

RAA48S Series Absolute Encoder

User Manual



Changchun Rongde Optics Co., Ltd.



www.roundss.cc



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1. Safety Precautions

To prevent malfunctions and accidental operation when using this product, please be sure to observe the following important precautions. Please use this product only after fully understanding the following information.

1.1 Precautions for Storage, Transportation, and Installation

1.1.1 Do not store or install this product in the following environments:

- Locations exposed to direct sunlight
- Locations where the ambient temperature exceeds the storage and installation temperature requirements
- Locations where the relative humidity exceeds the storage and installation humidity requirements
- Locations with rapid temperature changes or prone to condensation
- Locations near corrosive gases※1 (hydrogen sulfide, sulfurous acid, chlorine, ammonia, etc.) or flammable gases
- If installing in other special gas environments, the customer must conduct their own testing

before use. This product is not guaranteed for use in special gas environments.

- Radiation-exposed environments or locations exposed to radiation
- Locations with high levels of dust, dirt, salt, or metal shavings
- Locations prone to contact with water, oil, chemicals, etc.
- Locations where excessive vibration and impact may be transmitted to the encoder body

※Please note that in addition to the normal surrounding environment, corrosive gases may be generated due to the volatilization of components such as lubricating grease around the encoder.

1.2 Installation Precautions

1.2.1 Please assemble and adjust according to the operation manual during installation.

- Please pay close attention to the installation environment to prevent oil, foreign objects, etc. from entering the encoder.
- Please loosen the screws and bolts used to secure the encoder before tightening.
- Please take effective electrostatic discharge control measures to prevent electrical components from being subjected to overvoltage, etc.
- Vibration or impact to the encoder may cause it to malfunction or operate incorrectly; please carefully check the installation environment.
- Do not apply external force such as hammering to the encoder.
- Ensure that the encoder cable and the connection between the cable and the outer cover are not subjected to pulling, bending, or other loads during installation. Otherwise, issues such as cable detachment or unplugging may occur.



1.2.2 Interference affecting the encoder may cause malfunctions. Please pay close attention to the installation environment, including the encoder housing mounting method and motor wire connection method:

- ✘ Use a shield cable metal material for the encoder housing to maintain a stable potential. Ensure sufficient space distance from electrical components on the circuit board. If the encoder is affected by magnetic fields generated by nearby motors or soldering currents, use a soft magnetic material (such as soft iron) for the encoder housing.
- ✘ Do not place the motor power cable close to the encoder.
- ✘ Ensure proper grounding of the motor's FG wire and the FG wire of the mechanical device.
- After encoder installation, users should conduct a thorough system evaluation beforehand.
- Do not perform withstand voltage tests or insulation resistance tests on the encoder.

1.3 Wiring Precautions

1.3.1 Please perform wiring correctly and reliably.

- Perform wiring with the power off.
- Use the specified power supply voltage. Also, be aware of voltage drops caused by wire length variations.
- Do not run encoder wiring through the same conduit as other power lines, or bundle them parallel to each other.
- Use twisted-pair cables for both signal and power lines in the encoder wiring.
- Use bundled shielded cables for encoder wiring. Ensure that the bundled shielded cables are properly grounded on both the encoder and the other side (the controller side).

1.4 Operating Precautions

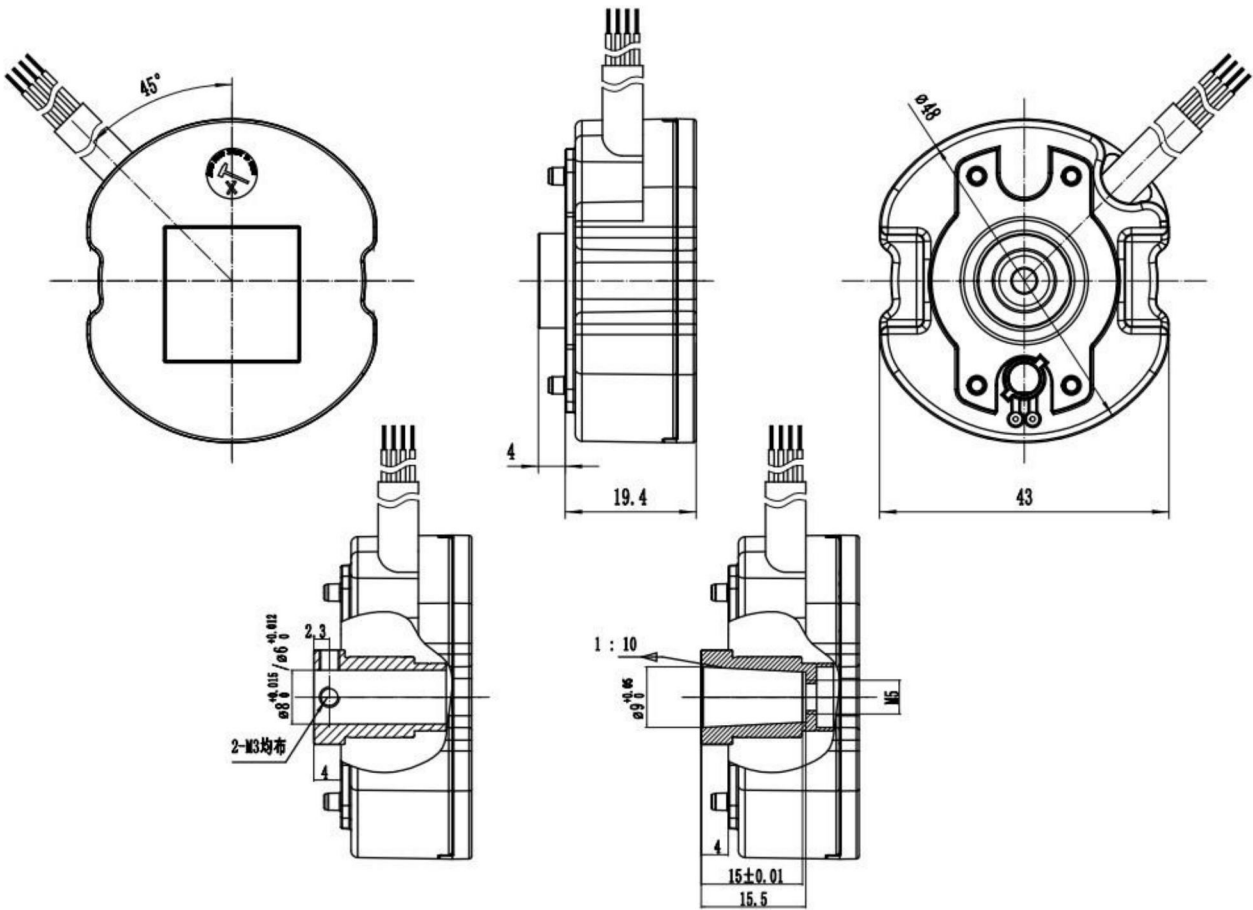
- Thoroughly study and confirm the device's safety design for encoder malfunctions and false alarms before use.
- In case of an alarm, troubleshoot the cause, ensure safety, and then reset the alarm to restart operation.
- Do not overstretch the cable, as this may cause breakage.
- Do not apply overvoltage or reverse voltage exceeding the absolute maximum rated value, as this may damage components or even cause a fire.



2. General Precautions

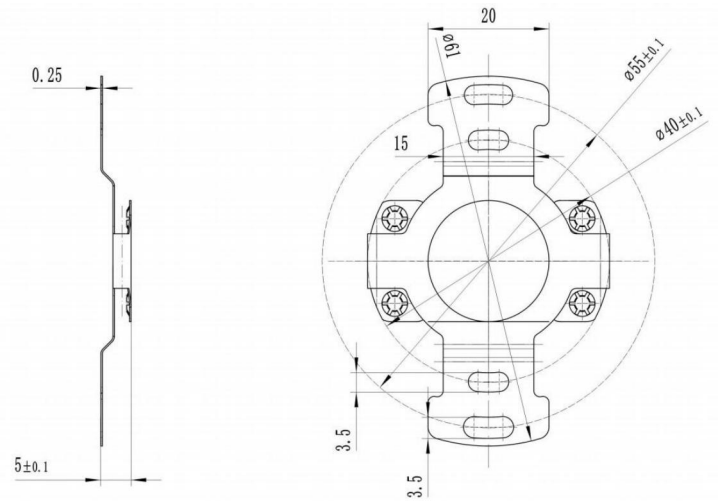
- This specification may be changed without notice due to product improvements and technical upgrades. Always inquire about the latest specifications and confirm the intended use before actual use.
 - Please note that this product is intended for use as part of common electronic devices (OA devices, communication devices, home appliances, entertainment devices, measuring devices, general industrial equipment, etc.). It is not intended for applications requiring extremely high reliability and safety (transportation equipment, aerospace equipment, nuclear power control systems, medical devices for life support, etc.).
 - While our company strives to improve quality and reliability, malfunctions and failures in semiconductor products are generally unavoidable. Therefore, when using this product, please consider the potential impact of malfunctions and take safety precautions to prevent accidents. Our company is not liable for any damage to life or property caused by malfunctions, failures, or inability to use this product, or for any malfunctions in equipment, facilities, or machinery caused by the installation and use of this product, regardless of the extent of the damage. Users are responsible for the safety design of their systems.

1. Mechanical Dimensions

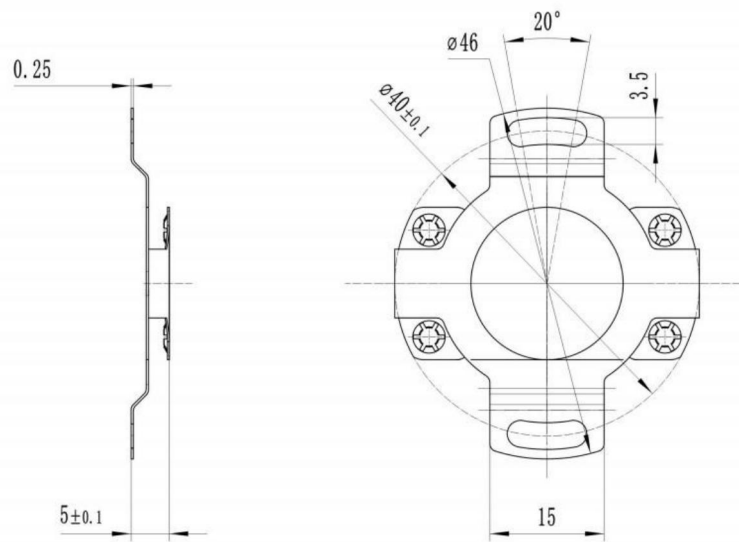


1.1 Accessory:

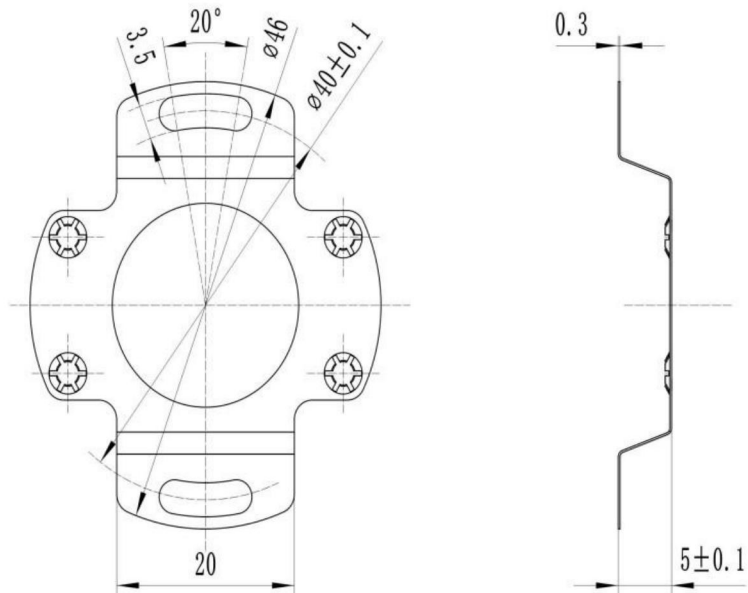
1.1.1 Accessory A



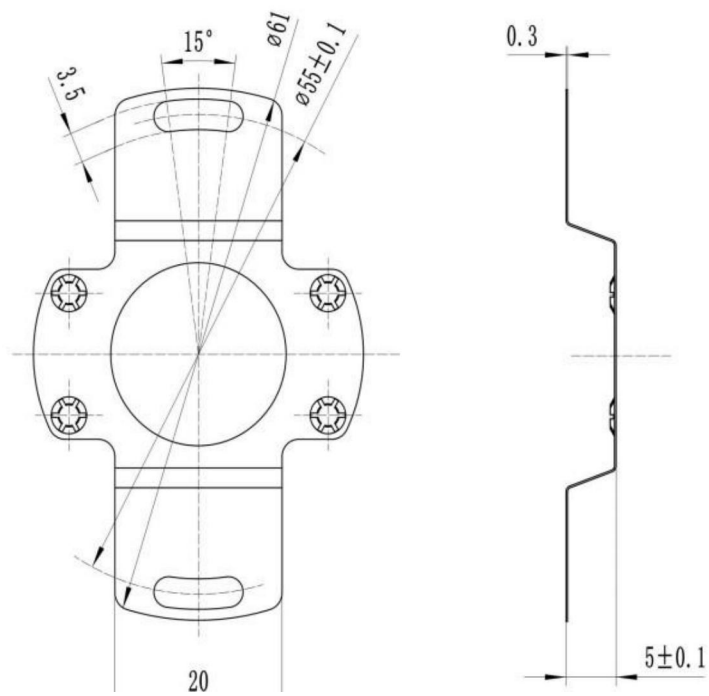
1.1.2 Accessory B



1.1.3 Accessory C



1.1.4 Accessory D



2. Connections

<u>Color</u>	<u>Defination</u>
<u>BK</u>	<u>Power 0V</u>
<u>RD</u>	<u>Power 5V</u>
<u>GN</u>	<u>Signal D+</u>
<u>BN</u>	<u>Signal D-</u>
<u>WH</u>	<u>Battery 3.6V</u>
<u>GY</u>	<u>Battery 0V</u>
<u>SHIELD</u>	<u>Fixed with bracket screws</u>

3. Technical Specifications:

Part Number	RAA48SV9-G0.2M1TLKT-23/16B-A
Single turn resolution	23bit, compatible 17bit
Multi turn resolution	16bit
Communication Interface	RS485
Supply voltage	5V±0.25
Battery voltage	3.6V
Battery error generating voltage	2.75V (±0.15v)
Battery alarm generating voltage	3.1V (±0.15V)
Baud rate	2.5MHZ (
Refresh rate	16K
Output code	Binary code
Fall time/Rise time	100ms
Operating Temp.	-10℃~90℃
Operating Humidity	90%RH bellow (No condensation)
Storage Temp.	-20℃~100℃
Storage humidity	95%RH bellow (No condensation)
Shock	980m/s ² , 11ms; 3 times for each direction, total 18 times
Vibration	10 to 55Hz, amplitude 1.5mm; 55 to 2000Hz, 98m/s ² ; 2 hours for each axis, total 6 hours
Rotational speed	Blank: Default ≤6000rpm G: 6000rpm < High Speed < 12000rpm
Protection class	IP54

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

4.1 General Specifications (17-23bit)

Items	Specifications	Remarks
Communication code	Binary	
Transmission type	Differential line driver	RS485
Transmission data	Single turn data	17bit(Max23bit)
	Multi turn data	16bit
	Status Flags	(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
Communication rate	2.5Mbps	--

*The protocol contents involved in this encoder are all customized by customers. It is normal if some customers cannot fully match them. If there is a need for protocol customization or matching, we can jointly negotiate and develop.

4.2 EEPROM

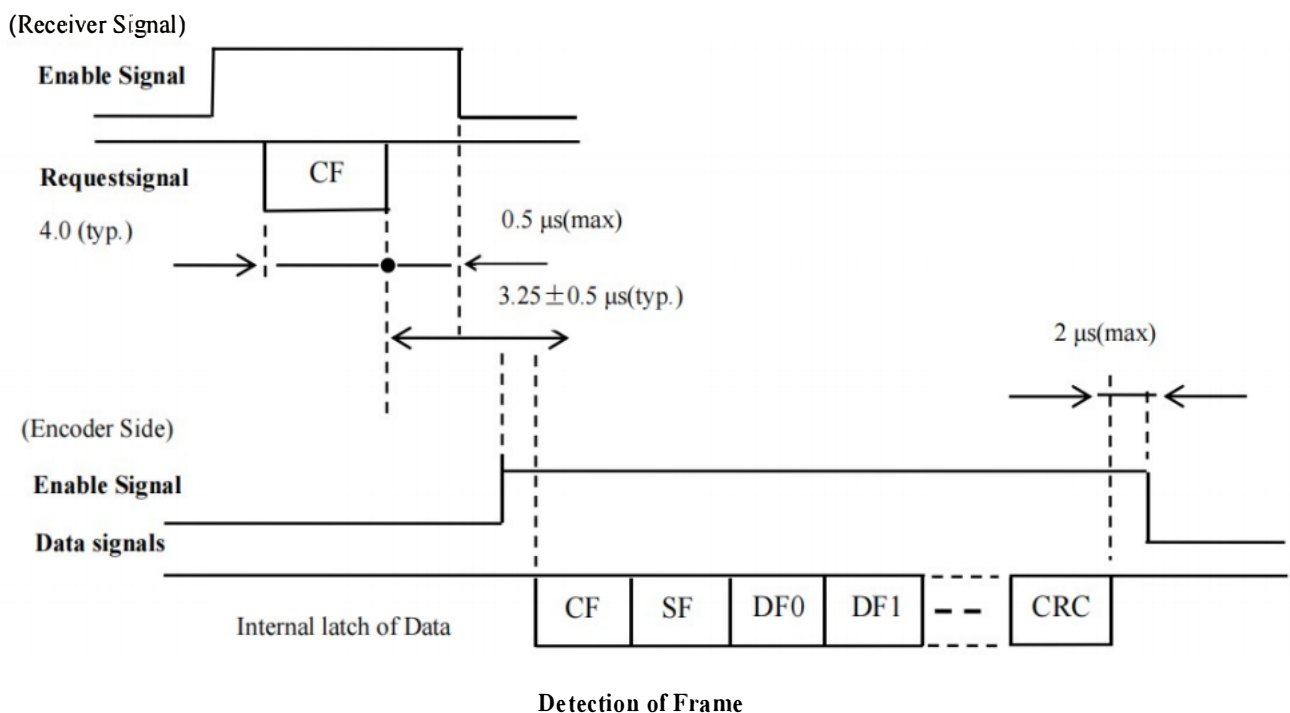
Items	Description	Remarks
User parameter address range can be read and written	0 ~ 0x7E	This address field can be used to store user parameters
Page address	0x7F	0-5
Permissible times for writing	100000次	User parameter saves the number of times the write operation can be executed

4.3 Frame Format

Items	Description	Remark
CF	Control Field	to identify different command types
SF	Status Field	Get the encoder status through this part
DF	Data Field	Encoder position data
ADF	Address Field	Accessible encoder addresses
EDF	E2PROM Field	the content of the address
CRC	CRC Field	Polynomial: x^8+1 (XOR all data except CRC)

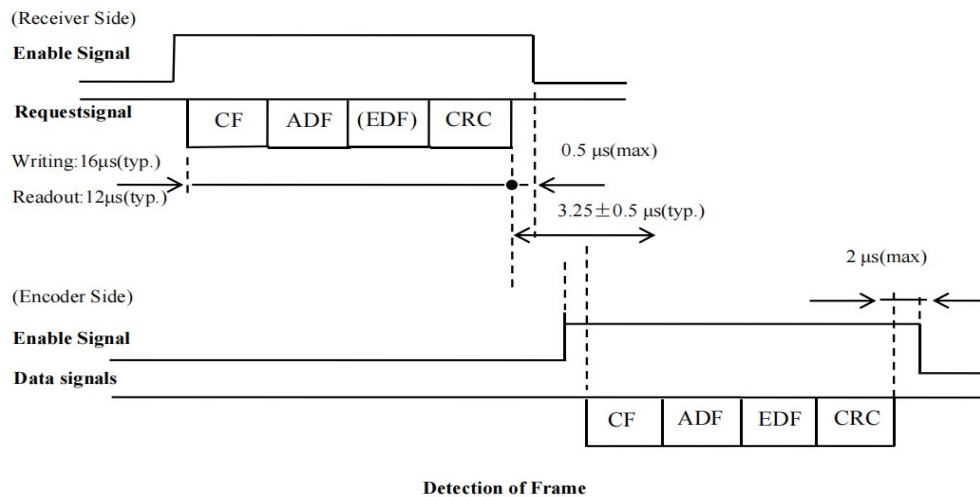
※The name used in data frame transmission are shown in the table above

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

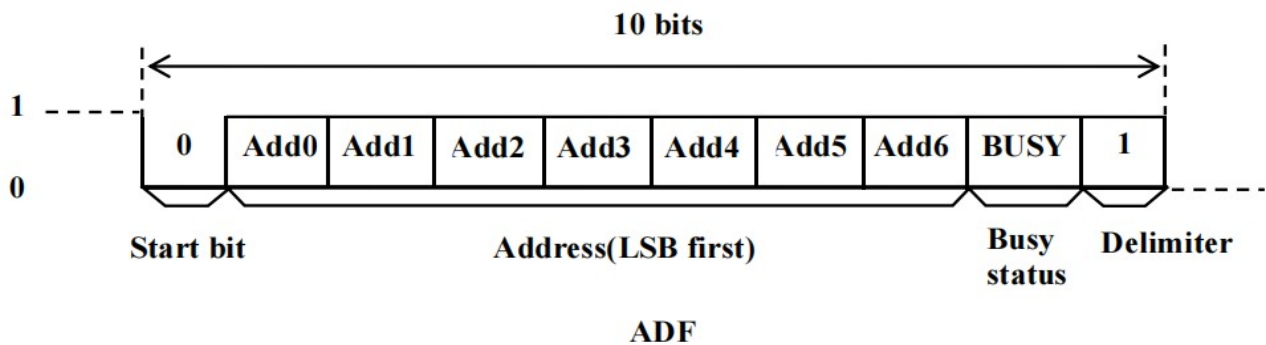


The number of data in DF depends on different CFs

4.3.2 Access (Writing) to E²PROM



4.3.3 ADF and EDF when operating EEPROM



- (1) Start bit: fixed
- (2) Address: eeprom Address range 0 ~ 127
- (3) Busy status: The access status to the eeprom can be checked through the busy status bit

	request	Encoder sends data			Description
	Busy	Busy	ADF	EDF	
eeprom Read	0	0	ADF	Eeprom Data	Normal read
		1	ADF	0x00	Encoder busy, request Read invalid
eeprom Write	0	0	ADF	EDF	Accepting Requests
		1	ADF	0x00	Encoder busy, request Read invalid

4.4 Details

4.4.1 Control Field (CF)

Application	Data ID	Remark
Data readout	ID0(0x02)	Read absolute position information (CF+SF+ABS+CRC)
	ID1(0x8A)	Multi-turn data information reading (CF+ABM+CRC)
	ID2(0x92)	Encoder ID information read (CF+ID+CRC)
	ID3(0x1A)	Read all data (CF+SF+ABS+ID+ABM+ALMC+CRC)
	ID4(0x2B)	Read necessary data (SF+ABS+ABM0+ABM1+ALMC+CRC)
Writing to E2PROM	ID6(0x32)	The 8-bit "user data" can be written into the data corresponding to the specified address. Within 20 μ s after sending according to the command format, the encoder will send back data. Do not communicate with the encoder during this process.
Readout from E2PROM	IDD(0xEA)	8-bit "user data" can be read from the specified address. Within 20 μ s after sending according to the command format, the encoder will send back data. Do not communicate with the encoder during this process.
Reset	ID7(0xBA)	This reset command requires 10 consecutive commands to be sent at a time interval of not less than 62.5 μ s to reset all fault flags.
	ID8(0xC2)	This reset command requires 10 consecutive commands to be sent at a time interval of not less than 62.5 μ s to reset any single-turn position to zero. Even if the power is turned on again, the position still retains the position data after reset.
	IDC(0x62)	This reset command requires that the command be sent 10 times continuously at a time interval of not less than 62.5 μ s, and the multi-turn data will be reset to zero (single-turn data will not be affected). At the same time reset all fault flags.

4.4.2 Status Field (SF)

Bit No	Description	Remark
Bit0	Rsvd	all are fixed to "0"
Bit1	Rsvd	
Bit2	Rsvd	
Bit3	Rsvd	
Bit4	Counting Error	Logic "1" is transmitted when any error occurs
Bit5	Output multi-turn error, battery error and battery alarm	confirm them in ALMC
Bit6	Rsvd	all are fixed to "0"
Bit7	Rsvd	

※CF consists of 1 byte, the category and content are shown in the table above

4.4.3 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					

※According to different CF types, there are different number of bytes in DF, as shown in the above table

Note:

1. ABS0~ABS2 are the low, middle and high bits of the absolute position of the encoder. Higher 7 bits of ABS2 are always logic "0", and then the valid data consists of total 17 bits (for a 23-bit encoder, the high 1 bit of ABS2 is 0, and the rest are valid bits).
2. ABM0~ABM2 are the low, middle and high bits of the multi-turn position of the encoder. ABM2 is always logic "0", and then the valid data consists of total 16 bits.
3. ENID: Encoder ID, =0x11 (17Bit) or 0x17 (23Bit).

4.4.4 Fault Description

ALMC Faults see the table below:

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	Functional Description	Solution
Over Speed	Acceleration greater than 2000rad/s ² is detected with 5V battery off. This flag should be used only as it is intended, as it may not be detected in some cases.	Fault reset
Full absolute status	During the 5V power-on process, the encoder speed is detected to be greater than 100rpm (± 20 rpm)	Restart the power supply
Counting error	Single turn information solution failure	Restart the power supply
Over heat	Over temperature	Fault reset
Multi-turn error	Multi-turn data loss, multi-turn counting failure	Fault reset
Counter overflow	When the multi-turn counter overflows, a logic "1" is indicated	Fault reset
Battery error	The battery voltage is lower than 2.75V, set	Check the electromagnetic power supply circuit and replace the battery
Battery alarm	The battery voltage is lower than 2.75V, set	After replacing the battery with normal voltage, the fault disappears automatically

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

5.1 General Specifications(25bit)		
Items	Specifications	Remarks
Communication code	Binary	
Transmission type	Differential line driver	RS485
Transmission data	single turn data	25bits/26bit
	multi turn data	16bit
	Status Flags	(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
Communication rate	2.5Mbps	25bit
	10 Mbps	26bit

*The protocol contents involved in this encoder are all customized by customers. It is normal if some customers cannot fully match them. If there is a need for protocol customization or matching, we can jointly negotiate and develop.

5.2 EEPROM		
Items	Description	Remarks
Accessible address	0 ~ 0x7E	This address field can be used to store user data
Page address	0x7F	0-5
Permissible times for writing	100000 times	The number of times the operation can be performed

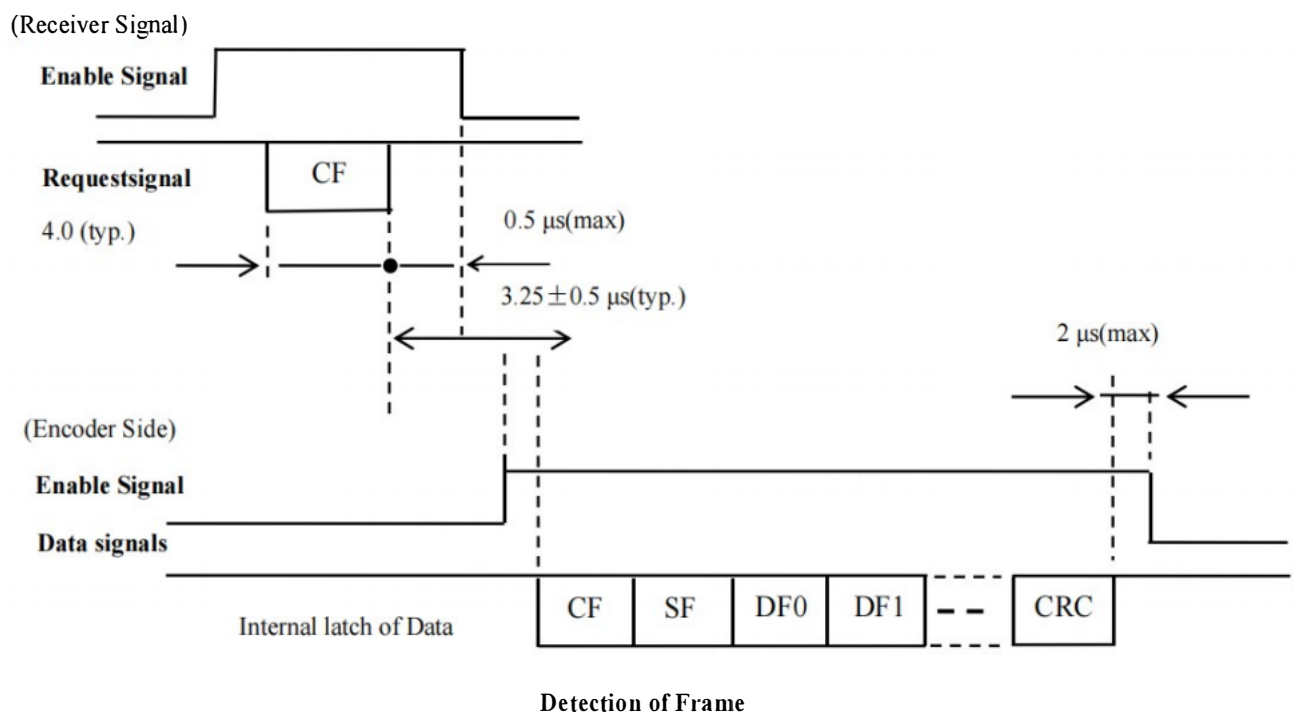
5.3 Frame Format

Items	Description	Remark
CF	Control Field	to identify different command types
SF	Status Field	Get the encoder status through this part
DF	Data Field	Encoder position data
ADF	Address Field	Accessible encoder addresses
EDF	E2PROM Field	the content of the address
CRC	CRC Field	Polynomial: x^8+1 (XOR all data except CRC)

※The name used in data frame transmission are shown in the table above

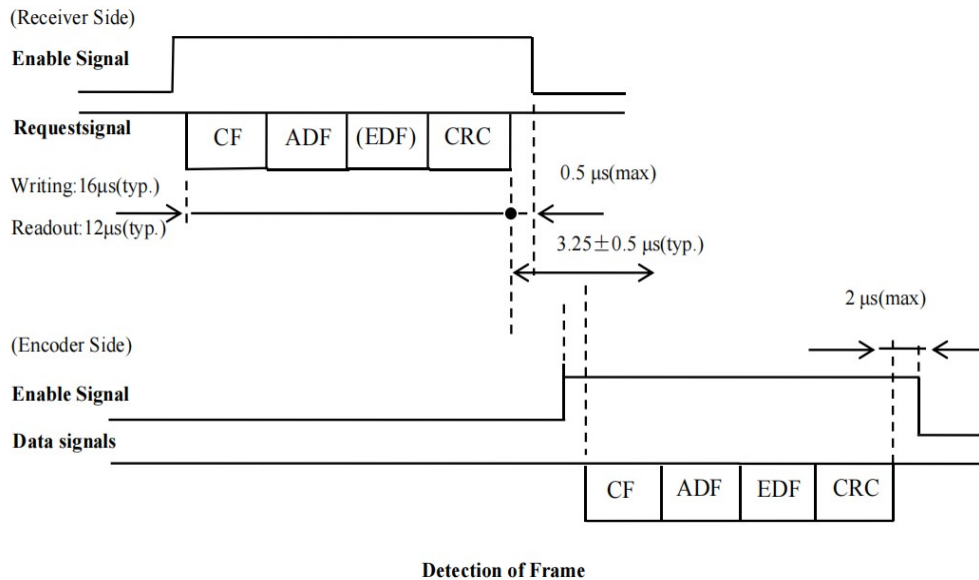
Each data frame is divided into several bytes, and the transmission and reception of each byte is realized by 1 start bit, 8 data bits and 1 stop bit, the low bit is in front and the high bit is behind.

5.3.1 Data Readout

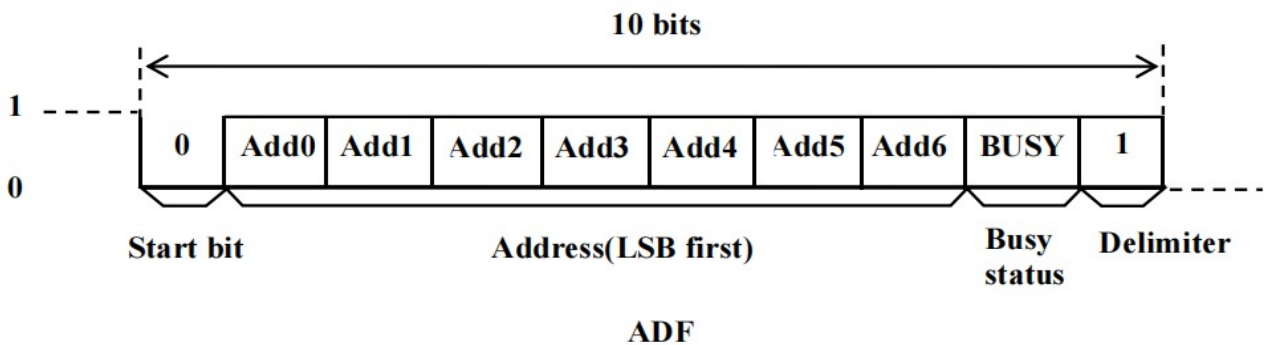


The number of data in DF depends on different CFs

5.3.2 Access (Writing) to E²PROM



5.3.3 ADF and EDF when operating EEPROM



- (1) Start bit: fixed
- (2) Address: eeprom address range 0 to 127
- (3) Busy status: The access status to eeprom can be checked through the busy status bit

	Request	Encoder sends data			Description
	Busy	Busy	ADF	EDF	
eeprom read	0	0	ADF	Eeprom data	Normal read
		1	ADF	0x00	Encoder busy, request Read invalid
eeprom write	0	0	ADF	EDF	Accepting Requests
		1	ADF	0x00	Encoder busy, request Read invalid

5.4 Details

5.4.1 Control Field (CF)

CF type	CF Content	Remark
Data readout	ID2(0x92)	25bit encoder ID information read (0x19)
	ID3(0x1A)	Read all data (single turn + multi-turn + fault flag + encoder ID)
	ID4(0xA2)	Reading single-turn position
	ID5(0x2A)	Read single-turn and multi-turn positions
Writing to E2PROM	ID6(0x32)	The 8-bit "user data" can be written into the data corresponding to the specified address. Within 20 μ s after sending according to the command format, the encoder will send back data. Do not communicate with the encoder during this process.
Readout from E2PROM	IDD(0xEA)	8-bit "user data" can be read from the specified address. Within 20 μ s after sending according to the command format, the encoder will send back data. Do not communicate with the encoder during this process.
Reset	ID7(0xBA)	This reset command requires 10 consecutive commands to be sent at a time interval of not less than 62.5 μ s to reset all fault flags.
	ID8(0xC2)	This reset command requires 10 consecutive commands to be sent at a time interval of not less than 62.5 μ s to reset any single-turn position to zero. Even if the power is turned on again, the position still retains the position data after reset.
	IDC(0x62)	This reset command requires that the command be sent 10 times continuously at a time interval of not less than 62.5 μ s, and the multi-turn data will be reset to zero (single-turn data will not be affected). At the same time reset all fault flags.

※CF consists of 1 byte, the category and content are shown in the table above

5.4.2 Status Field (SF)

Bit No	Description	Remark
Bit0	Rsvd	all are fixed to " 0 "
Bit1	Rsvd	
Bit2	Rsvd	
Bit3	Rsvd	
Bit4	Counting Error	Logic " 1 " is transmitted when any error occurs
Bit5	Output multi-turn error, battery error and battery	confirm them in ALMC
Bit6	Rsvd	all are fixed to " 0 "
Bit7	Rsvd	

CF consists of 1 byte, the category and content are shown in the table above

5.4.3 Data Field (DF0~DF7)

CFtype	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					

Depending on the type of CF, there are different numbers of bytes in DF, as shown in the table above.

Note:

For the absolute position of a 25-bit encoder ABS0~ABS3, there are 32 bits of data in total. ABS0 is the lowest bit and ABS3 is the highest bit. The lower 7 bits of ABS0 are "0", and the remaining valid data constitutes 25 bits of single-turn position data;

For the absolute position of a 26-bit encoder ABS0~ABS3, there are 32 bits of data in total. ABS0 is the lowest bit and ABS3 is the highest bit. The lower 6 bits of ABS0 are "0", and the remaining valid data constitutes 26 bits of single-turn position data.

ABM0~ABM1 are the low and high bits of the encoder multi-turn position, and the two data constitute 16 bits of multi-turn information.

ENID is the ID of the encoder, the 25-bit value is 0x19, and the 26-bit value is 0x1A.

ALMC is the encoder fault flag

6. Over-temperature Alarm Settings and Temperature Measurement

1. Over-temperature alarm settings and temperature measurements can be performed on the encoder using EEPROM interface commands.
2. Over-temperature alarm settings are performed using EEPROM page 7 address "4", and temperature readings are performed using EEPROM page 7 address "5".

6.1 Over-temperature Alarm Setting Table

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

	1	1	1	1	1	1	1	+126 °C	
	1	1	1	1	1	1	1	+127 °C	

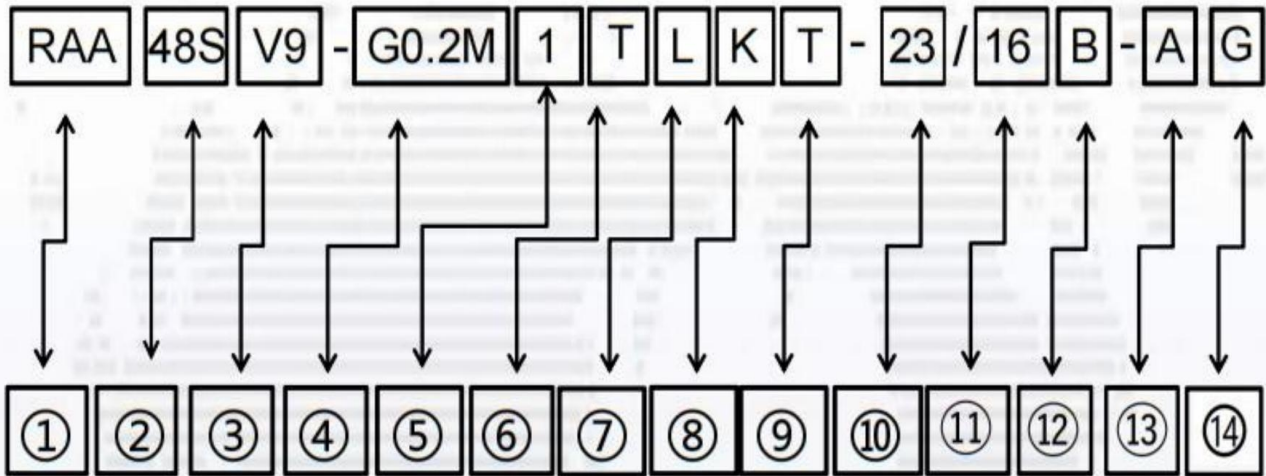
6.2 Read Temperature

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

	1	1	1	1	1	1	1	-1 °C
	0	0	0	0	0	0	0	± 0 °C
	0	0	0	0	0	0	1	+1 °C

	0	1	1	1	1	1	0	+126 °C
	0	1	1	1	1	1	1	+127 °C

7.Part Number Defination :



Items	Definition
①	Main model
②	Injection Body Outer Diameter
③	Taper Shaft 9mm (1:10) /Straight Shaft 8mm
④	0.2m Cable
⑤	Power 5V
⑥	RS485
⑦	2.5MHz baud rate
⑧	16K refresh rate
⑨	Communication protocol periodic sending
⑩	23bit single turn resolution (17/25/26 bit optional)
⑪	16bit multi turn resolution
⑫	Positive logic binary code
⑬	Accessory A
⑭	Blank: Default ≤6000rpm G: 6000rpm < High Speed < 12000rpm

8. Fault Description :

8.1. ALMC faults are shown in the table below.:

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

8.2. The descriptions of each fault flag are shown in the table below:

Fault Name	Function Description	Solutions
Over speed	When the 5V power is off, and acceleration greater than 2000 rad/s ² is detected in battery mode, this flag should only apply to this target, as it may not be detectable in some situations..	Fault Reset
Full absolute status	During the 5V power-on process, the encoder speed was detected to be greater than 100 rpm (± 20 rpm).	Reconnect power
Counting error	Single-turn information calculation failure	Reconnect power
Over heat	Overtemperature	Fault Reset
Multi-turn error	Multi-turn of data lost, multi-turn counting failure.	Fault Reset
Counter overflow	When a multi-turn counter overflows, a logic "1" will be marked.	Fault Reset
Battery error	If the battery voltage is below 2.75V, set the position.	Check the battery power supply circuit and replace the battery.
Battery alarm	If the battery voltage is below 3.1V, set the position.	The problem disappeared automatically after replacing the battery with one that had the correct voltage.