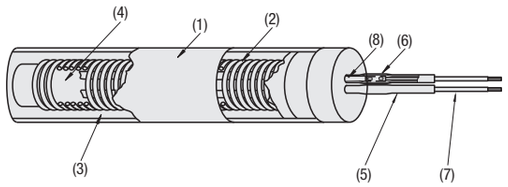
Cartridge Heaters -Guide-

■Features

This heater has long-life and high-power density, which is perfect for heating metal plates.
- For the maximum operating temperature, refer to specification of each product. A High Temperature Type whose maximum operating temperature is up to 900˚C is available.

■Basic Structure

Compression type heater with ceramic core of high temperature property wrapped with Nickel-chrome wires and isolated by magnesium oxide.



(1)Stainless Steel Sheath (Incoloy for High Temperature Type)
(2)Heating Coil (Nickel-chrome Wire)
(3)Insulation Powder (Magnesium Oxide)
(4)Ceramic Core
(5)Silicon (Insulation) Tube
(6)Crimp Terminal
(7)Lead Wire Film
(8)Nickel Pin

* Outer diameter of Lead Wire is approximately in the range of Ø2~Ø4, depending on the voltage and the amount of electric power.

■Mounting Method

- The clearance of the mounting hole of heated metal block should be as small as possible. Recommended clearance of hole machining is 0.05 or less (one side).

* The degree of adherence between a heater and heating product affects the life of heater. Also, a large clearance increases the time needed to raise the temperature and creates a slow response speed for temperature control. When the temperature of heating product is 300˚C or less, drill holes can be used, but reamer holes (H7) for the mounting hole of all heaters are always preferable.
* The life span of the heater largely depends on the operating environment.

■Precautions for Use

(1) Do not let heater be in idle running in the atmosphere. Breaking of wire and ignition may occur by abnormal heat if the heater is operated in the condition the heat-generating part is even partly out of heated object.
(2) Prevent the lead wire of the heater from getting wet.
(3) Remove machine oil and grease used at the time of hole machining of heated parts. it may carbonize and can be a cause of abnormal heating.
(4) When the ON-OFF cycle is extraordinarily short, it affects the life of a heater. Use of PID control is recommended.
(5) When the nickel pin is bent frequently, it may brake prematurely.
(6) Do not use over the rated voltage (V).
(7) When the heater is removed from the heat generating body, make sure that the power is turned off. In addition, do not touch the heater immediately after the power is turned off.
(8) Keep the temperature around the lead wire exit at 130°C or less.
(9) Keep the temperature around the flange at 180°C or less when using Flanged Type.
(10) Do not use in a vacuum.
* Refer to Cautions of each type of heaters and ensure a proper and safety use of the heaters.

■ Cartridge Heater Selection Chart

		Shapes		
		Straight	With Flange	L-shaped
Select from the Standard type Products with fewer days to ship	Reduces cost	L Dimension, W Electrical Power Standard Type (P.3223)		
	High electrical power density	High Temperature Type (P.3225)		
Want to choose the length, power, and etc freely	Reduces cost	Configurable L & W (P.3229) Lead Wire Selectable (P.3229)	Flange Type (P.3230) Lead Wire - Flange Selectable Type (P.3233)	L-shaped Type (P.3237) L-shaped Knurled Flanged Type (P.3238)
	Avoid Breaking	Lead Wire Protection / Internal Connection (P.3228) Break Resistant, Internal Connection (P.3234)		
	Lead wire protection	Flexible Hose Type (P.3231) Knurled Flanged Lead Wire Protection (P.3235)		L-shaped Reinforcement (P.3239)
	Sensor embedded	With Sensor (P.3232)		
	Usage at high temperature (800°C or more)	High Temperature Configurable L & W (P.3227)		
	The temperature on the heated object will be more uniform	Uniform Heating (P.3236)		
	Warms the tip only	Heat Generating Part & Length Configurable (P.3240)		

■Selection Method

(1) Determine the calories(W) required for the heater.

Calculate with the following formula, by using the weight of heating product, the specific heat of heating product, the increased temperature, and the heating time until the setting temperature.

$$\text{Calories Required for The Heater (kW)} = \frac{\text{Weight of Heating Product (kg)} \times \text{Specific heat of Heating Product (kcal/kg°C)} \times \text{Increased Temperature (°C)}}{860 \times \text{Heating Time (h)} \times \text{Efficiency } \eta}$$

It is difficult to calculate the Efficiency η precisely because it varies by heat-retention, insulation, arrangement of heaters but the suitable value is generally about 0.2~0.5.

- Specific Gravity and Specific Heat of Major Materials

Materials	Specific Gravity (g/cm³)	Specific Heat (kcal/kg°C)
Aluminum (7075 Aluminum Alloy P Type)	2.80	0.230
Steel	7.85	0.113
Stainless Steel	7.82	0.110
Brass	8.70	0.100

Ex.) When the heater block of around 8kg, 200x100x50 (mm) stainless steel, is heated to 180˚C.
(It is assumed that the temperature of the heater block is 20°C, and the heating time until the setting temperature is 30 minutes.)

$$\text{Calories Required for The Heater (kW)} = \frac{8 \times 0.11 \times (180-20)}{860 \times 0.5 \times 0.3} = 1.1 \text{ (kW)} = 1100 \text{ (W)}$$

* Efficiency is assumed to be 0.3 as the standard. *Refer to Actual Measurement Data: Temperature Rise Time / Electrical Power (Electrical Power Density)

(2) Determine the number of heaters and the quantity of heat (W) per one heater.

Determine the number of heaters based on the size of the heated product, and total calories (W) to be the quantity of heat required for heating product.
Ex.) Using 2 heaters of 550(W) (Total 1100W)

- Selection of Cartridge Heater (P. 3223 MCHS)

(1) Determine the diameter and length of the heater.
Ex.) MCHS12-200
(D) (L)

(2) Determine the voltage (V) to use.
Ex.) MCHS12-200-V200
(D) (L) (V)

(3) Determine the calories (W) required for the heating product.
Ex.) MCHS12-200-V200-W550
(D) (L) (V) (W)

(4)Check if required heater diameter (D), length (L), voltage (V) and calories (W) are available in L dimension - W (Electrical Power) Fixed Type (**P.3223**) and High Temperature Type (**P.3225**).

Caution: Select the larger electric power (W) than the required for L dimension - W (electric power) Fixed Type.

Ex.) MCHS12-200-V200-W550 L Dimension, Calories (Electrical Power) Fixed Type is Not Available (Go to (5))
(D) (L) (V) (W)

(5) Available to produce when the electrical power density (W/cm2) of heat-generating part is between 2 and 15 (W/cm2).

$$\text{Electrical Power Density (W/cm}^2\text{)} = \frac{\text{Electrical Power (W)}}{\pi(3.14) \times \text{Heater Diameter (cm)} \times (*)\text{Length of Heat-Generating Part (cm)}}$$

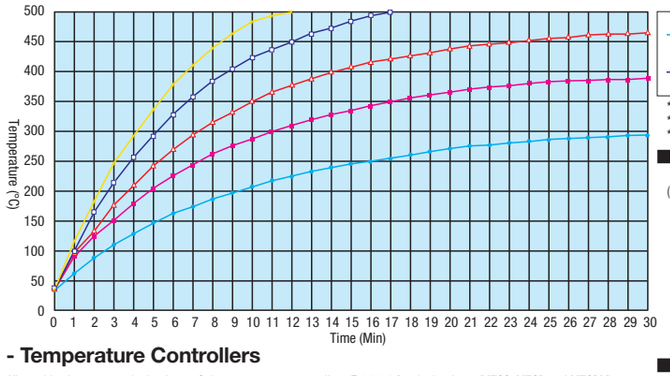
$$\text{Ex.) Electrical Power Density (W/cm}^2\text{)} = \frac{550}{3.14 \times 1.2 \times (20-1.5)} = 7.9$$

→ Available to produce *Length of Heat-Generator Part = L/10-1.5(cm)

(6) Determine the length of lead wires.
Ex.) MCHS12-200-V200-W550-F500
(D) (L) (V) (W) (F)

* When the electrical power density (W/cm²) is not more than 2: 1) Reduce the heater diameter, 2) Shorten the heater length, 3) Reduce the number of heaters to use.
* When the electrical power density (W/cm²) is not 15 or less: 1) Increase the heater diameter, 2) Increase the heater length, 3) Increase the number of heaters to use.
* The electrical power density (W/cm²) of heater should be as low as possible, which enables a long-life and stable control.

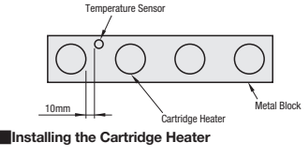
- Actual Measurement Data: Temperature Rise Time / Electrical Power (Electrical Power Density)



* Heater Used: Diameter Ø10, Length 65mm (Heat-generating Part 50mm)
* Heated Object : Aluminum (60x50x20)
* The temperature is of the central surface temperature of aluminum.

■Temperature Control

The position of the temperature sensor is determined by the setting conditions of the heated product (metal block), however, it is recommended to place near the heater to prevent heater overheating.
* Generally, around 10mm suitable for the distance between the heater and the temperature sensor.



- Temperature Controllers

All cartridge heaters are single-phase. Select temperature controllers (**P.3294**) for single-phase (MTCS, MTCD and MTCRM).
For the possible numbers of cartridge heaters to connect one controller, refer to the example below.
(Ex.)When connecting MTCS (Max. allowable electric current: 20A) to MCHK12-150-V100-W300

The electric current which streams in one cartridge heater Electrical Current (A) = $\frac{\text{Electrical Power (W)}}{\text{Voltage (V)}} = \frac{300 \text{ (W)}}{100 \text{ (V)}} = 3 \text{ (A)}$

The possible numbers (N) of cartridge heaters to connect one temperature controller (MTCS) $N = \frac{20 \text{ (A)}}{3 \text{ (A)}} = 6.7 \rightarrow 6$ pcs.

(However, only 2 cartridge heaters can be connected to a terminal. Please use terminal blocks (**P.3292**) for branching.)

■Installing the Cartridge Heater

In order to prevent the cartridge heater from falling off
(1) Fix the sheath with screw.
(2) Fix the lead wires onto angle, etc.