Dear users:

Welcome to using LST series of online dynamic outer diameter measuring & instrument. If you use it for the first time, please do carefully read "Operating Manual".

I. Introduction of Instrumen

1.1 Overview

LST laser diameter measuring instrument, professional non-contact dynamic diameter measuring instrument, is suitable for online diameter measurement of round workpieces such as: optical fiber and cable, electric wire & cable, glass tube, plastic tube and bearing. It not only measure display diameter and deviation value but also could diameter automatically according to user requirement to keep consistency of wire diameter.

● Suitable for online measurement of any round wires and workpieces.

● Non-contact measurement, high-speed inspection, high precision and stable performance.

● With Fθ optical lens, there is small influence of shaking on measured wire.

● With inbuilt PID module, wire diameter can be automatically controlled.

● With all-dimensional revolving operating panel, long-distance displays of various dimensions are equipped.

● With multi-address RS232/485 counication .

● With semiconductor laser of long service life.

● With Switzerland brushless DC motor, it could be adapted to working under severe environment.

LST series of diameter measuring instrument could be classified into two types such as one-dimension and two-dimension according to the measurement pattern. One-dimension diameter measuring instrument only measures the diameter value of workpiece in one direction while two-dimension diameter measuring instrument measures the diameter value in two directions of X and Y. One and two-dimension measuring instruments features compact structure, same operation function and output interfaces.

Basic LST series of diameter measuring instrument is comprised of laser measuring head, operation panel and remote controller, and can be connected with long-distance displays of various dimensions as shown by the Fig. 1.

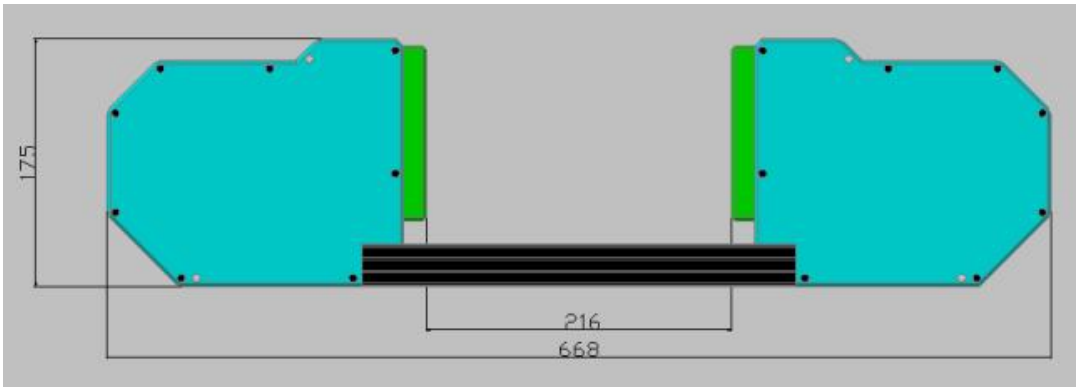
The measuring instrument is equipped with high-precision laser scanning system and embedded digital processing circuit. The diameter signal produced by the scanning system is firstly converted into digital signal to obtain practical diameter value and related data through series of calculations and processing. The output interface of diameter measuring instrument contains 1 set of 485 counication interface and 2 set of synchronic serial ports. The data of diameter measuring instrument could be transmitted to PC or remote controller through 485 counication interface. It can be connected with operation panel and remote controllers and displays of various dimensions through synchronic serial port to realize remote control and display.

Operational panel is installed above measuring head. It is used for setting parameters of data display. There are two rows of nixie tube, which could display two groups of data and adjust angle at random.

Remote controller is mainly used for automatic control. It receives data including the diameter and deviation value of diameter measuring instrument through synchronic serial port and 485 counication interface. Remote controller generates PID regulatory signal through data it receives to the rotating speed of tractor so as to finally control wire diameter.

1.2 Type & technical indicator

1.2.1 Type & specification



Measuring range: 1-100

Type: one axis scanning

Resolution: 0.001

1.2.2 Technical parameters

Equivalent scanning speed: 600 times/sec （1400 times/ sec at fastest speed）
Control output: - 10V~+10V
Maximum output current: 5mA
Center-height adjustable range: 850~1100

Model	Measuring Range	Precision	Resolution	External Dimension of Measuring Head	Weight
LST-100/JIBN	1.0-100.00	±2μm	1μm	670×60×180	10kg

Table 1

1.2.3 Working conditions

Power: DC 24V
Working temperature: -5~+50℃
Air humidity: ≤90% （no condensate water）
Power consumption: ≤15W

II. Laser Measuring Head

2.1 Principle of measurement

The light beam generated by laser is irradiated on the revolving prism. The light beam irradiated by the prism becomes the one in parallel motion through lens 1 while the parallel light beam will be converged on the receiving element. Please refer to the Fig. 2. When the tested object on the focal plane of lens 1, part of light ray is shield, thus the shadow is generated. As a result, the corresponding electric signal is generated on receiving element. The diameter value and a series of related signals are obtained after the signal is processed with diameter measuring instrument.

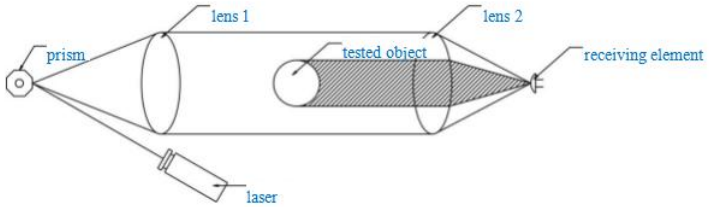


Fig. 2 （a） One-axis Measurement Principle

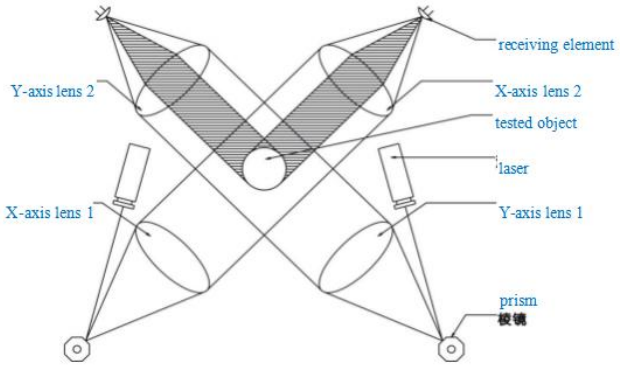
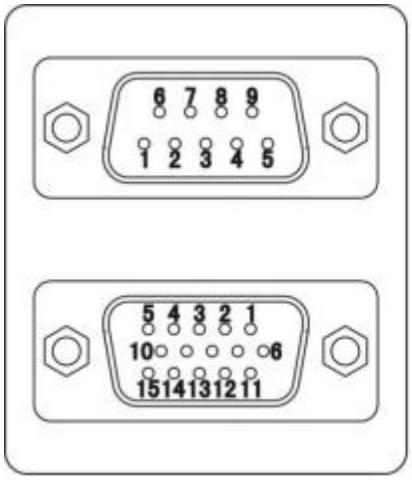


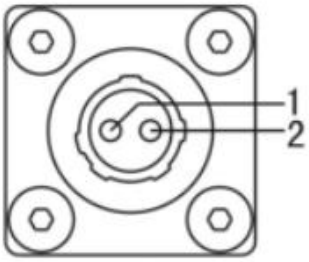
Fig. 2 （b） Two-axes Measurement Principle

2.2 Interface description



485 communication interface:
2-pin: 485-A
3-pin: 485-B
5-pin: ground wire

Synchronized serial port 2 interface:
1 and 2-pin: first pair of synchronized serial ports output
4 and 5-pin: second pair of synchronized serial ports output
14 and 15-pin: third pair of synchronized serial port output
Any pair of synchronized serial port output can be used as the input of displays or controllers such as: LST-02X or LST-03T or LST-04X or LST-05X

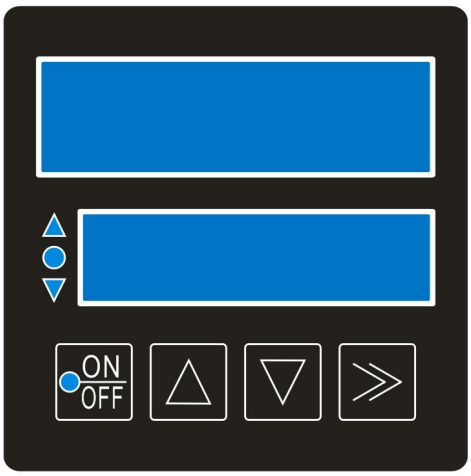


Power input port：1 Pin：24V input　　2 Pin：Ground cable
Power wiring diagram of LST-100/JIBN

Ⅲ . LST Operation Panel

3.1 Function layout of operation panel

Operation panel is installed above measuring head and connected with it through synchronized serial port 1 as shown by the Fig. It is used for data display, parameter setting, over-deviation indication and alarm. It is suitable for LST series of products. For the function layout of panel, please refer to the Fig.



Key operation Process:

Keep pressing  Beyond 2S, the measurement state can be returned；

In the parameter browsing state，Press key  to enter parameter adjustment state；

At this point, key  functions as a shift, the order is from high to low.

The corresponding move to the flashing display, indicating that the corresponding bit data can be changed. Change data with key  or  key .

Keep pressing  Beyond 2S, Returns the parameter browsing status and saves the modified parameters.

When the electricity，Press key  and key  at the same time to enter the power-on setting state， Prompt for password，Password: Corresponding passwords。

The secondary display is PASS，Press key  and the highest bit flashes to enter the password input state.

Press key  or key  to change the value of the current bit，

Press key  to move to the next password entry, Shift the normal data to the last bit.

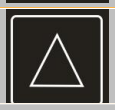
Press key  to enter the password.

If the password is correct, enter different operations according to the password.

If the password is incorrect, 1 is displayed as the primary message and “error” is displayed as the secondary message.

3.2 Set parameter definition

Key	Parameter Functions	Code	Type	Setting Range	Factory Default
First-level Parameter					
	Diameter Standard (X Diametr for Two-axes model)	PA-01	LST-100/JIBN	0.100～99.000	50.000
	+ Tolerance set value	PA-02	LST-100/JIBN	0.001～2.000	0.05
	- Tolerance set value	PA-03	LST-100/JIBN	0.001～2.000	0.05
	Counication and address	PA-04	LST-100/JIBN	Ln=LST none Lo=LSTodd Le=LST even Rn=Modbus RTU none Ro=Modbus RTU odd Re=Modbus RTU even	RN
	Baud rate	PA-05	LST-100/JIBN	2400、4800、9600、19200、38400	9600
	Y diameter setting	PA-06	LST-100/JIIBN	0.100～99.000	50.000
	Y+ tolerance set value	PA-07	LST-100/JIIBN	0.001～2.000	0.05
	Y- tolerance set value	PA-08	LST-100/JIIBN	0.001～2.000	0.05
	Y axis counication, address	PA-09	LST-100/JIIBN	Ln=LST none Lo=LSTodd Le=LST even Rn=Modbus RTU none Ro=Modbus RTU odd Re=Modbus RTU even	RN
	Y-axis baud rate	PA-10	LST-100/JIIBN	2400、4800、9600、19200、38400	9600
Level 2 Parameter Password: 66666					
	P values	PA-11	LST-100/JIBN	0～200	24
	I values	PA-12	LST-100/JIBN	0～200	16
	Sampling frequency	PA-13	LST-100/JIBN	1～4000	20

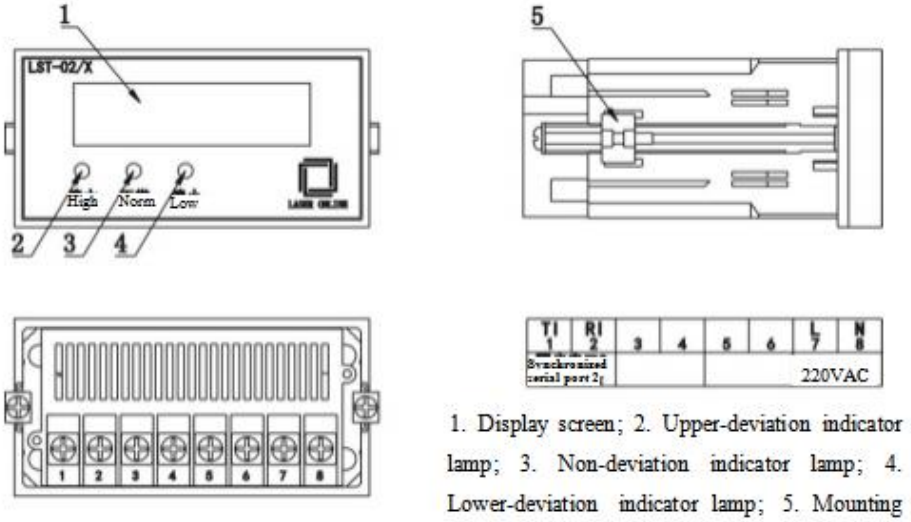
	Main display selection	PA-14	LST-100/JIBN	0=Deviation 1=Location value 2=Other values	0
	Secondary display selection	PA-15	LST-100/JIBN	0=Mean diameter value 1=Mean deviation 2=Other values 3=X axis diameter 4=Y axis diameter 5=X axis deviation 6=Y axis deviation 7=X axis position 8=Y axis position	1
	Alarm input	PA-16	LST-100/JIBN	0=OFF 1=ON	0
	Enter any key	PA-17	LST-100/JIBN		
Level 3 Parameter Password: 32768					
	Shrinkage ratio	PA-18	LST-100/JIBN	0.000～2.047	1.024
	X diameter fine tuning	PA-19	LST-100/JIBN	0～0.250	0.1
	Y diameter fine tuning	PA-20	LST-100/JIBN	0～0.250	0.1
	Detection time parameter	PA-21	LST-100/JIBN	/	/
	Detection time parameter	PA-22	LST-100/JIBN	/	/
	Other Output Settings	PA-23	LST-100/JIBN	/	/
	Polarity is se	PA-24	LST-100/JIBN	/	/
	Packet output	PA-25	LST-100/JIBN	/	/
	Decimal number	PA-16	LST-100/JIBN	/	/

	Measuring type	PA-27	LST-100/JIBN	/	/
	Measurement model	PA-28	LST-100/JIBN	0=Solid measurement 1=Glass measurement 2=Position measurement	0
	The factory default	PA-29	LST-100/JIBN	/	/
Function keys					
	Automatic indicator light	The indicator light is on and the control is on			
	Automatic indicator light	The indicator is off, and the is off			
	The rise in key	Parameter Settings add key			
	Reduce the key	Parameter Setting Reduction key （directly press this key initially and enter the password to directly enter the second and third parameter ）			
	Data modification confirmation	Save or exit parameter modification. The start button is used to measure runout when measuring runout。			

Ⅳ. LST Remote Display

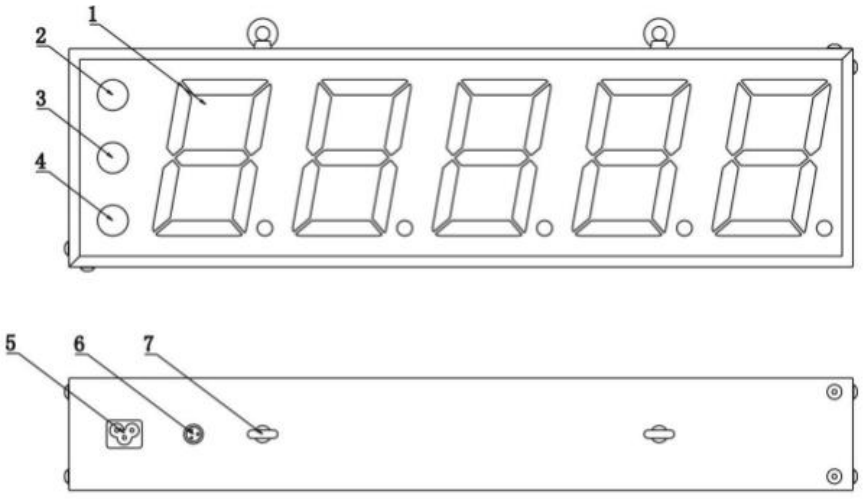
Remote display is used for long-distance displaying. The user can choose two models such as: LST-02/X or LST-03/X. Remote display is connected with diameter measuring instrument through wiring terminal （LST-02/X） or aviation plug （LST-03/X）. The transmission distance could reach 200m. The connecting line is provided by the user.

Connection type: according to the table 2



1. Display screen; 2. Upper-deviation indicator lamp; 3. Non-deviation indicator lamp; 4. Lower-deviation indicator lamp; 5. Mounting bracket

Fig. 4 (a) LST-02/X



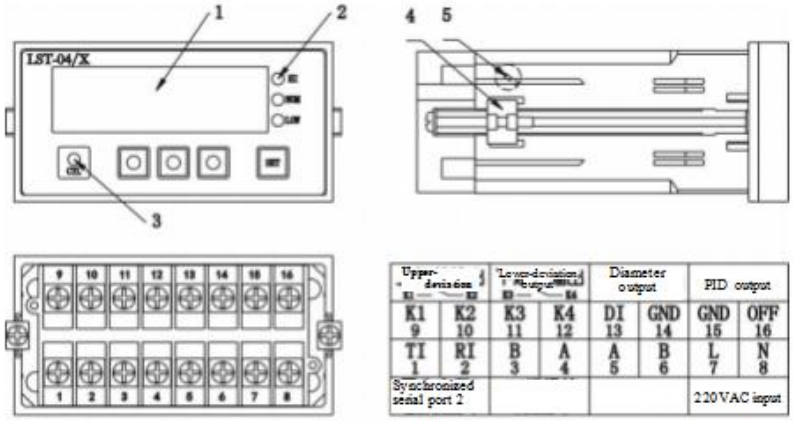
1. Display screen; 2. Upper-deviation indicator lamp; 3. None-deviation indicator lamp; 4. Lower-deviation indicator lamp; 5. 220V power; 6. Synchronized serial port 2 (connecting and measuring head); 7. Display hook

V. LST Remote Controller

LST series of remote controller is connected with diameter measuring instrument through synchronized serial port 2. The crew speed of plastic extruding machine revolving speed is controlled according to the measured wire and nominal value, so that the actual wire diameter may approach nominal value. That is, outer diameter automatic is realized to keep consistency of wire diameter. The user can choose two models such as: LST-04/X or LST-05/X according to different hole sizes.

5.1 LST-04/X

5.1.1 Function layout



Upper-deviation		Lower-deviation		Diameter output		PID output	
K1 9	K2 10	K3 11	K4 12	DI 13	GND 14	GND 15	OFF 16
TI 1	RI 2	B 3	A 4	A 5	B 6	L 7	N 8
Synchronized serial port 2						220VAC input	

a. 1. Display screen; 2. Alarm indicator lamp; 3. Input indicator lamp; put impedance of 100 Ω.

b. 4. Mounting bracket; 5 Output setting

c. Deviation /PID quantity: ±0.2V~2.3V adjustable, adjusted to ± 2V before delivery.

d. Out of tolerance alarm: relay output.

e. Synchronous serial port 2: The remote controller must be connected according to Table 2.

f. RS485 counication （connected to measuring head）: according to Table 3,4 connect to port A, 3 connect to port B, when 485 counication is needed.

g. RS485 counication port （connecting to PC） : 5 connects to port A, 6 connects to port B.

5.1.2Parameter setting

1) Power on: Press the shift key to enter the specified modified parameters.For example, the parameter " " can be displayed as" " "by pressing the shift key once.Similarly, the parameter " " should press the double shift key.

2) Enter the parameter modification state: after completing the previous step, press the setting key to enter the parameter modification state. At this time, the lowest digital tube indicator in the display window flashes.In this state, pressing the shift key will move the blinking nixie tube forward one bit.

3) Parameter setting: Press the plus or subtraction key to modify the size of the parameter. When the lowest nixie tube flickers, press the plus or subtraction key to add or subtract 1. If the flicker moves forward, press the plus or subtraction key to change the parameter to add or subtract 10 or 100.

4) Parameter storage: press the set key for 2 seconds to save the parameter and exit the parameter modification state.

Code	Function	Model	Setting range	Factory value
	Display window option	One axis	0: Digital tube display diameter value; 1: Digital tube display deviation value; 2: Digital tube display runout value	0
	PID output selection		0：PID output 1：Deviation output	0
	Diameter analog output ratio		0~2.000	1.000
	PID output is set to zero		-999~999	0

5.2 LST-05/X

5.2.1 Function layout

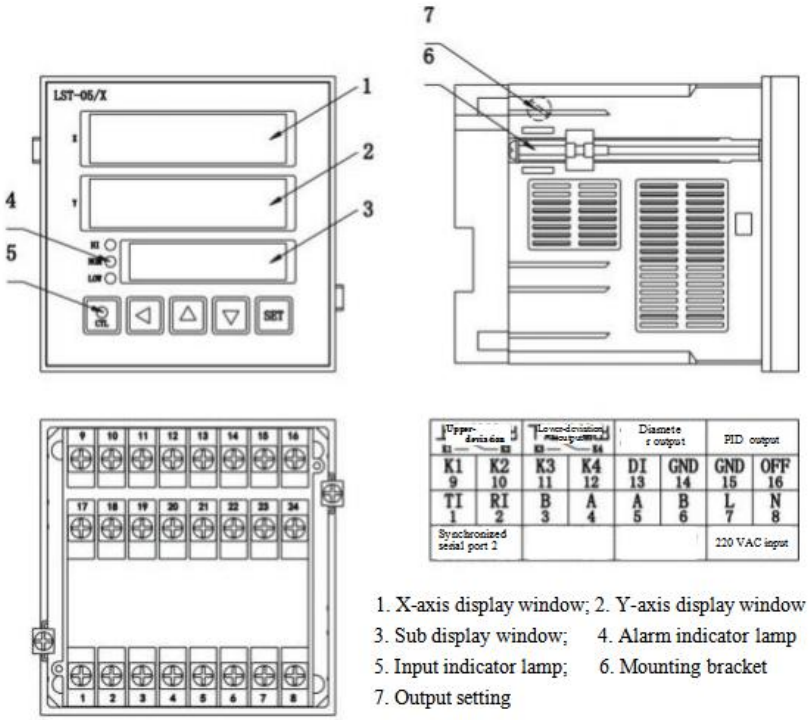


Fig. 5 (b) LST-05/X

a. Analog output: two independent 12 bit D/A output （photoelectric isolation）, output impedance of 100 Ω.

b. Diameter: 0~10V （10V corresponds to full scale）.

c. Deviation /PID quantity: ±0.2V~2.3V adjustable, adjusted to ± 2V before delivery.

d. Out of tolerance alarm: relay output.

e. Synchronous serial port 2: The remote controller must be connected according to Table 2.

f. RS485 counication （connected to measuring head）: according to Table 3,4 connect to port A, 3 connect to port B, when 485 counication is needed.

g. RS485 counication port （connecting to PC） : 5 connects to port A, 6 connects to port B.

5.1.2Parameter setting

1) Power on: Press the shift key to enter the specified modified parameters.For example, the parameter "  " can be displayed as"  "by pressing the shift key once.Similarly, the parameter "  " should press the double shift key.

2) Enter the parameter modification state: after completing the previous step, press the setting key to enter the parameter modification state. At this time, the lowest digital tube indicator in the display window flashes.In this state, pressing the shift key will move the blinking nixie tube forward one bit.

3) Parameter setting: Press the plus or subtraction key to modify the size of the parameter. When the lowest nixie tube flickers, press the plus or subtraction key to add or subtract 1. If the flicker moves forward, press the plus or subtraction key to change the parameter to add or subtract 10 or 100.

4) Parameter storage: press the set key for 2 seconds to save the parameter and exit the parameter modification state.

Code	Function	Model	Setting range	Factory value
	**Display window option**	**One axis**	**0: Digital tube display diameter value;** **1: Digital tube display deviation value;** **2: Digital tube display runout value**	0
	**PID output selection**		**0：PID output** **1：Deviation output**	0
	**Diameter analog output ratio**		**0~2.000**	1.000

	**PID output is set to zero**		**-999~999**	0

Ⅵ. Use of Diameter Measuring Instrument

6.1 Installation

1) Open the package and check whether the instrument and accessories are complete according to the packing list.

2) Install the measuring head on the bracket and tighten the fixed gong nail.

3) Place the measuring head in an appropriate position on the production line, move the bracket, align the cable under test with the center of the groove of the conductor wheel, set the anchor screw, and fix the measuring head on the production line.

4) Loosen the fastening screw, raise and lower the measuring head so that during normal operation the cable touches the bottom of the conductor wheel groove and there is a slight pressure, then tighten the fastening screw.

5) Insert the power cable into the power socket and tighten it, turn on the power, and the instrument will start to work.

6.2.6 Instrument state

* Normal state

1) The main display displays the outer diameter value of the object to be measured, the display range is 1.000 mm ~ 100.000mm;

2) Deviation value of secondary display (position value and runout value can be displayed by modifying parameters);

3) When the outer diameter value is within the allowable tolerance range, indicator  is on, indicating that the cable is normal;

4) When the outer diameter exceeds the upper tolerance, indicator  is on, indicating that the cable is too thick.

5) When the outer diameter exceeds the lower tolerance, indicator  is on, indicating that the cable is too thick.

6) When the automatic feedback control is opened, the indicator  is on, indicating that the feedback is opened;

7) When the automatic feedback control is closed, the indicator  is on, indicating that the feedback is closed;

* Abnormal state

1) When main display displays  , it indicates the password is wrong (check the password is correct or not;

2) When main display displays  , it indicates the communication is wrong (check whether the communication wire is normal);

3) When main display displays  , it indicates the communication is wrong (check whether the communication wire is normal);

4) When main displaydisplays  , it indicates the motor fault (report to the after-sale service personnel).

VII. Communication

Standard asynchronous serial interface is adopted for bus of controller and RS232485 of remote controller. The real-time diameter value can be obtained and internal parameter can be modified through this interface (please refer to the following table).

Data format: 1 start bit, 8 data bits and 1 stop bit. Odd-even check can be selected according to ^3 parameter.

7.1 LST communication format

Standard asynchronous serial interface is adopted for bus of controller and RS232485 of remote controller. The real-time diameter value can be obtained and internal parameter can be modified through this interface (please refer to the following table).

Read parameter: address parameter

Diameter measuring instrument output: address & parameter two bits data and the high-order comes first, CRC is check code.

Write parameter: address & parameter two bits data and the high-order comes first, CRC is check code.

CRC check code is the result value (1 bit) of all bits. 8-bit CRC code of CCITT will be adopted for CRC. Its generator polynomial is $G(x)=X_8 + X_5 + X_4 + 1$.

Example 2: read diameter value

Assuming the address of diameter measuring instrument is 1 (01 H). When the current diameter is 6.234 (185aH), then:

Input: 01H41H

Diameter measuring instrument output is: 01 H 4 1 H 1 8 H 5 a H C R C code

Example 2: read position value

Assuming the address of diameter measuring instrument is 1 (01 H). when the current position value is -05, then:

Input: 01H44H

Diameter measuring instrument output is: 01 H 4 4 H F F H F B H C R C code

Example 3: write reference diameter value

Assuming the address of diameter measuring instrument is 1 (01 H), the reference

diameter value will be changed into 60.00 (1770H), then:

Input: 01H 66H 17H 70H CRC code

CRC calculation example: CRC code

Sending address: sci_txt[0]=01H; sending parameter: sci_txt[1]=41H

Sending data is higher than 8 bits:sci_txt[2]=18H; sending data is lower than 8 bits: sci_txt[3]=5AH. CRC value to be calculated: sci_txt[4]=2AH

Subroutine of Verify_CRC8 is as below:

n: indicates number of bit calculating CRC; crc: indicates initial CRC value; *p: indicates the data address of CRC.

```
unsigned char Verify_Crc8(unsigned char n,unsigned char crc,unsigned char
*p){ unsigned char i,j,crc_buf;
    for(j=0;j<n;j++){
        crc_buf=*p++;
        for(i=0;i<8;i++){
            if (((crc^crc_buf)&0x01)==0){//Lowest bit is the same
                crc>>=1;
            }else{//Lowest bit is not the same
                crc^=0x18;
                crc>>=1;
                crc|=0x80;
            }
            crc_buf>>=1;
        }
    }
    return(crc);
}
```

For reading of other parameters, please observe the table

Read parameter	Write parameter	Attribute	Register name	Data format and scope
0X41	------	Read	Read diameter	Average diameter value of two axes model
0X42	------	Read	Read X diameter	X diameter of two axes model
0X43	------	Read	Read Y diameter	Y diameter of two axes model
0X44	------	Read	Read position	-100-100
0X45	------	Read	Read Y position	-100-100
0X46	0X66	Read Write	X Diameter	Range and units depend on model number
0X47	0X67	Read Write	X+ deviation	Range and units depend on model number

0X48	0X68	Read Write	X- deviation	Range and units depend on model number
0X49	0X69	Read Write	Downward shows	0= Average diameter (one axis), average XY Average diameter (two axes) 1= position value (one axis),XY mean deviation value (two axes) 2= Other values 3=X diameter, 4=Y diameter 5 is the X-axis deviation, 6 is the Y-axis deviation 7=X position, 8=Y position
0X4A	0X6A	Read Write	Upward shows	Downward shows
0X4B	0X6B	Read Write	Sampling frequency	1～4000
0X4C	0X6C	Read Write	P values	0～200
0X4D	0X6D	Read Write	I values	0～200
0X4E	0X6E	Read Write	PID output	-2048～2047，Binary code-
0X4F	0X6F	Read Write	Y-axis reference diameter	Range and units depend on model number
0X50	0X70	Read Write	Y+ deviation	Range and units depend on model number
0X51	0X71	Read Write	Y- deviation	Range and units depend on model number
0X52	OX72	Read Write	Shrinkage	The ratio of the measured value to the actual value
0X53	-----	Read	Other measurements	Including runout value, minimum value, ellipticity, concave-convex number, etc
0X54	OX74	Read Write	Alarm output selection	Bit0:1=Upper tolerance alarm, Bit1:1=Lower tolerance alarm Bit4:1=Fault alarm，B it5:1=Feedback saturation alarm Bit6:1=Empty alarm， Bit7:1=Warning keep
0X55	OX75	Read Write	Communication format address1	Bit6-0:Correspondence address 0～99 Bit10-8:Communication format 0～5
0X56	OX76	Read Write	Communication baud rate1	0=2400，1=4800，2=9600 3=19200，4=38400
0X57	OX77	Read Write	Communication format address2	Address with communication format1
0X58	OX78	Read Write	Communication baud rate2	With the baud rate1

0X5A	OX7A	Read Write	Testing time	Duration of measurement
0X5E	OX7E	Read Write	Measurement model	0=Standard measurement， 1=position measurement， 2=maximum
0X5F	OX7F	Read Write	Resolution	0=0.01mm, 1=0.001mm 2=0.0001mm, 3=Inch
0X60	OX80	Read Write	Measuring type	One axis： 0=Measure the outside diameter， 1=Measured runout value 2=Maximum and minimum values，3=Bump detection Two axes： 0=Measure the outside diameter， 1=Measuring ellipticity 2=Measurement of ellipticity， 3=Bump detection
0X61	OX81	Read Write	Other output options	Bit0:1= Open any key Bit1:1=XY Separate set Bit2:1=PIDReverse output Bit3:1=Packet output
0X62	0X82	Read Write	Revised	Bit7-0:0～200 X Revised Bit15-8:0～200 Y Revised
------	0XC8	Write	Alarm reset	Write0x0044
------	0XC9	Write	Feedback switch	0X0055=Stop，0X0066=Open
------	0XCC	Write	Detection of start	Write0x0077Testing began(When the measurement type is greater than 0)

7.2 MODBUS RTU communication format

Asynchronous serial port is adopted for bus of controller and RS232/485 of remote controller.For communication, the master device on the bus of RS-485 firstly sends out order. When the communication order is sent to the instrument, the equipment meeting corresponding address code will receive the communication order. If there is no error, it will execute the corresponding task and send the execution result to the sender. The returned information includes: address code, function codes of execution action, the data and wrong check code (CRC) after execution action. If there is no error, it will not send any information.

7.2.1 Information frame format

START	initial structure	delay (transmission time with ≥3.5 bit)
ADDR	address code	1 byte (8 bits)
CS	function code	1 byte (8 bits)
DATA	data area	N byte (N×8 bits)
CRC	Wrong check	2 bytes (16 bits)
END	end structure	delay (transmission time with ≥3.5 bit)

7.2.2 Initial and end structure

Initial structure symbolizes the beginning of a data frame while the end structure symbolizes the ending of a data frame, generated by the sender of data frame. The method: reduce the bus of RS-485 to the transmission time with 3.5 bytes. All data bytes of a data frame should be sent continuously. If the interval with transmission time of 1.5 bytes emerges in certain data frame, it will be abandoned as invalid frame.

At receiving terminal, once the bus idle of 3.5-byte transmission time is detected, it assumes that a new data frame begins. However, during receiving data frame, once the bus idle of 3.5-bytetransmission time is detected, it assumes that the data frame is received. If the bus idle of transmission time with byte larger than 1.5 and smaller than 3.5 during receiving the data frame is detected, the data frame will be abandoned as invalid frame. Then, the next initial structure will restart.

7.2.3 Address code

Address code is the first data byte in information frame sent by the communication every time. Standard Modbus RTU protocol supports slave address code 1-247. Allowable address code range of LST-XXJ outer diameter measuring instrument is 01-6F. It can be set through panel of instrument. For setting methods, please refer to the section 3.4.

7.2.4 Function code

Function code is the first data byte in information frame sent by communication every time. The function code defined by Modbus RTU communication protocol is 1- 127 (0x01-0x7F). The following function codes are used for LST-XXJ outer diameter measuring instrument:

03	Read holding register	Read register content with one or many continuous address
06	Write single register	Write first 16-bit data into register

7.2.5 Data area

(1) 03 function (read holding register) data area of request frame includes four bytes:

Byte 3	initial address of register (high byte)
Byte 4	initial address of register (low byte)
Byte 5	quantity of register (high byte)
Byte 6	quantity of register (low byte)
After request order is normally executed, the returned response frame data area includes 2N+1 bytes (N: quantity of register)	
Byte3	number of bytes of follow-up data (=2N)
Byte4-3+2N	N registers' value (high byte comes first, followed by the low byte)

(2) 06 function (write single register) data area of request frame includes four bytes:

Byte 3	register address (high byte)
Byte 4	register address (low byte)
Byte 5	Register value to write (high byte)
Byte 6	Register value to write (low byte)
After the request order is normally executed, the returned response frame data area is completely the same with the request frame.	

7.2.6 Exceptional response frame

If the abnormality occurs to the slave when executing request order, an exceptional response frame will be returned. Its structure is:

START	Initial structure	Delay (transmission time with ≥3.5 bytes)
ADDR	Address code	1 byte, the address of slave
ES	Poor & error code	1byte,=original function code +128 (decimal system) or+80h (hexadecimal)
EC	Exception code	1 byte
CRC	Error checkout	2 bytes (16 bits)
END	End structure	Delay (transmission time with ≥3.5 bytes)
In which poor & error code=original function code = original function code +128 (decimal system) or +80h (hexadecimal). For example, for function request 03, its poor & error code= 83h (hexadecimal). The definition of exception code: 01= function code that is not supported; 02=wrong address of register; 03=data error; 04=execution failure		

7.2.7 CRC check

Modbus RTU communication protocol, CRC is used to control transmission error. Sender calculate CRC codes including address code, function code and data area and sent them by attaching them to the data (CRC code contains two bytes. The low byte shall be firstly sent). The receiver shall recalculate CRC check code after receiving the data frame, and compare it with the received one. If equivalent, the data frame is valid. Conversely, if not equivalent, it assumes that the data frame is invalid.

Calculation method of CRC: preset 1 16-bit register, and then calculate continuous 8 bytes in the message. Note: only 8 data bits in character participates in calculation of generated CRC. Start bit, stop bit and odd-even check bit don't participate in calculation of CRC. During generation of CRC, every 8-bit character is different from the value in register, then move the result to the direction of LSB by one bit while MSB position is zeroed. Then, extract and check LSB: if LSB=1, conduct exclusive-or calculation of value in register with a fixed prevalue (binary system 1010 0000 0000 0001 or hexadecimal: A001h). If LSB=0, don't conduct it. This process will be repeated until 8 times' shift is executed (one byte). After last times' (8^{th} times) shift and related operations are completed, the next exclusive-or calculation of 8-bit byte with the current value of register will be implemented. Then, repeat it for 8 consecutive times like the abovementioned content. When bytes in message are calculated, the final value in register is obtained, namely CRC code. That is, the process of CRC generation is:

(1) Load a 16-bit register into hexadecimal FFFFh (all 1s).Call this a CRC register.

(2) Xor the first 8-bit byte of the message with the lower byte of the 16-bit CRC register, and the result is placed in the CRC register.

(3) Move the CRC register one bit to the right (in the direction of LSB), and fill the highest bit MSB with zero.The lowest LSB was extracted and detected.

(4) If LSB=0: Repeat step (3) to start another shift. If LSB=1: perform xOR operation on CRC register with constant value A001h (1010 0000 0000 0001).

(5) Repeat steps 3 and 4 until 8 shifts are completed.At this point, we are done with the byte.

(6) Repeat Steps 2 to 5 for the next byte in the packet until all packets are processed.

(7) The final content in the CRC register is the CRC check code.

7.2.8 Examples of information frame

Assuming the address of outer diameter measuring instrument (slave) is 01, all data shall be indicated with hexadecimal.

(1) Read measured outer diameter value

Request frame: 01 03 00 61 00 01 d5 d4

Response frame: 01 03 02 XX YY RR RR

In which, XX and YY are high and low bytes of measured outer diameter. RR RR are CRC check codes of 2 bytes. Thereupon concluded: measured outer diameter value= 256×(XX) + (YY). Unit is micronmeter (um).

(2) Read nominal value of outer diameter

Request frame： 01 03 00 65 00 01 94 15

Response frame： 01 03 02 XX YY RR RR

In which, XX and YY are high and low bytes of measured outer diameter. RR RR are CRC check codes of 2 bytes. Thereupon concluded: measured outer diameter value= 256×(XX) + (YY). Unit is micronmeter (um).

(3) Wire nominal value of outer diameter

Requirement: write nominal value of outer diameter=6.000mm= 6000um(hexadecimal=1770h) into the instrument

Request frame ： 01 06 00 65 17 70 97 c1

Response frame ： 01 06 00 65 17 70 97 c1

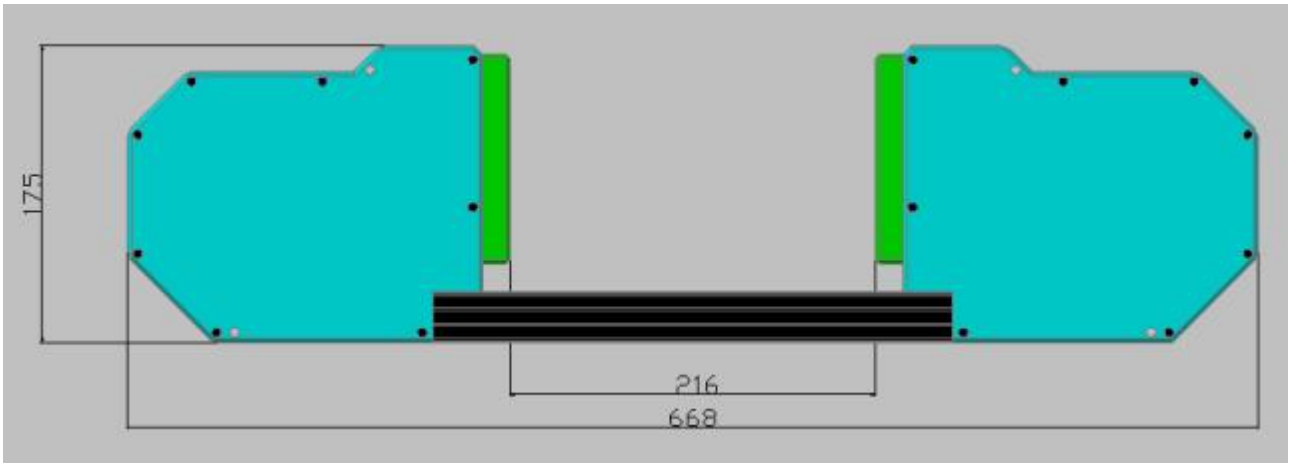
7.2.9 Register address distribution

Address	Combination of address	Attribute	Register name	Data format and scope
0000	------	----	----------	----------
0X01	------	Read	Instrument specification code	0x0019=LST-100JIBN
0X02	------	Read	Software and hardware versions	0x0400
0X03	------	Read	Instrument configuration	0= Transparency, 1= Position, 2= Standard
005A	40091	Read	Equipment state	Bit1-1=No fault， Bit1-99=Fault
005B	40092	Read	Alarm	Bit0:Measurement object is too large， Bit1:Measurement object is too small Bit2:Alarm turned on， Bit3:Feedback control switch on
005C	40093	Read	Other measurements	Including runout value, minimum value, ellipticity, bump number, etc
005D	40094	Read	Feedback control output	-2048～2047， Binary complement
005E	40095	Read	Feedback control state	Bit1-0:00=OFF，±15% of the measured value over the set value. 10=Freezing, instrument failure or no object to be measured 11=ON，Instrument in good working order
005F	40096	Read	Center position	-100-100(The high 8 bits are in the Y position and the low 8 bits are in the X position)
0061	40098	Read	Actual measurement of diameter value	Average of XY in two axes
0062	40099	Read	Instrument operating condition	0=Normal， 1=Error
0063	40100	Read	X measures the diameter	Average of X in two axes
0064	40101	Read	Y Measures the diameter	Average of Y in two axes
0065	40102	Read Write	X axis nominal value	Range and units depend on model number
0066	40103	Read Write	X + tolerance	Range and units depend on model number
0067	40104	Read Write	X - tolerance	Range and units depend on model number
0068	40105	Read Write	Y + tolerance	Range and units depend on model number
0069	40106	Read Write	Y - tolerance	Range and units depend on model number

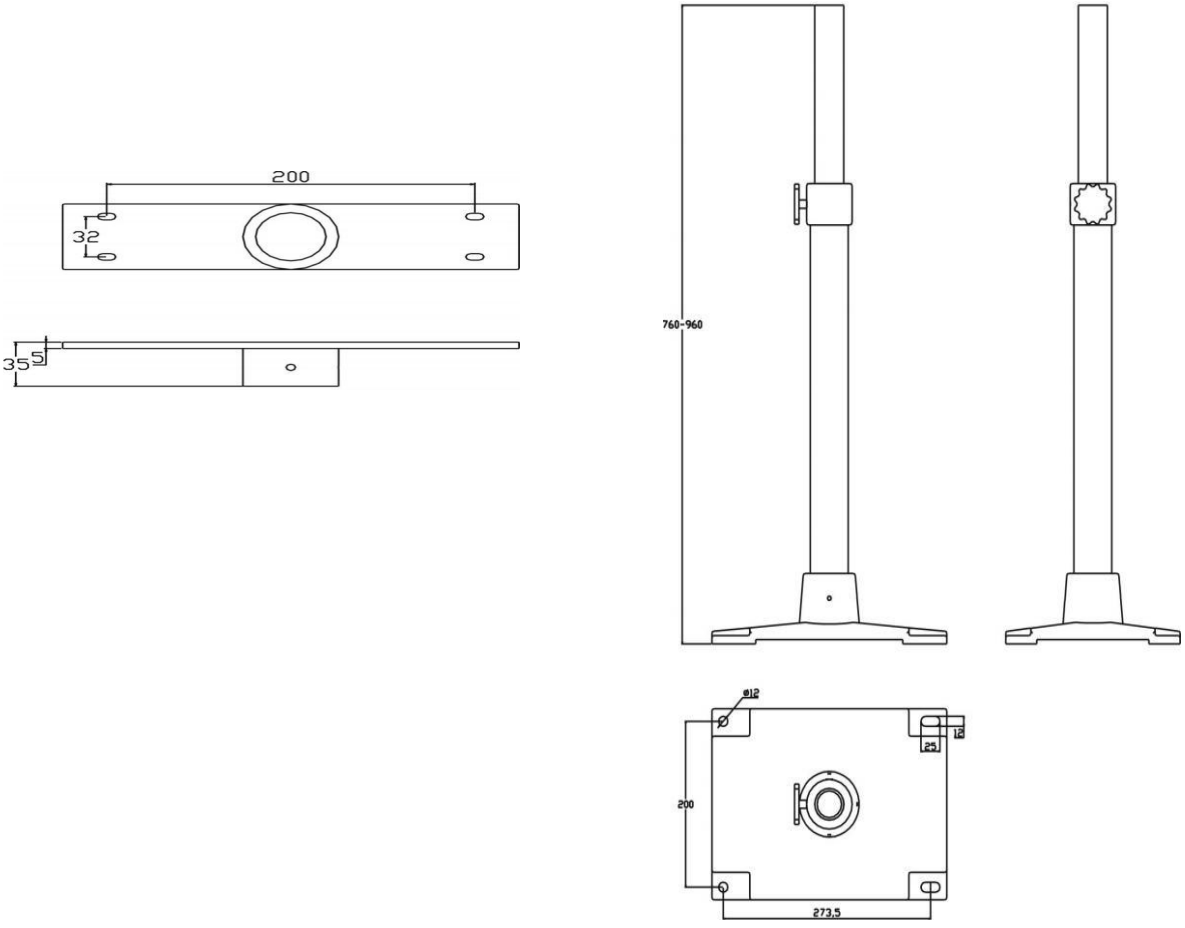
006A	40107	Read Write	Testing time	Duration of measurement
006B	40108	Read Write	Y axis nominal value	Range, unit and model dependent
006C	40109	Read Write	Shrinkage ratio	The ratio of the measured value to the size of the display value
006D	40110	Read Write	Line 2 shows the selection	0= Deviation value (One axis), Average XY diameter (Two axes) 1= Position value (One axis),XY deviation value (Two axes) 2= Other measurements 3=X-axis diameter, 4=Y-axis diameter 5=X-axis deviation, 6=Y-axis deviation 7=X position, 8=Y position
006E	40111	Read Write	Line 1 shows the selection	0= Deviation value (One axis), Average XY diameter (Two axes) 1= Position value (One axis),XY deviation value (Two axes) 2= Other measurements 3=X-axis diameter, 4=Y-axis diameter 5=X-axis deviation, 6=Y-axis deviation 7=X position, 8=Y position
006F	40112	Read Write	Communication format address 1	Bit6-0: communication address 1 0 to 99 Bit10-8: communication format 10 ~ 5
0070	40113	Read Write	Baud rate1	0=2400， 1=4800， 2=9600 3=19200， 4=38400
0071	40114	Read Write	Communication format address 2	Address with communication format1
0072	40115	Read Write	Baud rate2	Same baud rate1
0073	40116	Read Write	Measuring type	One axis: 0= measuring outer diameter value 1= measuring runout value 2= maximum and minimum value 3= bump detection Two axes: 0= measure the outside diameter value 1= measure the ellipticity

				2= elliptic rate measurement 3= bump detection
0074	40117	Read Write	Other output Settings	Bit0:1= Any key open Bit1:1 =XY set separately Bit2:1=PID Reverse output Bit3:1= packet output
0079	40122	Read Write	Ratio	0～200
007A	40123	Read Write	Integral coefficient	0～200
008C	40141	Read Write	Measurement model	0= Standard measurement, 1= Position measurement, 2= Maximum
008D	40142	Read Write	Sampling frequency	1～4000
008E	40143	Read Write	Display resolution	0=0.01mm, 1=0.001mm 2=0.0001mm, 3=Inch
008F	40144	Read Write	Display correction	Bit7-0:0～200 X-axis correction value Bit15-8:0～200 Y-axis correction value
0092	40147	Read Write	Alarm output setting	Bit0:1= Upper difference alarm, bit1:1 = Lower difference alarm Bit4:1= Fault alarm, Bit5:1 = Feedback saturation alarm Bit6:1= Null alarm, bit7:1 = Alarm hold
00C8	40201	Write	Alarm reset	Write0x0044
00C9	40202	Write	Feedback control switch	0X0055=OFF， 0X0066=ON
00CC	40205	Write	Detection start	Write 0x0077 Detection begins (when measurement type is greater than 0)

VIII. Overall Dimensions



Volume: 670×180×60mm



LST-ZJ

IX. Maintenance

1) When using diameter measuring instrument, it is necessary to pay attentions and keep protective lens of light inlet clean. In case of oil stain and dirt, it shall be wiped out with lens paper.

2) When the diameter measuring instrument is used for wire production line, drying treatment shall be done after the wire comes out of the water thank to prevent the precision from being influenced due to the water or water drop on the surface of wire in the measurement zone.

3) The standard rod shall be degreased with gasoline or alcohol and wiped out with lens paper or absorbent cotton before use every time and it shall be coated with rust protection after use.

4) Input voltage of diameter measuring instrument shall be kept within 180~260V.

X. Accessories

a. Power line ---------- 1 piece
b. Standard rod ---------- 1 piece
c. Cleaning ball ---------- 1 piece
d. Lens paper ---------- 1 piece
e. Connecting cable (the length is configured according to the user requirement) ---------- 1 piece
f. Specification ---------- 1 piece
g. Certificate of qualification ---------- 1 piece

XI. After-sale Service

As of the date of shipment, in case of any faults in controller under the circumstance of rational storage and use within one year, our company will provide repair and exchange services. The right to interpret shall be reserved by our company.