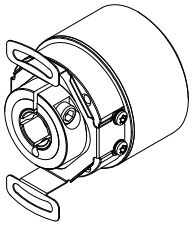
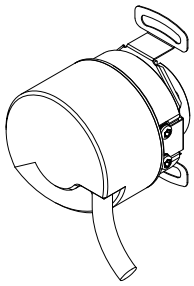
1. KM39 Absolute encoder (Blind shaft)

1.1 Introduction

KM39 is a blind shaft miniaturzed design, high precision photoelectric absolute encoder, capable of outputting 24Bits of single-turn position information, expandable up to 32Bits, can read up to 24Bits of multi -turn position information. The structure is sturdy and durable.

KM39-S





1.2 Feature:

- External diameter Ø39mm、thickness 41mm、diameter of shaft up to Ø10mm;
- Compact and sturdy structure;
- Adopt non-contact photoelectric reflection principle;
- Communication Protocol: BiSS-C 、SSI、Modbus RTU;
- System Accuracy: ±100";
- Single-turn resolution of 24Bits is expandable up to maximum 32Bits;
- Support multi-turn data recording without power failure, the maximum recording is 24 Bits.

1.3 Application:

Servo motor,robot and other industrial automations.

1.4 Connection:

Cable connection (length 1000mm)

1.5 Protection:

IP65

1.6 Weight:

about 130g

2. Model Selection Guide

Model composition(select parameters)

KM39-	S	10	B	24	16	R		D	-	000
Product model series	Connection S=Cable connection	Diameter of shaft: (Blind hoie) 6=Ø6mm 8=Ø8mm 10=Ø10mm	Communication Protocol: B=BISS-C (Binary) S=SSI (Binary) G=SSI (Gray) R=Modbus RTU (Standard protocol) ❶ H=Modbus RTU (Hengxiang protocol) ❷	Resolution Single-turn: 10=10Bits 11=11Bits 12=12Bits 13=13Bits 14=14Bits 15=15Bits 16=16Bits 17=17Bits 18=18Bits 19=19Bits 20=20Bits 21=21Bits 22=22Bits 23=23Bits 24=24Bits Other resolutions can be customized	Multi-turn: 10=10Bit 11=11Bit 12=12Bit 13=13Bit 14=14Bit 15=15Bit 16=16Bit 17=17Bit 18=18Bit 19=19Bit 20=20Bit 21=21Bit 22=22Bit 23=23Bit 24=24Bit Blank= no multi-turn	Electrical interface: R=RS-485	Supply voltage: Blank=DC5V H=DC8-30V	Special requirement: Blank=❸ D=IP65		Management No.

Communication:

❶. Modbus RTU Standard Protocol（Applicable only to resolutions of 16Bits or less. For detailed specifications, refer to P10～P14, Modbus RTU Standard Communiation Protocol Parameter Specifications）;

❷. Modbus RTU Hengxiang Protocol（For detailed specifications, refer to P15～P19, Modbus RTU Hengxiang Communication Protocol Parameter Specifications).

Special requirement:

❸. IP=50; cable length 1m, if need to change the length C+number, max 100m (indicated by C100).

3. Basic specification

3.1 Resolution

Communication Protocol	Single-turn(ST)		Multi-turn(MT)	
	Number of Bits	Number of Positions	Number of Bits	Number of Positions
BISS-C (Binary) SSI (Binary) SSI (Gray) Modbus RTU(Hengxiang Protocol)	5Bits……24Bits UP to 24bits as standard; expandable to a maximum of 32Bits.	2^5(0～+31)……2^{24}(0～+16777215) is standard.	5Bits……16Bits Up to 16 bits as standard; expandable to a maximum of 24 Bits.	2^5(0～+31)……2^{24}(0～+16777215) Maximum Number of Positions
Modbus RTU (Standard Protocol)	5Bits……16Bits Maximum 16Bits	2^5(0～+31)……2^{16}(0～+65535) Maximum Number of Positions	5Bits……16Bits Maximum 16Bits	2^5(0～+31)……2^{16}(0～+65535) Maximum Number of Positions

3.2 Specification parameter

Item	Parameter	Remarks
Sensing Principle	Photoelectric	
Electrical Interface	RS 485 (compatible with RS422)	
System Accuracy	±100″	
Repeatability	≤1 bit, depending on the resolution	
Response Speed	During normal operation：6000min^{-1}	
Position Data Jitter	±2 @16 Bits/r	
Communication Protocol	BiSS-C (Binary)	Refer to the BiSS-C standard
	SSI (Bianry/Gray Code)	Refer to the SSI standard
	Standard format for resolutions up to 16 bits，R=Modbus RTU (RS485)	See pages P10、P11、 P12、 P13、 P14 for details
	Hengxiang proprietary format for resolutions up to 32 bits，H=Modbus RTU (RS485)	See pages P15、P16、 P17、 P18、 P19 for details
Communication Clock Frequency	≤10 MHz(BiSS) or ≤5 MHz(SSI)	See pages P8 and P9 for frame information(data frame)
Baud Rate - Modbus RTU (RS485)	1200～115200	Default: 9600
Startup Time	Typical value：13 ms	
Absolute Position Sampling Period	≤75 ns	
Permissible Speed	≤32200 r/min	Limited by the machanical speed
Connection Method	Cable connection	See page P5 for details
Internal Single-turn Position Update Rate	15000kHz	Access rate is limited by the communication frequency
Internal Multi-turn Position Update Rate	11.5kHz	
Temperature Alarm Limits	-40℃～95℃	

3.3 Mechanical specification

Name	Parameter	Remark
Mechanical Connection	Ring locking with shaft, flexible spring plate fixed connection	
Diameter of shaft	Ø6mm、Ø8mm、Ø10mm(Blind hole, depth 20mm)	Pls refer to page 5 for dimensions
Shaft material	Stainless steel	
Starting Torque	less than 9.8×10^{-3} N·m	
Inertia Moment	less than 6.5×10^{-6} kg·m²	
Shaft load	Radial 30N; Axial 20N	
Allowed speed	≤6000 rpm(IP50); ≤5000 rpm(IP65)	
Shell material	Aluminium alloy	
Weight	about 130g	

3.4 Environmental specification

Name	Parameter
Environmental temperature	Operaing：－40～95℃
	Storage：－40～+95℃
Environmental humidity	Operating and storage:35～85%RH (Noncondensing)
Vibration	Amplitude 1.52mm ,5～55HZ,2h for X,Y,Z direction individually
Shock	980m/s² 11ms three times for X,Y,Z direction individually
Protection	IP50 & IP65

4. Electrical Characteristics

4.1 Absolute maximum ratings

Symbol	Descriptions	Minimum	Maximum	Unit
Vcc	Supply Voltage	-0.3	+6.0	V
V_{BAT}	Backup Voltage	-0.3	+6.0	V
T_{STG}	Storage Temperature	-40	+85	° C
T_J	Junction Temperature	-40	+100	° C

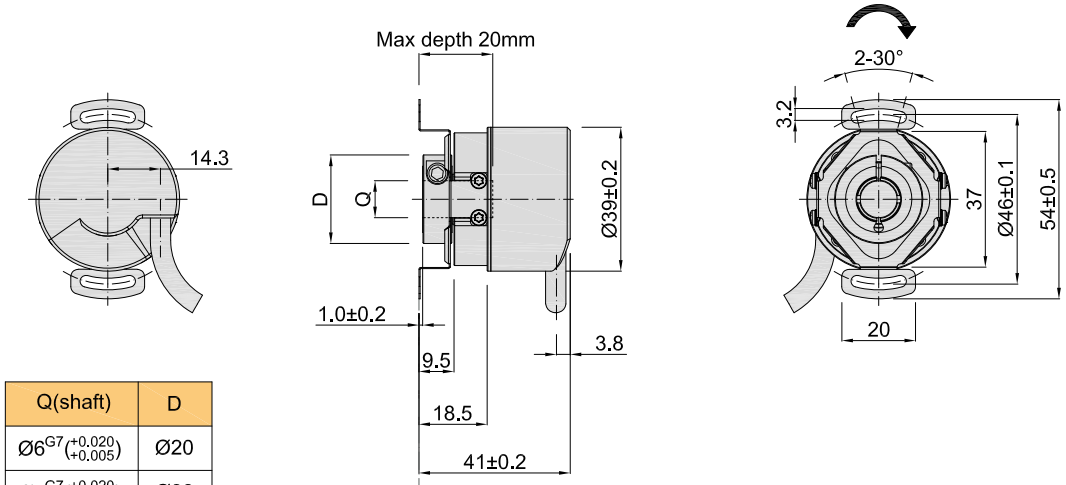
4.2 Electrical parameters

Symbol	Descriptions	Minimum	Typical value	Maximum	Unit
Vcc	Supply Voltage DC5V	4. 75	5. 0	5. 5	V
	Supply Voltage DC8-30V	7. 75	30. 0	32. 0	V
I_{DD}	Operating Current	–	–	120	mA
V_{BAT}	Backup Voltage ❶	3. 0	3. 6	4. 2	V
$I_{(BAT)}$	Backup Current	–	–	35	uA
f_{BISS} ❷	BISS-C Communication Clock Frequency	–	–	10	MHz
	SSI Communication Clock Frequency	–	–	5. 0	MHz
Modbus RTU (RS485)	Baud Rate	1200	9600（默认）	115200	Baud
	Slave Address	1	1（默认）	127	–
	Internal Refresh Cycle	–	–	＜50	us
Ta	Operating Temperature	−40	–	+95	℃

❶ For the power supply sequence of multi-turn absolute encoders, be sure to power on the system after the battery has been powered up.
❷ Pls refer to BiSS-C and SSI standards.

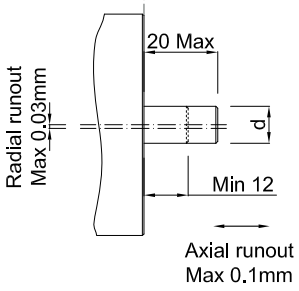
5. Basic dimensions

5.1. Encoder dimensions



Q(shaft)	D
$Ø6^{G7}(^{+0.020}_{+0.005})$	Ø20
$Ø8^{G7}(^{+0.020}_{+0.005})$	Ø22
$Ø10^{G7}(^{+0.020}_{+0.005})$	Ø24

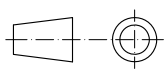
5.2. Specification for mounting shaft



d
$Ø6_{g6}(^{-0.005}_{-0.014})$
$Ø8_{g6}(^{-0.005}_{-0.014})$
$Ø10_{g6}(^{-0.005}_{-0.014})$

Mounting screws
Inner hexagon bolt +flat washer Specification: M3*6 Material: stainless steel Quantity: 2

Unit: mm




= Shaft rotation direction of the signal output

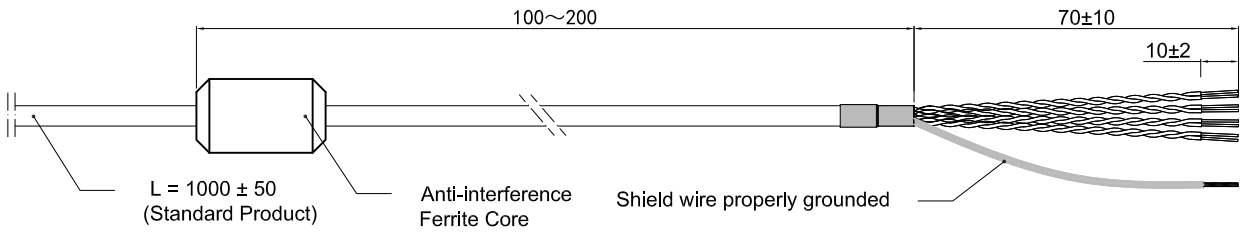
6. Interface Definition

6.1 Functional definition of wire colors BISS-C / SSI / Modbus RTU

Wire colors	BISS-C		SSI		Modbus RTU		Function	Twisted-paired cable
	ST	MT	ST	MT	ST	MT		
Red	Up	Up	Up	Up	Up	Up	Power positive	
Black	Un	Un	Un	Un	Un	Un	Power negative	
White	SL-	SL-	DATA-	DATA-	485A+	485A+	Data signal	
White/BK	SL+	SL+	DATA+	DATA+	485B-	485B-	Data signal	
Green	N.C.	N.C.	N.C.	N.C.	SET	SET	Encoder Reset and Setting Wire❶	
	MA-	MA-	CLOCK-	CLOCK-	N.C.	N.C.	Clock signal	
Green/BK	MA+	MA+	CLOCK+	CLOCK+	N.C.	N.C.	Clock signal	
Yellow	N.C.	Vbat	N.C.	Vbat	N.C.	Vbat	备份电源正	
Yellow/BK	N.C.	0V	N.C.	0V	N.C.	0V	备份电源负	
GND No encoder body connected								

❶ After power-on, short the SET wire to Up for a certain period of time (T), then disconnect it to active the corresponding function.
2s < T < 10s: Resets the encoder position data (single-turn: default value 0; multi-turn: default midpoint value).
10s < T < 60s: Restores the encoder to its initial settings (default serial communication parameters: 9600/N/8N1; slave address: 1).
During normal operation, connect the SET wire to Un to prevent interference.

6. 2 Cable connection ❷



Unit: mm

❷ The standard factory cable length is 1.0 m. Optional cable lengths of up to 10 m are available.

7. Electrical Connection

Electrical Connection Diagram

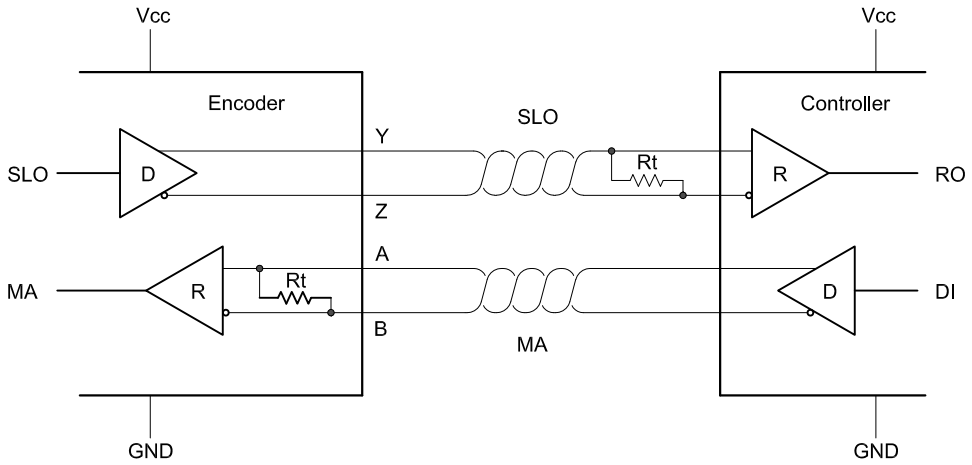
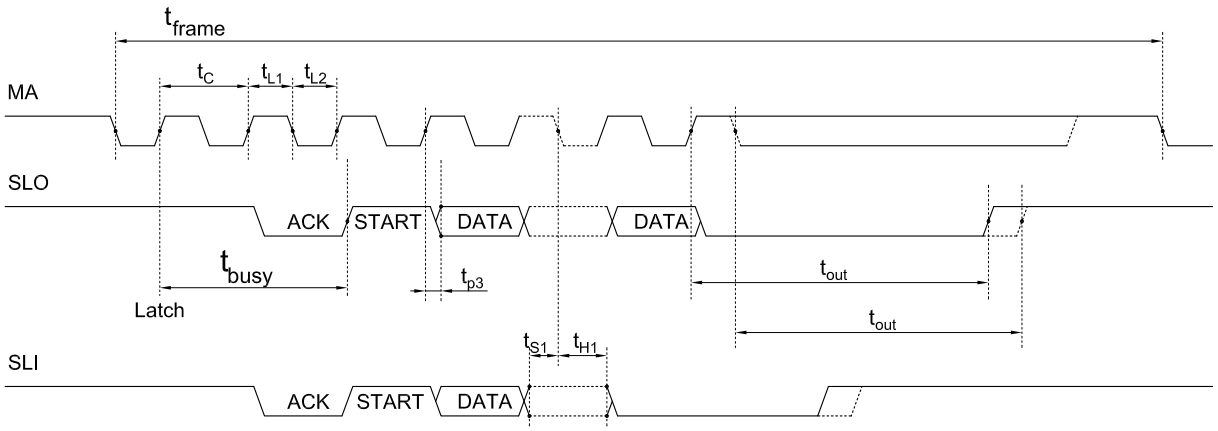


Figure 1: Point-to-Point Connection

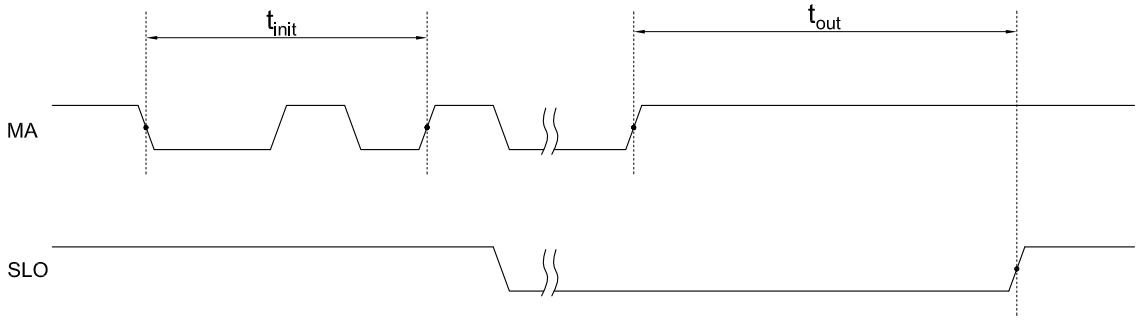
Note: The MA and SLQ lines use differential twisted-pair transmission via RS485 (compatible with RS422). The termination resistor for the MA transmission line is integrated inside the encoder.

8 BiSS-C Communication Protocol

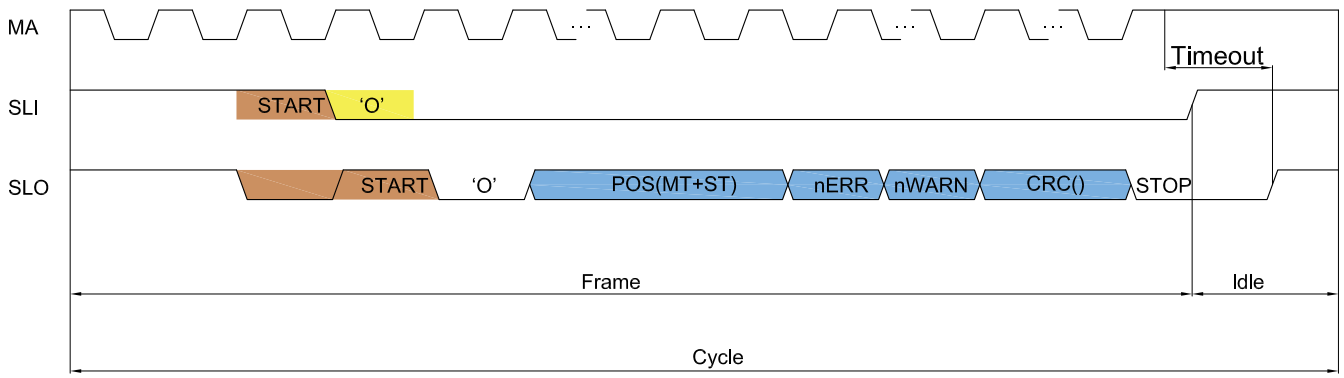
8.1 BISS-C Timing Diagram



8.2 BISS-C Slave Timeout TIming

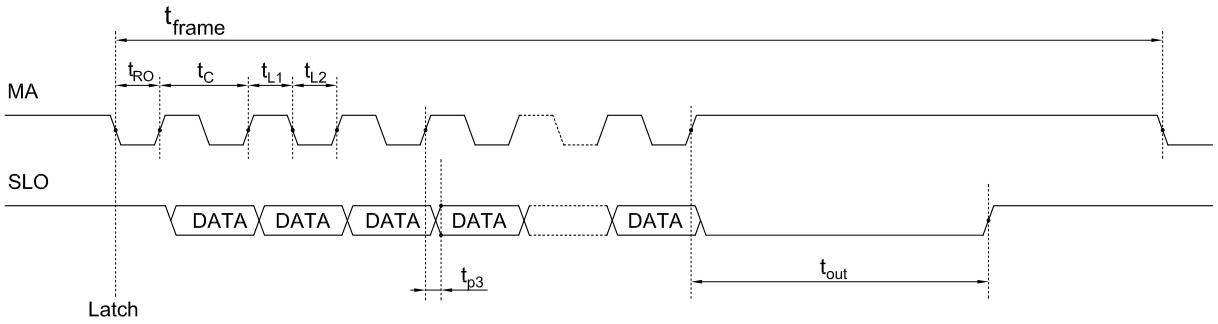


8.3 BISS-C Frame Structure

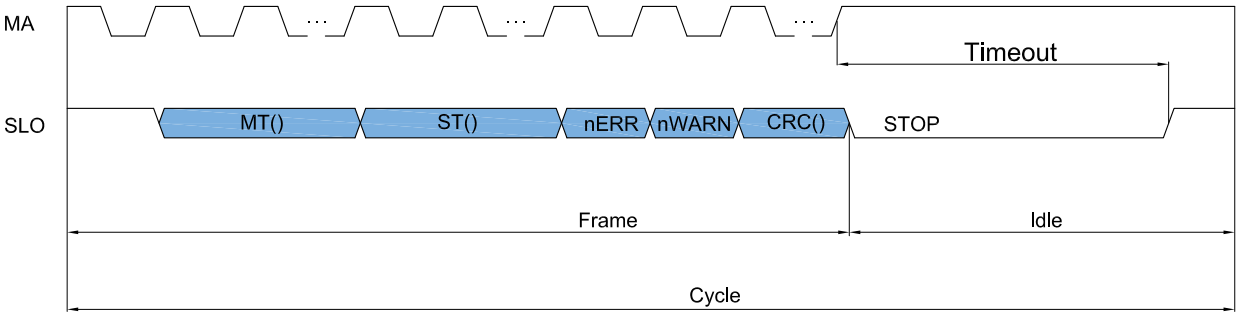


9 SSI Communication Protocol

9.1 SSI Timing Diagram



9.2 SSI Data Frame Structure



9.3 SSI Data Field

The data frame consists of the frame structure and the data to be transmitted. Data is transmitted MSB first.

The error bit and warning bit are active low, and the CRC bits are output with inverted logic levels.

The detailed data composition is shown in the table below:

Bits No.	Data Field	Instruction
[55:32]	MT[23:0]	Records the accumulated number of revolutions after the encoder is powered on
[31:8]	ST[23:0]	Current absolute position data
[7]	nERR	Error bit, active low
[6]	nWARN	Warning output, active low
[5:0]	CRC[5:0]	CRC bits: polynomial 0x43, initial value 0 (output with inverted logic levels)

10. Modbus RTU Standard Communication Protocol (Applicable Only to Resolutions of 16 Bits or Less)

10.1 Introduction to Modbus RTU

Modbus RTU is a master-slave communication protocol. The encoder operates as a slave device, receiving data request commands from a master device, such as PLC or microcontroller, and returning the requested data.
A single RS-485 bus can support up to 127 slave devices, making the protocol suitable for both single-master/single-slave single-master/multiple-slave applications.

The encoder supports a simplified Modbus RTU protocol with function codes 03H, 06H, and10H.

CRC-16 is used for error checking, with the low-order byte transmitted first, followed by the high-order byte.

10.2 Function Code 03H (Read Holding Registers)

Master Request:

Byte	1	2	3	4	5	6	7	8
Content	ADR	0x03	Starting Register Address High Byte	Starting Register Address Low Byte	Number of Registers High Byte	Number of Registers Low Byte	CRC Low Byte	CRC High Byte
Description	Slave Address	Function Code	Starting Register Address		Number of Registers		CRC Check	

Encoder Response:

Byte	1	2	3	4、5	◦ ◦	M−1、M	M+1	M+2
Content	ADR	0x03	Total Number of Bytes	Register Data 1	◦ ◦	Register Data M	CRC Low Byte	CRC High Byte
Description	Slave Address	Function Code	From 4 to M		Data, Two Bytes		CRC Check	

10.3 Function Code 06H (Write Single Register)

Master Request:

Byte	1	2	3	4	5	6	7	8
Content	ADR	0x06	Register Address High Byte	Register Address Low Byte	Register Data High Byte	Register Data Low Byte	CRC Low Byte	CRC High Byte
Description	Slave Address	Function Code	Register Address		Data to Be Written		CRC Check	

Encoder Response:

Byte	1	2	3	4	5	6	7	8
Content	ADR	0x06	Register Address High Byte	Register Address Low Byte	Register Data High Byte	Register Data Low Byte	CRC Low Byte	CRC High Byte
Description	Slave Address	Function Code	Register Address		Data to Be Written		CRC Check	

10.4 Function Code 10H (Write Multiple Registers)

Master Request:

Byte	1	2	3	4	5	6	7	8、9	10、11	N、N+1	N+2	N+3
Content	ADR	0x10	Starting Register Address High Byte	Starting Register Address Low Byte	Number of Registers High Byte	Number of Registers Low Byte	Byte Count	Data 1	Data 2	Data M	CRC Low Byte	CRC High Byte
Description	Slave Address	Function Code	Starting Register Address		Number of Registers		Number of Registers*2	Data to Be Written			CRC Check	

Encoder Response:

Byte	1	2	3	4	5	6	7	8
Content	ADR	0x10	Starting Register Address High Byte	Starting Register Address Low Byte	Number of Registers High Byte	Number of Registers Low Byte	CRC Low Byte	CRC High Byte
Description	Slave Address	Function Code	Starting Register Address		Number of Registers		CRC Check	

10.5 Modbus RTU Register List

Address	Description	Supported Function Code	Value Range	Default Value	Remarks
0x0000	Single-turn value	03H	0～65535		
0x0001	Number of turns	03H	0～65535		For a single-turn encoder, this value is fixed at 0.
0x0002	Slave address	03H/06H/10H	0～127	1	
0x0003	Baud Rate	03H/06H/10H	0x01～0x08	0x01	0x01：9600 0x02：19200 0x03：38400 0x04：57600 0x05：115200 0x06：4800 0x07：2400 0x08：1200
0x0004	Parity	03H/06H/10H	0x01～0x03	0x01	0x01：No parity 0x02：Odd parity 0x03：Even parity
0x0005	Encoder Zero Reset	06H/10H	0xFF		Write 0xFF to this register to reset the zero position
0x0006	Increment Direction	03H/06H/10H	0x01～0x02	0x01	0x01: Clockwise increment 0x02: Counterclockwise increment
0x0007	Communication Protocol	03H/06H/10H	0x01～0x02	0x01	0x01: Modbus RTU 0x02: RS485 Custom Protocol （Takes effect after restart）
0x0008	Upload Interval	03H/06H/10H	1~3000	10	Unit: ms. Valid only for RS485 custom protocol
0x0009	Encoder Value	03H			High 16 Bits of encoder value
0x000A		03H			Low 16 Bits of encoder value
0x000B	Rotation Direction	03H	0～2	0	0：Stop 1：Clockwise 2：Counterclockwise
0x000C	Rotation Speed	03H			Unit: RPM; Resolution: 1RPM
0x0023	Zero-position reference	03H/06H/10H	1～2	1	1: Midpoint 2: Zero; valid for multi-turn encoders
0x0024	Speed Sampling Period	03H/06H/10H	1～200	1	Unit: 10ms
0x0032	Set Current Encoder Value	10H			Low 16 bits of current encoder value
0x0033					High 16 bits of current encoder value
0x400	Encoder Value	03H			Low 16 bits of encoder value
0x401		03H			High 16 bits of encoder value

10.6 Modbus RTU Standard Protocol Communication Examples
(Example: 10-bit single-turn and 12-bit multi-turn)

10.6.1 Read Encoder Values (Read Single-turn and multi-turn Values Separately)

Master Request	01	03	00	00	00	02	C4	0B
	Slave Address	Function Code	Starting Register Address		Read two Registers: 0x00 and 0x01		CRC Check	
Encoder Response	01	03	04	01	D7	02	09	8A	91
	Slave Address	Function Code	Byte Count	Single-turn Value, High Byte First		Multi-turn Value, High Byte First		CRC Check	

Read two register 0x0000 and 0x0001 to obtain the single-turn and multi-turn values, respectively.
The returned single-turn value is 0x01D7, which is 471 in decimal.
The returned number of turns is 0x0209, which is 512 turns in decimal.
Single-turn angle = (471/1024) *360°=165.59°.
Total angle = single-turn angle + number of turns * 360.
For a single-turn encoder, the number of turns is always 0.

10.6.2 Read Encoder Value(Read Total Encoder Value)

Master Request	01	03	00	09	00	02	14	09
	Slave Address	Function Code	Starting Register Address		Read two Registers: 0x09 and 0x0A		CRC Check	
Encoder Response	01	03	04	00	20	08	CB	BD	AE
	Slave Address	Function Code	Byte Count	Total Encoder value, 4 Bytes, High Byte First			CRC Check	

Read two register 0x0009 and 0x000A.The response contains 4 bytes (32 bits). In this example, the encoder uses 12 bits for the multi-turn value and 10 bits for the single-turn value, for a total of 22 bits.
Of the returned 32-bit data, only the lower 22 bit are used; the upper 10 bits are always 0.
The total encoder value 0x002008CB converts to 2099403 in decimal.
Divide the encoder value by the single-turn resolution. The integer quotient is the number of turns, and the remainder is the single-turn value.
2099403÷1024 gives an integer quotient of 2050 and a remainder of 203. Therefore, the current number of turns is 2050 and the single-turn value is 203.

10.6.3 Set Encoder Address (Change Slave Address from 1 to 2)

Master Request	01	06	00	02	00	02	A9	CB
	Slave Address	Function Code	Register Address		Write Slave Address 2		CRC Check	
Encoder Response	01	06	00	02	00	02	A9	CB
	Slave Address	Function Code	Register Address		Write Slave Address 2		CRC Check	

10.6.4 Set Encoder Zero Position

Master Request	01	06	00	05	00	0xFF	D9	8B
	Slave Address	Function Code	Register Address		Write Zero-reset Command 0xFF		CRC Check	
Encoder Response	01	06	00	05	00	0xFF	D9	8B
	Slave Address	Function Code	Register Address		Write Slave Address 2		CRC Check	

This function takes effect immediately. The encoder sets the current position as the zero position.

10.6.5 Set an Arvitrary Value as the Current Encoder Value

Master Request	01	10	00	32	00	02	04	03	E8	00	00	F1	12
	Slave Address	Function Code	Register Address		Number of registers		Bytes Count	Total Value to Be Written				CRC Check	
Encoder Response	01	10	00	32	00			02				D9	8B
	Slave Address	Function Code	Register Address		Number of Registers							CRC Check	

The data to be written is 0x000003E8, which is 1000 in decimal.
This function takes effect immediately. The current total encoder value is set to 1000.
The value to be written must not exceed the maximum range of the encoder.

10.7 Modbus RTU Standrad Protocol Zero Position Setting Methods

10. 7. 1 Zero Setting Via Wiring：

After the encoder is powered on and operating normally, connect the SET wire to Up for more than 2 seconds but less than 10 seconds, then disconnect it. The encoder will be reset to zero.
When the SET wire (green wire) is not in use, connect it to Un to prevent interference.

10. 7. 2 Zero Setting via Command：

The host sends a command to the encoder to force the encoder position to zero.
Command-based zero setting is available only in Modbus RTU mode. Write 0xFF to register 0x05 to reset the encoder position to zero.

10. 7. 3 Example：

After the factory default zero setting, the output value of a multi-turn encoder is set to the midpoint. Taking a 12-bit single-turn value (2048) and a 10-bit multi-turn value (1024) as an example:
After zero settings, the single-turn value is 0 and the number of turns is 512.
After zero settings, register 0x00, contains 0 and register 0x01 contains 512.
If registers 0x09 and 0x0A are read, the 32-bit data after zero setting is represented in binary as follows:

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

* If a value of 0 or any specified value is required after zero settings, it can be configured through the corresponding registers.

10.8 Modbus RTU Factory Reset Methods

10.8.1 Method 1：

After encoder is powered on normally, apply a high level to the SET wire (green wire), i.e. connect it to the Up power supply wire. Maintain this connection for more than 10 seconds but less than 60 seconds to restore the encoder to its factory settings.

10.8.2 Method 2:

When powering on the encoder, power the SET wire (green wire) and the Up power supply wire simultaneously. After 2 seconds, the encoder will be restored to its factory settings.
After the reset, connect the SET wire (green wire) to GND to prevent interference. Power-cycle the encoder, and it will then operate normally.

10.9 Modbus RTU Default Parameters

Baud Rate	9600bps
Parity	None
Encoder Address	0x01

11. Modbus RTU Standard Protocol – Auxiliary Function: Custom Protocol

The custom protocol is supported only when the Modbus RTU standard protocol is selected.
In this mode, the encoder periodically transmits real-time data without requiring polling commands from the master device.
This mode can increase the RS-485 communication rate to a maximum of 1 kHz (the encoder baud rate must be set to 115200 bps or higher).

The user can enable the custom protocol using the configuration tool or by sending a command.
After a power cycle, once the custom protocol takes effect, the encoder continuously transmits data and no longer accepts any commands.

To modify the parameters, restore the encoder to Modbus RTU communication mode as described in the initialization section, modify the parameters,
and then switch back to the custom protocol.

The data format in Custom Protocol mode is as follows:

Frame Header		Data Length	Encoder Data				Sum Check	XOR Check	Frame End
0xAB	0xCD	0x05	0x00	0x23	0x02	0x34	Check code	Check code	0x3D
Fixed Value			Number of Turns, High Byte	Number of Turns, Low Byte	Single-turn Value, High Byte	Single-turn Value, Low Byte	—	—	Fixed Value

- Sum check = 0x05 + high byte of number of turns + low byte of number of turns + high byte of single-turn value + low byte of single-turn value.
- XOR check = 0x05 ^ high byte of number of turns ^ low byte of number of turns ^ high byte of single-turn value ^ low byte of single-turn value.
- The number of turns is 0x0023, which is 35 in decimal.
- The single-turn value is 0x0234, which is 564 in decimal.

Once the device is switched to Custom Protocol mode, the Modbus Tool cannot be used. The current data can be viewed using a serial port terminal. Command-based zero setting is not supported in Custom Protocol mode. Zero setting can only be performed using the external SET wire: after power-on, connect the green wire (SET) to the red wire (Up) for more than 2 seconds but less than 10 seconds (2s < t < 10s), then disconnect it. The encoder will be reset to zero.

12. Modbus RTU Hengxiang Protocol (Applicable to Resolutions of 32 Bits or Less)

12.1 Introduction to Modbus RTU

Modbus RTU is a master-slave protocol. The encoder operates as a slave device. A master device, such as a PLC or microcontroller, sends data request commands to the encoder, and the encoder responds with the requested data.
Up to 127 slave devices can be connected to a single RS-485 bus, making it suitable for single-master/multiple-slave applications.

The encoder supports a simplified Modbus RTU protocol with function codes 03H, 06H, and 10H.

CRC-16 is used for error checking, with the low-order byte transmitted first and the high-order byte transmitted second.

12.2 Function Code 03H (Read Holding Registers)

Master Request:

Byte	1	2	3	4	5	6	7	8
Content	ADR	0x03	Starting Register Address High Byte	Starting Register Address Low Byte	Number of Registers High Byte	Number of Registers Low Byte	CRC Low Byte	CRC High Byte
Description	Slave Address	Function Code	Starting Register Address		Number of Registers		CRC Check	

Encoder Response:

Byte	1	2	3	4、5	◦ ◦	M−1、M	M+1	M+2
Content	ADR	0x03	Total Number of Bytes	Register Data 1	◦ ◦	Register Data M	CRC Low Byte	CRC High Byte
Description	Slave Address	Function Code	From 4 to M		Data, Two Bytes		CRC Check	

12.3 Function Code 06H (Write Single Register)

Master Request:

Byte	1	2	3	4	5	6	7	8
Content	ADR	0x06	Register Address High Byte	Register Address Low Byte	Register Data High Byte	Register Data Low Byte	CRC Low Byte	CRC High Byte
Description	Slave Address	Function Code	Register Address		Data to Be Written		CRC Check	

Encoder Response:

Byte	1	2	3	4	5	6	7	8
Content	ADR	0x06	Register Address High Byte	Register Address Low Byte	Register Data High Byte	Register Data Low Byte	CRC Low Byte	CRC High Byte
Description	Slave Address	Function Code	Register Address		Data to Be Written		CRC Check	

12.4 Function Code 10H (Write Multiple Registers)

Master Request:

Byte	1	2	3	4	5	6	7	8、9	10、11	N、N+1	N+2	N+3
Content	ADR	0x10	Starting Register Address High Byte	Starting Register Address Low Byte	Number of Registers High Byte	Number of Registers Low Byte	Byte Count	Data 1	Data 2	Data M	CRC Low Byte	CRC High Byte
Description	Slave Address	Function Code	Starting Register Address		Number of Registers		Number of Registers*2	Data to Be Written			CRC Check	

Encoder Response:

Byte	1	2	3	4	5	6	7	8
Content	ADR	0x10	Starting Register Address High Byte	Starting Register Address Low Byte	Number of Registers High Byte	Number of Registers Low Byte	CRC Low Byte	CRC High Byte
Description	Slave Address	Function Code	Starting Register Address		Number of Registers		CRC Check	

12.5 Modbus RTU Hengxiang Protocol Register List

Address	Description	Supported Function Code	Value Range	Default Value	Remarks
0x0000	Single-turn Position - Low 16 Bits	03H	0～4294967295		
0x0001	Single-turn Position - High 16 Bits				
0x0002	Turn Count - Low 16 Bits	03H	0～4294967295		Fix at 0 for a single-turn encoder
0x0003	Turn Count - High16 Bits				
0x0004	Slave Address	03H/06H/10H	0～127	1	
0x0005	Baud Rate	03H/06H/10H	0x01～0x08	0x01	0x01：9600 0x02：19200 0x03：38400 0x04：57600 0x05：115200 0x06：4800 0x07：2400 0x08：1200
0x0006	Parity	03H/06H/10H	0x01～0x03	0x01	0x01：No parity 0x02：Odd parity 0x03：Even parity
0x0007	Encoder Zero Reset	06H/10H	0xFF		Write 0xFF to this register to reset the zero position
0x0008	Increment Direction	03H/06H/10H	0x01～0x02	0x01	0x01: Increment clockwise 0x02: Increment counterclockwise
0x0009	Communication Protocol	03H/06H/10H	0x01～0x02	0x01	0x01: Modbus RTU 0x02: RS485 Custom Protocol （Takes effect after restart）
0x000A	Upload Interval	03H/06H/10H	1-3000	10	Unit: ms. Valid only for RS485 Custom Protocol
0x000B 0x000C	Encoder Value	03H			High 32 Bits of encoder value
0x000D 0x000E		03H			Low 32 Bits of encoder value
0x000F	Rotation Direction	03H	0～2	0	0：Stop 1：Clockwise 2：Counterclockwise
0x0010	Rotation Speed	03H			Unit: r/min; resolution: 1 r/min
0x0023	Origin Position	03H/06H/10H	1～2	1	1: Midpoint 2: Zero; valid for multi-turn encoders
0x0024	Speed Sampling Period	03H/06H/10H	1～200	1	Unit: 10ms
0x0032 0x0033	Write Current Encoder Value	10H			Low 32 bits of current encoder value
0x0034 0x0035					High 32 bits of current encoder value
0x400 0x401	Encoder Value	03H			Low 32 bits of encoder value
0x402 0x403		03H			High 32 bits of encoder value

12.6 Modbus RTU Hengxiang Protocol Communication Examples
(Example: 10-bit single-turn and 12-bit multi-turn)

12.6.1 Read Encoder Values (Read Single-turn and multi-turn Values Separately)

Master Request	01	03	00			00		00			04	44	09
	Slave Address	Function Code	Starting Register Address					Read four Register: 0x00，0x01，0x02，0x03				CRC Check	
Encoder Response	01	03	08	00	00	01	D7	00	00	02	09	21	72
	Slave Address	Function Code	Byte Count	单圈值高16位		单圈值低16位		多圈值高16位		多圈值低16位		CRC Check	

Read four registers 0x0000，0x0001，0x0002，and 0x0003 to obtain the single-turn and multi-turn values, respectively.
The returned single-turn value is 0x000001D7, which is 471 in decimal.
The returned number of turns is 0x00000209, which is 512 turns in decimal.
Single-turn angle = (471 / 1024) *360° = 165.59°.
Total angle = single-turn angle + number of turns * 360.
For a single-turn encoder, the number of turns is always 0.

12.6.2 Read Encoder Value (Read the Total Encoder Value)

Master Request	01	03	00			0B		00			04	35	CB
	Slave Address	Function Code	Starting Register Address					Read four Register: 0x0B，0x0C，0x0D，0x0E				CRC Check	
Encoder Response	01	03	08	00	00	00	00	00	20	08	CB	52	47
	Slave Address	Function Code	Byte Count	Total Encoder value, 8 Bytes, High Byte First								CRC Check	

Read four registers 0x000B, 0x000C, 0x000D, and 0x000E. The response contains 8 bytes (64 bits). In this example, the encoder uses 12 bits for the multi-turn value and 10 bits for the single-turn value, for a total of 22 bits.
Of the returned 64-bit data, only the lower 22 bits are used; the upper 42 bits are always 0.
The total encoder value 0x00000000002008CB converts to 2099403 in decimal.
Divide the encoder value by the single-turn resolution. The integer quotient is the number of turns, and the remainder is the single-turn value. 2099403÷1024 gives a quotient of 2050 and a remainder of 203. Therefore, the current number of turns is 2050 and the single-turn value is 203.

12.6.3 Set Encoder Address (Change Slave Address from 1 to 2)

Master Request	01	06	00	04	00	02	49	CA
	Slave Address	Function Code	Register Address		Write Slave Address 2		CRC Check	
Encoder Response	01	06	00	04	00	02	49	CA
	Slave Address	Function Code	Register Address		Write Slave Address 2		CRC Check	

12.6.4 Set Encoder Zero Position

Master Request	01	06	00	07	00	0xFF	78	4B
	Slave Address	Function Code	Register Address		Write Zero-reset Command 0xFF		CRC Check	
Encoder Response	01	06	00	07	00	0xFF	78	4B
	Slave Address	Function Code	Register Address		Write Slave Address 2		CRC Check	

This function takes effect immediately. The encoder sets the current position as the zero position.

12.6.5 Set an Arbitrary Value as the Current Encoder Value

Master Request	01	10	00	32	00	04	03	E8	00	00	00	00	00	00	48	33
	Slave Address	Function Code	Register Address		Number of registers		Total Value to Be Written								CRC Check	
Encoder Response	01	10	00	32	00				04						60	5
	Slave Address	Function Code	Register Address		Number of Registers										CRC Check	

The data to be written is 0x0000000000003E8, which is 1000 in decimal.
This function takes effect immediately. The current total encoder value is set to 1000.
The value to be written must not exceed the maximum range of the encoder.

12.7 Modbus RTU Hengxiang Protocol - Zero Position Setting Methods

12. 7. 1 Zero Setting Via Wiring：

After the encoder is powered on and operating normally, connect the SET wire to Up for more than 2 seconds but less than 10 seconds, then disconnect it. The encoder will be reset to zero.
When the SET wire (green wire) is not in use, connect it to Un to prevent interference.

12. 7. 2 Zero Setting via Command：

The host sends a command to the encoder to force the encoder position to zero.
Command-based zero setting is available only in Modbus RTU mode. Write 0xFF to register 0x0007 to reset the encoder position to zero.

12. 7. 3 Example：

After the factory default zero setting, the output value of a multi-turn encoder is set to the midpoint. Taking a 12-bit single-turn value (2048) and a 10-bit multi-turn value (1024) as an example:
After zero settings, the single-turn value is 0 and the number of turns is 512.
After zero settings, register 0x00 contains 0 and register 0x02 contains 512.
If registers 0x0B, 0x0C, 0X0D and 0x0E are read, the 64-bit data after zero setting is represented in binary as follows:

63 62 61 60 59 58 57 56 55 54 53 52 51 50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0

31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 09 08 07 06 05 04 03 02 01 00
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

* If a value of 0 or any specified value is required after zero settings, it can be configured through the corresponding registers.

12.8 Modbus RTU Factory Reset Methods

12.8.1 Method 1：

After the encoder is powered on and operating normally, apply a high level to the SET wire (green wire), i.e. connect it to the Up power supply wire.
Maintain this connection for more than 10 seconds but less than 60 seconds to restore the encoder to its factory settings.

12.8.2 Method 2:

Before powering on the encoder, connect the SET wire (green) to Up. Then power on the encoder while maintaining the connection.
After 2 seconds,the encoder will be restored to its factory settings.
After the reset, connect the SET wire (green) to Un (0V/GND) to prevent interference. Power-cycle the encoder, and it will then operate normally.

12.9 Modbus RTU Default Parameters

Baud Rate	9,600bps
Parity	None
Encoder Address	0x01

13. Modbus RTU Hengxiang Protocol - Auxiliary Function: Custom Protocol：

The custom protocol is supported only when the Modbus RTU Hengxiang Protocol is selected.
The host does not need to send query commands; the encoder periodically transmits real-time values.
This method can increase the RS485 communication update rate to a maximum of 1 kHz
(the encoder baud rate must be 115,200 bps or higher).

The user can set the operating mode to the custom protocol using the configuration tool or by sending a command.
Once the setting takes effect after a power cycle, the encoder will continuously transmit data and will no longer accept any commands.
To configure parameters again, restore the encoder to Modbus RTU communication mode, modify the parameters, and then switch it back to the custom protocol.

To restore the custom protocol to Modbus RTU mode, refer to the initialization section.

The data format in Custom Protocol mode is as follows:

Frame Header		Data Length	Encoder Data								Sum Check	XOR Check	Frame End
0xAB	0xCD	0x09	0x00	0x00	0x00	0x23	0x00	0x00	0x02	0x34	Check code	Check code	0x3D
Fixed Value			High 16 Bits of turn Count		Low 16 Bits of turn Count		High 16 Bits of single-turn Value		Low 16 Bits of single-turn Value		—	—	Fixed Value

- Sum check = 0x09 + high 16 bits of the number of turns + low 16 bits of the number of turns + high 16 bits of single-turn value + low 16 bits of single-turn value.
- XOR check = 0x09 ^ high 16 bits of the number of turns ^ low 16 bits of the number of turns ^ high 16 bits of single-turn value ^ low 16 bits of single-turn value.
- The number of turns is 0x00000023, which is 35 in decimal.
- The single-turn value is 0x00000234, which is 564 in decimal.

Once the device is switched to Custom Protocol mode, the Modbus Tool cannot be used. The current data can be viewed using a serial terminal. Command-based zero setting is not supported in Custom Protocol mode. Zero setting can only be performed using the external SET wire: after power-on, connect the green wire (SET) to the red wire (Up) for more than 2 seconds but less than 10 seconds (2 s < t < 10 s), then disconnect it. The encoder will be reset to zero.

13. Precautions

13.1 Operating Precautions

- The working temperature shall not exceed the storage temperature.
- The working humidity shall not exceed the storage humidity.
- Do not use the encoder in environments subject to sudden temperature changes or condensation.
- Do not close to corrosive and flammable gas.
- Keep away from water, salt powder, and metal powder.
- Keep away from places exposed to water, oil, or chemicals.
- Undue vibration and shock will impact the encoder.

13.2 Installation Precautions

- Electrical components should not be subjected to excessive pressure, etc., and electrostatic assessment of the installation environment should be conducted.
- Do not route the motor power cable close to the encoder.
- The FG wire of the motor and mechanical device should be grounded.
- The shielding wire must be effectively grounded since the shielding is not connected to the encoder.

13.3 Wiring Precautions

- Use the encoder under the specified supply voltage. Please note that the supply voltage range may drop due to the wiring length.
- Do not put the encoder wiring and other power lines through the same duct, and do not use them by bundling in parallel.
- Please use twisted pair wires for the signal and power wires of encoder.
- Do not apply excessive force to the encoder cable, as this may cause the cable to break.