**Selection Process**

1. Determine the following circuit operating parameters:
   - Maximum circuit voltage – $V_{MAX}$
   - Normal operating current – $I_{HOLD}$
   - Ambient operating temperature
   - Max fault current ($I_{MAX}$)
   - Parameters:
     - Hold Current ($I_{HOLD}$)
     - Chip Size

2. Select the suitable form factor.

3. Compare the PTC data sheet ratings on
   - Surface Mount
   - Radial Leaded
   - Battery Strap

4. Verify that the ambient operating temperature within close proximity to the device is within its normal operating temperature range. Thermally derate $I_{HOLD}$ and $I_{MAX}$ as necessary. See equation below.

5. Check that the trip time protects the circuit.
6. Verify that the post trip resistance ($R_{1MAX}$) of the device is taken into consideration for the circuit design.
7. Independently test and evaluate the suitability and performance of the PTC in the actual application.

### PTC Selection Table

<table>
<thead>
<tr>
<th>Series Name</th>
<th>0805L</th>
<th>1206L</th>
<th>1210L</th>
<th>1812L</th>
<th>2016L</th>
<th>2920L</th>
<th>USBR</th>
<th>30R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Voltage</td>
<td>60V</td>
<td>60/250V</td>
<td>60/600V</td>
<td>15-30V</td>
<td>15-24V</td>
<td>15-20V</td>
<td>16V</td>
<td>NA</td>
</tr>
<tr>
<td>Amp Rating</td>
<td>0.100-3.75A</td>
<td>0.080-0.180A</td>
<td>0.150-0.160A</td>
<td>1.20-4.20A</td>
<td>0.700-3.40A</td>
<td>1.7-13A</td>
<td>1.10-2.40A</td>
<td>2.10-2.30A</td>
</tr>
<tr>
<td>Max Voltage</td>
<td>60-72V</td>
<td>60/250V</td>
<td>60/600V</td>
<td>15/30V</td>
<td>24V</td>
<td>15/20V</td>
<td>16V</td>
<td>16V</td>
</tr>
<tr>
<td>Amp Rating</td>
<td>NA</td>
<td>0.500-1.50A</td>
<td>0.050-1.50A</td>
<td>0.140-2.60A</td>
<td>0.300-2.00A</td>
<td>0.300-3.00A</td>
<td>0.750-2.50A</td>
<td>0.900-9.00A</td>
</tr>
</tbody>
</table>

### PTC Selection Table (cont.)

<table>
<thead>
<tr>
<th>Series Name</th>
<th>60R</th>
<th>250R</th>
<th>600R</th>
<th>ST</th>
<th>LT</th>
<th>LR</th>
<th>VT</th>
<th>VL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Voltage</td>
<td>60V</td>
<td>60/250V</td>
<td>60/600V</td>
<td>15-30V</td>
<td>15-24V</td>
<td>15-20V</td>
<td>16V</td>
<td>NA</td>
</tr>
<tr>
<td>Amp Rating</td>
<td>0.10-3.75A</td>
<td>0.08-0.18A</td>
<td>0.15-0.16A</td>
<td>1.2-4.2A</td>
<td>0.7-3.4A</td>
<td>1.7-10.00A</td>
<td>1.7-2.4A</td>
<td>1.7-2.3A</td>
</tr>
</tbody>
</table>

### International Sales, Distribution and Engineering Facilities:

**North America**
- Lansing, Michigan USA
- Des Plaines, Illinois USA
- North America Engineering Facilities:
  - Swindon, England
  - Munich, Germany
  - Munich, Germany
- Tyco/Raychem Series
  - RXE TR250 TR600 SRP LTP LR4 VTP VLR

**Europe**
- Barcelona, Spain
- Munich, Germany
- Munich, Germany
- Tyco/Raychem Series
  - RXE TR250 TR600 SRP LTP LR4 VTP VLR

**Asia/Pacific**
- Shanghai, China
- Singapore
- Tyco/Raychem Series
  - RXE TR250 TR600 SRP LTP LR4 VTP VLR

**Central and South America**
- São Paulo, Brasil
- Central and South America
  - São Paulo, Brasil
PTC Characteristics and Terminology

A positive temperature coefficient (PTC) fuse is a type of overcurrent protection device that operates in a manner similar to a thermostat. Unlike a traditional fuse (which melts and opens the circuit when the current exceeds its rating), a PTC fuse has a positive temperature coefficient, meaning its resistance increases with temperature.

**Leakage Current**: A PTC is said to have "leaked" when it is transformed from a low impedance state to a high impedance state due to current flow. Protection is accomplished by limiting the current flow to a low leakage level. Leakage current can range from less than a hundred milliamperes at rated voltage up to a few hundred milliamperes at lower voltages.

**Fuse Element**: The fuse element is designed to continuously interrupt the current flow and open circuit results in no leakage when the fuse has been subjected to an overload current.

**FAUL TR CURRENT**: The PTC used for a maximum short circuit current arcing voltage. This fault current level is the maximum current that the device can safely limit keeping in mind that the PTC will not actually interrupt the current flow (see LEAKAGE CURRENT above). The typical short circuit rating of a rim-mounted radial leaded PTC is 450A for battery strap PTCs, this value can reach 1000A. Fuses do in fact interrupt the current flow (see TRIPPING below) and are therefore not usable in user or technician.

**Operating Voltage Rating**: The PTC and its housing are designed to carry the maximum current that the device can safely limit keeping in mind that the PTC will not actually interrupt the current flow (see LEAKAGE CURRENT above). The典型短路电流等级为450A，适用于电池带状PTC，此值可以达到1000A。保险丝确实会中断电流（参见跳闸以下），因此不可用于用户或技术人员。

**Temperature Derating**: The useful lifetime for a PTC is generally 80°C while the maximum operating temperature is 120°C. The following temperature derating curve shows the change in the ratio of ampacity for equivalent conditions. The ability of PTCs to reset themselves after exposure to a fault current makes them ideal for use in circuits that are not easily accessible to a user or technician.

**Applications**: PTCs are used in circuit protection applications where sensitive components are at risk of damage from overcurrent conditions. The ability of PTCs to reset themselves after exposure to a fault current makes them ideal for use in circuits that are not easily accessible to a user or technician. Typical applications include port protection on personal computers (USB, Firewire, keyboards, mouse, and serial ports), peripherals (external drives, video capture, and hub, optical, telephone, battery packs, industrial controls, lighting ballast and motor control.

**Temperature Derating Curve Comparing PTCs to Fuses**

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>PTC</th>
<th>Fuse</th>
</tr>
</thead>
<tbody>
<tr>
<td>-60°C</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>0°C</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>20°C</td>
<td>97%</td>
<td>100%</td>
</tr>
<tr>
<td>-76°F</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>68°F</td>
<td>97%</td>
<td>100%</td>
</tr>
<tr>
<td>140°F</td>
<td>100%</td>
<td>60%</td>
</tr>
<tr>
<td>212°F</td>
<td>100%</td>
<td>60%</td>
</tr>
</tbody>
</table>

Understanding the differences in performance between the two types of devices is essential when choosing the appropriate overcurrent protection device. The most obvious difference is that the PTCs do not carry a fixed current rating, instead they are designed to operate in a manner similar to a thermostat, in which the device transforms from one state to another when power is removed and the device cools down. There are a number of other operating characteristics that differentiate the two types of products.

**Leakage Current**: A PTC is said to have "leaked" when it is transformed from a low impedance state to a high impedance state due to current flow. Protection is accomplished by limiting the current flow to a low leakage level. Leakage current can range from less than a hundred milliamperes at rated voltage up to a few hundred milliamperes at lower voltages.

**Temperature Derating**: The useful lifetime for a PTC is generally 80°C while the maximum operating temperature is 120°C. The following temperature derating curve shows the change in the ratio of ampacity for equivalent conditions. The ability of PTCs to reset themselves after exposure to a fault current makes them ideal for use in circuits that are not easily accessible to a user or technician. Typical applications include port protection on personal computers (USB, Firewire, keyboards, mouse, and serial ports), peripherals (external drives, video capture, and hub, optical, telephone, battery packs, industrial controls, lighting ballast and motor control.

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<td>97%</td>
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</tr>
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<td>100%</td>
<td>60%</td>
</tr>
<tr>
<td>212°F</td>
<td>100%</td>
<td>60%</td>
</tr>
</tbody>
</table>
## Selection Process

1. Determine the following circuit operating parameters:
   - Maximum interrupt current – $I_{\text{MAX}}$
   - Maximum circuit voltage – $V_{\text{MAX}}$
   - Normal operating current – $I_{\text{HOLD}}$

2. Select the suitable form factor.

3. Compare the PTC data sheet ratings on $I_{\text{HOLD}}$ and $V_{\text{MAX}}$ to ensure that the circuit parameters do not exceed these ratings.

4. Verify that the ambient operating temperature is within close proximity to the device's maximum operating temperature range. Thermally derate $I_{\text{HOLD}}$ and $V_{\text{MAX}}$ as necessary. See equation below.

5. Check that the time limit protects the circuit.

6. Verify that the post trip resistance ($R_{\text{MAX}}$) of the device is taken into consideration in the circuit parameters.

7. Independently test and evaluate the suitability and performance of the PTC in the actual application.

### Selection Process

![Surface Mount](image1)

![Battery Strap](image2)

![Radial Leaded](image3)

![High Voltage](image4)

---

**PTC Selection Table**

<table>
<thead>
<tr>
<th>Model</th>
<th>Chip Size</th>
<th>Max Voltage</th>
<th>Amp Rating</th>
<th>Hold Current</th>
<th>Max Fault Current</th>
<th>Operating Temperature Range</th>
<th>Lead-Free</th>
<th>RoHS Compliant</th>
</tr>
</thead>
<tbody>
<tr>
<td>600R</td>
<td>0805</td>
<td>60-72V</td>
<td>0.100-3.75A</td>
<td>0.10-3.75A</td>
<td>40A</td>
<td>-40°C to 85°C</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>ST</td>
<td>1206</td>
<td>15/30V</td>
<td>0.080-0.180A</td>
<td>0.05-1.75A</td>
<td>2.60A</td>
<td>-40°C to 85°C</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>LT</td>
<td>1210</td>
<td>15/20V</td>
<td>0.150-2.60A</td>
<td>0.10-2.60A</td>
<td>2.00A</td>
<td>-40°C to 85°C</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>LR</td>
<td>1812</td>
<td>16V</td>
<td>1.20-4.20A</td>
<td>0.10-4.20A</td>
<td>2.00A</td>
<td>-40°C to 85°C</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>VT</td>
<td>2016</td>
<td>16V</td>
<td>1.70-13A</td>
<td>0.10-13A</td>
<td>10.00A</td>
<td>-40°C to 85°C</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>VL</td>
<td>2920</td>
<td>12V</td>
<td>1.70-2.40A</td>
<td>0.10-2.40A</td>
<td>9.00A</td>
<td>-40°C to 85°C</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

---

**Thermal Derating Factor**

\[
\text{Thermal derating factor} = T_{\text{ambient}} - T_{\text{case}}
\]

---

**PTC Selection Table (cont.)**

<table>
<thead>
<tr>
<th>Model</th>
<th>Chip Size</th>
<th>Max Voltage</th>
<th>Amp Rating</th>
<th>Hold Current</th>
<th>Max Fault Current</th>
<th>Operating Temperature Range</th>
<th>Lead-Free</th>
<th>RoHS Compliant</th>
</tr>
</thead>
<tbody>
<tr>
<td>MF-RX</td>
<td>0805</td>
<td>60/250V</td>
<td>0.08-0.18A</td>
<td>0.08-0.18A</td>
<td>100A</td>
<td>-40°C to 85°C</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>MF-RX</td>
<td>1206</td>
<td>60/600V</td>
<td>0.15-0.16A</td>
<td>0.15-0.16A</td>
<td>100A</td>
<td>-40°C to 85°C</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>MF-RX</td>
<td>1812</td>
<td>15-30V</td>
<td>1.2-4.2A</td>
<td>1.2-4.2A</td>
<td>40A</td>
<td>-40°C to 85°C</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>MF-RX</td>
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<td>15-24V</td>
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<td>Yes</td>
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<tr>
<td>MF-RX</td>
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<td>15-20V</td>
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<td>1.9-10.00A</td>
<td>40A</td>
<td>-40°C to 85°C</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>MF-RX</td>
<td>30R</td>
<td>16V</td>
<td>1.70-2.40A</td>
<td>1.70-2.40A</td>
<td>40A</td>
<td>-40°C to 85°C</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

---

**Polymax Polyfuse® PTC Selection Guide**

- **Surface Mount**
  - Battery Strap
  - Radial Leaded
- **High Voltage**
  - Radial Leaded

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**World Headquarters**

- Littelfuse, Inc.
  - 1200 Technology Drive
  - Sycamore, IL 60178 USA
  - 847 391 0459

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**Technical Assistance**

- Littelfuse, Inc.
  - World Headquarters
  - 1200 Technology Drive
  - Des Plaines, IL 60016 USA
  - 847 391 0459

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**Contact Information**

- [littelfuse.com](http://www.littelfuse.com)

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**Polyfuse® PTC Selection Guide**

- [Polyfuse® PTC Selection Guide](http://www.littelfuse.com)
PTC Characteristics and Terminology

A positive temperature coefficient (PTC) is a type of circuit protection device that automatically resets itself to a low-resistance state after an overcurrent event. It is often used in electronic devices to prevent damage from overcurrent conditions.

LEAKAGE CURRENT: A PTC in series with a circuit will have a leakage current when it is in its low-resistance state. This leakage current is referred to as leakage at different points in the circuit.

Protection is accomplished by limiting the current flow to a safe level. Leakage current can be set to lower values than a hundred milliamps at higher voltages, but lower milliamps at lower voltages.

The fuse element has an overcurrent rating that prevents the current from reaching a hazardous level. When the current flow exceeds the fuse's rating, it will blow and interrupt the power supply.

FAULT CURRENT: The PTC is designed to limit the short-circuit current to a safe level. This fault current rating is the maximum current that the circuit can tolerate without damage. In contrast, the fuse is designed to interrupt the current flow immediately to protect the circuit.

OPERATING VOLTAGE RATING: The operating voltage rating of a PTC is the maximum voltage that the device can tolerate without damage. This voltage rating is important to ensure that the device is not damaged by voltage surges or fluctuations.

TEMPERATURE DEGRADING: The useful upper limit for a PTC is generally 80°C while the maximum operating temperature is 120°C. The temperature derating curve shows the maximum temperature that the PTC can tolerate at different operating voltages.

APPLICATIONS: PTCs are used in a wide range of applications where overcurrent protection is required. These applications include:

- Personal computers (USB, Firewire, Peripherals)
- Batteries (Li-ion, Lithium polymer)
- Power supplies (UPS, Power inverters)
- Mobile phones
- Automotive systems

The choice of whether to use a PTC or a fuse is often influenced by the application's specific requirements and the designer's preference.

Understanding the differences in performance between the two types of circuit protection devices is crucial in selecting the most suitable device for a specific application.

PTC Applications

PTCs are used in circuit protection applications where sensitive components are at risk of damage from overcurrent conditions. The ability of PTCs to reset themselves after exposure to a fault current makes them ideal for use in circuits that are not easily accessible to a user or technician.

Typical applications include:

- Gate protection on personal computers (USB, Firewire)
- Peripherals (hard drives, video cards, and serial ports), on personal computers (USB, Firewire, keyboard/mouse, and serial ports),
- Set Top Box
- LCD Monitor
- SC1
- IEEE 1394
- USB
- CPU
- PBX/KTS And Key Telephone System
- Cable Telephony
- ADSL
- T1/E1/J1 And HDSL
- Power Over Ethernet Li-ion Battery Pack
- Power on USB 1.1
- Power on USB 2.0
- Power on IEEE 1394 – FireWire Tip/Ring circuit – Metallic
- Power on Tip/Ring circuit – Metallic

When to apply a resettable PTC or a traditional fuse is often a choice of the designer. The choice will depend on the specific application and the requirements of the circuit.

The following are typical examples of circuits using PTCs and fuses in combination or with other circuit protection devices to provide complete protection for the circuit. Contact your location Littelfuse application expert for detailed technical specifications or visit www.littelfuse.com/PTCs.
The terminology used for PTCs is often operating characteristics that differentiate cool down. There are a number of other after power is removed and the device resets (returns to low resistance state) makes the choice easier. The most obvious difference devices will make the best circuit protection to limit current flow. The fuse element melts open, interrupting the current flow and this open circuit results in no leakage current after it has been subjected to an overload current.

FAULT CURRENT: The PTC is used as a maximum short circuit current arresting voltage. This fault current is the maximum current that the device can safely handle and is monitored by the circuit. If the PTC actually interrupts the current flow (LEAKAGE CURRENT above), the typical short circuit rating of a molded-down molded case PTC is 40A, for battery strap PTCs, this value can range 10A. Fuses do in fact interrupt the current flow in response to the overload and the speed of response for a PTC is similar to time-current curves of fuses show that more derating is required for a PTC at a maximum operating temperature for circuit results in no leakage current after it has been subjected to an overload current.

TEMPERATURE DERATING: The world upper limit for a PTC is generally 85°C while the maximum operating temperature for a fuse is 120°C. The following temperature versus current curves show the characteristic of pug that compare PTCs to fuses illustrate that more derating is required for a PTC at a given temperature. Additional operating characteristics can be reviewed by the circuit designer in making the decision to choose a PTC or a fuse for overload protection.

AGENCY APPROVALS: PTCs are recognized under the Component Program of Underwriters Laboratories to UL Standard 481 for PRODUCTS. The devices have also been approved for use in Canada by Underwriters Laboratories. Approvals for fuses include Recognition under the Component Program, Underwriters Laboratories and the CSA. Component Acceptance Program in many fuse ratings, are listed in accordance with UL/CSA/Underwriters Laboratories 248-1. Supplemental Fuses.

REVERSING: Reversing product specifications indicate that the polarity of PTCs has about twice (hence sometimes more than twice the temperature of fuse.)

TIME-CURRENT CHARACTERISTIC: Characterizing the time-current properties of PTCs to time-current curves of fuses show that the speed of response for a PTC is similar to the time delay of a Slo-Blo® fuse.

The fuse element melts open, interrupting the current flow and this open circuit results in no leakage current after it has been subjected to an overload current.

A polymeric PTC (positive temperature coefficient) overcurrent protector is an overcurrent protection. The fuse on the other hand completely interrupts the current flow and this open circuit results in no leakage current after it has been subjected to an overload current.

LEAKAGE CURRENT: A PTC is said to have “leaked” when it is transformed from its low resistance state to its high resistance state as a result of a fault current. This function is called “tripping” of the overload current protection device.

Overcurrent circuit protection can be accomplished with the use of either a traditional fuse or the more recently developed resettable PTC. Both devices function by reacting to the heat generated from the circuit results in no leakage current after it has been subjected to an overload current. A Polymeric PTC (Positive Temperature Coefficient) overcurrent protector is an overcurrent protection.

Protection is accomplished by limiting the current flow to a safe level, low leakage, current can range from less than a hundred milliampere to several hundred milliamps at lower voltages. The fuse is not the only device completely interrupts the current flow and this open circuit results in no leakage current after it has been subjected to an overload current.

LEAKAGE CURRENT: The current that flows through a PTC in series with it’s associated components when it’s circuit is not carrying fault current. The graph below shows the response of the PTC device to temperature.

Understanding the differences in performance between the two types of overcurrent protection is often the key to the easier and more efficient circuit in which the PTC resets from a fault current state and after power is removed and the device cools down. There are a number of other operating characteristics that differentiate the current carrying capacity of the two product categories.

The terminology used for PTCs is often similar but not the same as for fuses. Two parameters that fall into this category are leakage current and fault current rating.
### PTC Selection Table

<table>
<thead>
<tr>
<th>Series</th>
<th>0805L</th>
<th>1206L</th>
<th>1210L</th>
<th>1812L</th>
<th>2016L</th>
<th>2920L</th>
<th>USBR</th>
<th>30R</th>
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<tr>
<td>Max voltage</td>
<td>60V</td>
<td>60/250V</td>
<td>60/600V</td>
<td>15-30V</td>
<td>15-24V</td>
<td>15-20V</td>
<td>16V</td>
<td>NA</td>
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<td>Amp Rating</td>
<td>0.100-3.75A</td>
<td>0.080-0.180A</td>
<td>0.150-0.160A</td>
<td>1.20-4.20A</td>
<td>0.700-3.40A</td>
<td>1.7-13A</td>
<td>1.10-2.40A</td>
<td>2.10-2.30A</td>
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<tr>
<td>Bourns Series</td>
<td>MF-R/MF-RX</td>
<td>MF-R/250</td>
<td>MF-R/600</td>
<td>MF-S</td>
<td>MF-LS</td>
<td>MF-LR</td>
<td>MF-VS</td>
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<tr>
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<td>60/250V</td>
<td>60/600V</td>
<td>15/30V</td>
<td>24V</td>
<td>15/20V</td>
<td>16V</td>
<td>16V</td>
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<tr>
<td>Amp Rating</td>
<td>0.100-3.75A</td>
<td>0.080-0.180A</td>
<td>0.150-0.160A</td>
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<td>micro SMD</td>
<td>mini SMD</td>
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<td>SMD</td>
<td>RUSB</td>
<td>RUE</td>
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<td>60V</td>
<td>16V</td>
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<td>0.10-2.60A</td>
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<td>0.75-2.5A</td>
<td>0.9-9.00A</td>
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</tbody>
</table>

### Selection Process

1. Determine the following circuit operating parameters:
   - Maximum interrupt current – IMAX
   - Maximum circuit voltage – VMAX
   - Normal operating current – IHOLD
   - Ambient operating temperature

2. Select the suitable form factor.

3. Compare the PTC data sheet ratings on littelfuse.com for IMAX and VMAX to ensure that the circuit parameters do not exceed these ratings.

4. Verify that the ambient operating temperature within close proximity to the device is within its normal operating range. Thermally derate IMAX and IHOLD as necessary. See equation below.

5. Check that the trip time protects the circuit.

6. Verify that the post trip resistance (R1MAX) of the device is taken into account in the circuit design.

7. Independently test and evaluate the suitability and performance of the PTC in the actual application.

### Thermal derating factor

\[
Thermal\ \text{derating\ factor} = \frac{1}{1 + \frac{T - T_{ref}}{T_r}}
\]

where:
- \( T \) is the operating temperature within close proximity to the device in °C
- \( T_{ref} \) is the reference temperature, typically 85°C
- \( T_r \) is the temperature range in °C

### Additional Information

- **Littelfuse, Inc.**
  - World Headquarters: Des Plaines, Illinois USA
  - North America: Birmingham, Michigan USA, Des Plaines, Illinois USA, Utrecht, The Netherlands
  - Europe: Munich, Germany
  - Asia/Pacific: Hong Kong, China, Singapore, Shenzhen, China, Tokyo, Japan, Seoul, Korea, Singapore
  - Central and South America: São Paulo, Brasil, Mexico City, Mexico
  - International Sales, Distribution and Engineering Facilities:
    - Europe: Berlin, Germany, Munich, Germany
    - North America: Birmingham, Michigan USA, Des Plaines, Illinois USA, Utrecht, The Netherlands

### Footnotes

- Specifications, descriptions and illustrative material in this literature are as accurate as known at the time of publication, but are subject to change without notice.
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