



Automatic Voltage Regulator ET-SZ6 Operating Instructions

Shanghai Huaming Power Equipment Co., Ltd.

Thank you for using our Automatic Voltage Regulator

**Please make sure you will read this “Operation Instruction”
carefully before operating this regulator.**

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1. Features

ET-SZ6 series automatic voltage regulator (hereinafter is referred to as ET-SZ6), is applicable to monitor of tap positions and remote transmission of tap position signal. With the functions of manual, automatic and remote control as well as remote control by computer (RTU), it can be used together with the series of CMA7, CMA9 motor drive mechanisms.

The major features are as follows:

- Adopting the large LCD on the interface, on which it can display position, operation counter, signal voltage, and time delay, etc.
- Providing functions of manual, automatic and remote control. Under the manual control mode, the operation of 1-N, N-1, stop of OLTC can be achieved locally
- Converting position signal into remote analog signal (analog:4-20mA)
- Being capable of communicating with RS-485 or RS-232 serial ports so as to take control of action of 1-N, N-1, stop of OLTC.
- Being available for either one or maximum three pieces of controllers, which are connected in parallel, with serial ports under the same communication protocol, identifying by addresses without interfering each other.
- Input mode : Decimal line encoded input.(for details see 6.4 Connection Diagram)

2. Operation conditions

- 2.1 Ambient air temperature is not lower than -20°C and not more than $+40^{\circ}\text{C}$;
- 2.2 Relative air humidity should not exceed 90%;
- 2.3 The height above sea level is not higher than 2500M;
- 2.4 Places without obvious vibration or violent impact;
- 2.5 The surrounding medium can not contain corrosive metal, conductive dust or easily insulation-destroyed gas, and no risk of explosion around;
- 2.6 No erosion by rain or snow;

3. Technical parameters

Assistant power supply : AC220V±10%, 50HZ

Time delay: 10S-199S, adjustable, step length: 1S (default setting: 180S)

Pulse time of operation : 1S-199S, adjustable, step length: 1S

(Default setting is 1S when ET-SZ6 is used with CMA7 or CMA9)

Signal voltage : 80-200V AC, continuously adjustable.

Sensitivity : 1.00%-5.00 %, continuously adjustable, step length: 0.01%

Analog output : current : 4~20mA

Remote signal output : BCD code output with passive contact point

(Contact point capacity: AC250V/5A)

Control output : Passive contact point, capacity: 250V/5A

Position display : 1-35 positions

Operation counter : 0-99999 times

Size : L ×W ×H = 220×102 ×250 (unit: mm)

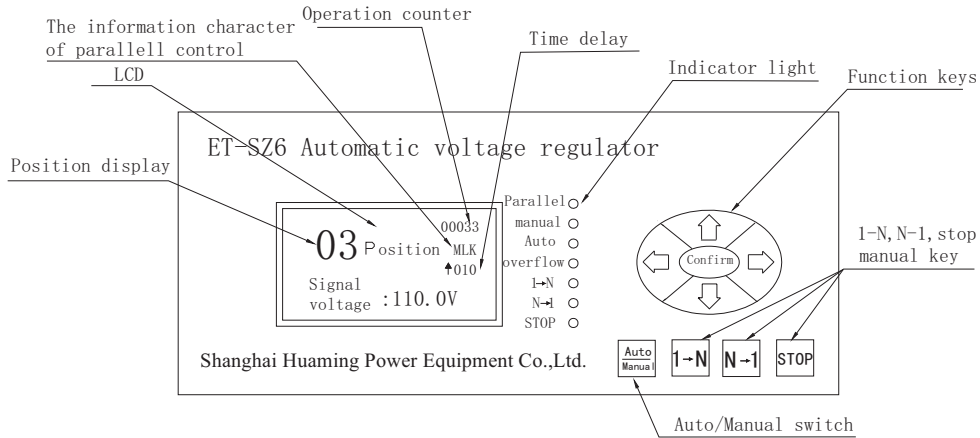
Weight : 2.0 Kg

4. Operation principles

The position signal of OLTC (on-load tap changer) is transmitted into ET-SZ6 through a 19 pins socket, then isolated and sent into CPU for encoding, and then BCD code is output through its passive contact point. The SCM (Single-Chip computer) outputs the digital analog as remote measuring signal after converting position data into digital analog quantity. The CPU proceeds to accumulate operational times and displays it, simultaneously, the signal of position and accumulated operational times are transmitted afar via RS-485 or RS-232 serial ports (9 pins socket). In order to prevent ET-SZ6 from losing the data due to loss of electricity, the SCM stores the operational times into EEPPROM. The remote control signal of RTU (computer) is fed into ET-SZ6 via RS-485 or RS-232 serial ports for the purpose of controlling relays of 1-N, N-1 and stop. The ET-SZ6's signal outputs of 1-N, N-1 and stop are passive contact points, which aim to control the mechanism of OLTC. The communication protocol is in accordance with communication protocol of IEC 870-5-101.

5. Control panel

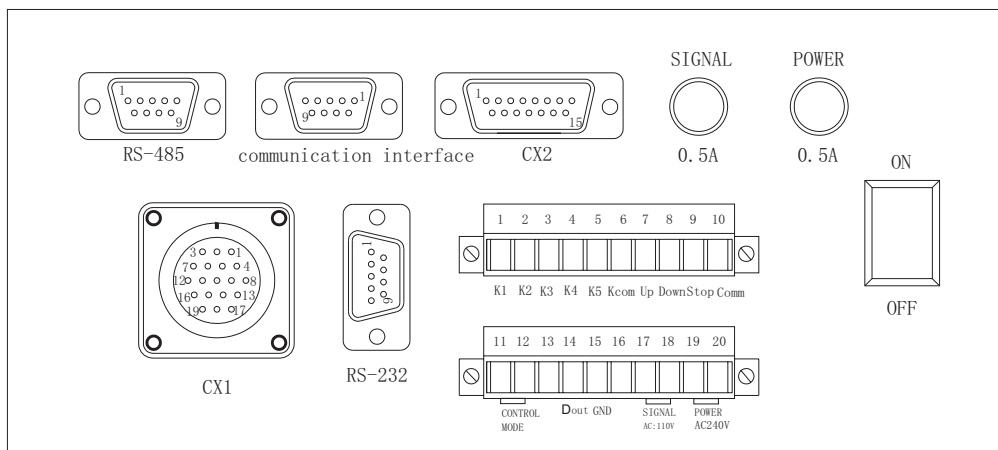
5.1 The diagram of front panel:



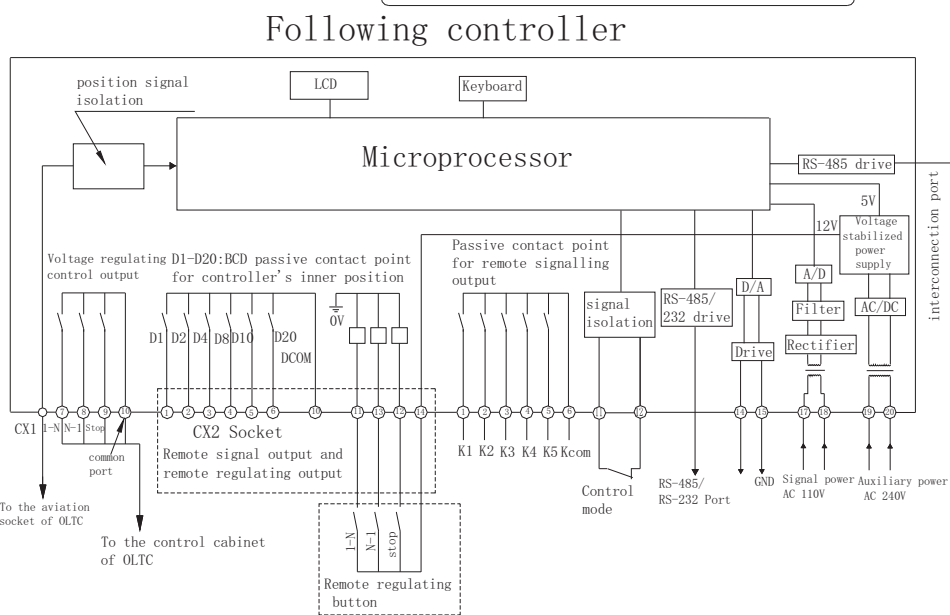
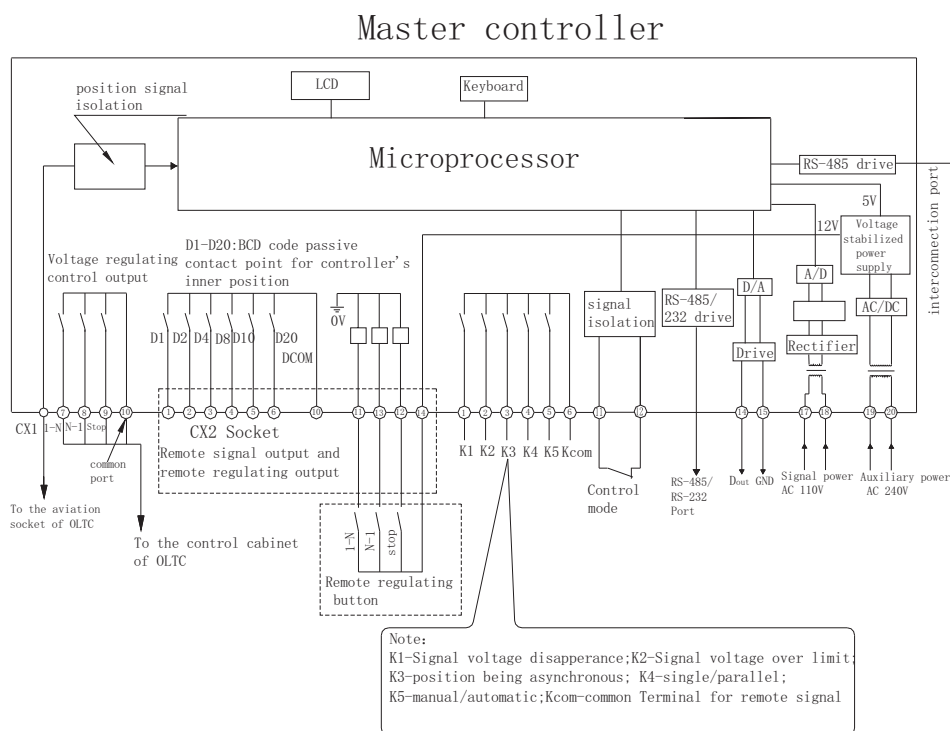
Note : “The information character of parallel control” will appear only in parallel connection control , the meaning of the characters are :

MASTER CONTROLLER	FOLLOWING CONTROLLER
MLK : The parallel connection control is normal	SRD : The communication with the master controller is normal
MNL: The following controller isn't connected.	SNR : The communication with the master controller is abnormal
MNS : The tap position is asynchronous	

5.2 The diagram of the back panel



5.3 The connection diagram of master and following controllers



Note :

D_{OUT}.....The remote measuring output of position

GND.....Analog output

Control options.....Passive contact point input, select the manual control at the breaking of connection at this point, while select auto control at closing. (The above operation will effect only when the option is “External”)

Interconnection port..... Used for exchanging the information when one ET-SZ6 is

connected with another one in parallel.

Signal voltage..... Connected to the voltage signal.

1-N, N-1, Stop, Common terminal.....Used for control output, and the relays are dead contact. (Capacity: 250V/5A AC)

6. Connection diagram

6.1 The connection diagram CX-1 for positions of OLTC (19 pins socket)

19 pins socket serial Number	Explanations	Remarks
CX— 1	Tap changer position 1	Connected to the aviation socket of OLTC
CX— 2	Tap changer position 2	
CX— 3	Tap changer position 3	
CX— 4	Tap changer position 4	
CX— 5	Tap changer position 5	
CX— 6	Tap changer position 6	
CX— 7	Tap changer position 7	
CX— 8	Tap changer position 8	
CX— 9	Tap changer position 9	
CX— 10		
CX— 11		
CX— 12	Ten's place of tap changer position 1	
CX— 13	Ten's place of tap changer position 2	
CX— 14		
CX— 15	The common terminal "L" for position display	
CX— 16	The common terminal for operation display	
CX— 17	Running indication signal port for "1-N"	
CX— 18	Running indication signal port for "N-1"	
CX— 19	Running indication signal port for "Stop"	

6.2 The connection diagram of CX2 socket (15 pins sockets) :

15 pins socket No.	Instructions	Remarks
CX2— 1	BCD code (passive contact point): “ 2^0 ”	BCD code output of positions and input of voltage regulating command
CX2— 2	BCD code (passive contact point): “ 2^1 ”	
CX2— 3	BCD code (passive contact point): “ 2^2 ”	
CX2— 4	BCD code (passive contact point): “ 2^3 ”	
CX2— 5	BCD code (passive contact point): “ 10×2^0 ”	
CX2— 6	BCD code (passive contact point): “ 10×2^1 ”	
CX2— 7		
CX2— 8		
CX2— 9		
CX2— 10	Common terminal for BCD code output	
CX2— 11	Port for “1-N” command input	
CX2— 12	Port for “stop” command input	
CX2— 13	Port for “N-1” command input	
CX2— 14	Common terminal for voltage regulating	
CX2— 15		

6.3 The connection diagram of RS-485 :

DB-9	1	2	3	4	5	6	7	8	9
Signal	A	B							

6.4 The connection diagram of the communication interface :

DB-9	1	2	3	4	5	6	7	8	9
Signal	A	B							

Note : When the controllers are connected in parallel, the wires A, B of master and following controllers should be connected respectively, cross connection of wire A and B is not allowed.

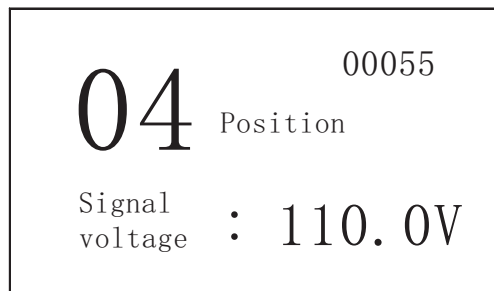
7. Description of operation keys

Caution: the operation keys only can be operated when the position displaying is working properly. Before operating the operation keys, the options of “Control mode”, “Time delay”, “Pulse time”, “Reference voltage” and “Sensitivity” must be pre-set, (the operation mode should also be pre-set under parallel control situation).

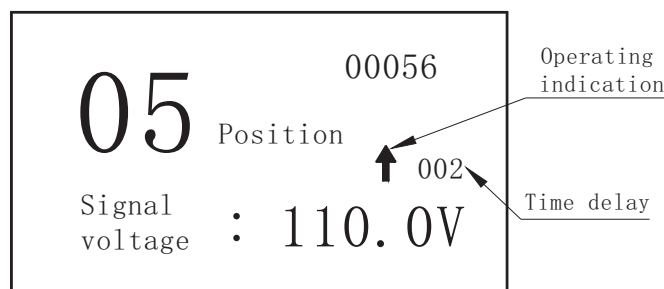
7.1 Manual control :

Use local manual control keys (for details of “1→N”, “N→1”, “Stop” keys see diagram of front panel) to carry out manual control. (The signal voltage will not be in effect under such circumstance) .

7.1.1 Turn on power switch; the LCD will display the operation controller as shown below.



7.1.2 Press the “1→N” key in the mode of manual control (the LED indicator light is on, which is set by function keys, for more detail see 8), the indicator light of “↑” will be on, and the OLTC will raise its position to next one (shown as below)



7.1.3 Press “N→1” key, the indicating light “↓” will be on; the LOT will lower its position to next one.

7.1.4 In the process of operation of 1-N or N-1, the OLTC will stop raising or lowering the positions in case of pressing button “stop” with the indicating

light flashing, the operating indication above will show as “■”.

7.2 Automatic Control

7.2.1 In the mode of automatic control, ET-SZ6 will compare the signal voltage with the set voltage, once the signal voltage deviates from the set voltage, a control signal of “1-N” or “N-1” will occur (The indicator light for operational controller on LCD flash at the same time), then making the OLTC switch from one tap position to the next one, and realizing the purpose of regulating voltage.

7.2.2 When losing the tap position signal, ET-SA6 will automatically lock the action command of “1-N” and “N-1”, meanwhile, the indicator light for disconnection alarm will be on.

7.2.3 ET-SZ6 will send out a quick-lowering command once the ratio of signal voltage and reference voltage exceeds 110%, accompanied by the lighting of indicator light for over voltage; while ET-SZ6 will lock operation as the ratio falls below 70%, accompanied by the lighting of indicator light for disconnection alarm.

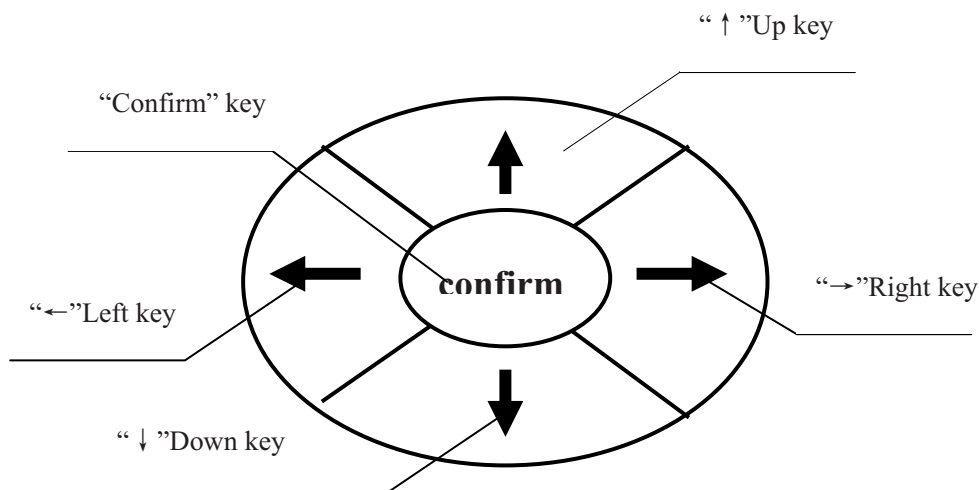
7.3 Remote Control:

The remote control consists of passive contact point control and serial ports control, the RS-485 or RS-232 serial ports adopt the method of bus communication, and the communication protocol is in accordance with IEC870-5-101, with function of return proofreading. (For communication protocol see appendix).

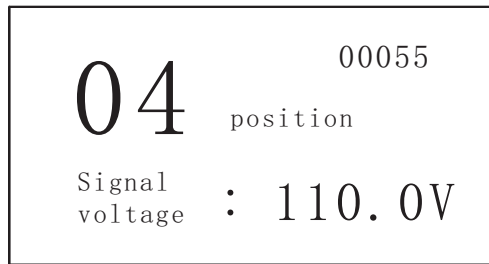
Note: Manual control and remote control are valid in the mode of manual control.

8. Description of function keys

1. Names of function keys:

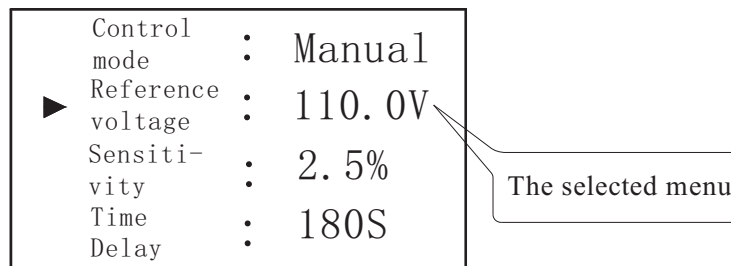


2. Main menu on LCD:

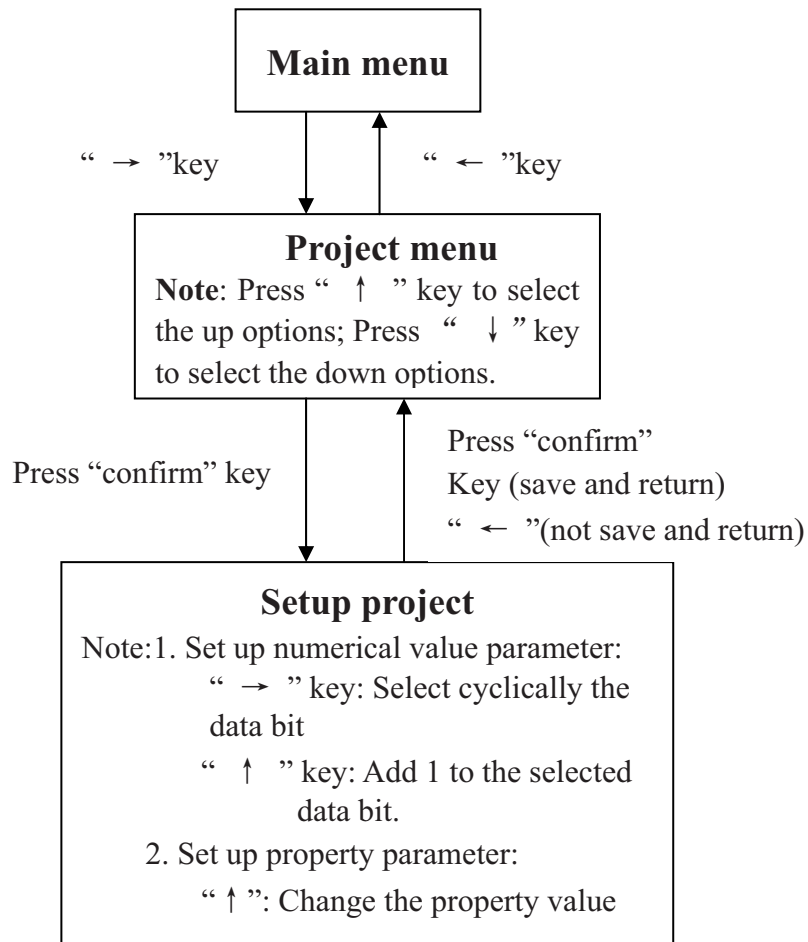


04 --tap position signal; 00055—operation counter; signal voltage-110.0V

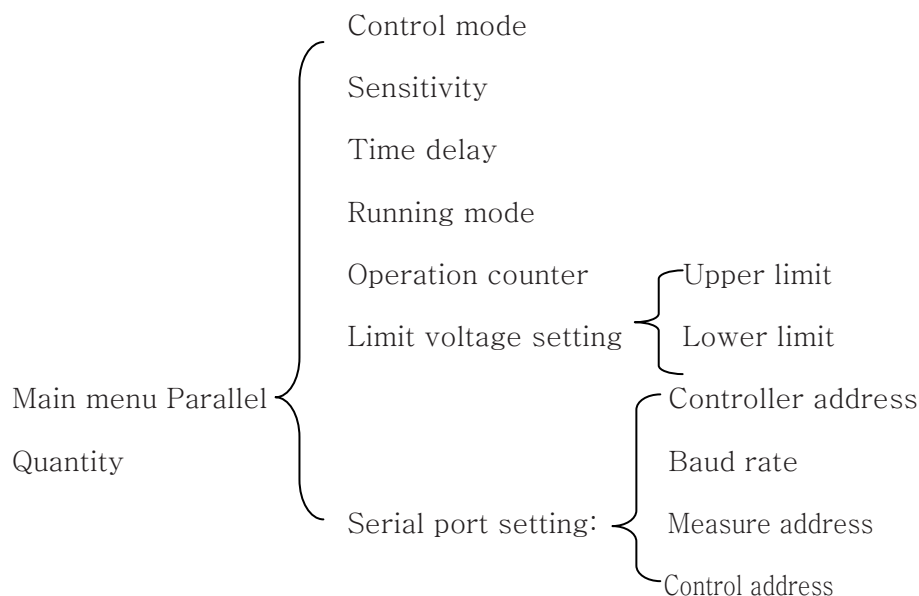
3. Setting menu on LCD : (Example)



4. General operational sequence of the function keys:



5. The structure diagram of menu:



6. Description of menu :

Remarks: The following functions such as “Reference voltage”, “Sensitivity” and “Time delay” are valid in the mode of automatic control.

6.1 Control mode: This option is composed of four control modes; they are “Panel” control and “External” control, and other two control ways—manual control and automatic control. In the mode of “Panel” control. Press keys on front panel to switch between manual and automatic control; while in the mode of “External”, Press switch outside to change over between manual and automatic control.

6.2 Reference voltage: In the mode of automatic control, ET-SZ6 will compare the signal voltage with reference voltage, if the signal voltage deviates from the scope of the pre-set value of sensitivity, the controller will adjust the tap positions of OLTC, keeping the signal voltage within permissible range.

6.3 Sensitivity: It limits the signal voltage, including upper limit voltage and lower limit voltage. Which are calculated by following formula:

$$\text{Upper limit voltage} = \text{Reference voltage} + \text{reference voltage} \times \text{Sensitivity}$$

$$\text{Lower limit voltage} = \text{Reference voltage} - \text{reference voltage} \times \text{Sensitivity}$$

For Example: User' Reference voltage is 400V, the Sensitivity is 2.5%.

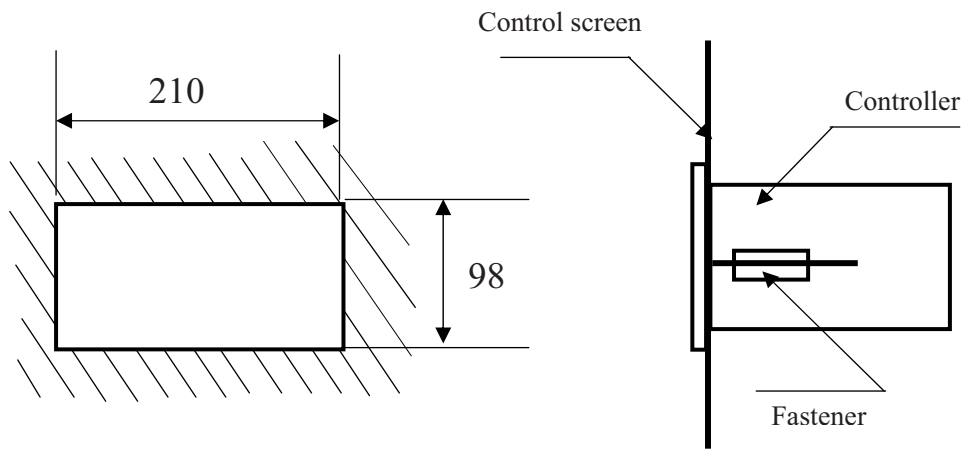
$$\text{Then: Upper limit voltage} = 400\text{V} + 400\text{V} \times 2.5\% = 410\text{V}$$

$$\text{Lower limit voltage} = 400\text{V} - 400\text{V} \times 2.5\% = 390\text{V}$$

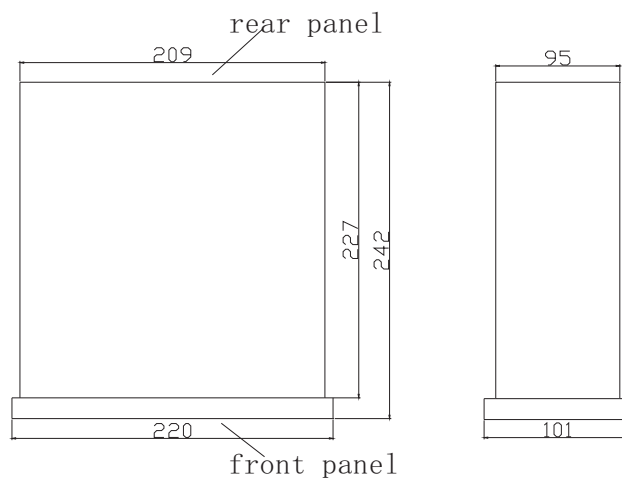
6.4 Time delay: 10~199S

- 6.5 Parallel quantity: When connected in parallel, the quantities of controllers including the master controller must be set correctly.
- 6.6 Running mode: There are four running modes including “master”, “independent”, “follow 1”, and “follow 2”. One ET-SZ6 will be set as master controller when the transformers are running in parallel, others as following ones, which must be set in sequence starting from “follow 1”, then, the master unit will take control of the following units.
- 6.7 Operation counter: This option provides function of setting the operational times when the controller is used for the first time.
- 6.8 Limit voltage setting: This option is used for setting upper limit voltage and lower limit voltage, of which both actuates the alarm of limit voltages.
- 6.9 Controller address: Refer to the exclusive serial number for identifying this controller in RS-485 or RS-232 serial port communication network.
- 6.10 Baud rate: RS-485 or RS-232 serial port communication ranges over 600bit/s, 1200bit/s, 2400bit/s and 4800bit/s.
- 6.11 Remote measure address: Refer to RS-485 or RS-232 serial port communication protocol.
- 6.12 Remote control address: Refer to RS-485 or RS-232 serial port communication protocol.

9. Installation and dimension diagram (Unit: mm)



1. Installation diagram



2. Dimension diagram

10.RS-485 communication protocol (IEC870-5-101)

10.1 REPERTOIRE:

- a) Links S1 (ask / no answer)
Emendation time broadcast
- b) Links S2 (send / confirm)
Load working parameter
- c) Links S3 (application / answer)
Application: Request user data class 1
Answer: Requested data not available
Remote measuring data (step number)
Remote information data

10.2 TRANSMISSION RULES:

- a) Character format:
 - 1 Start bit
 - 8 Data bits
 - 1 Stop bit for no parity
- b) Format
Figure shows the two frame formats in IEC870-101 format class FT 1.2

i. Frame with fixed length

Start	10H
Control field	C
Address field	A
Checksum	CS
End	16H

ii. Frame with variable length

L	}	Start	68H
		Length	L
		Repeat length	L
		Start	68H
		Control field	C
		Address field	A
		Links user data (variable length)	*
		Checksum	CS
		End	16H

Length (L): including control field (C), address field (A), user data, frame length= (L) + 6

Address field (A): range 00~0FEH, 0FFH = broadcast

Checksum (CS): CS = control field + address field + user data (range up to 255 octets have to be a parameter.)

Control field (C)

Master station→Primary station

0	1	0	0	Function code	
				0	Reset remote link
				1	Reset of user process
				3	Data transmission(S2)
				4	Data transmission(S1)
				9	Request status of link
				10	Request user data class 1
				11	Request user data class 2

Primary station→Master station

1	0	1	0	Function code	
				0	affirm
				1	Link busy
				8	User data response
				9	Requested data not available
				11	Status of link or access demand

c) Links user data (application layer)

Data unit	Data unit type	Type identification	
		Variable qualifier	structure
		Cause of transmission	
		Application layer address	
		Information objects address	
		Information objects element	
		Time by Information objects	

Type identification

Master station→Primary station

- <46> 02EH: = remote control (remote regulate)
- <103> 067H: = emendation time command
- <110> 06EH: = loading parameter
- <122> 07AH: = convene fixed data command
- <123> 07BH: = amend fixed data command
- <124> 07CH: =confirm fixed data command
- <125> 07DH: =convene RAM data
- <127> 07FH: =amend RAM data

Primary station→Master station

- <1> 001H: = single status YX (remote information) without time identification
- <2> 002H: = single status YX (remote information) with time identification

- <3> 003H: = double status YX (remote information) without time identification
- <4> 004H: = double status YX (remote information) with time identification
- <9> 009H: = YC (remote measure)
- <15> 00FH: = YM (remote pulse)
- <17> 011H: = protection event
- <122> 07AH: = up-transmission fixed data
- <123> 07BH: = fixed data return check
- <126> 07EH: = up-transmission RAM data

Variable structure qualifier

SQ	Information elements counts (0~127)
----	-------------------------------------

SQ = 0 addressing of non sequence information elements

SQ = 1 sequence of information elements

Cause of transmission

- <1>: = periodic, cyclic
- <3>: = spontaneous (remote measure, remote information)
- <6>: = activation (remote control)
- <7>: = activation confirmation
- <8>: = deactivation
- <10>: = activation termination

Application layer address:

Is links address field (A) in general condition, application layer 1~254 is broadcasting.

Information objects:

Information objects consist of information object address, information elements and time identification.

Information objects address has 16 bits, with low byte former and high byte latter. Information object address of remote information (YX), remote measuring (YC), and controlling can be fixed by convening and amending RAM, with detailed relevant addresses as follows:

RAM data address 7F00H: Remote measure (YC) high byte address

RAM data address 7F01H: Remote measure (YC) low byte address

RAM data address 7F02H: Remote control/regulate (YK) high byte address

RAM data address 7F03H: Remote control/regulate (YK) low byte address

Information objects address can be fixed as 1010H when amending RAM data.

Information objects data:

Remote measure (YC):

D7	D6	D5	D4	D3	D2	D1	D0
S	D14	D13	D12	D11	D10	D9	D8

S=0 YC>0 Example: YC = 0200H (+ 512)

S=1 YC<0 complement YC = FE00H (-512)

YC data available should be 11 bits in this protocol.

Remote information (YX):

YX7	YX6	YX5	YX4	YX3	YX2	YX1	YX0
-----	-----	-----	-----	-----	-----	-----	-----

Remote control /regulate (YK)

S(select)/E(execute)	QU	DCS/RCS
----------------------	----	---------

S/E = 0 select

= 1 execute

QU = 1 short pulse

= 2 long pulse

DCS/RCS = 00H not allowed

=01H Trip (fall)

=02H Close (rise)

=03H not allowed

10.3 EXAMPL

10.3.1 Request status of link

10H	Start byte
49H	Control field
01H	Links address
4AH	Check sum
16H	End byte

Links normal

10H	Start byte
ABH	Control field
01H	Links address
ACH	Check sum
16H	End byte

10.3.2 Request user data class 1 sequence of remote measure (801H) =000BH, (802H) =002CH

10H	Start byte
4AH	Control field
01H	Links address
4BH	Check sum
16H	End byte

68H	Start byte
0EH	L
0EH	L
68H	Start byte
A8H	Control field
01H	Links address
09H	Type identification
82H	Variable structure qualifier
01H	Cause of transmission
01H	Application layer address
01H	Information object address
08H	
0BH	YC=000BH
00H	
2CH	YC=000BH
00H	
56H	Check sum
16H	End byte

3.3 remote control command

control address(201H) step rise select

68H	Start byte
09H	L
09H	L
68H	Start byte
43H	Control field
01H	Links address
2EH	Type identification
01H	Variable structure qualifier
06H	Cause of transmission
01H	Application layer address
01H	Information object address
02H	
8AH	S/E QU DCS/RCS
07H	Check sum
16H	End byte

remote control return check

68H	Start byte
09H	L
09H	L
68H	Start byte
80H	Control field
01H	Links address
2EH	Type identification
01H	Variable structure qualifier
07H	Cause of transmission
01H	Application layer address
01H	Information object address
02H	
8AH	S/E QU DCS/RCS
44H	Check sum
16H	End byte

Note: S/E QU DCS/ ---8AH rise (close) select
 ---89H down (open) select

Control address (201H) step rise execute

68H	Start byte
09H	L
09H	L
68H	Start byte
43H	Control field
01H	Links address
2EH	Type identification
01H	Variable structure qualifier
06H	Cause of transmission
01H	Application layer address
01H	Information object address
02H	
0AH	S/E QU DCS/RCS
87H	Check sum
16H	End byte

Note: S/E QU DCS/ — 0AH rise (close) execute
 — 09H down (open) execute

3.4 Convene / amend RAM data

Convene RAM data

68H	Start byte
0CH	L
0CH	L
68H	Start byte
4AH	Control field
01H	Links address
7DH	Type identification
01H	Variable structure qualifier
06H	Cause of transmission
01H	Application layer address
10H	Information object address
10H	
00H	Begin address
7FH	
MH	RAM data length <7
00H	
XH	Check sum
16H	End byte

up-transmission RAM data

68H	Start byte
NH	L
NH	L
68H	Start byte
88H	Control field
01H	Links address
7EH	Type identification
01H	Variable structure qualifier
07H	Cause of transmission
01H	Application layer address
10H	Information object address
10H	
00H	Begin address
7FH	
MH	RAM data length<7
...	RAM data
XH	Check sum
16H	End byte

Amend RAM data

68H	Start byte
NH	L
NH	L
68H	Start byte
44H	Control field
01H	Links address
7FH	Type identification
01H	Variable structure qualifier
06H	Cause of transmission
01H	Application layer address
10H	Information object address
10H	
00H	Begin address
7FH	
MH	RAM data length <7
...	RAM data
XH	Check sum
16H	End byte

7F00H	Remote measure (YC)	high byte address
7F01H	Remote measure (YC)	low byte address
7F02H	Remote control (YK)	high byte address
7F03H	Remote control (YK)	low byte address

RAM address mean of RAM data

Default setting :

Information object of remote measure (YC) = 0801H (step number) ; (YC)=802H (action number)

Information object of remote control (YK) = 0201H



Shanghai Huaming Power Equipment Co., Ltd.

Address: No. 977 Tongpu Road, Shanghai 200333, China

Tel/Fax: (86) 21 - 5270 2715

Web Site: www.huaming.com

E-mail: public@huaming.com

export@huaming.com