RAA50.1C10系列
编码器使用说明

诚信铸就品质

创新引领未来

长春荣德光学有限公司
Changchun Rongde Optics Co.,Lt

www.roundss.net

1. Securit Matters:

When using this product, please adhere to the following important precautions to prevent malfunctions and unintended actions. Use this product only after fully understanding the following content.

1.1 Precautions for Storage, Transportation, and Setup:

1.1.1 Do Not Store or Configure in the Following Environments:

- Sunshine direct exposure;
- places where the ambient temperature exceeds the storage and setting temperature conditions;
- relative humidity exceeding the storage and setting humidity conditions;
- places where temperature changes rapidly and condensation is likely to occur;
- Corrosive gases*1 (hydrogen sulfide, sulfurous acid, chlorine, ammonia, etc.) and flammable gases in nearby areas; (**If installed in other special gas environments, customers must conduct their own tests before use. This product is not guaranteed for use in special gas environments.)**
- radiation environment or a place exposed to radiation;
- locations with high concentrations of dust, particulate matter, salt, and metal powders;
- places where water, oil, or chemicals are easily accessible;
- excessive vibration and impact may be transmitted to the main body of the site;
- **Please note that corrosive gases may be generated not only from the surrounding environment but also from the volatilization of components such as grease around the encoder.**

1.2 Installation Notes:

1.2.1 Follow the Manual for Assembly and Adjustment During Installation.

- Ensure proper environmental setup to prevent oil, foreign objects, or other contaminants from entering the encoder.
- When securing the screws and bolts for the fixed encoder, ensure they are loosened during installation.
- Implement electrostatic countermeasures in the setup environment to prevent electrical components from being subjected to overvoltage.
- If the encoder is subjected to vibration or impact, it may malfunction or operate incorrectly. Please carefully verify the installation environment.
- Do not apply external forces such as hammering to the encoder.
- For the encoder wires and their connections to the outer cover, ensure they are not subjected to tension, bending, or other stresses during installation. Otherwise, the wires may detach or become disconnected.

1.2.2 Interference With the Encoder May Cause Malfunctions. Ensure Proper Installation of the Encoder Housing and Motor Wiring Connections.

- ※The encoder housing must be made of electromagnetic shielding metal to maintain stable potential. Ensure sufficient clearance between the housing and internal circuit board components. When the encoder is exposed to magnetic fields from nearby motors or welding currents, use soft magnetic materials (e.g., soft iron) for the housing.

- Do not place the motor power cord near the encoder.
- ※Ensure proper grounding of the motor's FG wire and the mechanical device's FG.
- After installing the encoder, users should conduct a thorough system evaluation beforehand.
- Do not perform voltage test and insulation impedance test on the encoder.

1.3 Cabling Considerations:

1.3.1 Perform Wiring Correctly and Properly:

- Power off before wiring.
- Use the specified power supply voltage. Also, be aware of potential voltage drops caused by wiring length.
- Encoder wiring must not share conduits with other power lines or be bundled in parallel.
- For encoder wiring, use twisted-pair cables for both signal and power lines.
- For encoder wiring, use grouped shielded cables, and ensure both the encoder and the controller are properly grounded.

1.4 Operation Notes:

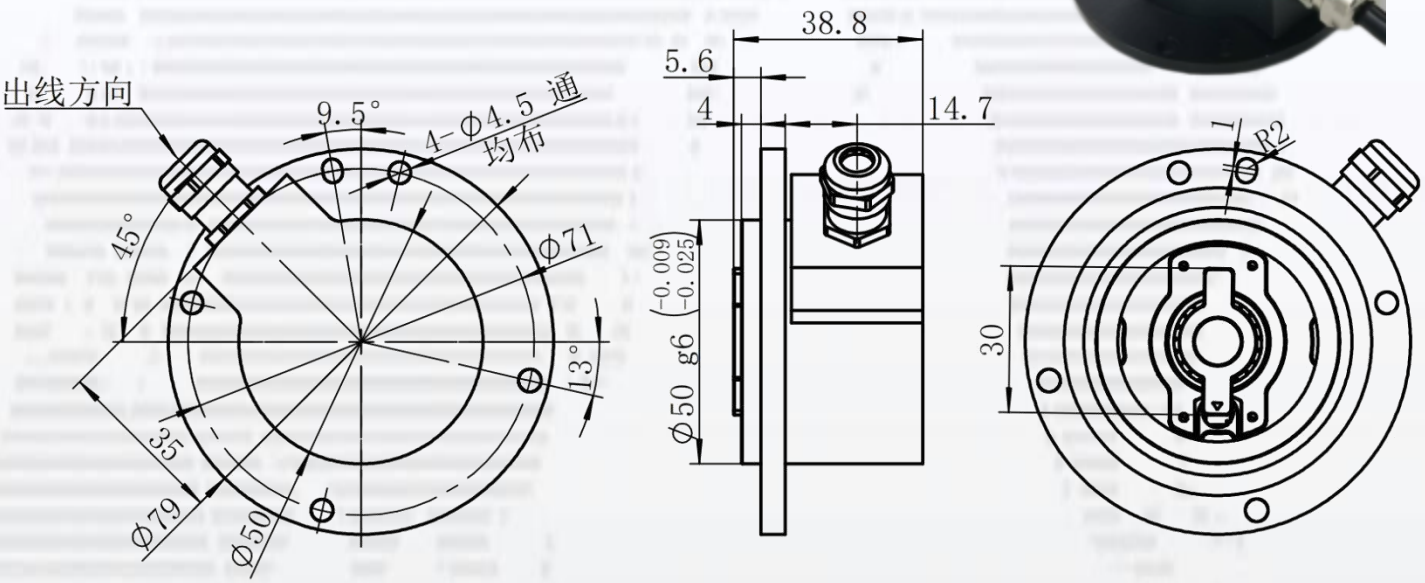
- Before use, thoroughly study and confirm the safety design of the device for encoder malfunctions and misoperations. When an alarm occurs, identify the cause and ensure safety before resetting the alarm and restarting operation. Do not subject the cable to excessive stress, as this may lead to wire breakage.
- Do not apply overvoltage or reverse voltage exceeding the absolute maximum rated value, as this may cause component damage or even fire.

2. General Precautions:

- This specification may be modified without prior notice due to product improvements and technical upgrades. Please consult the latest specifications and confirm the intended use before actual application.
- Please note that this product is intended for use as an embedded component in conventional electronic devices (e.g., OA devices, communication devices, household appliances, entertainment devices, measurement devices, general industrial equipment, etc.) and is not designed for applications requiring extremely high reliability and safety (e.g., transportation devices, aerospace devices, nuclear power control systems, medical devices for life support, etc.).
- Our company is committed to enhancing product quality and reliability. However, under normal circumstances, malfunctions and failures in semiconductor products cannot be entirely prevented. Therefore, when using this product, please consider potential impacts such as operational defects and take safety precautions to avoid accidents. In the event that malfunctions, failures, or lifespan-related issues caused by this product result in damage to others' lives or property, or lead to malfunctions in equipment, facilities, or machinery due to installation or use, the company shall not be held liable for any consequences, regardless of severity. Users are responsible for ensuring proper system safety design.

3. Encoder Categories:

3.1 RAA50.1C10 Line-out and Line-out Mechanical Dimension Drawing:

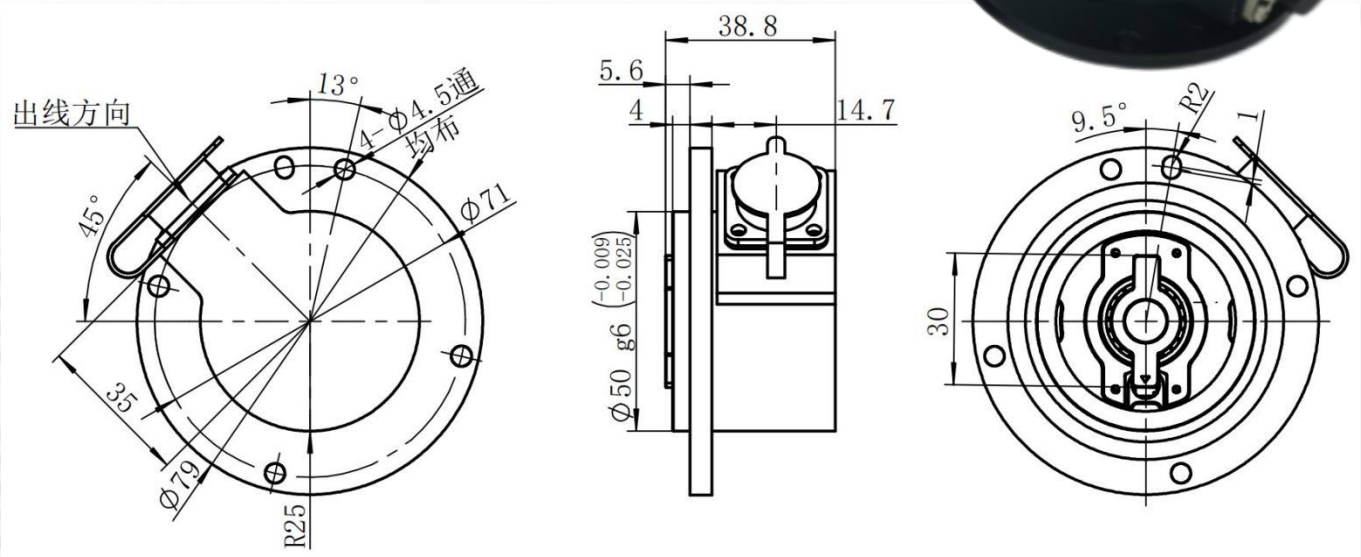


为防止因螺丝松动产生的故障，建议采用点胶螺丝。

安装时固定编码器使用螺钉（螺钉非附属品）

名称	简称	标准	等级	数量
内六角柱头螺钉	M4x10	GB/T818-2016	A2-70	4

3.2 RAA50.1C10 Plug Wire Exit Mechanical Dimension Diagram:



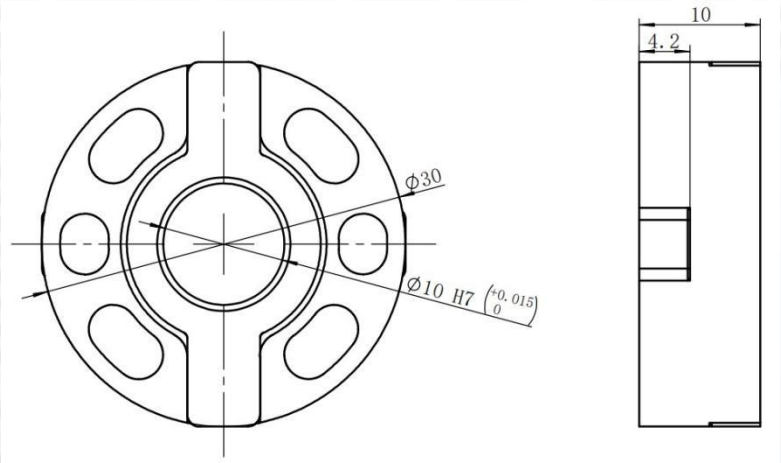
为防止因螺丝松动产生的故障，建议采用点胶螺丝。

安装时固定编码器使用螺钉（螺钉非附属品）

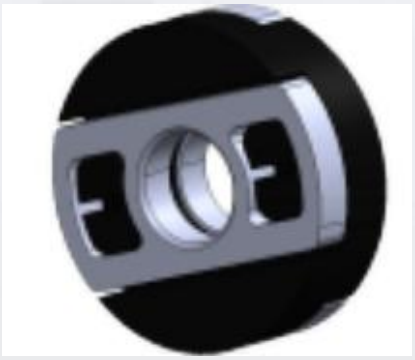
名称	简称	标准	等级	数量
内六角柱头螺钉	M4x10	GB/T818-2016	A2-70	4

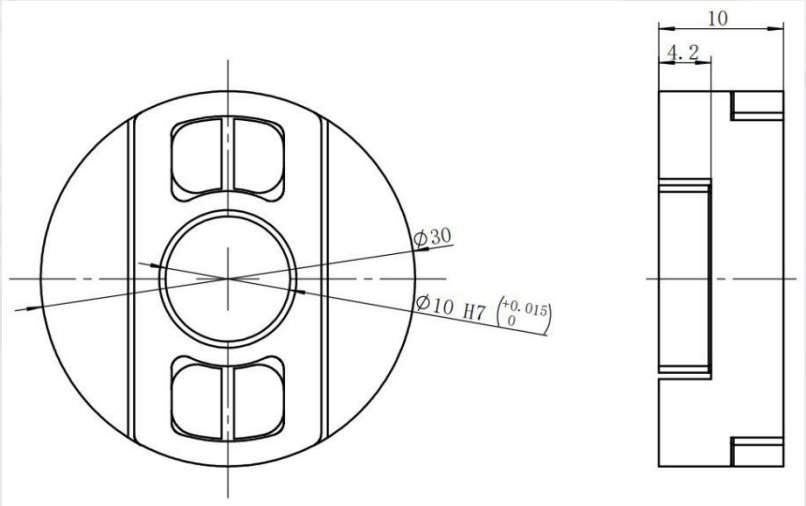
3.3 Attachment Type:

3.3.1 Default Attachments:

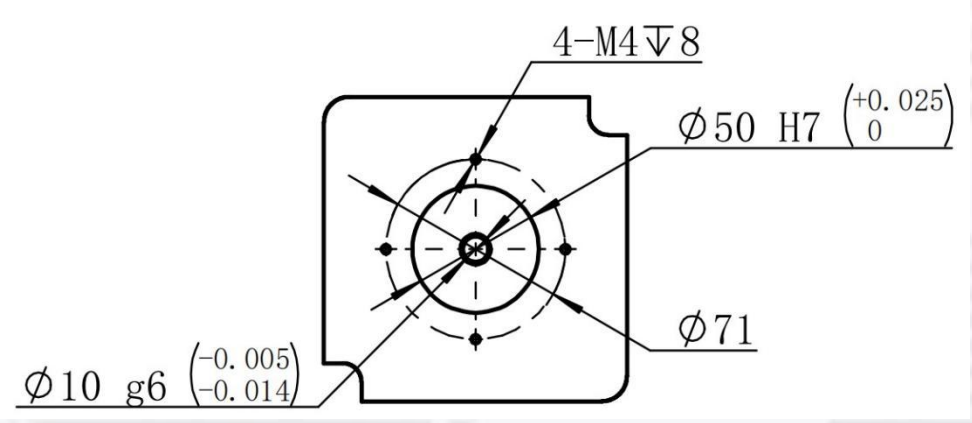


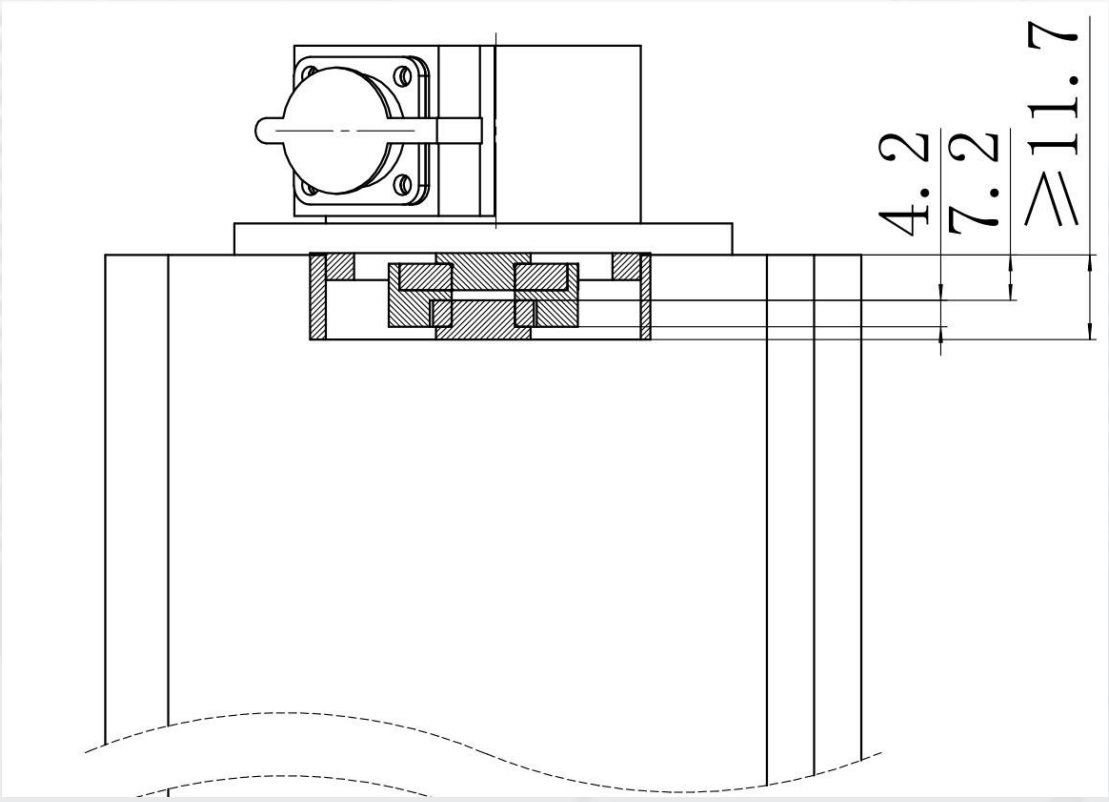
3.3.2 Appendix A:



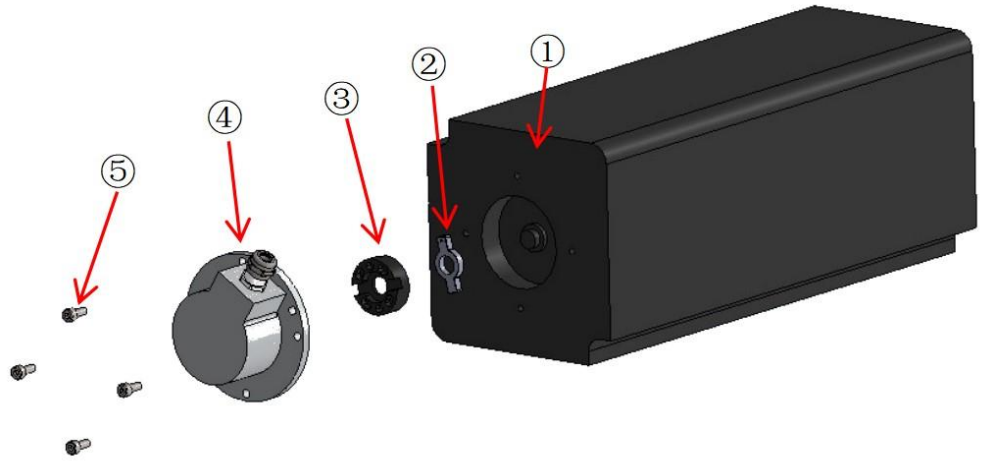


4 Recommended Motor Design Form:





4.1 Recommended Installation Method:



1. Clean the dust, dirt and rust on the motor shaft and cross coupling assembly (②);

2. Apply adhesive evenly on the motor shaft and the inner wall of the ten-piece coupling assembly (an anaerobic adhesive (648) is recommended).

3. Then install the cross coupling assembly (②) onto the motor shaft, ensuring that the lower end face of the assembly (②) aligns with the upper end face of the motor shaft in the same plane during installation.

4. Wait 30 minutes for the glue to fully cure before proceeding to the next step.

5. Gently insert the cross-coupling motor end assembly (③) into the assembly (②) to prevent damage to the motor and encoder assembly.

6. Gently press the cross coupling encoder (④) into position until its stop face fully engages with the motor's stop face, while ensuring the encoder's lower end flushes against the motor's upper end (never use striking or similar forceful methods during this process).

7. The 4-M4 (⑤) screws are tightened in a crosswise sequence along the mounting hole.

5. Connection Definition:

5.1 Connection Definition:

5.1.1 RS485 and RS232 Protocols:

1	2	3	4	5	6	7	8
5V	0V	D+	D-	3.6V battery	0V battery	Empty	Shield
Red	Black	Lan	Huang	Palm	White	Empty	Shield

5.1.2 BISS, SSI Protocol:

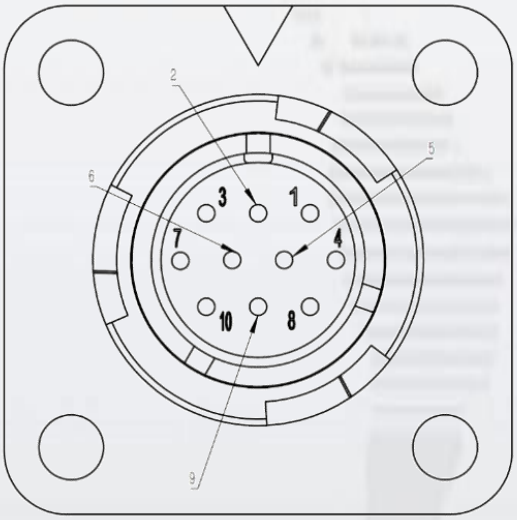
1	2	3	4	5	6
Data-	Data+	Clock-	Clock+	GND	VCC
Red	Black	Lan	Huang	Palm	White

5.2 Socket Definition:

5.2.1 RS485 and RS232 Protocols:

Rear socket pin sequence	Definition
4	5V
9	GND
1	D+
2	D-
6	Cell +
5	Cell GND
10	PE

5.2.2 BISS, SSI Protocol:

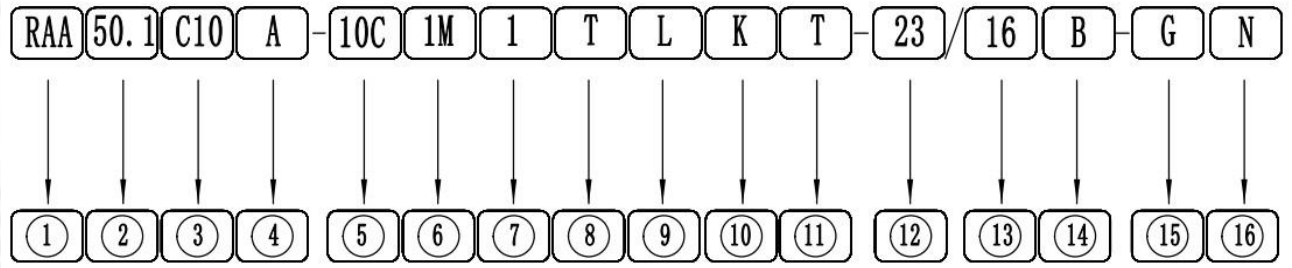


Rear socket pin sequence	Definition
4	5V
9	GND
1	Data+
2	Data-
6	Clock+
5	Clock-
10	PE

6. Technical Parameter：

Product model	Example: RAA50.1C10A-10C1MTLKT-23/16B-GN
Single loop resolution	23-bit (17-bit, 25-bit, or 26-bit optional)
Multi-turn resolution	16bit
CI	RS485(RS232、BISS、SSI)
Service voltage	5V±0.25
Cell voltage	2.5MHz (5MHz or other high-frequency options available)
Battery supply voltage	Supports up to 16K
Battery warning voltage	Binary system
Baud rate	2.5 MHz (available in bulk)
Refresh rate	Supports up to 16K
Communication code	Binary system
Along the time of change	100ms
Working temperature	-10 ° C~90 ° C
Working humidity	Below 90%RH (no condensation)
Storage temperature	-20°C~100°C
Storage humidity	Below 95%RH (no condensation)
Lash	Impact acceleration: 980 m/s², 11 ms; 3 impacts per direction, total 18 impacts.
Vibrate	Maintain an amplitude of 1.5mm between 10 and 55 Hz; apply an acceleration of 98ms² between 55 and 2000Hz; perform X, Y, and Z-axis movements for 2 hours per axis, totaling 6 hours.
Maximum permissible speed	None: Default speed (6000 rpm) G: High speed (6000rpm <speed <12000 rpm)
Levels of protection	IP65
accuracy	None: Default precision (40″ ±10) N: High-precision custom-made (≤20″)

7. Model Definition:



Order number	Definition description
①	Basic model: RAA50.1C10 Temperature-sensing model: RTA50.1C10
②	External dimensions: Φ50 mm
③	Φ10 cross coupling
④	Appendix A
⑤	10C: Φ10 radial aviation plug output G: radial cable outlet
⑥	1M line
⑦	5V
⑧	RS485 (RS232, BISS, SSI) communication interface
⑨	2.5 MHz baud rate (5 MHz or other high-volume options available)
⑩	16K update rate
⑪	Synchronous communication protocol
⑫	23-bit single-cycle resolution (17-bit, 25-bit, or 26-bit single-cycle resolution available)
⑬	16-bit multi-turn resolution
⑭	Positive logic binary code
⑮	None: Default speed (≤6000rpm) G: High speed 6000rpm<speed≤12000rpm)
⑯	None: Default precision (40″ ±10) N: High-precision custom (≤20″)

The specifications shown in the figure are: 50mm outer diameter, Type A (cross coupling) connector, 1-meter aviation plug output, 5V operating voltage, RS485 interface with 2.5MHz baud rate and 16K update rate, scheduled communication protocol transmission, 23-bit for single revolution and 16-bit for multiple revolutions, positive logic binary code output, high-speed operation, and high-precision custom design.

8. Communication Protocol (17bit-23bit):

8.1 Overview (17bit-23bit)		
cell	description	Remarks
Communication code	Binary system	
Communication circuit	Differential drive	RS485
Data transfer content	Single-loop position information	17 bits (maximum 23 bits)
	Multi-loop position information	16bit
	Status flag	(1)Over Speed (2)Full absolute status (3)Counting Error (4)Counter overflow (5)Over-heat (6)Multi-turn error (7)Battery alarm (8)Battery error
Traffic rate	2.5Mbps	--

*The protocol specifications for this encoder are all customized by clients. It is normal for some clients to have partial mismatches. For any protocol customization or alignment requirements, we can collaborate to develop solutions.

8.2 EEPROM communication specification		
cell	description	Remarks
Read and write user parameter address range	0～0x7E	This address field can store user parameters
Address	0x7F	0-5
Maximum number of write cycles	100,000 times	The number of times the user can save and write parameters

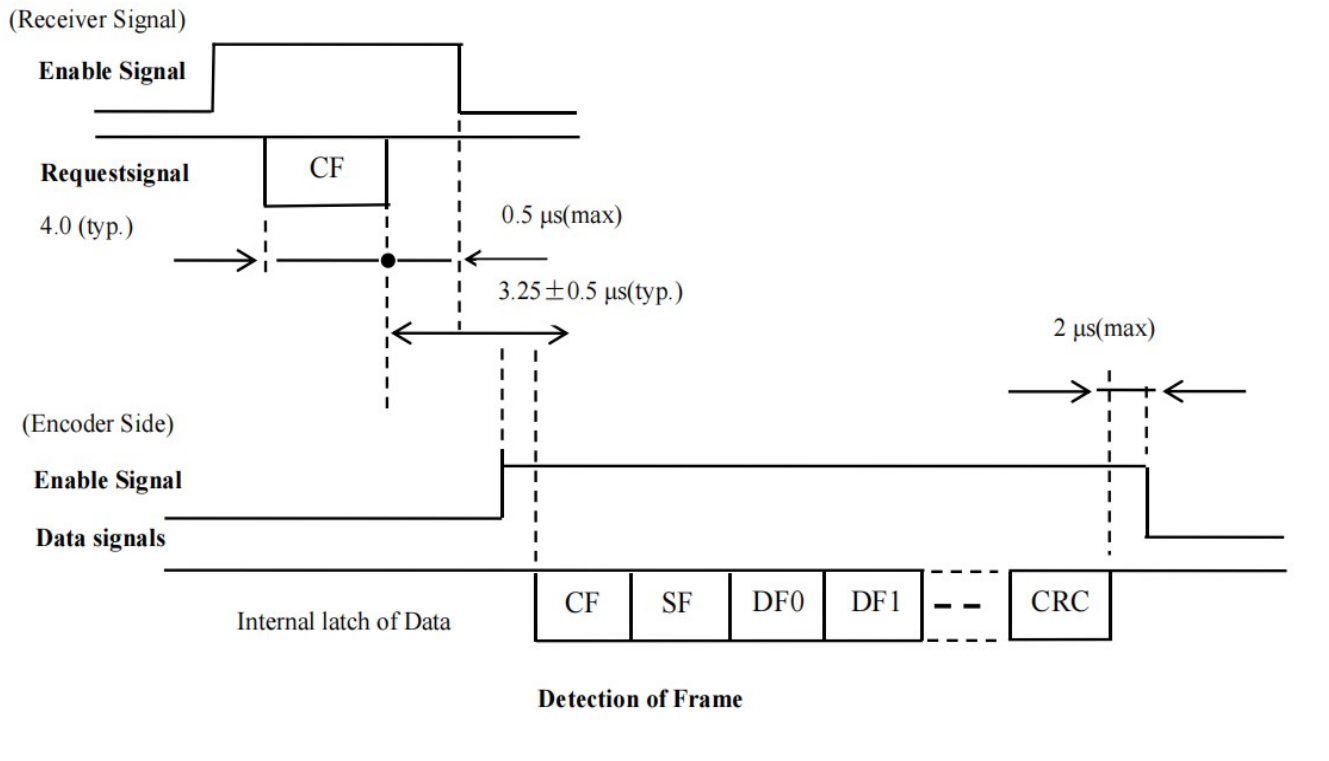
8.3 Frame Format

Each data frame is divided into several bytes, each byte is sent and received by 1 start bit, 8 data bits and 1 stop bit, the low bit is in front, the high bit is behind.

Terms used in data frame transmission:

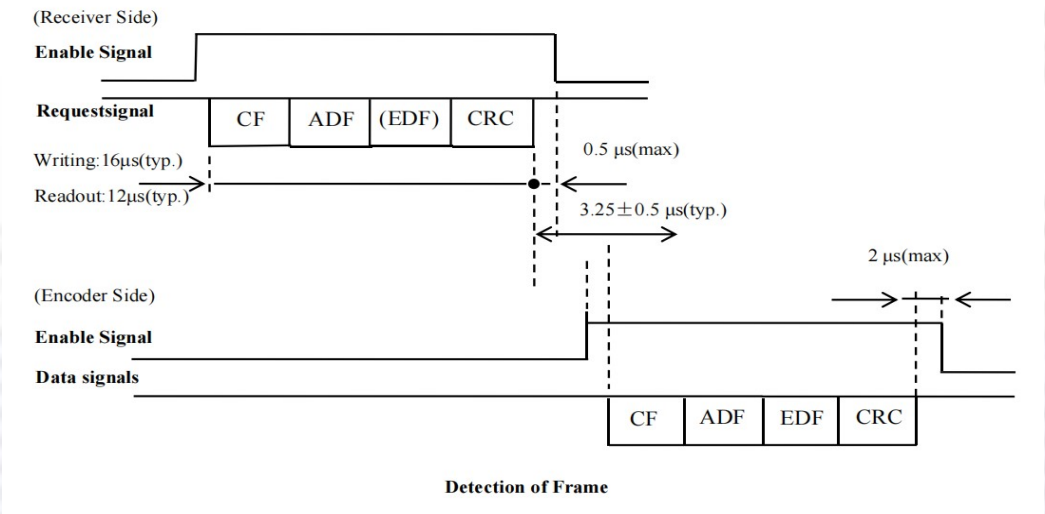
cell	description	Remarks
CF	Control Field	Use this to identify different command types
SF	Status Field	The encoder state is obtained through this section.
DF	Data Field	Encoder position data
ADF	Address Field	Accessible encoder address
EDF	E2PRM Field	Address content
CRC	CRC verification	Polynomial: x^8 + 1 (exclusive OR of all data except CRC)

8.3.1 Location Data Reading



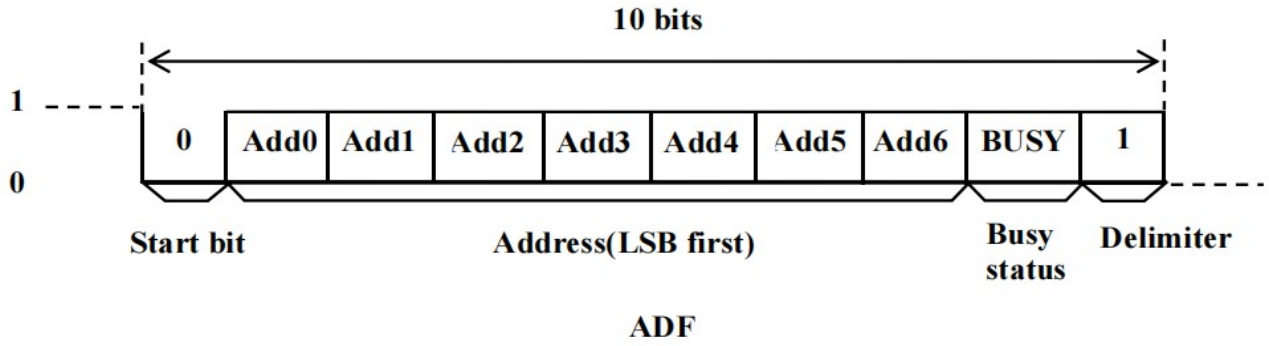
※The number of DF data varies depending on the CF.

8.3.2 Read-Write EEPROM



Detection of Frame

8.3.3 ADF and EDF During EEPROM Operations



ADF

(1) Start Bit: Fixed
(2) Address: EEPROM Address Range 0 to 127
(3) Busy Status: The Access Status of EEPROM Can Be Checked Through the Busy Status Bit.

	Ask	Encoder data transmission			description
	Busy	Busy	ADF	EDF	
EEPROM read	0	0	ADF	Eeprom data	Normal read
		1	ADF	0x00	The encoder is busy. The read request is invalid.
EEPROM write	0	0	ADF	EDF	Accept request
		1	ADF	0x00	The encoder is busy. The read request is invalid.

8.4 Explain

8.4.1 Control Field (CF)

CF class	CF content	Remarks
Read data	ID0(0x02)	Absolute Position Information Reading (CF+SF+ABS+CRC)
	ID1(0x8A)	Multi-loop data information reading (CF+ABM+CRC)
	ID2(0x92)	Encoder ID information reading (CF+ID+CRC)
	ID3(0x1A)	Read all data (CF+SF+ABS+ID+ABM+ALMC+CRC)
	ID4(0x2B)	Read the required data (SF+ABS+ABM0+ABM1+ALMC+CRC)
Write E2PROM	ID6(0x32)	The 8-bit "user data" can be written to the specified address. Within 20μs after the instruction format is sent, the encoder will respond with data. Do not communicate with the encoder during this process.
Read E2PROM	IDD(0xEA)	The 8-bit "user data" can be read from the specified address. Within 20μs after the instruction format is sent, the encoder will respond with data. Do not communicate with the encoder during this process.
Reset	ID7(0xBA)	The reset command requires sending 10 consecutive commands at intervals of no less than 62.5us to reset all fault flag bits.
	ID8(0xC2)	The reset command requires 10 consecutive transmissions at intervals no shorter than 62.5us to reset any single loop position to zero. Even after a power cycle, the position data remains unchanged from the reset state.
	IDC(0x62)	The reset command requires 10 consecutive transmissions at intervals no shorter than 62.5us, resetting all multi-turn data (unaffected by single-turn data) while simultaneously resetting all fault flags.

Note: CF consists of 1 byte, with categories and content as shown in the table above.

8.4.2 Status Field (SF)

Item	description	Remarks
Bit0	Rsvd	All zeros
Bit1	Rsvd	
Bit2	Rsvd	
Bit3	Rsvd	
Bit4	Counting Error	Encoder position calculation failure, all bits will be set to "1"
Bit5	Multiple circuit errors, battery error, and battery alarm	View sub-faults via ALMC
Bit6	Rsvd	All zeros
Bit7	Rsvd	

Note: CF consists of 1 byte, with categories and content as shown in the table above.

8.4.3 Data Field (DF0~DF7)

CF type	DF0	DF1	DF2	DF3	DF4	DF5	DF6	DF7
ID0 (0x02)	ABS0	ABS1	ABS2					
ID1 (0x8A)	ABM0	ABM1	ABM2					
ID2 (0x92)	ENID							
ID3 (0x1A)	ABS0	ABS1	ABS2	ENID	ABM0	ABM1	ABM2	ALMC
ID4 (0x2B)	ABS0	ABS1	ABS2	ABM0	ABM1	ALMC		
ID7 (0xBA)	ABS0	ABS1	ABS2					
ID8 (0xC2)	ABS0	ABS1	ABS2					
IDC (0x62)	ABS0	ABS1	ABS2					

※The number of bytes in DF varies depending on the CF type, as shown in the table above

pour：

1、 ABS0 to ABS2 represent the low, middle, and high bits of an encoder's absolute position. The high 7 bits of ABS2 are set to 0, while the remaining bits form a 17-bit position code. For 23-bit encoders, the high 1 bit of ABS2 is 0, with all other bits being valid.

Bit.

2、 ABM0~ABM2 Represent the Low, Middle, and High Bits of the Encoder's Multi-Turn Position, Where ABM2 Is All Zeros and the Others Are Digits.

The 16bits multi-loop information is composed.

3、 ENID Is the ID of the Encoder, With Values of 0x11 (17-Bit) or 0x17 (23-Bit).

8.4.4 Fault Description

See the table below for ALMC faults:								
Bit	0	1	2	3	4	5	6	7
Fault name	Over Speed	Full absolute status	Counting error	Counter overflow	Over heat	Multi-turn error	Battery error	Battery alarm

Description of each fault flag		
Fault name	Function declaration	Countermeasure
Over Speed	When the battery is drained at 5V, an acceleration exceeding 2000 rad/s² is detected. This indicator should be used solely as a reference, as it may not be detectable under certain conditions.	Fault reset
Full absolute status	During the 5V power-on process, the encoder speed was detected to exceed 100 rpm (±20 rpm).	Power on again
Counting error	Single loop information solution failure	Power on again
Over heat	Excess temperature	Fault reset
Multi-turn error	Multiple circuit data loss, multiple circuit counting failure	Fault reset
Counter overflow	When the multi-cycle counter overflows, the logic '1' is marked.	Fault reset
Battery error	The battery voltage is below 2.75V. Set it.	Check the electromagnetic power supply line and replace the battery
Battery alarm	The battery voltage is below 2.75V. Set it.	The fault automatically disappears after replacing the battery with a properly voltageed one.

9. Communication Protocol (25bit/26bit):

9.1 Overview

cell	description	Remarks
Communication code	Binary system	
Communication circuit	Differential drive	RS485
Data transfer content	Single-loop position information	25bits/26bit
	Multi-loop position information	16bit
	Status flag	(1)Over Speed (2)Full absolute status (3)Counting Error (4)Counter overflow (5)Over-heat (6)Multi-turn error (7)Battery alarm (8)Battery error
Traffic rate	2.5Mbps	25bit
	10Mbps	26bit

*The protocol specifications for this encoder are all customized by clients. It is normal for some clients to have partial mismatches. For any protocol customization or matching requirements, we can collaborate to develop solutions.

9.2 EEPROM communication specification

cell	description	Remarks
Read and write user parameter address range	0～0x7E	This address field can store user parameters
Address	0x7F	0-5
Maximum number of write cycles	100,000 times	The number of times the user can save and write parameters

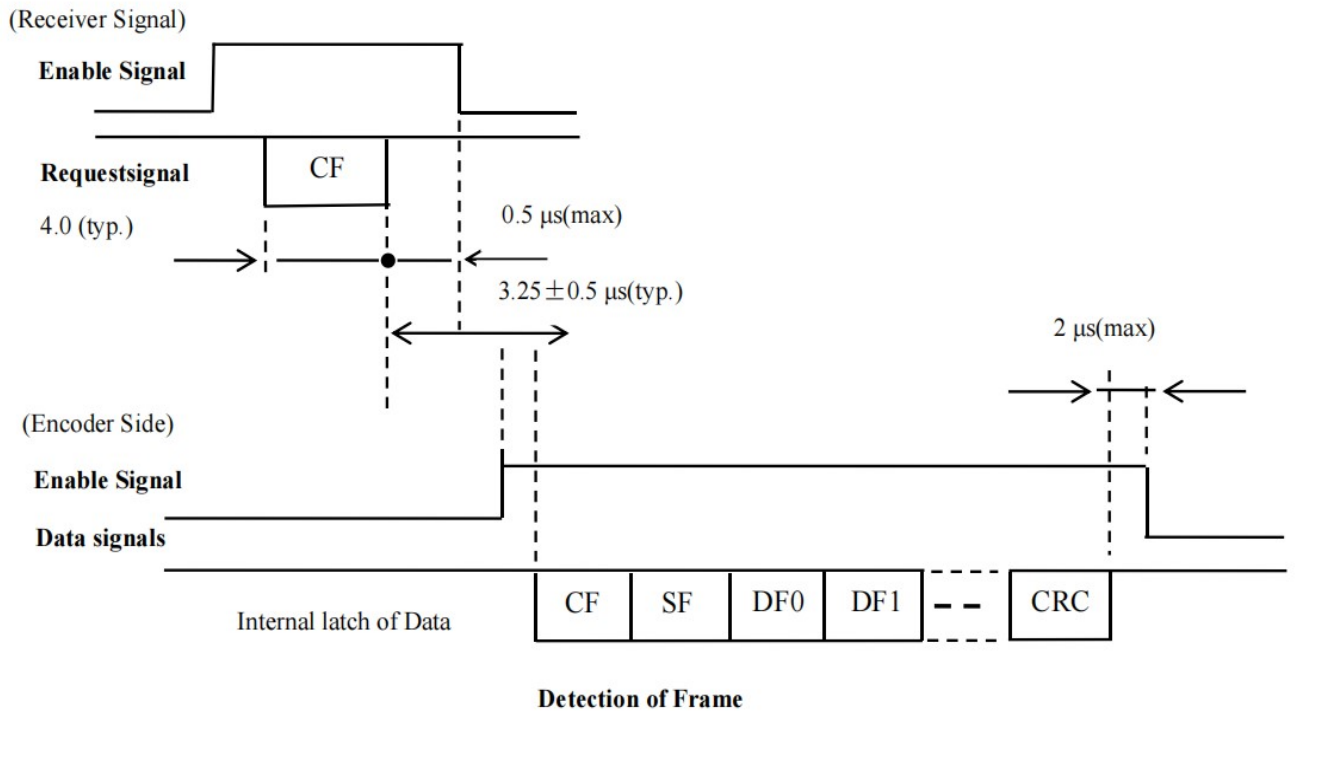
9.3 Frame Format

Each data frame is divided into several bytes, each byte is sent and received by 1 start bit, 8 data bits and 1 stop bit, the low bit is in front, the high bit is behind.

Terms used in data frame transmission:

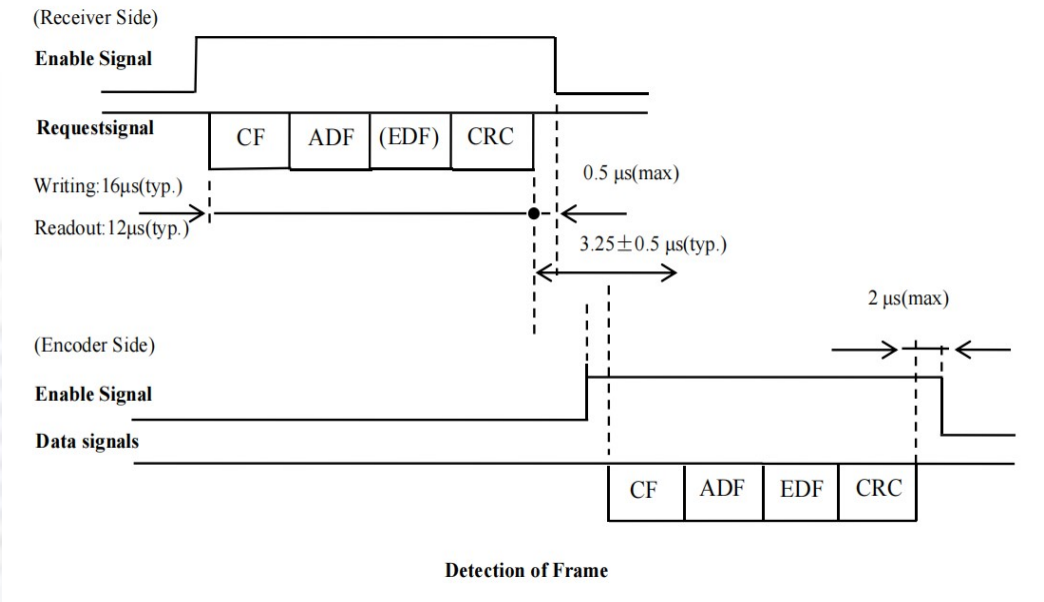
cell	description	Remarks
CF	Control Field	Use this to identify different command types
SF	Status Field	The encoder state is obtained through this section.
DF	Data Field	Encoder position data
ADF	Address Field	Accessible encoder address
EDF	E2PRM Field	Address content
CRC	CRC verification	Polynomial: x^8 + 1 (exclusive OR of all data except CRC)

9.3.1 Location Data Reading



※The number of DF data varies depending on the CF.

9.3.2 Read-Write EEPROM



Detection of Frame

9.3.3 ADF and EDF During EEPROM Operations

ADF

(1) Start Bit: Fixed
(2) Address: EEPROM Address Range 0 to 127
(3) Busy Status: The Access Status of EEPROM Can Be Checked Through the Busy Status Bit.

	Ask	Encoder data transmission			description
	Busy	Busy	ADF	EDF	
EEPROM read	0	0	ADF	Eeprom data	Normal read
		1	ADF	0x00	The encoder is busy. The read request is invalid.
EEPROM write	0	0	ADF	EDF	Accept request
		1	ADF	0x00	The encoder is busy. The read request is invalid.

G.4 Detailed Description

9.4.1 Control Field (CF)

CF class	CF content	Remarks
Read data	ID2(0x92)	25-bit encoder ID information reading (0x19) 26-bit encoder ID information reading (0x1A)
	ID3(0x1A)	Read all data (single cycle + multiple cycles + fault flag + encoder ID)
	ID4(0xA2)	Read single loop position
	ID5(0x2A)	Read single and multiple loop positi-ons
Write EEPROM	ID6(0x32)	The 8-bit "user data" can be written to the specified address. Within 20 μs after the instruction format is sent, the encoder will respond with data. Do not communicate with the encoder during this process.
A slight pause in reading EEPROM	IDD(0xEA)	The 8-bit "user data" can be read from the specified address. Within 20 μs after the instruction format is sent, the encoder will respond with data. Do not communicate with the encoder during this process.
Reset	ID7(0xBA)	The reset command requires sending 10 consecutive commands at intervals of no less than 62.5us to reset all fault flag bits.
	ID8(0xC2)	The reset command requires 10 consecutive transmissions at intervals no shorter than 62.5us to reset any single loop position to zero. Even after a power cycle, the position data remains unchanged from the reset state.
	IDC(0x62)	The reset command requires 10 consecutive transmissions at intervals no shorter than 62.5us, resetting all multi-turn data (unaffected by single-turn data) while simultaneously resetting all fault flags.

Note: CF consists of 1 byte, with categories and content as shown in the table above.

9.4.2 Status Field (SF)

Item	description	Remarks
Bit0	Rsvd	All zeros
Bit1	Rsvd	
Bit2	Rsvd	
Bit3	Rsvd	
Bit4	CountingError	Encoder position calculation failure, all bits will be set to "1"
Bit5	Multiple circuit errors, battery error, and battery alarm	View sub-faults via ALMC
Bit6	Rsvd	All zeros
Bit7	Rsvd	

Note: CF consists of 1 byte, with categories and content as shown in the table above.

9.4.3 Data Field (DF0~DF7)

CF type	DF0	DF1	DF2	DF3	DF4	DF5	DF6	DF7
ID2 (0x92)	ENID							
ID3 (0x1A)	ABS0	ABS1	ABS2	ENID	ABS3	ABM0	ABM1	ALMC
ID4 (0xA2)	ABS0	ABS1	ABS2	ABS3				
ID5 (0x2A)	ABS0	ABS1	ABS2	ABS3	ABM0	ABM1		
ID7 (0xBA)	ABS0	ABS1	ABS2					
ID8 (0xC2)	ABS0	ABS1	ABS2					
IDC (0x62)	ABS0	ABS1	ABS2					

※The number of bytes in DF varies depending on CF type, as specified in the table above.

The 25-bit encoder generates 32-bit absolute position data for each cycle (ABS0 to ABS3), where ABS0 is the least significant bit and ABS3 is the most significant bit. The lower 7 bits of ABS0 are set to "0", while the remaining valid bits form the 25-bit single-cycle position data.

The 26-bit encoder generates 32-bit absolute position data for each revolution (ABS0-ABS3), where ABS0 is the least significant bit and ABS3 is the most significant bit. The first 6 bits of ABS0 are set to '0', with the remaining valid bits forming the 26-bit single revolution position data. Similarly, the 16-bit multi-revolution information consists of the lower and upper bits of the encoder's multi-revolution position data (ABM0-ABM1).

ENID is the identifier for the encoder, with the 25-bit value being 0x19 and the 26-bit value being 0x1A.

ALMC bit encoding fault flag

9.4.4 Fault Description

1.ALMC 故障见下表：

Bit	0	1	2	3	4	5	6	7
故障名称	Over speed	Full absolute ststus	Counting error	Counter overflow	Over heat	Multi-turn error	Battery error	Battery alarm

2.各故障标志位说明见下表：

故障名称	功能说明	解决措施
Over speed	5V 掉电，电池状态下检测到加速度大于 2000rad/s², 这个标志应该是仅用于该目标，因为在某些情况下无法检测到它。	故障复位
Full absolute ststus	5V 上电过程中检测到编码器转速大于 100rpm（±20rpm）	重新上电
Counting error	单圈信息解算故障	重新上电
Over heat	过温度	故障复位
Multi-turn error	多圈数据丢失，多圈计数故障	故障复位
Counter overflow	在多圈计数溢出时，逻辑“1”会被标记出来	故障复位
Battery error	电池电压低于 2.75V，置位	查电池供电线路，更换电池
Battery alarm	电池电压低于 3.1V，置位	更换电压正常的电池后，故障自动消失

9.5 BISS and SSI Overview:

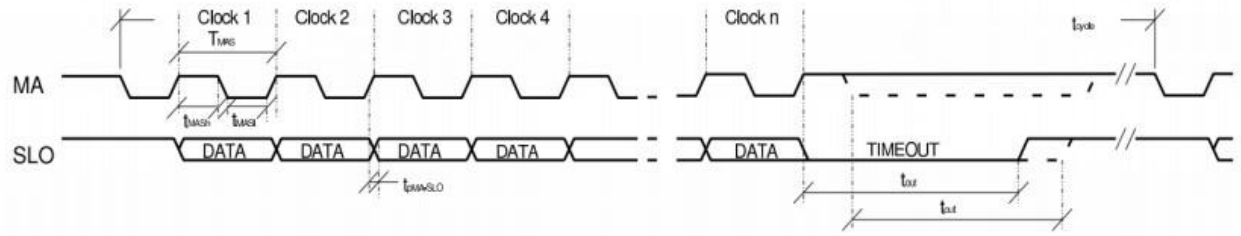


图 1：采用 SSI 协议的 I/O 接口时序

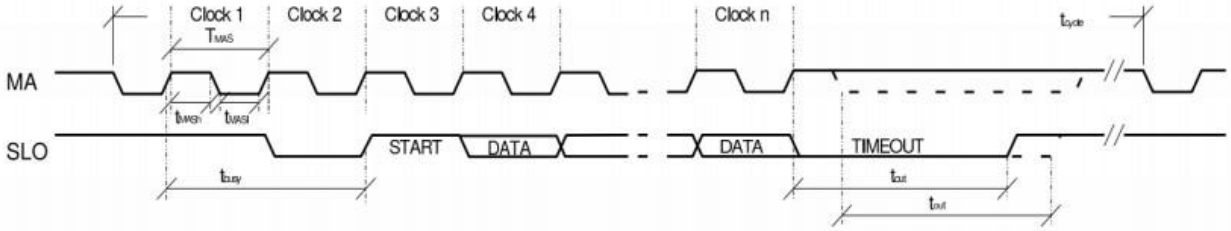


图 2：采用 BiSS C 协议的 I/O 接口时序

序号	符号	参数	条件	最小	最大	单位
SSI 协议						
I001	T_{MAS}	允许时钟周期	t_{out} 1, 2, 8, 16µs可出厂时设定	250	2x t_{out}	ns
I002	t_{MASh}	时钟信号的高电平持续时间		25	t_{out}	ns
I003	t_{MASl}	时钟信号的低电平持续时间		25	t_{out}	ns
I004	t_{cycle}	允许的周期时间： 3 轨道游标码计算的 19 位 单圈数据示例	MODE_ST = 0x05...0x07, UBL_M = 13 bit, UBL_N + SBL_N = 7 bit, UBL_S + SBL_S = 7 bit	11.25		µs
BiSS C 协议(NBISS = 0x0)						
I005	T_{MAS}	允许时钟周期	t_{out} 1, 2, 8, 16µs可出厂时设定	100		ns
I006	t_{MASh}	时钟信号的高电平持续时间		25	t_{out}	ns
I007	t_{MASl}	时钟信号的低电平持续时间		25		ns
I008	t_{busy}	最小数据输出延迟	MODE_ST = 0x05...0x0B, 0x0D...0x0F, MA lo→hi 直到 SLO lo→hi	2x T_{MAS}		µs
I009	t_{busy}	最大数据输出延迟：来自3轨道游标码计算的19位单圈数据的示例	MODE_ST = 0x00...0x02, fclk(MA) = 10 MHz, UBL_x 和 SBL_x 参见 I004		5.3	µs
I010	t_{busy}	最大数据输出延迟：来自3轨道游标码计算的19位单圈数据的示例	MODE_ST = 0x03...0x04, fclk(MA) = 10 MHz, UBL_x 和 SBL_x 参见 I004		10	µs
I011	t_{busy}	最大数据输出延迟：来自没有同步的3轨道插值的39位单圈数据的示例	MODE_ST = 0x0C, fclk(MA) = 10 MHz, UBL_M 13 bit, UBL_N 13 bit, UBL_S 13 bit		14	µs
I012	t_{cycle}	允许周期时间：3轨道游标码计算的19位单圈数据	MODE_ST = 0x05...0x07, UBL_x 和 SBL_x 参见 I004	11.25		µs

10 Overtemperature Alarm Settings and Temperature Measurement

10.1.1 Set the Over-Temperature Alarm Device and Measure the Temperature at the Encoder End by Using the EEPROM Interface Command.

10.1.2 To configure the over-temperature alarm, use address '4' on page 7 of the EEPROM, and read the temperature value from address '5' on page 7 of the EEPROM.

10.1.3 Set Temperature Alarm Table

Address	EEP ROMdata		Over heat detection Temperature
	Edd7	edd6。。。。。。。。Edd（）	
Page7 Address4	0	X X X X X X X	Not output
	1	0 0 0 0 0 0 1	+1° C
	1	0 0 0 0 0 1 0	+2° C
	1	0 0 0 0 0 1 1	+3° C
	..	...	...
	1	1 1 1 1 1 1 1	+126° C
	1	1 1 1 1 1 1 1	+127° C

10.1.4 Read Temperature

Address	EEP ROMdata	Temperature measurements
	Edd7 edd6。。。。。。。。Edd（）	
Page7 Address5	1 0 0 0 0 0 0 0	-128° C
	1 0 0 0 0 0 0 1	-127° C
	...	...
	1 1 1 1 1 1 1 1	-1° C
	0 0 0 0 0 0 0 0	±0° C
	0 0 0 0 0 0 0 1	+1° C
	...	...
	0 1 1 1 1 1 1 0	+126° C
	0 1 1 1 1 1 1 1	+127° C