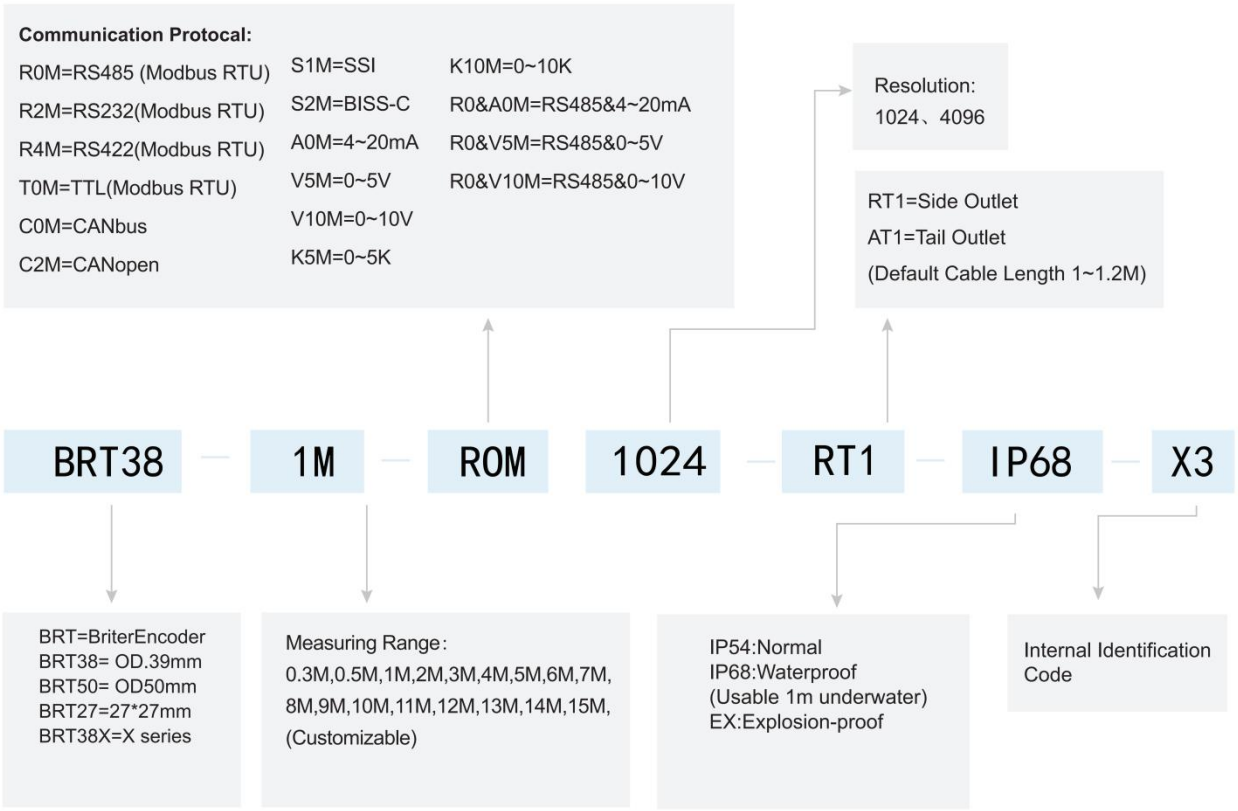
Briterencoder Linear Wire Displacement Sensor

RS485 with Modbus-RTU Interface User Manual V202407

1. Product Model Description



Model description:

1.Structural form of the encoder: e.g., BRT38 indicates an outer diameter of 38mm.

2.Measuring range: e.g., 1M indicates a measuring stroke range of 0 - 1000mm.

3.Communication interface: e.g., R0M indicates an electrical interface of RS485 and the communication protocol is Modbus RTU.

4.Resolution: e.g., 1024 means that the internal encoder and the winding wheel feed back 1024 data when rotating one circle. For a 1 - meter stroke, referring to the corresponding table parameters, if the diameter of the internal winding wheel is 100mm, it means that the encoder feeds back 1024 data when moving 100mm. The minimum displacement resolution: 100mm / 1024 = 0.098mm. That is, the displacement resolution of 1024 is 0.098mm.

5.Inventory: Some randomly combined models may be out of stock. Please consult in advance to ensure that the selected model is available.

2. Wiring Definition and connection

Red wire	Power Supply	DC 5V~24V
Black wire	0V (GND)	-
Green wire	RS485B	TR-
White wire	RS485A	TR+
Yellow wire	Function line	1. It serves for encoder zero position setting and factory settings restoration. 2. During normal encoder operation, keep the yellow wire suspended and disconnected.

Three simple ways to set absolute encoder to zero position?

- Method 1. Connect yellow wire to ground (black wire) more than 100mS. After set zero, please separate the yellow and black wire.
- Method 2. After right connected the wires according to the wiring definition. send set zero position command according to the user manual.
- Method 3. Use the upper computer provided by our company (BriterEncoder).

How to restore the absolute encoder to factory settings?

- Step 1, After power off, connect the yellow wire to the black wire.
- Step 2, power on, and hold for two minutes.
- Step 3, power off, then separate the yellow wire from the black wire. now the rotary encoder had been restored to factory settings.

3. Product Parameters

Measuring Range	Interface	Pull Rope Tension	Resolution 1024PPR	Resolution 4096PPR	Winding wheel diameter(mm)
0~650mm	BRT27 Series	3.5N	0.0586mm	0.0146mm	60mm
500mm	BRT38 Series	3~4N	0.098mm	0.0244mm	100mm
1000mm			0.098mm	0.0244mm	100mm
2000mm		2.5N	0.146mm	0.0366mm	150mm
3000mm		3~4N	0.195mm	0.0488mm	200mm
4000mm			0.244mm	0.061mm	250mm
5000mm		5~6N	0.244mm	0.061mm	250mm
6000mm			0.220mm	0.0549mm	225mm
7000mm		7~8N	0.220mm	0.0549mm	225mm
8000mm		8~9N	0.332mm	0.0830mm	340mm
9000mm		9~10N	0.332mm	0.0830mm	340mm
10000mm			0.332mm	0.0830mm	340mm
11M~15M		20~25N	0.341mm	0.0854mm	350mm
16M~20M		25~30N	0.341mm	0.0854mm	350mm
500mm	BRT38X Series	2N	0.126mm	0.031mm	130mm
1000mm			0.126mm	0.031mm	130mm
2000mm		3N	0.175mm	0.043mm	180mm
3000mm		6N	0.224mm	0.056mm	230mm
4000mm		4~5N	0.292mm	0.073mm	300mm
5000mm		9N	0.375mm	0.093mm	385mm

BRT27	BRT38	BRT38X

Service times	>5million times	Working temp.	-40~+85°C
Body Material	Aluminum alloy housing with anti-static surface, tainless steel puller, IP68-rated encoder in stainless iron.	Drawstring diameter	0.8mm
Max. Working Speed	1m/s	Pull rope material	steel wire, outer nylon coating
Protection Grade	IP54, IP68waterproof, Explosion proof	Cable Length	1-1.2meters
Working voltage	5~24V	Baud rate	9600-115200 (default 9600)
Working current	100mA	Node number	1-255 （default1）
Kernel refresh cycle	50uS	Electrical life	> 100000 h
Resolution	1024, 4096 (default)	Linearity Accuracy	±0.1% of Full Scale

4. How to calculate the displacement length

Firstly, it is necessary to determine the inner wheel perimeter and resolution of the sensor you purchased; When using, the position values feedback by the sensor before and after pull the rope are X2 and X1.

Method 1: For the rope sensor you purchased with a range of Part No. BRT38-0.5M with 500mm and a resolution of 4096ppr, referring to the corresponding wheel diameter of 100mm in the table, the displacement calculation formula is: Length = (X2 - X1) * 100 / 4096 mm.

Part No.	Measuring Range	Interface	Linear accuracy	Resolution 1024PPR	Resolution 4096PPR	Winding wheel diameter(mm)
BRT38-0.5M	500mm	RS485	±0.1%	0.098mm	0.0244mm	100

Method 2: For the rope sensor you purchased with a range of Part No. BRT38-0.5M with 500mm and a resolution of 4096ppr, according to the table, the actual resolution is 0.0244mm, so the displacement calculation formula is: Length = (X2 - X1) * 0.0244 mm.

Note: When X1 displays a large value, it is caused by the principle of multi-turn absolute encoder used in the draw-wire displacement sensor. Therefore, moving backward from the zero position results in a large numerical value.
To address this situation, simply preset the initial value of X1 to 1000 (this can be modified via the PC software or by sending a command), which can effectively solve the problem.

5. RS485 with Modbus-RTU communication protocol

This encoder uses the MODBUS-RTU (national standard GB/T19582-2008) communication protocol for communication, supporting one master station to control multiple slave stations. Through the built-in upper computer, 127 slave station addresses can be configured, and the master station can be a microcontroller unit, PLC, or PC, etc.

Communication parameters

The default configuration of the serial port at the factory is 9600bps, with a data bit of 8, no verification, and a stop bit of 1; The baud rate can be configured in the range of 9600~115200bps, and the default communication address (station number) of the encoder is 1.

MODBUS-RTU Frame format

This encoder supports MODBUS's 0x03 (read hold register), 0x06 (write single register)

1) 0x03 Read the holding register

Main Station Sending

Byte	1	2	3	4	5	6	7	8
Content	ADR	0x03	Start register high byte	Start register low byte	High byte of register number	Low byte of register number	CRC High byte	CRC low byte

The 1st byte ADR: Slave address code(1 ~ 127)

The 2nd byte 0x03 : Read register value function code

The 3rd.、4th. byte: Starting address of the register to be read

The 5th.、6th. byte: Number of registers to be read

The 7th.、8th. byte: CRC16 checksum from bytes 1 to 6

Slave Station Response:

Byte	1	2	3	4、5	6、7		M-1、M	M+1	M+2
Content	ADR	0x03	Total byte	Register data 1	Register data 2	…..	Register data M	CRC High byte	CRC Low byte

The 1st byte ADR: Slave address code(2 ~ 127)

The 2nd byte 0x03 : Return to read function code

The 3rd byte: The total number of bytes from 4 to M (including 4 and M)

The 4th. ~ M byte: Register data

The M + 1、 M+2byte: CRC16 checksum from bytes 1 to M

2) 0x06 Write a single register

Main Station Sending

Byte	1	2	3	4	5	6	7	8
content	ADR	0x06	Start register high byte	Start register low byte	High byte of register number	Low byte of register number	CRC High Byte	CRC Low byte

When the slave station receives correctly, the slave station sends back:

Byte	1	2	3	4	5	6	7	8
Content	ADR	0x06	Register high byte	Register low byte	High byte of register number	Low byte of register number	CRC high byte	CRC low byte

3) Register definition

List of encoder register

Register address	Description	Value ranges	Function code	Remarks
0x0000~0x0001	Encoder value	0~0xFFFFFFFF (0~4294967295)	0x03	/
0x0002	Encoder number of turns	0~0xFFFF (0~65535)	0x03	/
0x0003	Encoder singe turn value	0~0xFFFF (0~65535)	0x03	/
0x0004	Encoder address	1~127	0x06	Communication address (default 1)
0x0005	Baud rate	0x0000~0x0004	0x06	0x00: 9600 0x01: 19200

				0x02: 38400 0x03: 57600 0x04: 115200
0x0006	Encoder mode	0x0000 0x0001 0x0005	0x06	0x00: Query mode 0x01: Automatic return of angle encoding value 0x05: Automatic return of angular velocity encoding value
0x0007	Encoder automatic return time	0~65535(ms)	0x06	default: 50mS (If the auto-transmission interval is set below 20 ms, setting other parameters may fail. Use with caution!)
Note: Once the automatic transmission time is set to less than 20 milliseconds, the encoder will set other parameters that may fail. Use with caution.				
0x0008	Encoder reset zero position	0x0001	0x06	Write 0x0001，the encoder takes the current position as the zero point
0x0009	Encoder value increasing direction	0x0000~0x0001	0x06	0x00: clockwise 0x01: counterclockwise
0x000A	Encoder angular velocity Sampling time	0~65535(ms)	0x06	Default: 100mS
0x000B~0x00C	Set the current value of the encoder	0~0xFFFFFFFF (0~4294967295)	0x10	Set the current position value of the encoder
0x000E	Set the encoder's midpoint	0x0001	0x06	Write 0x0001，the encoder takes the current position as the mid-point
0x000F	set the current turn value to 5 turns	0x0001	0x06	Write 0x0001，Encoder takes the current position as a 5 turn value
0x0020~0x0021	Encoder angular velocity value	-2147483648~2147483647	0x03	Signed integer

4) Example of Encoder communication

Read encoder value

Register Address	0x0000~0x0001	Siemens PLC address	40001~40002
Data Range	0~X (X is for single turn resolution*multiturns-1)	Unit	-
Default value	-	Read/Write	Read only (supports function codes 0x03)
Effective method	-	Memory	Data can be memorized after power failure
data type	Unsigned integer	Applicable scope	All the multi-turn encoders

The encoder current multi turn angle=Encoder value*360/ single turn resolution.
e.g. reading the encoder value is 4000, the single turn resolution is 1024 (10bit). then the encoder current multi turn angle= 4000*360/1024=1406.25°
Communication examples:
Tx:01 03 00 00 00 02 (C4 0B)
Rx:01 03 04 00 01 76 3B (CC 40)

Note: The CRC check bits are shown in parentheses，the return data of the encoder value is 00 01 76 3B (Decimal: 95803)

Read encoder number of turns

Register Address	0x0002	Siemens PLC address	40003
Data Range	0~Y (multiturns-1)	Unit	-
Default value	-	Read/Write	Read only (supports function codes 0x03)
Effective method	-	Memory	Data can be memorized after power failure
data type	Unsigned integer	Applicable scope	All the multi-turn encoders

Communication examples:
Tx:01 03 00 02 00 01 (25 CA)
Rx:01 03 04 00 08 (59 83)

Note: The CRC check bits are shown in parentheses，the return data of the encoder circle value is 00 08 (Decimal: 8 turns)

Encoder single-turn value

Register Address	0x0003	Siemens PLC address	40004
Data Range	0~N(N is for the single turn value-1)	Unit	-
Default value	-	Read/Write	Read only (Support function codes 0x03)
Effective method	-	Memory	Data can be memorized after power failure
data type	Unsigned integer	Applicable scope	All the multi-turn encoders

The encoder current single turn angle=Encoder single turn value*360/ single turn resolution.
e.g. reading the encoder single turn value is 1000, the single turn resolution is 1024 (10bit). then the encoder current single turn angle= 1000*360/1024=351.5625°
Communication examples:
Tx:01 03 00 03 00 01 (74 0A)
Rx:01 03 04 02 7A (D8 C6)

Note: The CRC check bits are shown in parentheses，The return data of encoder single turn value is 02 7A (Decimal: 634)

Set the encoder address (ID/ Station Number)

Register Address	0x0004	Siemens PLC address	40005
Data Range	1~255	Unit	-
Default value	1	Read/Write	Write Only (Support function codes 0x06)
Effective method	Effective immediately	Memory	Data can be memorized after power failure
data type	Unsigned integer	Applicable scope	All the encoders

Communication examples:
Tx:01 06 00 04 00 02 (49 CA)
Rx:01 06 00 04 00 02 (49 CA)

Note: The CRC check bits are shown in parentheses，Set the address as 02 (HEX:0x0002)

Set the encoder baud rate

Register Address	0x0005	Siemens PLC address	40006
Data Range	0~4 (0: 9600bps 1: 19200bps 2: 38400bps 3: 57600bps 4: 115200bps)	Unit	-
Default value	0 (9600bps)	Read/Write	Write Only (Support function codes 0x06)

Effective method	Effective immediately	Memory	Data can be memorized after power failure
data type	Unsigned integer	Applicable scope	All the encoders

Communication examples:
Tx:01 06 00 05 00 02 (18 0A)
Rx:01 06 00 05 00 02 (18 0A)

Note: The CRC check bits are shown in parentheses， Set the baud rate as 38400bps (0x02)

Set encoder data mode.(Encoder working mode)

Register Address	0x0006	Siemens PLC address	40007
Data Range	0~5 (0x00: Query mode 0x01: Automatic return of angle encoding value 0x05: Automatic return of angular velocity encoding value)	Unit	-
Default value	0 (Query mode)	Read/Write	Write Only (Support function codes 0x06)
Effective method	Effective immediately	Memory	Data can be memorized after power failure
data type	Unsigned integer	Applicable scope	All the encoders

Communication examples:
Tx: 01 06 00 06 00 01 (A8 0B)
Rx: 01 06 00 06 00 01 (A8 0B)
Note: The CRC check bits are shown in parentheses, Set the current encoder data mode to automatically return encoder values.

Set encoder automatic return time (milliseconds).

Register Address	0x0007	Siemens PLC address	40008
Data Range	0~65535	Unit	Milliseconds (mS)
Default value	50 (mS)	Read/Write	Write Only (Support function codes 0x06)
Effective method	Effective immediately	Memory	Data can be memorized after power failure
data type	Unsigned integer	Applicable scope	All the encoders

Explanation: The time period for the encoder to automatically return data (to be used in conjunction with the encoder's automatic data return mode)
Communication examples:
Tx: 01 06 00 07 00 64 (39 E0)
Rx: 01 06 00 07 00 64 (39 E0)

Note: The CRC check bits are shown in parentheses， Set the automatic return time to 100 milliseconds (HEX:0x0064)

Note: Once the automatic transmission time is set to less than 20 milliseconds, setting other parameters on the encoder can easily fail. Use with caution.

Set Encoder zero position

Register Address	0x0008	Siemens PLC address	40009
Data Range	0~1	Unit	-
Default value	-	Read/Write	Write Only (Support function codes 0x06)
Effective method	Effective immediately	Memory	-
data type	Unsigned integer	Applicable scope	All the encoders

Communication examples:
Tx:01 06 00 08 00 01 (C9 C8)
Rx:01 06 00 08 00 01 (C9 C8)
Note: The CRC check bits are shown in parentheses, set the current position of the encoder to 0.

Set the encoder value increment direction.

Register Address	0x0009	Siemens PLC address	40010
Data Range	0~1	Unit	-

	(0: CW Clockwise increment) (1: CCW Counterclockwise increment)		
Default value	1 (CCW Counterclockwise increment)	Read/Write	Write Only (Support function codes 0x06)
Effective method	Effective immediately	Memory	Data can be memorized after power failure
data type	Unsigned integer	Applicable scope	All the encoders

Explanation: Encoder value increasing direction (Encoder output shaft facing observer)
Communication examples:
Tx:01 06 00 09 00 00 (59 C8)
Rx:01 06 00 09 00 00 (59 C8)

Note: The CRC check bits are shown in parentheses, Set the current encoder value to increase clockwise value

Encoder angular velocity sampling time

Register Address	0x000A	Siemens PLC address	40011
Data Range	0~65535	Unit	Milliseconds (mS)
Default value	100 (mS)	Read/Write	Write Only (Support function codes 0x06)
Effective method	Effective immediately	Memory	Data can be memorized after power failure
data type	Unsigned integer	Applicable scope	All the encoders

Communication examples:
Tx: 01 06 00 0A 03 E8 (A9 76)
Rx: 01 06 00 0A 03 E8 (A9 76)

Note: The CRC check bits are shown in parentheses, Set the automatic return time to 1000 mS (HEX:0x3E8)

Set encoder current value

Register Address	0x000B~0x000C	Siemens PLC address	40012~40013
Data Range	0~X (X is the single turn resolution*multiturns-1)	Unit	-
Default value	-	Read/Write	Write Only (Support function codes 0x10)
Effective method	Effective immediately	Memory	-
data type	Unsigned integer	Applicable scope	All the multi-turn encoders

Communication examples:
Tx:01 10 00 0B 00 02 04 00 00 30 39 (66 0E)
Rx:01 10 00 0B 00 02 (30 0A)

Note: The CRC check bits are shown in parentheses, Set the current position to 12345 (HEX:0x00003039)

Set the midpoint of the encoder

Register Address	0x000E	Siemens PLC address	40015
Data Range	0~1	Unit	-
Default value	-	Read/Write	Write Only (Support function codes 0x06)
Effective method	Effective immediately	Memory	-
data type	Unsigned integer	Applicable scope	All the encoders

Explanation: Set the current encoder value to M (M is the single circle resolution*multi-turns/2)
Communication examples:
Tx:01 06 00 0E 00 01 (29 C9)
Rx:01 06 00 0E 00 01 (29 C9)

Note: The CRC check bits are shown in parentheses, Set the current position or angle of the encoder to the midpoint of the range.

Set the encoder to 5 turns value

Register Address	0x000F	Siemens PLC address	40016

Data Range	0~1	Unit	-
Default value	-	Read/Write	Write Only (Support function codes 0x06)
Effective method	Effective immediately	Memory	-
data type	Unsigned integer	Applicable scope	All multi-turn encoders

Explanation: Set the current encoder value to Z(Z is the single turn resolution*5)
Communication examples:
Tx:01 06 00 0F 00 01 (78 09)
Rx:01 06 00 0F 00 01 (78 09)

Note: The CRC check bits are shown in parentheses，set the current point of the encoder to 5 turns.

Set the encoder angular velocity value

Register Address	0x0020~0x0021	Siemens PLC address	40033~40034
Data Range	-2147483648~2147483647	Unit	-
Default value	-	Read/Write	Read only (Support function codes 0x03)
Effective method	Effective immediately	Memory	-
data type	Signed integer	Applicable scope	All the encoders

Encoder rotation speed= Encoder angular velocity value/ single turn resolution/ Speed calculation time (Unit: rpm)

e.g. The encoder angular velocity value is returned as 1000，single turn resolution is 32768 (15bit), Speed calculation time is 100ms (0.1/60min).
Encoder rotation speed= 1000/32768/(0.1/60) = 1000*0.0183 = 18.31rpm.
Communication examples:
Tx:01 03 00 20 00 02 (C5 C1)
Rx:01 03 04 00 01 B3 FC (DE 82)

Note: The CRC check bits are shown in parentheses，The return data of the encoder's single turn value is 00 01 B3 FC (Decimal: 111612)

5) CRC Check Function Code Reference

```
unsigned int Crc_Count(unsigned char pbuf[],unsigned char num)
{
int i,j; unsigned int wcrc=0xffff;
for(i=0;i<num;i++)
{
          wcrc^=(unsigned int)(pbuf[i]);
          for (j=0;j<8;j++)
          {
              if(wcrc&0x0001)
              {
                wcrc>>=1; wcrc^=0xa001;
              }
               else
                  wcrc>>=1;
          }
}
          return wcrc;
}
```

6. Precautions and warranty

- The displacement sensor of the pull rope is installed in a fixed position, and when the pull head is pulled out, it is strictly prohibited to let go and allow the pull rope to retract instantly.
- Movement needs to be kept unobstructed, and the cable should be pulled out vertically during installation.
- Non technical personnel are strictly prohibited from disassembling. If necessary, please disassemble and reassemble under the guidance of technical personnel;
- When installing the stainless steel ropes, attention should be paid to angle control. If necessary, pulleys can be added appropriately to change direction to ensure measurement accuracy and the service life of the steel rope, and to avoid friction between the wire and the outlet.
- Please confirm the power is turned off when wiring, and be aware that incorrect wiring may cause the encoder main board to burn out.

● The product is guaranteed for one year free of charge when used correctly.
● When exceed the warranty period, or the product is damaged due to improper use, the product can be sent back to the original factory for repair (only raw material cost is required when repair).

7. Indicator Lights Description

1. The status lights display as follows.
1) The default state consists of 5 flashing statuses in the following sequence: “Blue -> Blue -> Blue -> Cyan -> Blue” with a slow flash every 1 second, indicating normal power supply to the encoder.

2) Other operational status indications
a. Query encoder data status: Green light flashing quickly every 0.5 seconds.
b. Setting the zero point for the yellow line: Orange light flashing quickly every 0.5 seconds.
c. Power-on reset status for the yellow line: Purple light flashing quickly every 0.5 seconds.
d. Encoder data automatic return status: Pause for 1 second, slow flash, interval of 0.5 seconds fast flash, blinking 5 times, defined with reference to the first item.
e. The red light indicates encoder malfunction.

3) When the encoder’s ID and baud rate are changed, the colors of the flashing lights will correspondingly change. Here is the color reference table for the status lights and their meanings:

Table 1 Color and Numerical Definition Relationship

Color	Blue	Cyan	Orange	Purple	Green	Red
Numerical Value	0	1	2	3	4	5

Table 2 RS485 Baud Rate and Numerical Definition Relationship

Baud Rate	9600	19200	38400	57600	115200
Numerical Value	0	1	2	3	4

(1) Upon power-on in normal operation:
a. There is a 4-second pause followed by 5 slow flashes with a 1-second interval.
b. The colors of the first 4 flashes form a quaternary (base-4) data that corresponds to the encoder ID number.
c. The color of the last flash defines the baud rate.

(2) For example: Orange -> Cyan -> Purple -> Orange -> Blue. Referring to Table 1 and Table 2, we can determine the corresponding numbers: 21320. The last digit is 0, according to Table 2, which corresponds to a baud rate of 9600. The first four digits form the quaternary number 2132, which converts to decimal ID: 2 * 4^3 + 1 * 4^2 + 3 * 4^1 + 2 * 4^0 = 158 (Encoder ID).

Table 3 Status LED Blinking Definitions and Examples

		Section 1 Encoder ID				Section 2 Baud Rate	
LED Status	OFF	ON	ON	ON	ON	ON	OFF
Hold Time	4s	1s	1s	1s	1s	1s	4s
Status Color	-	orange	Cyan	purple	orange	blue	-
Number	-	2	1	3	2	0	-

Status Analysis	-	2*4^3+ 1*4^2 + 3*4^1 + 2*4^0 ＝ 158	Baud rate is 9600	-
Status Meaning	-	Encoder ID	Baud Rate	-

8. Contact us and technology support

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Technical documentation

Detailed version of the instruction manual;
PC software;
2D drawings and 3D model files;
Additional Video Tutorials;

For more details, please visit our website:**www.briterencoder.com.**