

The value set for each DI：

0：No movement

1：Negative limit switch

2: Positive limit switch

3：Reference switch

4: Stop immediately

5: Deceleration and stop

- **Digital input 0x0018h**

The digital input parameter at address 0x0018 in the input register is a total of 4 bytes. The high 16 bits represent the DI status.

The definition is as shown in the figure：

Table 5-6

High 16 bits						Lower 16 bits			
31…21	20	19	18	17	16	15…3	2	1	0
—	DX2	DX1	DI3	DI2	DI1	—	Origin switch	Positive limit switch	Negative limit switch

The digital input parameters display the current status of the digital quantity. The status of the positive limit switch, negative limit switch and origin switch can only be displayed after special function configuration; otherwise, it is 0.

5.1.2 Digital Output

The digital output of this device is a DX1 that can be configured as a digital output.When the 0th bit of the DX1 configuration parameter 0x0034 is set to 0, the DX1 port is configured as input. When set to 1, the port is configured as output.The following figure shows the object Settings involved in the output of DO.

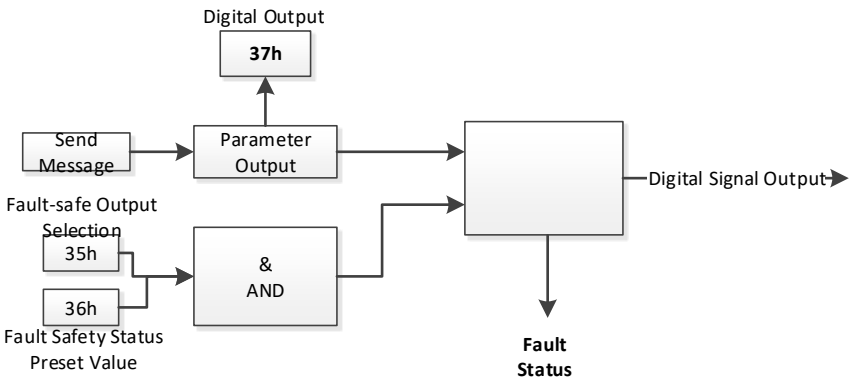

Figure 5-2

- **Fault-Safe Output Selection 0x0035h**

When an error occurs inside the device, select the output terminal.Bit0 is DO1,and so on.

Table 5-1

Bit	15~8	7	6	5	4	3	2	1	0
Description	—	—	—	—	—	—	—	DX2	DX1

The definition of set value:

0: Retain the output value of the last time.

1:Output according to the preset value of the fault-safe state.

- **Fault-Safety Status Preset Value 0x0036h**

Bit0 is DO1 and so on.

Table 5-8

Bit	15~8	7	6	5	4	3	2	1	0
Description	—	—	—	—	—	—	—	DX2	DX1

The definition of the set value: represents the predetermined value of the fault-safe state.

- **Digital output 0x0037h**

It is 4 bytes in total, with the high 16 bits representing the value output by DO.

Table 5-9

High 16 bits			Lower 16 bits
31…18	17	16	15…0
—	DX2	DX1	—

The digital output parameters change the status of the digital output port.

Table 5-10

Step	Request Message	Response Message	Note
1	01 10 00 37 00 02 04 00 01 00 00	01 10 00 37 00 02	Set the digital output DX1 to output 1.

5.2 Origin and Zero Point Setting

The zero point and origin of the motor position can be achieved by setting parameters without changing the mechanical position to move the origin and zero point.

When the current mechanical position is set as the origin, the current position is equal to the offset value of the origin.

Table 5-11

Step	Request Message	Response Message	Note
1	01 06 00 48 53 48	01 06 00 48 53 48	Set origin point

When the position zero point is set, the origin offset value will change accordingly based on the current position zero point and the current position origin.

Table 5-12

Step	Request Message	Response Message	Note
1	01 06 00 47 53 5A	01 06 00 47 53 5A	Set zero point

5.3 Position Display Selection

There are two types of motor positions, namely the absolute position of the encoder and the internal

cumulative position.The selection of the current position of the motor is shown in the following figure.

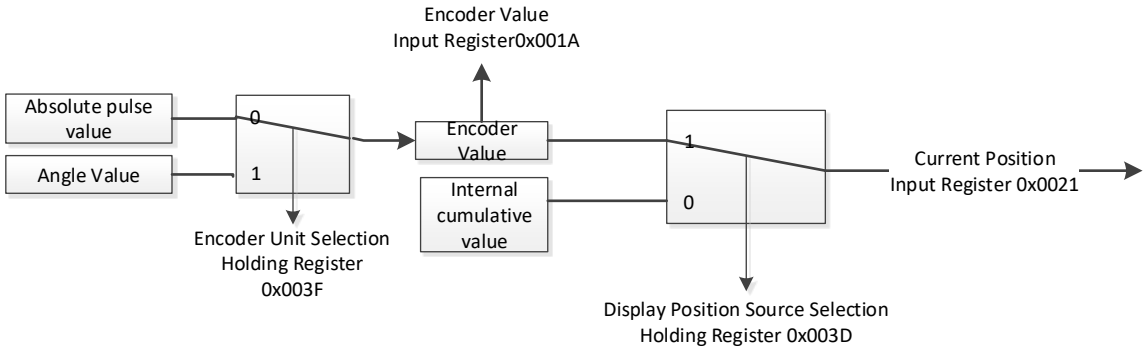

Figure 5-3

After the motor encoder unit (0x003F) is set to the Angle value, the motor encoder value is output as the absolute Angle value. By setting to keep the register address 0x003E, choose whether to display the Angle value for one turn or the absolute Angle value.

5.4 Position Recovery

The motor is able to regain its absolute position after being powered down and then powered back up.

By setting the position recovery method 0x0045 to a value of 1, it applies to single-turn round-trip motions in which the motor is in the negative direction with respect to the zero point and the return to zero point requires positive operation; and in which the motor is in the positive direction with respect to the zero point and the return to zero point requires negative operation.

The position recovery mode of register 0x0045 can be selected as absolute position recovery within a single turn.

For single-turn position recovery, the parameter 0x0046 can be set to change the direction of return to zero by blocking the position.

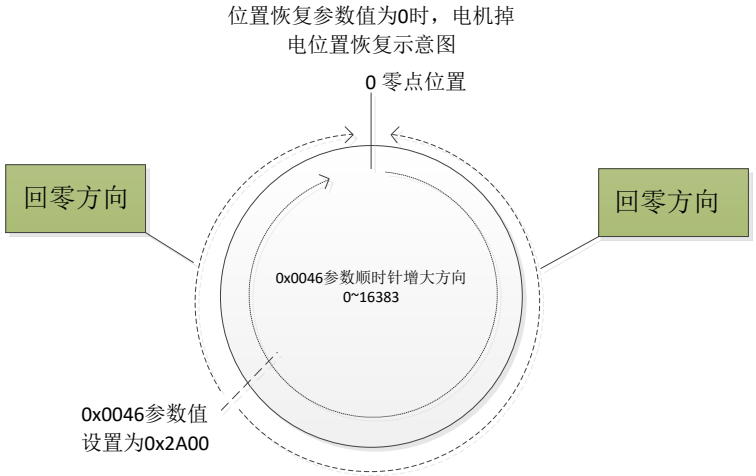

Figure 5-4

When the value of the position recovery mode is 1, which applies in multi-turn motion trajectories, the motor is able to recover the current absolute position.

5.5 Closed Loop Control

The position mode can be selected as either closed-loop control or open-loop control.

Holding register

Table 5-13

Modbus Address	Description
0x0040	0：Open-loop control 1：Closed-loop control
0x0041	Closed-loop pulse compensation threshold value. Under closed-loop control, when a locked rotor is detected internally in the motor and the number of out-of-step pulses exceeds this parameter value, a pulse compensation operation is carried out.
0x0042	The threshold for locked-rotor alarm: When the value is 0, it indicates that no locked-rotor alarm will be triggered. When the number of out-of-step pulses equals the set value, a locked-rotor alarm will be triggered.
0x0043	Locked rotor alarm threshold. When the value is 0, it indicates that no locked-rotor alarm will be triggered. When the number of out-of-step pulses equals the set value, a locked-rotor alarm will be triggered.

Input register

Table 5-14

Modbus Address	Description
0x001D	Number of out-of-step pulses. This parameter value is retained until the next operation of the motor and reset to zero during the next operation of the motor.

5.6 Diagnosis

The diagnostic support functions in Modbus for integrated motors are as follows：

Table 5-15

	Name of Function Code	Function Code	Sub-function Code
Diagnosis	Return the query data	0x08	0x0000
	Restart the communication options	0x08	0x0001
	Forced only listening mode	0x08	0x0004
	Clear the counter and diagnostic register	0x08	0x000A
	Return the bus message count	0x08	0x000B
	Return the bus communication error count	0x08	0x000C
	Return the abnormal error count of the child node	0x08	0x000D
	Return the message count of the child node	0x08	0x000E
	Return the count of no response from the child node	0x08	0x000F
	Return the NAK count of the child node	0x08	0x0010
	Return the busy count of the child node	0x08	0x0011
	Return the bus character overflow count	0x08	0x0012

	Error register (Manufacturer's custom)	0x08	0x0015
	The number of alarms for incorrect memory (Manufacturer's custom)	0x08	0x0016
	Error memory (Manufacturer's custom)	0x08	0x0017
	Clear the error memory (Manufacturer's custom)	0x08	0x0018
	The current error alarm value (Manufacturer's custom)	0x08	0x0019
	Hardware self-check (Manufacturer's custom)	0x08	0x001A

5.6.1 Return the Query Data

Return (send back) the data passed in the request data field in the response. All response messages should be consistent with the request message.

Request Message

Table 5-2

Address	Function Code	Sub-function Code	Data	CRC Value
01	0x08	00 00	73 76	-

Response Message

Table 5-3

Address	Function Code	Sub-function Code	Data	CRC Value
01	0x08	00 00	73 76	-

5.6.2 Restart the communication options

The serial link port of the remote device must be initialized and restarted, and all communication event counters must be cleared. If the port is in listening-only mode, no response is returned. It is the only function that can exit the port from the listening mode. If the port is not in listening-only mode, return a normal response before restarting.

Request Message

Table 5-4

Address	Function Code	Sub-function Code	Data	CRC Value
01	0x08	00 01	00 00 or FF 00	-

Response Message

Table 5-5

Address	Function Code	Sub-function Code	Data	CRC Value
01	0x08	00 01	00 00 or FF 00	-

Data is 0xFF00,that means clear all counters.

Data is 0x0000,that means the counter value remains the same as before the restart.

5.6.3 Forced Listening Mode Only

When the slave machine enters the listening but not responding mode, the only function that can be processed after entering this mode is to restart the communication option function.

Request Message

Table 5-20

Address	Function Code	Sub-function Code	Data	CRC Value
01	0x08	00 04	00 00	-

The operation was successful without a response message.

5.6.4 Clear the Counter and Diagnostic Registers

The purpose is to clear all counters and diagnostic registers.

Request Message

Table 5-21

Address	Function Code	Sub-function Code	Data	CRC Value
01	0x08	00 0A	00 00	-

The response message is the same as the request message.

5.6.5 Return the Bus Message Count

The response data field returns the number of messages detected by the device in the communication system since the last restart, clear the counter operation, or power-on.

Request Message

Table 5-22

Address	Function Code	Sub-function Code	Data	CRC Value
01	0x08	00 0B	00 00	-

Response Message

Table 5-23

Address	Function Code	Sub-function Code	Data	CRC Value
01	0x08	00 0B	Total message count	-

5.6.6 Return the Bus Communication Error Count

The response data field returns the number of CRC errors and length errors encountered by the device since the last restart, counter clearance operation, or power-on.

Request Message

Table 5-24

Address	Function Code	Sub-function Code	Data	CRC Value

01	0x08	00 0C	00 00	-

Response Message

Table 5-25

Address	Function Code	Sub-function Code	Data	CRC Value
01	0x08	00 0C	CRC and length error count	-

5.6.7 Return the Bus Abnormal Error Count

The response data field returns the number of abnormal response messages and broadcast abnormal messages returned by the device since the last restart, clear the counter operation, or power-on.

Request Message

Table 5-6

Address	Function Code	Sub-function Code	Data	CRC Value
01	0x08	00 0D	00 00	-

Response Message

Table 5-7

Address	Function Code	Sub-function Code	Data	CRC Value
01	0x08	00 0D	Abnormal error count	-

5.6.8 Return the Slave Message Count

The response data field returns the number of messages processed or broadcast messages processed by the device since the last restart, clear counter operation, or power-on.

Request Message

Table 5-28

Address	Function Code	Sub-function Code	Data	CRC Value
01	0x08	00 0E	00 00	-

Response Message

Table 5-29

Address	Function Code	Sub-function Code	Data	CRC Value
01	0x08	00 0E	Slave message count	-

5.6.9 Return the Count of no Response from the Slave Station

The response data field returns the number of messages since the last restart, counter clearance operation, or power-on that the device has not returned a response (neither a normal response nor an abnormal response).

Request Message

Table 5-30

Address	Function Code	Sub-function Code	Data	CRC Value
01	0x08	00 0F	00 00	-

Response Message

Table 5-31

Address	Function Code	Sub-function Code	Data	CRC Value
01	0x08	00 0F	Slave station no response count	-

5.6.10 Return the Slave Station NAK Counter

The response data field returns the number of NAK (Abnormal Response) messages returned by the device since the last restart, counter clearance operation, or power-on.

Request Message

Table 5-32

Address	Function Code	Sub-function Code	Data	CRC Value
01	0x08	00 10	00 00	-

Response Message

Table 5-33

Address	Function Code	Sub-function Code	Data	CRC Value
01	0x08	00 10	**Slave station NAK counter**	-

5.6.11 Return to the Slave Station for Busy Counting

The response data field returns the number of messages that the device has returned to the slave device in response to the busy anomaly since the last restart, counter clearance operation, or power-on.

Request Message

Table 5-34

Address	Function Code	Sub-function Code	Data	CRC Value
01	0x08	00 11	00 00	-

Response Message

Table 5-35

Address	Function Code	Sub-function Code	Data	CRC Value
01	0x08	00 11	The slave station equipment is busy counting	-

5.6.12 Return the Bus Character Overflow Count

The response data field returns the number of messages from devices that could not be processed due to the over-limit status of some characters in the message data since the last restart, counter elimination operation, or power-on. Character over-limit occurs when the speed at which characters arrive at the port is higher than the speed at which they are stored or when characters are lost due to hardware failure.

Table 5-36

Address	Function Code	Sub-function Code	Data	CRC Value
01	0x08	00 12	00 00	-

Response Message

Table 5-8

Address	Function Code	Sub-function Code	Data	CRC Value
01	0x08	00 12	Count the number of slave station characters exceeding the limit	-

5.6.13 Alarm

The operations related to alarms include obtaining the latest alarm information, obtaining historical alarm information, obtaining the number of historical alarms, and clearing historical alarms, etc. There are 16 alarm queues in the device, which are stored in a stacked manner and follow the first-in, first-out rule.

- **Error register**

The error register is 16 bits long, and each bit of information is defined as shown in the following table:

Table 5-38

The bit definition of error register								
Bit 15~ Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
—	Manufacturer	Reserved	Sub-protocol	Communication	Temperature	Voltage	Current	Conventional

When an error (error, alarm, fault) occurs, the regular bit of Bit0 will be filled with "1", and the other bits will be filled with "1" according to the error classification (see: Error Code Description and Classification). When the error is eliminated, the bit corresponding to the error category is reset to "0". If all errors have been eliminated, the regular error bit is reset to "0".

Request message

Table 5-39

Address	Function Code	Sub-function Code	Data	CRC
01	0x08	00 15	00 00	

Response message

Table 5-40

Address	Function Code	Sub-function Code	Data	CRC
01	0x08	00 15	2-byte error register	-

- **The number of alarms for error memory**

The number of alarms exists in the current error memory list.

Request message

Table 5-41

Address	Function Code	Sub-function Code	Data	CRC
01	0x08	00 16	00 00	-

Response message

Table 5-42

Address	Function Code	Sub-function Code	Data	CRC
01	0x08	00 16	The number of 2-byte error memory alarms	-

- **Error memory**

The error memory is the record of historical alarms, and it can hold a maximum of 16 errors.When all the error memory is occupied, a new alarm is generated, which deletes the earliest error and moves the previous errors down in sequence, similar to a stack process.
The diagnostic query for error memory will return 32 bytes of data.

Table 5-43

Mis-classification	Error Code (Hexadecimal)	Fault Action	Meaning
Current	2200	Yes	Over-current
Voltage	3110	No	Over-voltage
Voltage	3120	No	Under-voltage
Temperature	4310	No	Over-Temperature
Sub-protocol	5530	Yes	EEPROM read/write failure
Sub-protocol	7121	No	Stall alarm
Sub-protocol	7122	No	Stall alarm under velocity mode
Sub-protocol	8612	Yes	Position-limit alarm
Manufacturer	FF00	Yes	Shut down due to overheating
Manufacturer	FF01	No	Error command
Manufacturer	FF02	No	Unexecutable command
Manufacturer	FF03	Yes	EEPROM self-check failure
Manufacturer	FF06	Yes	Encoder self-check failure
Manufacturer	FF07	Yes	Driver self-check failure
Manufacturer	FF08	No	The encoder reads the data frame incorrectly
Manufacturer	FF09	No	Encoder verification error
Manufacturer	FF0A	No	Encoder instruction error
Manufacturer	FF0B	No	Encoder frame error

Mis-classification	Error Code (Hexadecimal)	Fault Action	Meaning
Manufacturer	FF0C	Yes	The magnetic field of the encoder is too high
Manufacturer	FF0D	Yes	The magnetic field of the encoder is too low
Manufacturer	FF0E	Yes	Over-negative limit alarm
Manufacturer	FF0F	Yes	Over-positive limit alarm
Manufacturer	FF10	No	Communication baud rate adaptive failure alarm.

When either over-temperature or over-current faults occur, the driver fault will be triggered.

In the above list, the "yes (No)" of the fault action indicates whether the motor enters the fault state (status word value 0x18) after this fault occurs. After the fault is recovered, the fault needs to be cleared by sending control 0x80 (the rising edge of the control word bit7 is valid) before normal operations can be carried out.

Request message

Table 5-44

Address	Function Code	Sub-function Code	Data	CRC
01	0x08	00 17	00 00	-

Response message

Table 5-45

Address	Function Code	Sub-function Code	Data	CRC
01	0x08	00 17	Error memory value (32 bytes)	-

5.6.14 Clear the Error Memory

Clear all the alarm information in the error memory.

Request message

Table 5-46

Address	Function Code	Sub-function Code	Data	CRC
01	0x08	00 18	00 00	-

Response message

Table 5-47

Address	Function Code	Sub-function Code	Data	CRC
01	0x08	00 18	00 00	-

5.6.15 Current Error Alarm

Get the recent error value.

Request message

Table 5-48

Address	Function Code	Sub-function Code	Data	CRC
01	0x08	00 19	00 00	-

Response message

Table 5-49

Address	Function Code	Sub-function Code	Data	CRC
01	0x08	00 19	Error code	-

5.6.16 Hardware Self-check

It is used to detect whether the hardware of the encoder, EEPROM and motor drive part of the equipment is normal. When the device is powered on for the first time, it will automatically perform a self-check function. If an alarm is detected, the fault needs to be eliminated. After the fault is eliminated, a command needs to be sent again for a self-check to ensure that the hardware truly returns to normal. When the motor status word belongs to the operation and running state (0x33, 0x37, etc.), the slave station cannot perform self-check.

Table 5-9

Definition of hardware self-check results				
Bit15~ Bit4	Bit 3	Bit 2	Bit 1	Bit0
—	Drive the self-check result	EEPROM self-check result	—	Encoder self-check result

Each representative value of 1 indicates that an error occurred during this self-check, and a value of 0 indicates that there was no problem during the self-check.

Request message

Table 5-51

Address	Function Code	Sub-function Code	Data	CRC
01	0x08	00 1A	00 00	-

Response message

Table 5-52

Address	Function Code	Sub-function Code	Data	CRC
01	0x08	00 1A	Self-check result	-

5.7 Version Information

The hardware version, software version and product serial number of the equipment can be queried through function code 04.

- **Serial number query：**

Request message

Table 5-53

Address	Function Code	Sub-function Code	Data	CRC
01	0x04	00 02	00 02	-

Response message

Table 5-54

Address	Function Code	Sub-function Code	Data	CRC
01	0x04	00 04	XX XX	-

- **Hardware version query：**

Request message

Table 5-55

Address	Function Code	Sub-function Code	Data	CRC
01	0x04	00 04	00 02	-

Response message

Table 5-56

Address	Function Code	Sub-function Code	Data	CRC
01	0x04	00 04	XX XX	-

- **Software version query：**

Request message

Table 5-57

Address	Function Code	Sub-function Code	Data	CRC
01	0x04	00 0A	00 02	-

Response message

Table 5-58

Address	Function Code	Sub-function Code	Data	CRC
01	0x04	00 04	XX XX	-

6 Register List

The setting status indicates the device status that allows parameters to be written. The parameter setting allows the representation of the equipment status machine status (motor operation status machine), which enables the reading and writing operations of parameters.Unrestricted means that parameters can be read and written in any state. When the motor is offline, it refers to the situation where there is no current output from the motor drive part and the motor shaft is in a free state. In the effective mode, re-powering indicates that after setting a new value for this parameter, the parameter needs to be saved and the motor restarted to be effective.Immediate effect means that there is no need to restart the motor operation and it will be effective in this event. Some parameters require a storage space of 32 bits for storage. The register width in the Modbus protocol is 16 bits, so two registers are needed to represent one piece of data.When parameters occupy two registers, the data adopts big-endian mode.

List of holding register:

Table6-1

Address Hexadecimal	Name	Description	Number of Registers	Data Range	Default Value	Set Status	Effective Mode
0	Node address	The address of the station	1	1～247	1	Unrestricted	Re-power
1	Baud rate	0x00:Baud rate adaptive(from 1 to 8) 0x01:9.6kbps 0x02:19.2kbps 0x03:38.4 kbps 0x04:57.6kbps 0x05:115.2kbps 0x06:256kbps 0x07:500kbps 0x08:1Mbps 0x09:1.51Mbps	1	0～9	5	Unrestricted	Re-power
2	Network data format	0x00:8 data bit, even parity, 1 stop bit 0x01:8 data bit, odd parity, 1 stop bit 0x02:8 data bit, no parity check, 1 stop bit 0x03:8data bit, no parity check, 2 stop bit	1	0～3	2	Unrestricted	Re-power
3~7	Reserve		5	—	—	—	—

Address Hexadecimal	Name	Description	Number of Registers	Data Range	Default Value	Set Status	Effective Mode
8	Save all parameters	Write to 0x7376 to save. A read parameter of 1 indicates support for instruction saving.	1	UNSIGNED16	1	Unrestricted	Immediate effect
9~A	Reserve		2	—	—	—	—
B	Restore all parameter default values	Write 0x6C64 to restore all parameters to the manufacturer's default values.	1	UNSIGNED16	1	Unrestricted	Re-power
C~14	Reserve		12	—	—	—	—
16	Idle motor current	Non-STM86 and STM57H series.The step size is 31.25mA. 0:31.25mA 1:62.5mA ... 95:3A	1	0~95	15	Parameter Settings allow	Immediate effect
		STM86 Series(The step size is 260mA) 0:260mA 1:520mA ... 37:9.8A	1	0~37	1	Parameter Settings allow	Immediate effect
		STM57H Series(The step size is 260mA) 0:260mA 1:520mA ... 22:6A	1	0~22	1	Parameter Settings allow	Immediate effect
17	Stall current	Non-STM86 and STM57H series.The step size is 31.25mA. 0:31.25mA 1:62.5mA ... 107:3.375A	1	0~107	63	Unrestricted	Immediate effect
		STM86 Series(The step size is 260mA) 0:260mA 1:520mA ... 37:9.8A	1	0~37	7	Unrestricted	Immediate effect

Address Hexadecimal	Name	Description	Number of Registers	Data Range	Default Value	Set Status	Effective Mode
		STM57H Series(The step size is 260mA) 0:260mA 1:520mA ... 22:6A	1	0～22	7	Unrestricted	Immediate effect
18	Operating current	Non-STM86 and STM57H series.The step size is 31.25mA. 0:31.25mA 1:62.5mA ... 95:3A	1	0~95	41	Unrestricted	Immediate effect
		STM86 Series(The step size is 260mA) 0:260mA 1:520mA ... 37:9.8A	1	0~37	7	Unrestricted	Immediate effect
		STM57H Series(The step size is 260mA) 0:260mA 1:520mA ... 22:6A	1	0~22	7	Unrestricted	Immediate effect
19	Overload current	Non-STM86 and STM57H series.The step size is 375mA. 0:375mA 1:700mA ... 8:3.375A	1	0~8	8	Parameter Settings allow	Immediate effect
		STM86 and STM57H series.The step size is 0.9A. 0:1A 1:1.9A ... 0xA:10.4A	1	0~10	9	Parameter Settings allow	Immediate effect
1A	Subdivision	00：full step 01：half step 02：1/4 step 03：1/8 step 04：1/16step	1	0~4	3	When the motor is offline	Immediate effect

Address Hexadecimal	Name	Description	Number of Registers	Data Range	Default Value	Set Status	Effective Mode
1B	Overvoltage alarm setting	0：No alarm 1-4：Reserved 5:Alarm for exceeding 5V …… 60：Alarm for exceeding 60V	1	Non-STM86 and STM57H series:0~30 STM57H series:0~36 STM86 series:0~60	30	Unrestricted	Immediate effect
1C	Undervoltage alarm setting	0：No alarm 1-4：Reserved. 5:Alarm when the voltage is lower than 5V. …… 60：Alarm when the voltage is lower than 60V.	1	Non-STM86 and STM57H series:0~30 STM57H series:0~36 STM86 series:0~60	12	Unrestricted	Immediate effect
1D~2B	Reserve	-	15	-	-	-	-
2C	DI function select	Bit0~bit3 is DI1 and so on.Each DI occupies 4 bits. 0: No movement 1：Negative limit switch 2：Positive limit switch 3：Origin switch 4: Stop the machine immediately 5: Deceleration and shutdown 6: Running direction: rising edge in the positive direction, falling edge in the reverse direction (in speed mode) 7: Enable: rise edge enable, fall edge offline (in	2	0～2290649224	0	Parameter Settings allow	Immediate effect

Address Hexadecimal	Name	Description	Number of Registers	Data Range	Default Value	Set Status	Effective Mode
		speed mode) 8: Run/Stop: run at the rising edge, and stop at the falling edge (in speed mode)					
2E	Reverse the input polarity	0：No reverse 1： Reverse	1	Unsigned8	0	Parameter Settings allow	Immediate effect
2F	Input the pull-up enable	There are a total of 8 bits, from the 0th bit to DI1, and so on. 0:Invalid 1:Enable	1	Unsigned8	Non-STM57H:0 Non-STM57H:7	Parameter Settings allow	Immediate effect
30	Input trigger method	A total of 4 bytes. Bit0~bit3 is DI1 and so on. Each DI occupies 4 bits. The value corresponding to each byte： 0：Invalid 1：Rising edge trigger； 2：Falling edge trigger； 3：Rising/falling edge trigger	2	0～858993459	69905	Parameter Settings allow	Immediate effect
32	Input filtering parameters	A total of 4 bytes. Bit0~bit3 is DI1 and so on. Each DI occupies 4 bits. Unit:ms.	2	Unsigned32	0	Parameter Settings allow	Immediate effect
34	Special input/output settings	The configuration of the input and output ports consists of 8 bits, with the 0th bit->DX1, and so on. Value of each bit: 0:Input 1:Output Note:STM57H series does not have this function.	1	Unsigned8	0	Parameter Settings allow	Immediate effect
35	Fail-safe output selection	When an error occurs inside the device, select the output terminal. There are a total of 8 bits, from bit 0 to >DO1, and so on. Value of each bit: 0：Retain the output value of the last time. 1：Output according to the preset value of the fault-safe state.	1	Unsigned8	0	Unrestricted	Immediate effect

Address Hexadecimal	Name	Description	Number of Registers	Data Range	Default Value	Set Status	Effective Mode
36	Fault safety status preset value	There are a total of 8 bits, from bit 0 to >DO1, and so on Each value: represents the predetermined value of the fault-safe state	1	Unsigned8	0	Unrestricted	Immediate effect
37	Digital output	It consists of 4 bytes, with the high 16 bits representing the output value of DO and the low 16 bits representing the special function value of DO.	2	Unsigned32	0	Unrestricted	Immediate effect
39	Motion mode	1：Position mode 2：Velocity mode 4：Homing mode	1	1～3	1	Parameter Settings allow	Immediate effect
3A	Start-stop Settings	Value range：0~1 0 is no deceleration shutdown 1 is to stop the machine at a certain deceleration (the deceleration setting is determined by the parameter emergency stop deceleration.)	1	0～1	1	Unrestricted	Immediate effect
3B	Emergency stop setting	Value range：0~1 0 is no deceleration shutdown 1 is to stop the machine at a certain deceleration (the deceleration setting is determined by the parameter emergency stop deceleration.)	1	0～1	0	Unrestricted	Immediate effect
3C	Fault stop setting	Value range：0~1 0 is no deceleration shutdown 1 is to stop the machine at a certain deceleration (the deceleration setting is determined by the parameter emergency stop deceleration.)	1	0～1	0	Unrestricted	Immediate effect
3D	Position information source selection	0:Incremental position value 1:Absolute position value	1	0～1	1	Unrestricted	Immediate effect
3E	Angle selection	0:Single-turn angle value 1:Absolute angle value	1	0～1	1	Unrestricted	Immediate effect

Address Hexadecimal	Name	Description	Number of Registers	Data Range	Default Value	Set Status	Effective Mode
3F	Encoder unit	0:Pulse 1:Angle(0 to 0x3FFF corresponds to 0°to 360°)	1	0～1	1	Unrestricted	Immediate effect
40	Open-loop/closed-loop selection	0:Open-loop 1:Closed-loop	1	0～1	1	Parameter Settings allow	Immediate effect
41	Closed-loop pulse compensation threshold value	Unit:Pulse	1	Unsigned16	6	Parameter Settings allow	Immediate effect
42	Closed-loop locked rotor stop value	Unit:Pulse	1	Unsigned16	65535	Parameter Settings allow	Immediate effect
43	Threshold of stall alarm	0：No alarm； N：When the blockage reaches this value, an alarm will be triggered. Unit:pulse	2	UNSIGNED16	5	Unrestricted	Immediate effect
45	Position recovery	0：Single-turn position recovery，1：Muti-turn position recovery	1	0～1	0	Unrestricted	Immediate effect
46	Maximum forward rotation Angle	This value is valid when the parameter position recovery mode value is 0 and is used for position recovery.	1	0～16383	10752	Unrestricted	Immediate effect
47	Zero point setting	The write parameter value 0x535A is set, and a read parameter of 1 indicates support for instructions	1	21338	1	Unrestricted	Immediate effect
48	Origin point setting	The write parameter value 0x5348 is set, and a read parameter of 1 indicates support for instructions	1	21320	1	Unrestricted	Immediate effect
49~4F	Reserve	—	8	—	—	Unrestricted	Immediate effect
51	Control word	Change motor status	1	—	—	—	—
52	Direction of movement	-	1	0~1	1	Unrestricted	Immediate effect
53	Target position	Given the target position in position mode	2	Integer32	0	Unrestricted	Immediate effect
55	Target speed	Unit：step/s	2	0～268435455	500	Unrestricted	Immediate effect
57	Minimum position value	Unit：step	2	Integer32	0	Parameter Settings allow	Immediate effect

Address Hexadecimal	Name	Description	Number of Registers	Data Range	Default Value	Set Status	Effective Mode
59	Maximum position value	Unit：step	2	Integer32	0	Parameter Settings allow	Immediate effect
5B	Maximum speed	Unit：step/s	2	0～268435455	250	Unrestricted	Immediate effect
5D	Minimum speed	Unit：step/s	2	0～268435455	16	Unrestricted	Immediate effect
5F	Acceleration	Unit：step/s²	2	1～268435455	2000	Unrestricted	Immediate effect
61	Deceleration	Unit：step/s²	2	1～268435455	2000	Unrestricted	Immediate effect
63	Maximum acceleration	Unit：step/s²	2	1～268435455	2000	Parameter Settings allow	Immediate effect
65	Maximum deceleration	Unit：step/s²	2	1～268435455	2000	Parameter Settings allow	Immediate effect
67	Emergency stop deceleration	Unit：step/s²	2	1～268435455	2000	Parameter Settings allow	Immediate effect
69	Origin offset value	Unit：pulse	2	INTEGER32	0	Parameter Settings allow	Immediate effect
6B	Homing method	17~31	1	17~31	31	Parameter Settings allow	Immediate effect
6C	Look for the speed of the switch	Unit:Step/s	2	0～268435455	100	Unrestricted	Immediate effect
6E	Look for the speed of the zero position switch	Unit:Step/s	2	0～268435455	10	Unrestricted	Immediate effect
70	Acceleration of homing method	Unit：step/s²	2	1～268435455	1000	Unrestricted	Immediate effect
72	Zero-point regression	After the motor has completed its origin return, whether it runs back to the zero position or not, 0x01 enables and 0x00 disables	1	0～1	0	Parameter Settings allow	Immediate effect

Note：The parameters "0x47 set zero point", "0x48 set origin", "0x51 motion control word", "0x52 motion direction", "0x53 target position in position mode" and "0x55 target speed in speed mode" in the above table cannot be saved after modification.And the default value is set each time the power is restored.

Input Register List

Table 6-1

Address Hexadecimal	Name	Description	Register Numbers
0	Manufacturer name		2
2	Product serial number		2
4	Hardware version number	Hardware version number	2
6	Software version number	Software version number	2
8	Software version number	Software version number	2
A	Software version number	Software version number	2
C	Working hours	The cumulative working time of the motor.（Unit：h）	2
E~14	Reserve		8
16	Drive circuit status	Drive circuit status	1
17	Input voltage	Unit：V	1
18	Digital input	The high 16 bits represent the input value of DI, and the low 16 bits represent the special function value of DI, namely (positive limit switch status, negative limit switch status, origin switch status).	2
1A	Current value of encoder	Angle or pulse	2
1C	Number of out-of-step pulses	The cumulative number of out-of-step pulses when the motor is locked	2
1E	Current motion mode		1
1F	Status word	Status word	1
20	Current direction of movement	Current direction of movement	1
21	Current display position	Current display position（Unit：pulse）	2
23	Current display velocity	Current display velocity（Unit：rpm）	2

7 Instruction Quick Reference Table

Table 7-1

Name		Instruction
Read parameter（Holding register）		01 03 xx xx 00 0z（CRC omitted）
Read parameter（Input register）		01 04 xx xx 00 0z（CRC omitted）
Write parameter	Parameter size：1 register	01 06 xx xx yy yy（CRC omitted）
Write parameter	Parameter size：2 register	01 10 xx xx 00 02 04 yy yy yy yy（CRC omitted）
Relative move	Set the target position	01 10 00 53 00 02 04 yy yy yy yy（CRC omitted）
	Set the direction of movement	01 06 00 52 00 00 或 01 06 00 52 00 01（CRC omitted）
	Start	01 06 00 51 00 06（CRC omitted）
	Switch to position mode	01 06 00 39 00 01（CRC omitted）
	Start	01 06 00 51 00 06（CRC omitted）
	Enable	01 06 00 51 00 07（CRC omitted）
	Send control word 4F	01 06 00 51 00 4F（CRC omitted）
	Send control word 5F	01 06 00 51 00 5F（CRC omitted）
	Keep moving	Modify the target position and movement direction (if necessary), and successively send control words 4F and 5F.
Absolute move	Set the target position	01 10 00 53 00 02 04 yy yy yy yy（CRC omitted）
	Start	01 06 00 51 00 06（CRC omitted）
	Switch to position mode	01 06 00 39 00 01（CRC omitted）
	Start	01 06 00 51 00 06（CRC omitted）
	Enable	01 06 00 51 00 07（CRC omitted）
	Send control word 0F	01 06 00 51 00 0F（CRC omitted）
	Send control word 1F	01 06 00 51 00 1F（CRC omitted）
	Keep moving	Modify the target position and movement direction (if necessary), and successively send control words 0F and 1F.
Moving in velocity mode	Set the target speed	01 10 00 55 00 02 04 yy yy yy yy（CRC omitted）
	Set the direction of movement	01 06 00 52 00 00 or 01 06 00 52 00 01（CRC omitted）
	Start	01 06 00 51 00 06（CRC omitted）
	Switch to velocity mode	01 06 00 39 00 02（CRC omitted）
	Start	01 06 00 51 00 06（CRC omitted）
	Enable	01 06 00 51 00 07（CRC omitted）
	Send control word 0F	01 06 00 51 00 0F（CRC omitted）
	Modify the running speed	Modify the target speed and movement direction (if necessary), and send the control word 0F
Homing Method	Start	01 06 00 51 00 06（CRC omitted）
	Switch to the homing method	01 06 00 39 00 03（CRC omitted）
	Start	01 06 00 51 00 06（CRC omitted）
	Enable	01 06 00 51 00 07（CRC omitted）
	Send control word 0F	01 06 00 51 00 0F（CRC omitted）
	Send control word 1F	01 06 00 51 00 1F（CRC omitted）
Motor motion state switching	Start	01 06 00 51 00 06（CRC omitted）
	Enable	01 06 00 51 00 07（CRC omitted）
	Start	01 06 00 51 00 06（CRC omitted）
	Running	01 06 00 51 00 0F（CRC omitted）
	Enable	01 06 00 51 00 07（CRC omitted） Sending the above can be stopped while it is in operation
	Start	01 06 00 51 00 06（CRC omitted） Sending the above can be stopped while it is in operation

Name		Instruction
	Emergency stop	01 06 00 51 00 06（CRC omitted） or 01 06 00 51 00 02（CRC omitted） After making an emergency stop with control word 02, before the next exercise, you need to write control word 06 first.
Restore the parameters to the manufacturer's default values		01 06 00 0B 6C 64（CRC omitted）
Restore the parameters to the user-defined default values		01 06 00 0B 64 6C（CRC omitted）
Save the parameters to the manufacturer parameter list		01 06 00 08 73 76（CRC omitted）
Save the parameters to the user-defined parameter list		01 06 00 08 76 73（CRC omitted）
Hardware self-check		01 08 00 1A 00 00（CRC omitted） The motor is in a state where the power supply is disabled.
Obtain the latest alarm		01 08 00 19 00 00（CRC omitted）
Obtain the historical number of alarms		01 08 00 16 00 00（CRC omitted）
Obtain historical alarms		01 08 00 17 00 00（CRC omitted）
Clear historical alarms		01 08 00 18 00 00（CRC omitted）
Clear the faulty status of the equipment		01 06 00 51 00 80（CRC omitted） After the source of the fault has been cleared, sending this instruction can lift the fault status of the equipment.

Note：In the above table, "xx xx" represents the parameter address; "00 0z" indicates the number of registers; "yy yy yy yy" represents the specific parameter value.

8 Version information

Manual Version	Date	Revision History
A	2025.07.17	Establish

- The whole or part contents of this manual is prohibited from being reprinted or copied without authorization.
- Performance, specifications and appearance of products may change without prior notice due to improvements, please understand.
- We strive to make the contents of the manual as correct as possible. if you find any problems、 errors or omissions, please contact Beijing NiMotion Control Technology Co., Ltd.

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