

# **ST10 Digital**

## **Single Phase All Control Rectifier Trigger Regulator**

(Close Loop Constant Voltage And Constant Current Control)

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**● Safety regulations and notes before operation:****>> Safety regulations:**

- The wrong use may cause permanent damage to the product or serious personal accidents. Therefore, the operating procedures must strictly follow the user manual, National and industry standards and safety regulations.
- The installation, maintenance or guidance installation, maintenance control devices should be charged by professional and technical person with relevant experience.
- Under no circumstances can you plug out the wiring or try to touch the contacts in the socket while it is still on power to prevent electric shock and accidents.
- This machine is designed to be used in a cool and dry environment. It needs to maintain a good ventilation and heat dissipation environment. Please do not soak in water or exposing under the sun.
- To work outside the temperature range required by electrical characteristics, clean the control panel regularly.
- Under no circumstances should the control panel be operated beyond the design limit.
- Please strictly follow the instructions for use. For any equipment or personal injury caused by failure to follow these operating instructions, we do not assume any civil and criminal responsibility.
- Trying to repair the damaged control board (regulator) may cause permanent damage to the equipment. If the unit malfunctions, please contact us, we will provide technical support as soon as possible. Please do not attempt to repair the unit all by yourselves.
- This manual can only be applied to its supporting equipment. We will be continuously upgrade and improve our products and to modify the versions of user manual as well. Pls follow our latest updates on website, we won't contact you directly for the latest technical data.

**>> Note:**

1. When ordering, pls indicate the exact model and requirement of your required product in PO. Or we may supply with default parameters, namely: voltage level at AC380V, rated frequency at 50Hz, current and voltage feedback signal at DC0-5V and given signal at DC0-5V and potentiometer, non-special design type; Regular products are available in stock, for special design product, pls contact us to determine the specific delivery period when ordering.
2. At the thyristor trigger interface, please note that K1-K6 and G1-G6 are three-phase full-control trigger control ports. If there is a wrong connection, the risk of damage to the device will occur; the thyristor on the main circuit should be settled with proper capacitance absorption and VDR to protect the circuit. RC resistance-capacitance absorption protection device in wiring diagram is convenient for users. We have related RC absorption board STP10 and STP11. Please contact us if you need to order.
3. Before power-on, pls check if the control board is connected according to its actual requirements, then disconnect the control line of the thyristor trigger terminal first, do not connect to the load, power-on after correct operation. And then enter the menu to set and modify the relevant parameters of the control panel according to your own needs. Connect the thyristor trigger regulator to the load after finishing the parameter settings, and the actual operation can be performed.
4. Refer to the wiring diagram of the user manual of this control board for proper wiring. To prevent interference, given the control line and the thyristor trigger line, the main circuit power line is better wired separately. If the wires are not separated, use a twisted shielded wire for the given control line; strictly follow the corresponding relationship between the control board and the thyristor connection at the same time.
5. Before powering on, please check the wiring carefully, disconnect the load, and connect to a small power resistive dummy load test. It is recommended to connect the 1KW bulb for the experimental load. When using the incandescent lamp as the load for debugging, please press the start button to observe the brightness changes of the incandescent lamp. If the incandescent lamp can continuously and smoothly change according to different set values, the control panel wiring is normal; if it is out of control, then is abnormal, please turn off the power and check if there

is a wiring errors to avoid burning the device. After the control board is debugged normally, you can access the real load for running.

6. The external control terminal has a corresponding power supply configuration. Do not send active signals to the port. Otherwise, the product may be irreparable.

7. If the thyristor device needs to be tested for insulation, please remove the control board from the device, otherwise the control board may be permanently damaged.

8. We do not responsible for the damages of other components outside the thyristor regulator board.

9. Our Service Commitment: Provide one-year free warranty service and lifetime maintenance within the normal operation of the users. After the expiration of the warranty period, we can continue to provide technical support and assistance, and during this time, the replacement parts are available at our lowest cost price.

### **>> Circuit wiring control:**

If the electromagnetic interference of the control panel is serious, pls follow the measures as below while controlling the circuit wiring in order to prevent the equipment from working abnormally due to electromagnetic interference.

1. When the control cable is long, it is recommended to use a shielded cable. The shield of the cable should be grounded at one end.

2. The analog and digital signal cables should be routed separately;

3. All signal cables should be placed in the steel pipe or cable trough when necessary;

4. The signal cable and the strong electrical equipment should have as much isolation distance as possible;

5. Provide a separate grounding loop for the system;

6. All shielding layers are grounded at the transmitter port;

7. Do not connect wires of different metals to each other;

8. Minimize or eliminate intermediate terminals or connection points;

9. The pipe and cable trough should be grounded reliably and ensure continuous grounding over the entire length.

**Before operating this control panel, please read the user manual carefully to avoid incorrect operation and accidents!**

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## I. Introduction:

ST10 single-phase rectifier thyristor trigger regulator board adopts 32-bit industrial grade high-performance microprocessor, high digital precision quality design, support network remote control and on-site control mode. The fuzzy-PID parameter is open-ended, which integrates open-loop voltage regulation, closed-loop constant voltage and constant current in one, to control the thyristor to achieve constant voltage current limiting or constant current voltage limiting. The fault alarm and interface parameters are displayed on the LED digital tube menu, and parameters are automatically stored after setting. The control board (regulator) has the functions such as phase loss protection, power-on soft start, soft shutdown, constant current output, constant voltage output, overvoltage protection, overcurrent protection, short circuit protection, and working status indication. It has three-phase full-control bridge rectification, double anti-star rectification and thyristor anti-parallel AC triggering mode, which can trigger thyristor below 1000A, suitable for resistive load and, inductive load, capacitive load, transformer primary side and other types of loads which adjust by voltage and current regulation in various fields of industry. It has been widely used in electrolytic and plating devices, battery charge and discharge devices, single-phase thyristor power supply devices, electric heating temperature control devices, arc discharge control and other equipment.

This trigger board adopts industrial-grade high-performance microprocessor, which continues to lead the innovation of core control algorithms and software technology in the industry. The structure of the control software package and the processing speed of the single-chip microcomputer ensures all the adjustment of the control loops to be finished during transform (conversion) time of the six thyristor bridges in the main circuit, so that the voltage and current loop sampling time can be less than 3.33mS (50HZ power supply) or 2.77mS (60HZ power supply) for superior performance.

ST10 single-phase digital rectifier thyristor trigger regulator has a variety selections of given control signal, and supports analog input automatic control modes such as 0-5Vdc, 0-10Vdc, 0-10mA, 4-20mA, etc., and can also controlled by potentiometers (10K 2W) Manually. Flexible and convenient, with reliable and stable performance, strong anti-interference ability, unique anti-interference measures, normal operation in harsh interference environment, complete control panel self-diagnosis and load operation protection. It is also with power failure protection, over-voltage protection, overload protection, phase failure protection, etc. Therefore, regardless of the external or internal interference types and fault signals, the performance of the control board is safer and more reliable due to the above-mentioned protection functions. The outputs are completely isolated and has a wide application range. It has complete fault detection and alarm indication and protection function. All parameters of ST10 are digital, no temperature drift changes which improves the adjustment accuracy and power utilization efficiency.

## II. Technical specifications:

Working power supply	380Vac $\pm 15\%$ , 50/60HZ
Main circuit working voltage	50~660Vac $\pm 15\%$ , 50/60HZ
Voltage adjustment range:	0 ~ 100%
Current adjustment range:	0 ~ 100%
Phase shift range	0~178°
Adjust output resolution	1/4000
Stability accuracy	better than $\pm 1\%$
Trigger current:	$\geq 600\text{mA}$
Trigger capacity	$\leq 1000\text{A}$ one-way thyristor
PID dynamic response time:	$\leq 50\text{mS}$
Overshoot:	$\leq 10\%$

Input signal:	DC0-5V, DC0-10V, 0-10mA, 4-20mA, 10K potentiometer adjustment
Three-phase trigger imbalance	$\leq 0.3^\circ$
Applicable load:	Resistive, inductive, capacitive, transformer load and other loads
Alarm relay contact capacity:	250Vac/10A
Dielectric strength:	3500 VRMS
Ambient (working) temperature:	-20°C~ 60°C
Working Relative humidity:	$\leq 90\%$ RH (no frost)
Indoor installation requirements	no flammable, no explosive, no corrosive gas, no conductive dust, and vibration should be less than 0.5G
Dimensions:	190X130X38mm
Dimensions between install holes:	178X118mm
Weight:	1KG
<b>Altitude should be under 3000m, otherwise need to reduce the capacity level.</b>	

**ST10 meets the standard:**

IEC60947-4-2: Low-voltage switchgear and controlgear. Part 4-2: Contactors and motor-starters. AC semiconductor motor

Controllers and starters.

GB14048.6-1998: Low-voltage switchgear and controlgear Part 4-2: Contactors and motor starters AC semiconductor motor controllers and starters.

GB3797-89: Electronic Control Equipment Part II - Electronic Control Equipment with Electronic Devices.

IEC61000-4: Electromagnetic compatibility, test and measurement technology.

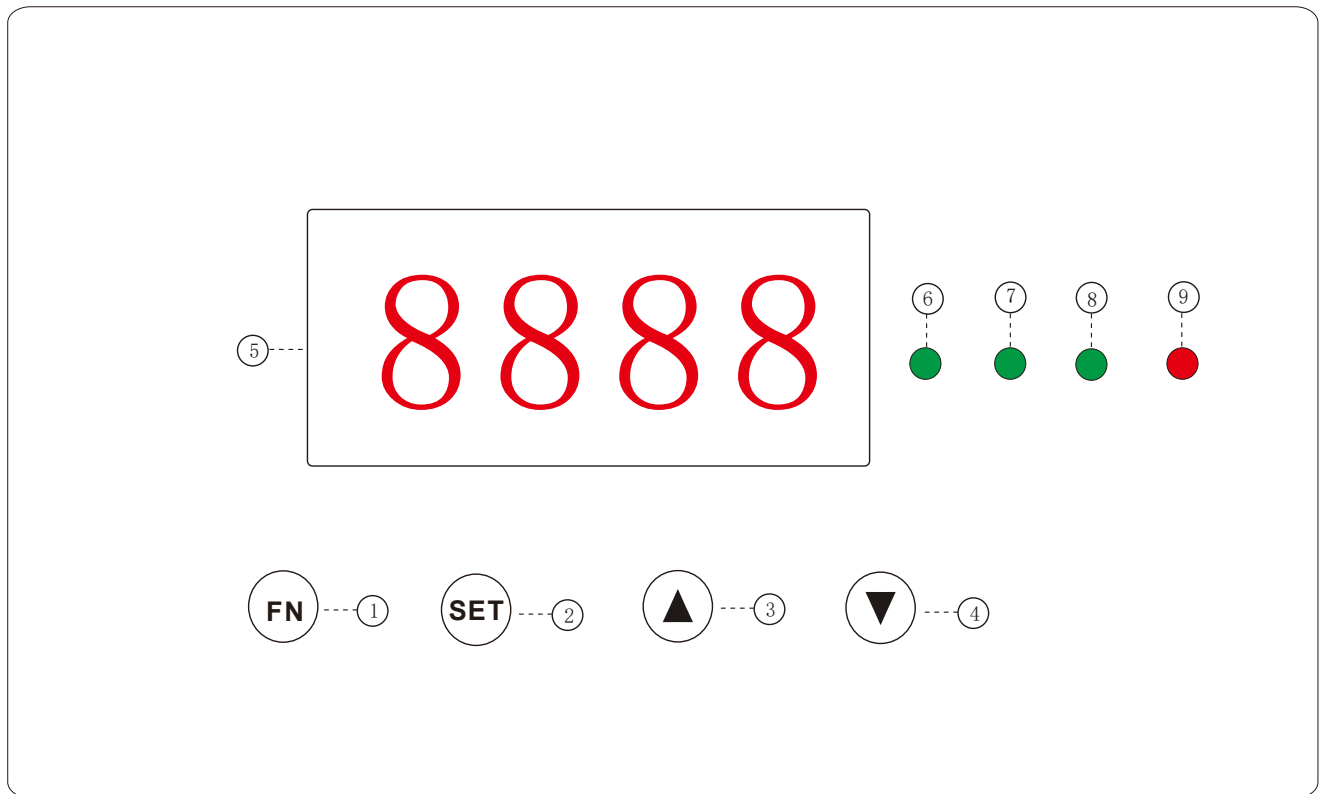
IEC65: Safety of household and similar general purpose electronic and related equipment powered by grid power.

**III. Features:**

1. Using 32-bit industrial high-speed microprocessor, LED digital tube menu for operation, fully automatic SMD process manufacturing, stable and reliable performance.
2. With digital constant current, constant voltage function, current limiting and voltage limiting function, it can control the loads precisely. It has overcurrent and overvoltage abnormal protection function.
3. Complete fault detection and alarm function, real-time detection of load status, load current, control signal, feedback signal loss and other parameters.
4. Intelligent PID control solution, parameter opening, can be set to any physical quantity flexibly. Great dynamic characteristics, adapts to different loads.
5. Phase loss protection: When the main circuit power supply is out of phase, the alarm prompts, and the load is stopped in real time to stop output
6. Interface compatibility: support 0-5Vdc, 0-10Vdc, 0-10mA, 4-20mA and other automatic input signals, direct interface with various instruments and PLC, can be manually controlled by potentiometer.
7. Overload protection: After starting, it will judge whether the load is overloaded. When it continuous overload the settled protection time, it stops running and the alarm relay outputs;
8. Soft start: At startup, the output voltage will gradually increase from zero to 100% to eliminate the impact on the grid and itself during load operation. The soft start time parameter can be set.
9. Soft shutdown: When stopped, the output voltage will gradually decrease from 100% to zero to eliminate the impact on the grid and itself when the load stops. The soft shutdown time parameter can be set.
10. It has the function of automatic phase sequence identification, no phase sequence requirement for the power supply of the control board, no debugging, very convenient wiring;

11. Current loop (voltage loop) feedback input signal supports various analog input signals such as transformer, Hall current (voltage) sensor, 0-75mV shunt, 0-5V, etc.
12. Adopts intrinsically safe design, the control board (regulator) is designed with the function of preventing thyristor trigger interface from burnout protection, and supports input and output multi-function expansion board;
13. All output ports and digital switch input interface are electronic isolated, it is of better anti-electromagnetic interference protection.

#### IV. LED control panel operation instructions:



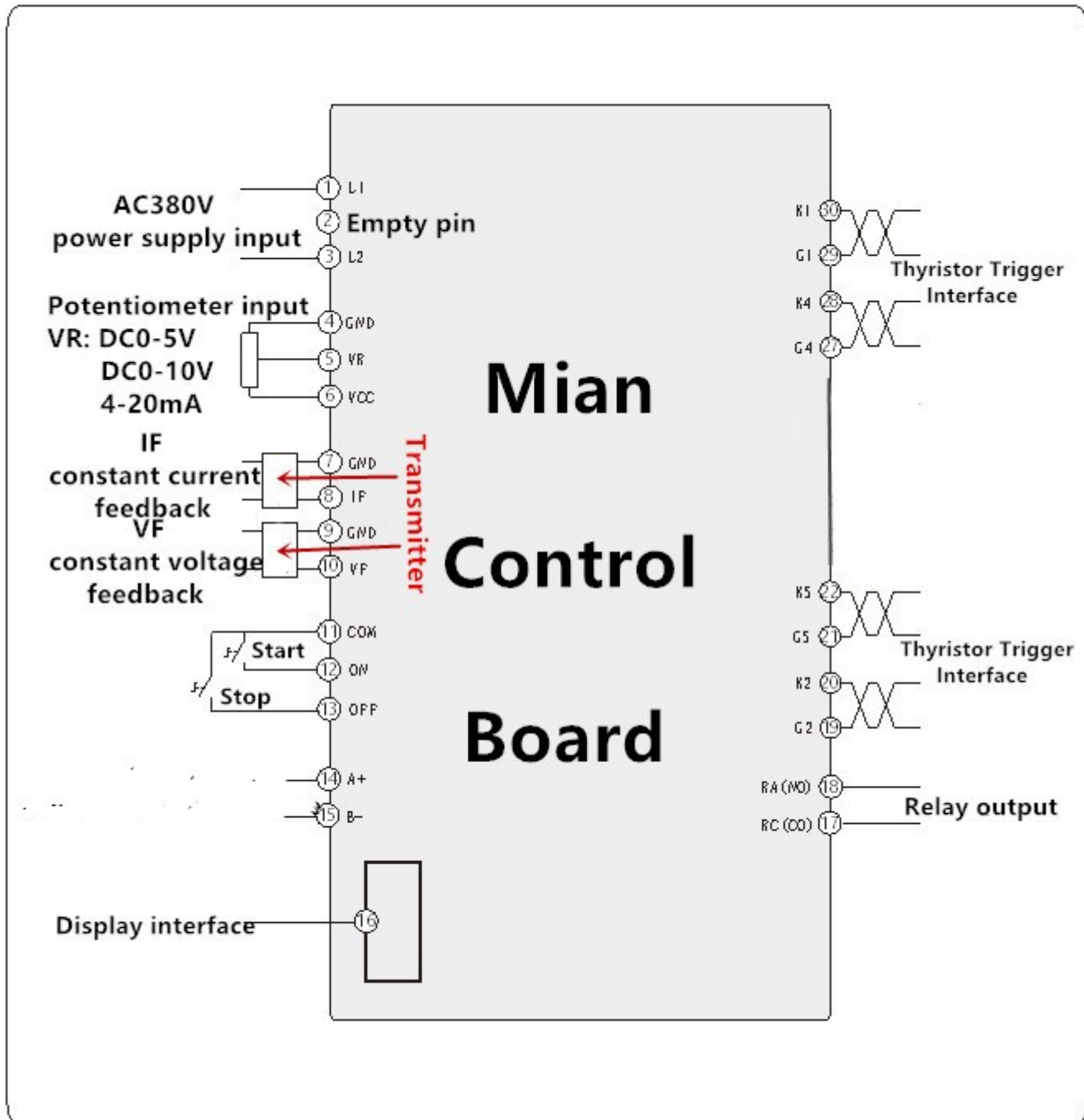
Parts	Function
① FN	Function button.
② SET	Press the button for 3 seconds into parameter setting mode; after entering the setting mode, press the button once to choose the parameter function.
③ ▲	To increase the parameter value when modify.
④ ▼	To decrease the parameter value when modify.
⑤ LED Display interface	When it shows "XXX", the displayed value is the percentage of the current input signal; It will alarm when there is a mistake.
⑥ CV mode indicator	When it lights, means the control board is in constant voltage regulation mode; when both ⑥ and ⑦ are not lit, the control board is in open loop regulation mode.
⑦ CC mode indicator	When it lights, means the control board is in constant current adjustment mode.
⑧ FT indicator	It can be used as Alarm output indicator or Output running indicator, there are 2 different software. Default as output running indicator.
⑨ LK lock indicator	When the setting parameter in lock mode, this indicator will stay in light, and parameters cannot be modified under this circumstance.

Security protection indication instruction (when it indicates Errx, the related relay will act and cut off the output):

Err1	Main loop power supply incoming line missing phase	Err6	Over temperature protection, to detect the temperature of the thyristor
Err2	IF overload indication	Err7	Function reserved, pls contact for technical support.
Err3	IF overcurrent indication	Err8	Phase sequence false indication
Err4	Over voltage protection indication	Err9	The power frequency of the main loop is unstable, not within the error range of 50HZ or 60HZ
Err5	Under voltage protection indication		



## V. Control board terminal definition:



- 1, 2 and 3: Power input terminal of the control board, Pin 1 and 3 are for 380Vac power supply connection.
- 4, 5 and 6: Potentiometer regulation input terminal. This input terminal can also be controlled by input other automatic control signals (0-5V, 0-10V, 4-20 mA) through GND (-) and VR (+) terminal, it is also called the given signal input terminal.
- 7 and 8: The signal terminal of the constant current feedback input, factory default is DC0-5V, GND (-), IF (+), if you need other signals, please express in advance.
- 9 and 10: The signal terminal of VF constant voltage feedback input, factory default is DC0-5V, GND (-), VF (+), if you need other signals, please express in advance.

- 11, 12 and 13: Common COM, start and stop control terminal. When the start mode is "self-locking", short circuit 11 and 12 to start working, disconnect to stop. When the start mode is "jog", connect 11 and 12 to start working, connect 11 and 13 to stop.
- 14 and 15: RS485 communication interface, not used in Single phase version.
- 16: Fault relay output, for alarm output.
- 17 and 18: Fault relay output terminal, used as alarm output.

## VI. LED Panel menu display and parameter setting instructions:

1. Key lock mode: Unlock by pressing and holding ▲ and ▼ for three seconds at the same time. When it's locked, the D indicator will stay in light; the default is in lock status after power-on, and you need to unlock before entering the setting menu.

2. In stop working mode, press the SET button for more than three seconds, the control panel will enter the parameter setting mode, the function parameter value display flashes. Short press the SET button to switch into the next setting function, press the ▲ or ▼ key to modify the parameter value. The current setting parameters will be automatically saved after setting by press the SET button for three second or no operation in 10 seconds. And then the control panel returns to the data just displayed, and automatically performs the action. It automatically works according to the stored data the next time it's on.

**To restore factory default parameters: In the parameter setting mode, long press ▲ or ▼ key to execute the factory default value, then it will automatically shut down and restart.**

Main menu display code and instructions:

Function Parameter	Constant Voltage	Constant Current	Open Loop	Default Value	Unit	Remark
Fc X: Working Mode Setting	•	•	•	0	--	X is the number from 0~2, 0 is constant voltage mode, 1 is constant current mode, 2 is open loop voltage adjustment mode.
Co X: Input Signal Setting	•	•	•	1	--	X is the number 0 or 1, 0 is the key operation on the control board; 1 is the external input signal, such as 0-5Vdc, 0-10Vdc, 0-10mA, 4-20mA, potentiometer and so on.
HU X: Limit Voltage Value Setting	○	•	○	--	%	X is the number from 10~99, adjust to higher than 99 will display --, when it's -- it means the limit voltage protection is cancelled.

oU X: Over Voltage Value Setting	•	•	•	--	%	X is the number from 10~99, adjust to higher than 99 will display --, when it's -- it means the over voltage protection is cancelled
HA X: Limit Current Value Setting	•	○	○	--	%	X is the number from 10~99, adjust to higher than 99 will display --, when it's -- it means the limit current protection is cancelled
oA X: Over Current Value Setting	•	•	•	--	%	X is the number from 10~99, adjust to higher than 99 will display --, when it's -- it means the over current protection is cancelled, it usually is 1.2 times of the rated current on the load.
do X: Soft Start Time	•	•	•	10	Second	X is the number from 1-90; It can be set to 0 when in open loop, and start transferring to the setting value immediately.
dc X: Slow Close Time	•	•	•	10	Second	X is the number from 1-90.
F X: Limit Phase Offset Range	•	•	•	--	%	X is the number from 1-100, the related phase offset angle is 0-175°
P X: Phase Offset Calibration	•	•	•	0	Angle	X is the number from -30°~30°, when there is transformer, such as $\Delta/Y$ , in the main circuit, the phase difference will be generated between the primary and secondary of the transformer, then the parameter will need to adjust.
H X: Phase Parameter Setting	•	•	•	0	--	X is the number from -260~260. Please consult for our technical support before adjustment, do not adjust in random.
lk X: Function reserved	•	•	•	0	--	When lk = 5, press the SET button to enter the setting mode, pls refer to the instructions in the following form.

**Note:** 1. • means this setting menu is available, ○ means no this menu setting.

2. External input signal, this trigger regulator is default as 0-5V or potentiometer. For other control input signals, please contact our technical staff or order

### PID regulation display code and instructions:

Function Parameter	Setting Parameter	Default Value	Remark
PID X: PID Mode Setting	1~4	2	<b>Note: Press FN button for over 3 seconds, the control board will enter the PID parameter setting mode, the operation methods is same as the main menu.</b>  PID mode 1 is the fast speed PID adjustment (suitable for resistive
P X: P Value	1~128	--	

Setting			load, constant voltage and constant current), 2 is medium speed PID adjustment, 3 is slow speed PID adjustment (suitable for sensitive and capacitive load, constant voltage and current), 4 is manual PID adjustment, users can adjust the P and I parameter.
I X: I Value Setting	1~128	--	
d X: D Value Setting	Not Adjustable	10	

3. When set  $C_0 = 0$ , directly use the buttons on the control panel to digitally perform constant voltage or constant current output operation. The digital adjustment display also provides accurate reference data for the user to understand the operation of the device. In this mode, the external reference input signal does not work.

Constant voltage output setting: When  $F_c = 0$ , the control board is in the constant voltage output mode (the window display value is the voltage percentage value of the current input signal), press the SET button shortly to enter the voltage value setting, and the display window flashes at this time. Press ▲ or ▼ to increase or decrease the voltage setting value. Long press will adjust continuously and automatically, and automatically adjust the voltage output according to the set value. No button action for five seconds or short press SET button automatically save the settings and return to normal operation.

Constant current output setting: When  $F_c = 1$ , the control board is in the constant current output mode (the window display value is the voltage percentage value of the current input signal), press the SET button shortly to enter the current value setting, and the display window flashes at this time. Press ▲ or ▼ to increase or decrease the current setting value. Long press will adjust continuously and automatically, and automatically adjust the current output according to the set value. No button action for five seconds or short press SET button automatically save the settings and return to normal operation.

Open-loop voltage regulation output setting: When  $F_c = 2$ , the control board is in the open-loop voltage regulation output mode (the window display value is the voltage percentage value of the current input signal), press the SET button shortly to enter the voltage value setting, the window flashes. Press ▲ or ▼ to increase or decrease the voltage setting value. Long press the button will adjust quickly and continuously, and automatically adjust the voltage output according to the set value. If there is no button action for five seconds or short press the SET button, the set value is automatically saved and returned to normal operation.

4. When set  $C_0 = 1$ , the control board can accept various external industrial standard signals or sensors and other input signals to control the running mode (0-5Vdc, 0-10Vdc, 0-10mA, 4-20mA input signals are connected to the VR and GND ports). Press the ▲ or ▼ key on the panel to adjust the voltage or current will be disabled, and only the function parameters can be set. The external input signal control is effective, at this time, the control board automatically controls the operation according to the external input signal. Only one of the external input signals, such as 0-5Vdc, 0-10Vdc, 0-10mA, 4-20mA and potentiometer, can be selected. If you have special requirements, please contact our technical staff to help. The percentage value of the current voltage or current feedback signal will be displayed on the display window, and constant voltage or constant current control will be performed according to the external input signal.

5. Start or stop output: Connect the control switch on the external control port, press the ON or OFF button to start or stop. When in the stop mode the C indicator is off, the control board enters the stop output mode; When the indicator light is on, it indicates that the control board enters the running output mode; the control mode is with jog (two-button control) or self-locking (one-button control) two ways. The jog mode is: using a jog switch, connecting

GND and ON is to operation, connect GND and OFF to stop; self-locking mode: Start when GND and ON connected, disconnect to stop.

#### 6. Current and voltage parameter quick setting reference method:

The input signal value of this control board adopts the percentage setting mode. In order to facilitate the user to set such parameters, please press the FN key in the running mode. At this time, the A display window will flash to display UXXX, and then press the FN key again to switch to display AXXX. The current display value is the signal value of the voltage U or the feedback port of the current A. When setting, users can refer to the feedback signal to set the current voltage parameter quickly and accurately.

## VII. Output feedback control connection instruction:

### 1. Constant voltage and constant current feedback input terminal reference:

During constant voltage feedback, the feedback voltage signal is DC0-5V (factory default). If there is a transformer isolation control before the load, the load terminal can take the feedback voltage by adding two resistors to divide the voltage to obtain the signal. Connect VF to GND constant voltage feedback port, please refer to the wiring diagram below; Or use the rated output voltage of 0-5V Hall voltage sensor, we also have STP30 constant voltage acquisition module used along with this trigger board, please consult our sales for details.

In the voltage divider circuit on the diagram below, R2 generally takes 1K and the power is no less than 2W. The calculation formula of the resistance value (unit K $\Omega$ ) and power P (unit W) of the voltage dividing resistor R1 is:

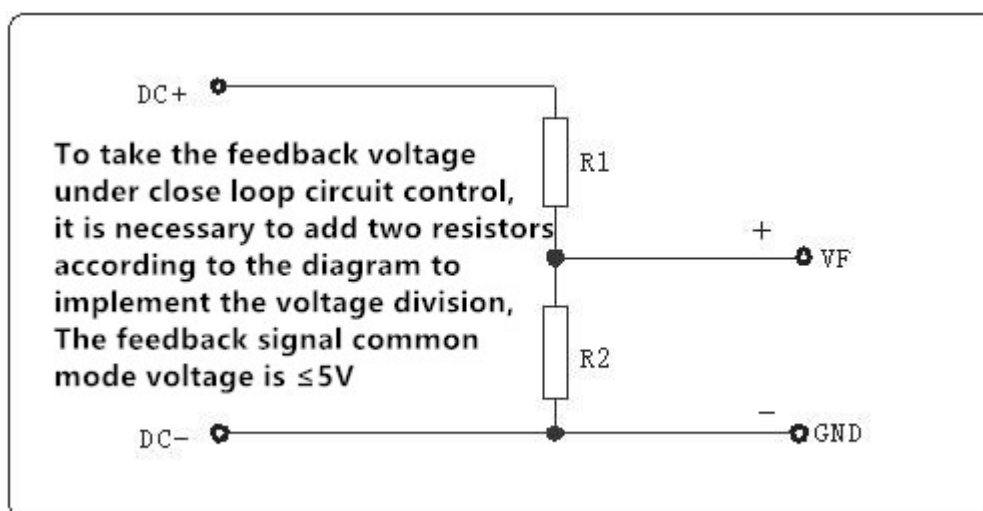
$$R_1 = V_0/5 - 1 (\text{K}\Omega) \quad P = 0.2 \times R_1 (\text{W})$$

$V_0$  in the formula is the rated rectification output voltage, unit is Vdc.

Eg: the rated rectification output voltage  $V_0 = 500\text{V}$ , to calculate voltage divider resistance value and power P of  $R_1$

$$R_1 = 500/5 - 1 = 99 (\text{K}\Omega) \quad P = 0.2 \times 99 = 19.8 (\text{W})$$

Select the voltage divider resistor  $R_1$  resistance value = 100K, and power = 20W.



For constant current feedback, please use Hall current sensor, connect to IF and GND constant current feedback interface, feedback voltage signal is DC0-5V (factory default); If using shunt to sampling current signal to connect the interface, please express to us in advance

## VIII. Analysis and elimination of common problems:

Number	Fault	Possible Reason	Solution
1	No display on the display screen	1、No connection of AC power	1、Check if the power is on, or the fuse is fused
		2、AC power voltage is too low	2、Check input voltage of the control power
		3、Display screen interface is broken	3、Return to factory for replacement
2	No output on from the control board	1、Control wire on the trigger port is connected wrong	1、Follow the wiring diagram, check the wiring of the control wire
		2、The thyristor is damaged	2、Replace the thyristor
		3、There is an indicator light (six red lights) not lit on the trigger port	3、The related indicator of certain road is not lit, check if the thyristor on this road is connected right
		4、There is an indicator light (six green lights) not lit on the trigger port	4、Return to factory for replacement
3	The output voltage is unstable	1、Open load	1、Check if the load is wired
		2、Power of the load is low	2、Change for a high power load, please take >1000W for experiment
		3、One of the thyristor is not conductive	3、Replace the thyristor
		4、PID parameter is wrong	4、Reset the PID parameters according to the feature of the load
4	The differ ratio between the input signal value and the actual output voltage is too big.	1、Constant current or constant voltage does not match with feedback signal	1、Check if the feedback signal is DC0-5V
5	Output voltage can't adjust to the rated value.	1、Constant current or constant voltage does not match with feedback signal	1、Check if the feedback signal is DC0-5V
		2、The settled value of limit voltage or limit current is too low	2、Reset the value of limit voltage or limit current
		3、The main circuit is not with 380V or synchronous transformer	3、Re-phase calibration, adjust parameters

## IX. Main circuit and control circuit wiring diagram:

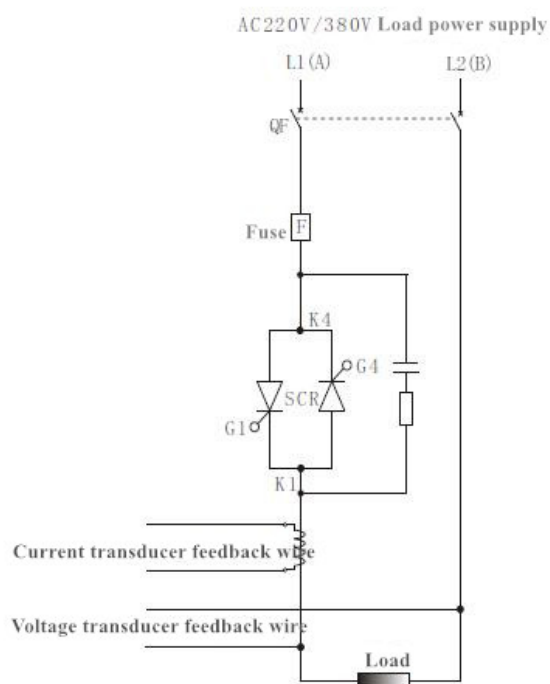
The wiring diagram below is a schematic diagram of the main circuit, the trigger terminal of the control board and the thyristor when the three-phase full-controlled rectifier control board is combined with other components. In the process of wiring the control panel trigger terminal and the thyristor, it should be noted that the correspondence of the position between the cathode (K) and the gate (G) as the diagram below, users should avoid the misconnection and reverse connection, otherwise a short-circuit will occur to burnout the device or damage the control board; The main circuit must be added with the necessary protection components, such as fast-melting for over-current protection, piezoresistor for over-voltage protection, and both side of thyristor connected to the RC to absorption circuit and so on.

**Note:** 1. Transformers, circuit breakers, contactors, fast-melting and thyristors, etc., needs to be purchased by users.

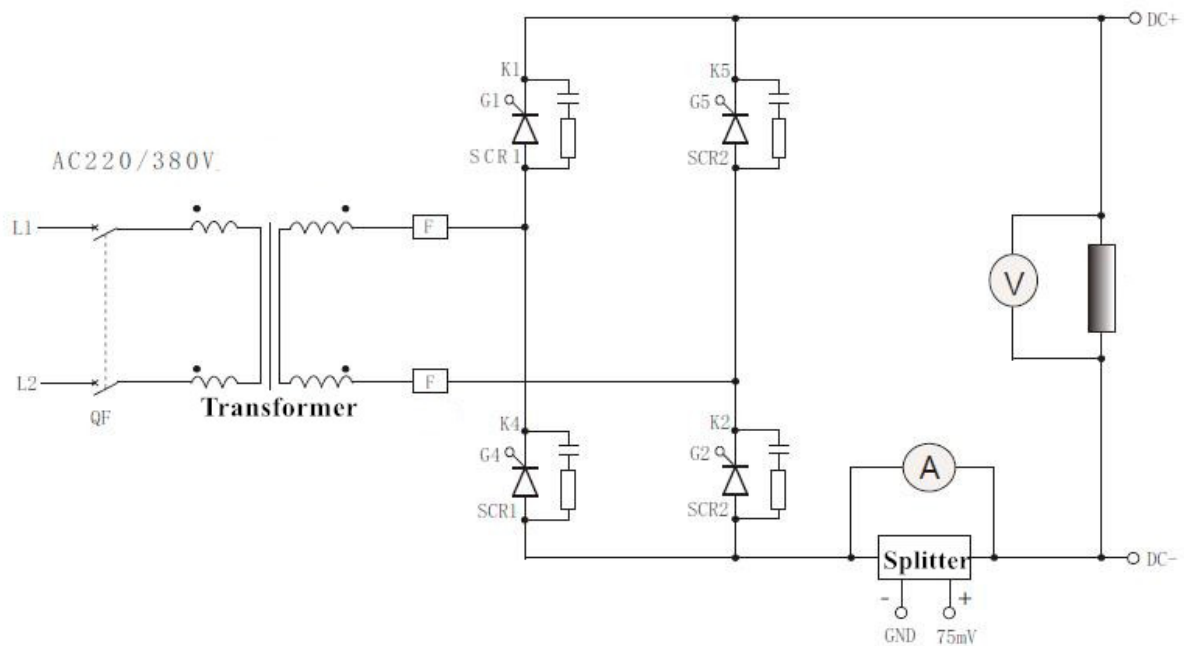
2. Hall voltage sensor, Hall current sensor, transformer and shunt needs to be purchased by the user.

3. Thyristor RC absorption components are optional accessories.

### Single phase AC constant current/ constant voltage control wiring



## Feedback isolated transformer full control rectifier wiring



## Feedback isolated full control bridge style rectifier wiring

