BZH Bearing-Type Absolute Encoder

Series User Manual V2.61

ShenZhen BriterEncoder Technology Co. Ltd

Catalog

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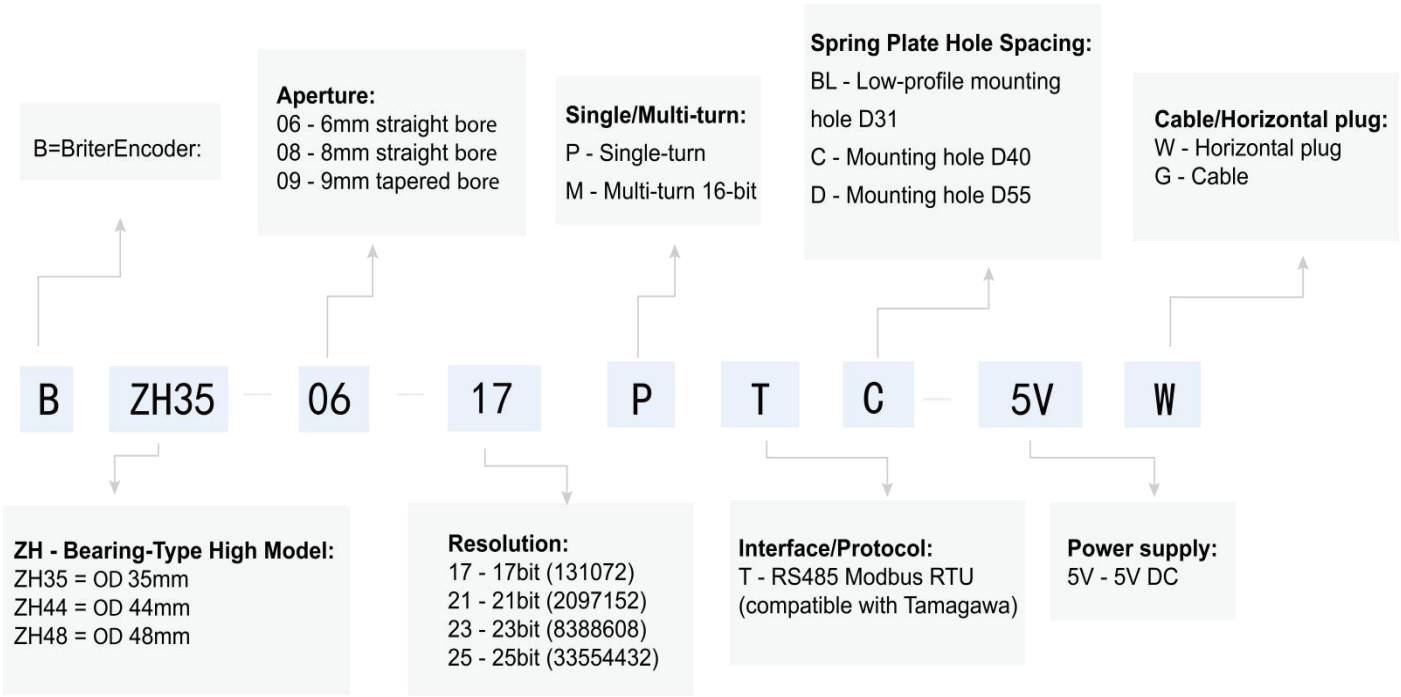
1.Product Advantages & Model Nomenclature

● Compatible with Tamagawa protocols; RS485 digital output supports baud rates up to 2.5 MHz (customizable to 5 MHz), enabling efficient data exchange with both multi-turn and single-turn absolute values.
● High-resolution options: 17bit (131,072), 21bit (2,097,152), 23bit (8,388,608), 25bit (33,554,432); supports up to 16bit multi-turn (65,536 turns). Absolute positioning accuracy: <±50 arcseconds.
● Built-in battery ensures long-term data retention. High single-turn resolution (25-bit) and redundant multi-turn backup enable reliable, cost-effective absolute positioning in industrial settings.
● All parameters can be configured via RS485 communication with a computer. The zero point can be set at any position, allowing the encoder to be installed while the device is stopped at any arbitrary position. There is no need to consider the encoder's initial rotational position—simply fix the coupling shaft. After powering on, a single zero-setting operation through the external wiring or RS485 communication will automatically correct the position.
● Ideal for precise position and speed feedback in tower cranes, mining hoists, construction elevators, CNC machines, 3D printers, automation lines, robotics, printing, packaging, logistics systems, and moving display rails.
● Wide operating range: -20°C to +105°C; ≤90% RH (40 °C, 21 days, no condensation, per EN 60068-2-78); protection class:IP40.



2.Electrical Characteristics

Electrical Parameters			
Supply Voltage	5V	Signal Output	Differential Output
Main Power Operating Current	<100mA	Edge Transition Time	100ns
Battery Voltage	3.6V DC	Insulation Resistance	50MΩ
Battery Fault Voltage	2.5V	Absolute Positioning Accuracy	<±50 arcsec
Battery Warning Voltage	3.1V	Repeatability	<±3 arcsec
Electrical Lifetime	> 100000 h	Communication Interface	RS485
Communication Frequency	≤16K	Baud Rate	2.5MHz、5MHz
Battery Voltage Fault Warning	Available		

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Number of multi-turns	Single Turn or 65536（16bit）
Single-Turn Resolution	131072（17bit）、2097152（21bit）、8388608（23bit）、33554432（25bit）
Mechanical Parameters	
Rotor Angular Acceleration (Power Supply)	≤80000rad/s^2
Rotor Angular Acceleration (Battery Supply)	≤4000rad/s^2
Mechanical Shock	980 m/s², 11 ms, 3 times per direction (18 times total)
Vibration	10–55 Hz, amplitude 1.5 mm; 55–2000 Hz, acceleration 98 m/s²; 2 hours per axis (X, Y, Z), total 6 hours
Permissible Input Shaft Deviation	Axial: ±0.5 mm Radial: ±0.02 mm Tilt: 0.1° Axial Float: <0.1 mm Radial Runout: <0.01 mm
Maximum Shaft Speed	≤6000rpm
Bore Diameter:	Straight Bore: Φ6 mm, Φ8 mm Taper Bore: Φ9 mm (Taper 1:10)
Moment of Inertia	0.68kg·mm^2
Environmental Parameters	
Operating Temperature	-20 ~ + 105 °C
Relative Humidity	≤90% (at 40°C/21 days, no condensation, EN 60068-2-78)
Protection Rating	IP40

3. Resolution and Accuracy

Resolution	Single-turn Resolution	Absolute Positioning Accuracy	Repeatability
17bit	131072(0.0027466°)	±50 arcsec(±0.013889°)	±3 arcsec(±0.000833°)
21bit	2097152(0.0001717°)	±50 arcsec(±0.013889°)	±3 arcsec(±0.000833°)
23bit	8388608(0.0000429°)	±50 arcsec(±0.013889°)	±3 arcsec(±0.000833°)
25bit	33554432(0.0000107°)	±30 arcsec(±0.008333°)	±3 arcsec(±0.000833°)

4. Wiring Definition

Single-Turn Encoder

Color	Pin No.	Definition	Remarks
Red	1	Power Supply +5V	Please check the voltage value on the encoder label before powering on.
Black	2	Ground (GND)	0V
Blue	3	RS485A	TR+
Yellow	4	RS485B	TR-

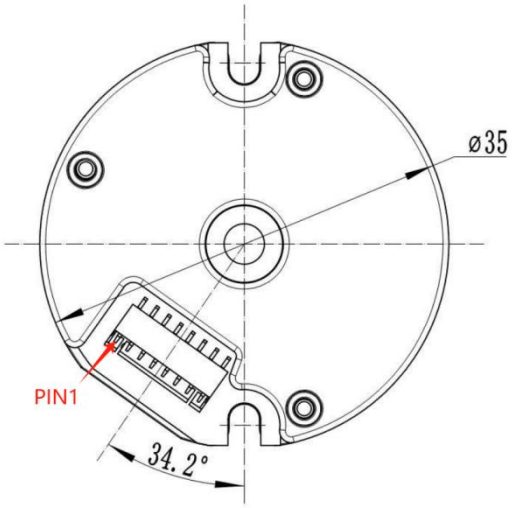
Brown	5	NC	No battery required for single-turn
White	6	NC	No battery required for single-turn
Shield	8	P	

Multi-Turn Encoder

Color	Pin No.	Definition	Remarks
Red	1	Power Supply +5V	Please check the voltage value on the encoder label before powering on.
Black	2	Ground (GND)	0V
Blue	3	RS485A	TR+
Yellow	4	RS485B	TR-
Brown	5	Battery +	
White	6	Battery（GND）	
Shield	8	P	

1.BZH44、BZH48 Cable Wiring Definition：

2.BZH35 Horizontal plug connection：



Note: From left to right, the socket pins correspond to the wiring definition, with socket pin 1 to pin 8.

5. RS485 Modbus Communication Protocol

5.1.Overview:

Unit	Description	Remarks
Code Format	Binary	
Communication Circuit	Differential Drive	RS485
Data Transmission Content	Single-turn Position Information	17 bits (max support 25 bits)
	Multi-turn Position Information	16bit
Communication Speed	2.5Mbps/5Mbps	
Communication Speed Accuracy	±50ppm	
Communication Waveform Jitter	±100ns	See:3.3The structure of ADF field
Initialization Time	< 405ms	

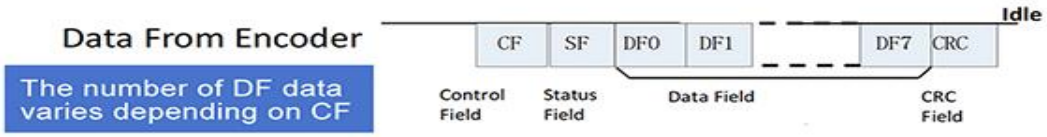
5.2.E2PROM Communication Specifications：

Unit	Address	Description	Remarks
Writable User Parameter Address Range	0~0x7E*6 Pages	User Parameter Area	This address area is used to store user parameters. Pages 6 and 7 are reserved areas and not recommended for use by customers.
Page Address	0x7F	0~7	Cannot exceed this range.
Maximum Writable Times	100000 times		The number of times the operation can be executed.

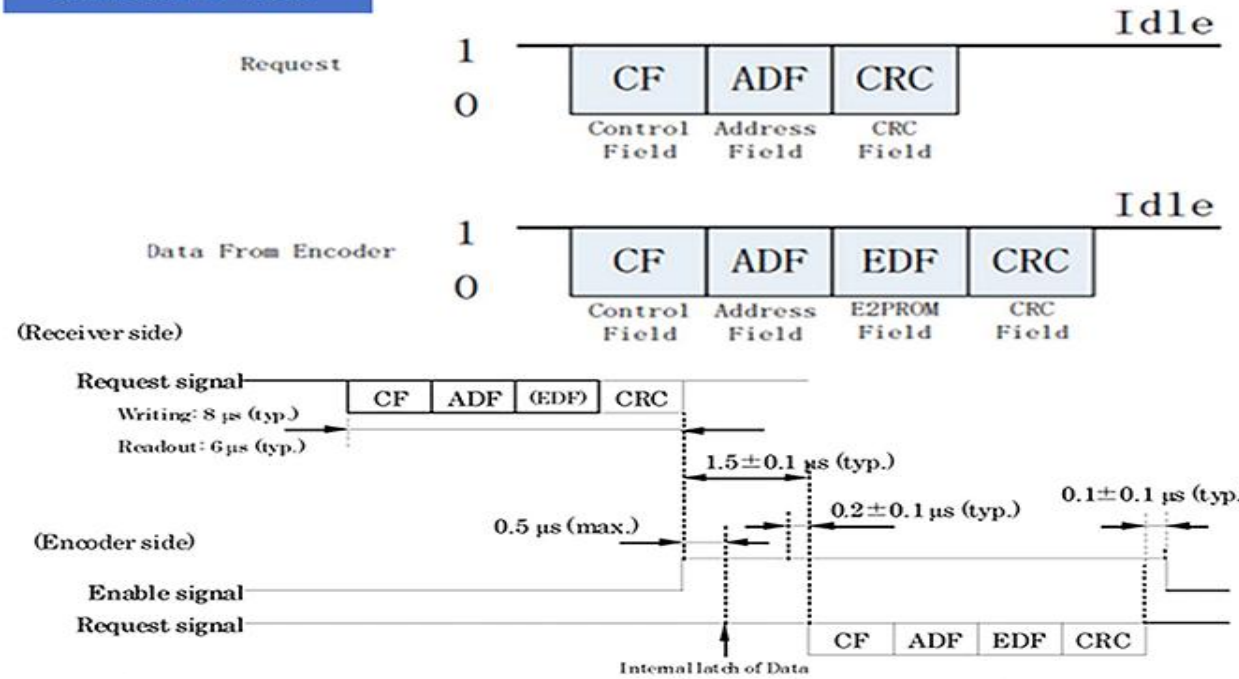
5.3.Frame Format：

Each data frame is divided into several data words. The transmission and reception of each data word consist of 1 start bit, 8 data bits, and 1 stop bit, with the least significant byte sent first and the most significant byte sent last. The terms used in data frame transmission are shown in the table below:

Unit	Description	Remarks
CF	Control Field	Identifies different command types
SF	Status Field	Provides the encoder status
DF	Data Field	Encoder position data
ADF	Address Field	Accessible encoder address
EDF	E2PROM Field	Content at the specified address
CRC	CRC Check	Polynomial: x8 + 1 (All data XORed except CRC)

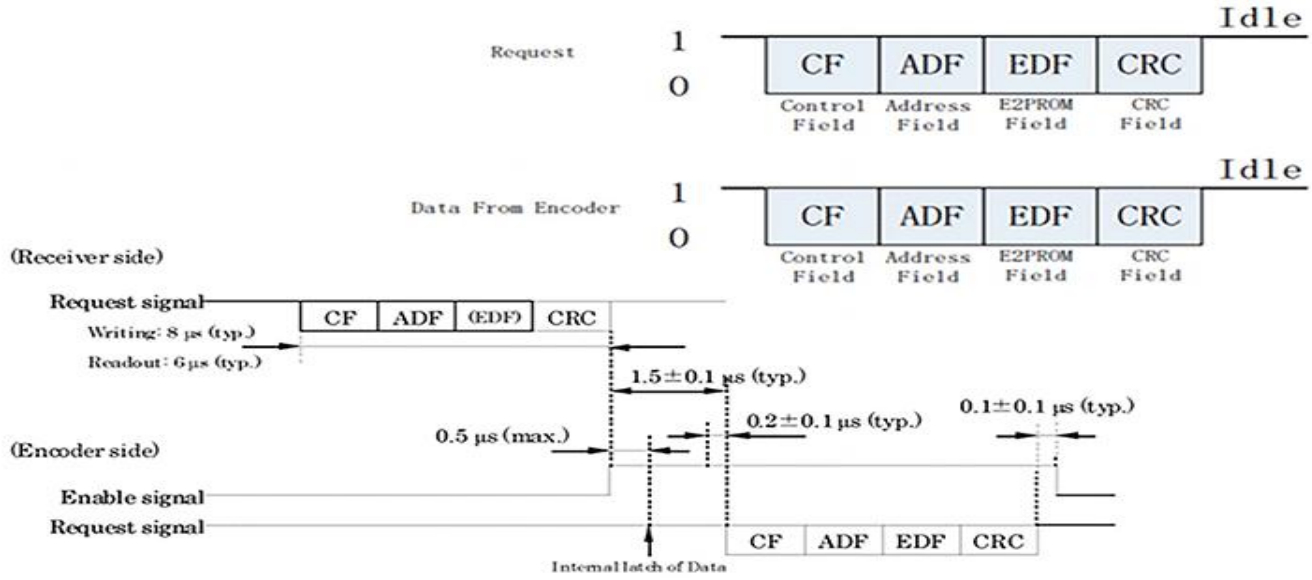


3.2 Read E²PROM

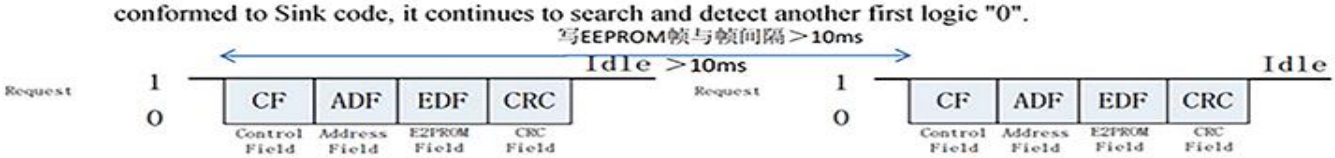


conformed to Sink code, it continues to search and detect another first logic "0".

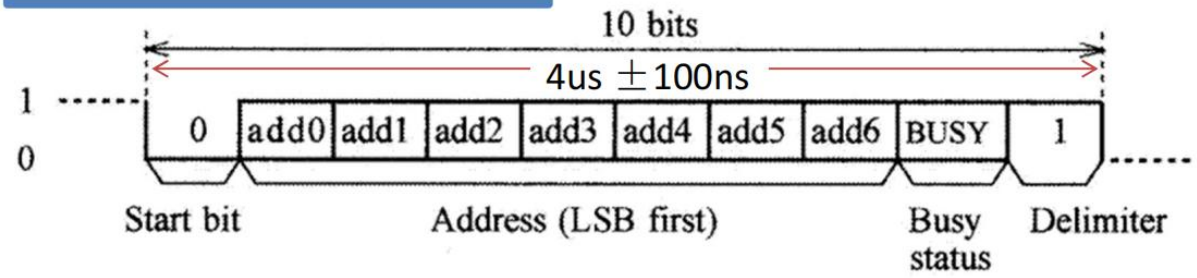
3.3 Write to E²PROM



conformed to Sink code, it continues to search and detect another first logic "0".



The structure of ADF field



	Request	Transmission data from Smart-Abs			Description
	Busy	Busy	ADF	EDF	
Read-out	0	0	ADF of the Request	Proper data of EEPROM	Readout is normally completed.
		1	ADF of the Request	00 [HEX]	Writing is in practice, and any request for Readout is invalid.
Writ-ing	0	0	ADF of the Request	EDF of the Request	Request for Writing was accepted.
		1	ADF of the Request	00 [HEX]	Writing is in practice and any request for Writing is invalid.

5.3.1 Control Field（CF）

CF Category	CF Type	Remarks
Read Data	ID0(0x02)	Absolute position read (CF+SF+ABS+CRC)
	ID1(0x8A)	Multi-turn data read (CF+SF+ABM+CRC)
	ID2(0x92)	Encoder ID read (CF+SF+ID+CRC)
	ID3(0x1A)	Read all data (CF+SF+ABS+ID+ABM+ALMC+CRC)
	ID3(0x1A)	25-bit encoder: read all data (CF + SF + ABS + ID + ABS + ABM + ALMC + CRC)
	ID4(0xA2)	25-bit encoder: read absolute position data only (CF + SF + ABS + CRC)
	ID5(0x2A)	25-bit encoder: read all position-related data (CF + SF + ABS + ABM + CRC)
Write E²PROM	ID6(0x32)	An 8-bit "user data" value can be written to the specified address. The host determines whether the request has been accepted by checking the status bit of the returned address from the encoder, and then sends a read EEPROM command to confirm whether the write operation was successful. Alternatively, ensure the interval between command frames is greater than 10 ms.
Read E²PROM	IDD (0xEA)	Reads 8-bit "user data" from specified address.
Reset	ID7(0xBA)	Requires 10 consecutive commands (≥62.5μs interval) to reset all fault flags.
	ID8(0xC2)	Requires 10 consecutive commands (≥62.5μs interval) to reset single-turn position to zero (persists after power cycle).
	IDC(0x62)	Requires 10 consecutive commands (≥62.5μs interval) to reset multi-turn data (single-turn unaffected) and all fault flags.

5.3.2 Status Field (SF)

SF The SF is a 1-byte field with bit definitions as follows:

Bit	Description	Remarks
Bit0	Rsvd	All "0"
Bit1	Rsvd	
Bit2	Rsvd	
Bit3	Rsvd	
Bit4	Counting Error	Set to "1" when encoder position calculation fails
Bit5	Multi-turn Error / Battery Error /Battery Alarm	Check ALMC sub-status for detailed fault information
Bit6	Rsvd	0
Bit7	Rsvd	0

5.3.3. Data Field (DF0-DF7)

DF byte count varies by CF type. This table applies to 17/21/23-bit protocols:

CF Type	DF0	DF1	DF2	DF3	DF4	DF5	DF6	DF7
ID0 (0×02)	ABS0	ABS1	ABS2					
ID1 (0×8A)	ABM0	ABM1	ABM2					
ID2 (0×92)	ENID							
ID3 (0×1A)	ABS0	ABS1	ABS2	ENID	ABM0	ABM1	ABM2	ALMC
ID4 (0×2B)	ABS0	ABS1	ABS2	ABM0	ABM1	ALMC		
ID7 (0×BA)	ABS0	ABS1	ABS2					
ID8 (0×C2)	ABS0	ABS1	ABS2					
IDC (0×62)	ABS0	ABS1	ABS2					

Note:
1.ABS0 to ABS2 represent the low, middle, and high bits of the encoder's absolute position, where the high 7 bits of ABS2 are 0. The remaining data forms a 17-bit position (for a 23-bit encoder, the high 1 bit of ABS2 is 0, and the remaining bits are valid).
2.ABM0 to ABM2 represent the low, middle, and high bits of the encoder's multi-turn position, with ABM2 being all zeros. The remaining data forms a 16-bit multi-turn position.
3.ENID is the encoder ID, with values of 0x11 (17-bit) or 0x17 (23-bit).

This table applies to 25-bit protocols

	DF0	DF1	DF2	DF3	DF4	DF5	DF6	DF7
ID2 (0×02)	ENID							
ID3 (0×8A)	ABS0	ABS1	ABS2	ENID	ABS3	ABM0	ABM1	ALMC
ID4 (0×92)	ABS0	ABS1	ABS2	ABS3				
ID5 (0×1A)	ABS0	ABS1	ABS2	ABS3	ABM0	ABM1		

ID7 (0×2B)	ABS0	ABS1	ABS2					
ID8 (0×BA)	ABS0	ABS1	ABS2					
IDC (0×C2)	ABS0	ABS1	ABS2					

Note:The blank fields in the above table indicate no data transmission.
1.The 25-bit encoder differs in 1A/A2/2A commands, while other commands remain consistent.
2.ABS0 to ABS3: Single-turn absolute data.
3.ABS0 is located in the low byte of the frame, and ABS3 is in the high byte, with a total length of 32 bits.
4.The lower 7 bits of ABS0 are always logic "0," so the valid data is 25 bits in total.
5.ABM0 to ABM1: Multi-turn data.
6.ABM0 is in the low byte, and ABM1 is in the high byte, with a total length of 16 bits, providing 16 bits of valid data.
7.ENID: Encoder ID (fixed at 19H).
8.ALMC: Encoder fault flag, as detailed in the next section.

5.3.4. ALMC Explanation

ALMC Faults – See Below

Bit	0	1	2	3	4	5	6	7
Fault Name	Over-speed	"0"	Counting Error	"0"	"0"	Multi-turn error	Battery error	Battery alarm

Fault flag descriptions are listed below:

Fault Name	Function Description	Solution
Over-speed	Speed exceeds 7200 RPM under 5V power supply mode	Power cycle
Counting Error	Single-turn position calculation fault	Power cycle
Multi-turn error	Multi-turn data loss or counting fault	Fault reset
Battery error	Battery voltage below 2.7±0.1V, set	Check the battery power circuit and replace the battery
Battery alarm	Battery voltage below 3.1±0.1V, set	After replacing with a properly charged battery, the fault will clear automatically

6.RS485 Modbus Communication Protocol

6.1.Host Computer Communication Example Using Control Field (CF)

When sending commands from the host, it is necessary to understand the data format and function code type. Frame format explanation is on page 5, and function command explanation is on page 8. Please review these before connecting the encoder with the host.

6.1.1.Read Absolute Position Information (17-bit, 21-bit, 23-bit)

Function Command	02 (Hex)	Description	Read Encoder Absolute Value
Data Range	0 ~ X (X is the single-turn resolution)	Read/Write	Read Only
Data Type	Unsigned Integer	Memory	Power-off Memory
Activation	Immediate	Applicable Range	17-bit, 21-bit, 23-bit

Description:Encoder Current Angle = Encoder Value * 360 / Resolution.Given Encoder Value = 3963156 and Single-Turn Resolution = 2^23 (8388608),Encoder Current Angle ≈ 3963156 * 360 / 8388608 ≈ 170.08°.

Communication Example:

Tx (Send): 02

Rx (Receive): 02 00 14 D9 3C F3

Note:In the received data, "02" is CF (Command Type), "00" is SF (Status Field), 14 D9 3C" represents the ABS (Single-Turn Encoder Value) in little-endian format (3C D9 14), and "F3" is the CRC checksum. The encoded value after conversion is 3963156.

6.1.2.Read Absolute Position Information (17-bit, 21-bit, 23-bit)

Function Command	8A (Hex)	Command Description	Read multi-turn encoder information
Data Range	0 ~ 65536	Read/Write	Read only
Data Type	Unsigned integer	Memory	Power-off reset
Activation	Immediate	Applicable Range	17-bit, 21-bit, 23-bit

Explanation:Multi-turn encoder value = number of turns * resolution + current encoder value. With a current value = 3963156, turns = 2, and resolution = 2^23 (8388608), the multi-turn value is 2 * 8388608 + 3963156 = 20740372.

Communication Example:

Tx (Send): 8A

Rx (Receive): 8A 00 02 00 00 88

Note:In the received data, "8A" is CF (Command type), "00" is SF (Encoder status), "02 00 00" is ABM (Number of turns), with low byte first (00 00 02), and "88" is CRC check. The current turn count is 2.

6.1.3.Read Encoder ID (17-bit, 21-bit, 23-bit, 25-bit)

Function Command	92 (Hex)	Command Description	Read encoder ID
Data Range	0 to X (X is the encoder ID)	Read/Write	Read only
Data Type	Unsigned Integer	Memory	Power-off Memory
Activation	Immediate	Applicable Range	17-bit, 21-bit, 23-bit, 25-bit

Explanation: The encoder ID represents its single-turn resolution.

Communication Example:

Tx (Send): 92

Rx (Receive): 92 00 17 85

Note: In the received data, "92" is the CF (Command Type), "00" is the SF (Encoder Status), "17" is the Encoder ID, and "85" is the CRC checksum. By conversion, the encoder ID is 23, which also indicates the encoder resolution of 2^23.

6.1.4.Read All Data (17-bit, 21-bit, 23-bit)

Function Command	1A (Hex)	Command Description	Read all data
Data Range	-	Read/Write	Read only
Data Type	Unsigned Integer	Memory	Partial power-off reset
Activation	Immediate	Applicable Range	17-bit, 21-bit, 23-bit

Communication Example:

Tx (Send): 1A

Rx (Receive): 1A 00 20 33 2C 17 02 00 00 00 30Note: "1A" is the CF (Command Type), "00" is the SF (Encoder Status), "20 33 2C" is the ABS (Single Turn Value), "17" is the Encoder ID, "02 00 00" is the ABM (Multi-turn Value), "00" is the ALMC (Fault Flag), and "30" is the CRC. The calculated results are: single-turn value = 2896672, ID = 23, and turns = 2.

6.1.5.Read Single-turn Data (25-bit)

Function Command	A2 (Hex)	Command Description	Read single-turn data (25-bit)

Data Range	-	Read/Write	Read-only
Data Type	Unsigned Integer	Memory	Partial power-off reset
Activation	Immediate	Applicable Range	25-bit

Description: This command is only applicable to 25-bit single-turn resolution encoders.
Communication Example:
Tx (Send): A2
Rx (Receive): A2 00 00 FD FF FF 5F
Note: In the received data, "A2" is the CF (Command Field), "00" is the SF (Encoder Status), "00 FD FF FF" represents the ABS (Single-Turn Encoder Value) in little-endian format (FF FF FD 00), and "5F" is the CRC checksum. During conversion, since the lower 7 bits of the single-turn encoder data are all 0, the data must be right-shifted by 7 bits (FF FF FD 00 >>7), resulting in a final encoder value of 33,554,426.

6.1.6.Read Multi-turn Data (25-bit)

Function Command	2A (Hex)	Command Description	Read multi-turn data (25-bit)
Data Range	-	Read/Write	Read-only
Data Type	Unsigned Integer	Memory	Partial power-off reset
Activation	Immediate	Applicable Range	25-bit

Description: This command is only for 25-bit single-turn resolution encoders.Total value = multi-turn count × resolution + single-turn value

Communication Example:
Tx (Send): 2A
Rx (Receive): 2A 00 00 36 F6 A9 03 00 40

Note:In the received data, "2A" represents CF (Command Function), "00" represents SF (Encoder Status), and "00 36 F6 A9" is the ABS (Single-Turn Code Value). The byte order is little-endian, so the actual order for calculation is A9 F6 36 00. "03 00" is the multi-turn data, and "40" is the CRC checksum.During the conversion process, since the lower 7 bits of the single-turn encoder data are always 0, the decimal value needs to be right-shifted by 7 bits (A9 F6 36 00 >> 7).The final calculated position value is 22,277,228.

6.1.7.Read All Data (25-bit)

Function Command	1A (Hex)	Command Description	Read all encoder data
Data Range	-	Read/Write	Read-only
Data Type	Unsigned Integer	Memory	Partial power-off reset
Activation	Immediate	Applicable Range	25-bit

Description: This frame structure is specific to 25-bit encoders.

Communication Example:
Tx (Send): 1A
Rx (Receive): 1A 00 00 5C 47 19 28 01 00 00 31

Note: In the received data, "1A" is CF (Command Function), "00" is SF (Status). Per the protocol, the 25-bit single-turn position spans 4 bytes: ABS0~ABS2 are before ENID, with one high byte after ENID. So "00 5C 47 28" is ABS (position), "19" is ID, "01 00" is ABM (multi-turn), "00" is ALMC (alarm), "C9" is CRC. All data follows little-endian format. Final values: ABS = 5,279,416; ID = 25; ABM = 1.

6.1.8.Encoder Fault Flag Reset (17-bit, 21-bit, 23-bit, 25-bit)

Function Command	BA (Hex)	Command Description	Reset Fault Flag
Data Range	0 ~ 1	Read/Write	Write Only

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Data Type	Unsigned Integer	Memory	-
Activation	Immediate	Applicable Range	17-bit, 21-bit, 23-bit, 25-bit

Description:When a fault is indicated by SF (Status Flag) or ALMC (Alarm Code), refer to the manual to identify and resolve the issue, then use this command to clear the fault flag.

Communication Example:
Tx (Send): BA
Rx (Receive): BA 00 5A 31 2C FD

Note:Send the reset command 10 times at intervals of at least 62.5 μs. Once the fault is cleared, the returned SF (status) value should be “00”, indicating success. If not, the fault may still exist.

6.1.9.Single-Turn Zero Reset (17-bit, 21-bit, 23-bit, 25-bit)

Function Command	C2 (Hex)	Command Description	Single-Turn Zero Reset
Data Range	0 ~ 1	Read/Write	Write Only
Data Type	Unsigned Integer	Memory	Power-off Memory
Activation	Immediate	Applicable Range	17-bit, 21-bit, 23-bit, 25-bit

Description:Send this command 10 times at ≥62.5 μs intervals to reset the single-turn position to zero. The new zero point will be retained even after power-off/on.

Communication Example:
Tx (Send): C2
Rx (Receive): C2 00 00 00 00 C2

Note:After sending the command 10 times, the encoder will return a single-turn value of “00 00 00”, confirming successful reset. As the zero point overlaps with the max value, the encoder may display the maximum in some cases.

6.1.10.Multi-Turn Reset & Fault Flag Clear (17-bit, 21-bit, 23-bit, 25-bit)

Function Command	62 (Hex)	Command Description	Multi-Turn Reset and Fault Flag Clear
Data Range	0 ~ 1	Read/Write	Write Only
Data Type	Unsigned Integer	Memory	-
Activation	Immediate	Applicable Range	17-bit, 21-bit, 23-bit, 25-bit

Description:Send this command 10 times at ≥62.5 μs intervals to reset the multi-turn value (single-turn value unaffected) and clear all fault flags.

Communication Example:
Tx (Send): 62
Rx (Receive): 62 00 BD 72 00 AD

Tx (Send): 8A
Rx (Receive): 8A 00 00 00 00 8A

Note:After 10 consecutive commands, send “8A” to verify multi-turn reset. A returned value of “00 00 00” confirms success, and all faults are cleared.

7.Precautions

- The encoder is a precision instrument. Handle it with care. Avoid knocking, impacting, or forcibly pulling the encoder shaft.
- Use flexible couplings or elastic brackets to connect the encoder to mechanical components. Rigid misaligned connections may cause mechanical damage.
- Although the encoder itself will not lose position counts in an electromagnetic interference environment, transmission errors may still occur. In such cases, it is recommended to use isolated power supplies and double-shielded communication cables for better protection.
- Ensure proper grounding of the encoder housing and shielding layer to prevent damage from lightning or high-voltage static discharge.
- The product's Mean Time Between Failures (MTBF) is considered sufficiently long, but failure probability is not zero. Users should be responsible for any issues caused by encoder failure and are advised to incorporate multiple safety mechanisms into their system designs to prevent critical failures.

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2-Year Warranty · Lifetime Support

For after-sales service, please contact us.