Briterencoder Linear Wire Displacement Sensor

BRT38X Series RS485 & Analog Output User Manual V202409

1. Product Model Description

Communication Protocal:

R0M=RS485 (Modbus RTU)
R2M=RS232(Modbus RTU)
R4M=RS422(Modbus RTU)
T0M=TTL(Modbus RTU)
C0M=CANbus
C2M=CANopen

S1M=SSI
S2M=BISS-C
A0M=4~20mA
V5M=0~5V
V10M=0~10V
K5M=0~5K

K10M=0~10K
R0&A0M=RS485&4~20mA
R0&V5M=RS485&0~5V
R0&V10M=RS485&0~10V

Resolution:
1024、4096

RT1=Side Outlet
AT1=Tail Outlet
(Default Cable Length 1~1.2M)

BRT38X	1M	R0M	1024	RT1	IP68

BRT=BriterEncoder
BRT38= OD.39mm
BRT50= OD50mm
BRT27=27*27mm
BRT38X=X series

Measuring range:0.3M、0.5M、1M、2M、3M、4M、5M、6M、7M、8M、9M、10M、11M、12M、13M、14M、15M、(Customizable)

IP54:Normal
IP68:Waterproof
(Usable 1m underwater)
EX:Explosion-proof

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

RS485 & Output 4~20mA

White wire	RS485A	TR+
Green wire	RS485B	TR-
Grey wire	4-20mA positive	-
Brown wire (optional)	4-20mA negative.	1. In three-wire configuration, this line remains unconnected as the signal negative and power negative are directly connected. 2.In four-wire configuration, this line needs to be connected to the negative of the 4-20mA current loop (i.e., the signal negative).
Black wire	0V (GND)	-
Red wire	Power Supply	DC 12-24V
Orange wire	Function line	SETH/ Direction
Yellow wire	Function line	SETL/ Reset

RS485 & Output 0-5V

White wire	RS485A	TR+
Green wire	RS485B	TR-
Grey wire (optional)	0-5 negative	1.In a three-wire system, since the signal negative and the power negative are directly connected, this line is left unconnected. 2.In a four-wire system, this line must be connected to the negative of the 0-5V voltage loop (i.e., the signal negative).
Brown wire	0-5V positive	-
Black wire	0V (GND)	-
Red wire	Power Supply	DC 12-24V
Orange wire	Function line	SETH/ Direction
Yellow wire	Function line	SETL/ Reset

RS485 & Output 0-10V

White wire	RS485A	TR+
Green wire	RS485B	TR-
Grey wire (optional)	0-10V negative	1.In a three-wire system, since the signal negative and the power negative are directly connected, this line is left unconnected. 2.In a four-wire system, this line must be connected to the negative of the 0-10V voltage loop (i.e., the signal negative).
Brown wire	0-10V positive	-
Black wire	0V (GND)	-
Red wire	Power Supply	DC 12-24V
Orange wire	Function line	SETH/ Direction
Yellow wire	Function line	SETL/ Reset

3. Product Parameters

Measuring Range	Interface	Linear accuracy	Resolution 1024PPR	Resolution 4096PPR	Winding wheel diameter(mm)
500mm	RS485&4-20mA RS485&0-10V RS485&0-5V	±0.1%	0.126mm	0.031mm	130
1000mm		±0.1%	0.126mm	0.031mm	130
2000mm		±0.1%	0.175mm	0.043mm	180
3000mm		±0.1%	0.224mm	0.056mm	230
4000mm		±0.1%	0.292mm	0.073mm	300
5000mm		±0.1%	0.375mm	0.093mm	385
Service times	>5million times		Working temp.	-40~+85°C	
Pull Tension	2~3N		Resolution	1024(10bit), 4096(12bit)	
Max. Working Speed	1m/s		Pull rope material	Stranded steel wire	
Protection Grade	IP54, IP68waterproof, Explosion proof		Drawstring diameter	0.6mm	
Cable Length	1-1.2meters		Electrical life	> 100000 h	
Working voltage	12~24V		Kernel refresh cycle	50uS	
Working current	100mA		Address	1-255（default 1）	
Baud rate	RS485/RS232/ModBus RTU:9600~115200(Default 9600)		Service life	5million times	
Body material	Aluminum alloy (anti-static), stainless steel head; IP68/ex-proof encoder in stainless steel.				

4. Function Line Setting Method

Set the minimum value:

When power on, use the yellow wire to touch the black wire (0V) for a short time (more than100ms) to set the current position to the minimum analog value;

Set the maximum value:

When power on, use the orange wire to touch the black wire (0V) for a short time (more than100ms) to set the current position to the maximum analog value;

Set the midpoint value:

When power on, use the yellow wire and the orange wire for to touch the black wire (0V) a short time (more than100ms) to set the current position to the midpoint analog value;

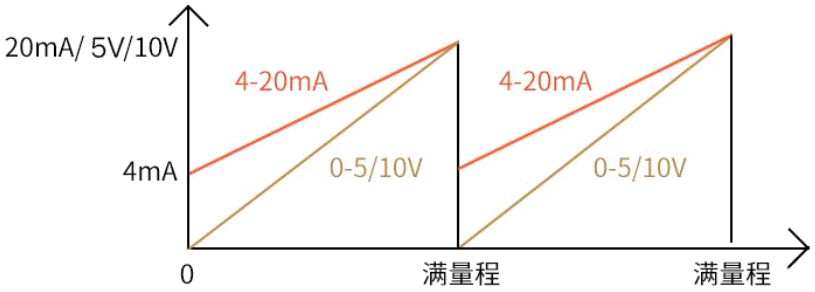
Restore the encoder to factory settings:

When the sensor is in power-off state, connect the yellow wire to the black wire (0V). Then power on and keep it on for 2 minutes (110~130 seconds) to reset the encoder.

Set the sensor's value direction

When the encoder is in a powered-off state, the orange wire contacts the black wire (0V). Then power on and keep it on for 2 minutes (110~130 seconds), the encoder can switch its direction of value.

5. Schematic diagram of output signal



6. How to calculate the displacement length for Analog

- **Output 4~20mA:**

The displacement length=measuring range * (current -4)/16 (unit: mm)
E. g. If a single turn 4-20mA sensor with the measuring range of 500mm is used and the current is 12mA, then the displacement length=500* (12-4)/16=250mm

- **Output 0-5V:**

The displacement length=measuring range * voltage/5 (unit: mm)
E.g. If a single turn 0-5V sensor with the measuring range of 500mm is used and the voltage is 2.5V, then the displacement length=500* 2.5/5=250mm

- **Output 0-10V:**

The displacement length=measuring range * voltage/10 (unit: mm)
E.g. If a single turn 0-10V sensor with the measuring range of 500mm is used and the voltage is 2.5V, then the displacement length=500* 2.5/10=125mm

7. How to calculate the displacement length for RS485

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.

8. 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
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 (0: CW Clockwise increment) (1: CCW Counterclockwise increment)	Unit	-
Default value	1 (CCW Counterclockwise	Read/Write	Write Only (Support function codes

	increment)		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	Effective immediately	Memory	-

method			
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;
}
```

9. 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).

10. Indicator Lights Description

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.

11. 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.

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