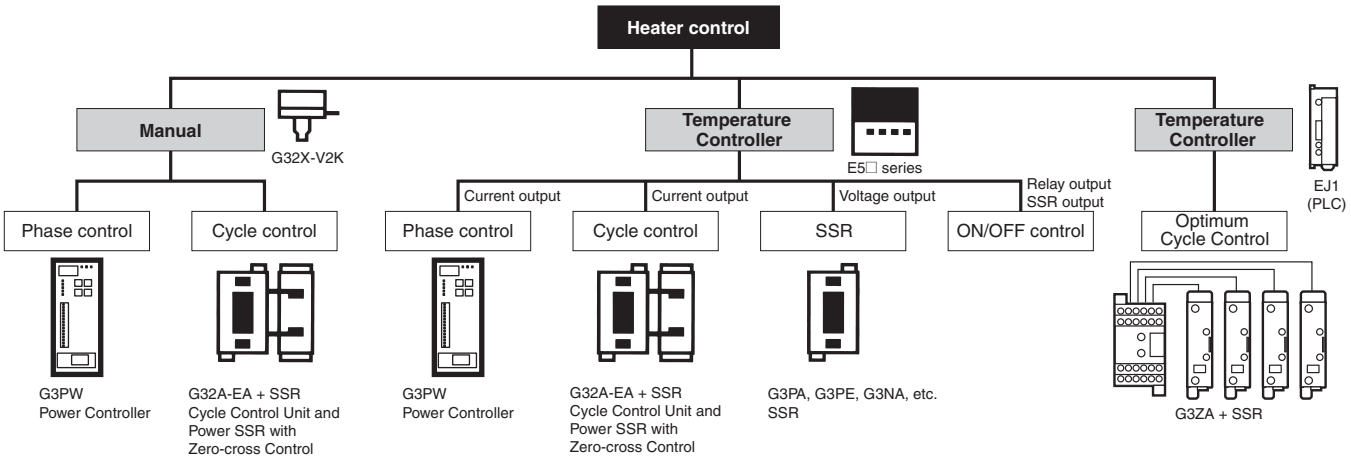
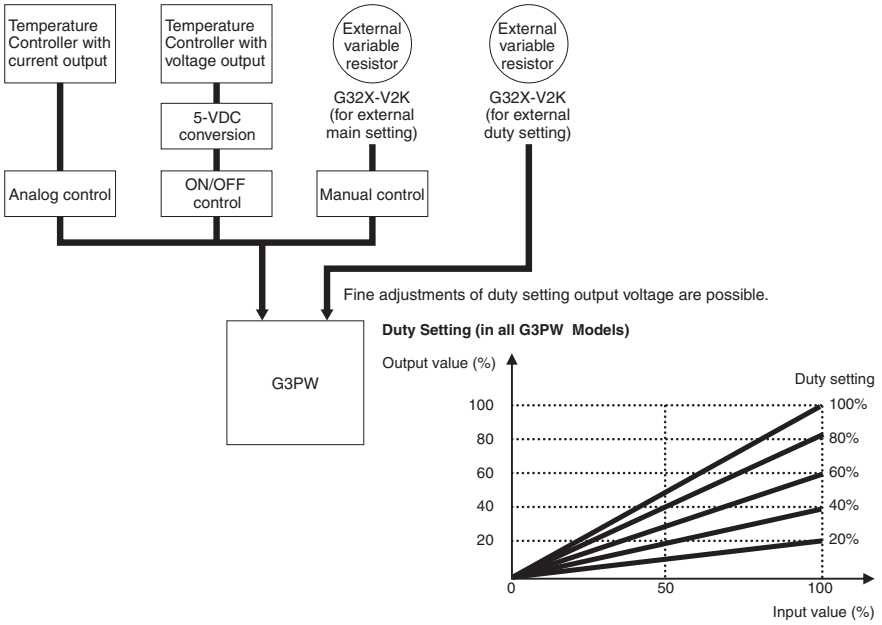
Overview of Power Controllers

■ Example of Combining Different Types of Heater Control



■ G3PW Control Methods



Analog Control

The change in current output of the Temperature Controller between 4 and 20 mA is used for precise heater control by the G3PX, which outputs smoothly adjusted power. Fine adjustments of the heater temperature are possible with external or internal duty setting.

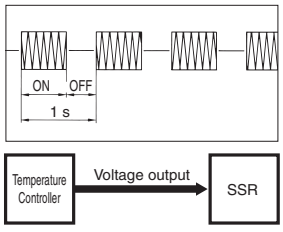
ON/OFF Control

The voltage output of the Temperature Controller is used for ON/OFF heater control. Fine adjustments of the heater temperature are possible with external or internal duty setting.

Manual Control

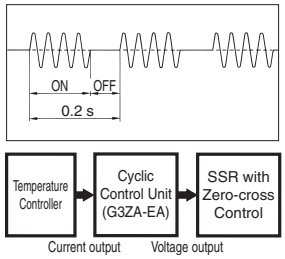
Output adjustments are possible with an external variable resistor.

ON/OFF Control



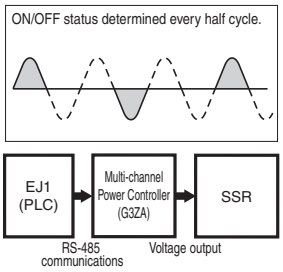
Enables noiseless temperature control at low cost with no complicated maintenance work required.

Cycle Control



Noiseless, high-speed response

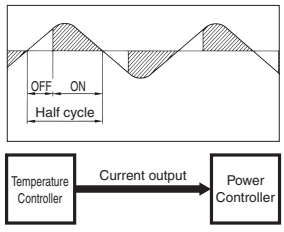
Optimum Cycle Control (High-accuracy zero-cross control)



Multi-channel heater control using communications.
High-speed response with no noise.

Note: Optimum cycle control can be achieved with the G3PW as well.

Phase Control

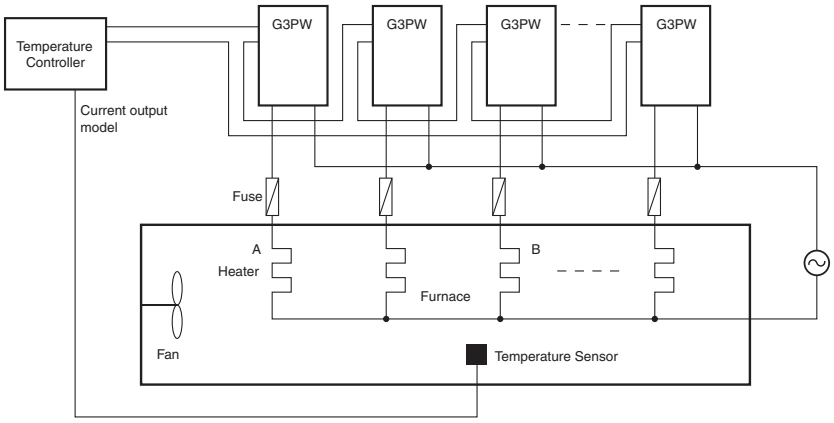


Highly accurate temperature control enables each heater to withstand long use.

■ Connection Examples of G3PW and Temperature Controller

- The soft-start time is adjusted between 0 and 99.9 s, thus enabling the heaters to withstand long use.
- If a single Temperature Controller is in control of more than one heater, by making a proper duty setting, the difference in temperature between the heaters can be improved.

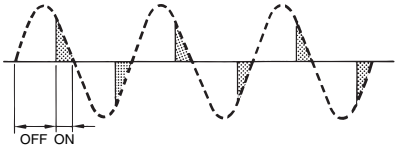
Note: The temperature at point B can be higher than that at point A due to thermal interference. In that case, make the duty set value for heater B smaller than that for heater A so that there will be no difference in temperature between points A and B.



Power Controller Glossary

Phase Control

- Output is varied at half-phase intervals, which enables highly accurate temperature control.



- Changes in the current output from the Temperature Controller between 4 and 20 mA are used for analog control of the output power.
  The more-detailed control resists disturbance better and results in less heat shock, which can also length the life of heaters.

Duty Setting

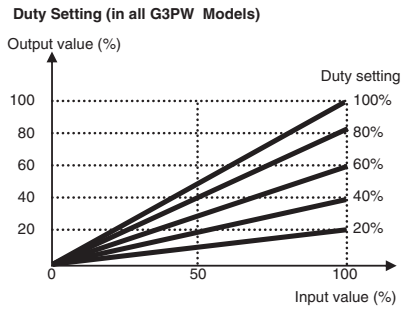
As shown in the following graph, changes in the output can be adjusted with key operations or with an external variable resistor.

In the case of an electric oven, overshooting may result by using a heater with a capacity that is excessively high for the size of the oven.

By adjusting the duty-setting variable resistor, the overshooting can be suppressed.

For example, if a duty of 60% is set for a 5-kW heater, a maximum of 3 kW will be input into the heater. Thus, it operates as a 3-kW heater.

Duty Setting
All G3PW Models



Monitoring the Total Operation Time

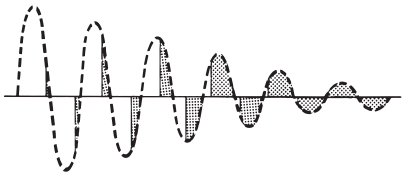
The time that power is supplied to the G3PW is totaled and a warning is output if the preset time is exceeded.

This is useful for the management of maintenance according to the life of the load.

Soft-start

This function suppresses the inrush current that is caused when the load is turned ON, thus ensuring smooth starting of the load.

This function is especially effective for loads that involve high inrush current, such as halogen lamps.



Base-up

This function briefly keeps the output of the G3PX turned ON after heating when the input signal is OFF.

This is effective for a smooth start of equipment that is slow in initial heating operation.

Output Limit

The output range is limited by an upper limit and a lower limit.

This feature functions for the control input. It does not suppress inrush current.

Use the soft start to suppress inrush current.

Constant Current (for Constant Current Models Only)

The constant current function automatically suppresses the inrush current when it is too large to be sufficiently suppressed by the soft start function, thus protecting the heater and system from damage.

Load Current Limit (for Constant Current Models Only)

The load current is measured by a built-in CT to adjust the output phase angle and suppress the load current.

The response time from measurement to suppression is 500 ms max. To suppress inrush current, use the soft start together with the load current limit.

Precautions for Correct Use of Power Controllers

Load

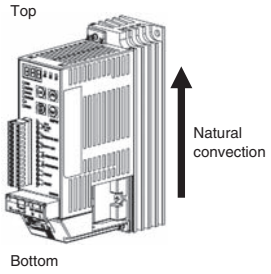
The primary side of a transformer can be connected as the load provided that the magnetic flux density of the transformer is 1.25 T or less.

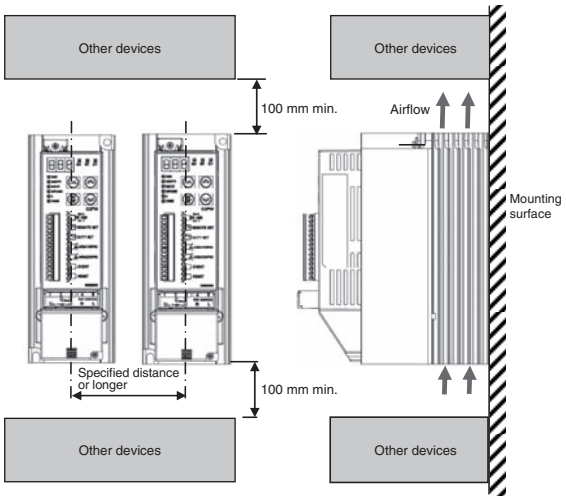
Installation Precaution

The 60-A G3PW weighs approximately 2 kg. Injury may result if the G3PW falls during installation. Handle it with care.

Mounting Procedure

For cooling efficiency, install the Power Controller in the correct direction. If you mount the G3PW in any direction other than the direction that is shown in the following figure, product failure or accidents may occur. Installing the Power Controller in the wrong direction may cause it to malfunction or to be damaged.

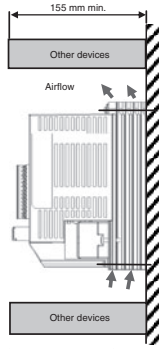




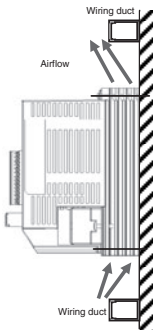
Note: Specified Dimensions

G3PW-A220	51 mm
G3PW-A245	71 mm
G3PW-A260	90 mm

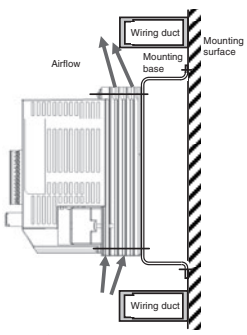
Mounting Position in Relation to Wiring Duct



If a device with a depth of 155 mm or more blocks the top or bottom of the Power Controller, the flow of air will be obstructed and heat will not dissipate.



Use short wiring ducts or other devices around the Power Controller

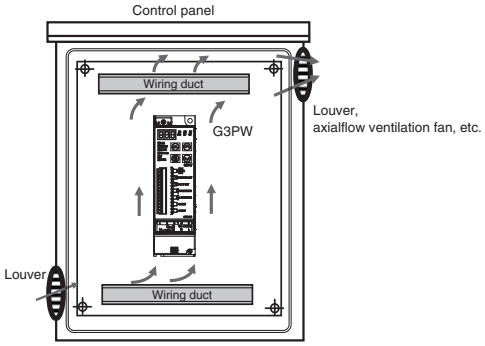


If tall devices or wiring ducts must be used, take measures such as mounting the Power Controller to a mounting base to improve ventilation.

Control Panel Ventilation

When mounting the Power Controller in a control panel, consider measures such as installing louvers or fans for ventilation in the control panel.

- If the air intake and outlet ports have filters, perform periodic maintenance to prevent the filters from becoming clogged.
- Install devices in such a way that airflow is not blocked inside or outside of the air intake and outlet ports.
- If using a heat exchanger for cooling inside the panel, it is most effective to mount it on the front of the Power Controller.



Wiring

- Make sure that the lead wires are thick enough according to the current.
- Be sure to turn off power to the G3PW when wiring. The G3PW has current leakage although the G3PW is turned off if the power supply is connected to the G3PW, which may give an electric shock.
- Do not wire power lines or high-tension lines along with the lines of the G3PW in the same conduit, otherwise the G3PW may be damaged or malfunction due to induction. Be sure to wire the lines of the G3PW separated from power lines or high-tension lines or laid in an exclusive, shielded conduit.

Tightening Torque

- Load Terminals

When connecting to the load terminals, use the specified wire size for each model of Power Controller.

Model	Recommended wire size	Tightening torque	Terminal screws
G3PW-A220	AWG 10 to 18	1.8 N·m	M4
G3PW-A245	AWG 6	2.8 N·m	M5
G3PW-A260	(See note.)		

Note: Crimp terminals that conform to UL and CSA specifications must be used.

- Command Input and Power Supply Terminals

Model	Recommended wire size	Tightening torque	Terminal screws
All models	AWG 14 to 18	0.8 to 1.0 N·m	M3.5

- Control Terminals

Model	Recommended wire size	Tightening torque	Terminal screws (See note.)
All models	AWG 26 to AWG 16	0.22 N·m	M2

Note: Only models with terminal blocks with small slotted screws have terminal screws.

- Use copper AWG26 to AWG16 twisted-pair cable when connecting the wires directly.
- Strip the wire sheathing for the following lengths, according to the connector type.
  - Small slotted terminals: 7 mm
  - Screwless clamp terminals: 9 mm
- When using twisted wires, it is recommended that you attach a ferrule with an insulating cover that conforms to DIN 46228-4 and connect the ferrule to the terminal.
- Use shielded twisted-pair wires for RS-485 communications wires. A maximum of 500 m total of wiring can be used.

Wiring for Error Detection

If a contactor is employed and operated with the relay output signal of the G3PW for error detection, make sure that the G3PW is closer to the power supply than the contactor.

However, if you shut off only the load terminals (L1 and T1) with a breaker or contactor, there will still be a voltage at the load terminals if a voltage is applied to the power supply terminals (terminals 4 and 5). Always shut OFF the voltage to the power supply terminals whenever you perform wiring work.

Instruments

Instrument	Remarks
Thermal type	Available
Digital type displaying root-mean-square values	
Moving-iron type	
Rectifier type	Not available (not precise enough)
Multimeter	
Digital multimeter	

Note: Use a meter that displays the effective values of the AC circuit voltage and current.

Operation Monitoring

You can check the operating status on the seven-segment display.

Variable Resistors

Use the following variable resistor for the main external setting and the external duty setting.

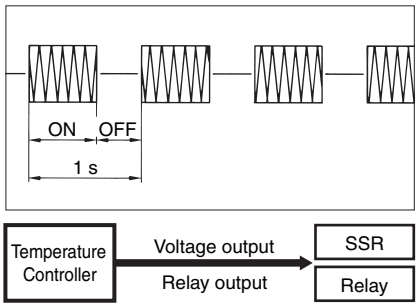
G32X-V2K (2 kΩ)

Q&A for Power Controllers

Q1 **In PID control, what are the differences between ON/OFF time-sharing proportional control, cycle control, optimum cycle control, and phase control?**

A1

ON/OFF Control

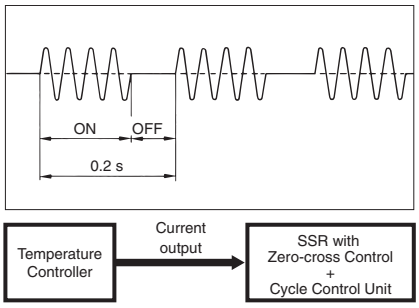


Note: This is just one example of the control cycle.

1. ON/OFF time-sharing proportional control is the most widely used control method in combination with Temperature Controllers.
2. The large difference in temperature of the heater, when turning ON and OFF will shorten the service life.
3. This method is suitable for controlling items with a large heat capacity, which are difficult to heat and cool.

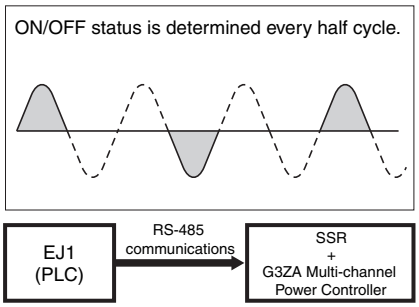
		Controllability Response	Space	Cost	Noise	Temperature Controller output
Phase		Best	Good	Good	Acceptable	Analog current
Cycle		Good	Good	Good	Best	Analog current
ON/OFF time sharing	**SSR**	Good	Best	Good	Best	Pulse voltage
	Relay	Acceptable	Best	Best	Acceptable	Relay

Cycle Control G32A-EA + SSR



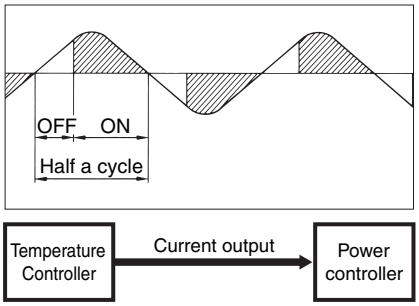
1. The output cycle of the voltage output enables detailed control with a short cycle, which achieves temperature control with greater precision than ON/OFF time-sharing proportional control.
2. Manual control without the use of Temperature Controllers has been achieved. (An external variable resistor is used.)

Optimum Cycle Control



1. Optimum cycle control is performed with SSR operation using load power supply detection and a trigger signal.
2. High-speed response is provided and high-accuracy temperature control is performed by turning the output ON and OFF every half cycle while suppressing generation of noise.

G3PW Phase Control

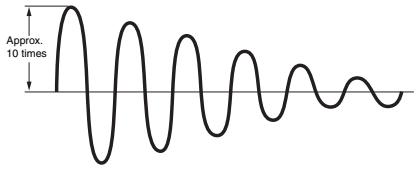


1. The output amount is changed each half cycle, enabling high-accuracy temperature control.
2. More finely tuned control enables resistance to external disturbances and few heat shocks, thereby extending the service life of the heater.
3. The gradient can be set as desired, and so the output amount can be set when a power controller is used in a set with a temperature controller.
4. Inrush current can be suppressed by using a soft start or a constant-current circuit.
5. Noise occurs due to phase control.

Q2 What is the constant-current function?

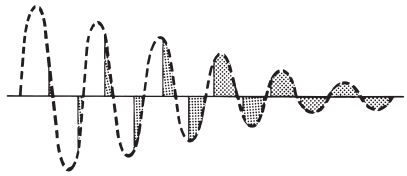
A2 This is a function that protects the heater and the system by automatically suppressing excessively large inrush current, such as with pure metal heaters. As shown in the following figure, ten times the rated current flows when power is applied to pure metal heaters, for which molybdenum and tungsten are typical.
(This current cannot be fully suppressed by using a long soft-start time.)

Flow without Constant-current Function



As shown in the following diagram, the constant-current circuit functions to automatically regulate to the current in response to the input signal. Inrush current is suppressed by reducing the ON phase.

Flow with Constant-current Function



Note: Protection is not provided in case of protection short circuit. Also use a quick-burning fuse.

Q3 For models with the constant-current function, can protection be provided with a G3PW against load short circuiting?

A3 Protection is not provided.

If short-circuit current flows, the elements will be destroyed before the constant-current or overcurrent detection currents operate. To protect the G3PW from short-circuit accidents, connect a quick-burning fuse.

Quick-burning Fuses

Product model	Fuse model	Fuse Holder
G3PW-A220E□-□□□	CR6L-20/UL	CMS-4
G3PW-A245E□-□□□	CR6L-50/UL	
G3PW-A260E□-□□□	CR6L-75UL	CMS-5

Q4 Why is the same phase used for the power supply circuit and the load circuit?

A4 The phase zero point must be detected to perform phase control. To detect the zero point, the phases must be the same. Phase difference may result in malfunctions. (The input signal and output amount will not match.)

ALL DIMENSIONS SHOWN ARE IN MILLIMETERS.
To convert millimeters into inches, multiply by 0.03937. To convert grams into ounces, multiply by 0.03527.