

## 5 FAQs why and how to use Thermal fuse

According to statistics, there were 250,000 fires occurred only in the last year. In electrical fires, circuit problems such as short circuits, overload, and poor contact accounted for 68.9% of the total. The direct property loss was 4.009 billion yuan and 1,183 people died.

### Why do we have to add a thermal fuse to the appliance?

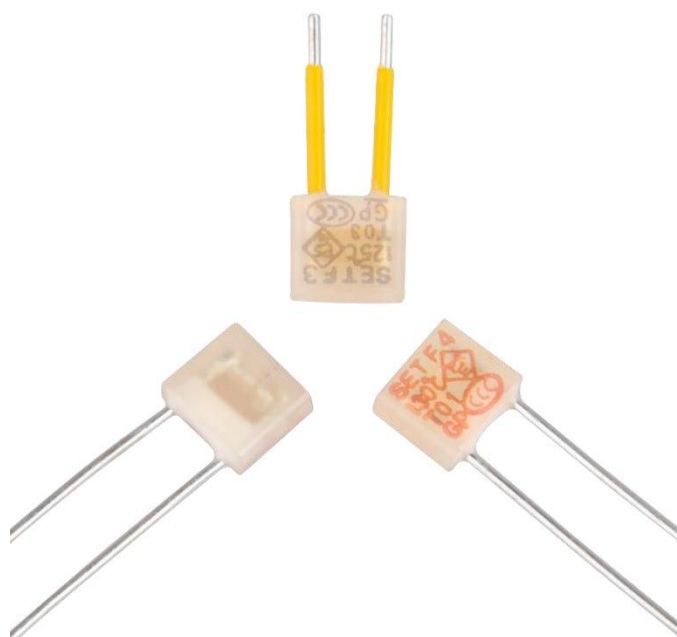
We use too many electrical appliances in our lives, such as induction cookers, rice cookers, electric water heaters, electric heaters, coffee machines, waffle machines, and so on. Under normal circumstances, there will be a control panel inside. The Control Management Chip technology will detect the ambient temperature. Usually, the NTC temperature sensing element is used, according to different heating process requirements, and the heater controls work to achieve the desired temperature setting. Although the control chip turns off the heater when the proper temperature is reached, the heater is a very dangerous device. If the NTC fails or the control chip fails to turn off the power supply of the heating element, it may cause safety accidents such as an explosion or fire. Therefore, the independent design of temperature detection and control is not completely reliable and cannot pass the safety certification. So that is why we must add a thermal fuse to achieve double protection.



### What is a thermal fuse?

Thermal Fuse is called in the safety standards as **Thermal Cutoff / Thermal-Link (TCO)**. The thermal fuse is an electrical over-temperature protection element. Such components are usually installed in electrical appliances that are prone to overheating. When an electrical appliance fails and generates heat, then the temperature exceeds an abnormal temperature, the thermal fuse will automatically activate and disconnect the power supply to prevent the electrical appliance from causing a fire. This is equivalent to sacrificing itself and protecting the life of an entire family/home/building/business. There're two types of thermal fuse: Alloy Type and Organic type. According to the shape, we divided it into Radial type and Axial type.

#### Radial type



#### Axial type



## How do they work?

First of all, we need to understand several important parameters when choosing a thermal fuse:

- **Tf (Rated Functioning Temp.):**

The temperature of the Alloy Thermal-Link which causes it to change the state of conductivity with a detection current up to 10 mA as the only load.

- **Fusing Temp:**

The temperature of the Alloy Thermal-Link which causes it to change its state of conductivity is measured with silicone oil bath in which the temperature is increased at the rate of 0.5 °C to 1 °C / minute, with a detection current up to 10 mA as the only load.

- **Th (Holding Temp.):**

The maximum temperature at which an Alloy Thermal-Link will not change its state of conductivity when conducting rated current for 168 hours.

- **Tm (Maximum Temp. Limit):**

The temperature of the Alloy Thermal-Link stated by the manufacturer, up to which the mechanical and electrical properties of the Alloy Thermal-Link having changed its state of conductivity, will not be impaired for a given time.

- **Ir (Rated Current):**

The current is used to classify an Alloy Thermal-Link, which is the maximum current that Alloy Thermal-Link allows to carry and is able to cut off the circuit safely.

- **Ur (Rated Voltage):**

The voltage used to classify an Alloy Thermal-Link, which is the maximum voltage that Alloy Thermal-Link allows to carry and is able to cut off the circuit safely.

- **In (Nominal Discharge Current):**

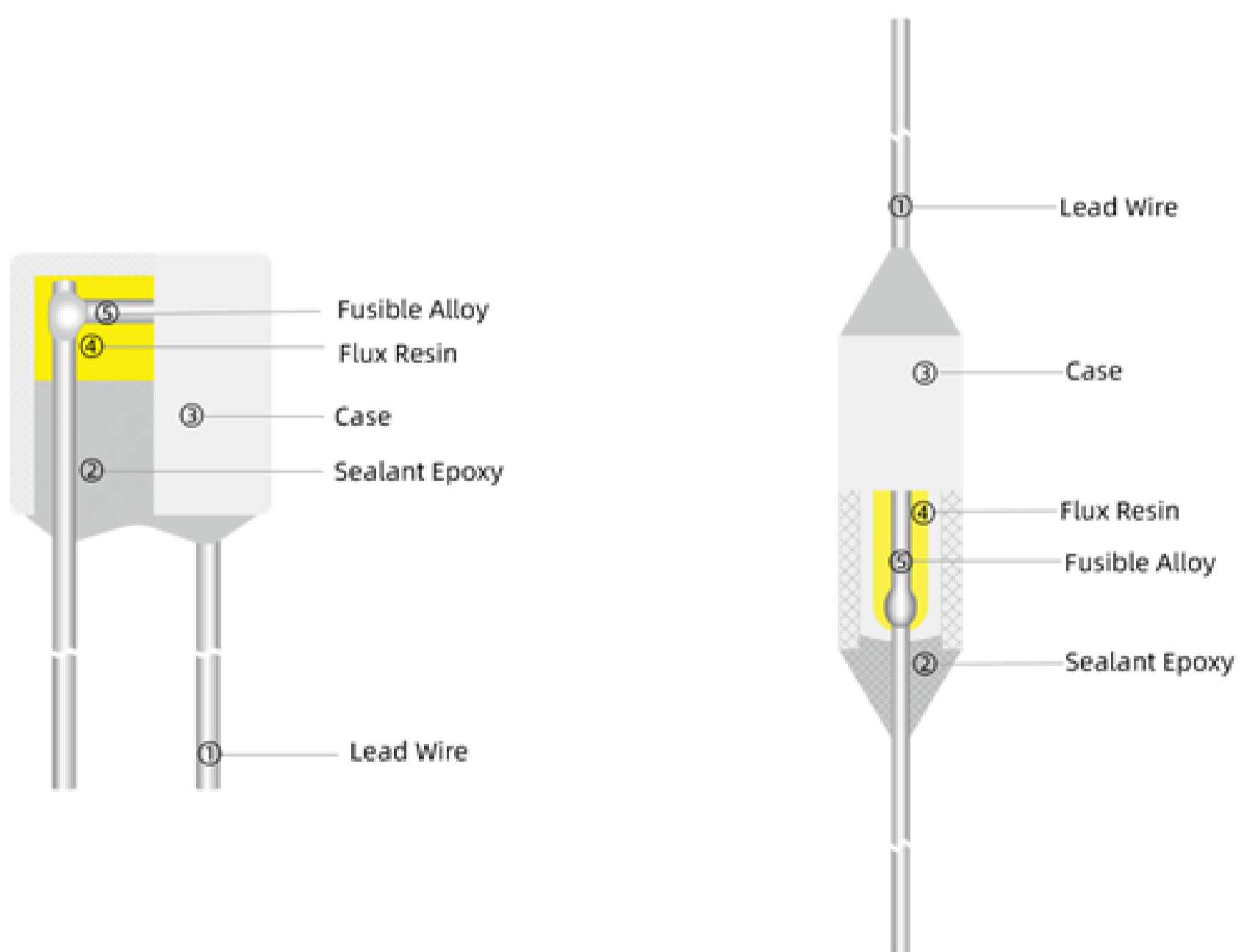
Being able to withstand 15 peak currents of waveform 8/20 µs to test the product's durability of withstanding pulse current.

- **Imax (Max. Discharge Current):**

Being able to withstand 1 peak current of waveform 8/20 µs to test max. pulse current that the product can withstand.

## Alloy Thermal-Link / Alloy Thermal Cutoff (ATCO):

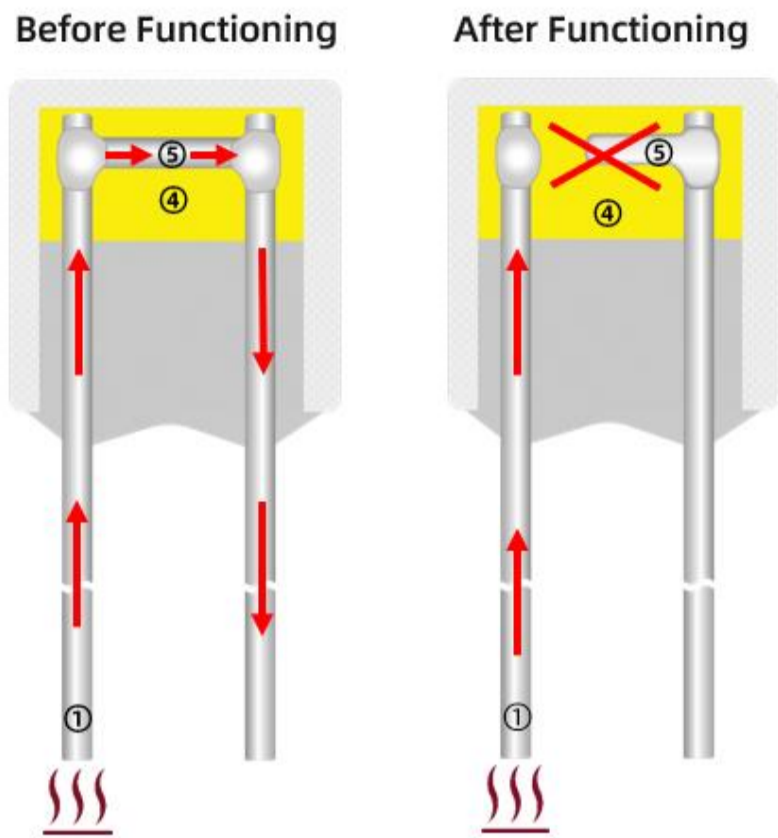
It is a non-resettable protection device that can only play a role once. As the picture shows: It mainly consists of lead wires①, sealant Epoxy②, case ③, flux resin④, and fusible alloy⑤. The two lead wires① of the thermal fuse are connected with a piece of fusible alloy⑤, and the flux resin④ is coated with the fusible alloy⑤. Current can flow from one Lead Wire① to the other. When the temperature around the thermal fuse rises to its operating temperature, the fusible alloy⑤ melts, and under the action of surface tension with the help of the flux resin④, it shrinks into a ball and attaches to the ends of the two Lead Wires①, permanently cutting off the circuit.



## Working Principle

### Radial Type - Alloy Thermal Cutoff (ATCO)

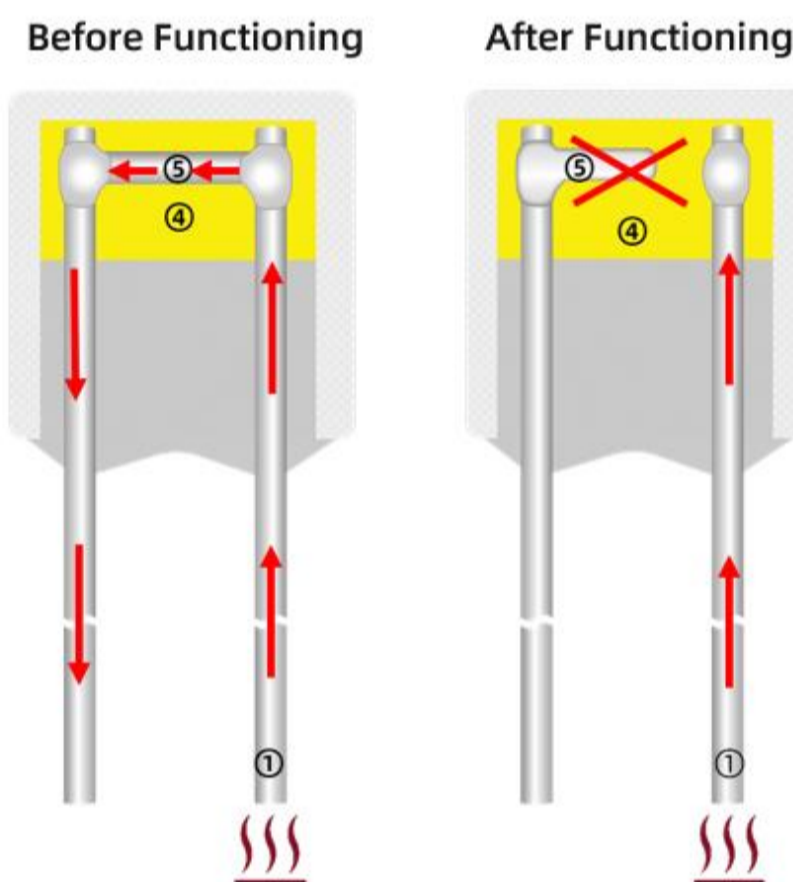
#### 1: When the heat source is on the left Lead Wire



Heat is transferred from the left Lead Wire① to the Fusible Alloy⑤. When the temperature reaches Fusing Temp. fusible alloy⑤ disconnects.

Since the shrinkage and breaking speed of the fusible alloy ⑤ is not enough, and the electrical gap to be broken is not enough, Therefore, the surface tension of Flux Resin④ is needed to improve the disconnection speed and distance of fusible alloy⑤, to achieve the time and electrical gap of the main circuit safely disconnection. (For GB98161.1 clearance requirements for thermal fuses: when the rated voltage is 126 ~ 250 V, the minimum value of the clearance should be at least 1.5 mm)

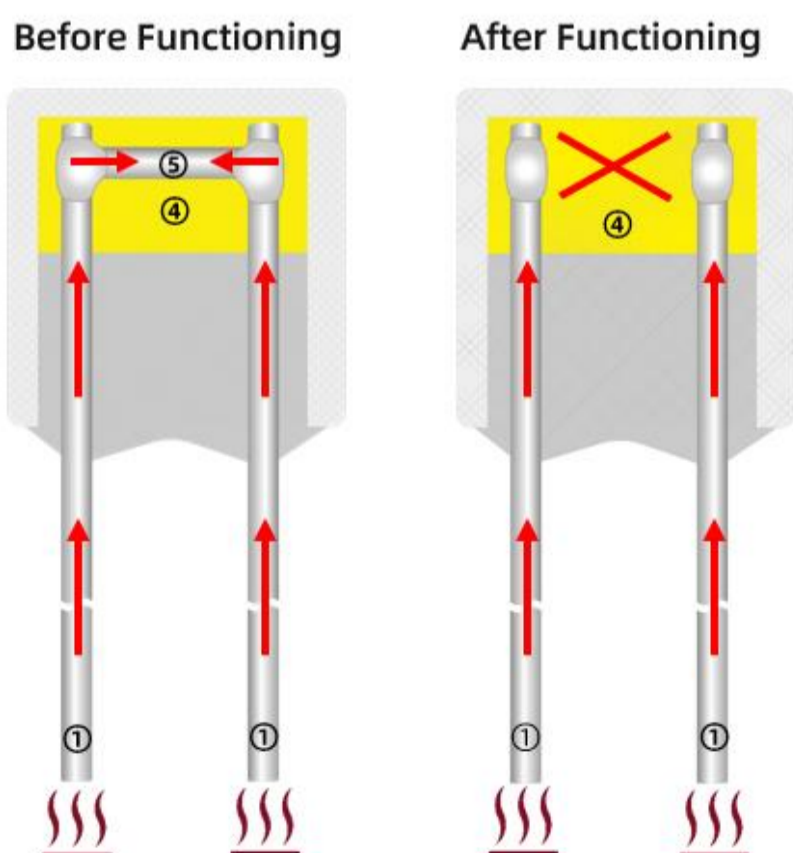
#### 2: When the heat source is on the right Lead Wire



Heat is transferred from the right Lead Wire① to the Fusible Alloy⑤. When the temperature reaches Fusing Temp. fusible alloy⑤ disconnects.

Since the shrinkage and breaking speed of the fusible alloy ⑤ is not enough, and the electrical gap to be broken is not enough, Therefore, the surface tension of Flux Resin④ is needed to improve the disconnection speed and distance of fusible alloy⑤, to achieve the time and electrical gap of the main circuit safely disconnection. (For GB98161.1 clearance requirements for thermal fuses: when the rated voltage is 126 ~ 250 V, the minimum value of the clearance should be at least 1.5 mm)

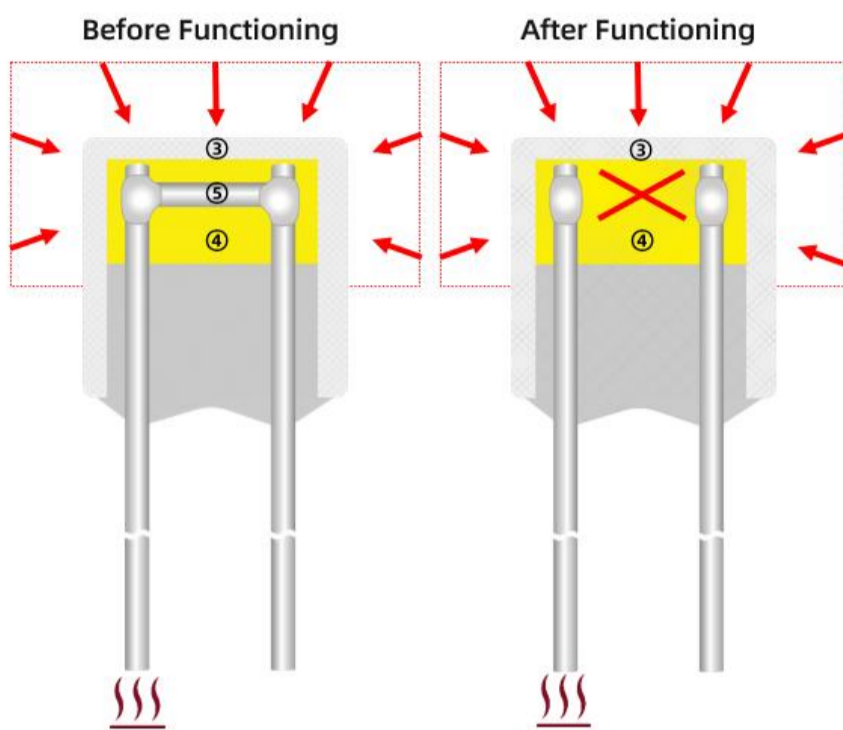
#### 3: When both Lead Wires have a heat source



Heat is transferred from both Lead Wires① to the Fusible Alloy⑤. When the temperature reaches Fusing Temp. fusible alloy⑤ disconnects.

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## 4: When the heat source surrounds the case



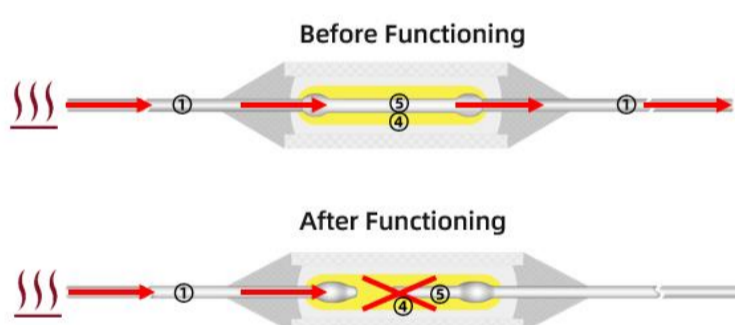
Heat is transferred from the case③ to the Fusible Alloy⑤. When the temperature reaches Fusing Temp. fusible alloy ⑤ disconnects.

Since the shrinkage and breaking speed of the fusible alloy ⑤ is not enough, and the electrical gap to be broken is not enough, Therefore, the surface tension of Flux Resin④ is needed to improve the disconnection speed and distance of fusible alloy⑤, to achieve the time and electrical gap of the main circuit safely disconnection. (For GB98161.1 clearance requirements for thermal fuses: when the rated voltage is 126 ~ 250 V, the minimum value of the clearance should be at least 1.5 mm)

In the case of space permitting, the closer the better cut off the time of abnormal heating, to ensure that the thermal runaway will not lead to other more dangerous possibilities.

## Axial Type - Alloy Thermal Cutoff (ATCO)

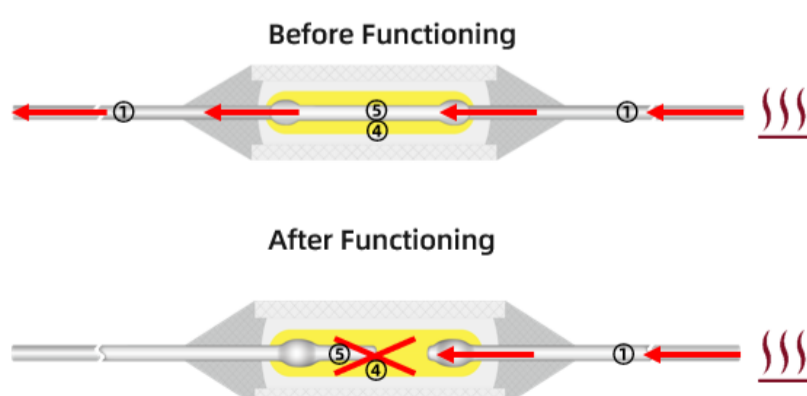
### 1: When the heat source is on the left Lead Wire



Heat is transferred from the left Lead Wire① to the Fusible Alloy⑤. When the temperature reaches Fusing Temp. fusible alloy⑤ disconnects.

Since the shrinkage and breaking speed of the fusible alloy ⑤ is not enough, and the electrical gap to be broken is not enough, Therefore, the surface tension of Flux Resin④ is needed to improve the disconnection speed and distance of fusible alloy⑤, to achieve the time and electrical gap of the main circuit safely disconnection. (For GB98161.1 clearance requirements for thermal fuses: when the rated voltage is 126 ~ 250 V, the minimum value of the clearance should be at least 1.5 mm)

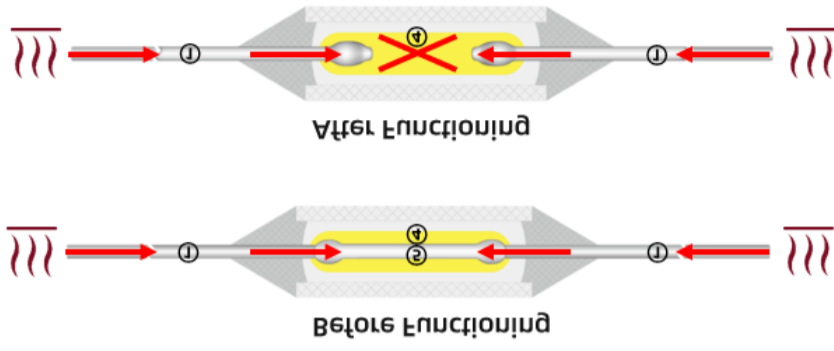
### 2: When the heat source is on the right Lead Wire



Heat is transferred from the right Lead Wire① to the Fusible Alloy⑤. When the temperature reaches Fusing Temp. fusible alloy⑤ disconnects.

Since the shrinkage and breaking speed of the fusible alloy ⑤ is not enough, and the electrical gap to be broken is not enough, Therefore, the surface tension of Flux Resin④ is needed to improve the disconnection speed and distance of fusible alloy⑤, to achieve the time and electrical gap of the main circuit safely disconnection. (For GB98161.1 clearance requirements for thermal fuses: when the rated voltage is 126 ~ 250 V, the minimum value of the clearance should be at least 1.5 mm)

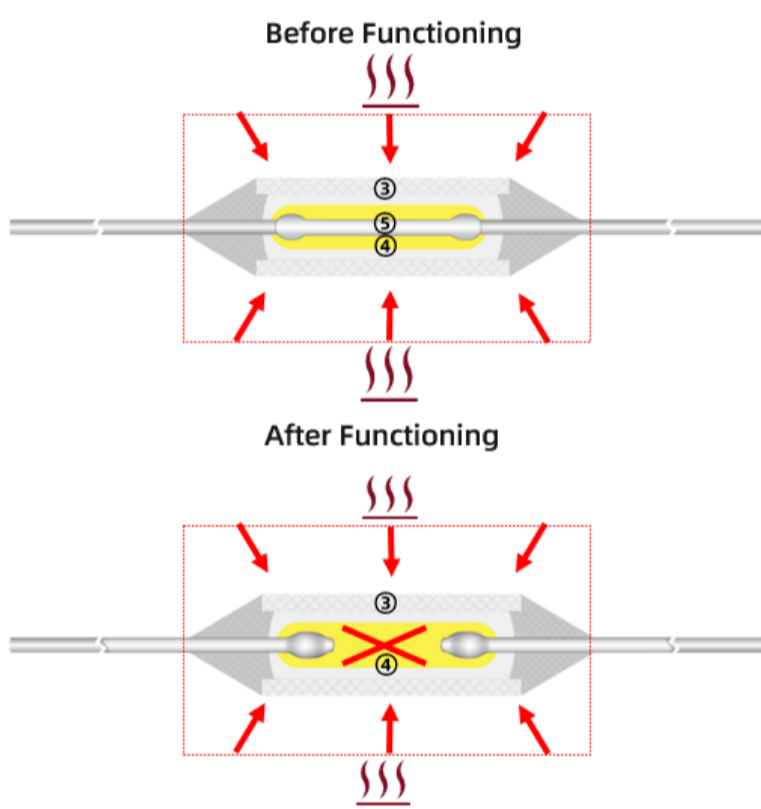
### 3: When both Lead Wires have a heat source



Heat is transferred from both Lead Wires① to the Fusible Alloy⑤. When the temperature reaches Fusing Temp. fusible alloy⑤ disconnects.

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### 4: When the heat source surrounds the case



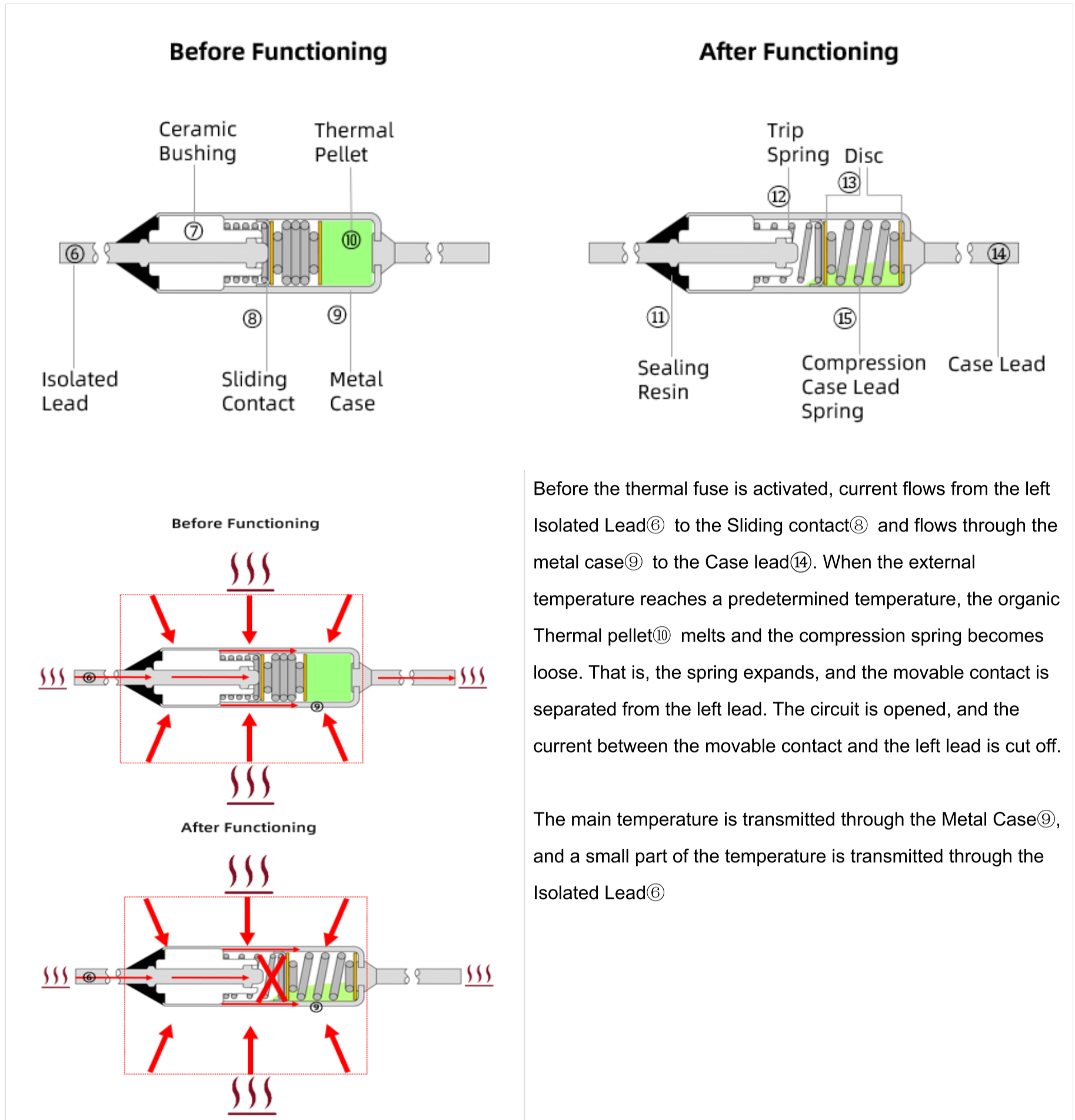
Heat is transferred from the case③ to the Fusible Alloy⑤. When the temperature reaches Fusing Temp. fusible alloy⑤ disconnects.

Since the shrinkage and breaking speed of the fusible alloy ⑤ is not enough, and the electrical gap to be broken is not enough, Therefore, the surface tension of Flux Resin④ is needed to improve the disconnection speed and distance of fusible alloy⑤, to achieve the time and electrical gap of the main circuit safely disconnection. (For GB98161.1 clearance requirements for thermal fuses: when the rated voltage is 126 ~ 250 V, the minimum value of the clearance should be at least 1.5 mm)

In the case of space permitting, the closer the better cut off the time of abnormal heating, to ensure that the thermal runaway will not lead to other more dangerous possibilities.

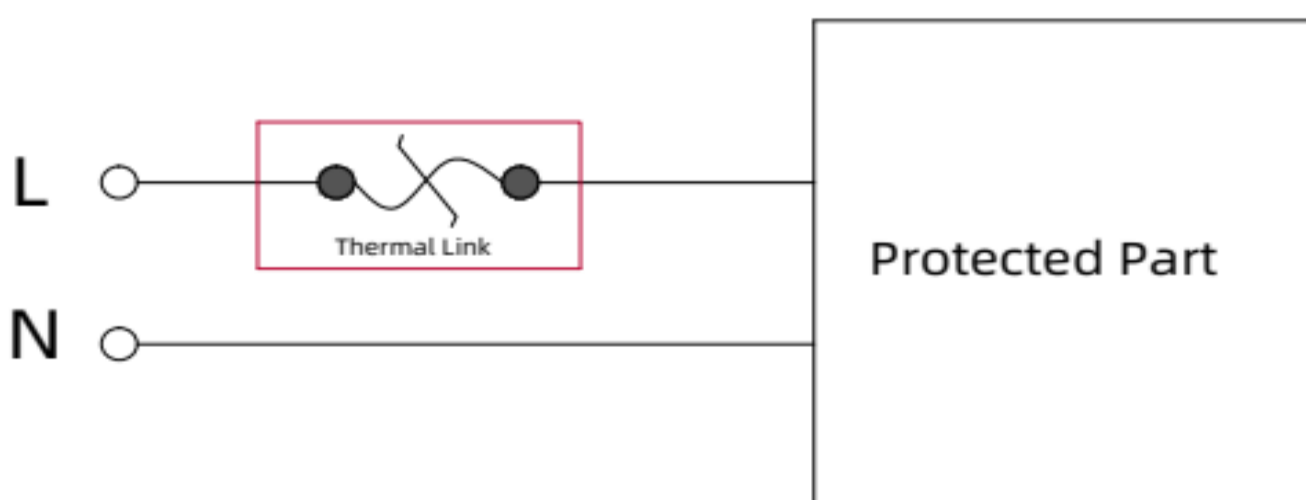
### Organic Thermal-Link (OTCO):

It is a non-resettable protection device that can only play a role once. As the picture shows: It mainly consists of metal case<sup>⑨</sup>, spring<sup>⑫</sup>, Ceramic Bushing<sup>⑦</sup>, Disc<sup>⑬</sup>, Sealing Resin<sup>⑪</sup>, sliding contact<sup>⑧</sup>, and thermal pellet<sup>⑩</sup>. The organic thermal pellet<sup>⑩</sup> responds to abnormal temp. situation and triggers the cutoff function.



### How do they (ATCO & OTCO) apply to the circuit?

They are connected in the same way in the circuit, as shown in the figure below is the simplest circuit application, which is connected in series in the circuit to protect the subsequent circuit. When the overheating problem occurs, the circuit can be cut off in time to ensure the safety of the downstream part.



## How to choose these two kinds of temperature fuses?

They have the same function of protecting the circuit from over-temperature. But there're some differences in materials, theory, rated current, and application. Let's look at the comparison table below to understand it clearly:

ITEM	ALLOY THERMAL CUTOFF – ATCO	ORGANIC THERMAL-LINK (OTCO)
RATED CURRENT	1 ~ 200 A	10 / 15 / 16 A
RATED FUNCTIONING TEMP.	76 ~ 230 °C	72 ~ 263 °C
PRECISION	±2 °C	±2 °C
MATERIALS	Case: Plastic/Ceramic (Shell insulation) Inner: Alloy + Flux Resin	Case: Metal (shell live) Inner: Spring + Sliding Contact + Thermal Pellet
THEORY (WHEN REACHES THE FUSING TEMP.)	The fusible Alloy melts and quickly retracts to the two Lead Wires ends	The organic thermal pellet melts and the compression spring becomes loose
SHAPE	Axial / Radial	Axial
APPLICATION	<ul style="list-style-type: none"> <li>● Outlet PDU</li> <li>● AC motor</li> <li>● Indoor lighting</li> <li>● Civil power</li> <li>● Electric vehicle</li> <li>● Kitchen and bathroom appliances</li> <li>● Environmental ventilation</li> <li>● Living appliances</li> <li>● Main Appliances</li> <li>● Transformer</li> </ul>	<ul style="list-style-type: none"> <li>● Small Home Appliances: Electric Cooker, Bread Maker, Coffee Machine, Soymilk Machine, etc.</li> <li>● Comfort Home Appliances: Washing Machine, Refrigerator, Air Conditioner, etc.</li> <li>● Personal Care Appliances: Hair Dryer, Hair Straightener, Electric Iron, etc.</li> <li>● Commercial Appliances: Printer, Scanner, Fax Machine, etc.</li> <li>● Automobile Field: Air Conditioner, Heated Seat, etc.</li> </ul>

## Summary

Have you gotten the five basic answers about the thermal fuse? This is a small but indispensable component. If there is no such protective element in some necessary circuits, when overheating fault occurs, the electrical appliance will burn out, nonetheless to say the risk of a safety hazard can cause danger to life. All we must pay attention to!

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