TG-1-10~140
TG-2-32~250
TG-3-32~2500

AC Thyristor Power Controller Instruction Manual

(Automatic Temperature Control)

Contents

1. Overview

• 1-1 As one of the "Semiconductor AC Power Controllers" defined by the International Electrotechnical Commission (IEC), the AC thyristor power controller uses thyristors (Silicon Controlled Rectifiers/SCR or Triode AC Switches/TRIAC) as switching elements. Its capability of fast, precise control over switching time makes it, as a non-contact switch, ultimately an essential power terminal control device for automatic temperature control systems requiring high precision and high dynamic performance.

• 1-2 Two types of AC thyristor power controllers have been developed and manufactured by Greegoo:
  • AC Thyristor power regulators with zero-crossing pulse triggering;
  • AC Thyristor voltage regulators with phase-shift pulse triggering.

• 1-3 AC Thyristor power regulators control output power by regulating the number of AC cycles within a fixed or variable period. Thyristors conduct at sine wave zero-crossings and turn off automatically at subsequent zero-crossings; the load gets a complete sine wave output during conduction.

• 1-4 Greegoo's AC Thyristor Power Regulators comply with the IEC-TC22B Standards, featuring integrated circuits, serialized power ratings, generalized components, and intelligent instruments.

• 1-5 AC Thyristor power regulators are mainly used for automatic and manual temperature control of various electric heating equipment, such as resistance furnaces, electric heaters, diffusion furnaces, thermostatic baths, ovens, and melting furnaces.

• 1-6 AC Thyristor power regulators are suitable for resistive loads (power factor = 1), including heating elements such as nickel-chromium, iron-chromium-aluminum, and nickel-iron resistance wires; tungsten-molybdenum wires; silicon carbide rods; and far-infrared electric heating plates.

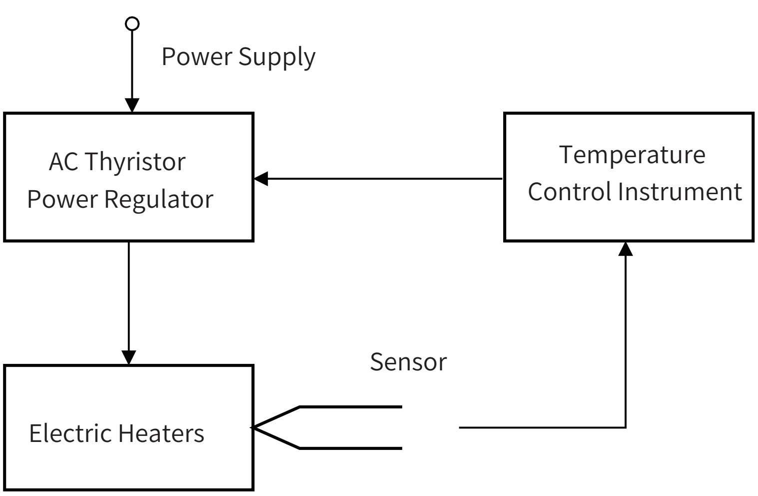
• 1-7 Power is supplied directly to heating elements by the power regulator, with no transformer coupling required.

• 1-8 AC Thyristor power regulators include components such as a cycle controller, thyristors (TRIACs, anti-parallel SCRs), fast-acting fuses, overcurrent protection, audio alarms, power supply voltmeters, and output power indicators; those with automatic temperature control also include temperature display and control instruments.

• 1-9 Advanced instruments are used for temperature display and control, featuring Proportional-Integral-Derivative (PID) control or adaptive PID control.

2. Temperature Control System

• 2-1 Single-point Temperature Control System



http://www.greegoo.com
Peter@greegoo.com

・2-2 Circuit Block Diagram of AC Thyristor Power Regulator

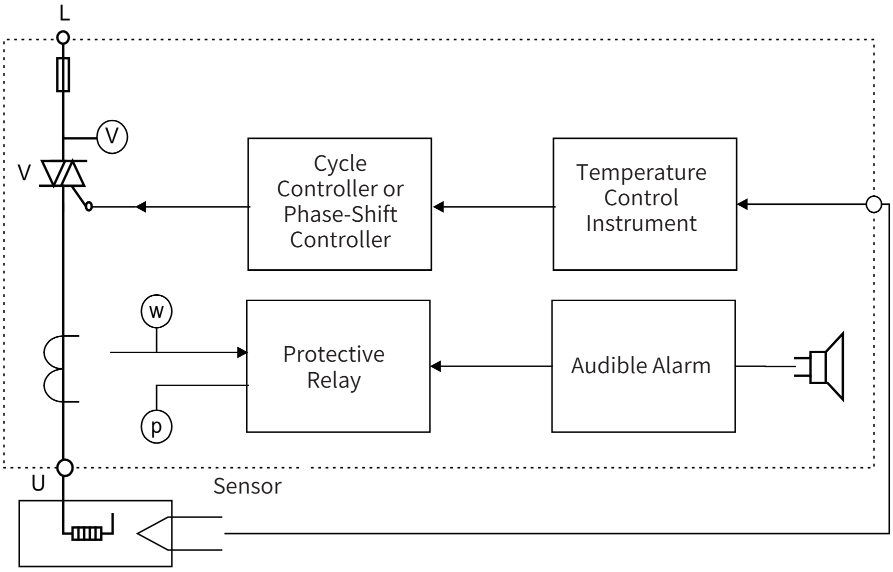


Figure 2 AC Thyristor power control circuit

3. Features of AC Thyristor Power Regulator

・3-1 To control output power, Fixed-period AC Thyristor Power Regulator, with thyristors as zero-voltage non-contact switches, function by changing the number of output AC cycles within a fixed period T (e.g., one second). That means the output power varies with the number of wave groups in the period. Its output waveform is shown in Figure 3.

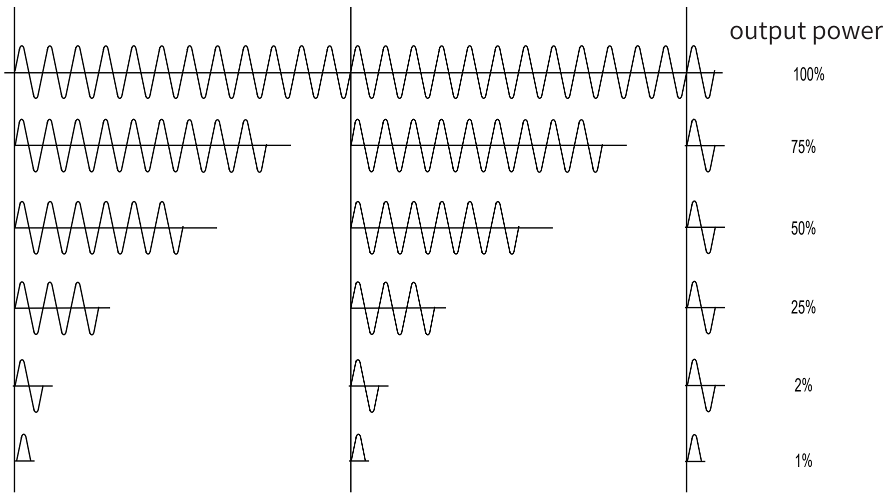


Figure 3: Output Waveform of Fixed-cycle AC Thyristor Power Regulator

http://www.greegoo.com
Peter@greegoo.com

・3-2 Variable-cycle AC Thyristor Power Regulators with uniformly distributed output sine waves are also known as intermittent power regulators, whose repetitive periods are arranged at minimum sine wave intervals: for example, they reach their minimum period at 50% output power—a 40-millisecond (0.04-second) period with one cycle on and one cycle off. They reach their peak period at maximum and minimum output power: for example, they see a 20-second period with 99.9% output power (999 cycles on, 1 cycle off) and the same 20-second period with 0.1% output power (1 cycle on, 999 cycles off), with their output waveform shown in Figure 4.

These two new continuous temperature control methods, which adjust the number of cycles within a period, feature high precision and small temperature fluctuation.

・3-3 The AC thyristor power regulator minimizes its radiated interference, conducted interference, and transient surge of load current because it adopts the sine wave zero-crossing triggering mode and outputs a complete sine wave.

・3-4 The AC thyristor power regulator delivers noiseless operation, long service life, higher efficiency than electromagnetic devices (reaching 99%), and a high power factor (cosφ=1) — all of which are beneficial for energy conservation.

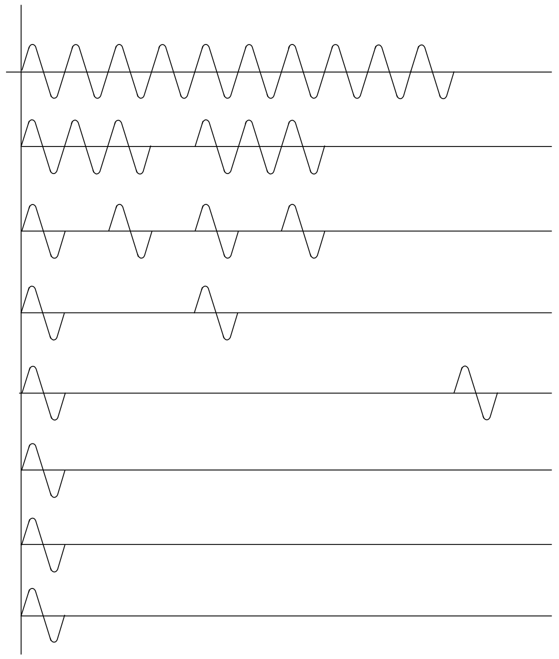


Figure 4 the output waveform of the variable-period AC thyristor power regulator

4. Technical Specifications

- 4-1 Multiple Specification Availability :
- Power Supply Voltage: AC: 110V, 220V, 380V, 660V, +10%, -15%
- Power Supply Frequency: 47~63Hz
- Phases: 1 phase, 2 phase, 3 phase
- Output Power : 10~2500KW series
- Temperature Control Range: 0~2400°C
- Temperature Control Accuracy: 1%, 0.5%
- Temperature Control Mode: Constant Temperature (PID, PID Adaptive)
- Setting Cycle of Power Regulator: 1s, 0.5s, 2s, Variable Cycle
- Load Power Factor: cosφ=1

http://www.greegoo.com
Peter@greegoo.com

- Load Connection Method (Three-phase):
  - Type Y attachment (neutral grounded)
  - Type Y attachment (neutral ungrounded)
  - △-connection
- Thyristor Cooling Method: Self-cooling, Forced Air Cooling
- Rating: Continuous
- Temperature Control Points: Single-point, Multi-points
- Output Impedance of the Control Signal Circuit (Without Temperature Control Instrument):

  DC 0~10mA   800Ω
  DC 4~20mA   250Ω
  DC 0~5V   ⩾ 10KΩ
  DC 0~10V   ⩾ 10KΩ
  LOGIC   ⩾ 10KΩ

- 4-2 Operating Environment
  - Ambient Temperature: -15～45°C (for self-cooling and forced air cooling)
  - Storage and Transportation Temperature: -25～55°C
  - Relative Humidity: 15～90% (without condensation)
  - For Indoor Use
  - Prohibited in environments containing chemically corrosive and explosive gases

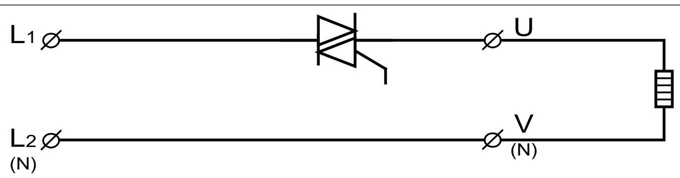
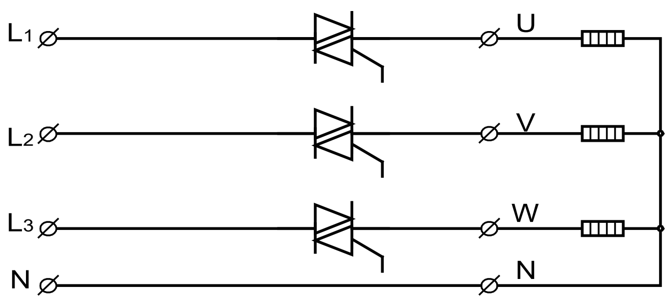
- 4-3 Requirements for AC power supply

In accordance with the provisions of IEC-TC22B for semiconductor power controllers, the impedance of the power transformer shall be ⩽ 1% of the load impedance; i.e., the impedance voltage drop of the power transformer shall be ⩽ 1% of the load voltage. In practical use, the transformer capacity shall be greater than 2~3 times that of the total capacity of the thyristor AC power regulators.

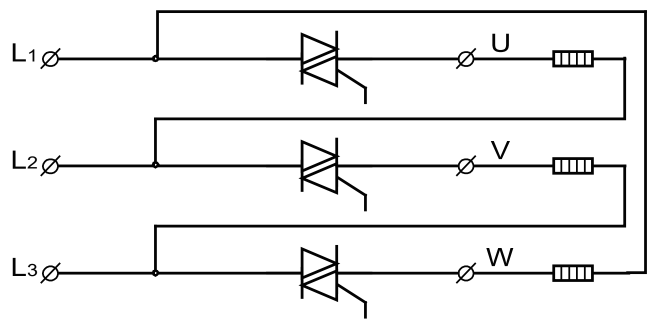
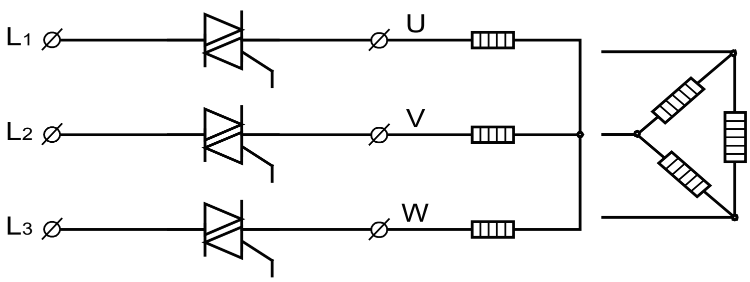
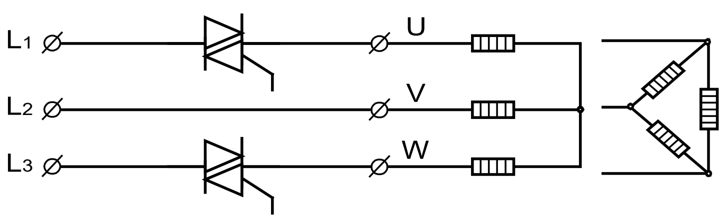
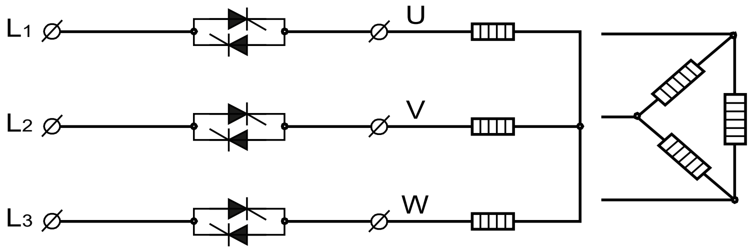
- 4-4 Safe Isolation

The AC thyristor power controller only controls AC power and cannot achieve safe isolation from the power supply even when the thyristor is in the off state. Therefore, to ensure safety during shutdown or maintenance, devices such as knife switches and automatic switches shall be installed before the controller.

5. Main Circuit Connection Type of the AC Thyristor Power Controller

Code	Name	Connection Type	IEC Code
0	Single-phase Circuit Bidirectional Control		W1-1AA
1	Three-phase Four-wire Circuit Bidirectional Control		W3-3AN

http://www.greegoo.com
Peter@greegoo.com

2	Three-phase Delta Circuit Bidirectional Control		W3-3AA
3	Three-phase Three-wire Circuit Bidirectional Control		W3-3AX
4	Three-phase Three-wire Circuit Two-wire Bidirectional Control		W3-2AX
5	Three-phase Three-wire Circuit Anti-parallel Bidirectional Control		WN3-3AX

6. Power Series of the AC Thyristor Power Controller

Specification	Rated Power (KW)	Rated Current (A)	Phases	Nominal Input/Output Voltage (V)	Power Regulation Range (KW)	Thyristor		Circuit
						Type	Cooling Method	IEC Standards
TG-1-10	10	50	1	220	0~10	Bidirectional	Forced Air Cooling	W1-1AA
TG-1-20	20	100	1	220	0~20	Bidirectional	Forced Air Cooling	W1-1AA
TG-1-50	50	250	1	220	0~50	Bidirectional	Forced Air Cooling	W1-1AA
TG-2-80	80	400	1	220	0~80	Bidirectional	Forced Air Cooling	W1-1AA

http://www.greegoo.com
Peter@greegoo.com

TG-2-18	18	50	2	380	0~18	Bidirectional	Forced Air Cooling	W1-1AA
TG-2-35	35	100	2	380	0~35	Bidirectional	Forced Air Cooling	W1-1AA
TG-2-71	71	200	2	380	0~71	Bidirectional	Forced Air Cooling	W1-1AA
TG-2-90	90	250	2	380	0~90	Bidirectional	Forced Air Cooling	W1-1AA
TG-2-140	140	400	2	380	0~140	Bidirectional	Forced Air Cooling	W1-1AA
TG-2-32	32	50	2	380	0~32	Bidirectional	Forced Air Cooling	W3-2AX
TG-2-63	63	100	2	380	0~63	Bidirectional	Forced Air Cooling	W3-2AX
TG-2-160	160	250	2	380	0~160	Bidirectional	Forced Air Cooling	W3-2AX
TG-2-250	250	400	2	380	0~250	Bidirectional	Forced Air Cooling	W3-2AX
TG-3-32	32	50	3	380	0~32	Bidirectional	Forced Air Cooling	W3-3AN W3-3AX
TG-3-63	63	100	3	380	0~63	Bidirectional	Forced Air Cooling	W3-3AN W3-3AX
TG-3-160	160	250	3	380	0~160	Bidirectional	Forced Air Cooling	W3-3AN W3-3AX
TG-3-250	250	400	3	380	0~250	Bidirectional	Forced Air Cooling	W3-3AN W3-3AX
TG-3-315	315	500	3	380	0~315	Anti-parallel	Forced Air Cooling	W3-3AN W3-3AX
TG-3-500	500	800	3	380	0~500	Anti-parallel	Forced Air Cooling	W3-3AN W3-3AX
TG-3-630	630	1000	3	380	0~630	Anti-parallel	Forced Air Cooling	W3-3AN W3-3AX
TG-3-800	800	1250	3	380	0~800	Anti-parallel	Forced Air Cooling	W3-3AN W3-3AX
TG-3-1000	1000	1600	3	380	0~1000	Anti-parallel	Forced Air Cooling	W3-3AN W3-3AX
TG-3-1600	1600	2500	3	380	0~1600	Anti-parallel	Forced Air Cooling	W3-3AN W3-3AX
TG-3-1000	1000	1000	3	660	0~1000	Anti-parallel	Forced Air Cooling	W3-3AN W3-3AX
TG-3-1600	1600	1600	3	660	0~1600	Anti-parallel	Forced Air Cooling	W3-3AN W3-3AX
TG-3-2500	2500	2500	3	660	0~2500	Anti-parallel	Forced Air Cooling	W3-3AN W3-3AX

http://www.greegoo.com
Peter@greegoo.com

Part Numbers and Model explanation

TG – □ □ □ □ □ □

Power Regulator

Phase	
1	1 phase
2	2 phase
3	3 phase

Output Power	
Value	kW

Cooling Method	
F	Forced Air Cooling

Rated Voltage	
Value	V

Temperature Range	
Value	℃

Accuracy	
1	1%
05	0.5%

7.Principle of Electric Circuit

The electrical schematic diagrams of the AC thyristor power controller is provided (see Figures 5, 6, 7).

• 7-1 Main Circuit

- Six types of the main circuit (namely 0, 1, 2, 3, 4, and 5) as introduced in Section 5.
- The rated on-state current (RMS value) of the thyristor is twice the rated current of the circuit, with sufficient margin provided. Two available thyristor cooling methods: self-cooling, forced air cooling.

• 7-2 Controller

For the triggering and control of thyristors, different controllers are used depending on the operating mode; the power regulator adopts the TG-G1/3-A/B type cycle controller. When receiving input signals from various temperature control instruments or under manual control, the controller regulates the magnitude of the output power by controlling the output and timing of trigger pulse. When receiving protection signals from relays, it quickly cuts off the trigger pulses to turn off the thyristor immediately and prevent it from being damaged by overload or short-circuit currents.

• 7-3 Protection and Alarm

Protection against short circuits and overloads is provided by the fast fuse FU.Before the thyristor turns off rapidly when the output of trigger pulses stops immediately, its internal non-contact switch closes quickly to short the P+ and P- terminals of the TG-G cycle controller once the temperature exceeds the set upper limit. To alert on-duty personnel, all protection actions trigger an audible alarm and a flashing light signal.

• 7-4 Indication and Measurement

There are signal light H1~H3 at the power input terminal for indicating each phase. There are also signal light H4~H6 at the output terminal for indicating each phase. There is an AC voltmeter PV connected between phases L12 and L13 to measure the line voltage. The integrating power meter PW, installed for each output phase of the power regulator, measures the percentage of output power, which is adjusted to full scale at rated power with a potentiometer RP (this adjustment is completed before delivery).

• 7-5 Automatic Temperature Control

Automatic temperature control is performed by the temperature controller. Modern temperature controllers have the following functions:

- Digital display of measured temperature and set temperature;
- Temperature alarms setting of first-level upper limit and second-level upper limit;
- Output signals (including analog signals or logic signals) to control power actuators;
- Prevention of temperature overshoot, assurance of rapid stabilization, and wide-range adjustable P, I, D parameters
- No need to reconfigure setpoints after power failure;
- A small number of operation buttons, resulting in a concise panel.

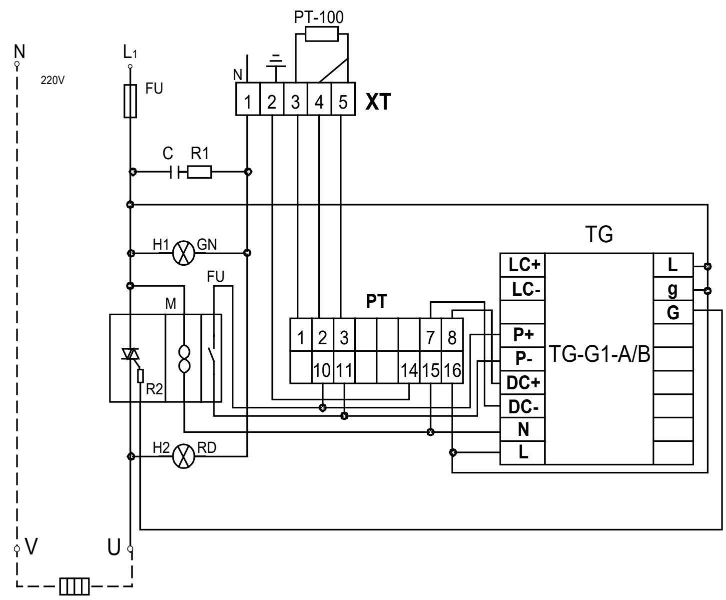
For constant temperature control, two temperature control accuracies are available:

1. 1%: Moving-coil controllers with fixed P, I, D parameters, outputting DC 0~10mA for general use.
2. 0.5%: Digital controllers with fixed or adjustable P, I, D parameters, offering DC or logic output.

• 7-6 Neutral Wire and Grounding

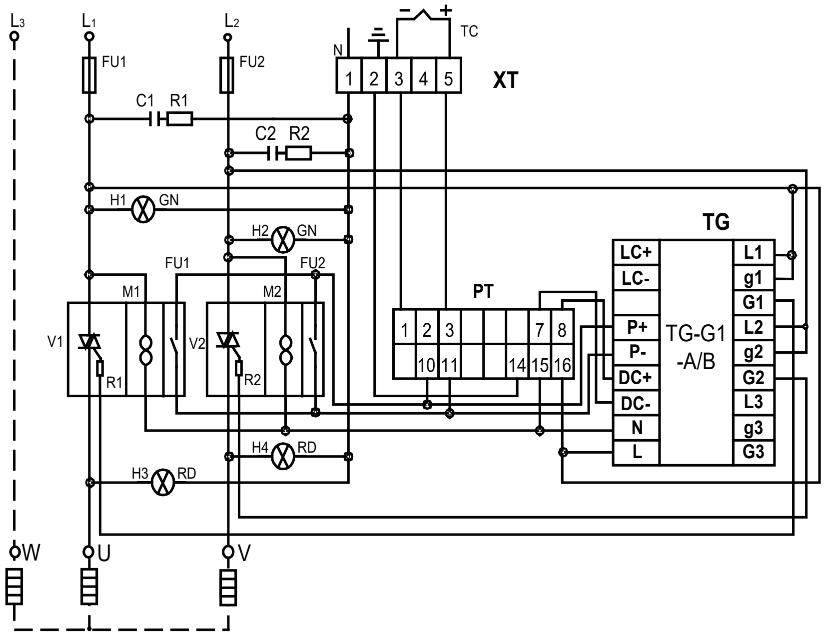
1. A neutral wire (N) and phase wires (L) must be connected inside the cabinet to supply 220V power to the instruments, with a power consumption not exceeding 220VA. Both the neutral wire and phase wires shall be connected to the terminal block; refer to the factory-provided circuit diagram during installation.

2. A grounding bolt is equipped at the bottom of the cabinet, intended specifically for the cabinet's protective grounding. It must not be used as a neutral wire for 220V power input.



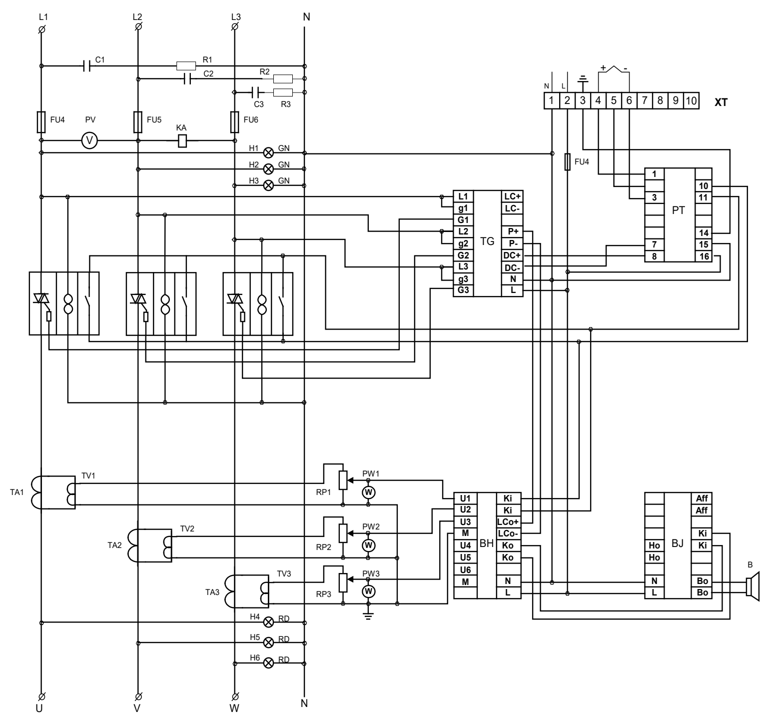
TG	Controller	TG-G1-A/B-0~10mA
PT	Temperature Controller	TMT-9912-400°C
M	Fan	220V ϕ125
R2	Resistor	RJ-100Ω
V	Thyristor	KS-100A-700V
H2	Signal Light	AD-11-220V-RD
H1	Signal Light	AD-11-220V-GN
R1	Resistor	RX-20-10Ω20W
C	Capacitor	CB-100μf500V
FU	Fuse	RS3-75A
Code	Name	Model
TG-1-10-F-220-400-05		

Figure 5 Thyristor AC Single-Phase Power Regulator ---- Furnace Temperature Over-Temperature Protection



TG	Controller	TG-G1-A/B-0~10mA
PT	Temperature Controller	TMT-9911-600°C
M1~2	Fan	220V ϕ125
R1~2	Resistor	RJ-2-100Ω
V1~2	Thyristor	KS-200A-1100V
H3~4	Signal Light	AD-11-220V-RD
H1~2	Signal Light	AD-11-220V-GN
R1~2	Resistor	RX-20-5.1Ω30W
C1~2	Capacitor	CB-100µf500V
FU1~2	Fuse	RS3-150A
Code	Name	Model
TG-2-63-F-380-600-05		

Figure 6 Thyristor AC Two-Phase Power Regulator
----Three-phase controlling two-phase; Neutral point is not connected to the neutral wire
---- Furnace Temperature Over-Temperature Protection



XT	Terminal	TZ-20
FU4	Fuse	R014-2A
FU1~3	Fuse	RS0-350A
BJ	Alarm	BJ-3
BH	Protector	BH-8
PT	Control Instrument	XMT-9912-1000°C
TG	Controller	TG-G-3-A/B
PW1~3	Integrator	6L2-W%
RP1~3	Potentiometer	WH148-1A-1-10KΩ
TV1~3	Matrix Converter	LY5-5A/12V
TA1~3	Current transformer	LMZ1-0.5-250/5
M1~3	Fan	220V ϕ125
V1~3	Thyristor	KSZ-500A-1100V
H4~6	Signal Light	AD11-220V-RD
H1~3	Signal Light	AD11-220V-GN
PV	Voltmeter	6L2-0-450V
R1~3	Resistor	RX-20-5.1Ω-30W
C1~2	Capacitor	CBB-10µf-500V
Code	Name	Model

Figure 7 Thyristor Three-Phase AC Power Regulator

8. Testing and Functional Debugging

・8-1 Before inspecting the equipment, the user shall, upon receiving and unpacking the goods, read the product manual and circuit diagrams (including electrical schematic diagrams and wiring diagrams). If you contact us with any questions our company will provide a satisfactory response in a timely manner. Materials such as the product manual and product qualification certificates shall be filed in accordance with regulations for easy reference at any time.

・8-2 Check if there are any loose fixing screws and wire connections in various parts of the cabinet. If there are any abnormalities or damages in all instruments and components, rectify any such issues in a timely manner. After you first contact us in a timely manner to explain the specific situation regarding the difficulties, they will be addressed by our personnel.

・8-3 Perform power-on debugging by applying simulated loads and inputting various simulated control signals.

・1. Operate in accordance with the wiring instructions for the control signal terminal block at the rear of the cabinet, as specified in the electrical schematic diagram of this product. Connect the platinum resistor to Terminals 1, 2, and 3 on the terminal block. Note that Terminals 1 and 2 are for connecting the resistor signal, while Terminals 2 and 3 are for connecting the temperature compensation signal. For the terminal block, Terminals 5 and 6 shall first be short-circuited with a single wire to handle the instrument control signals.

・2. Select the simulated load's connection method based on that of the electric heater's resistance wire.

・A. Star connection: With three incandescent bulbs (220V, 100W or higher) of the same power, connect them in a star configuration, each to output copper busbar terminals A, B, and C respectively. The common wire of the bulbs shall be connected to the neutral busbar.

・B. Delta connection: With six incandescent bulbs (220V, 100W or higher) of the same power, first connect two bulbs in series respectively, then configure them in delta, each group to output copper busbar terminals A, B, and C respectively. Whether the power regulator is functioning normally can be checked intuitively by using bulbs as the simulated load.

・3. Input terminals L1, L2, and L3 are connected to the 380V three-phase AC power, and the neutral busbar to the neutral wire. To prevent equipment damage caused by line faults, before setting the output to zero by turning the manual adjustment potentiometer knob in the center of the panel fully counterclockwise, first press out the "ON/OFF" toggle switch of the cycle controller (hereinafter referred to as "CC") and set it to the "OFF" position; press out the "MAN/AUT" toggle switch and set it to the "MAN" position.

・4. Indicator lights illuminate under the following switch states:
When main circuit power switch QF and control switches QF2, QF3 are closed: phase A/B/C input and input voltage indicator lights.When control switch QF1 is closed: power regulator cabinet’s green stop indicator light (with voltmeter showing AC voltage).For universal circuit breaker QF: phase A/B/C input indicator lights illuminate when QF1 is closed (triggering auto energy storage) and the cabinet’s start button is pressed.

・5. Pressing the power regulator cabinet’s start button comes with its red start indicator light illuminating. For a single-circuit control system, turning the transfer switch ZK clockwise to the 45° right position comes with the protection relay’s power indicator light illuminating, with the temperature controller (hereinafter referred to as "TC") display lighting up. TC functionality is confirmed by its upper display showing the temperature measured by the platinum resistor and lower display showing the factory-set temperature. Locked-out output of the CC comes with the heater lockout indicator light illuminating. The power regulator cabinet operates normally and the cooling fans start to work on the premise that the DCS instrument control signal is input (with terminals 5 and 6 short-circuited), followed by the CC's power indicator light illuminating. With the instrument control signal applied, the permission (heating) indicator (red light) illuminates.
Terminals 8 and 9 ("Power Regulator Cabinet Operation Signal") on the terminal block should be closed, as measured with a multimeter in resistance mode. If a check reveals abnormal operation of all six fans, power off the cabinet to inspect for fan damage or loose wiring. For a dual-circuit control system: The fans require not only pressing the power regulator

http://www.greegoo.com
Peter@greegoo.com

cabinet's start button but also switching the " Ⅰ Instrument Control Selection Ⅱ" to " Ⅰ " or " Ⅱ " to operate.

Caution: Do not touch the thyristor heat sinks as they are energized during normal operation.

・6. Manual adjustment of heating power is achieved by pressing in the "ON/OFF" power switch button of the CC and setting it to the "ON" position. After slowly rotating the manual adjustment potentiometer knob in the center of the panel clockwise, there are an increase in the redlight bar of the input indicator on the CC, and three sets of components flashing: the "OUT" output signal light (on the CC), the power regulator cabinet’s phase A, B, C output indicators, and the load incandescent bulbs—all with uniform brightness, so it is with the temperature controller’s main circuit output indicator light bar, plus these cabinet indicators and load incandescent bulbs. Rotating the knob to the maximum position triggers two kinds of illumination: the full one of the redlight bar, and the steady one of the output signal light, phase A, B, and C output indicator lights, and load incandescent bulbs. Measurement of the three-phase output line voltage (≈380V) and phase voltage (≈220V) indicates their balanced state when using a multimeter in AC voltage mode.

・7. TC automatic control of the CC’ s output is performed simply via pressing the CC’s "MAN/AUT" to the "AUT". Full-power output of the power regulator cabinet occurs during debugging, caused by a large gap between the actual and set temperatures. For testing the cabinet’ s automatic power adjustment function, set the TC’s set value close to the measured temperature.

Take 10°C (current temperature on the controller, measured by PT-100) as an example: press and hold the controller’s "SET" key until "SU" displays, then use "∧" and "<" to set it to 9°C, 8°C, or lower. After PID adjustment, a gradual decrease will occur in the cycle’s redlight bar, the controller’s main circuit output indicator, and output power—followed by the incandescent lamp turning off completely.

Conversely, repeat the "SET" key until "SU" appears, then use "∨" and "<" to set the value to 11°C, 12°C, or higher. Post-PID adjustment, a gradual rise will occur in these indicators and output power, ending with the lamp fully lit. Measurement of the three-phase output line voltage (≈380V) and phase voltage (≈220V) indicates their balanced state when using a multimeter in AC voltage mode.

・8. The bringing about of the cabinet's shutdown by pressing the stop button is accompanied by the operation indicator going off and the stop indicator light coming on.

・9. External Start/Stop Debugging:
Normal start-up of the power regulator cabinet is achieved by short-circuiting terminals 12 and 13 ("External Start for Power Regulator Cabinet") on the rear terminal block with a hard jumper wire (Caution: The circuit is live!); Normal stop of the power regulator cabinet is achieved by short-circuiting terminals 15 and 16 ("External Stop for Power Regulator Cabinet") on the rear terminal block with the same jumper wire (**Caution**: The circuit is live!).

・10. Debugging of "Fast Fuse Blown" or "Load Overcurrent" Protection Function：

The protection function is designed to safeguard the load terminal and the power regulator cabinet itself when the main circuit encounters load overload, current exceeding limits, or short circuits at the load terminal due to various reasons during operation.

For Systems with Fast-Blow Fuse (with Protection Control): The illumination of the "Fast Blow Fuse" indicator on the panel occurs when the normally open (NO) control contact is toggled closed, which is followed by the shutdown of power output and the sounding of the buzzer's alarm immediately. Four lighting elements turn off simultaneously, including redlight bar of the input indicator on the CC, the output signal light, the A/B/C three-phase output indicator lights of the cabinet, and the three-phase incandescent lamps. Measuring the two "Power Regulator Cabinet Operation Signal" terminals on the rear terminal block with a multimeter in "Diode" mode shows them open. The "Power Regulator Cabinet Operation Signal" is connected by releasing the fast fuse's normally open contact to reset it, followed by the clearance of all alarms and the normal operation of the power regulator cabinet. Opening the fast fuse's normally open contact triggers the clearance of all alarms, followed by the illumination of the "Power Regulator Cabinet Operation Signal" to indicate normal operation.

For Systems with BH-8 Type Protection Relays (hereinafter referred to as "Protection Relays"): The illumination of the protection relay's power indicator light on the cabinet panel occurs when the power regulator cabinet is normally turned on. The illumination of the "Load Overcurrent" light panel on the cabinet occurs when the "Test Button" on the protection relay is pressed, which is followed immediately by the shutdown of power output, the illumination of the "Overcurrent" indicator, and the buzzer's alarm. Four lighting elements turn off simultaneously, including the red light bar for the cycle's input indicator, the output signal light, the cabinet's A/B/C three-phase output indicator lights, and the three-phase incandescent lamps—along with the disconnection of the "Power Regulator Cabinet Operation Signal." Measuring the two "Power Regulator Cabinet Operation Signal" terminals on the rear terminal block with a multimeter in "Diode" mode shows them open. Pressing the "Reset Button" on the protection relay triggers the clearance of all alarms and the going off of the protection relay's "Overcurrent" indicator light, followed by the connection of the "Power Regulator Cabinet Operation Signal" to indicate normal operation.

- 11."Over-Temperature" Function Debugging:

This protection function is designed to protect the electric heater's resistance wire by preventing the heating temperature from exceeding the electric heater's preset maximum allowable temperature (based on its parameters) for an extended period during heating operations. The thyristor over-temperature protection function—equipped in power regulator cabinets for some high-power loads or high-demand occasions—is designed to integrate into the "over-temperature" circuit to achieve over-temperature protection.

Following the previously mentioned 10°C (the current temperature measured and displayed on the temperature controller) as an example: Adjustment of the temperature controller's high-limit temperature to 9°C brings the shutdown of power output, the illumination of the "Over-Temperature" light panel on the cabinet front, and the buzzer alarm. Four lighting elements turn off simultaneously, including the cycle's input indicator red light bar, the output signal light, the cabinet's A/B/C three-phase output indicator lights, and the three-phase incandescent lamps—along with the disconnection of the "Power Regulator Cabinet Operation Signal." For systems with a protection relay, the "Over-Temperature" indicator illuminates. Conversely, readjustment of the temperature controller's high-limit temperature to 12°C (with the set operating temperature at 11°C) brings the clearance of all alarms, the return of the power regulator cabinet to normal functioning, and the connection of the "Power Regulator Cabinet Operation Signal." During PID adjustment, the cabinet gradually increases its output power until eventually reaching full power.

The "Over-Temperature" alarm features an auto-reset function: for the temperature controller, the alarm clears automatically once the temperature returns to the normal range.

The method for setting the upper and lower temperature limits on the temperature controller is as follows:

Pressing and holding the "SET + ∧" key on the temperature controller panel for approximately 3 seconds until "AL1" appears in the upper measurement display window, then releasing it, results in the lower display window showing the first-level alarm temperature value.

Pressing the "∨", "∧", and "<" keys adjusts the two-level upper temperature limits (parameters in the lower display window when "AL1" or "AL2" is shown in the upper measurement display window) to meet on-site requirements.

After pressing the "SET" key continuously until the set temperature appears in the lower display window, exit the parameter setting window.

- 12. Sound Alarm Muting Function:

Manual muting of the sound alarm, performed by staff after detecting an alarm from the power regulator cabinet, helps reduce noise pollution at the work site. The light alarm remains active unless the fault is eliminated or the cabinet' s power is cut off.

For general systems, manual muting requires adjusting the small "OFF - Alarm Sound - ON" switch (on the cabinet's front panel) to "OFF"; switching to the "ON" position under normal conditions ensures the sound alarm works effectively.

For systems with the BJ-type flashing sound alarm: Its power indicator stays on during operation. Pressing the "TEST" button on its panel triggers the buzzer's sound and the flash of red LED. The alarm sound can be adjusted via the knob-type potentiometer in the middle of its panel to an appropriate volume. During a normal alarm, pressing the "CONFIRM" button results in three outcomes: the muting of the sound alarm, the steady illumination of the red LED on the panel, and the extinguishing of the red LED after fault elimination.

・8-4 After the "I Instrument Control Select II" selector switch is switched to the other circuit, perform debugging according to the steps in ■8-3-6 to ■8-3-11.

・8-5 After confirming no major faults in the equipment (through above inspection and debugging), restore all components to their pre-debugging state, set the temperature control parameters according to on-site heating temperature requirements, then proceed with installation and connect the external wiring.

9. Equipment Installation and Initial Commissioning

• 9-1 Prerequisites for Power Regulator Cabinet Installation

・1 . Checking for short circuits (between phases and between each phase and ground) with a measuring tool is mandatory before connecting the cabinet's power input line and load. In particular, proper three-phase load connection (e.g., star (Y) or delta (Δ)) ensures no load short circuits and smooth initial operation.

・ 2 .Connection of control wires and signal wires to the terminal block must follow the wiring instructions on the electrical schematic.

・3 . Correctness of all connections is a prerequisite for operation.

• 9-2 Notes on Power Regulator Cabinet Installation

・ 1.Small control switch QF1: Main power switch for the cabinet's internal control circuit, governing its operation.

・2.Small control switch QF2: Power control switch for the three-phase input indicator lights (Phase A, B, C) on the cabinet' s front panel.

・3.Small control switch QF3: Power control switch for the three-phase output indicator lights (Phase A, B, C) on its front panel.

・4.Main circuit control switch QF: Controls the operation of the main circuit.

・5.Platinum resistor PT-100 connection: Connect via terminals 1, 2, and 3 on the cabinet's rear terminal block. Note: A resistance signal is present between terminals 1 and 2, and a temperature compensation signal between terminals 2 and 3.

・6.Instrumentation Control Signal: Indicate the remote control of the cabinet's operation: via connecting terminals 5 and 6 on the rear terminal block for the host computer (connected for permission, disconnected for prohibition), or by short-circuiting terminals 5 and 6 with a wire if there is no host computer. Note: This connection is an active contact.

・7.Operation Signal for Power Regulator Cabinet: Indicate the monitoring of the cabinet's operation, which is introduced via terminals 8 and 9 on the rear terminal block for the host computer (connected for operation, disconnected for shutdown), with the terminals left open if there is no host computer. Note: This connection is a passive contact.

・8.External Start Signal for Power Regulator Cabinet: Indicate the control of the cabinet's start: via the corresponding contacts on the terminal block (refer to the terminal block instructions in the electrical schematic) for the host computer (NO+ momentary contact for start), with the contacts left open if there is no host computer. Note: This connection is an active contact.

・9.External Stop Signal for Power Regulator Cabinet: Indicate the control of the cabinet's stop which is introduced via contacts on the terminal block (refer to the terminal block instructions in the electrical schematic) for the host computer (NO+ momentary contact for stop), with the contacts left open if there is no host computer. Note: This connection is an active contact.

・10.Signal for Controlling External Devices: Indicate the permission for operation of relevant subsequent equipment: Its output via the corresponding contacts on the terminal block (refer to the terminal block instructions in the electrical schematic) for standby use (connected for permission, disconnected for prohibition), with the contacts left open if not in use. Note: This connection is a passive contact.

・11.External Device Control Signal: Indicate the control of heating power by the host computer: which is introduced via the corresponding contacts on the terminal block (refer to the terminal block instructions in the electrical schematic) for DCS 4～20mA IN signal. A one-to-one correspondence must be maintained between 0%～100% power and the 4～20mA current signal; ensure to check the polarity (positive and negative) during wiring.

・12.Internal "DCS Control/Local Control" Switch: "DCS Control" indicates remote control of the power regulator cabinet's operation via the 4～20mA signal (from the host computer), which is introduced via two terminals on the terminal block at the rear of the cabinet. "Local Control" indicates control of the cycle's operation via the operating temperature value set on the temperature controller. By default (at factory shipment), the switch is set to the "Local Control" position.

13. Additional Notes：

If only one pair of control signals is provided by the DCS host computer system to the power regulator cabinet, they should be connected to the "instrumentation control signal" on the cabinet’s rear terminal block (connection starts cabinet operation; disconnection prohibits it). Local start/stop of the cabinet is controlled via its corresponding control buttons.

If two pairs of control signals are provided by the DCS host computer to the cabinet (one for continuous operation, one for momentary operation): The continuous operation signal should be connected to the "instrumentation control signal" on the rear terminal block (connection starts cabinet operation; disconnection prohibits it); the momentary signal should be connected to the "External Stop Signal for Power Regulator Cabinet" on the rear terminal block (a normally open (NO) contact; momentary contact triggers stop). Local start of the cabinet is controlled via its corresponding control button.

If three pairs of control signals can be provided by the DCS host computer to the cabinet, they should be connected in accordance with the terminal block instructions in the electrical schematic.

Any questions should be directed to our company, and we will provide a satisfactory response.

・9-3 Initial Operation Debugging

・1.Interlock Debugging (with load)

After ensuring there is no short circuit in the main circuit connections between devices, close the control switches QF1, QF2, QF3 and main switch QF (for systems with dual control circuits, first select " Ⅰ Instrument Control Select Ⅱ ") for one circuit. A test of starting and stopping via cabinet front panel is followed by another test by pressing the external start and stop buttons of the DCS host computer. This phenomenon is similar to that with simulated load and thus is omitted. For example: This debugging step is omitted if the DCS superordinate computer provides only one pair of control signals for the power regulator cabinet.

Controlling the power regulator cabinet’s operation requires cabinet’s operation (with display of the temperature controller), followed by adjustment of the instrument control signal from the DCS host computer.

Pressing the DCS button brings operation of the CC and the cabinet, along with the DCS host computer receiving the "power regulator cabinet in operation" signal. Releasing the DCS button brings stoppage of the cycle and the cabinet, along with the DCS superordinate computer receiving the "power regulator cabinet stopped" signal.

Control of the power regulator cabinet's power output is achieved via the cycle's 4~20mA control signal (from the DCS superordinate computer) by first pressing the cycle's "ON/OFF" power switch to "ON", then the "MAN/AUT" button to "AUT", and finally setting the internal "DCS Control/Local Control" switch to "DCS Control". 4mA corresponds to 0% output, 20mA to 100%. The cycle's redlight bar, the temperature controller's main circuit output indicator bar, the output signal light, the cabinet front's A/B/C three-phase output indicators, and the power output will all change accordingly when the current value is adjusted. For normal operation, it is recommended to set the switch to the "Local Control" position: "Local Control" adopts temperature-based PID closed-loop regulation, while "DCS Control" relies on power control output by the DCS superordinate computer (open-loop control).

After completion of interlock debugging, reset the cycle to its factory settings.

- 2. Activation Operation of Electric Heater

Understanding the operating temperature and high-limit temperature during activation of the electric heater facilitates setting the temperature controller's operating temperature and alarm temperature.

After pressing the cycle's power button to put it in manual adjustment mode, slowly turn the manual adjustment potentiometer knob to the end to achieve full power output of the power regulator cabinet, which is similar to the situation with simulated load.

Temperature rising from room temperature to the set temperature typically takes 15 to 30 minutes (depending on load power and heating gas flow), with the power regulator cabinet outputting full power during this process.

Measurement of three-phase output voltage shows balance with a multimeter in voltage mode. Measurement of three-phase output current shows balance with a clamp ammeter; if not, readjust the load resistance until balanced.

Ensure the indicated scales (of the A/B/C three-phase integral power meters on the cabinet front) read 100%; if the error is considered excessive, adjust the potentiometers behind the power meters respectively to make them indicate 100%.

Note that the pointer of the integral power meter moves slowly ; after each adjustment, wait a few seconds until the pointer stabilizes before adjusting again until the display is accurate.

After the stable operation of the power regulator cabinet, control of the cycle's operation is achieved by pressing the "MAN/AUT" button on the cycle panel to set it to the "AUT" position, where the temperature controller regulates the cycle via PID closed-loop control.

- 3. After the electric heater's activation is completed, adjust the temperature controller's normal operating temperature parameters and high-temperature alarm parameters. For a frequently used power regulator cabinet, it can be kept in the on state, with its operation controlled via the "instrument control signal" from the DCS host computer.

10. Temperature Control Parameter Setting and Commissioning Methods

When the instrument is in operation, the measured value of the controlled object is displayed in the upper display window, and the currently set main circuit control value is displayed in the lower secondary display window. The operating status of each output circuit is indicated by each indicator light after internal computer calculation based on the deviation between the set value and the measured value (if the corresponding module is not installed, the operating status of the indicator light does not necessarily reflect the actual output status). For instruments with an output light column, the display of output changes with an accuracy of approximately 1/10 (1/20 for XMTG) is also provided.

- **10-1 Parameter Setting Permissions**

Parameter setting of the instrument is divided into two levels. The first-level parameter setting includes common automatic control values; the second-level parameter setting includes PID values for correcting control quality, alarm values, manual output values, etc. The setting permissions are specified in the second-level parameter setting process.

• 10-2 Parameter Setting

After entry into the parameter setting state, press the increment key "∧", decrement key "∨", and shift key "<" for modification of the parameter under the prompt in the upper display window. Finally, pressing the function key "SET" saves the modified value, moves to the next setting item, and proceeds until return to the measurement state.

Immediate return to the measurement state after parameter setting is a requirement; otherwise, automatic reversion of the instrument to its pre-modification state occurs after a certain period meaning invalidity of value of the currently set parameter with the instrument maintaining operation according to the last saved setting).

• 10-3 Setting the Main Circuit Control Value

Pressing key "SET" for about three seconds brings the "SU" symbol on the upper display window and a flashing number in the lower display window. Gently pressing the increment key "∧", decrement key "∨", and shift key "<" means any value setting within the specified range of the meter's measurement upper and lower limits. After pressing the function key "SET" once more, the meter memorizes the new value and performs automatic regulation according to the newly set main circuit control value.

• 10-4 Entering the PID Parameter Self-Tuning State

The PID parameter automatic tuning function can handle special cases where correctly setting PID parameters is particularly challenging. Enabling it brings the "AT" light on the meter panel (indicating the self-tuning state) and on-off control output. After three oscillations of the controlled value, ideal PID parameter values are calculated and permanently stored.

If the main control setting value is not changed again, there is no need to go through the self-tuning process again after subsequent power-on.

The self-tuning offset value only shifts the stepping control value forward during tuning, which helps avoid large overshoots in the system during the tuning process.

• 10-5 Setting of the main circuit for two-position control

During Level 2 Parameter Setting, when the proportional value "P" is set to "0", the instrument automatically enters the return difference value setting for on-off control. At the value is evenly distributed above and below the set value—meaning its mid-value equals the main circuit set value.

• 10-6 Manual Output Setting Manual control output is achieved by two steps:

Pressing the function keys "SET + ∨" for approximately 3 seconds brings symbol "H XXX" on the lower display window, and a flash of number after "H". Lightly pressing the increment key "∧", decrement key "∨", and shift key "<" can adjust the control output within the range of 0–100%. Switch to automatic control is realized by pressing the "SET" key. Manual output is applicable to ovens or electric heating furnaces with low cold-state resistance, which require a low-power preheating stage. Special Note: For instruments with on-off PID control (such as on-off, zero-crossing, or solid-state relay (SSR) control), the maximum current and voltage value supplied to the load remains the same during the output period; only the average power per unit time is changed.

• 10-7 Level 2 Parameter Setting Process (Press "SET + ∧" for approximately 3 seconds to enter the setting state)

(1) AL1 (Alarm 1)

Alarm 1 corresponds to the setting of the first alarm value, with its output action mode as defined by the instrument model. For upper/lower limit alarm: It can be set within the instrument's current range (i.e., its current measuring range), with the factory value being the range's upper or lower limit. For upper/lower tracking alarm: It can be set within 0–50 (factory value: 20).

http://www.greegoo.com
Peter@greegoo.com

(2) AL2 (Alarm 2)

Alarm 2 corresponds to the setting of the second alarm value, with its output action mode following the instrument model' s definition. For upper/lower limit alarm: It can be set within the instrument's current range (i.e., its current measuring range), with the factory value being the range's upper or lower limit. For upper/lower tracking alarm: It can be set within 0–50 (factory value: 20).

(3) Sensor Correction (SC)

The measured value, when failing to be accurately reflected by the sensor due to factors like wiring or installation position, can have its readings corrected via this setting. The correction range is -20.0 to 20.0, with a factory correction value of 0.

(4) Proportional Band (P)

It refers to the range within which the control output changes, with its setting unit being a percentage of the instrument's set range. Its setting range is 0–100% of the set range (factory setting: 5). When P=0, the control switches to on-off mode.

(5) Dead band

It is accessible in the menu when the proportional band P=0. It refers to the hysteresis (or dead band) setting for on-off control instruments, with a setting range of 0–20.0 (factory setting: 2.0).

(6) Integral Time (I)

It is inversely proportional to the integral action: the longer the integral time, the weaker the integral action per unit time. Its setting range is 0–3000 seconds (factory setting: 210 seconds).

(7) Derivative Time (d)

It is directly proportional to the derivative action. The setting of derivative time to 0 prevents rapid system changes and frequent actuation of the executor, which is recommended when the instrument is used to control systems such as valve positions or speed regulation. Its setting range is 0–2000 seconds (factory setting: 30 seconds).

(8) Auto-tuning (AT)

It controls the activation or deactivation of the auto-tuning function. First-time control, when the control system operates at a new control value for the first time, allows activation of the auto-tuning function. Activation brings on the illumination of the AT indicator on the panel and puts the instrument into the parameter tuning state; automatic termination brings the extinction of the AT indicator. "OFF" indicates the function is disabled, and "ON" indicates it is enabled.

(9) Power Limit (LIN)

It is applicable to limiting the maximum power delivered to the controlled object. Its setting range is 20%–100% (factory setting: 100%).

(10) Proportional Offset (NSO)

The difference (between the measured value after the controlled object stabilizes and the ambient temperature) is defined by Proportional Offset (NSO), specifically when the output changes by 50%. For example, in a heating system requiring determination of the optimal control M50 value: the optimal control M50 value equals the system' s stabilized temperature (500°C) at 50% output minus the ambient temperature (20°C) with no output, i.e., 500 - 20 = 480°C. NSO is generally obtained automatically during auto-tuning, requiring no manual intervention.

(11) Auto-tuning Offset Value (dPU)

The Auto-tuning Offset Value (dPU) refers to the advance control quantity during auto-tuning. It is applicable to systems that do not allow large overshoot during the tuning process. The setting range of this advance control quantity is 0 to 40.0 (or 40) units, with a factory setting of 0.

(12) LOC (Keypad Lock)

LOC refers to the keypad lock function. In the locked state, parameters can only be viewed but not modified, preventing unauthorized personnel from altering the set parameters.

- 0 and 1: Unlock Level 1 and Level 2 setting processes
- 2: Only unlock the SU main circuit control value
- 3: Locked state where no parameters can be set (except for the LOC function itself)

Before returning to the measurement state, all parameter settings from (1) to (12) above are switched to submenus automatically via the "SET" key.

- **10-8 Communication Function**

This temperature controller adopts serial communication.

- Asynchronous serial communication interface: RS232 or RS485 (optional).
- Communication address range: 0～63.
- Baud rate: 1200, 2400, 4800, 9600 (bits/s) (optional).

11. Common Faults and Troubleshooting

- **11-1 Blown Fast Fuse**

Replacing a blown fast fuse requires a new product of the same model; it must not be substituted with copper wire or an ordinary fuse. Spare parts should be stocked for timely replacement in daily use.

- **11-2 Thyristor Damage**

Damage to thyristors, caused by overcurrent or overvoltage, is characterized by symptoms such as permanent on/off status and loss of control. It can be checked using the following methods:

For an intact thyristor (TRIACA): Measurement of each electrode (with a multimeter in ohmmeter mode) shows low resistance (approximately tens of ohms) between gate G and T1, and high resistance between G and T2. A note during measurement: T1 and T2 may be mislabeled (swapped) in products manufactured by some factories according to old standards.

For an intact thyristor (SCR): Measurement of each electrode (with a multimeter in ohmmeter mode) shows low resistance between gate G and cathode K, high resistance between G and anode A, and high resistance between A and K.

Replacement of damaged thyristors and stockpiling of spares are required; users should keep a number of spares on hand.

The TG-G component, when malfunctioning, should be replaced with a spare part, which should then be sent back to our company for repair and reused afterward.

- **11-3**

Failure to start the Power Regulator Cabinet during initial debugging requires checking if the 380V three-phase four-wire power supply is properly connected.

- **11-4**

Display of "HH" on the upper window, when the Power Regulator Cabinet is started and the temperature controller is operating normally, requires checking whether the temperature sensor is disconnected or the input exceeds the upper range limit.

http://www.greegoo.com
Peter@greegoo.com

Display of "LL" on the upper window requires checking the correctness of the PT-100 platinum resistor wiring on terminals "1, 2, 3"—with a resistance signal between 1 and 2, and a temperature compensation signal between 2 and 3.

A short circuit or reverse connection of the sensor means activation of the instrument's automatic protection function, which can be resolved by cutting off the load power supply; normal operation resumes only after troubleshooting.

Initial power-up brings display of the brand abbreviation "Ob" on the upper window and the software version number on the lower window. No pressing of the setting key is allowed to prevent instrument damage due to software corruption.

- **11-5**

Failure to control the power regulator cabinet via the external 4–20mA DCS control signal requires checking whether the polarity of the "4–20mA DCS IN" signal on the terminal block is reversed. Retry after adjustment.

- **11-6**

Unbalanced three-phase output beyond the allowable range during simulated load debugging requires checking the phase sequence of the A, B, C three-phase power input. After confirming correct phase sequence, swap the power inlet wires (L, N) behind the cycle board.

Replacement of the spare CC is required if that issue remains unsolved, or if unbalanced three-phase output of the power regulator cabinet or failure to achieve full-power output (in both manual and automatic modes) occurs due to long-term operation.

- **11-7**

The CC (to be sent back to our company for repair and reused as a spare after restoration) should be replaced with a spare one when there are faults such as abnormal light column display (no light, partial darkness, or no movement), failure to perform manual control, or inability to achieve automatic control/no output when the temperature controller sends signals to the DC+ and DC- pins of the CC.

- **11-8**

If you encounter any fault during commissioning and operation that cannot be resolved independently, please contact our company to get personnel to handle it for you.

12. Ordering Information

- 12-1 The product name, model number, and order quantity shall be specified when placing an order.
- 12-2 The power, voltage class, and wiring method of the supporting electric heater will be provided.
- 12-3 Please clearly specify whether dual-loop control is required (the control section of this device offers dual-loop control as an option).
- 12-4 The device is supplied with one factory certificate of conformity, and one copy of product manual and drawings upon delivery.
- 12-5 Special requirements shall be specified by the customer.

http://www.greegoo.com
Peter@greegoo.com