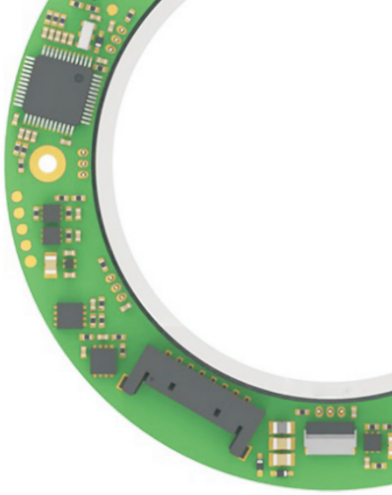
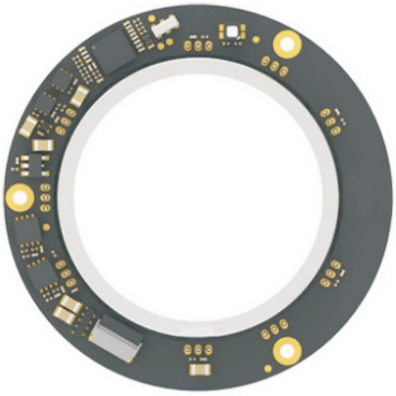
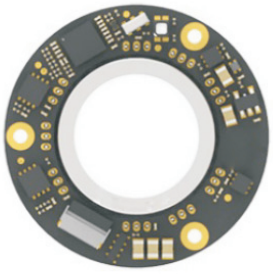
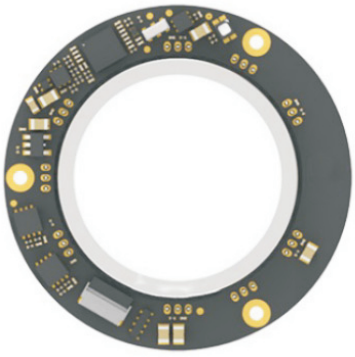
MOSRAC® Mosrac motor

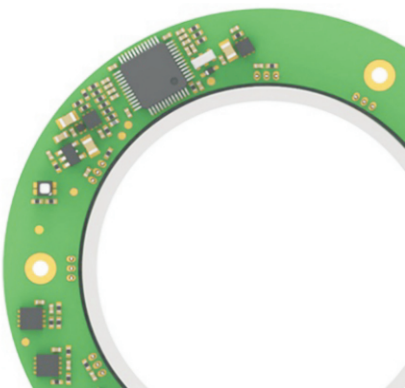


S Series Magnetic Encoder Data Sheet

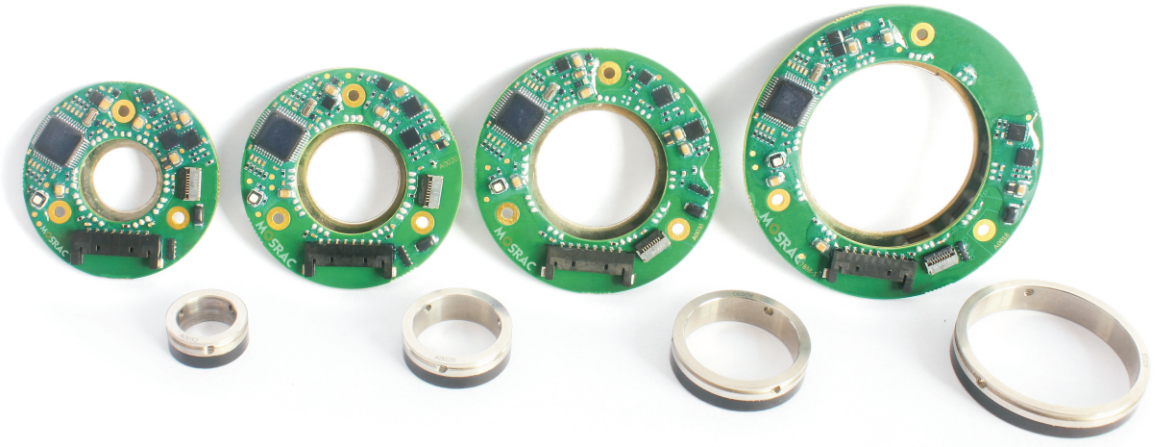








S Series Magnetic Encoder



S Series magnetic encoder is an ultra-thin absolute encoder with multiple output formats and strong anti-electromagnetic interference capabilities. Various sizes are available, suitable for applications requiring high output accuracy and limited space.

The encoder is driven by magnetoelectric technology and has unique interference shielding technology. The encoder has multiple high-precision Hall sensors inside to measure the magnetic field changes of the rotor magnetic ring, and is formed with precision calibration technology provided by MOSRAC. Each product leaves the factory with unique magnetic field calibration data, providing the best measurement accuracy.

The unique dynamic and static parts tolerances installation technology not only simplifies user installation,but also protects measurement accuracy.

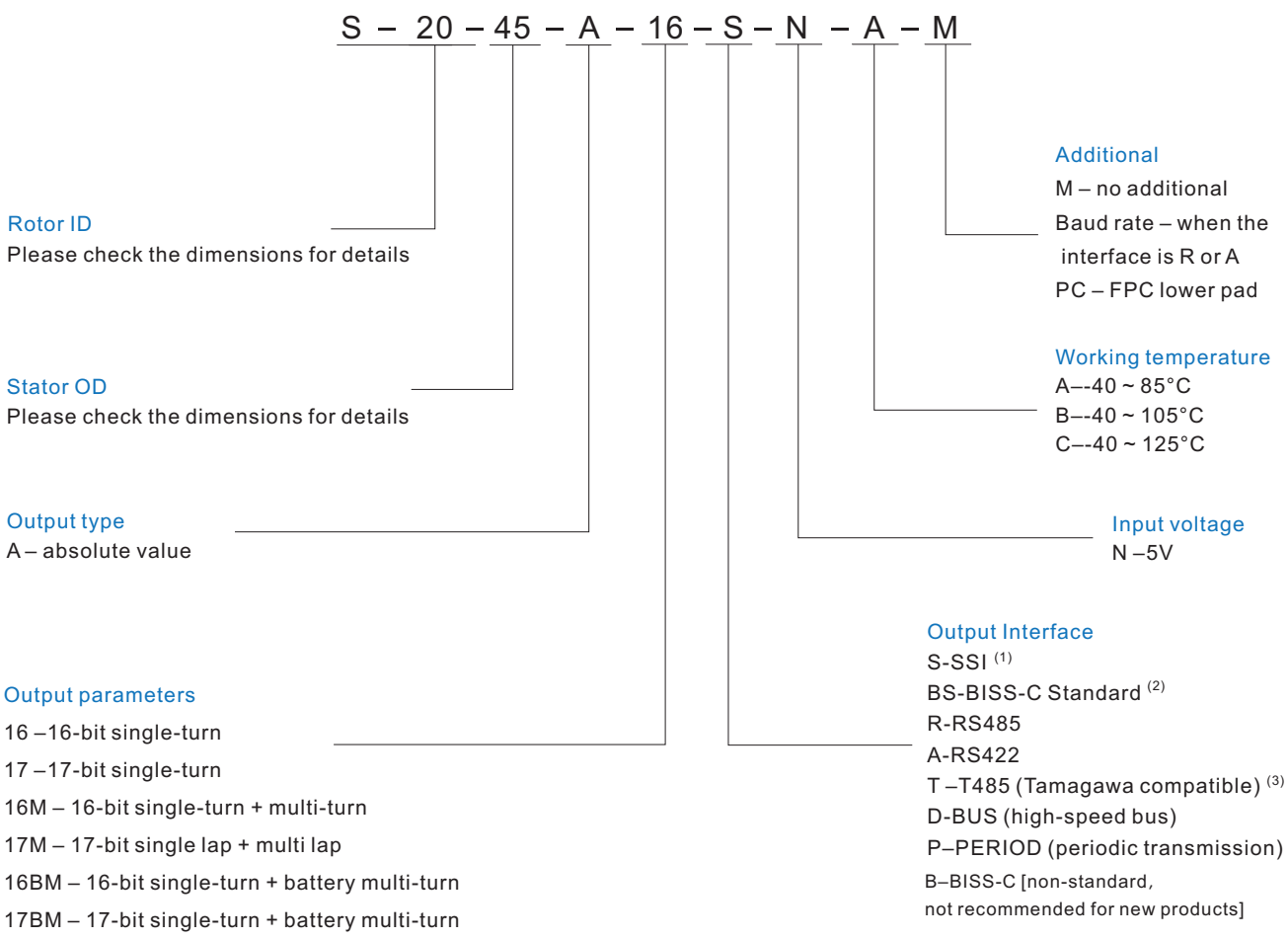
The separated magnetoelectric solution has stronger environmental tolerance, such as vibration, dust, oil, etc., and can operate at ultra-high speed without affecting the encoder accuracy and working life.

With unique magnetic shielding technology, the encoder can work normally and output with high precision in a strong electromagnetic interference environment.

Ultra-thin body with hollow shaft could easily suit with anyApplication.

- 17-bit absolute value output
- ±0.05° absolute positioning accuracy
- Ultra-thin structure (7mm)
- One model for every 2 or 3mm inner diameter
- Radial single side 8.5mm
- Stator and rotor tolerance matching installation technology
- Magnetic interference shielding technology
- Hollow, does not limit installation location
- Max speed > 20,000 rpm
- Unique data calibration shaping
- Multi-turn battery mode
- Various output interfaces
- Resistance to various environmental interferences

Model



(1) The SSI protocol haven't CRC check. Recommend to use BISS-C Standard with the same hardware instead to improve reliability.

(2) The BS protocol uses the completely standard BISS-C protocol format.

(3) The T485 protocol optional output parameters are 17M or 17BM.

(4) The ordinary multi-turn's multi-turn data is only valid when the power is turned on. Counting starts from zero after the power isturned off and then on again.

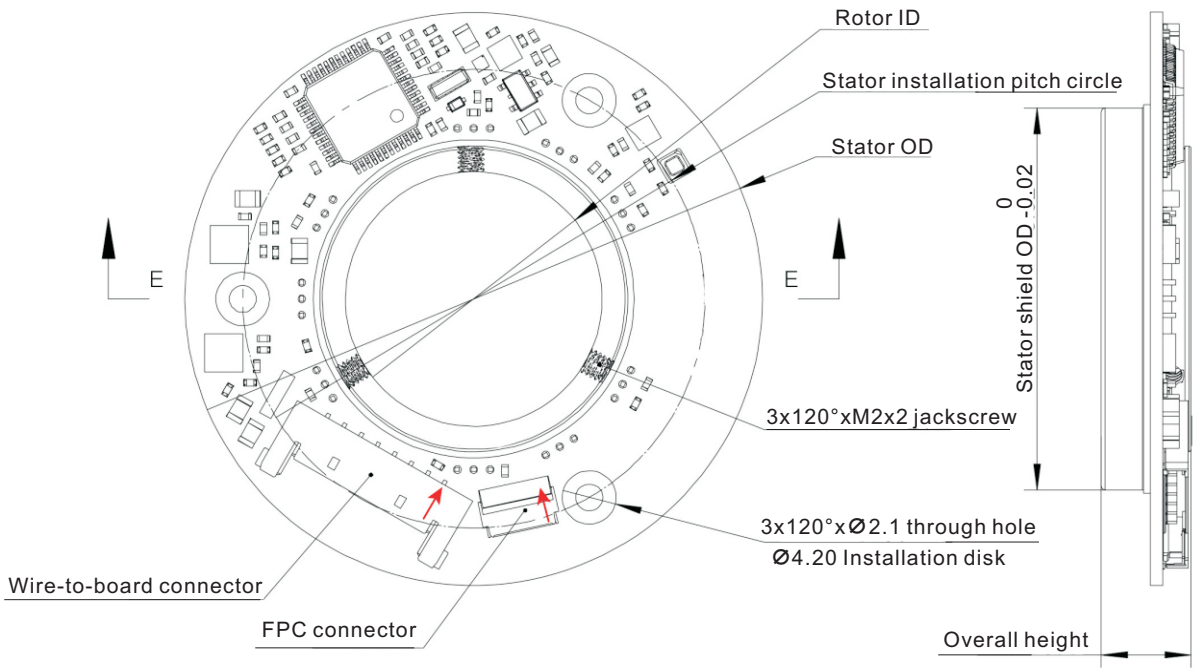
Size

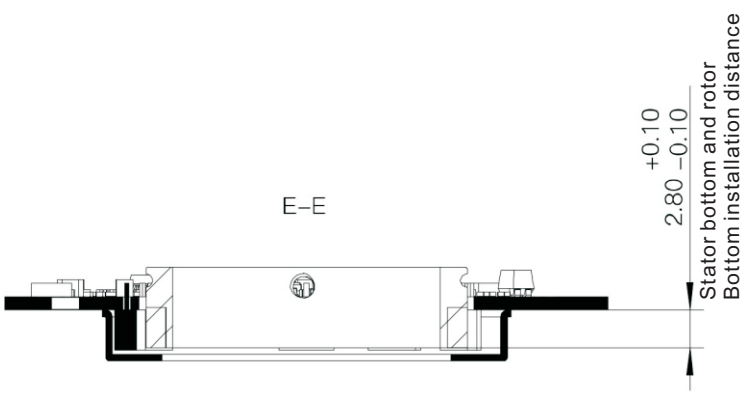
Series	Types	Size	Rotor ID	Stator OD	Stator installation pitch circle	Stator shield OD	Connector		Overall thickness
							Wire to board	FPC	
10	Standard	S-8-36	8	36	25	20	✓	✓	7
		S-10-36	10						
	Compact	S-8-27	8	27	23		–	✓	
		S-10-27	10						
15	Standard	S-12-40	12	40	30	25	✓	✓	
		S-13-40	13						
		S-15-40	15						
	Compact	S-12-32	12	32	28		–	✓	
		S-13-32	13						
		S-15-32	15						
20	Standard	S-6-45	6	45	36	30	✓	✓	
		S-8-45	8						
		S-10-45	10						
		S-15-45	15						
		S-18-45	18						
		S-20-45	20						
	Compact	S-18-37	18	37	33		–	✓	
		S-20-37	20						
25	Standard	S-23-50	23	50	40	35	✓	✓	
		S-25-50	25						
	Compact	S-23-42	23	42	38		–	✓	
		S-25-42	25						
30	Standard	S-28-55	28	55	45	40	✓	✓	
		S-30-55	30						
	Compact	S-28-47	28	47	43		–	✓	
		S-30-47	30						
35	Standard	S-33-60	33	60	50	45	✓	✓	
		S-35-60	35						
	Compact	S-33-52	33	52	48		–	✓	
		S-35-52	35						
40	Standard	S-38-65	38	65	55	50	✓	✓	
		S-40-65	40						
	Compact	S-38-57	38	57	53		–	✓	
		S-40-57	40						
45	Standard	S-43-70	43	70	60	55	✓	✓	
		S-45-70	45						
	Compact	S-43-62	43	62	58		–	✓	
		S-45-62	45						
50	Standard	S-48-75	48	75	65	60	✓	✓	
		S-50-75	50						
	Compact	S-48-67	48	67	63		–	✓	
		S-50-67	50						
55	Standard	S-53-80	53	80	70	65	✓	✓	
		S-55-80	55						
	Compact	S-53-72	53	72	68		–	✓	
		S-55-72	55						

Drawing

Standard

The drawings include standard stators and rotors of this series.

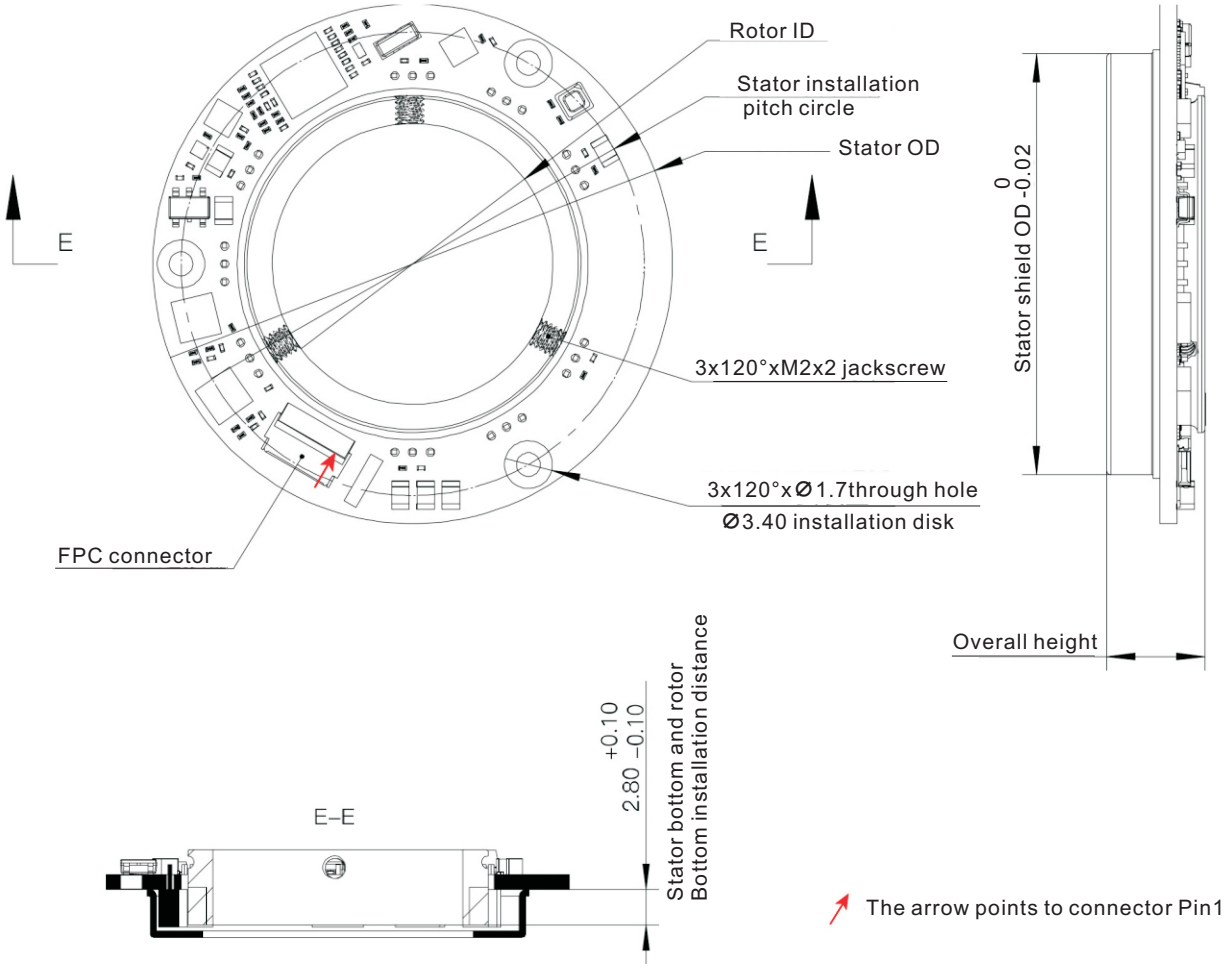




The arrow points to connector Pin1

Compact

The drawings include compact stators and rotors from this series



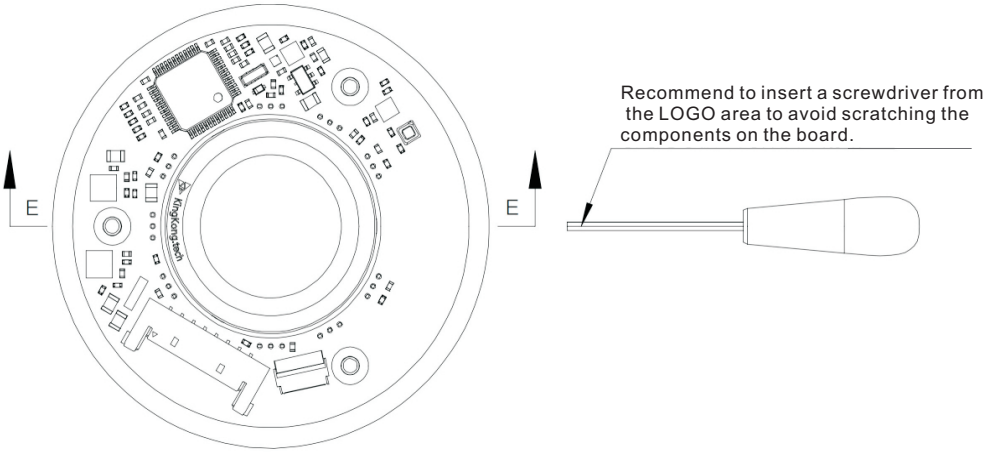
Stator and rotor matching

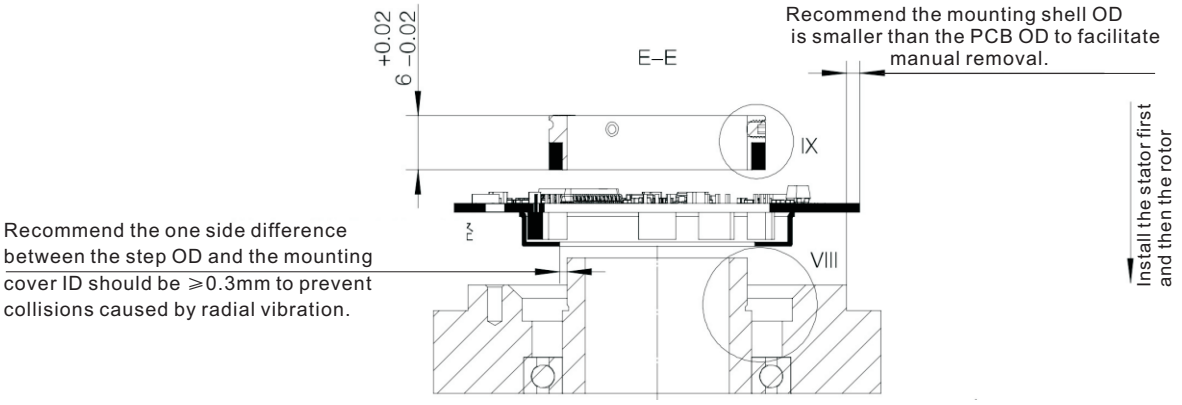
To use the encoder stator's shield OD to fit tolerance to locate the center of the encoder body. At the same time, the encoder rotor is installed concentrically with the measured shaft through the ID fit tolerance. These two operations ensure the concentricity of the encoder dynamic and static parts, thus basically eliminates installation errors and restores the data accuracy of factory calibration to the greatest extent.

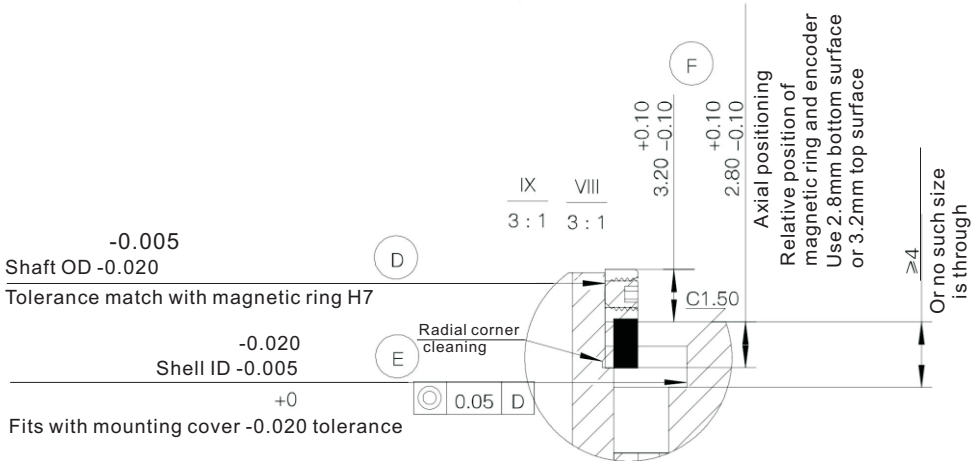
The encoder rotor is located in the radial part of the encoder stator,and is installed in the axial direction and tightened by radially outer jackscrew. When the distance between the bottom of the encoder rotor and the encoder stator shield is less than 1mm,the encoder can work normally. In order to achieve the highest measurement accuracy, the encoder moving part should be axially positioned by the shaft shoulder,the mounting surface distance between the shaft shoulder and the encoder static part is C(as shown in the figure,the encoder is calibrated on the tooling with a distance value of 2.8mm when leaving the factory). When the encoder is installed and used, the data accuracy of the factory calibration can be restored to the max extent when C is 2.8mm. For details,please refer to the installation suggestions in the next chapter.

Design and installation suggestions

The encoder stator shield matches the housing inner circle tolerance,and the encoder rotor bracket matches the shaft outer circle tolerance.







Three tolerance installation dimensions respectively locate:

1. Encoder rotor radial position (D)

2. Encoder stator radial position (E)

3. The relative axial position of the encoder rotor and stator (F)

The three dimensions and positions can clearly determine the relative position between the encoder stator and rotor. When the relative position is determined,the angle repeatability and absolute positioning accuracy can be locked.

The installation method shown in the figure can restore the relative position of the encoder rotor and stator when factory calibrated as much as possible. When installed and used with the same tolerance,the best data accuracy can be obtained directly without post-calibration,that is "ready to use".

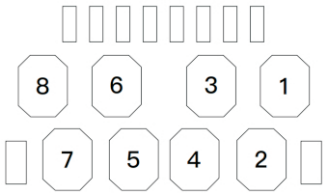
Electrical connections

Connectors

Model	MOLEX 504050-0891	FH34SRJ-8S-0.5SH	Soldering Pad
Type	Wire to board	FPC double-sided	Manual solder
Wire	4PxAWG28 twisted pair (OD~4.0mm)	8P 0.5mm FPC	Recommended wire diameter: less than AWG28
Scenario	Long wire, such as: servo motor	Small space or the driving circuit is head of encoder	Compact space where the it is so small that FPC cannot be used

Soldering pad

Soldering pad under FPC connector (Add PC addition in model), for manual solder corresponding pin(glue after are suggested)



Pin descriptions

Pin	Color	S	B	A	R	T	D	P
		SSI	BISS-C	RS422	RS485	T485	BUS	PERIOD
1	Red	+5V						
2	Black	0V(GND)						
3	Green	Clock +	MA +	RX +	A	A	A	-
4	Green/Black	Clock -	MA -	RX -	B	B	B	-
5	Yellow	Data +	SLO +	TX +	-	-	-	TX +
6	Yellow/Black	Data-	SLO -	TX -	-	-	-	TX -
7	White	Battery +	Battery +	Battery +	Battery +	Battery +	Battery +	Battery +
8	White/black	Battery +	Battery -	Battery -	Battery -	Battery -	Battery --	Battery -

* Battery +/- only in battery multiturn (BM) version.
* The battery- is connected to the internal GND of the encoder.
* The shield is recommended to be grounded at the driver side.

Parameters

System

Installation method	Axial hollow
Accuracy	±0.05°
Temperature drift	±0.01°/3 °C

Electrical

Power supply	4.5 ~ 5.5 V
Battery	2.7 ~ 3.6 V
Startup time	15 ms
Connection	Wire to board connector MOLEX 504050/FPC connector FH34SRJ-8S-0.5SH/Soldering Pad
Current	≈ 60 mA
Battery mode current	≈ 35μA (battery voltage 3.6V，in 6000rpm low power detection mode，see Battery features for details)
ESD resistance	HBM，max. ±2 kV CDM，max. ±1 kV

Mechanical

Rotor material	Stainless steel Aluminum alloy（MBS-6-45/MBS-8-45/MBS-10-45/MBS-12-45）

Environmental

Operating temperature	-40 ~ 85 ℃ / -40 ~ 105 ℃ / -40 ~ 125 ℃

Features

Maximum speed

With non-contact structure, there is no friction between the rotor and the stator, and the maximum speed can be extremely high, so it can be applied to high speed applications.

Environmental interference

The measurement method of the S can bring a certain resistance to vibration, and will not damage the encoder. It has strong anti-interference ability against non-magnetic objects such as oil and dust.

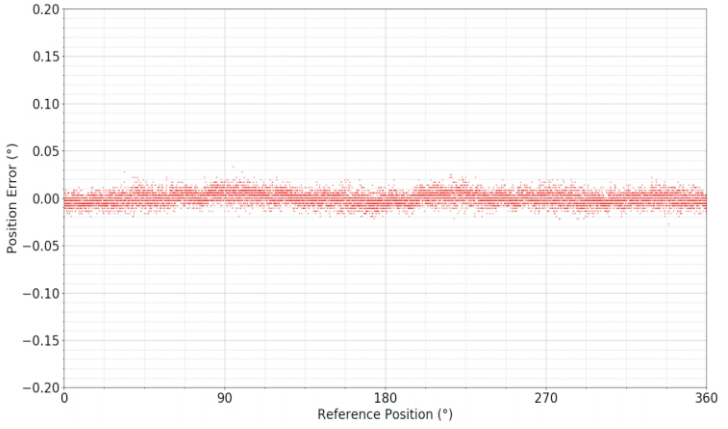
External magnetic field interference

The S encoder has a unique anti-electromagnetic interference technology. The electromagnetic shielding shell can shield the electromagnetic interference transmitted from the environment (such as motor coils), and the magnetic field strength of the magnetic ring is generally much greater than the external interference magnetic field. The combination of the shield and internal magnetic field can stable against external interferences.

Accuracy

During the magnetization process of the magnetic ring,the problem of low consistency of the magnetic field may occur, however each encoder of KingKong Technology.
Has the unique data information of its corresponding magnetic ring after being calibrated at the factory. Therefore, the error caused by the magnetic field consistency of the magnetic ring can be significantly Reduced.

The picture shows the typical encoder accuracy after calibration.



Specification

Output format

Single turn	
Output angle data	

Multi-turn

Output turns and angle data	The number of tums cannot be kept after power off, and it will reset to zero after repower on

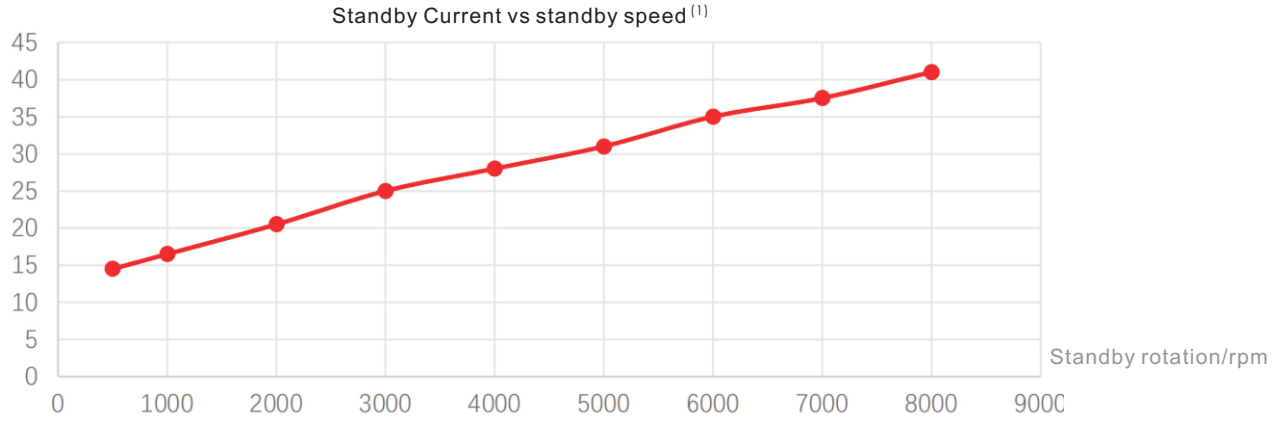
Battery multi-turn

Output turns and angle data	After the power supply is off, the battery is take over, and encoder enters to the low power mode. The rotation of the motor can still be measured, and the number of turns could be read after the power is recovered.

Calculation parameters

Angle resolution	17、16 bit
Rotation speed	> 20, 000 rpm
Update frequency	27 kHz
repeatable accuracy	0 ~ ±1 bit (change by singleturn angle bits selection)
Output interface	SSI、BISS-C、RS485、RS422、T485、BUS、PERIOD

Battery features



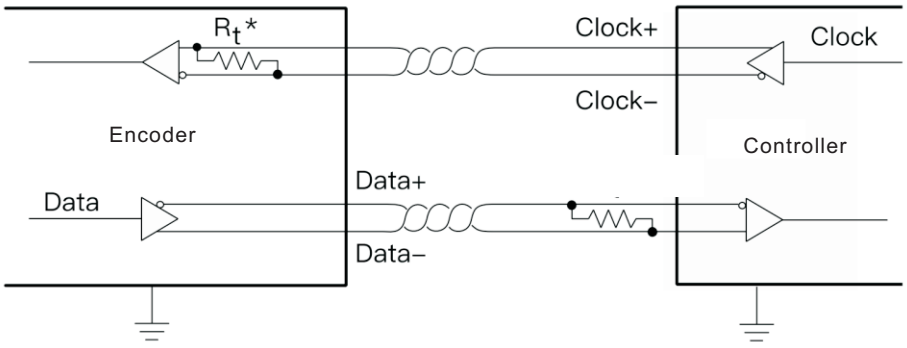
(1) Measured at a battery voltage of 3.6v and a temperature of 25℃

Calculate of battery standby time $\frac{\text{battery capacity (mAh)}\times 1000}{\text{standby current}(\mu A)\times 24\times 365}$ = standby time(year)

Please select the standby speed according to application to achieve longer battery life and standby time. The default shipment is 6000rpm. Please contact supplier for this option.

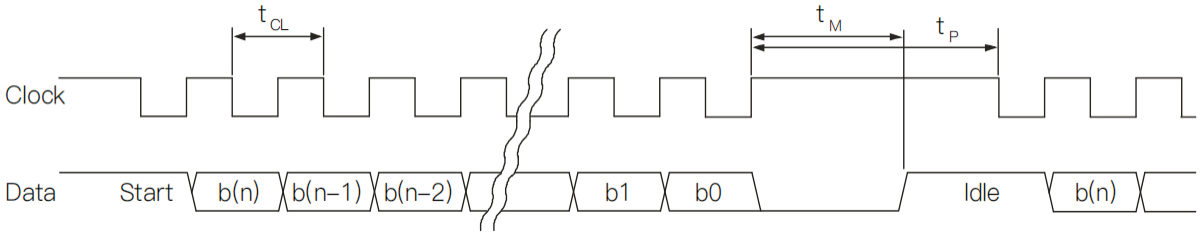
SSI protocol interface

Electrical connection diagram:



It is a four-wire interface, include the differential lines of Clock and Data. And the terminal resistors of theClock lines have been integrated into the encoder. The users only need to configure terminal resistors or choose other impedance matching schemes for Data lines.

Sequence diagram:



In this protocol,when the first falling edge of the Clock arrives, the system latches current data. The data is written to Data line on the rising edge of each Clock from the MSB, and on the controller side, the data on Data line is read from the falling edge of Clock,and so on until the LSB is read by the controller.

After the transfer is complete,when the t_M transfer time ends , the Data line goes high and the Clock signal must remain high until the next read is allowed, i.e. After t_P time t_{CL} must be less than t_M and the read can be terminated by making the time exceed t_M while any read operation is in progress.

Timing Parameters:

Parameters	Symbol	Min value	Typical value	Max value
Clock period	T_{CL}	400 ns		14 µs
Clock frequency	$1/t_{CL}$	110 kHz		1.5 MHz (1)
Transmit timeout	t_M		10 µs	
Pause duration	t_P	20 µs		

(1) If the Clock can be held at the first low level for 500ns, the subsequent clock frequency can be up to 10MHz.

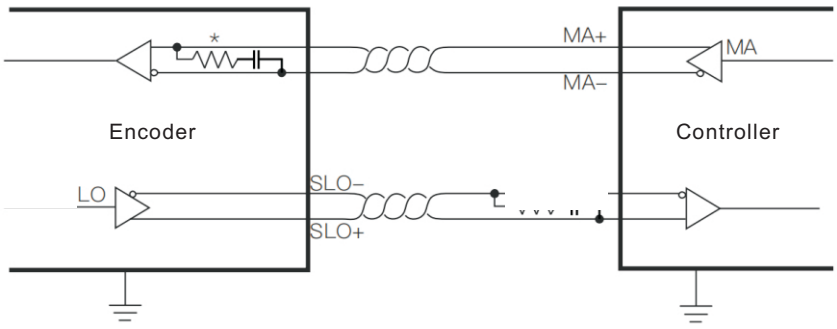
Data format:

Bits	B(23 + X) : b(8 + X)	B(7 + X) : b8	b7	b6	B5 : b0
Length	16 bits	X bits	1bit	1bit	6 bits
Data	Multiturn count (1)	Singleturn angle	Error bit	Warning bit	Status bit

(1) Multiturn count is only available on multiturn and battery multiturn versions.

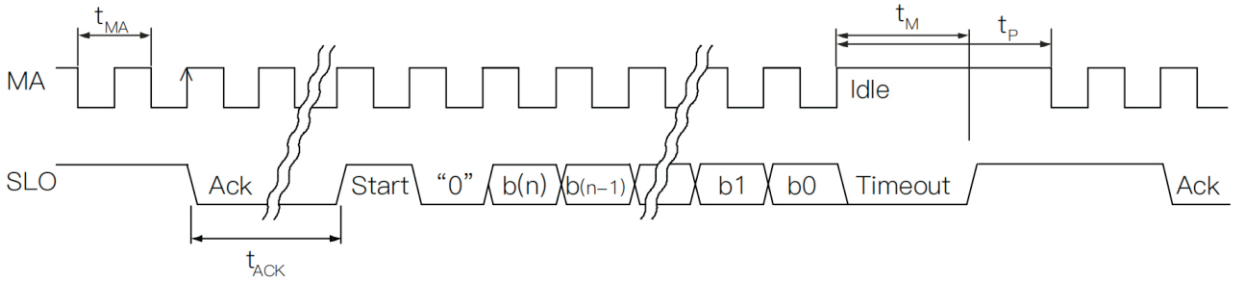
BISS-C protocol interface

BiSS-C Electrical connection diagram :



It is a four-wire interface, include the differential lines of MA and SLO. And the terminal resistors of the MA lines have been I ntegrated into the encoder. The users only need to configure terminal resistors or choose other impedance matching schemes for SLO lines.

Timing diagram:



The protocol uses MA as the synchronization clock, and the MA line is high when idle. When the first falling edge of the synchronous clock arrives, the system latches the current data.

The communication will start on the first falling edge, encoder will configure SLO low on the second MA rising edge. After the "0", the MSB will be written to the SLO line on each rising edge of MA, and on controller side, the data on Data line is read on the falling edge of Clock, and so on until the LSB is read by the controller.

Timing parameters:

Parameters	Symbol	Min value	Typical value	Max value
Clock period	tMA	400 ns		14 µs
Clock frequency	f	120 kHz		2.5 MHz(1)
ACK length	tACK		5bits	
Transmit timeout	tM		10 µs	
Pause duration	tP	20 µs		

(1) Up to 10 MHz if the user can compensate for the delay between differential conversions with phase compensation techniques.

After the transfer is complete, when the t_M transfer time is over, the SLO line goes high and the MA signal must remain high until the nex read is allowed, i.e. After t_P time t_{CL} must be less than t_M and the read can t_M while any read operation is in progress. be terminated by making the time exceed t_M while any read operation is in progress.

Data format:

Bits	B(24 + X) : b(9 + X)	B(8 + X) : b8	B7	B6	b5 : b0
Length	16 bits	X bits	1 bit	1bit	6 bits
Data	Multiturn count (1)	Signleturn	Error bit (2)	Warning bit (3)	CRC (4)

(1) Multitumn count is only available on multitumn and battery multitumn versions.

(2) The error bit is valid at low level. This bit may be low level only in the battery multi-turn version. When it is 1, it means that the battery-related status bits are normal and the multi-turn data is reliable; when it is 0, it means that the battery low voltage and battery interruption errors in the status bits are triggered. For solutions, please refer to the status bit section.

(3) The warning bit is low level effective. When it is 1, it means no error or warning is triggered; when it is 0, it means at least one error or warning is triggered.

(4) The CRC polynomial is x6+x1+1 (i.e. 0x43). According to the BISS-C protocol requirements, the calculated CRC will be inverted before being sent. Appendix CRC-6 calculation provides a directly portable calculation code for easy reference.

BISS-C protocol interface

This interface is mostly the same as the BISS-C Standard interface, except for the following data formats, which is a non-standard BISS-C interface.

Data format：

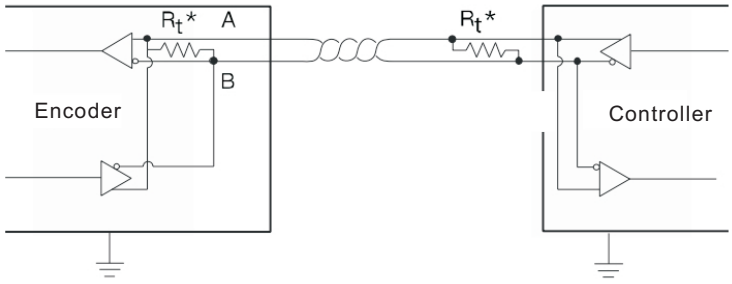
Bits	b(29 + X) : b(14 + X)	b(13 + X) : b14	b13	b12	b11: b6	b5 : b0
Length	16 bits	X bits	1 bit	1bit	6bits	6 bits
Data	Multiturn count (1)	Signleturn	Error bit	Warning bit	Status bit	CRC (2)

(1) Multiturn count is only available on multiturn and battery multiturn versions.

(2) The CRC polynomial is x6 + x1 + 1 (i.e. 0x43), According to the BISS-C protocol requirements, the calculated CRC value will be inverted before send. Appendix CRC-6 calculations gives directly portable calculation codes for easy reference.

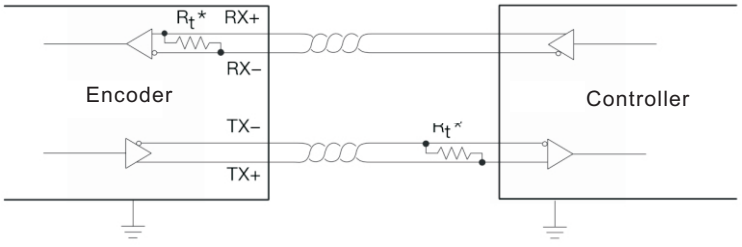
RS485/RS422 protocol interface

RS485 Electrical connection diagram:



It is a differential two-wire interface, both wires need to be terminated with parallel termination resistors. The terminal resistors have been integrated into the encoder. The users only need to configure terminal resistors or choose other impedance matching schemes for the differential wires of the controller side.

RS422 Electrical connection diagram:



It is a four-wire interface,include the differential lines of TX and RX. And the terminal resistors of the encoder RX lines have been integrated into the encoder. The users only need to configure terminal resistors or choose other impedance matching schemes for TX lines.

The underlying protocol of both RS485 and RS422 is UART. Since this protocol has no clock line,the encoder and controller must have the same transmission frequency and data format in order to ensure proper signal transmission.

Protocol configuration：

Length	Parity check	Stop bit	Stream control	Byte order
8 bit	-	1	-	LSB first

Protocol configuration：

Code	A	B
Baud rate (Mbps)	0.1152	2.5

Nteractive configuration command:

Command “0” (0x30) set encoder zero [3]	
Return	1 byte count value 1 byte CRC-8 check

Command “1” (0x31) get position	
Return	2 bytes multiturn count [1] ,MSB N bytes signleturn [2] ,MSB 1 byte CRC-8 check

Command “d” (0x64) get position + status	
Return	2 bytes multiturn count [1],MSB N bytes signleturn [2],MSB 1 byte status 1 byte CRC-8 check

Command “s” (0x73) get position + rpm	
Return	2 bytes multiturn count, [1] MSB N bytes signleturn [2] MSB 2 bytes rpm (the value = round/second * 10),signed,MSB 1 byte CRC-8 check

Command “t” (0x74) get position + temperature [4]	
Return	2 bytes multiturn count [1] ,MSB N bytes signleturn [2],MSB 2 bytes temperature (the value = ℃ * 10),signed,MSB 1 byte CRC-8 check [5]

(1) Multiturn count is only available on multiturn and battery multiturn versions.

(2) If singleturn bits <= 16, n = 2; else if singleturn 16 < bits < 24, n = 3.

(3) Send the command "1" and then command "0" one after another,and cycle it ten times to set the zero position. When the last command "0" is sent and the return count value is 10, the encoder will set the current position to 0. Afterwards,the encoder will not respond to any command for 40ms.

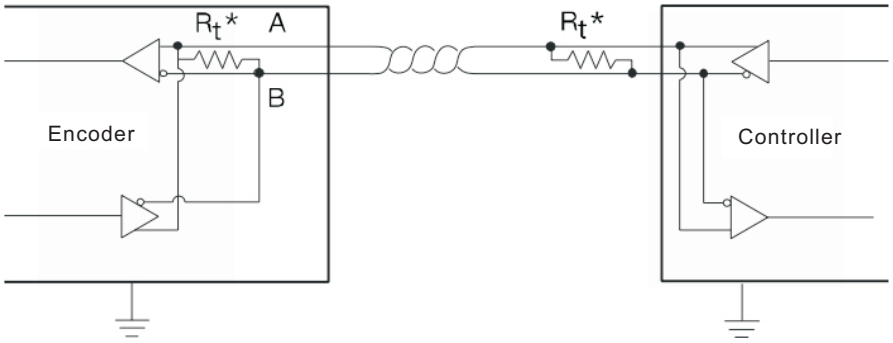
(4) The temperature is the junction temperature of the chip.

(5) CRC byte (CRC polynomial Is $x^8+x^7+x^4+x^2+x^1+1$ See Appendix for calculation method CRC-8 tabe $X^8+x^7+x^4+x^2+x^1+1$).

T485 protocol interface

*This interface is compatible with the tamagawa protocol.

RS485 Electrical connection diagram:



It is a differential two-wire interface, both wires need to be terminated with parallel termination resistors. The terminal resistors have been integrated into the encoder. The users only need to configure terminal resistors or choose other impedance matching schemes for the differential wires of the controller side.

T485 is based on RS485 and has a certain communication protocol. The interface receives a 1Byte operation request data, returns the corresponding encoder data based on the requested data, and adds CRC-8 to the end of the data for check.

Protocol configuration

Data length	Parity check	Stop bit	Stream control	Bytes order
8 bit	–	1	-	LSB frist

Command：

Bits	b7 ~ b3	b2	b1	b0
Data content	Operation type	0	1	0

Return：

Bytes	B0	B1	B（2~n）	B（n+1）
Data content	Command (1)	Status	Data	CRC (2)

(1) The operation request returned is the same as the one sent.

(2) CRC byte(CRC polynomial is x8 + 1, see CRC-8 calculate of Appendix for calculation method).

B1 format：

Bits	b7	b6	b5	b4	b3	b2	b1	b0
Data content	0	Transmit error	Encoder error	0	0	0	0	0

B(2 ~ n), operation type and the corresponding data returned(A for angle; M for multiturn; E for error)：

Operation type					Get angle	n	Data returned							
b7	b6	b5	b4	b3			B2	B3	B4	B5	B6	B7	B8	B9
0	0	0	0	0	Get multiturn	4	A0	A1	A2					
1	0	0	0	1	Get all data	4	M0	M1	M2					
0	0	0	1	1	Reset angle	9	A0	A1	A2	17	M0	M1	M2	E
1	1	0	0	0	Reset(3)	4	A0	A1	A2					
0	1	1	0	0	multitumis(4)	4	A0	A1	A2					

(1) An and Mn are left-aligned, i.e., if A is 17 bits of data, the higher 7 bits of A2 are 0.

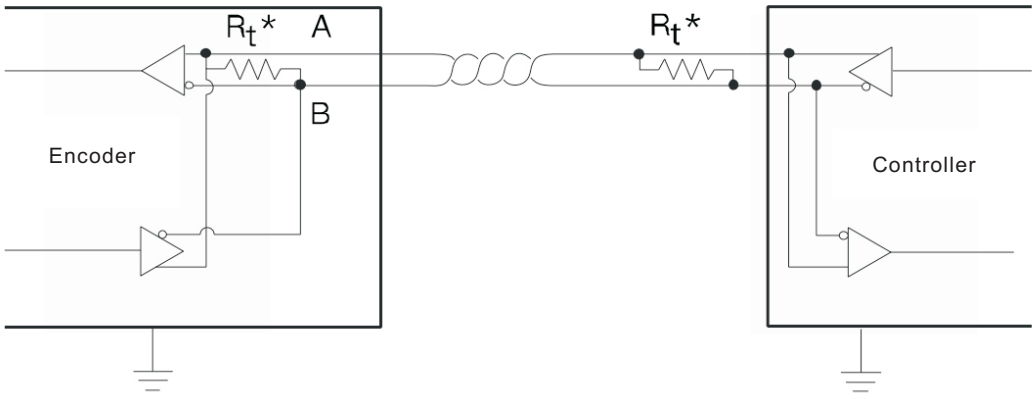
(2) If the operation type does not appear in the table of B (2~n), a communication error is triggered and the return data is the same as the return data of the get angle request.

(3) The reset of angle or multiturn requires 10 consecutive requests for the corresponding operation to take effect.

E, error byte(see the Status section later, the message in this byte only indicates an error exception):

b7	b6	b5	b4	b3	b2	b1	b0
Battery lost	Battery low voltage	0	0	0	0	0	0

BUS (High speed bus) protocol interface



It is a differential two-wire interface, both wires need to be terminated with parallel termination resistors. The terminal resistors have been integrated into the encoder. The users only need to configure terminal resistors or choose other impedance matching schemes for the differential wires of the controller side.

The protocol is the same as the 485 protocol level logic, the data is based on UART format, and the operating frequency is 2.5 Mbps.the interface receives 1Byte operation request, returns the corresponding encoder data and adds CRC-8 (x8+1) to the end of the data.

Version for select：

Singleturn bits	Multiturn bits	Model number
XX	-	XX-D
	8	XXM1-D
	16	XXM2-D

Protocol configuration：

Byte length	Parity check	Stop bit	Stream control	Bytes length
8 bit	-	1	-	LSB Frist

Command：

Data bits	b7	b6~b5	b4 ~ b0
Data content	Odd parity check	Operation type	Address

Return data：

Bytes	BO	B(1 ~ n)	B(n+1)
Data content	Operation request	Data	CRC

B(1 ~ n), operation type and the corresponding data returned(A is angle; M is multiturn; C is set count; S is status)：

Operation type		Request	Model version		n	Data					
b6	b5		Singleturn bits	Multiturn bits		B1	B2	B3	B4	B5	B6
0	0	Get data	⩽16	-	3	S	A0	A1			
			⩽16	8	4	S	A0	A1	M0		
			⩽16	16	5	S	A0	A1	M0	M1	
			⩽16	-	4	S	A0	A1	A 2		
			⩽16	8	5	S	A0	A1	A 2	M 0	
			⩽16	16	6	S	A0	A1	A 2	M0	M1
0	1	Set zero position			2	S	C				
1	0	Set address			2	S	C				

Operation type		Request	n	Data		
b6	b5			B1	B2	B3
0	0	Get data	3	S	AO	A1
0	1	Set zero position	2	S	C	
1	0	Set address	2	S	C	

Note :

(1) When the operation type does not appear in the table of B(1~n),such as 0b11, there will be no return response.

(2) C is the count data returned when the encoder is set, when it returns 10, it means that the setting will be executed immediately (the process takes about 50ms maximum, during which the encoder will not respond to any command)

(3) The default address is 0x1F, i.e. 0b11111

Set zero position:

To ensure that the setting of the zero position is not mistakenly operated, it is necessary to send the command of operation type 00, 01 in succession alternately, a total of ten groups (after each command is sent, the encoder finishing replying must be waited, before sending the next command), in order to set it successfully. The number of times still need to be sent based on the C value returned by the 01 command.

Note:

(1) When the previous command of 01 is not 00, the sequence start requirement is not met and the C value is 0.
(2) When the command before previous command of 01 is not 01, the sequence is not satisfied, the C value is 1, and the count starts from there

Set ID:

To ensure that the setting ID is not mistakenly operated, it is necessary to send a certain sequence of address values to make sure that the encoder has already enter the state of ID configuration, and then configure the ID. For example, the address value is sent continuously as shown in the table below, the next address value sent is twice the return value.

Address	X	2	4	6	8	10	12	14	16	Y
C	-	-	-	4	5	6	7	8	9	10

Note:

(1) X could be any value,Y is the actual address value want to be set.

(2) The first three sets of data sent are not returned with any corresponding response,to prevent the bus from being mistakenly triggered in the working state.

(3) When another command is inserted, the returned C value of the next set command is 1,and the count starts from there.

(4) When the sent address value does not match the sequence, the returned C value is 1, and the count restarts from 1.

Bus devices:

The devices on the bus need got into “sleep” for a certain period of time when the received ID is not their own, no responding to any commands on the bus, so as to prevent trigger the response ripples.

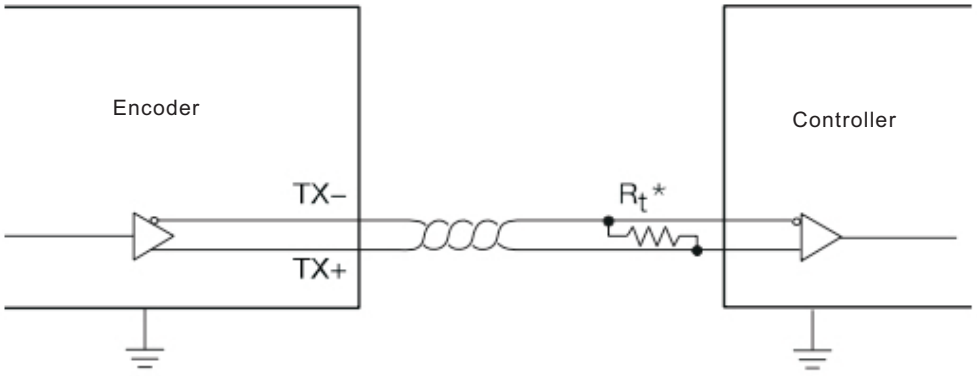
The sleep time is $T_{SUSPEND}$, and the following table shows the calculation:

Singleturn bits	Multiturn bits	Number of bus sleep bytesBSUSPEND	Time of bus sleep bytes/ Tsuspend (us)
XX	YY	Ceil (XX/8) + YY/8 + 4	$B_{SUSPEND}$ * (1 + 8 + 1) / 2.5

Take the 16M1-D model as an example:(ceil(16 / 8) + 8 / 8 + 4) * (1 + 8 + 1) / 2.5 = 28us.

PERIOD cycle sending protocol

PERIOD Electrical connection diagram:



It is a differential two-wire interface,both wires need to be terminated with parallel termination resistors. The terminal resistors have been integrated into the encoder. The users only need to configure terminal resistors or choose other impedance matching schemes for the differential wires of the controller side.

This protocol is based on the RS422 protocol,the only difference is that it actively sends data out through the TX at 1khz and does not respond to any message, the encoder internally triggers the command “d”(0x64) periodically to send the corresponding data, refer to RS485/RS422 protocol interface.

Status

In SSI/BISS-C/RS485/RS422 protocol, the usage of status bit is consistent, when a warning or error occurs, the warning bit or error bit will be set, and the user can specify the cause of the warning or error by viewing the status bit information.

The location of error/warning in protocols:

	Error bit	Warning bit
SSI	b7	b6
BISS-C	b13	b12
RS485/RS422	b7	b6
BUS	b7	b6
PERIOD	b7	b6

Status bit：

Location	For battery multiturn version only		b3	b2	b1	b0
	b5	b4				
Description	Battery lost	Battery low voltage	Large magnetic field	Weak magnetic field	Temperature out of range	Over speed
LED flashing	√	√	–	–	–	–

In normal condition, the LED status light is green. When the warning bit is 1, the data is still valid, and theLED turns yellow, but some parameters of status bit are close to their limit values, which can be viewed through the status bit. When the error bit is 1, the data is no longer valid, and the LED turns red. And the status bit shows specific error message.

The LED flashes in 1s intervals to alert the user to the occurrence of the corresponding error/warning problem.

Battery-related status bits:

	b5	b4
	Battery lost	Battery low voltage
Warning is1	–	Battery voltage<2.9V
Error bit is 1	The encoder is disconnected during a power failure or the battery is too low,resulting in an interruption of the multiturn count and thus untrustworthy multiturn data, and the multiturn is cleared if this error occur.	Battery voltage<2.7V
Solution	Check the battery voltage supply,repower the encoder then this bit will reset.	Replace the battery

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