

MICROTEMP® Thermal Fuses

Product Information and
Application Notes



Upper Limit Temperature Protection

MICROTEMP®, the original thermal fuse from Therm-O-Disc, offers the broadest combination of globally certified temperatures and electrical loads, as well as the broadest range of packages, mountings and design configurations on the market today.

MICROTEMP Features:

- Globally certified temperatures and electrical loads
- One-shot operation cuts off electrical power
- Current interruption capacity up to 25 amps @ 250VAC
- Low resistance
- Compact size
- RoHS compliant

Operating Principle

The active trigger mechanism of the thermal fuse is an exclusively formulated, electrically nonconductive pellet. Under normal operating temperatures, the solid pellet holds spring loaded contacts closed. When a predetermined temperature is reached, the pellet melts, allowing the compression spring to relax. The trip spring then slides the contact away from the lead and the circuit is opened.

After the thermal fuse opens a circuit, the fuse needs to be replaced. This replacement procedure must include correction of the fault condition before the product is operated again.

| | G4 | G5 | Z6 | G6 | G7 | G8 | S9 |
|------------------------------------|-----|-----|--------------------------|---|----|-----|-----|
| Typical Resistive Rating at 250VAC | 10A | 20A | 16A Higher Tm Than G6 | 16A More Temperature Ratings Than Z6 | 5A | 25A | 15A |
| Details found on page | 3 | 5 | 7 | See pages 14-15 | | | |

Application Notes - Page 16
Mountings & Configurations - Page 9

NOTE: The terms *thermal fuse*, *thermal cutoff*, *thermal link*, and *TCO* are synonymous and may be used interchangeably throughout the catalog.

G4 MICROTEMP Thermal Fuses



G4 MICROTEMP - the Original Thermal Fuse

Providing reliable back-up protection for temperature controlling thermostats and other over-temperature conditions, the G4 series MICROTEMP thermal fuse is the industry standard for over-temperature protection. The G4 is rated for continuous operating currents up to 10 amps @ 250VAC.

Benefits

- The industry standard for over-temperature protection
- Available in a wide range of temperatures to offer design flexibility in your application
- Available in mounted and packaged designs

Features

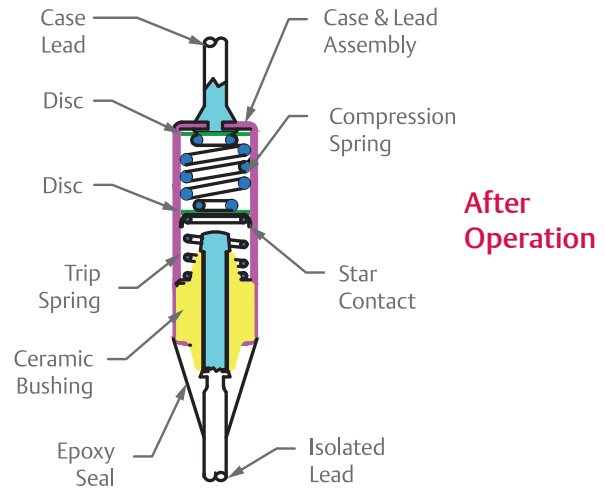
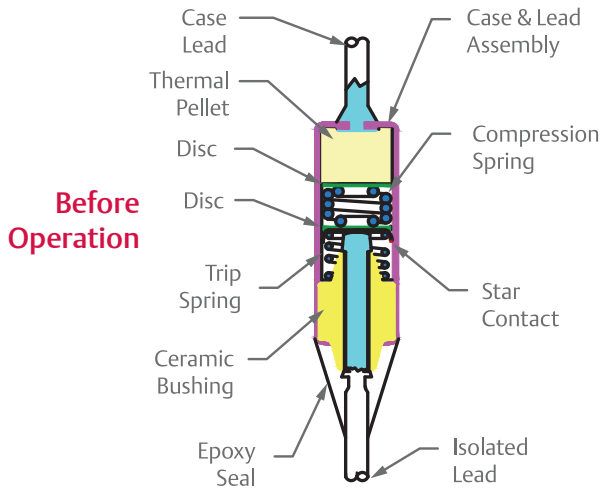
- One shot operation cuts off electrical power
- 10A/250VAC, 15A/120VAC, 5A/24VDC
- Low Resistance
- Compact size

Applications

- Portable Appliance
- Major Appliance
- HVAC
- Power Supplies
- Water Heater
- Other



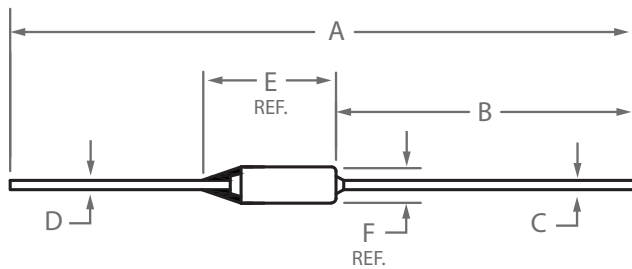
G4 MICROTEMP Product Information



Standard Dimensions

| | | Standard Leads |
|-----|--|--------------------------------------|
| A | Overall Length $\pm .12"$ ($\pm 3.0\text{mm}$)* | 2.51" (63.8mm) |
| B | Case Lead Length $\pm .06"$ ($\pm 1.5\text{mm}$) | 1.38" (34.9mm) |
| C | Case Lead Diameter | 0.040" (1.0mm) |
| | Case Lead Material | Tin Plated Copper |
| D | Isolated Lead Diameter | 0.040" (1.0mm) |
| | Isolated Lead Material | Silver Plated Copper |
| E/F | Case Dimensions, Including Epoxy | .58" L x .158" D (14.7mm x 4.0mm) |

* Overall length available up to 5.83" (148mm)



Electrical Ratings

| Agency | Resistive | Inductive |
|---------|--------------------------------------|-------------------------|
| UL/CSA | 10A/250VAC 15A/120VAC 5A/24VDC | 8A/250VAC 14A/120VAC |
| VDE | 10A/250VAC | 8A/250VAC |
| CCC | 10A/250VAC | 8A/250VAC |
| PSE JET | 10A/250VAC | |
| S JET* | 30A/16VDC** | |
| Korea | 10A/250VAC | |

*For S JET ratings for Japan replace 'G' with 'S' as first letter of nomenclature

**Load agency approved for 172C and 240C temperatures only

Operating Temperature Summary

| Tf°C | Th°C | Tm°C |
|------|------|------|
| 072 | 57 | 100 |
| 073 | 58 | 100 |
| 077 | 62 | 300 |
| 084 | 69 | 220 |
| 091 | 76 | 300 |
| 093 | 78 | 300 |
| 098 | 83 | 300 |
| 104 | 89 | 200 |
| 110 | 95 | 240 |
| 117 | 102 | 240 |
| 121 | 106 | 300 |
| 128 | 113 | 205 |
| 134 | 119 | 205 |
| 141 | 126 | 205 |
| 144 | 129 | 300 |
| 152 | 137 | 205 |
| 158 | 143 | 240 |
| 167 | 152 | 210 |
| 172 | 157 | 310 |
| 184 | 169 | 240 |
| 190 | 175 | 350 |
| 192 | 177 | 210 |
| 205 | 190 | 310 |
| 216 | 200 | 450 |
| 229 | 200 | 450 |
| 240 | 200 | 450 |
| 257 | 220 | 470 |

Tf = Functioning open temperature $+0/-5^{\circ}\text{C}$

Th = Maximum temperature of the thermal fuse, measured at the case end, at which the thermal fuse can be maintained for a period of at least 168 hours without opening

Tm = Maximum overshoot temperature. Temperature up to which the open thermal fuse will not change state

G5 MICROTEMP Thermal Fuses



G5 MICROTEMP - the Original Thermal Fuse

Designed for higher voltage and current applications, the G5 MICROTEMP Thermal Fuse is rated for operating currents up to 20 amps @ 277 VAC. The internal construction of the G5 is designed for interrupting higher currents and withstanding higher temperatures than other models.

Benefits

- Designed for higher voltage and current applications
- Available in a wide range of temperatures to offer design flexibility in your application
- Available in mounted and packaged designs

Features

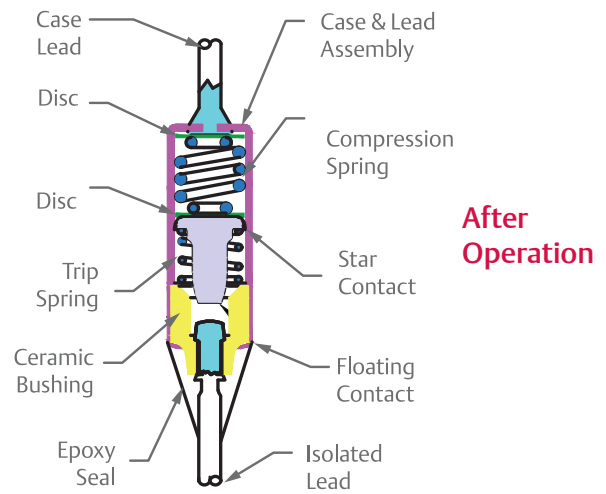
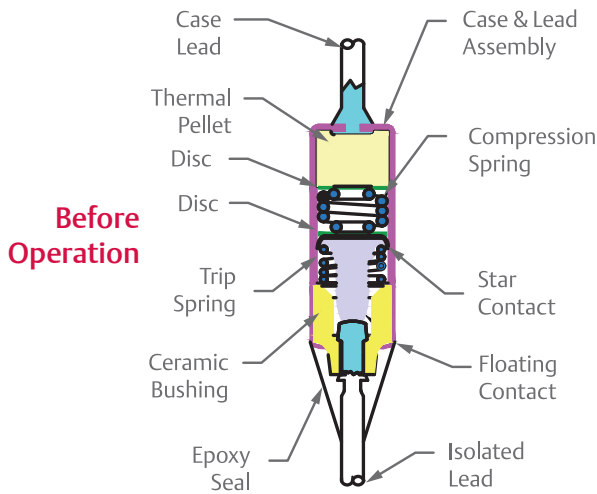
- One shot operation cuts off electrical power
- 20A/250VAC, 20A/277VAC, 25A/120VAC
- High Overshoot Temperature T_m
- Compact Size

Applications

- Portable Appliance
- Major Appliance
- HVAC
- Power Supplies
- Automotive
- Water Heater
- Other



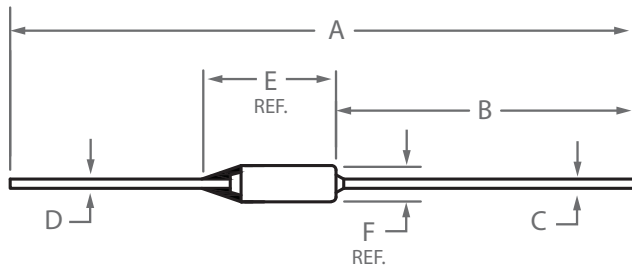
G5 MICROTEMP Product Information



Standard Dimensions

| | | Standard Leads |
|-----|----------------------------------|--------------------------------------|
| A | Overall Length ± .12" (±3.0mm)* | 2.51" (63.8mm) |
| B | Case Lead Length ± .06" (±1.5mm) | 1.38" (34.9mm) |
| C | Case Lead Diameter | 0.040" (1.0mm) |
| | Case Lead Material | Tin Plated Copper |
| D | Isolated Lead Diameter | 0.040" (1.0mm) |
| | Isolated Lead Material | Silver Plated Copper |
| E/F | Case Dimensions, Including Epoxy | .58" L x .158" D (14.7mm x 4.0mm) |

* Overall length available up to 5.83" (148mm)



Electrical Ratings

| Agency | Resistive |
|---------|---|
| UL/CSA | 20A/250VAC 25A/120AC 21A/240VAC 20A/277VAC |
| VDE | 20A/250VAC |
| CCC | 20A/250VAC |
| PSE JET | 15A/250VAC |
| Korea | 16A/250VAC |

Operating Temperature Summary

| Tf°C | Th°C | Tm°C |
|------|------|------|
| 072 | 57 | 410 |
| 073 | 58 | 410 |
| 077 | 62 | 410 |
| 084 | 69 | 220 |
| 091 | 76 | 430 |
| 093 | 78 | 410 |
| 098 | 83 | 410 |
| 104 | 89 | 225 |
| 110 | 95 | 225 |
| 117 | 102 | 410 |
| 121 | 106 | 410 |
| 128 | 113 | 235 |
| 134 | 119 | 410 |
| 141 | 126 | 350 |
| 144 | 129 | 410 |
| 152 | 137 | 410 |
| 158 | 143 | 410 |
| 167 | 152 | 410 |
| 172 | 157 | 410 |
| 184 | 169 | 410 |
| 190 | 175 | 410 |
| 192 | 177 | 350 |
| 205 | 190 | 410 |
| 216 | 200 | 410 |
| 229 | 200 | 410 |
| 240 | 200 | 410 |

Tf = Functioning open temperature +0/-5°C

Th = Maximum temperature of the thermal fuse, measured at the case end, at which the thermal fuse can be maintained for a period of at least 168 hours without opening

Tm = Maximum overshoot temperature. Temperature up to which the open thermal fuse will not change state

Z6 MICROTEMP Thermal Fuses



Z6 MICROTEMP - the Original Thermal Fuse

MICROTEMP thermal fuses offer an accurate, reliable solution to the need for upper limit temperature protection against overheating by interrupting an electrical circuit when operating temperatures exceed the rated temperature. Designed to meet European voltage and current applications, the Z6 is rated for operating currents up to 16 amps @ 250 VAC.

Benefits

- Same excellent quality and reliability you have come to expect in MICROTEMP thermal fuses
- Fast thermal response
- High Overshoot Temperature T_m ratings

Features

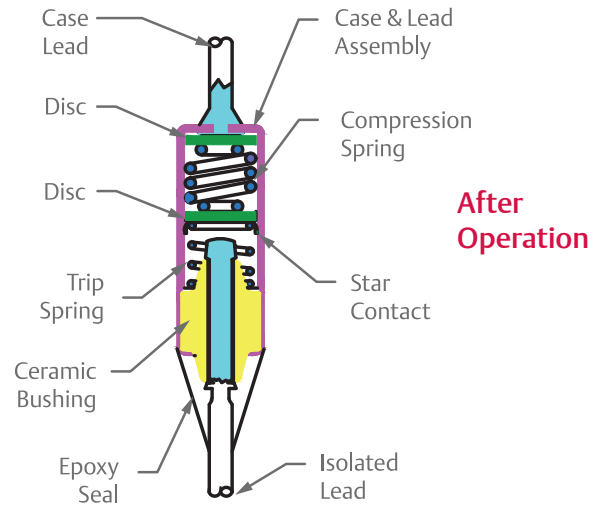
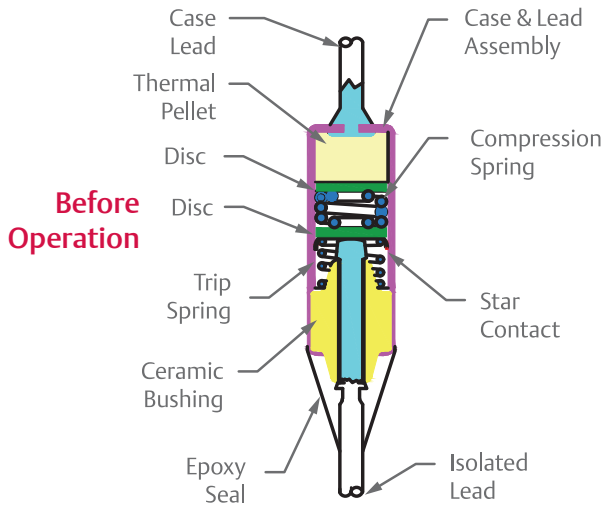
- One shot operation cuts off electrical power
- 16A/250VAC
- Low Resistance
- Compact Size

Applications

- Major Appliance
- Portable Appliance
- HVAC
- Water Heater
- Hair Care
- Other



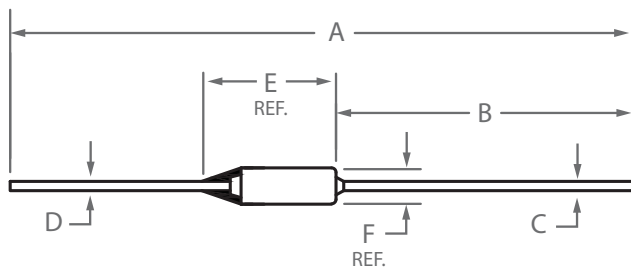
Z6 MICROTEMP Product Information



Standard Dimensions

| | | Standard Leads |
|-----|--|--------------------------------------|
| A | Overall Length $\pm .12"$ ($\pm 3.0\text{mm}$)* | 2.51" (63.8mm) |
| B | Case Lead Length $\pm .06"$ ($\pm 1.5\text{mm}$) | 1.38" (34.9mm) |
| C | Case Lead Diameter | 0.040" (1.0mm) |
| | Case Lead Material | Tin Plated Copper |
| D | Isolated Lead Diameter | 0.040" (1.0mm) |
| | Isolated Lead Material | Silver Plated Copper |
| E/F | Case Dimensions, Including Epoxy | .58" L x .158" D (14.7mm x 4.0mm) |

* Overall length available up to 5.83" (148mm)



Electric Rating

| Agency | Resistive |
|--------|------------|
| UL | 16A/250VAC |
| CSA | 16A/250VAC |
| VDE | 16A/250VAC |
| CCC | 16A/250VAC |

Operating Temperature Summary

| Tf °C | Th °C | Tm °C |
|-------|-------|-------|
| 098 | 083 | 280 |
| 104 | 089 | 260 |
| 117 | 102 | 275 |
| 121 | 106 | 380 |
| 144 | 134 | 380 |
| 152 | 142 | 380 |
| 167 | 157 | 380 |
| 184 | 174 | 380 |
| 229 | 200 | 380 |
| 240 | 200 | 380 |

Tf = Functioning open temperature $+0/-5^{\circ}\text{C}$

Th = Maximum temperature of the thermal fuse, measured at the case end, at which the thermal fuse can be maintained for a period of at least 168 hours without opening

Tm = Maximum overshoot temperature. Temperature up to which the open thermal fuse will not change state

Packaged Thermal Fuses

MICROTEMP thermal fuses also come in a variety of mounted and packaged options. Designed primarily for HVAC heating applications, the GXAM04 and GXAM06 packages mount a standard thermal fuse on a high temperature ceramic base.

The popular GXAP packages consist of a thermal fuse epoxy-potted into a plastic insulating mounting case. The assembly can be supplied with various case materials, shapes and terminations. They can be easily replaced in the field without disturbing the rest of the circuit.

Packaged TCO Material Specifications

| Type | Base Material | Material Rating Temperature °C | Maximum Tf°C Temperature °C |
|--------|----------------------------|--------------------------------|-----------------------------|
| GXAP02 | PPS Glass Filled | 220 | 192 |
| GXAP04 | PBT Glass Filled | 120 | 134 |
| GXAP05 | PBT Glass Filled | 120 | 134 |
| GXAP10 | PPS Mineral Filled | 220 | 192 |
| GXAP12 | PBT Glass Filled | 120 | 134 |
| GXAM04 | Ceramic DIN VDE 0335, C221 | >250 | 257 |
| GXAM06 | Ceramic DIN VDE 0335, C221 | >250 | 257 |
| GXAM11 | PBT | 120 | 134 |



GXAM06



GXAP04



GXAP02
GXAP10



GXAM04



GXAM11



GXAP05



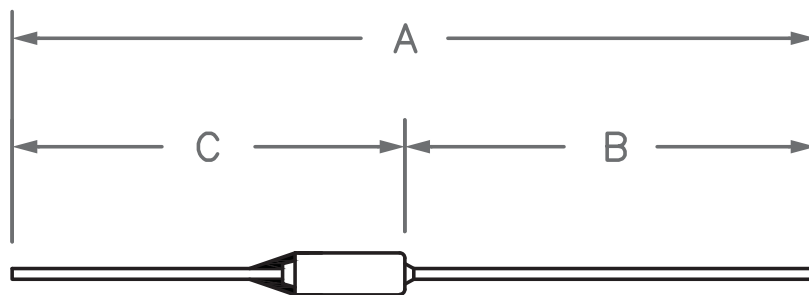
GXAP12

Lead Configurations

Thermal fuses can be furnished with virtually any lead configuration specified for an application. Lead curls are available to match most screw sizes along with varying lead lengths and lead forms. All types of terminations, such as quick connects, ring terminals and blade terminals are available at additional cost. In addition, tape and reel packaging can be specified to meet high volume requirements.



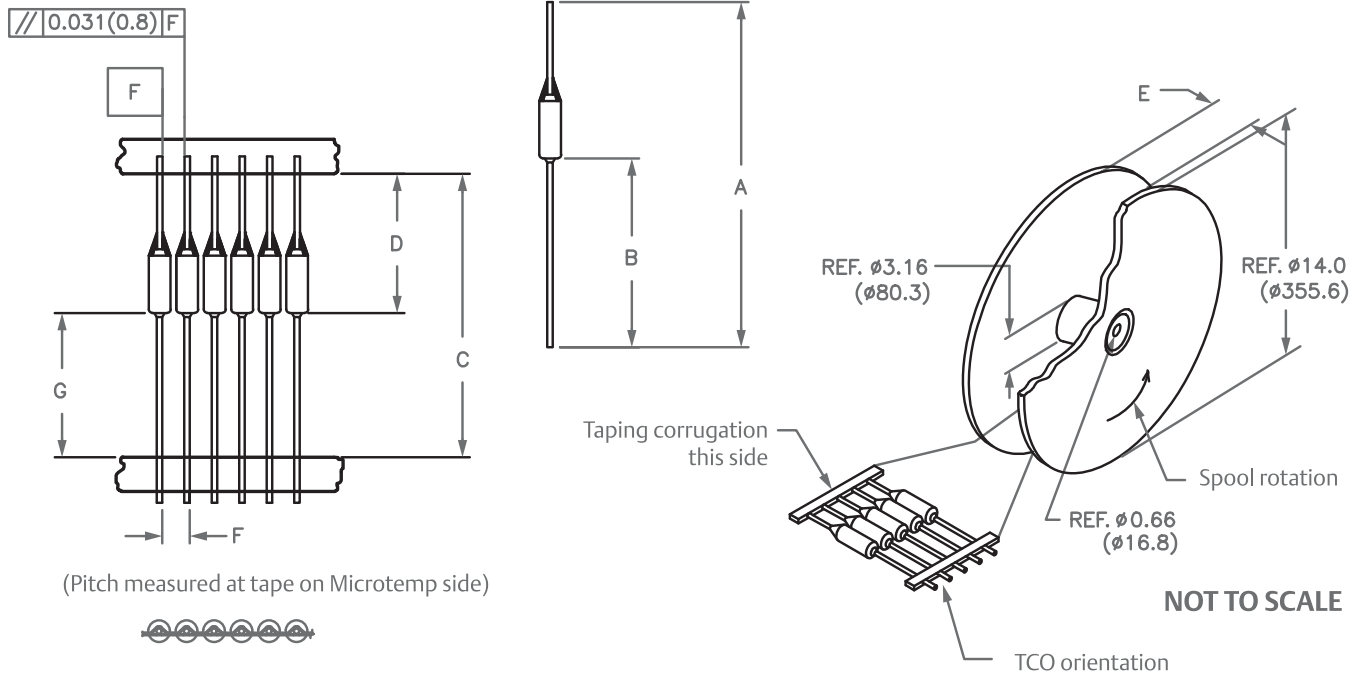
Lead Cutting



Minimum Dimensions - Inches (mm)

| A | B | C |
|-------------|------------|-------------|
| 0.95 (24.2) | 0.22 (5.6) | 0.73 (18.6) |

Tape & Reel Packaging



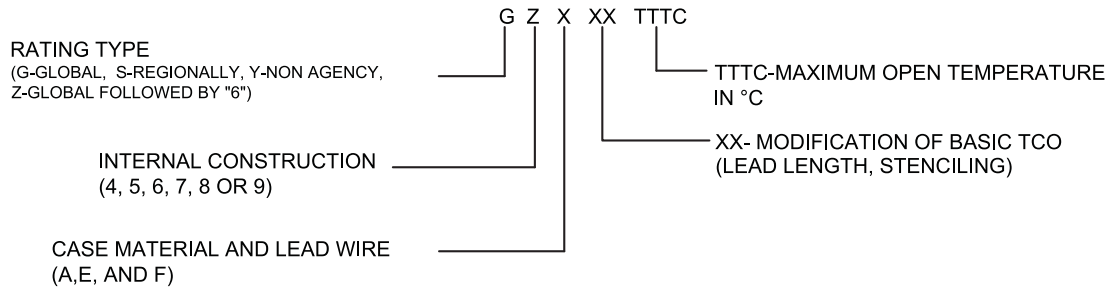
Dimensions - Inches (mm)

| Item | A | B | C | D | E | F | G |
|--------------|-------------|-------------|--------------|--------------|--------------|-------------|------------------|
| G4AA0901TTTC | 2.52 (63.8) | 1.38 (34.9) | 2.062 (52.4) | 1.031 (26.2) | 2.859 (72.6) | 0.200 (5.1) | - |
| G5AA0901TTTC | 2.52 (63.8) | 1.38 (34.9) | 2.062 (52.4) | 1.031 (26.2) | 2.859 (72.6) | 0.200 (5.1) | 1.13 (28.7) Min. |
| G7FA0900TTTC | 3.26 (82.9) | 1.38 (34.9) | 2.760 (70.1) | 1.630 (41.4) | 3.600 (91.4) | 0.197 (5.0) | 1.13 (28.7) Min. |

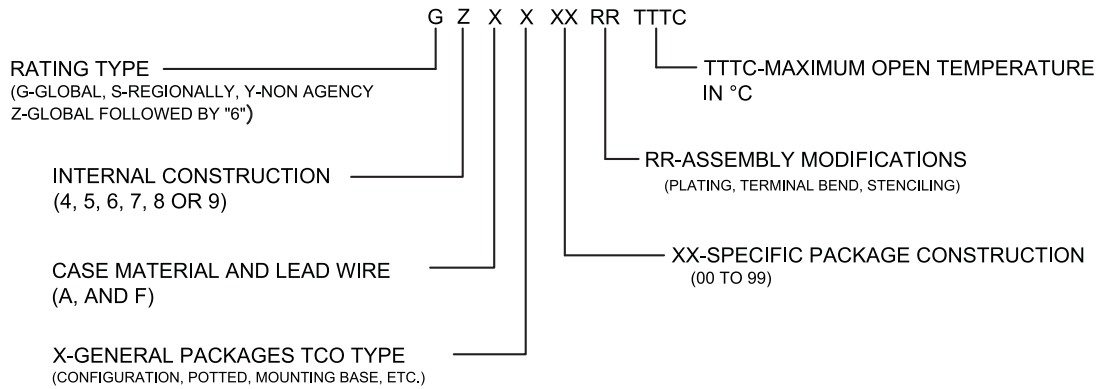
Additional packaging configurations available

Product Nomenclature

MICROTEMP® THERMAL CUTOFF GLOBAL PRIMARY NUMBERING SYSTEM




MICROTEMP® THERMAL CUTOFF GLOBAL SECONDARY NUMBERING SYSTEM



As shown above, Therm-O-Disc MICROTEMP TCOs follow a consistent product nomenclature that identifies the basic product type, lead wire size, special features and packaging options. For example, a standard G4 series TCO calibrated to open at 192°C would have a part number G4A00192C.

MICROTEMP TCO Product Markings

| | |
|---|---|
| XXXXXXXX | Special customer identification (when required, up to 9 characters) |
| MICROTEMP® | Registered trademark |
| PZZZZZ | Manufacturing plant (P); date code |
| G Z X XX | Primary part number |
| GZXXXXRR | Secondary part number |
| T _F TTTC | Maximum open temperature °C |
|  | Underwriters Labs logo |

Temperature Ratings

MICROTEMP thermal fuses are available in a wide range of opening temperatures, providing designers a high degree of flexibility. The proper calibration will be affected by application variables such as I²R self heating of the thermal fuse, heat transfer through insulation and heat dissipation due to heat sinking and air flow. Thermocoupled thermal fuse samples, that match the physical and electrical characteristics of a functional thermal fuse, are available to help evaluate application specific variables.

| Tf °C | G4A | | G5A | | G6A | | G7F | | G8A | | Z6A | |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | Th °C | Tm °C | Th °C | Tm °C | Th °C | Tm °C | Th °C | Tm °C | Th °C | Tm °C | Th °C | Tm °C |
| 72 | 57 | 100 | 57 | 410 | 47 | 100 | - | - | 47 | 410 | - | - |
| 73 | 58 | 100 | 58 | 410 | 48 | 100 | - | - | 48 | 410 | - | - |
| 77 | 62 | 300 | 62 | 410 | 62 | 300 | 62 | 125 | 62 | 410 | - | - |
| 84 | 69 | 220 | 69 | 220 | 69 | 220 | 69 | 125 | 69 | 220 | - | - |
| 91 | 76 | 300 | 76 | 430 | 76 | 300 | - | - | - | - | - | - |
| 93 | 78 | 300 | 78 | 410 | - | - | 78 | 140 | 78 | 410 | - | - |
| 98 | 83 | 300 | 83 | 410 | 83 | 300 | 83 | 140 | 83 | 410 | 83 | 280 |
| 104 | 89 | 200 | 89 | 225 | 89 | 200 | - | - | 89 | 225 | 89 | 260 |
| 110 | 95 | 240 | 95 | 225 | - | - | 95 | 140 | 95 | 225 | - | - |
| 117 | 102 | 240 | 102 | 410 | 102 | 240 | 102 | 150 | 102 | 410 | 102 | 275 |
| 121 | 106 | 300 | 106 | 410 | 106 | 300 | 106 | 150 | 106 | 410 | 106 | 380 |
| 128 | 113 | 205 | 113 | 235 | 113 | 205 | 113 | 150 | 113 | 235 | - | - |
| 134 | 119 | 205 | 119 | 410 | - | - | 119 | 175 | - | - | - | - |
| 141 | 126 | 205 | 126 | 350 | - | - | 126 | 175 | - | - | - | - |
| 144 | 129 | 300 | 129 | 410 | 129 | 300 | 129 | 175 | 119 | 410 | 134 | 380 |
| 152 | 137 | 205 | 137 | 410 | 127 | 205 | 137 | 175 | - | - | 142 | 380 |
| 158 | 143 | 240 | 143 | 410 | - | - | 143 | 200 | - | - | - | - |
| 167 | 152 | 210 | 152 | 410 | - | - | 152 | 200 | 152 | 410 | 157 | 380 |
| 172 | 157 | 310 | 157 | 410 | - | - | 157 | 200 | - | - | - | - |
| 184 | 169 | 240 | 169 | 410 | 169 | 210 | 169 | 200 | 169 | 410 | 174 | 380 |
| 190 | 175 | 350 | 175 | 410 | - | - | 175 | 270 | - | - | - | - |
| 192 | 177 | 210 | 177 | 350 | 167 | 210 | 177 | 210 | 177 | 350 | - | - |
| 205 | 190 | 310 | 190 | 410 | - | - | - | - | - | - | - | - |
| 216 | 200 | 450 | 200 | 410 | - | - | - | - | - | - | - | - |
| 229 | 200 | 450 | 200 | 410 | 200 | 375 | - | - | 200 | 410 | 200 | 380 |
| 240 | 200 | 450 | 200 | 410 | 200 | 450 | - | - | 200 | 410 | 200 | 380 |
| 257 | 220 | 470 | - | - | - | - | - | - | - | - | - | - |

Tf = Functioning open temperature +0/-5°C

Th = Maximum temperature of the thermal fuse, measured at the case end, at which the thermal fuse can be maintained for a period of at least 168 hours without opening

Tm = Maximum overshoot temperature. Temperature up to which the open thermal fuse will not change state

NOTES:

- It is advised that TCOs are not exposed to continuous operating temperatures in excess of T_f -25°C
- Comparative tracking index (all primary TCOs): 250VAC
- G4, G5, G6, G7 and G8 series TCOs with Tf ≥ 175°C comply with UL conductive heat aging (CHAT) requirements.

Electrical Rating Summary

Electrical Current & Voltage Rating

| Series | G4 | | G5 | G6 | Z6 | G7 | | G8 | S9 |
|--------------------|---|-------------------------|--|------------|------------|-----------------------|--|--------------------------|------------------------|
| Agency | Resistive | Inductive | Resistive | Resistive | Resistive | Resistive | Inductive | Resistive | Resistive |
| UL/CSA | 21A/240VAC ⁵ 10A/250VAC 15A/120VAC 5A/24VDC | 8A/250VAC 14A/120VAC | 20A/250VAC 25A/120VAC 21A/240VAC 20A/277VAC | 16A/250VAC | 16A/250VAC | 5A/250VAC 5A/24VDC | 4.5A/250VAC ⁴ 4.5A/120VAC ⁴ | 20A/277VAC 25A/250VAC | |
| VDE | 10A/250VAC | 8A/250VAC | 20A/250VAC | 16A/250VAC | 16A/250VAC | 5A/250VAC | 4.5A/250VAC | 25A/250VAC | |
| CCC | 5A/24VDC 10A/250VAC | 8A/250VAC | 20A/250VAC | 16A/250VAC | 16A/250VAC | 5A/24VDC 5A/250VAC | 4.5A/250VAC | 25A/250VAC | |
| PSE JET | 10A/250VAC | | 15A/250VAC | 15A/250VAC | 16A/250VAC | 5A/250VAC | | 25A/250VAC | 15A/250VAC |
| S JET ¹ | 30A/16VDC ² | | | | | | 15A/16VDC ³ | | 50A/16VDC ² |
| Korea | 10A/250VAC | | 16A/250VAC | | | 5A/250VAC | | | |

¹ For S JET ratings for Japan replace "G" with "S" as first letter of nomenclature

² Load agency approved for 172C and 240C temperatures only

³ Load agency approved for 152C temperature only

⁴ Except for 184C rating

⁵ For CSA only

Direct Current (DC) Applications

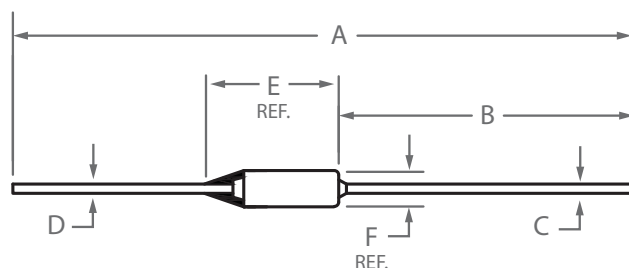
The G4, G7 and S9 series MICROTEMP thermal fuses have published electrical ratings for direct current (DC) applications. Current interruption capacity in DC circuits is highly application sensitive.

Therm-O-Disc recommends thorough testing of DC electrical applications.

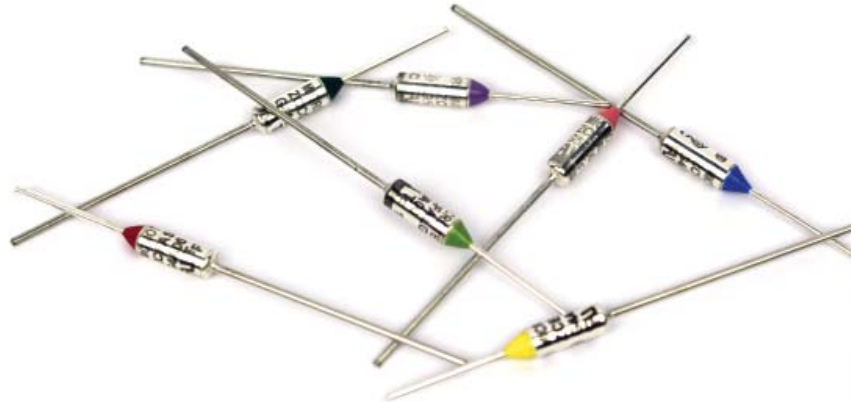
MICROTEMP TCO Standard Dimensions

| | | Dimensions - Inches (Millimeters) | G4, G5, G6, Z6, G8 Series | G7 Series | S9 Series | |
|--------------------------|---|--------------------------------------|------------------------------|--------------|--------------|-------------|
| Standard Leads | A | Overall Length ± .12 (±3.0) | 2.51 (63.8)* | N/A | 2.51 (64.8) | |
| | B | Case Lead Length ± .06 (±1.5) | 1.38 (34.9) | N/A | 1.38 (34.9) | |
| Long Leads | A | Overall Length ± .12 (±3.0) | 3.26 (82.9) | 3.26 (82.9) | 3.26 (82.9) | |
| | B | Case Lead Length ± .06 (±1.5) | 1.38 (34.9) | 1.38 (34.9) | 1.38 (34.9) | |
| Lead Material & Diameter | C | Case Lead | Tin Plated Copper | 0.040 (1.0) | 0.023 (.57) | 0.057 (1.4) |
| | D | Isolated Lead | Silver Plated Copper | 0.040 (1.0) | 0.023 (.57) | 0.057 (1.4) |
| Case Dimensions | E | Case Length (Reference) | 0.58 (14.7) | 0.38 (9.6) | 0.58 (14.7) | |
| | F | Case Diameter (Reference) | 0.158 (4.0) | 0.118 (3.0) | 0.158 (4.0) | |

*Overall length available up to 5.83" (148mm)



Application of Thermal Fuses



MICROTEMP® thermal cutoffs, available in a variety of standard and custom configurations, provide reliable one-shot, over-temperature protection in a wide range of applications. Performance can be affected by installation method and location of the thermal cutoff. Both application and installation is important in the overall performance of the product, and thorough testing is necessary for both AC and DC applications. The following guidelines will answer most questions concerning these two subjects.

General Considerations

Location

Sufficient time and effort must be used to determine the proper and most desirable location for a thermal fuse. The employment of infrared thermography, or a sufficient number of thermocouples to identify the highest temperature areas in the application during normal operation and fault conditions, should be considered. The location that provides the largest differential between these two conditions is generally most desirable.

Calibration Temperature

It is necessary to select a thermal fuse rating above the maximum temperature experienced by the thermal fuse during normal operation, including expected short-term temperature overshoots. The temperatures experienced by the thermal fuse during normal operation will determine the life expectancy of the thermal fuse. If the thermal fuse rating is too close to the temperature experienced during normal operation (including overshoot temperature after opening of a thermostat, etc.), the probability of a nuisance trip increases. Nuisance trips are caused by pellet shrinkage due to repeated operation at temperatures near but below calibration temperature, or excessive thermal gradients across the case of the TCO and its leads (see Thermal Gradients). The design engineer must make the decision between response and life of the TCO based on product requirements. It is important to remember that temperatures experienced in actual application will vary from unit to unit.

Thermal Gradients

Ideal thermal fuse placement subjects the entire thermal fuse case, leads, epoxy seal and internal components to a uniform temperature environment.

Care should be exercised in the placement of the thermal fuse to minimize thermal gradients across the thermal fuse body. In certain applications, the thermal fuse can be mounted in a position where heat is conducted to the body of the thermal fuse through one of the leads, resulting in thermal gradients across the thermal fuse. Over time, the thermal fuse life can be reduced by thermal gradients if the isolated (epoxy) lead is at a consistently lower temperature than the

case lead. Long term testing is recommended in determining whether these conditions exist in the application.

To minimize the effects of thermal gradients and the temperature increase of the TCO body from this heat flow, attach the isolated (epoxy) lead, rather than the case lead, to the heat source. Thermocoupled fuses can be supplied with the thermocouples on both ends to facilitate gradient evaluations.

Temperature Limits

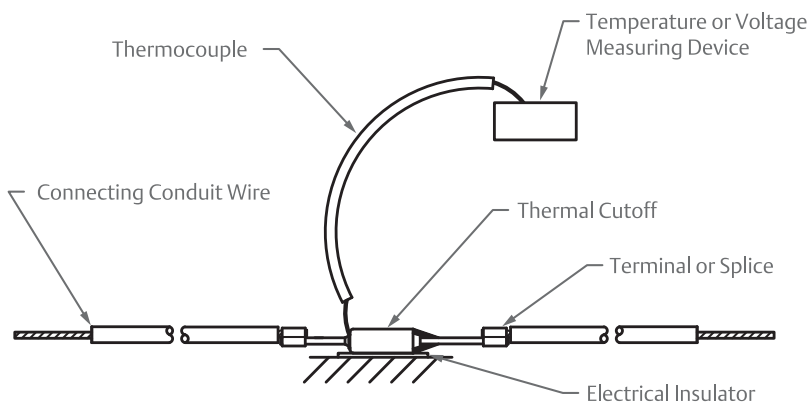
The temperatures experienced during normal operation, including expected temperature overshoots, will determine the life expectancy of the thermal fuse. Nuisance trips can result if the thermal fuse rating is too close to the temperatures experienced during normal operation. Thermal fuses of any temperature rating should not be subjected to continuous normal temperatures in excess of 200°C. Additionally, overshoot temperatures after the opening of the thermal fuse should be minimized to avoid possible dielectric breakdown and re-conduction of the thermal fuse.

Test Procedure

Application of Thermal Fuses

A thermal measurement procedure that utilizes a thermocoupled thermal fuse can assist in determining the appropriate calibration temperature and design location of MICROTEMP™ thermal fuses. The thermocoupled thermal fuse matches the electrical characteristics of the thermal fuse but does not have thermally responsive parts. The thermocoupled thermal fuse is supplied with a thermocouple attached to the case of the thermal fuse (see below). Thermocoupled thermal fuses can be supplied with Type J, Type T, or Type K thermocouples.

Install the thermocoupled thermal fuse in the electrical circuit that is to open in the event of a fault condition. Position it in the area that has been selected to be protected within the product based on prior determinations of the maximum permissible temperatures to be allowed. The thermocouple thermal fuse should be installed using the same mounting and electrical connection that will be used for functional thermal fuses in production. Connect the thermocouple leads to a digital temperature measuring device to record temperatures. The product to be protected can now be operated, and the normal operating temperature monitored. Note that the thermocouple thermal fuse is not a functional thermal fuse and therefore will not open the circuit in the test setup.



The figure above illustrates a typical installation of a thermocouple thermal fuse. Note that the body of the thermocouple thermal fuse is at the same potential as the connecting circuit; therefore, it must be electrically isolated from the surface against which the fuse is mounted. Also note that the thermocouple wire is at the same potential as the connecting circuit.

Installation, Processing and Handling of Thermal Fuses

CAUTION

To avoid a false reading of the unit under test, thermocouple wires must not make contact with each other except at the temperature sensing junction.

CAUTION

Ensure that the thermocouple wire insulation will provide isolation against short circuiting and shock hazards.

CAUTION

The terminal of the temperature measuring instrument, to which the thermocouple is attached, will be at the same potential as the connecting circuit wire. This instrument must be electrically isolated and considerable caution must be exercised in its use, since one of the thermocouple terminals is frequently grounded to the instrument chassis.

Before using measuring equipment powered directly from standard line voltages, check operation manuals. Be sure line voltages impressed on the thermocouple wires by the thermocoupled thermal fuse will not cause damage to the instrument.

Application testing is necessary to select a properly rated thermal fuse. Test factors include, but are not limited to, the heating effect of the current through the fuse, adjoining terminals and leads, heating or cooling effect of the terminals and external leads, rate of temperature rise, air flow, shock, vibration and other environmental and operating conditions unique to the application. The closer the actual operating and ambient conditions can be simulated during test, the more valid the test results will be.

The product and application being tested will determine the number of cycles that must be run to determine the maximum 'normal' operating temperature. 'Overshoot' temperatures should be included in the determination of the maximum 'normal' operating temperature. The overshoot temperature is often considerably higher than the temperature reached at the moment the thermal fuse opens. The conclusion of these tests will provide the maximum 'normal' operating temperature at the thermal fuse (at maximum anticipated voltage, ambient temperature, etc.). The overshoot temperature seen by the thermal fuse after the thermal fuse opens in the application must also be carefully examined and compared to overshoot temperature T_m .

Manufacturing tolerances and variations should be carefully considered, and a sufficient number of units evaluated, to provide statistical basis on which to determine the operating overshoot temperatures.

After obtaining the above information, test the product under fault conditions and monitor to determine that desired fault condition temperatures are not exceeded.

Where there are a variety of fault conditions, (eg, short-circuited thermostats and transform secondaries, locked motor rotors and solenoids, high ambient temperatures, restricted or blocked airflow, etc), consideration should be given to multiple fault conditions which could occur simultaneously during the lifetime of the product, and to faults which may cause localized overheating in areas away from the thermal fuse.

When the fault conditions have been set up, note the temperature of the thermocoupled fuses when the maximum desired temperature limit is reached. At this point the circuit is manually interrupted. This test should be run several times, in several different units. In some applications, it will not be possible to 'save' the tested item from damage, but only prevent the product from creating an external fire or electrical hazard. Damaged products should not be retest-

ed, since the results may not be the same as with undamaged units. The thermal fuse T_f selected should be equal to or less than the temperature recorded at the thermal fuse at the time the maximum desired temperature is reached.

CAUTION

Excessive overshoot temperature after the opening of the thermal fuse may cause dielectric breakdown of the thermal fuse and allow re-conduction to occur. Functional thermal fuses should be tested to verify proper operation of the thermal fuses in the application (see MICROTEMP Thermal Fuse Operating Temperature Summary and Electrical Rating Summary on page 14).

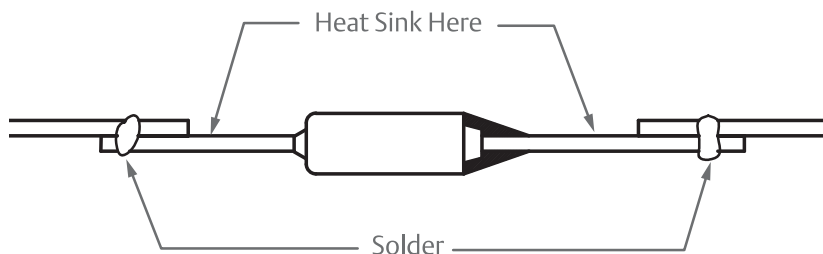


Substitute actual thermal fuses in a sufficient number of finished products and re-run the tests to obtain statistical verification of the results. For multiple thermal fuse applications, test functional thermal fuses under fault conditions so that the product overheats and each thermal fuse is independently called upon to interrupt the flow of current. Each thermal fuse should open the circuit independently of any other over-temperature limit controls, with product damage not exceeding an acceptable level. This test should be run using the maximum voltage and current the thermal fuse will be expected to interrupt and hold open.

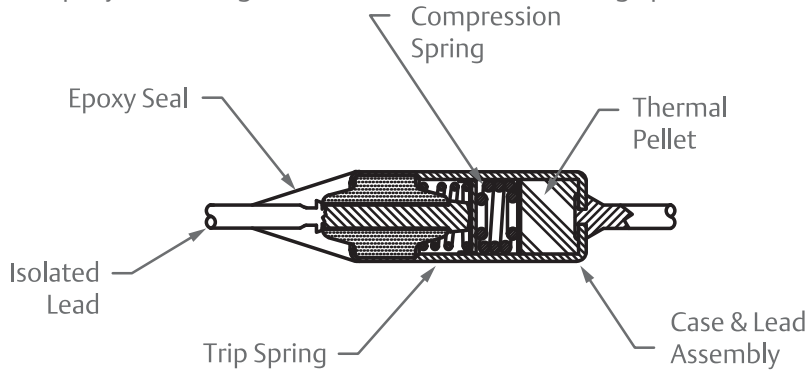
The performance of a MICROTEMP thermal cutoff can be affected by installation methods such as soldering, welding, splicing, lead bending, insulation, clamping and mounting. Certain precautions should be taken during installation to ensure that the MICROTEMP thermal cutoff is not damaged, which may cause it to not operate in its intended manner. Likewise, care should be taken during installation to ensure that the TCO in every unit experiences the expected temperature range environment previously determined during the calibration temperature selection. The following guidelines should be used to minimize undesirable conditions that can result from improper installation practices.

Soldering Leads

Thermal fuse leads should be heat-sunk during the soldering operation (see below). If excessive heat is conducted by the leads into the thermal fuse, it can shorten the life of the thermal fuse. In addition, excessive lead temperatures can damage the epoxy and possibly result in the thermal fuse failing to open. More heat-sinking is necessary for thermal fuses with lower T_f temperatures.

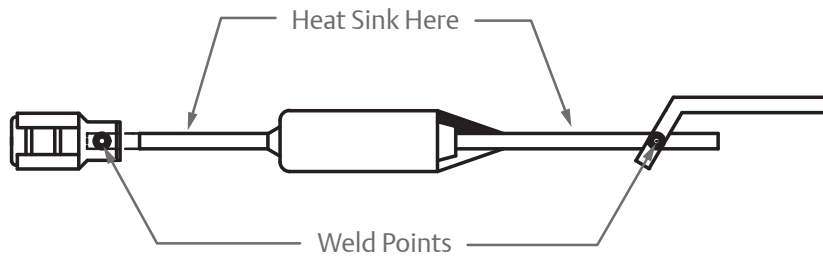


Test samples should be x-rayed before and after the soldering operation. The size of the pellet should be measured to verify that no shrinkage has occurred during the soldering operation. The epoxy seal should retain its size and shape and not discolor. If the pellet or the epoxy have changed size as a result of the soldering operation more heat sinking is required.



Welding Leads

The thermal fuse leads may also need to be heat sunk during a welding operation. The same precautions and tests described in the soldering section should be followed for welding leads.

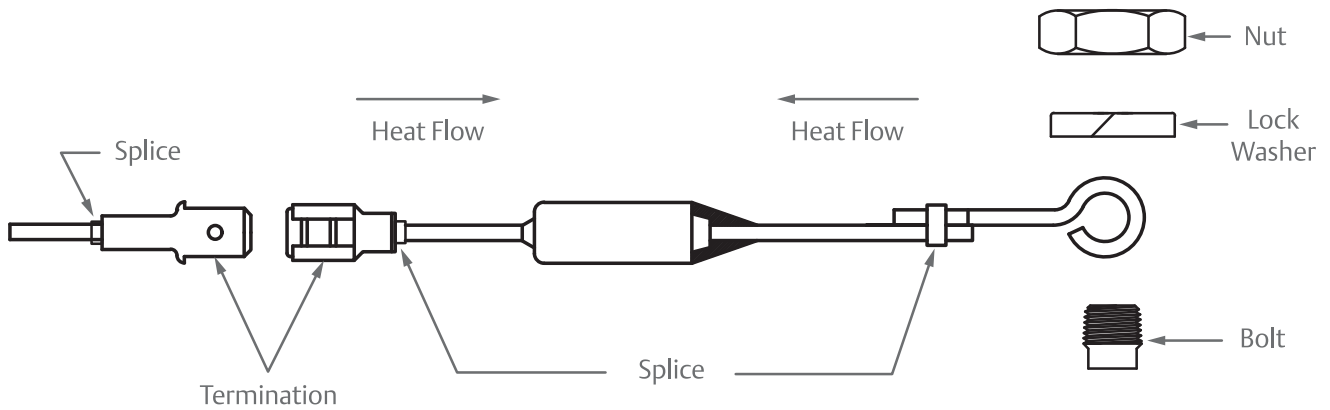


To avoid damaging or welding internal parts, care should be taken that none of the welding current is conducted through the thermal fuse. A welding current of hundreds of amperes can weld the internal parts together, resulting in the thermal fuse failing to open.

Thermal fuse leads must be supported during the weld operation to prevent damaging the thermal fuse epoxy seal.

Splices and Terminations

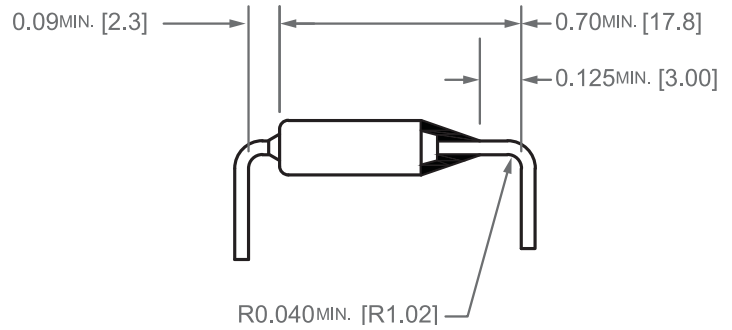
Insecure splices and terminations may produce high resistance junctions which can cause self-heating (I^2R) as power is dissipated across these junctions during product operation. Heat from these areas can flow down the thermal fuse leads and increase the temperature of the thermal fuse. Nuisance openings of the thermal fuse or degradation of the epoxy seal can occur as a result of the heat generated by high resistance junctions. The splice or termination junction may initially measure low resistance, but can change to a much higher resistance after several temperature cycles. It is generally better to splice thermal fuse leads to stranded lead wires rather than solid wires as the stranded wire may be crimped tighter and maintain better electrical contact during temperature cycling.



The temperature capabilities of the splice and/or termination should be considered. For example, solder back-up should be considered for splices of solid wires, and terminations in applications cycled at temperatures exceeding 150°C.

Bending Leads

When configuring leads, special care must be exercised in supporting the leads at each end near the body of the thermal fuse so that the case will not be distorted or the epoxy will not be cracked or broken. At least 0.125" (3mm) should be maintained between the epoxy seal and any lead bends.



CAUTION

The thermal fuse may fail to open the electrical circuit under certain conditions. Distortion of the case, breaking or cracking the seal, exposing the epoxy seal to cleaning solvents, compression of the leads and current surges that exceed the operating specifications of the thermal fuse may cause the thermal fuse not to open. In addition, pellet shrinkage due to thermal aging under some circumstances may also result in failure to open. Finally, a very low rate of temperature rise may produce conditions that may also result in failure to open. Care must be taken to avoid any mishandling or misapplication of the thermal fuse.

CAUTION

Although thermal fuses are highly reliable devices, a thermal fuse may fail to open for one or more of the reasons set forth above. These conditions must be taken into account by the product design engineer in determining the level of reliability needed for the application. If failure of the thermal fuse to open could result in personal injury or property damage, the product design engineer may want to consider using one or more redundant thermal fuses of different ratings to achieve the desired level of reliability. A number of consumer product design engineers have incorporated redundant thermal fuses of different ratings in their designs for this reason.

Samples and Quotations

Thermocoupled thermal fuse samples and thermal fuse samples are readily available for determining the correct response and desired performance in an application. Contact your nearest Therm-O-Disc sales office for more information.



Definition of Terms

Maximum Open Temperature or Rated Functioning Temperature (Tf or TF)

The maximum temperature at which the thermal fuse changes its state of conductivity to open circuit with detection current as the only load. The rated functioning temperature is measured during a temperature rise of approximately 0.5°C per minute.

Holding Temperature (Th or TH)

The maximum temperature of the thermal fuse, measured at the case end of the thermal fuse, at which the thermal fuse can be maintained for a period of 168 hours without opening. NOTE: It is advised that thermal fuses are not exposed to continuous operating temperatures in excess of Tf-25°C.

Maximum Overshoot Temperature or Maximum Temperature Limit (Tm or TM): The maximum temperature at which the thermal fuse, having changed its state of conductivity, can be maintained at twice rated voltage for a specified period of time, during which its mechanical and electrical properties will not be impaired.

Rated Voltage

The maximum voltage that can be applied to the circuit in which the thermal fuse is used.

Rated Current

The maximum current that the thermal fuse is rated to interrupt at the rated voltage.

Thermal Fuse, Thermal Cutoff, Thermal Link, and TCO

All are synonymous and may be used interchangeably throughout the catalog.

Agency Recognition

MICROTEMP™ thermal fuses are recognized by the following major agencies



UL
Underwriters
Laboratories Inc.
(USA)



BEAB
British
Electrotechnical
Approvals Board



METI
Ministry of
Economy, Trade
and Industry of
Japan



CSA
Canadian
Standards
Association



CCC
China
Compulsory
Product
Certification



VDE
Verband
Deutscher
Elektrotechniker e.V.
(F. R. G.)

MICROTEMP™ thermal fuses are recognized by the major approval agencies throughout the world for AC circuit applications. These agency electrical ratings can be used as a guideline when evaluating specific thermal fuse applications. However, the electrical and thermal conditions to which the thermal fuse may be exposed in an application may differ significantly from agency test conditions. Accordingly, customers should not rely solely on agency ratings but rather must perform adequate testing on the particular application to confirm that the thermal fuse selected is appropriate for that application and will operate as intended.

Important Notice

Users must determine the suitability of the thermal fuse for their application, including the level of reliability required, and are solely responsible for the function of the end-use product.

These thermal fuses contain exposed electrical components and are not intended to withstand exposure to water or other environmental contaminants which can compromise insulating components. Such exposure may result in insulation breakdown and accompanying localized electrical heating.

A thermal fuse may remain permanently closed or open as a result of exposure to excessive mechanical, electrical, thermal or environmental conditions or at normal end-of-life. Failure to control the operation could result in personal injury or property damage. The user should incorporate supplemental system control features to achieve the desired level of reliability and safety. For example, backup temperature limiting devices have been incorporated in a number of applications for this reason.



Scan with your smartphone
for more information or visit
Emerson.com

Important Notice

The scope of the technical and application information included in this article is necessarily limited. Operating environments and conditions can materially affect the operating results of Therm-O-Disc™ products.

Users must determine the suitability of any Therm-O-Disc component for their specific application, including the level of reliability required, and are solely responsible for the function of the end-use product. It is important to review the Application Notes which can be found at Emerson.com/thermodisc