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MPP Magnetic Encoder Datasheet v0.3

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MPP Magnetic Encoder

MPP magnetic encoder is super compact product, it uses the pattern magnetic technology of KingKong Technology, high precision measurements are possible in extremely limited volumes and each of them infinitely approaching the resolution and accuracy of photoelectric encoder, and has a strong anti-environmental interference ability.

MPP is driven by magnetoelectric technology and has a unique interference shielding technology. There are multiple high-precision magnetic field sensors inside the encoder to measure the filed strength changes of the rotor magnetic ring, and it is formed by the precision calibration technology provided by KingKong Technology. Each product has unique magnetic field calibration data at the factory, providing the best measurement accuracy.

The unique tolerances fit installation method with rotor and stator simplifies the installation for users, but also guarantees the measurement accuracy.

The separated magnetoelectric solution can ensure that the encoder can avoid the interference of external environmental factors such as vibration, dust, oil pollution, even when it is running at ultra-high speed, without affecting the accuracy and service life.

Ultra-thin body with hollow shaft could easily suit with any application.

- 24-bit absolute output
- Higher than ±0.01° accuracy
- Ring width 10mm
- Max 100mm large hollow
- Models for every 5mm on diameter
- Stator and rotor tolerance fit installation
- Magnetic interference shielding
- Hollow structure
- Permissible speed 8,000 rpm
- Unique data calibration
- Multi-turn with battery mode or flash
- Various output interfaces
- Resistance to various

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Models

MPP-20-30-A-24-S-N-A-M

Rotor inner diameter
Refer to Size

Stator outer diameter
Refer to Size

Output type
A — absolute

Output parameter
24 — 24 bits single-turn

Multi-turn clears on power-off, and recount from zero when power-on	24M	— 24 bits + Normal multi-turn
Multi-turn keep counting with battery supply after power-off	24BM	— 24 bits + Battery multi-turn
Multi-turn remains and rotation is limited to ±90°, no battery needed	24FM	— 24 bits + Flash multi-turn

Output interface
S — SSI[1]

B — BISS-C

R — R485

A — R422

T — T485 (17-bit Tamagawa compatible)[2]

T — T485 (23-bit Tamagawa compatible)[2]

D — BUS (high speed bus)

P — PERIOD (periodic send)

Input voltage
N — 5V

Operating temperature
A — -40 ~ 85 °C

B — -40 ~ 105 °C

C — -40 ~ 125 °C

Addition
M — no addition

Baud rate: interface in R/A

(1) SSI interface has no CRC check, it is recommended to use BISS-C instead on the same hardware to get more reliability

(2) Tamagawa compatible select 17bit ,the output parameter is 17M-T、17BM-T、17FM-T;Select 23bit, the output parameter is 23M-T、23BM-T、23FM-T

Size

Series	Size	Rotor ID	Stator OD	Rotor mount PD	Stator mount PD	Overall height
40	MPP-40-60	40	60	43.1	56.6	5.6
50	MPP-50-70	50	70	53.1	66.6	
60	MPP-60-80	60	80	63.1	76.6	6.7
70	MPP-70-90	70	90	73.1	86.6	
80	MPP-80-100	80	100	83.1	96.6	
90	MPP-90-110	90	110	93.1	106.6	
100	MPP-100-120	100	120	103.1	116.6	

Download 3D models: https://kingkong.tech/encoder/MPP

Electrical connections

Connectors

	SUR	MOLEX
Model	SM08–SURS–TF	MOLEX 504050–0891
Type	Wire to board	Wire to board
Wire	4PxAWG32 teflon twisted pair	4PxAWG28 twisted pair， shielding sheath， outside diameter≈4.0mm

Pin descriptions

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

* 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	±0.01°

Electrical

Power supply	4.5 ~ 5.5 V
Battery	2.7 ~ 3.6 V
Startup time	15 ms
Connection	Wire to board connector
Current	≈ 60 mA
Battery mode current	≈ 6 μA (Test on battery voltage 3.6V, in low power and static mode)
ESD resistance	HBM, max. ±2 kV CDM, max. ±1 kV

Mechanical

Rotor material	Stainless steel
Stator material	Aluminum alloy

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 MBS 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 MBT 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.

Specification

Format selection

Single-turn

Output angle data

Normal multi-turn

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

Battery multi-turn

Output the data of angle and multi-turn	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

Flash multi-turn

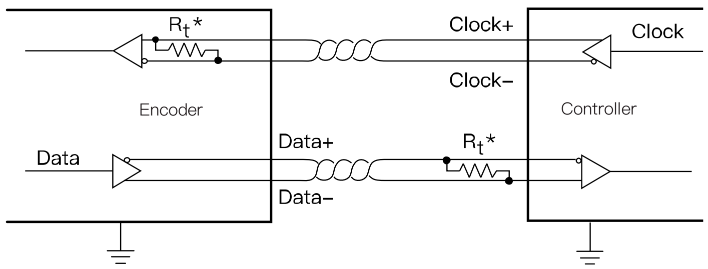
Output the data of angle and multi-turn	After the power supply is off, the multi-turns will be recorded in flash, mechanical rotation must be guaranteed in ±90° range, the multi-turns data is invalid if out of the range

Calculation parameters

Angle resolution	24 bit
Rotation speed	8,000 rpm
Update frequency	50 kHz
Repeatable accuracy	0 ~ ±1 bit (change by angle bits selection)
Output interface	SSI、BISS-C、RS485、RS422、T485、BUS、PERIOD

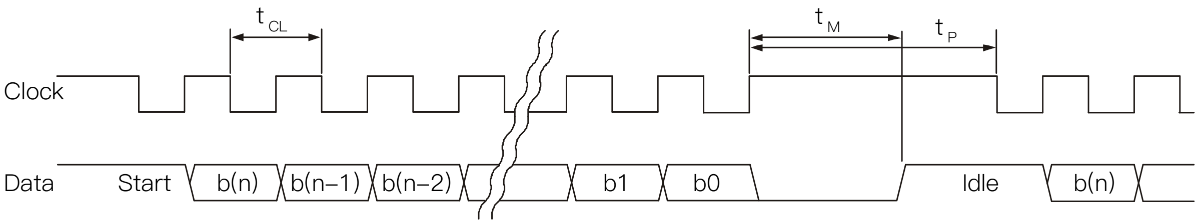
SSI protocol interface

Electrical connection diagram：



It is a four-wire interface, include the differential lines of Clock and Data. And the terminal resistors of the Clock 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：

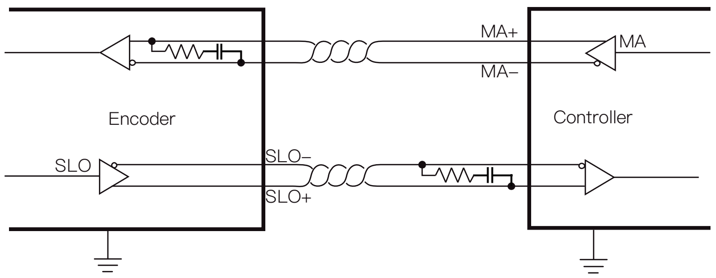
Bits	b(23 + X) : b(8 + X)	b(7 + X) : b8	b7	b6	b5 : b0
Length	16 bits	X bits	1bit	1bit	6 bits
Data	Multi–turn count(1)	Angle	Error bit	Warning bit	Status bit

(1) Multi–turn count is only available on multi–turn and battery multi–turn versions

For a detailed description of the status bit, see the Status section later.

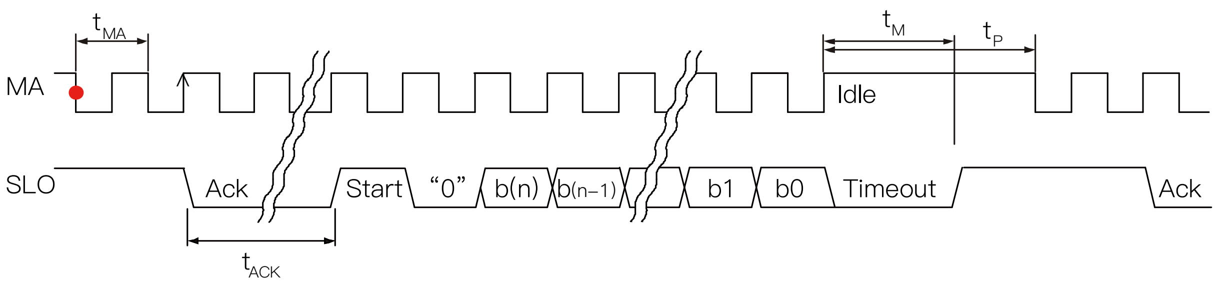
BISS–C protocol interface

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 integrated into the encoder. The users only need to configure terminal resistors or choose other impedance matching schemes for SLO lines.

Timing diagram：



(1) Angle will be latched at the red point

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	Typical	Max
Clock period	tMA	400 ns		14 μs
Clock frequency	f	120 kHz		2.5 MHz[(1)]
ACK length	tACK		5 bits	
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 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.

Data format:

Bits	b(24 + X) : b(9 + X)	b(8 + X) : b8	b7	b6	b5 : b0
Length	16 bits	X bits	1bit	1bit	6 bits
Data	Multi–turn count[(1)]	Angle	Error bit[(2)]	Error bit[(3)]	CRC[(4)]

(1) Multi–turn count is only available on multi–turn and battery multi–turn versions

(2) The error bit is valid at low level.

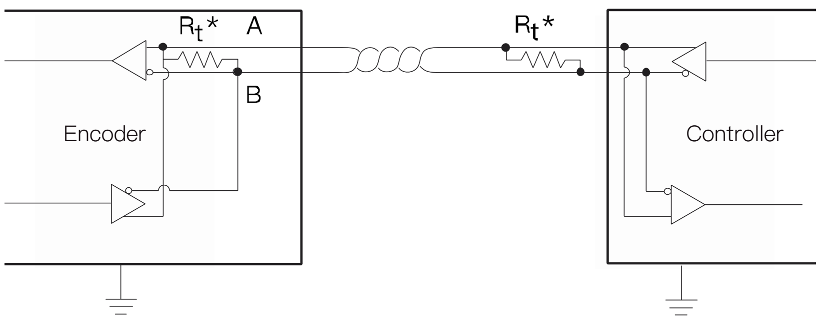
(3) The warn bit is valid at low level.

(4) 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

For a detailed description of the status bit, see the Status section later.

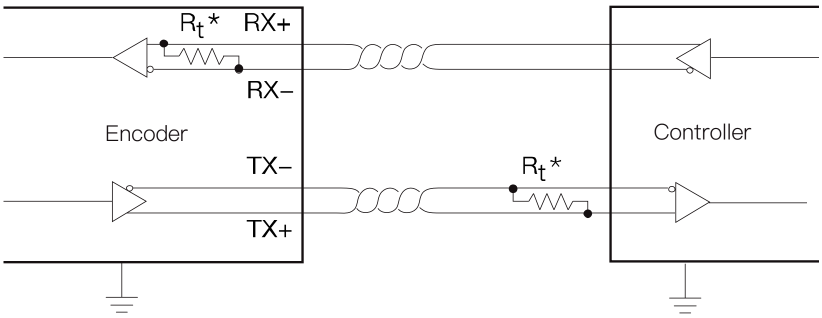
RS485/RS422 protocol interface

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

Baud rate supported (default A if not marked in additional and recommended B):

Code	A	B
Baud rate (Mbps)	0.1152	2.5

Sequence chart:

(1) Angle will be latched at the red point

Commands and data:

Com–mand	Function		Output parameter	N	Data (N Bytes)							
					B0	B1	B2	B3	B4	B5	B6	B7
0x30	set	Zero[1]	–	2	C	CRC						
0x31	get	Position	24	4	A2	A1	A0	CRC				
			24M 24BM 24FM	6	M1	M0	A2	A1	A0	CRC		
0x64	get	Position + Status	24	5	A2	A1	A0	S	CRC			
			24M 24BM 24FM	7	M1	M0	A2	A1	A0	S	CRC	
0x74	get	Position + Temperature[2]	24	6	A2	A1	A0	T1	T0	CRC		
			24M 24BM 24FM	8	M1	M0	A2	A1	A0	T1	T0	CRC

(1) Send the command "0x31" and then command "0x30" one after another, and repeat the combines ten times to set the zero position. When the last command "0" is sent and the return count value is 10, the encoder will execute the set zero procedure.

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

Letters represented in above table:

M	A	C	S	T	CRC
Multi–turn	Angle	Count for zero set	Status	Temperature[2]	CRC[1]

For a detailed description of the status bit, see the Status section later.

(1) CRC byte (CRC polynomial is $x^8+x^7+x^4+x^2+x^1+1$, See Appendix for calculation method CRC–8 table x8+x7+x4+x2+x1+1)

(2) The temperature calculation method is: int16_t temp = T0 | T1 << 8; float tempFloat = temp / 10.f; Unit °C

Example code:

If used 0x31, get uint8_t Buffer[7];

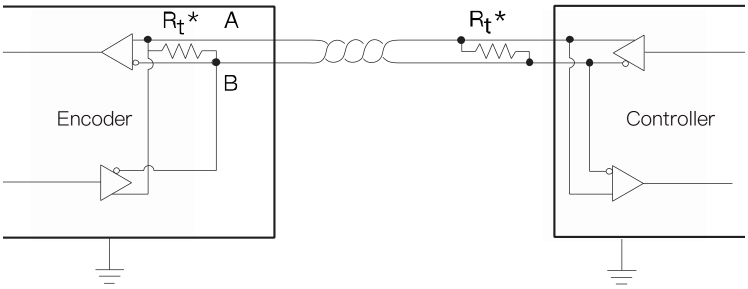
In use:

```
uint16_t multi = Buffer[0] << 8 | Buffer[1];
uint32_t angle = Buffer[2] << 16 | Buffer[3] << 8 | Buffer[4];
float angleFloat = angle / (float)(1 << 24) * 360;
```

T485 protocol interface

*This interface is compatible with the tamagawa protocol.

T485 Electrical connection diagram:



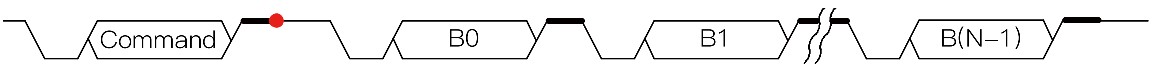
It is a differential two–wire interface, both wires need to be terminated with parallel termination resistors. The terminal resistors have been integrated into the encoder. The users only need to configure terminal resistors or choose other impedance matching schemes for the differential wires of the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

Sequence chart:



(1) Angle will be latched at the red point

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 $x^8 + 1$, 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 Multi-turn; E for error) :

Operation type					**Request**	**n**	**Data returned**							
b7	b6	b5	b4	b3			B2	B3	B4	B5	B6	B7	B8	B9
0	0	0	0	0	Get angle	4	A0	A1	A2					
1	0	0	0	1	Get multi-turn	4	M0	M1	M2					
0	0	0	1	1	Get all data	9	A0	A1	A2	17	M0	M1	M2	E
1	1	0	0	0	Reset angle(3)	4	A0	A1	A2					
0	1	1	0	0	Reset multi-turn(3)	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 multi-turn requires 10 consecutive requests for the corresponding operation to take effect

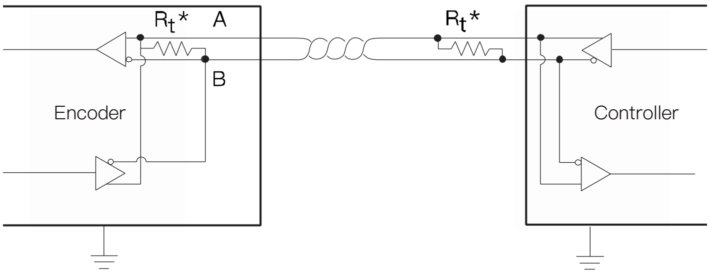
E, error byte (see the Status section later):

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

For LED-related indications, please refer to the Status chapter.

BUS (High speed bus) protocol interface

BUS 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.

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.

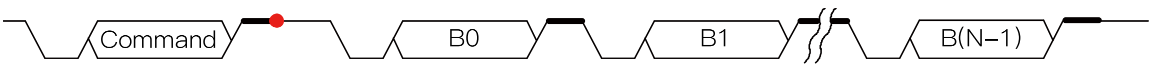
Version for select:

Angle bits	Multi-turn bits	Model number
XX	—	XX-D
	16	XXM-D

Protocol configuration:

Byte length	Parity check	Stop bit	Stream control	Bytes length
8 bit	—	1	—	LSB first

Sequence chart:



(1) Angle will be latched at the red point

Command:

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

Return data:

Bytes	B0	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 multi–turn; C is set count; S is status ）：

Operation type		Request	Model version		n	Data					
b6	b5		Angle bits	Multi–turn bits		B1	B2	B3	B4	B5	B6
0	0	Get data	≤16	—	3	S	A0	A1			
			≤16	16	5	S	A0	A1	M0	M1	
			>16	—	4	S	A0	A1	A2		
			>16	16	6	S	A0	A1	A2	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	A0	A1
0	1	Set zero position	2	S	C	
1	0	Set address	2	S	C	

For a detailed description of the status bit, see the Status section later.

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.

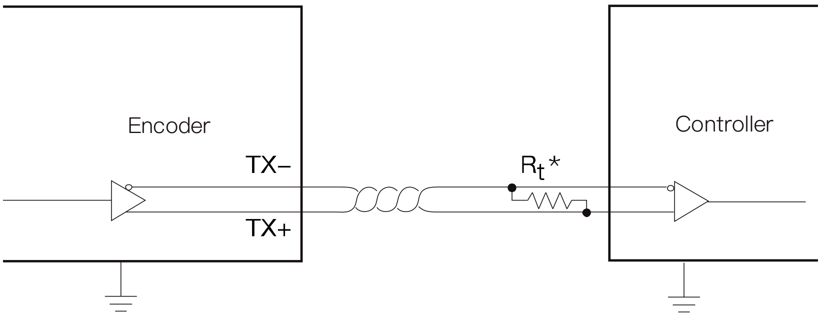
The sleep time is $T_{SUSPEND}$, and the following table shows the calculation:

Angle bits	Multi-turn bits	Number of bus sleep bytes /$B_{SUSPEND}$	Time of bus sleep bytes /$T_{SUSPEND}$ (us)
XX	YY	ceil(XX/8) + YY/8 + 4	$B_{SUSPEND}$ * (1 + 8 + 1) / 2.5

Take the 16M1-D model as an example: $T_{SUSPEND} = \left(ceil\left(\frac{16}{8}\right) + \frac{8}{8} + 4\right) * \frac{1+8+1}{2.5} = 28us$

Period 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 Bits

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 the LED 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

Appendix

CRC-8 Table($x^8+x^7+x^4+x^2+x^1+1$)

```
//poly = x8+x7+x4+x2+x1+1
uint8_t crcTable [256] = {
	0x00, 0x97, 0xB9, 0x2E, 0xE5, 0x72, 0x5C, 0xCB, 0x5D, 0xCA, 0xE4, 0x73, 0xB8, 0x2F, 0x01, 0x96,0xBA, 0x2D, 0x03, 0x94,
0x5F, 0xC8, 0xE6, 0x71, 0xE7, 0x70, 0x5E, 0xC9, 0x02, 0x95, 0xBB, 0x2C,0xE3, 0x74, 0x5A, 0xCD, 0x06, 0x91, 0xBF, 0x28, 0xBE,
0x29, 0x07, 0x90, 0x5B, 0xCC, 0xE2, 0x75,0x59, 0xCE, 0xE0, 0x77, 0xBC, 0x2B, 0x05, 0x92, 0x04, 0x93, 0xBD, 0x2A, 0xE1, 0x76,
0x58, 0xCF,0x51, 0xC6, 0xE8, 0x7F, 0xB4, 0x23, 0x0D, 0x9A, 0x0C, 0x9B, 0xB5, 0x22, 0xE9, 0x7E, 0x50, 0xC7,0xEB, 0x7C, 0x52,
0xC5, 0x0E, 0x99, 0xB7, 0x20, 0xB6, 0x21, 0x0F, 0x98, 0x53, 0xC4, 0xEA, 0x7D,0xB2, 0x25, 0x0B, 0x9C, 0x57, 0xC0, 0xEE, 0x79,
0xEF, 0x78, 0x56, 0xC1, 0x0A, 0x9D, 0xB3, 0x24,0x08, 0x9F, 0xB1, 0x26, 0xED, 0x7A, 0x54, 0xC3, 0x55, 0xC2, 0xEC, 0x7B, 0xB0,
0x27, 0x09, 0x9E,0xA2, 0x35, 0x1B, 0x8C, 0x47, 0xD0, 0xFE, 0x69, 0xFF, 0x68, 0x46, 0xD1, 0x1A, 0x8D, 0xA3, 0x34,0x18, 0x8F,
0xA1, 0x36, 0xFD, 0x6A, 0x44, 0xD3, 0x45, 0xD2, 0xFC, 0x6B, 0xA0, 0x37, 0x19, 0x8E,0x41, 0xD6, 0xF8, 0x6F, 0xA4, 0x33, 0x1D,
0x8A, 0x1C, 0x8B, 0xA5, 0x32, 0xF9, 0x6E, 0x40, 0xD7,0xFB, 0x6C, 0x42, 0xD5, 0x1E, 0x89, 0xA7, 0x30, 0xA6, 0x31, 0x1F, 0x88,
0x43, 0xD4, 0xFA, 0x6D,0xF3, 0x64, 0x4A, 0xDD, 0x16, 0x81, 0xAF, 0x38, 0xAE, 0x39, 0x17, 0x80, 0x4B, 0xDC, 0xF2, 0x65,0x49,
0xDE, 0xF0, 0x67, 0xAC, 0x3B, 0x15, 0x82, 0x14, 0x83, 0xAD, 0x3A, 0xF1, 0x66, 0x48, 0xDF,0x10, 0x87, 0xA9, 0x3E, 0xF5, 0x62,
0x4C, 0xDB, 0x4D, 0xDA, 0xF4, 0x63, 0xA8, 0x3F, 0x11, 0x86, 0xAA, 0x3D, 0x13, 0x84, 0x4F, 0xD8, 0xF6, 0x61, 0xF7, 0x60, 0x4E,
0xD9, 0x12, 0x85, 0xAB, 0x3C
};

uint8_t calcCRC(uint8_t * buffer, uint8_t length){
	uint8_t temp = *buffer++;
	while(--length){
		temp = *buffer++ ^ crcTable[temp];
	}

	return crcTable[temp];
}
```

CRC-8 Calculate(x^8+1)

```
//poly = x8+1
//The value of table check is the same as the result of polynomial calculation
// The calculation value of the polynomial is the same as itself

uint8_t calcCRC(uint8_t * buffer, uint8_t length){
	uint8_t temp = *buffer++;
	while(--length){
		temp = *buffer++ ^ temp;
	}

	return temp;
}
```

CRC-6 Calculate

```
#define DATA_TOTAL_BIT_LENGTH 47


//poly = x^6+x^1+1
uint8_t tableCRC6[64] = {
0x00, 0x03, 0x06, 0x05, 0x0C, 0x0F, 0x0A, 0x09, 0x18, 0x1B, 0x1E, 0x1D, 0x14, 0x17, 0x12, 0x11, 0x30, 0x33, 0x36, 0x35, 0x3C, 0x3F, 0x3A, 0x39, 0x28, 0x2B, 0x2E, 0x2D, 0x24, 0x27, 0x22, 0x21, 0x23,
0x20, 0x25, 0x26, 0x2F, 0x2C, 0x29, 0x2A, 0x3B, 0x38, 0x3D, 0x3E, 0x37, 0x34, 0x31, 0x32, 0x13, 0x10, 0x15, 0x16, 0x1F, 0x1C, 0x19, 0x1A, 0x0B, 0x08, 0x0D, 0x0E, 0x07, 0x04, 0x01, 0x02
};

uint8_t calcBissCCRC(uint8_t buffer[]){
	#define CRC_BIT_LENGTH 6
	#define DATA_CRC_MASK ((1 << CRC_BIT_LENGTH) - 1)
	#define DATA_WITHOUT_CRC_BIT_LENGTH (DATA_TOTAL_BIT_LENGTH - CRC_BIT_LENGTH)
	#define TOP_BYTE_BITLENGTH (DATA_WITHOUT_CRC_BIT_LENGTH % CRC_BIT_LENGTH)
	#if TOP_BYTE_BITLENGTH == 0
		#undef TOP_BYTE_BITLENGTH
		#define TOP_BYTE_BITLENGTH CRC_BIT_LENGTH
	#endif

	uint32_t firstWord = __REV(*(uint32_t *) buffer);
	#if DATA_WITHOUT_CRC_BIT_LENGTH > 32
	uint32_t secondWord = __REV(*(uint32_t *) (buffer + 4));
	#endif

	uint8_t crc = tableCRC6[firstWord >> (32 - TOP_BYTE_BITLENGTH)];

	#undef CURRENT_CRC_BIT_LENGTH
	#define CURRENT_CRC_BIT_LENGTH (TOP_BYTE_BITLENGTH + CRC_BIT_LENGTH * 1)
	#if DATA_WITHOUT_CRC_BIT_LENGTH - CURRENT_CRC_BIT_LENGTH >= 0
		crc = tableCRC6[crc ^ (firstWord >> (32 - CURRENT_CRC_BIT_LENGTH) & DATA_CRC_MASK)];
	#endif

	#undef CURRENT_CRC_BIT_LENGTH
	#define CURRENT_CRC_BIT_LENGTH (TOP_BYTE_BITLENGTH + CRC_BIT_LENGTH * 2)
	#if DATA_WITHOUT_CRC_BIT_LENGTH - CURRENT_CRC_BIT_LENGTH >= 0
		crc = tableCRC6[crc ^ (firstWord >> (32 - CURRENT_CRC_BIT_LENGTH) & DATA_CRC_MASK)];
	#endif

	#undef CURRENT_CRC_BIT_LENGTH
	#define CURRENT_CRC_BIT_LENGTH (TOP_BYTE_BITLENGTH + CRC_BIT_LENGTH * 3)
	#if DATA_WITHOUT_CRC_BIT_LENGTH - CURRENT_CRC_BIT_LENGTH >= 0
		crc = tableCRC6[crc ^ (firstWord >> (32 - CURRENT_CRC_BIT_LENGTH) & DATA_CRC_MASK)];
	#endif

	#undef CURRENT_CRC_BIT_LENGTH
	#define CURRENT_CRC_BIT_LENGTH (TOP_BYTE_BITLENGTH + CRC_BIT_LENGTH * 4)
	#if DATA_WITHOUT_CRC_BIT_LENGTH - CURRENT_CRC_BIT_LENGTH >= 0
		crc = tableCRC6[crc ^ (firstWord >> (32 - CURRENT_CRC_BIT_LENGTH) & DATA_CRC_MASK)];
	#endif

	#undef CURRENT_CRC_BIT_LENGTH
	#define CURRENT_CRC_BIT_LENGTH (TOP_BYTE_BITLENGTH + CRC_BIT_LENGTH * 5)
	#if DATA_WITHOUT_CRC_BIT_LENGTH - CURRENT_CRC_BIT_LENGTH >= 0
		#if 32 - CURRENT_CRC_BIT_LENGTH >= 0
			crc = tableCRC6[crc ^ (firstWord >> (32 - CURRENT_CRC_BIT_LENGTH) & DATA_CRC_MASK)];
		#elif 32 - CURRENT_CRC_BIT_LENGTH > -CRC_BIT_LENGTH
			crc = tableCRC6[crc ^ (((firstWord << -(32 - CURRENT_CRC_BIT_LENGTH)) & DATA_CRC_MASK) | (secondWord >> (64 - CURRENT_CRC_BIT_LENGTH)))];
		#else
			crc = tableCRC6[crc ^ (secondWord >> (64 - CURRENT_CRC_BIT_LENGTH) & DATA_CRC_MASK)];
		#endif
	#endif

	#undef CURRENT_CRC_BIT_LENGTH
	#define CURRENT_CRC_BIT_LENGTH (TOP_BYTE_BITLENGTH + CRC_BIT_LENGTH * 6)
	#if DATA_WITHOUT_CRC_BIT_LENGTH - CURRENT_CRC_BIT_LENGTH >= 0
		crc = tableCRC6[crc ^ (secondWord >> (64 - CURRENT_CRC_BIT_LENGTH) & DATA_CRC_MASK)];
	#endif

	#undef CURRENT_CRC_BIT_LENGTH
	#define CURRENT_CRC_BIT_LENGTH (TOP_BYTE_BITLENGTH + CRC_BIT_LENGTH * 7)
	#if DATA_WITHOUT_CRC_BIT_LENGTH - CURRENT_CRC_BIT_LENGTH >= 0
		crc = tableCRC6[crc ^ (secondWord >> (64 - CURRENT_CRC_BIT_LENGTH) & DATA_CRC_MASK)];
	#endif

	#undef CURRENT_CRC_BIT_LENGTH
	#define CURRENT_CRC_BIT_LENGTH (TOP_BYTE_BITLENGTH + CRC_BIT_LENGTH * 8)
	#if DATA_WITHOUT_CRC_BIT_LENGTH - CURRENT_CRC_BIT_LENGTH >= 0
		crc = tableCRC6[crc ^ (secondWord >> (64 - CURRENT_CRC_BIT_LENGTH) & DATA_CRC_MASK)];
	#endif

	#undef CURRENT_CRC_BIT_LENGTH
	#define CURRENT_CRC_BIT_LENGTH (TOP_BYTE_BITLENGTH + CRC_BIT_LENGTH * 9)
	#if DATA_WITHOUT_CRC_BIT_LENGTH - CURRENT_CRC_BIT_LENGTH >= 0
		crc = tableCRC6[crc ^ (secondWord >> (64 - CURRENT_CRC_BIT_LENGTH) & DATA_CRC_MASK)];
	#endif

	#if 32 - DATA_TOTAL_BIT_LENGTH >= 0
		crc = tableCRC6[crc ^ DATA_CRC_MASK ^ (firstWord >> (32 - DATA_TOTAL_BIT_LENGTH) & DATA_CRC_MASK)];
	#elif 32 - CURRENT_CRC_BIT_LENGTH > -CRC_BIT_LENGTH
		crc = tableCRC6[crc ^ DATA_CRC_MASK ^ (((firstWord << -(32 - DATA_TOTAL_BIT_LENGTH)) & DATA_CRC_MASK) | (secondWord >> (64 - DATA_TOTAL_BIT_LENGTH)))];
	#else
		crc = tableCRC6[crc ^ DATA_CRC_MASK ^ (secondWord >> (64 - DATA_TOTAL_BIT_LENGTH) & DATA_CRC_MASK)];
	#endif

	return crc;
}
```

Instruction:

This program can be applied to ARM series MCU, and can generate the fastest CRC-6 check through the compiler, just modify DATA_TOTAL_BIT_LENGTH to the value of the corresponding model.

For example: 17M model to 47, 16 model to 30

Caution:

When called this function, a 32-bit read command is used for the buffer, requiring the buffer to be 4-byte aligned (some core versions don't support unaligned data read; Even with support for unaligned reads, the kernel consumes more concatenation time).

For the reception of BISS-C, the first byte received will be a placeholder byte with ACK, and the position data starts from the second byte, to read data and calculate CRC quickly, it is necessary to calculate CRC from the address where the position data starts, and require the address to be 4-byte alignment data.

For example:

```
struct{
        uint8_t notUsedForAlignment[3];            //Only align data
        uint8_t placeholder;                       //The first placeholder byte of BISS-C is 0x82
        uint8_t buffer[8] __attribute__ ((aligned(4))); //Buffer of 4 bytes data align, for fast CRC
} receiveBuffer;

//Configure SPI and DMA
//Use  &receiveBuffer.placeholder  as the receiving address
//......

//CRC calculate
// Calculated using the  receiveBuffer.buffer  which is already 4-byte aligned
uint8_t crc = calcBissCCRC(receiveBuffer.buffer);

//The CRC result is equal to 0, indicating that the verification is passed
if ( crc != 0 ){
        //crc validation failed
}
```

Revision history

Time	Edition	Description
2023/09/28	V0.1	Initial release
2024/01/02	V0.2	Add MOLEX connectors
2024/05/01	V0.3	Adding RS485 Protocol

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