荣德光学 Roundss

Absolute Encoder
绝对式编码器
Operation Manual
使用说明书

RDE50T8 • Series

长春荣德光学有限公司

CHANGCHUN RONGDE OPTICS CO.,LTD

www.roundssencoder.com

Contents

1.1 Appearance and Features

Appearance:
1. Shell Color: Black、Silver (Optional).
2. Surface: Sandblast Oxidation.
3. Termination: Radial Output.
4. Cable Length: 0.2m～2m (Can be customized).
5. Color of Cable: Black、Gray (Optional).

Features:
1. Mini Absolute Encoder, apply for tight space.
2. Durable, long life, high temperature resistance, anti-interference.

RDE50T8

1.2 Part Number Defined

Asynchronous Serial Communication

RDE 50 T 8 - 16 - 1 - T A B B - T G

- RDE — Type: RDE:Optical Single Turn Encoder
- 50 — Outer Diameter: Φ50mm
- T — Shaft Type: T:Hollow Shaft
- 8 — Shaft Diameter: Φ8mm
- 16 — Counts Per Turn: 10-16bit
- 1 — Operating Voltage: 1: DC5V±5%; 2: DC10-30V
- T — Interface: R: RS422; T: RS485; E: RS232
- A — Baud Rate: A: 115200; B: 57600; E: 38400; F: 19200; G: 9600; H: 4800
- B — Refresh Rate: A: 2000Hz; B: 1000Hz; C: 500Hz; D: 400Hz; E: 200Hz; F: 100Hz; G: 50Hz; H: 20Hz
- B — Output Code: B: Binary Code; G: Gray Code
- T — Communication Protocoal: T : Timing Transmission; TC: Timing+Zero Clearing; C : Handshake; CC: Handshake+Zero Clearing; B : Bus Command; BC: Bus+Zero Clearing; M : MODBUS
- G — Connection: G: Radial Cable; E: Axial Cable

1.3 Notes

1. Please follow the instructions to use flexible connections for mounting to ensure the accuracy and service life of products.
2. Encoders are precise instruments adjusted strictly before leaving factory. Strong impact, dismantlement and changes on encoders are not allowed.
3. To guarantee the accuracy and work of encoder, when the operating voltage is DC5V ± 5%:
 (1) Cable length should not exceed 2 meters.
 (2) The current of the power supply should not be less than 0.5A.
 (3) The interference signal of the power supply should be within ± 50mV.
When operating voltage is 10-30V:
 (1) The current of the power supply should not be less than 0.3A.
 (2) The interference signal of the power supply should be within ± 50mV.
4. The corresponding supply voltage and connections to the equipment should be paid attention by the profesional installation people.
5. Please read the instructions carefully before using the product.

2.1 Basic Specifications

Resolution in Bit	10～21bit	Measuring Range	0 ～ 360° (Single-turn)

Resolution in Bit	10 bit	11 bit	12 bit	13 bit	14 bit	15 bit	16 bit
Angular Resolution			320″	160″	80″	40″	20″
Accuracy≤			±640″	±320″	±160″	±80″	±40″

2.2 Environment Specifications

Working Temperature	-40℃～+65℃	Protection Class	IP54
Storage Temperature	-50℃～+70℃		

2.3 Mechanical Specifications

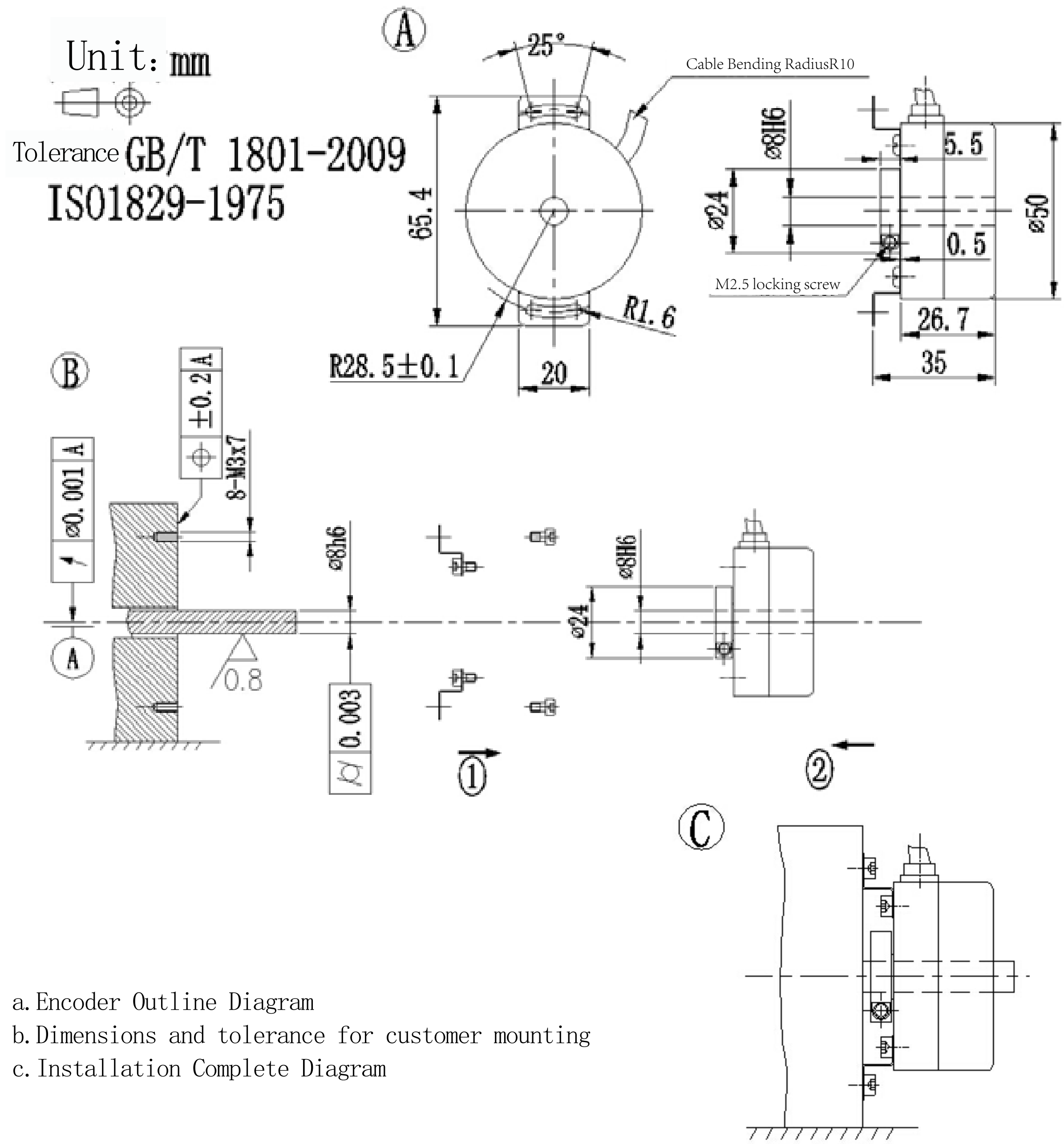
Outer Diameter	50 mm	Shaft Diameter	8 mm
Height	27 mm	Max Speed	300 r/min
Weight	150 g	Radial Shaft Load	≤20N
Vibration	2.5 g	Axial Shaft Load	≤10N
Shock	20 g		

2.4 Electrical Specifications

Asynchronous Serial Communication

Supply Voltage	DC5V, 10～30V
Interface	RS485、RS232、RS232
Communication Protocol	MODBUS、Timing Transmission、Timing Transmission+Zero Clearing、Handshake、Handshake+Zero Clearing、Bus Command、Bus+Zero Clearing
Baud Rate(b/s)	115200、57600、38400、19200、9600、4800、2400
Refresh Rate	2000Hz、1000Hz、500 Hz、400 Hz、200 Hz、100 Hz、50 Hz、20 Hz
Output Code	Binary Code, Gray Code

2.5 Installation Instruction



a. Encoder Outline Diagram
b. Dimensions and tolerance for customer mounting
c. Installation Complete Diagram

Product Communication

Asynchronous serial: Number of data bits per character :10 Bits start bits - 1 data bits - 8 parity bits - 0 stop bits - 1 Bit transfer order:LSB first (Odd Parity Check and even parity check are optional for customer requirements)

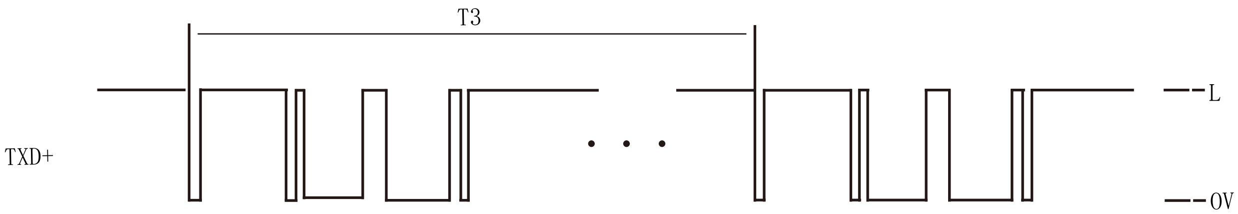
3.1 RS485

RS485 interface chip----MAX485 ESA (250kbps) or MAX13443EASA (10Mbps)

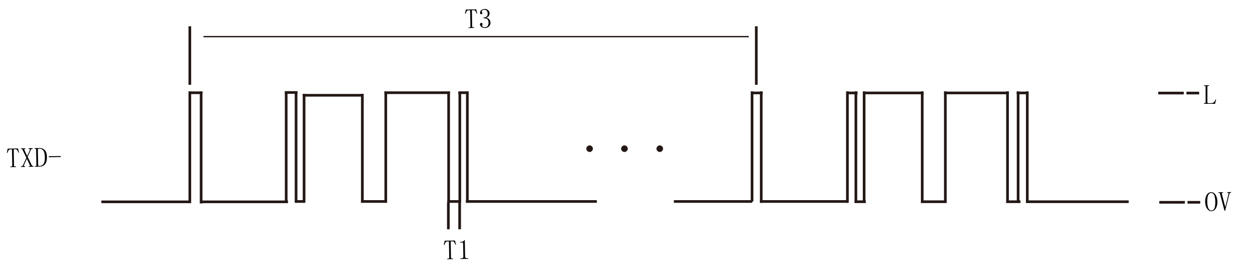
3.1.1 Timing Transmission

(1) Output data waveform
For Example, 0xff 0x81 0xd0 ...

- TXD+ Bit Transmission: 0 1111 1111 1 0 1000 0001 1 0 0000 1011 1 ...
3.3V≤L≤5V



- TXD- Bit Transmission: 1 0000 0000 0 1 0111 1110 0 1 1111 0100 0 ...
3.3V≤L≤5V



T1: Baud Rate T3: Refresh Rate

(2) Data Frame Format

	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte
≤16bit	FFH	81H	The Top Eight Bits	The Bottom Eight Bits	Checksum		
17～24bit	FFH	81H	The Top Eight Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum	
>24bit	FFH	81H	The Top Eight Bits	The Sub-top Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum

(Checksum is the sum of first n bytes data and rounded up to the bottom eight bits. n=4(≤16bit); n=5(17～24bit);n=6(>24bit)

(3) Connection

Color	RED	BLACK	YELLOW	GREEN	WHITE	SHIELD
Signal	VCC	0V	TXD+	TXD-	NC	G

(4) Angle Conversion Formula

θ = (360° ×a) /2n [a: data (decimal) , n: encoder bits]
Take an example of 14 bit absolute encoder, returned data FFH 81H 01H 7FH 00H, data bit 01H 7FH (decimal) 383, Checksum 00H.
a=383,n=14, $\theta = (360° \times 383) / 2^{14}$, θ = (360° ×383) /16384, θ =8.4155° .

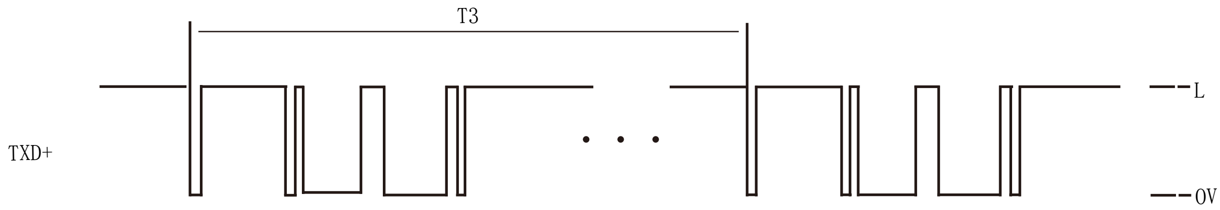
3.1.2 Timing Transmission + Zero Clearing

(1) Output data waveform

For Example 0xff 0x81 0xd0 ...

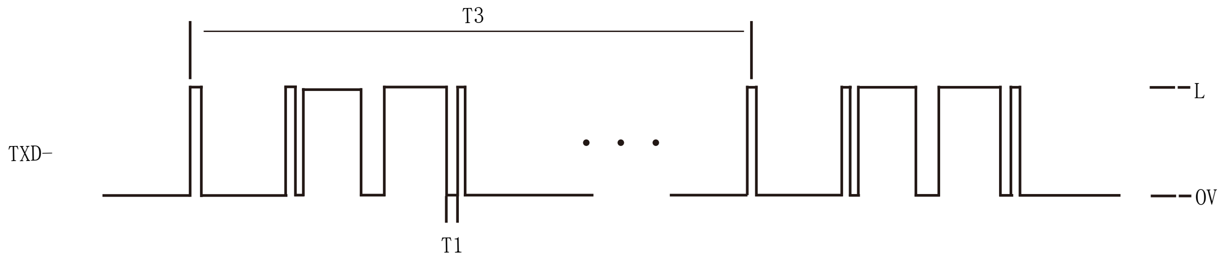
- TXD+ Bit Transmission: 0 1111 1111 1 0 1000 0001 1 0 0000 1011 1 ...

3.3V≤L≤5V



- TXD- Bit Transmission: 1 0000 0000 0 1 0111 1110 0 1 1111 0100 0 ...

3.3V≤L≤5V



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(2) Data Frame Format

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>24bit	FFH	81H	The Top Eight Bits	The Sub-top Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum

(Checksum is the sum of first n bytes data and rounded up to the bottom eight bits. n=4(≤16bit); n=5(17～24bit);n=6(>24bit)

(3) Connection

Color	Red	Black	Yellow	Green	White	Shield
Signal	VCC	0V	TXD+	TXD-	CLR	G

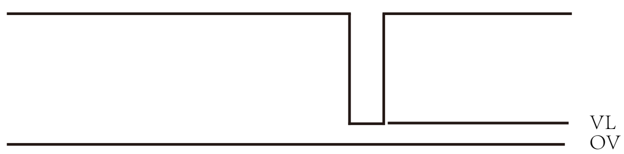
(4) Angle Conversion Formula

θ = (360° ×a) /2n [a: data (decimal), n: encoder bits]

Take an example of 14 bit absolute encoder, returned data FFH 81H 01H 7FH 00H, data bit 01H 7FH (decimal) 383, Checksum 00H.

a=383, n=14, θ = (360° ×383) /2^{14} , θ = (360° ×383) /16384, θ =8.4155° .

(5) Zero Clearing Signal:



Normally the voltage of CLR pin is 3.3V; When customer input a falling edge pulse and VL<0.5V, zero cleared.

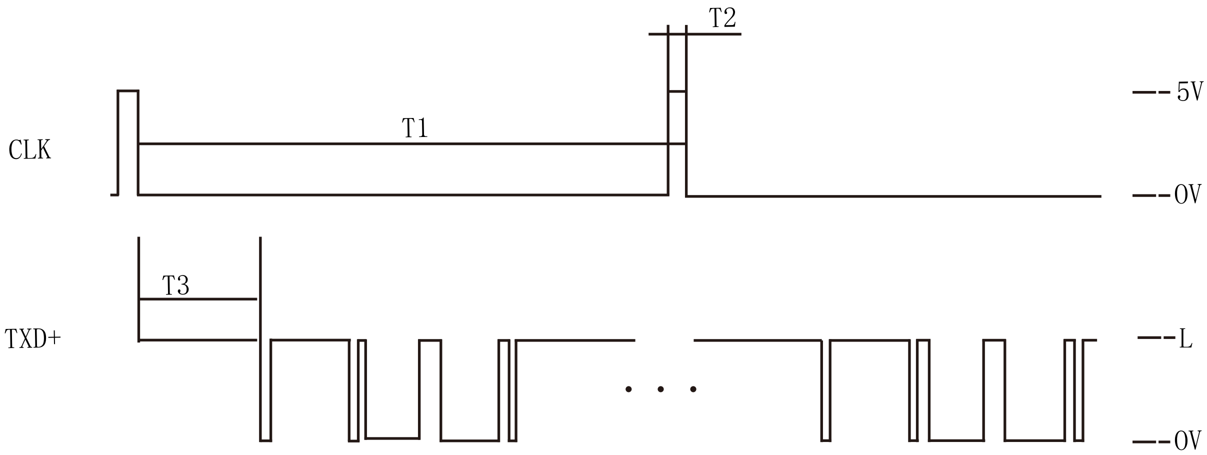
3.1.3 Handshake

(1) Output Data Wave Form

For example 0xff 0x81 0xd0 ...

TXD+ Bit Transmission：0 1111 1111 1 0 1000 0001 1 0 0000 1011 1 ...

$3.3V \leqslant L \leqslant 5V$



The falling edge of outer pules signal triggers encoder working

$T2 \geqslant 10us$

T3：Signal acquisition and processing time after receiving the falling edge outer pulse.

T1-T3：Data transmission time

T1、T3 will be different according to customer’s requirements.

(2) Data Frame Format

	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte
≤16bit	FFH	81H	The Top Eight Bits	The Bottom Eight Bits	Checksum		
17～24bit	FFH	81H	The Top Eight Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum	
＞24bit	FFH	81H	The Top Eight Bits	The Sub-top Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum

（Checksum is the sum of first n bytes data and rounded up to the bottom eight bits. n=4(≤16bit)；n=5(17～24bit);n=6(＞24bit)

(3) Connections

Color	Red	Black	Yellow	Green	White	Shield
Signal	VCC	0V	TXD+	TXD-	CLK	G

(4) Angle Conversion Formula

$\theta = (360° \times a)/2n$ [a：data (decimal)， n：encoder bits]

Take an example of 14 bit absolute encoder，returned data FFH 81H 01H 7FH 00H，data bit 01H 7FH (decimal) 383，Checksum 00H.

$a=383, n=14$, $\theta = (360° \times 383)/2^{14}$, $\theta = (360° \times 383)/16384$, $\theta = 8.4155°$.

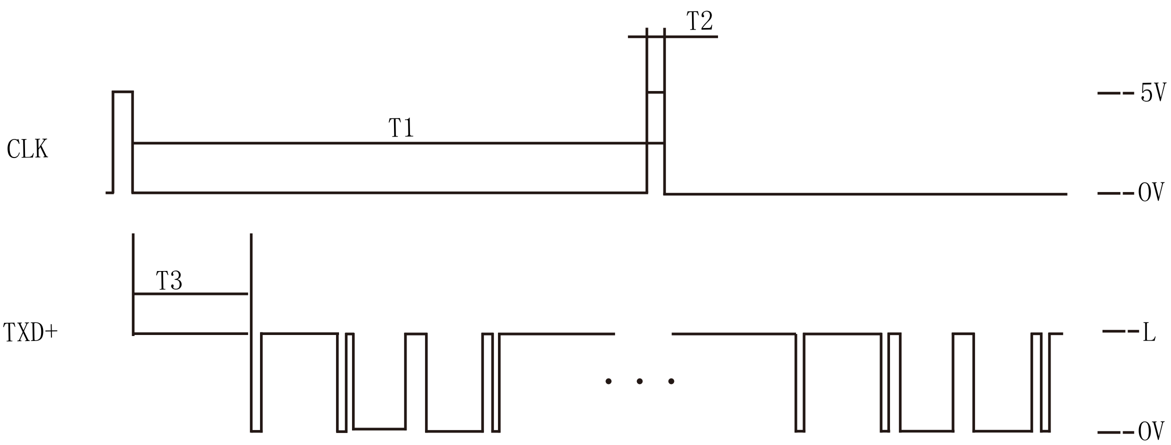
3.1.4 Handshake+Zero Clearing

(1) Output Data Wave Form

For example 0xff 0x81 0xd0 ...

TXD+ Bit Transmission: 0 1111 1111 1 0 1000 0001 1 0 0000 1011 1 ...

3.3V≤L≤5V



The falling edge of outer pules signal triggers encoder working

T2≥10us

T3: Signal acquisition and processing time after receiving the falling edge outer pulse.

T1-T3: Data transmission time

T1、T3 will be different according to customer's requirements.

(2) Data Frame Format

	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte
≤16bit	FFH	81H	The Top Eight Bits	The Bottom Eight Bits	Checksum		
17～24bit	FFH	81H	The Top Eight Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum	
>24bit	FFH	81H	The Top Eight Bits	The Sub-top Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum

(Checksum is the sum of first n bytes data and rounded up to the bottom eight bits. n=4(≤16bit); n=5(17～24bit);n=6(>24bit)

(3) Connections (8 core cable)

Color	Red	Black	Yellow	Green	Gray	White	Orange	Brown	Shield
Signal	VCC	0V	TXD+	TXD-	CLK	CLR	NC	NC	G

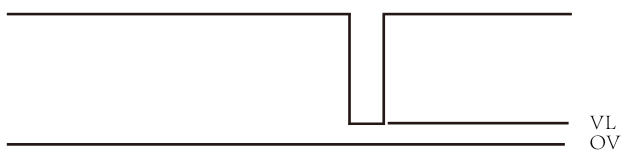
(4) Angle Conversion Formula

θ=(360° ×a)/2n [a: data(decimal), n: encoder bits]

Take an example of 14 bit absolute encoder, returned data FFH 81H 01H 7FH 00H, data bit 01H 7FH (decimal) 383, Checksum 00H.

a=383, n=14, $\theta=(360° \times 383)/2^{14}$, θ=(360° ×383)/16384, θ=8.4155°.

(5) Zero Clearing Signal:



Normally the voltage of CLR pin is 3.3V; When customer input a falling edge pulse and VL<0.5V, zero cleared.

3.1.5 Bus Command

(1) Control command:

BC AA BX (BX: Command Number. If customers don' t have special requirements, each encoder within same batch has sole command number. This number will be also used as encoder address number.)
For example, 3 encoders in same batch. control command: BC AA B1 、BC AA B2、BC AA B3;Corresponding returned data: FF B1……, FF B2 ……, FF B3 ……;The second byte of returned data is product address number.

(2) Data Frame Format

	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte
Control command	BCH	AAH	BXH				
≤16bit	FFH	81H	The Top Eight Bits	The Bottom Eight Bits	Checksum		
17~24bit	FFH	81H	The Top Eight Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum	
>24bit	FFH	81H	The Top Eight Bits	The Sub-top Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum

(Checksum is the sum of first n bytes data and rounded up to the bottom eight bits. n=4(≤16bit); n=5(17~24bit);n=6(>24bit)

(3) Connection

Color	RED	BLACK	YELLOW	GREEN	WHITE	SHIELD
Signal	VCC	0V	TXD+	TXD-	NC	G

(4) Angle Conversion Formula

θ = (360° ×a) /2n [a: data (decimal), n: encoder bits]

Take an example of 14 bit absolute encoder, returned data FFH 81H 01H 7FH 00H, data bit 01H 7FH (decimal) 383, Checksum 00H.

a=383, n=14, $\theta = (360° \times 383) / 2^{14}$, θ = (360° ×383) /16384, θ =8.4155° .

3.1. 6 Bus + Zero Clearing

(1) Control command:

BC AA BX (BX: Command Number. If customers don' t have special requirements, each encoder within same batch has sole command number. This number will be also used as encoder address number.)
For example, 3 encoders in same batch. control command: BC AA B1 、BC AA B2、BC AA B3;Corresponding returned data: FF B1……, FF B2 ……, FF B3 ……;The second byte of returned data is product address number.
Zero clearing command:
BC AA CX . (CX: zero clearing command. If customers don' t have special requirements, each product in same batch has sole zero clearing command. Generally, the X in zero clearing command is corresponding with the X in control command.)
For example, when control command is BC AA B1, its zero clearing command is BC AA C1.

(2) Data Frame Format

	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte
Control Command	BCH	AAH	BXH				
Zero Clearing Command	BCH	AAH	CXH				
≤16bit	FFH	81H	The Top Eight Bits	The Bottom Eight Bits	Checksum		
17~24bit	FFH	81H	The Top Eight Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum	
>24bit	FFH	81H	The Top Eight Bits	The Sub-top Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum

(Checksum is the sum of first n bytes data and rounded up to the bottom eight bits. n=4(≤16bit); n=5(17~24bit);n=6(>24bit)

(3) Connection

Color	RED	BLACK	YELLOW	GREEN	WHITE	SHIELD
Signal	VCC	0V	TXD+	TXD-	NC	G

(4) Angle Conversion Formula

θ = (360° ×a) /2n [a: data (decimal), n: encoder bits]

Take an example of 14 bit absolute encoder, returned data FFH 81H 01H 7FH 00H, data bit 01H 7FH (decimal) 383, Checksum 00H.

a=383, n=14, $\theta = (360° \times 383) / 2^{14}$, θ = (360° ×383) /16384, θ =8.4155° .

3.1.7 MODBUS Protocol

(1) Modbus Communication Protocol (RTU mode)。
(2) Baud Rate: 2400bps 4800bps 9600bps 19200bps 57600bps
(3) Factory Default Settings:①no odd-even parity ②Baud rate 19200bps③ address 0x01④ starting address 0x00 0x00
Note: When changing parameters, do not regularly send in case the internal structure of the device would be damaged.
Sending a return match on behalf of the data was set successfully.
(4) Function Code 03:
The 03 code function of Modbus communication protocol could help reading the encoder values.
The slave address, function code, starting address, number of bytes and CRC code are all included in command format of the master.
The format of slave response data is made up with the slave address, function code, data areas and CRC code. The data area is a binary code, two bytes (or three bytes), MSB first. CRC code is two bytes, LSB first.
(5) Data Frame Format:
① The reading real-time data of encoder is below - 16bit when the master is calling, the slave address is 01

01	03	00	00	00	01	84	0A
Slave address	Function code	Starting address		Reading points		CRC checksum(LSB first)	

Encoder Answering:

01	03	02	XX	XX	XX	XX
Slave address	Function code	Starting address	data (MSB first)		CRC checksum(LSB first)	

② The reading real-time data of encoder is between - 16bit and - 32bit
when the master is calling, the slave address is 01

01	03	00	00	00	02	C4	0B
Slave address	Function code	Starting address		Reading points		CRC checksum(LSB first)	

Encoder Answering:

01	03	04	XX	XX	XX	XX	XX	XX
Slave address	Function code	Single unit byte	data (MSB first)				CRC checksum(LSB first)	

01, 03, 02, XX, etc. above are all a byte. The data is two bytes, the higher byte ahead.
The interval time between the beginning and the end of each frame is at least 3.5 bytes.
When users programming for the master, in addition to the station number (address) and the CRC checksum code, all other byte characters used in the above remains unchanged. The reading points in the master format could be 01 or 02 (02 is for compatible with certain protocols). The function code 03 in the slave remains unchanged.

③ Check Device Address

Master calling	FF	A0	40	38
Encoder answering	FF	A0	01 (Slave address)	XX XX (CRC checksum code, MSB first)

④ Check Device Address

Mastering calling	01	A1	02 (new address)	XX XX (CRC checksum code, LSB first)
Encoder answering	02 (new address)	A1	XX;XX (CRC checksum code, LSB first)	

⑤ Change the baud , zero position and direction of device

Master calling	01	CC	02 (parameter)	XX XX (CRC checksum code, LSB first)
Encoder answering	01 (address)	CC	02 (parameter)	XX XX (CRC checksum code, LSB first)

Definition of Setting:
Ⅰ、0x00 Set the current position to zero; Ⅱ、0x01 positive bit; Ⅲ、0x02 negative bit;
Ⅳ、0x24 Baud Rate 2400bps; Ⅴ、0x48 Baud Rate 4800bps;Ⅵ、 0x96 Baud Rate 9600bps;
Ⅶ、0x19 Baud Rate 19200bps; Ⅷ、0x57 Baud Rate 57600bps;
The steps of calculating the CRC code is:
① Preset 16 bits slave is hexadecimal coding FFFF (that is 1 for all).We call this kind of slave as CRC slave;
② Exclusive OR the first 8-bit data with 16-bit CRC slave low-XOR, put the result into CRC slave;
③ Move one bit of the slave into right direction(towards low), filling the highest position with 0, checking the lowest position;
④ If the lowest bit (the moved out one) is 0: then repeat Step 3 (shifted again)
If the lowest bit (the moved out one) is 1: Exclusive OR CRC slave with polynomial A001 (1010 0000 0000 0001);
⑤ Repeat step 3 for and 4 until the right eight times, so that the whole 8-bit data are fully processed;
⑥ Repeat from the steps 2 to step 5, and carrying next 8-bit data processing;
⑦ The resulting of CRC slave is the CRC code。
⑧ Put CRC results into information frames, exchange the low bit with high bit, LSB first。

(6) Connection

Color	RED	BLACK	YELLOW	GREEN	WHITE	SHIELD
Signal	VCC	0V	TXD+	TXD-	NC	G

(7) Angle Conversion Formula

$\theta = (360° \times a)/2n$ [a: data (decimal), n: encoder bits]

Take an example of 14 bit absolute encoder, returned data FFH 81H 01H 7FH 00H, data bit 01H 7FH (decimal) 383, Checksum 00H.

a=383, n=14, $\theta = (360° \times 383)/2^{14}$, $\theta = (360° \times 383)/16384$, $\theta = 8.4155°$.

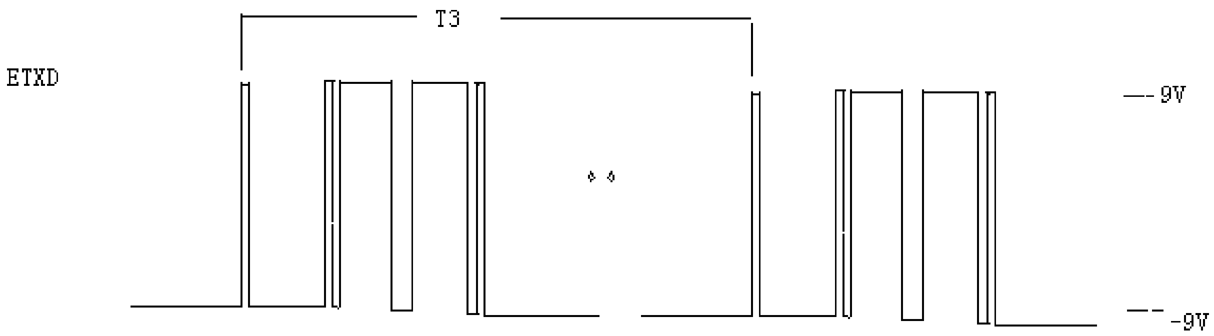
3.2 RS232 —— RS232 interface chip ----MAX232 ESA

3.2.1 Timing Transmission

(1) Output Data Waveform

For instance:0xff 0x81 0xd0 ...

TXD + Bit transfer: 0 1111 1111 1 0 1000 0001 1 0 0000 1011 1 ...



T3: Refresh Rate

(2) Data Frame Format

	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte
≤16bit	FFH	81H	The Top Eight Bits	The Bottom Eight Bits	Checksum		
17～24bit	FFH	81H	The Top Eight Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum	
>24bit	FFH	81H	The Top Eight Bits	The Sub-top Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum

(Checksum is the sum of first n bytes data and rounded up to the bottom eight bits. n=4(≤16bit); n=5(17～24bit);n=6(>24bit)

(3) Connections

Color	Red	Black	Yellow	Green	White	Shield
Signal	VCC	0V	ETXD	NC	CLR	G

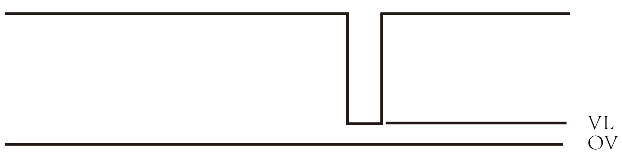
(4) Angle Conversion Formula

$\theta = (360° \times a) / 2n$ [a: data (decimal), n: encoder bits]

Take an example of 14 bit absolute encoder, returned data FFH 81H 01H 7FH 00H, data bit 01H 7FH (decimal) 383, Checksum 00H.

a=383, n=14, $\theta = (360° \times 383) / 2^{14}$, $\theta = (360° \times 383) / 16384$, $\theta = 8.4155°$.

(5) Zero Clearing Signal:



Normally the voltage of CLR pin is 3.3V; When customer input a falling edge pulse and VL<0.5V, zero cleared.

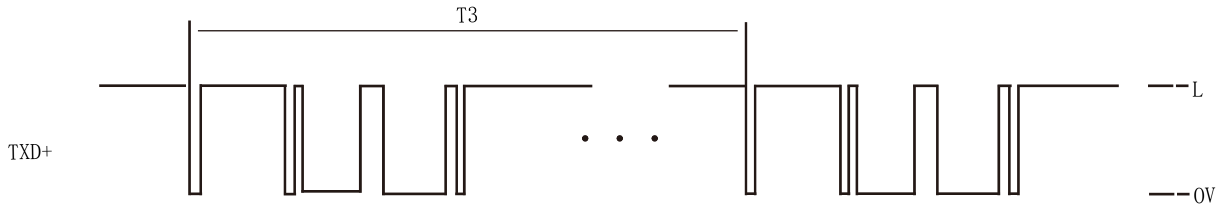
3.2.2 Timing Transmission + Zero Clearing

(1) Output Data Waveform

For Example 0xff 0x81 0xd0 ...

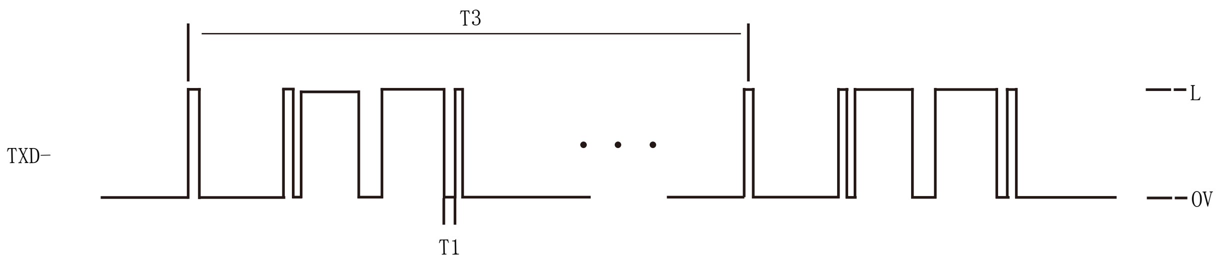
- TXD+ Bit Transmission: 0 1111 1111 1 0 1000 0001 1 0 0000 1011 1 ...

  3.3V≤L≤5V



- TXD- Bit Transmission: 1 0000 0000 0 1 0111 1110 0 1 1111 0100 0 ...

  3.3V≤L≤5V



T1: Baud Rate T3: Refresh Rate

(2) Data Frame Format

	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte
≤16bit	FFH	81H	The Top Eight Bits	The Bottom Eight Bits	Checksum		
17~24bit	FFH	81H	The Top Eight Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum	
>24bit	FFH	81H	The Top Eight Bits	The Sub-top Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum

(Checksum is the sum of first n bytes data and rounded up to the bottom eight bits. n=4(≤16bit); n=5(17~24bit);n=6(>24bit)

(3) Connections

Color	Red	Black	Yellow	Green	White	Shield
Signal	VCC	0V	ETXD	NC	CLR	G

(4) Angle Conversion Formula

$\theta = (360° \times a) /2n$ [a: data (decimal) , n: encoder bits]

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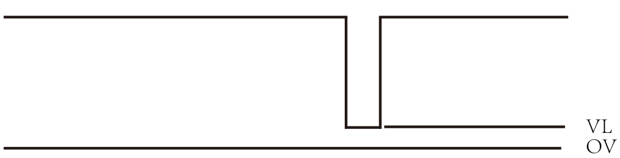
a=383, n=14, $\theta = (360° \times 383) /2^{14}$, $\theta = (360° \times 383) /16384$, $\theta = 8.4155°$.

(5) Zero Clearing Signal:



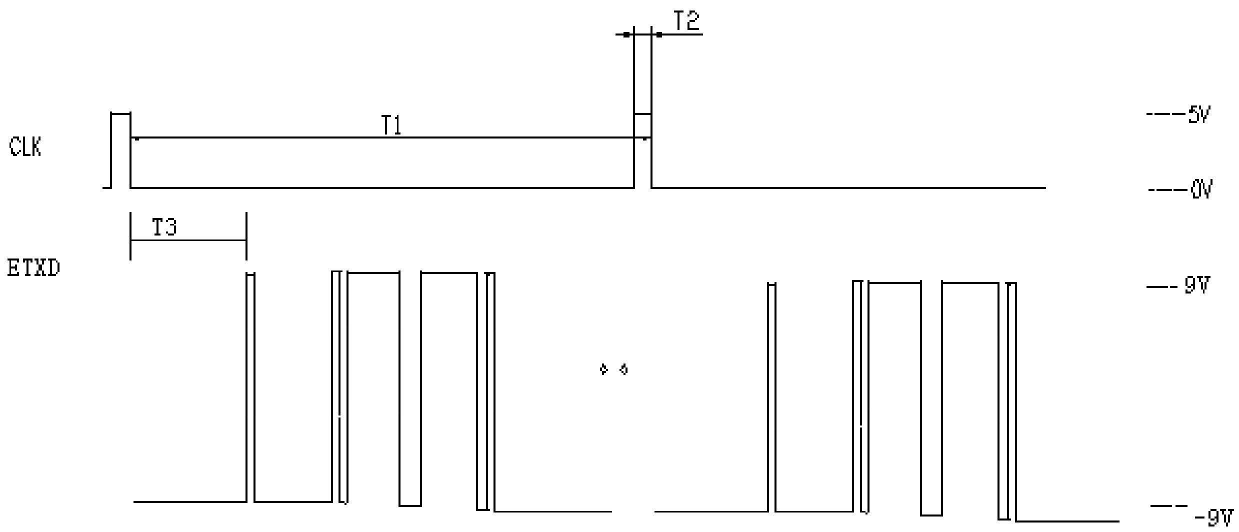
Normally the voltage of CLR pin is 3.3V; When customer input a falling edge pulse and VL<0.5V, zero cleared.

3.2.3 Pulse Handshake

(1) Output Data Waveform

For instance:0xff 0x81 0xd0 ...

TXD + Bit Transfer: 0 1111 1111 1 0 1000 0001 1 0 0000 1011 1 ...



Pulse Handshake: external falling edge pulse signal triggers encoder working

T2>=10us

T3: Signal acquisition and processing time after receiving the falling edge outer pulse.

T1-T3: Data Transmission Time

T1、T3 vary according to the actual requirements or customer’ s needs.

(2) Data Frame Format

	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte
≤16bit	FFH	81H	The Top Eight Bits	The Bottom Eight Bits	Checksum		
17～24bit	FFH	81H	The Top Eight Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum	
＞24bit	FFH	81H	The Top Eight Bits	The Sub-top Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum

(Checksum is the sum of first n bytes data and rounded up to the bottom eight bits. n=4(≤16bit); n=5(17～24bit);n=6(＞24bit)

(3) Connections

Color	Red	Black	Yellow	Green	White	Shield
Signal	VCC	0V	ETXD	NC	CLK	G

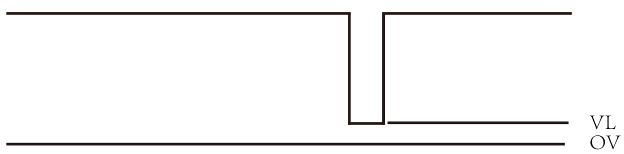
(4) Angle Conversion Formula

θ = (360° ×a) /2n [a: data (decimal), n: encoder bits]

Take an example of 14 bit absolute encoder, returned data FFH 81H 01H 7FH 00H, data bit 01H 7FH (decimal) 383, Checksum 00H.

a=383, n=14, $θ = (360° × 383) / 2^{14}$, θ = (360° ×383) /16384, θ =8.4155° .

(5) Zero Clearing Signal:



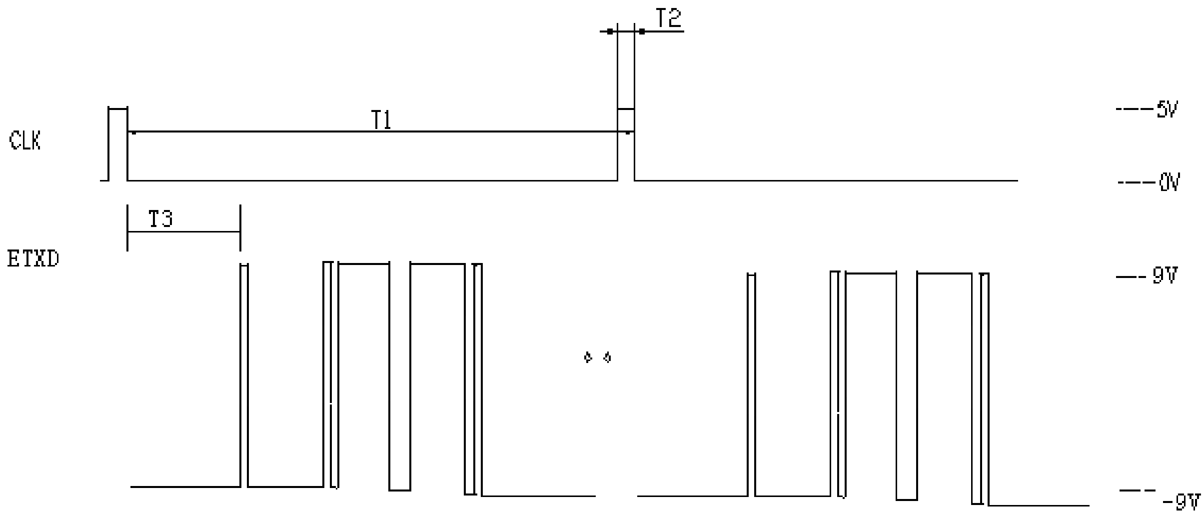
Normally the voltage of CLR pin is 3.3V; When customer input a falling edge pulse and VL<0.5V, zero cleared.

3.2.4 Handshake + Zero Clearing

(1) Output Data Waveform

For instance:0xff 0x81 0xd0 ...

TXD + Bit Transfer: 0 1111 1111 1 0 1000 0001 1 0 0000 1011 1 ...



Pulse Handshake: external falling edge pulse signal triggers encoder working

T2>=10us

T3: Signal acquisition and processing time after receiving the falling edge outer pulse.

T1-T3: Data Transmission Time

T1、T3 vary according to the actual requirements or customer's needs.

(2) Data Frame Format

	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte
≤16bit	FFH	81H	The Top Eight Bits	The Bottom Eight Bits	Checksum		
17～24bit	FFH	81H	The Top Eight Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum	
>24bit	FFH	81H	The Top Eight Bits	The Sub-top Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum

(Checksum is the sum of first n bytes data and rounded up to the bottom eight bits. n=4(≤16bit); n=5(17～24bit);n=6(>24bit)

(3) Connections

Color	Red	Black	Yellow	Green	Grey	White	Orange	Brown	Shield
Signal	VCC	0V	ETXD	NC	CLK	CLR	NC	NC	G

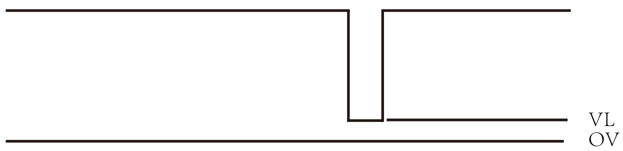
(4) Angle Conversion Formula

$\theta = (360° \times a) / 2n$ [a: data (decimal), n: encoder bits]

Take an example of 14 bit absolute encoder, returned data FFH 81H 01H 7FH 00H, data bit 01H 7FH (decimal) 383, Checksum 00H.

a=383, n=14, $\theta = (360° \times 383) / 2^{14}$, $\theta = (360° \times 383) / 16384$, $\theta = 8.4155°$.

(5) Zero Clearing Signal:



Normally the voltage of CLR pin is 3.3V; When customer input a falling edge pulse and VL<0.5V, zero cleared.

3.2.5 Bus Command

(1) Control Command:
BC AA BX (BX: Command Number. If customers don't have special requirements, each encoder within same batch has sole command number. This number will be also used as encoder address number.)
For example, 3 encoders in same batch. control command: BC AA B1 、BC AA B2、BC AA B3; Corresponding returned data: FF B1……, FF B2 ……, FF B3 ……; The second byte of returned data is product address number.

(2) Data Frame Format

	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte
Control command	BCH	AAH	BXH				
≤16bit	FFH	81H	The Top Eight Bits	The Bottom Eight Bits	Checksum		
17～24bit	FFH	81H	The Top Eight Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum	
>24bit	FFH	81H	The Top Eight Bits	The Sub-top Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum

(Checksum is the sum of first n bytes data and rounded up to the bottom eight bits. n=4(≤16bit); n=5(17～24bit); n=6(>24bit)

(3) Connections

Color	Red	Black	Yellow	Green	White	Shield
Signal	VCC	0V	ETXD	NC	CLK	G

(4) Angle Conversion Formula

θ = (360° ×a) /2n [a: data (decimal), n: encoder bits]

Take an example of 14 bit absolute encoder, returned data FFH 81H 01H 7FH 00H, data bit 01H 7FH (decimal) 383, Checksum 00H.

a=383, n=14, $\theta = (360° \times 383)/2^{14}$, θ = (360° ×383) /16384, θ =8.4155° .

3.2.6 Bus +Zero Clearing

(1) Control Command:
BC AA BX (BX: Command Number. If customers don't have special requirements, each encoder within same batch has sole command number. This number will be also used as encoder address number.)
For example, 3 encoders in same batch. control command: BC AA B1 、BC AA B2、BC AA B3; Corresponding returned data: FF B1……, FF B2 ……, FF B3 ……; The second byte of returned data is product address number.
Zero Clearing Command:
BC AA CX . (CX: zero clearing command. If customers don't have special requirements, each product in same batch has sole zero clearing command. Generally, the X in zero clearing command is corresponding with the X in control command.)
For example, when control command is BC AA B1, its zero clearing command is BC AA C1.

(2) Data Frame Format

	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte
Control Command	BCH	AAH	BXH				
Zero Clearing Command	BCH	AAH	CXH				
≤16bit	FFH	81H	The Top Eight Bits	The Bottom Eight Bits	Checksum		
17～24bit	FFH	81H	The Top Eight Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum	
>24bit	FFH	81H	The Top Eight Bits	The Sub-top Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum

(Checksum is the sum of first n bytes data and rounded up to the bottom eight bits. n=4(≤16bit); n=5(17～24bit); n=6(>24bit)

(3) Connections

Color	Red	Black	Yellow	Green	White	Shield
Signal	VCC	0V	ETXD	RTXD	NC	G

(4) Angle Conversion Formula

θ = (360° ×a) /2n [a: data (decimal), n: encoder bits]

Take an example of 14 bit absolute encoder, returned data FFH 81H 01H 7FH 00H, data bit 01H 7FH (decimal) 383, Checksum 00H.

a=383, n=14, $\theta = (360° \times 383)/2^{14}$, θ = (360° ×383) /16384, θ =8.4155° .

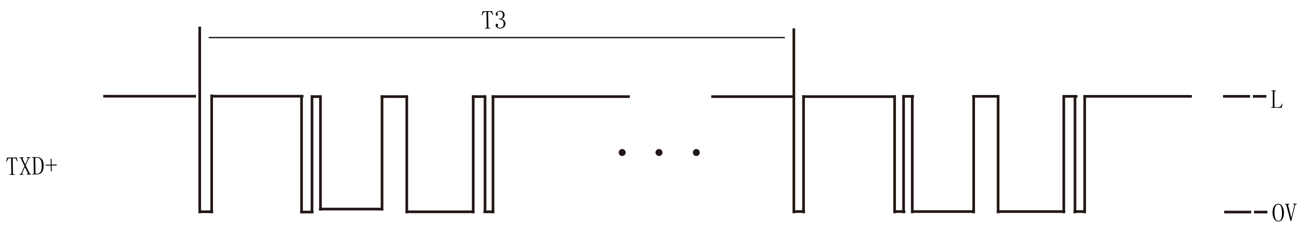
3.3.1 Timing Transmission

(1) Output Data Waveform

For Example, 0xff 0x81 0xd0 ...

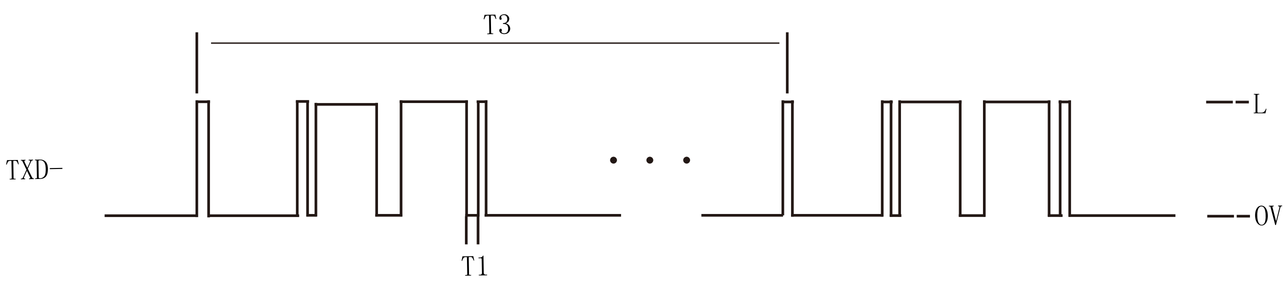
■ TXD+ Bit Transmission: 0 1111 1111 1 0 1000 0001 1 0 0000 1011 1 ...

3.3V≤L≤5V



■ TXD- Bit Transmission: 1 0000 0000 0 1 0111 1110 0 1 1111 0100 0 ...

3.3V≤L≤5V



T1: Baud Rate   T3: Refresh Rate

(2) Data Frame Format

	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte
≤16bit	FFH	81H	The Top Eight Bits	The Bottom Eight Bits	Checksum		
17~24bit	FFH	81H	The Top Eight Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum	
>24bit	FFH	81H	The Top Eight Bits	The Sub-top Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum

(Checksum is the sum of first n bytes data and rounded up to the bottom eight bits. n=4(≤16bit); n=5(17~24bit);n=6(>24bit)

(3) Connection

Color	RED	BLACK	YELLOW	GREEN	WHITE	SHIELD
Signal	VCC	0V	TXD+	TXD-	NC	G

(4) Angle Conversion Formula

θ = (360° ×a) /2n [a: data (decimal) ,   n: encoder bits]

Take an example of 14 bit absolute encoder, returned data FFH 81H 01H 7FH 00H, data bit 01H 7FH (decimal) 383, Checksum 00H.

a=383, n=14, θ = (360° ×383) /2^{14} , θ = (360° ×383) /16384, θ =8.4155° .

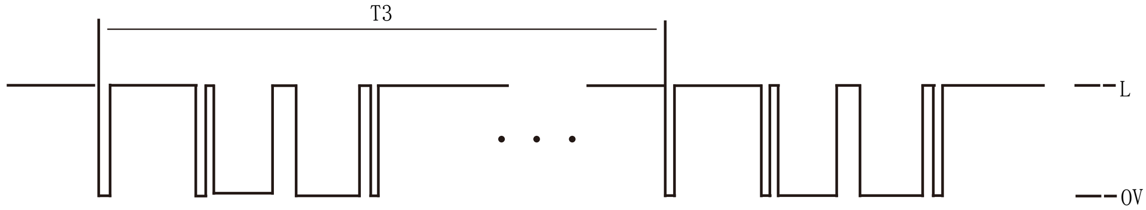
3.3.2 Timing Transmission+Zero Clearing

(1) Output Data Waveform

For Example 0xff 0x81 0xd0 ...

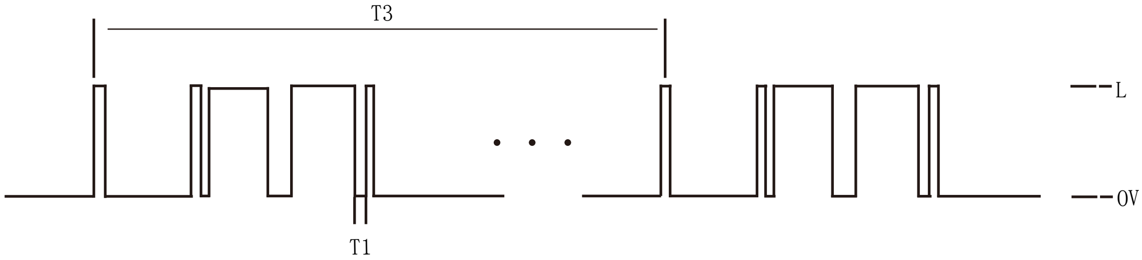
- TXD+ Bit Transmission: 0 1111 1111 1 0 1000 0001 1 0 0000 1011 1 ...

3.3V≤L≤5V



- TXD- Bit Transmission: 1 0000 0000 0 1 0111 1110 0 1 1111 0100 0 ...

3.3V≤L≤5V



T1: Baud Rate　T3: Refresh Rate

(2) Data Frame Format

	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte
≤16bit	FFH	81H	The Top Eight Bits	The Bottom Eight Bits	Checksum		
17～24bit	FFH	81H	The Top Eight Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum	
>24bit	FFH	81H	The Top Eight Bits	The Sub-top Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum

(Checksum is the sum of first n bytes data and rounded up to the bottom eight bits. n=4(≤16bit); n=5(17～24bit);n=6(>24bit)

(3) Connection

Color	Red	Black	Yellow	Green	White	Shield
Signal	VCC	0V	TXD+	TXD-	CLR	G

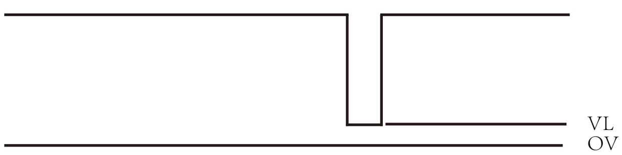
(4) Angle Conversion Formula

$\theta = (360° \times a) / 2n$　[a: data (decimal),　n: encoder bits]

Take an example of 14 bit absolute encoder, returned data FFH 81H 01H 7FH 00H, data bit 01H 7FH (decimal) 383, Checksum 00H.

a=383, n=14, $\theta = (360° \times 383) / 2^{14}$, $\theta = (360° \times 383) / 16384$, $\theta = 8.4155°$.

(5) Zero Clearing Signal:



Normally the voltage of CLR pin is 3.3V; When customer input a falling edge pulse and VL<0.5V, zero cleared.

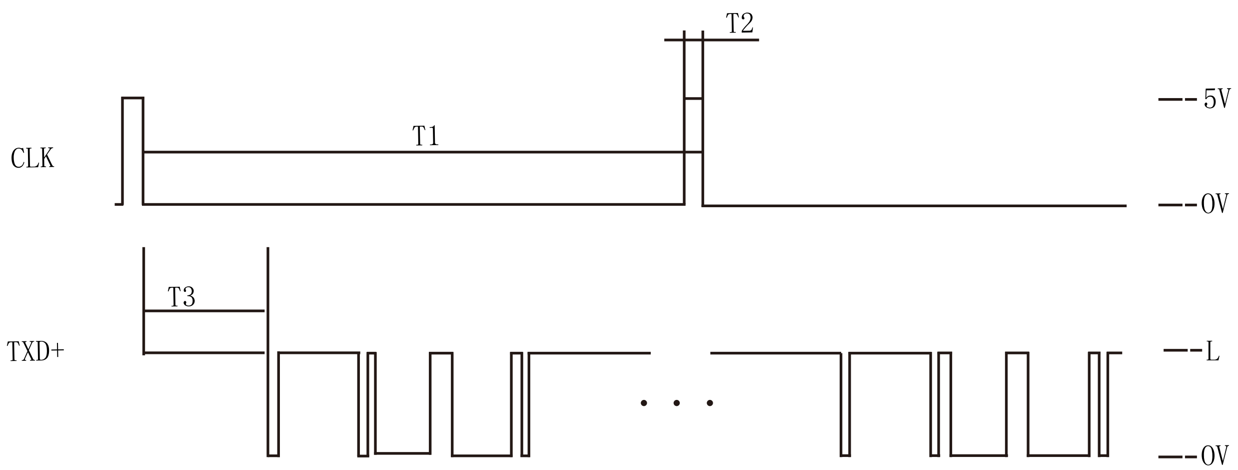
3.3.3 Bus Command

(1) Output Data Wave Form

For example 0xff 0x81 0xd0 ...

TXD+ Bit Transmission: 0 1111 1111 1 0 1000 0001 1 0 0000 1011 1 ...

3.3V≤L≤5V



The falling edge of outer pules signal triggers encoder working

T2≥10us

T3: Signal acquisition and processing time after receiving the falling edge outer pulse.

T1-T3: Data transmission time

T1、T3 will be different according to customer’s requirements.

(2) Data Frame Format

	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte
≤16bit	FFH	81H	The Top Eight Bits	The Bottom Eight Bits	Checksum		
17~24bit	FFH	81H	The Top Eight Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum	
>24bit	FFH	81H	The Top Eight Bits	The Sub-top Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum

(Checksum is the sum of first n bytes data and rounded up to the bottom eight bits. n=4(≤16bit); n=5(17~24bit);n=6(>24bit)

(3) Connections

Color	Red	Black	Yellow	Green	Grey	White	Orange	Brown	Shield
Signal	VCC	0V	TXD+	TXD-	CLK+	CLK-	NC	NC	G

(4) Angle Conversion Formula

$\theta = (360° \times a) / 2n$ [a: data (decimal), n: encoder bits]

Take an example of 14 bit absolute encoder, returned data FFH 81H 01H 7FH 00H, data bit 01H 7FH (decimal) 383, Checksum 00H.

a=383, n=14, $\theta = (360° \times 383) / 2^{14}$, $\theta = (360° \times 383) / 16384$, $\theta = 8.4155°$.

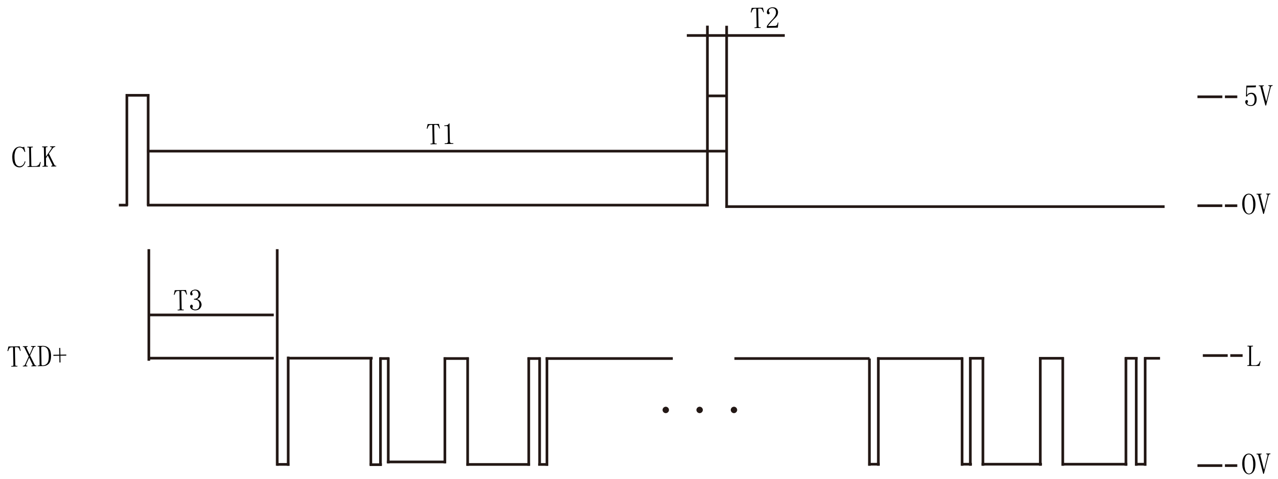
3.3.4 Bus + Zero Clearing

(1) Output Data Wave Form

For example 0xff 0x81 0xd0 ...

TXD+ Bit Transmission: 0 1111 1111 1 0 1000 0001 1 0 0000 1011 1 ...

3.3V≤L≤5V



The falling edge of outer pules signal triggers encoder working

T2≥10us

T3: Signal acquisition and processing time after receiving the falling edge outer pulse.

T1-T3: Data transmission time

T1、T3 will be different according to customer' s requirements.

(2) Data Frame Format

	1st Byte	2nd Byte	3rd Byte	4th Byte	5th Byte	6th Byte	7th Byte
≤16bit	FFH	81H	The Top Eight Bits	The Bottom Eight Bits	Checksum		
17～24bit	FFH	81H	The Top Eight Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum	
>24bit	FFH	81H	The Top Eight Bits	The Sub-top Bits	The Middle Eight Bits	The Bottom Eight Bits	Checksum

(Checksum is the sum of first n bytes data and rounded up to the bottom eight bits. n=4(≤16bit); n=5(17～24bit);n=6(>24bit)

(3) Connection

Color	Red	Black	Yellow	Green	White	Shield
Signal	VCC	0V	TXD+	TXD-	CLR	G

(4) Angle Conversion Formula

θ=(360° ×a)/2n [a: data (decimal), n: encoder bits]

Take an example of 14 bit absolute encoder, returned data FFH 81H 01H 7FH 00H, data bit 01H 7FH (decimal) 383, Checksum 00H.

a=383,n=14, θ=(360° ×383)/2^{14} , θ=(360° ×383)/16384, θ=8.4155° .