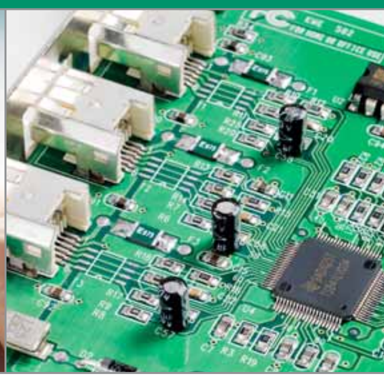
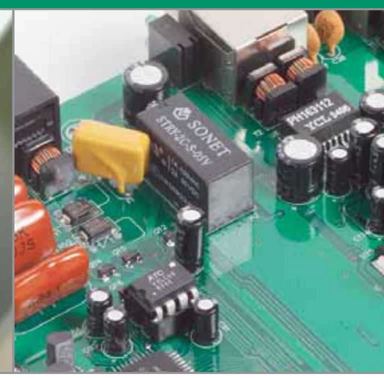
POLYFUSE® PTC SELECTION GUIDE

Littelfuse®

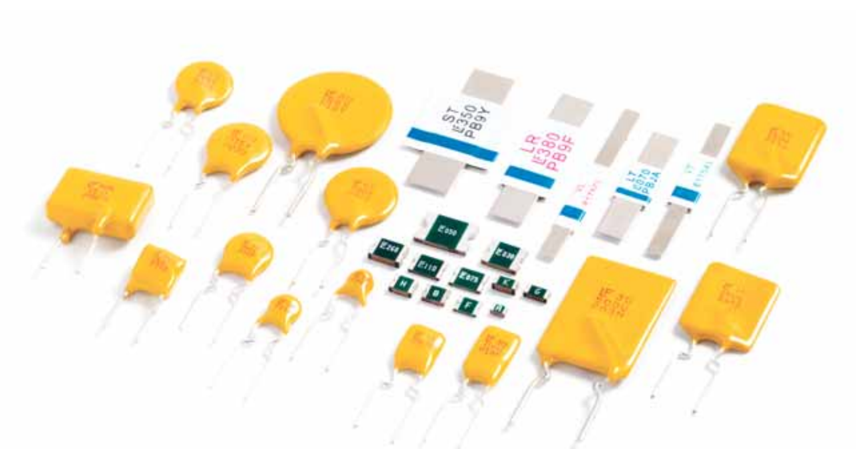


Surface Mount

Battery Strap

Radial Leaded

High Voltage Radial Leaded



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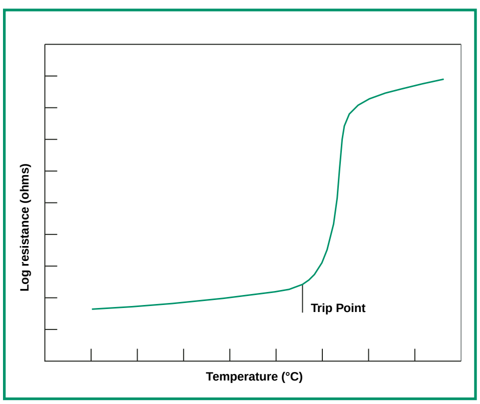
PTC Characteristics and Terminology

A polymeric PTC (positive temperature coefficient) overcurrent protector is an element placed in series with the circuit or assembly to be protected. The PTC element protects the circuit by changing from a low-resistance to a high resistance state in response to an overcurrent.

This function is called “tripping” of the overcurrent 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 by the excessive current flow in the circuit. The fuse element melts open, interrupting the current flow, while the PTC changes from low resistance to high resistance to limit current flow. The graph below shows the response of the PTC device to temperature.



Understanding the differences in performance between the two types of devices will make the best circuit protection choice easier. The most obvious difference is that the PTC is resettable. This is an inherent characteristic in which the PTC resets (returns to low resistance state) after power is removed and the device cools down. There are a number of other operating characteristics that differentiate the two types of products.

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.

LEAKAGE CURRENT: A PTC is said to have “tripped” when it has transitioned from its low resistance state to a high resistance state due to overload current.

Protection is accomplished by limiting the current flow to a low leakage level. Leakage current can range from less than a hundred milliamps at rated voltage up to a few hundred milliamps at lower voltages. 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.

FAULT CURRENT: The PTC is rated for a maximum short circuit current at rated 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 board-mounted PTC is 40A; for battery strap PTCs, this value can reach 100A. Fuses do in fact interrupt the current flow in response to the overload and the range of interrupting ratings vary from tens of amperes up to 10,000 amperes at rated voltage.

OPERATING VOLTAGE RATING: General use PTCs are not rated above 60V while fuses are rated up to 600V.

HOLD CURRENT RATING: The hold (operating) current rating for PTCs can be up to 14A while the maximum level for fuses can exceed 30A.

TEMPERATURE DERATING: The useful upper limit for a PTC is generally 85°C while the maximum operating temperature for fuses is 125°C. The following temperature derating curves (*see chart at bottom of page*) that compare PTCs to fuses illustrate that more derating is required for a PTC at a given temperature.

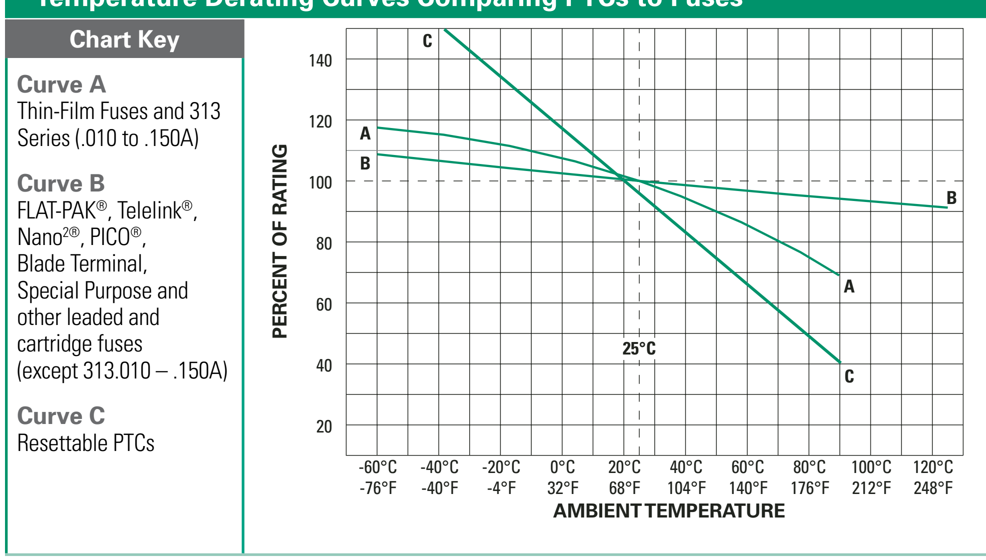
Additional operating characteristics can be reviewed by the circuit designer in making the decision to choose a PTC or a fuse for overcurrent protection.

AGENCY APPROVALS: PTCs are Recognized under the Component Program of Underwriters Laboratories to UL Standard 1434 for Thermistors. The devices have also been approved for use in Canada by Underwriters Laboratories. Approvals for fuses include Recognition under the Component Program of Underwriters Laboratories and the CSA Component Acceptance Program. In addition, many fuses are listed in accordance with UL/CSA/ANCE (Mexico) 248-14, Supplemental Fuses.

RESISTANCE: Reviewing product specifications indicates that similarly-rated PTCs have about twice (sometimes more) the resistance of fuses.

TIME-CURRENT CHARACTERISTIC: Comparing the time-current curves 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.

Temperature Derating Curves Comparing PTCs to Fuses



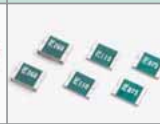
Selection Process

1. Determine the following circuit operating parameters:
   - Normal operating current – I_{HOLD}
   - Maximum circuit voltage – V_{MAX}
   - Maximum interrupt current – I_{MAX}
   - Ambient operating temperature
2. Select the suitable form factor.
3. Compare the PTC data sheet ratings on littelfuse.com for V_{MAX} and I_{MAX} 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 I_{HOLD} and I_{MAX} as necessary. See equation below.

$$I_{HOLD} = \frac{I_{MAX}}{\text{Thermal derating factor}}$$

5. Check that the trip time protects the circuit.
6. Verify that the post trip resistance ($R1_{MAX}$) 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.

PTC Selection Table

	SURFACE MOUNT						RADIAL LEADED	
Series Name	0805L	1206L	1210L	1812L	2016L	2920L	USBR	30R
Photos								
Chip Size	0805 (2012)	1206 (3216)	1210 (3225)	1812 (4532)	2016 (5041)	2920 (7351)		
Hold Current (I_{HOLD})	0.10-1.00A	0.125-2.00A	0.05-1.75A	0.10-2.60A	0.3-2.00A	0.30-3.00A	0.75-2.5A	0.9-9.00A
Max voltage (V_{MAX})	15V	30V	30V	60V	60V	60V	16V	30V
Max fault current (I_{MAX})	40A	100A	100A	100A	40A	40A	40A	40A
Operating Temperature Range	-40°C to 85°C	-40°C to 85°C	-40°C to 85°C	-40°C to 85°C	-40°C to 85°C	-40°C to 85°C	-40°C to 85°C	-40°C to 85°C
Agency approval	cULus, TUV	cULus, TUV	cULus, TUV	cULus, TUV	cULus, TUV	cULus, TUV	cULus, TUV	cULus, TUV
RoHS Compliant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lead-Free	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
COMPETITOR CROSS								
Tyco/Raychem Series		nano SMD	micro SMD	mini SMD	mid SMD	SMD	RUSB	RUE
Amp Rating	NA	0.500-1.50A	0.050-1.50A	0.140-2.60A	0.300-2.00A	0.300-3.00A	0.750-2.50A	0.900-9.00A
Max voltage	NA	6V	6-30V	6-60V	6-60V	6-60V	16V	30V
Bourns Series		MF-NSMF	MF-USMD	MF-MSMD	MF-SMDF	MF-SM		MF-R
Amp Rating	NA	0.12-2.00	0.05-1.50A	0.05-1.50A	0.55-2.00A	0.300-2.5A	NA	0.90-9.0A
Max voltage	NA	6-30V	6-30V	6-30V	10-60V	6-60V	NA	30V

NO = Not offered

PTC Selection Table (cont.)

				BATTERY STRAP (AXIAL LEADED)				
Series Name	60R	250R	600R	ST	LT	LR	VT	VL
Photos								
Chip Size								
Hold Current (I_{HOLD})	0.1-3.75A	0.08-0.18A	0.15-0.16A	1.2-4.2A	0.7-3.4A	1.9-10.00A	1.7-2.4A	1.7-2.3A
Max voltage (V_{MAX})	60V	60/250V	60/600V	15/24V	15/24V	15/20V	16V	12V
Max fault current (I_{MAX})	40A	3/10A	3/2.2A	100A	100A	100A	100A	100A
Operating Temperature Range	-40°C to 85°C	-40°C to 85°C	-40°C to 85°C	-40°C to 85°C	-40°C to 85°C	-40°C to 85°C	-40°C to 85°C	-40°C to 85°C
Agency approval	cULus, TUV	cULus, TUV	cULus, TUV	cULus, TUV	cULus, TUV	cULus, TUV	cULus, TUV	cULus, TUV
RoHS Compliant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lead-Free	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
COMPETITOR CROSS								
Tyco/Raychem Series	RXE	TR250	TR600	SRP	LTP	LR4	VTP	VLR
Amp Rating	0.100-3.75A	0.080-0.180A	0.150-0.160A	1.20-4.20A	0.700-3.40A	1.7-13A	1.10-2.40A	2.10-2.30A
Max voltage	60-72V	60/250V	60/600V	15/30V	24V	15/20V	16V	16V
Bourns Series	MF-R/MF-RX	MF-R/250	MF-R/600	MF-S	MF-LS	MF-LR	MF-VS	
Amp Rating	0.10-3.75A	0.08-0.18A	0.15-0.16A	1.2-4.2A	0.70-3.4A	1.9-9.0A	1.7-2.4A	NA
Max voltage	60V	60/250V	60/600V	15-30V	15-24V	15-20V	16V	NA

NA = Not Available

PTC Applications

PTCs are used as circuit protection in 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, keyboard/mouse, and serial ports), peripherals (hard drives, video cards, and hubs), cell phone, battery packs, industrial controls, lighting ballast and motor controls.

When to apply a resettable PTC vs. a traditional fuse is always the choice of the designer or technician but in some cases, PTC's offer a convenient form of circuit protection to improve the reliability of an application. There is an important area of applications where the use of resettable fuses (PTCs) has become a requirement. Much of the design work for personal computers and peripheral devices is strongly influenced by the Microsoft and Intel System Design Guide which states that "Using a fuse that must be replaced each time an overcurrent condition occurs is unacceptable." And the SCSI (Small Computer Systems Interface) Standard for this large market includes a statement that "....a Positive Temperature Coefficient device must be used instead of a fuse, to limit the maximum amount of current sourced".

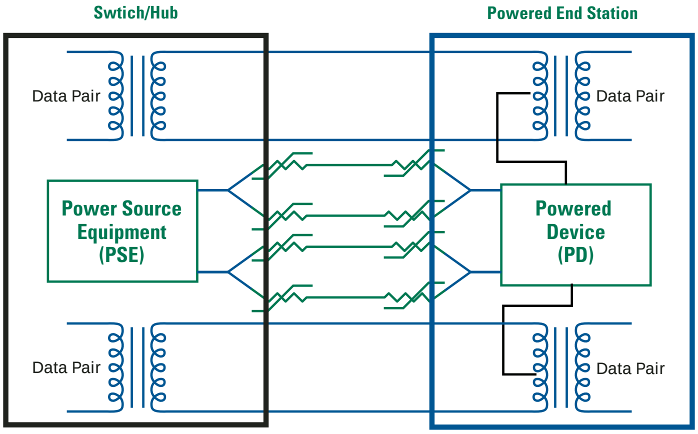
The application selection guide below should be used as an aid in selecting the proper device for your end application. Please consult the datasheets on www.littelfuse.com for detailed technical specifications.

		SURFACE MOUNT						RADIAL LEADED					BATTERY STRAP (AXIAL LEADED)				
	Series Name	0805L	1206L	1210L	1812L	2016L	2920L	USBR	30R	60R	250R	600R	ST	LT	LR	VT	VL
Telecom	**Application**																
Telecom	Ul60950 ,TIA-968-A, GR-1089 Requirements										X	X					
Telecom	ITU-T Recoomendations										X	X					
Telecom	CPE (Customer Premises Equipment)										X	X					
Telecom	Analog Line Card										X	X					
Telecom	T1/E1/J1 And HDSL										X	X					
Telecom	ISDN										X	X					
Telecom	ADSL										X	X					
Telecom	Cable Telephony										X	X					
Telecom	PBX/KTS And Key Telephone System										X	X					
Computer	CPU						X	X									
Computer	USB	X	X	X	X			X									
Computer	IEEE1284 Parallel Data Bus		X	X	X			X									
Computer	IEEE 802.3					X	X			X							
Computer	IEEE 1394				X		X		X								
Computer	I/O Ports		X	X	X		X	X									
Computer	PC Card	X	X	X	X		X	X									
Computer	SCSI		X	X	X		X	X									
Computer	Video Port		X	X	X		X	X									
Computer	LCD Monitor	X	X	X	X			X									
Consumer Electronics	Set Top Box		X	X	X		X										
Consumer Electronics	Loudspeaker								X								
Consumer Electronics	Smart Card Reader		X														
Consumer Electronics	Mobile Phone	X	X	X													
Consumer Electronics	Linear AC/DC Adapter	X	X	X	X		X		X	X							
Consumer Electronics	Portable Electronic Input Port	X	X	X	X	X											
Consumer Electronics	Electromagnetic Loads, Motor					X	X		X	X							
Consumer Electronics	Solenoid Protection				X		X		X	X							
Battery	Lithium Cell												X	X	X	X	X
Battery	Battery Pack												X	X	X	X	X
Medical electronic	Voltage / Current Input Terminal		X		X												

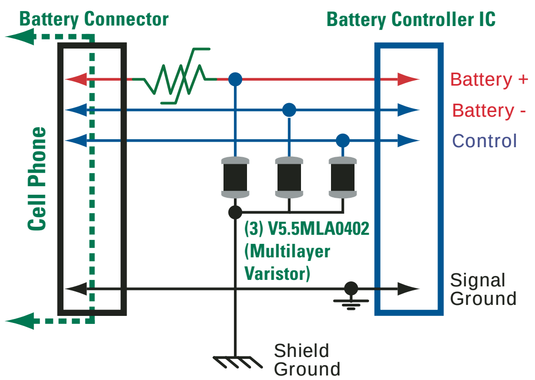
NOTE: The application summary is for reference only. Determination of suitability for a specific application is the responsibility of the customer.

Littelfuse offers a full range of battery strap, surface mount and radial leaded resettable PTC devices designed to protect applications where overcurrent protection is required. The following are typical examples of circuits using POLYFUSE® resettable PTCs in combination with other Littelfuse circuit protection devices to provide complete protection for the circuit. Contact your location Littelfuse application expert for additional design assistance or visit www.littelfuse.com/PTCs.

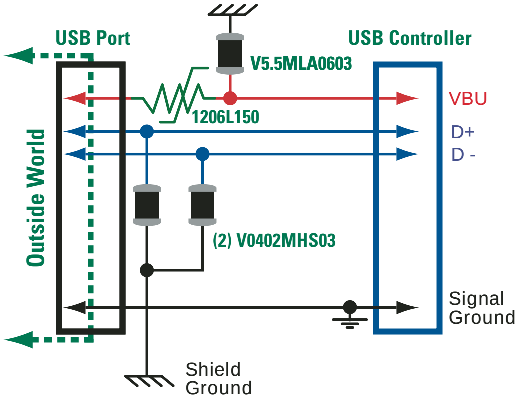
Power Over Ethernet



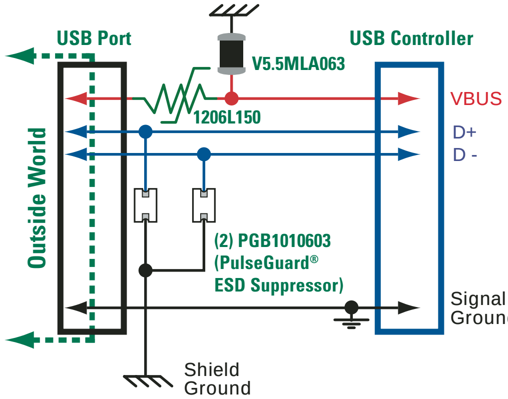
Li-ion Battery Pack



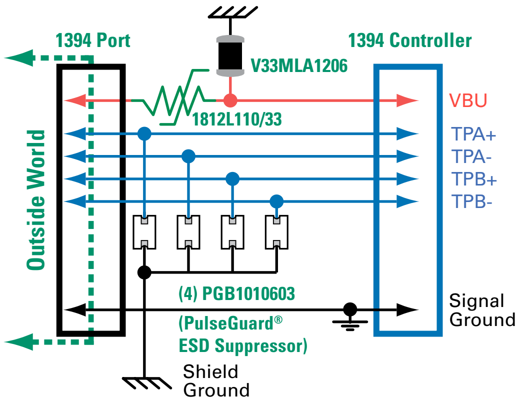
USB 1.1



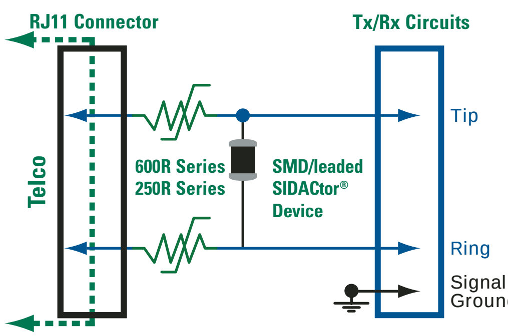
USB 2.0



IEEE 1394 – FireWire



Tip/Ring circuit – Metallic



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