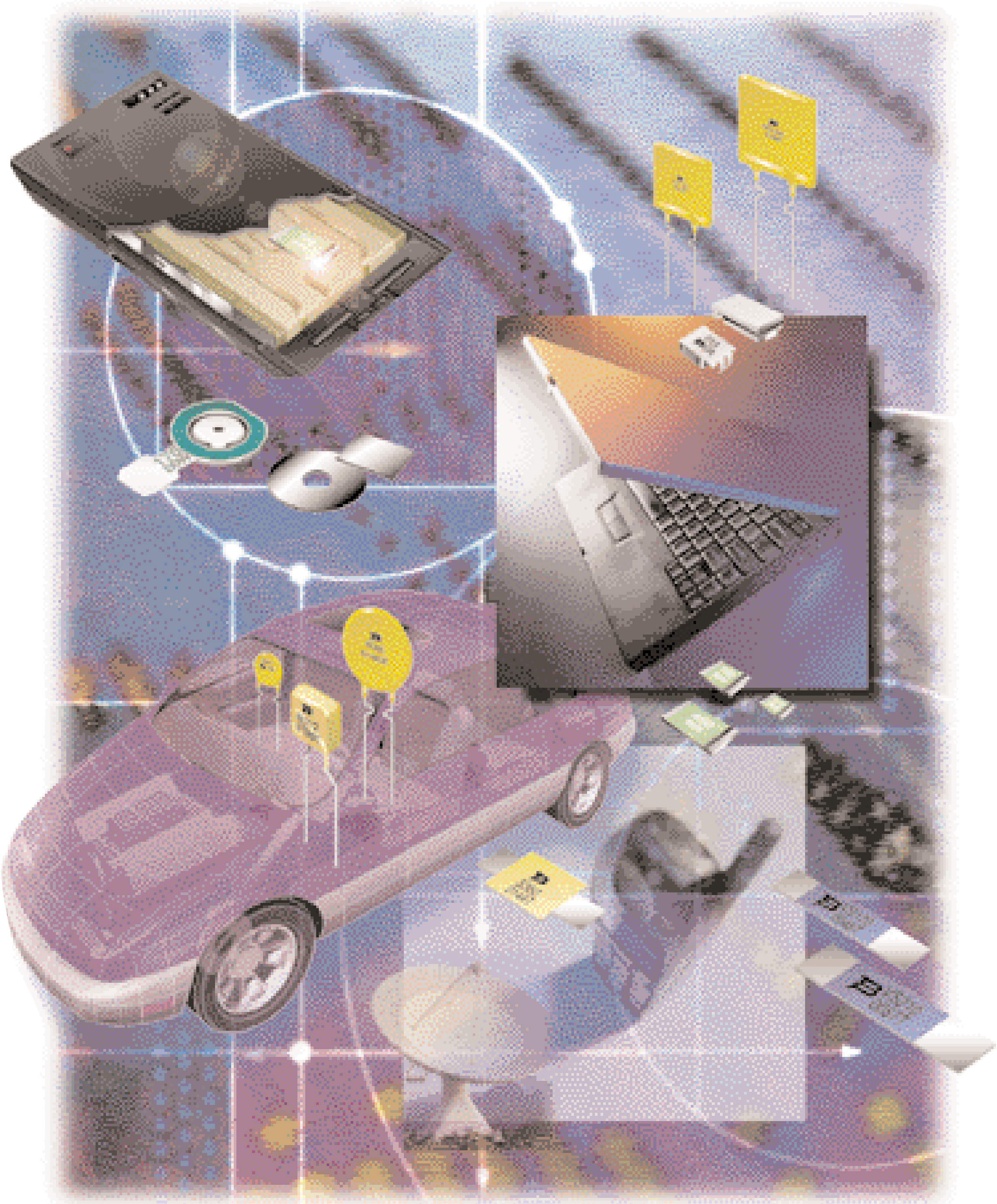
Multifuse® PTC Resettable Fuses

SOLUTIONS GUIDE



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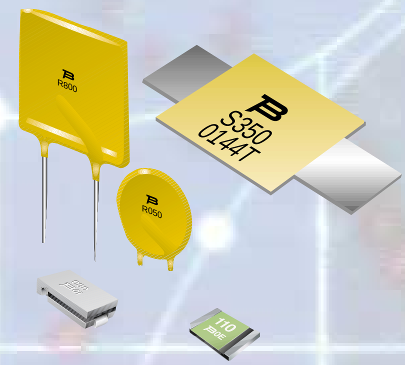
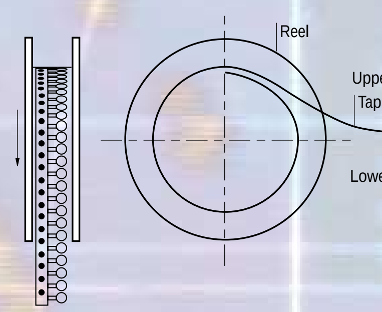
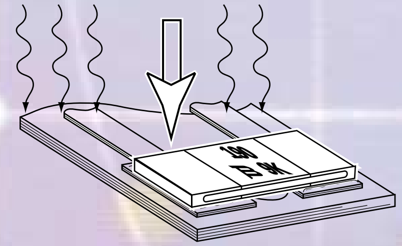
BOURNS®

Multifuse® Products





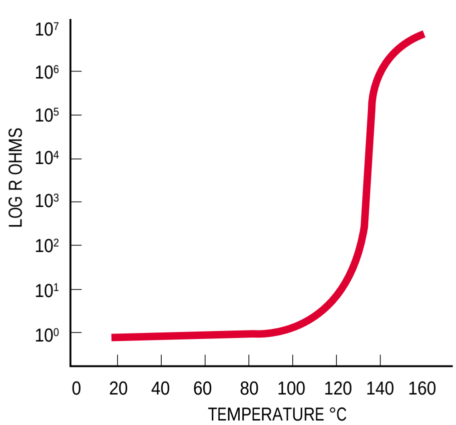


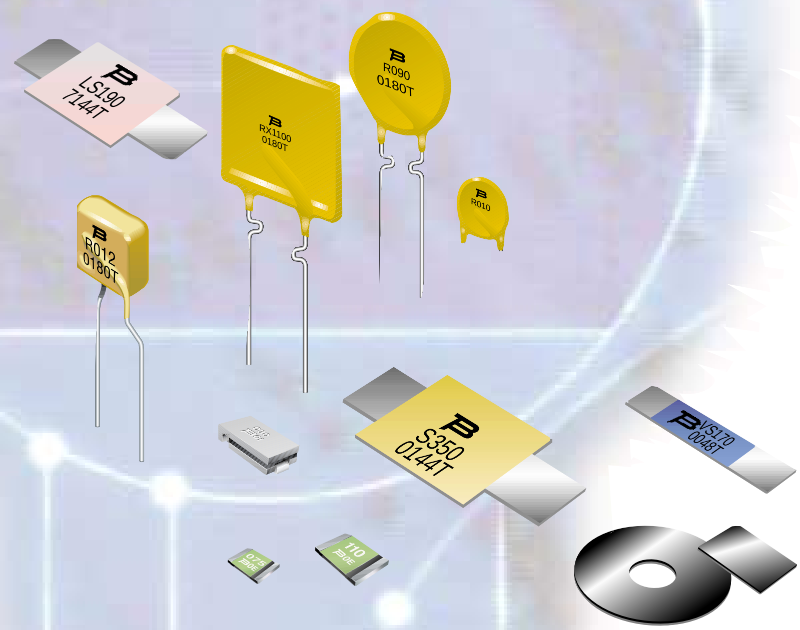
Circuit Protection

When it comes to Polymeric Positive Temperature Coefficient (PPTC) circuit protection, you now have a choice. If you need a reliable source, look to MULTIFUSE® Resettable Fuses from Bourns.

MULTIFUSE products are made from a conductive plastic formed into thin sheets, with electrodes attached to either side. The conductive plastic is manufactured from a non-conductive crystalline polymer and a highly conductive carbon black. The electrodes ensure even distribution of power through the device, and provide a surface for leads to be attached or for custom mounting.

The phenomenon that allows conductive plastic materials to be used for resettable over-current protection devices is that they exhibit a very large non-linear Positive Temperature Coefficient (PTC) effect when heated. PTC is a characteristic that many materials exhibit whereby resistance increases with temperature. What makes the MULTIFUSE conductive plastic material unique is the magnitude of its resistance increase. At a specific transition temperature, the increase in resistance is so great that it is typically expressed on a log scale.



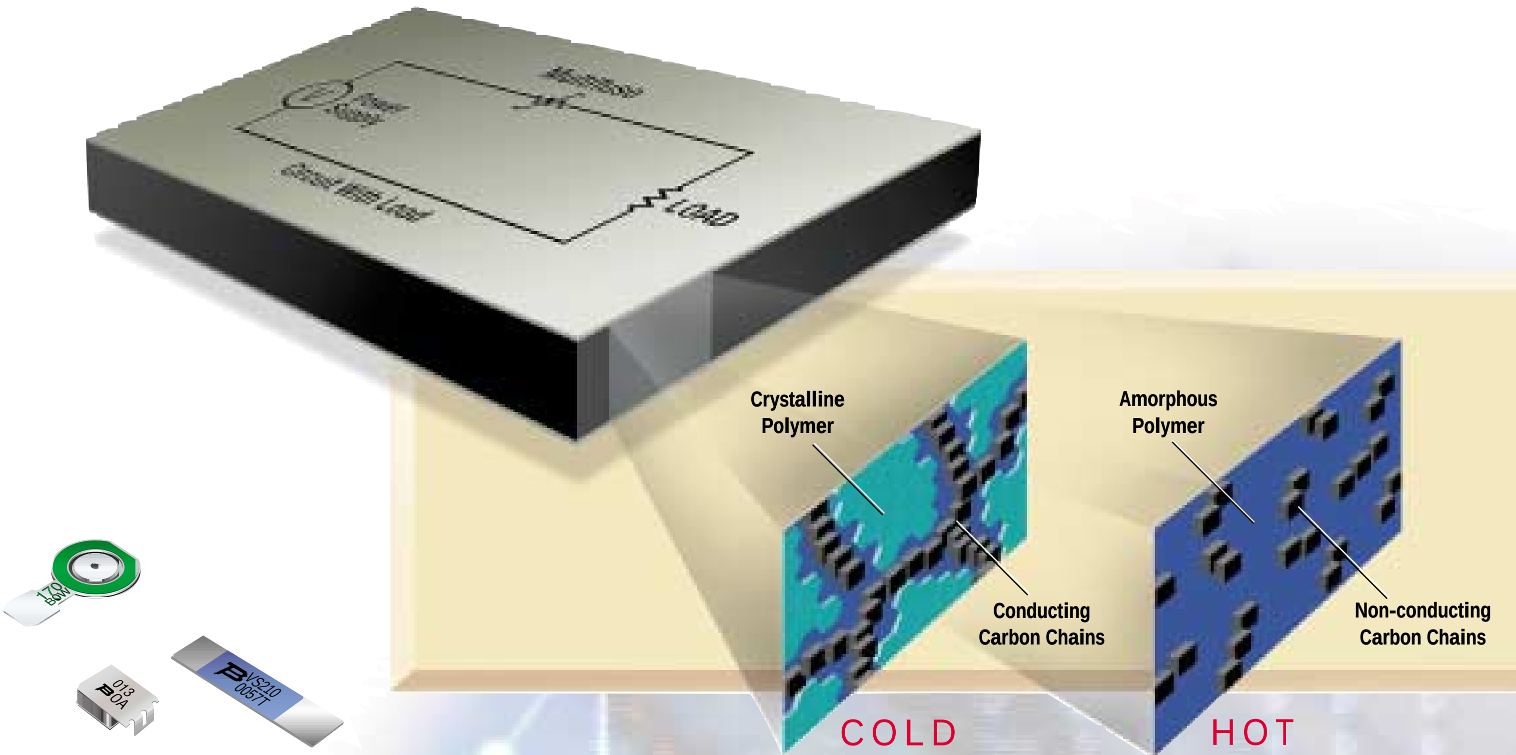


How Multifuse Resettable Fuses Work

The conductive carbon black filler material in the MULTIFUSE device is dispersed in a polymer that has a crystalline structure. The crystalline structure densely packs the carbon particles into its crystalline boundary so they are close enough together to allow current to flow through the polymer insulator via these carbon "chains."

When the conductive plastic material is at normal room temperature, there are numerous carbon chains forming conductive paths through the material.

Under fault conditions, excessive current flows through the MULTIFUSE device. I^2R heating causes the conductive plastic material's temperature to rise. As this self heating continues, the material's temperature continues to rise



Reset Your Current Thinking®

until it exceeds its phase transformation temperature. As the material passes through this phase transformation temperature, the densely packed crystalline polymer matrix changes to an amorphous structure. This phase change is accompanied by a small expansion. As the conductive particles move apart from each other, most of them no longer conduct current and the resistance of the device increases sharply.

The material will stay "hot," remaining in this high resistance state as long as the power is applied. The device will remain latched, providing continuous protection, until the fault is cleared and the power is removed. Reversing the phase transformation allows the carbon chains to reform as the polymer re-crystallizes. The resistance quickly returns to its original value.

General Applications

Almost anywhere there is a low-voltage power source and a load, a MULTIFUSE Resettable Fuse can be used.

The fact that these protection devices reset automatically sets them apart among circuit protection devices.

Circuit designers know there are circumstances they have no control over which can result in potentially damaging overcurrent conditions. Non-resettable fuses work well, *once*, and in many applications, replacement is not an option due to inconvenience, warranty costs or damaged reputations.

The benefits of MULTIFUSE Resettable Fuses are being recognized by more and more design engineers, and new applications are being discovered every day. The use of MULTIFUSE types

of devices have been widely accepted in the following applications and industries:

- Personal computers
- Laptop computers
- Personal digital assistants
- Transformers
- Small and medium electric motors
- Audio equipment and speakers
- Test and measurement equipment
- Security and fire alarm systems
- Medical electronics
- Personal care products
- Point-of-sale equipment
- Industrial controls
- Automotive electronics and harness protection
- Marine electronics
- Battery-operated toys

Polymer Positive Temperature Coefficient (PPTC) Fuses have provided designers in numerous industries a new tool in their battle to improve product quality and performance while at the same time reducing total installed cost.

As PPTC fuses are resettable, warranty costs and service calls are largely avoided. Since they do not need to be serviced, they can be utilized as embedded circuit protection devices.

Based on PPTC technology, MULTIFUSE Resettable Fuses are packaged in Radial Leaded, Surface Mount, Axial Leaded “Battery Strap” and Uncoated Disk form and have a wide range of power ratings. With this comprehensive selection of packages and power ratings, there is sure to be a MULTIFUSE Resettable Fuse that meets your application requirements.

There are many applications for MULTIFUSE Resettable Fuses in a variety of market segments, including:

- Computers and Peripherals
- Primary and Secondary Batteries
- Automotive
- Telecommunications
- Industrial Controls
- Consumer Electronics

Computers and Peripheral Devices

Circuit protection in desktop, laptop, notebook computers and peripheral devices is growing increasingly complex and important. Overcurrent protection applications for MULTIFUSE

Resettable Fuses include:

- Hard Disk Drives
- Keyboard and Mouse Ports
- SCSI Interface Ports
- SCSI Adapter Cards
- Audio and Video Cards
- Ethernet and Token Ring LAN Ports and Adapter Cards
- Cooling Fan Motors
- Universal Serial Bus (USB)

Because computers have grown more modular, portable and flexible in their design and size, circuit protection requirements have changed dramatically. Consequently, circuit protection may entail overcurrent or overvoltage protection, and filtering applications. A proactive approach to the selection of circuit protection components will enable the computer or peripheral manufacturer to meet the necessary safety requirements while providing the consumer the assurance of a reliable, trouble-free computing tool. At the same time, warranty costs due to consumer misuse can be greatly reduced.

PPTC resettable fuses afford manufacturers the option to improve their hardware design and set their equipment apart from that of manufacturers who are not as forward thinking in their designs. MULTIFUSE products are the answer to the overcurrent circuit protection challenges of today's electronic design engineer.

The protection requirements of all computer applications are very similar when motherboards or back planes need to be protected from faults in devices being "hot plugged" in or faults in the devices themselves. Compliance with industrial standards and agency safety requirements is also similar in most cases.

MULTIFUSE Resettable Fuses in the MF-R, MF-SM and MF-MSMD configurations provide solutions for all computer and peripheral overcurrent protection requirements.

Battery Applications

Since batteries are important components of today's diverse array of portable equipment, protection of the battery pack is essential to keep the system up and running. Battery chargers are designed to accommodate the power specifications of specific batteries. Charging is limited to the needs of a battery's given charge at any point in time. If the charger's current limiting circuitry fails, the battery pack can be charged beyond what it is designed to handle, thus damaging an expensive battery pack.

Protection of the battery and equipment being powered while the battery is installed can be achieved by several current limiting technologies including PPTC resettable fuses. However, when the battery pack is removed from the portable equipment, it is susceptible to a short circuit across its contacts. Here, designers have fewer choices. High discharge due to short circuits can permanently damage the battery pack, and may constitute a serious potential hazard. MULTIFUSE Resettable Fuses in the MF-S and MF-LS form factors can prevent such accidents, and the consumer will greatly appreciate the manufacturer's attention to this detail.

MultiFuse®
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Automotive

MULTIFUSE Resettable Fuses provide ideal protection for a wide range of automotive electrical applications. And they eliminate the nuisance factor of replacing blown fuses.

Automotive manufacturers continue to design more powered accessories such as seats, antennas, mirrors and windows into their vehicles. With added features comes the added complexity of wiring harnesses, motors, the electronics that control them, and the protection required to make them safe.

In addition to fuse replacement throughout the vehicle, MULTIFUSE devices are ideal for:

- Motors – protection for the small motors that power door lock actuators, seats, mirrors, etc.
- "Black Box" Control Modules
- Wire Harness Protection
- Car Alarm Module Protection
- Instrument Panel Protection
- Diagnostic Port Protection
- Cigarette Lighters

Industrial Controls

Designers of pressure sensing equipment are now turning to PPTC Resettable Fuses to help protect the control electronics of their sensors. PPTC Resettable Fuses are low-resistance, resettable overcurrent protectors which may be placed in series with the input and output lines of a pressure sensor to protect the electronics. This is especially important for sensors which need to work in gaseous environments and must be explosion protected.

Many of the more advanced pressure sensors integrate complex combinations of resistors and data processing components to digitally compensate for the non-linearity and temperature dependence of the membrane used to sense pressure. For sensors which must operate in a gaseous environment, it must be ensured that the sense circuit components do not overheat as a result of a short circuit. Multifuse® Resettable Fuses can be used to reduce potentially damaging overcurrents to safe levels, preventing such component overheating situations.

Loud Speaker Crossover Networks

The Design Challenge:

Loudspeakers and amplifiers (amps) are manufactured by numerous companies building one or both of the systems. Different design parameters cause impedance mis-matching which can be damaging to speakers. Overcurrent situations caused by overdriving power amps can damage the wirewound coils, causing shorts or opens in the copper windings of speaker components. Low power amps may act as clippers, causing a frequency shift or high frequency signals which can damage speakers, tweeters and constant directivity horns. Another common failure mode is caused by taking a speaker from a zero state to a highly excited state in extremely short amounts of time. The design of crossover networks concerns itself with the load seen from the amplifier. The initial internal resistance of the device is extremely small compared to the total impedance of a cross-over circuit such as Zobel network or conjugate impedance network.

The obvious solution is circuit protection using overcurrent protection devices. Two choices are fuses and circuit breakers. Circuit breakers can add undesirable distortion as the metal contacts separate. The electric field generated by the current flow resists the change in current, resulting in arcing and electrical white noise. Fuses must be accessible and manually replaced. The cost of the fuse, fuse holder and access panel to the fuse makes typical fusing economically unattractive. Also, there is the possibility of mistakenly or intentionally over-rating the fuse, setting the system up for damage and violating agency safety certifications. In crossover networks, a minimal number of components are used to protect the tweeter. The obvious solution is to use an inexpensive resettable fuse that can be buried in the cabinet without needing maintenance or replacement.

The Application:

A MULTIFUSE PPTC is frequently used in a parallel circuit with a large resistor (typically 10k ohms) and this circuit is placed in series upstream of the speaker. (See Figure 1.) During normal operation within the parameters of the tweeter, the MULTIFUSE PPTC acts as a conductor for the speaker. When an overcurrent situation such as an overdriven amp occurs, the polymer within the PPTC will expand and the carbon chains will disengage. This shunts all of the current into the shunt resistor, dropping the voltage across the resistor and protecting the speaker. Once the signal changes to a low value, the PPTC will begin to reset and the circuit will react as designed.

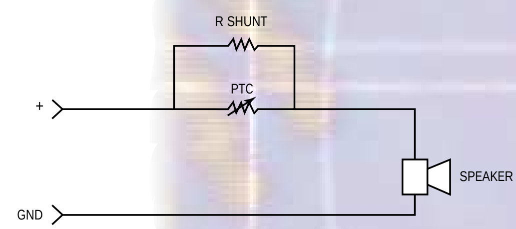


Figure 1

Another application is to use the PPTC without a shunt resistor (see Figure 2). As the PPTC's resistance increases exponentially, the speaker, horn or other delicate instrument will see little to no current flow.

The choice of MULTIFUSE PPTC used depends upon the current demanded by the parameters of the speaker which the PPTC protects during normal operation. The Ihold of the PPTC is the amount of operational current desired in the design. The Itrip is the value at which you wish to begin protecting the circuit, keeping in mind that the ambient temperature is an integral part of the circuit design when selecting the correct device.

A typical crossover network design is drawn below (Figure 2), with typical values.

C_1 = Ranges from 10 to 2uF
R_1 = Ranges from 2.7 to 22 ohms
C_2 = Ranges from 4uF to 2.2uF
L_1 = Ranges from 450uH to 300uH
L_2 = Ranges from .7uH to 2.5mH
C_3 = Ranges from 4.7uH to 33uF

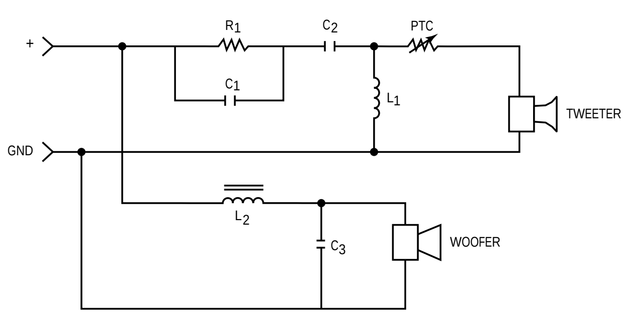


Figure 2

The input voltage can range up to 60 volts continuous for newer speaker systems and about 53 volts on older systems. Typical music peaks are a minimum of 12db and normally 15db. New woofers can handle 500 watts while older styles are limited to 350 watts. Tweeters fall into values of 60 watts for new speakers, and 40 watts for older speakers.

Typical MULTIFUSE component values for the PPTC would be the MF-R040 for the 60-volt system and MF-R030 for the 53-volt system.

** Acknowledgement: Special thanks to Jon Risch for his technical input to this application note.*

Automotive Door Locks

The Design Challenge:

Two considerations in automotive engineering are weight and reliability. As cars become equipped with more options and safety requirements, the weight of the car increases. As the weight increases, performance characteristics decrease and fuel efficiency decreases. Standard fusing requires wiring through the fuse panel to the circuit being protected. This adds to a vehicle's weight, while the added wiring increases the opportunity for malfunctions. A standard blown fuse must be manually changed, and the circuit is inoperative while the fuse is in the non-functional state. The fuse box must be accessible in order to service fuses, limiting the locations the fuse box can be placed.

Automotive door lock circuits require overcurrent protection. If a door lock is jammed or forced into a position so the lock cannot move in the ordered direction, the IC chips controlling the system can be damaged. A multitude of hazardous situations can occur, such as physical damage to the door or short-circuiting due to water leakage into the door panel or low temperatures causing freezing of mechanical mechanisms. Current designs include wiring from the control module in the cockpit of the car to the door locks via the fuse box under the dash. Using standard fusing, once the fuse is blown, the door locks remain in a non-operative state until the fuse is replaced.

Agency certifications such as those issued by Underwriters Laboratory (UL), are concerned strictly with safety standards. Automotive standards far exceed the testing required by agencies such as UL. The Automotive Electrical Council (AEC) sets forth the standards for passive electrical components in the QEC 200 test standards. These tests are concerned with reliability as well as safety. Companies such as Visteon, Delphi, and Daimler/Chrysler are currently testing to QEC 200 requirements. (For a copy of AEC's QEC 200, please contact your local Bourns sales representative.)

The Application:

In a typical door lock design, the lock motor is energized through a relay by a control processor via an inverter IC (See Figure 1). A pulse is sent to the processor from the contact lock/unlock switch, key lock, motion sensor, door ajar circuit or remote control. The coils of the relay have a positive voltage from V(Batt) at pin 5 to prevent relay chatter from noise or nuisance tripping of the relays (See Figure 1). V(Batt) is typically 12 volts, but will soon be upgraded for the 42 volt automotive platform. The signal from the logic controller is sent to an inverter to bias the coil for current flow through pins 6 or 7 depending on the required workload of unlocking or locking.

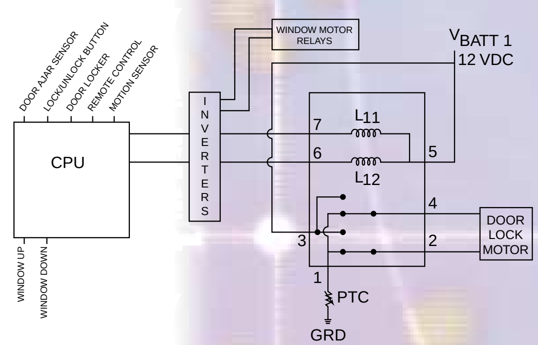


Figure 1

If the coil from pin 5 to pin 7 is energized, the armature from pin 4 will change state to pin 3 conducting current through the door lock motor in a direction to lock the door (See Figure 2). The path of the current will continue from the door lock motor to pin 2 of the relay. At pin 2 the second armature will not be engaged and will continue contacting pin 1, giving a ground through the PPTC. If a short or fault condition were to occur, the excess current flow from V(Batt) through the door lock motor and relay would cause I^2R heating in the PPTC. As the PPTC heats up, the resistance of the PPTC goes exponentially high, isolating the ground and negating circuit flow. Once the overcurrent fault condition is removed, the polymer will return to its semi-crystalline structure with the carbon chains reconnected, and current will once again flow through the PPTC.

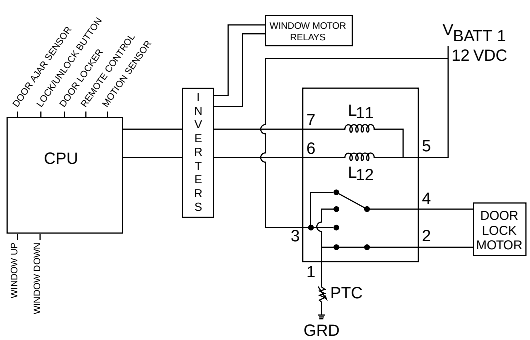


Figure 2

The unlocking portion is similar. The coil from pin 5 to pin 6 of the relay will be energized by the inverter and controller circuit. The armature at pin 1 will change state to pin 3. When this happens, the V(Batt) will let current flow through the contacts at pins 3 and 2 (See Figure 3) through the motor (changing lock position) back through pin 4 to pin 1 to the PPTC and ground, thus changing the state of the lock position.

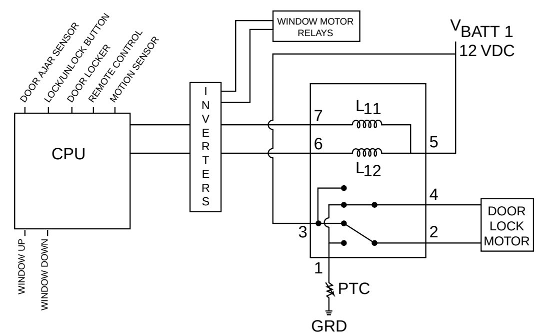


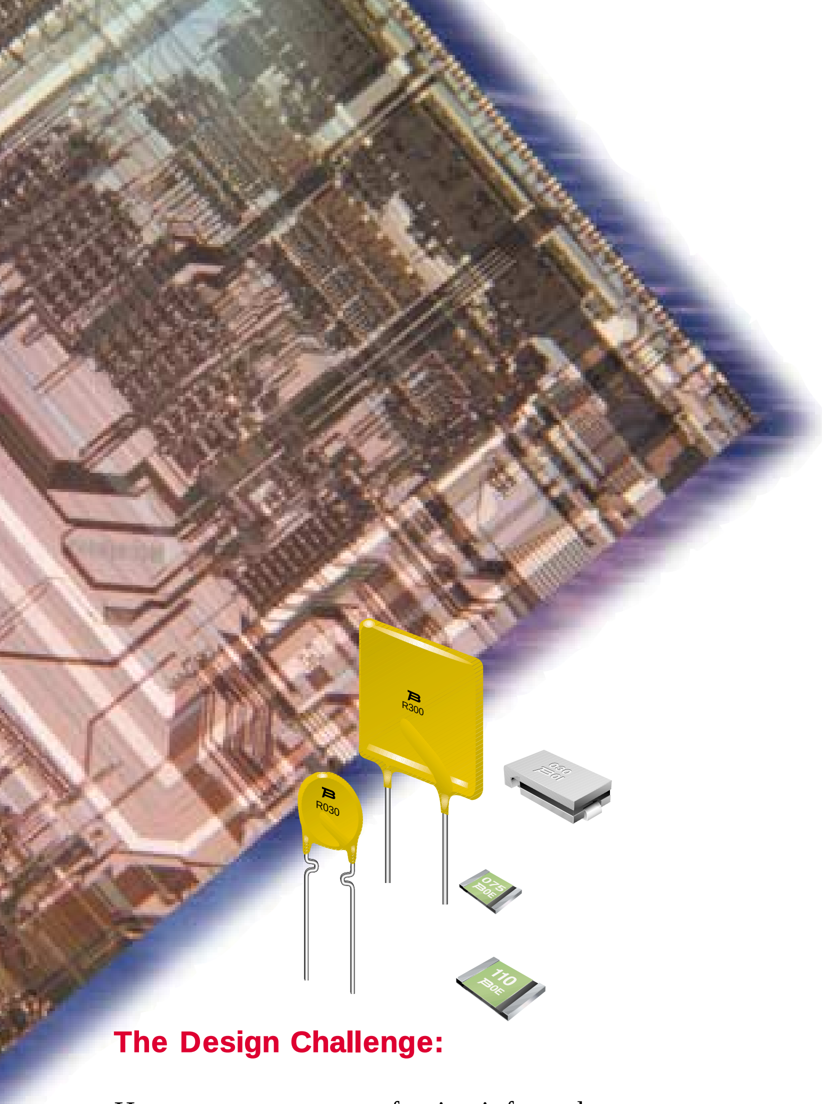
Figure 3

Consult you local Bourns, Inc., representative for additional automotive applications such as:

- Window lifts
- Electric seats
- Wiring harnesses
- Lighting
- Modules
- Underhood applications
- Accessory outlets
- Moon/sun roofs

Application Note

Circuit Isolation and Protection



The Design Challenge:

How to separate a part of a circuit from the power source while maintaining the integrity of the remaining circuit in a working status. In instances where a part of a system could be damaged and the remaining section will need to continue to operate, the following circuit design is an option.

The Application:

A series of circuits are attached to the secondary side of the transformer or single bus bar from the power supply. The total resistance of each circuit branch is calculated using the algebraic form of Ohm's law. (Voltage = Resistance X Current.) Typically, the inductance and capacitance are negligible when compared to the overall impedance of the device. In series, the resistance is added directly (see Figure 1.)

Figure 1

$$R(T) = R_1 + R_2$$

(Calculation 1)

Resistances in parallel are added using the parallel resistance formula $Rt = 1/((1/R_1)+(1/R_2))$ where Rt is the total resistance of the two resistors in parallel. R_1 and R_2 (see Figure 2) are the values of the resistors in the parallel circuit.

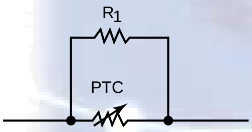


Figure 2

$$R(T)= 1/((1/R_1) + 1/(R_2))$$

(Calculation 2)

A MULTIFUSE PPTC device is chosen depending on the value of each branch resistance and the voltage applied. (See Calculation 3 and Figure 3.) With the known voltage of the power supply and the calculated value of the branch circuit, we can determine the current of the branch. For the branch at node one, the calculated resistance is 8 ohms. We then determine the current using the voltage of 24 volts and Ohm's law. The current is 3 amps, so we choose the MF-R300. In the same way, the value of current at node 2 is determined to be 2 amps, so the MF-R200 is chosen.

If the overall resistance is calculated (see Calculation 2), the current can be solved by using Ohm's law. The overall current calculation should equal the sum of the current at node 1 (I1) and node 2 (I2) where I(T) = I1 + I2.

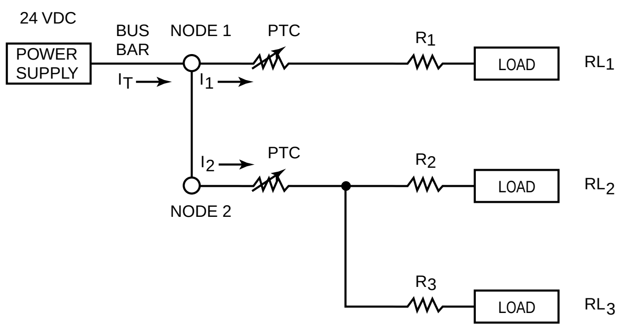


Figure 3

R(T1) @node 1 = R1 + RL1 = 8 ohms

R(T2) @node 2 = 1/((1/(R2 + RL2))
+ (1/(R3 + RL3)) = 12 ohms

V = IR
V = I1 (R1 + RL1) = I1 8 ohms V = 24 Vdc
24Vdc/8 ohms = 3 Amps = I1 @ node 1

V = IR
V = I2 R(T2) = I2 12 ohms V= 24 Vdc
24Vdc/12 ohms = 2 Amps = I2 @ node 2

The Ihold for the PPTC device R1 at Node 1 will be 3 amps, so an MF-R300 will be chosen

The Ihold for the PPTC device R2 at Node 2 will be 2 amps, so an MF-R200 will be chosen.

I(T) for the circuit will be I1 + I2 = 5 amps. So the Imax over current rating of the PPTC is not violated.

(Calculation 3)

If there is a short circuit at load RL2, the current, which is the same current through the MF-R200 at node 2 (R2), will rise. As this occurs, the I2R will also rise. As the I2R rises, the resistance of the PPTC will rise exponentially. According to Ohm's law, as the resistance rises, the current will drop sharply. This will not affect the circuit at node 1. The current will be blocked from node 2 until the fault condition is removed and the PPTC is reset through thermal radiant dissipation. The entire resistance of node 2 becomes exponentially high, causing I2 to go towards 0 amps. Thus the total current I(T) = I1.

USB Port Protection

The Design Challenge:

In today's ever-expanding world of information technology, the priority becomes to create devices carrying more information in a smaller package. Not only are computers becoming more compact, they are able to contain bytes once needed for a computer the size of a conference room. The same can be said about the peripherals attached to the computer. Several years ago, all information was carried from a serial or parallel port to the external components of the computer (i.e. printers, scanners, mouse, keyboards). Today we are able to use the same equipment at higher peripheral-to-PC connection speeds. With the addition of these components comes the need to protect them from current consumption. Two types of current consumption for these components are DC current and transient current. When faced with this problem, what can be used to ensure that these components do not become potential hazards?

The Application

Overcurrent protection must be implemented at the host and all self-powered hubs for safety reasons, with a way to detect the overcurrent condition. A high-power hub port is required to supply 500 mA per port. A low-power hub port only has to supply 100 mA. If an overcurrent condition occurs on any port, subsequent operation of the Universal Serial Bus (USB) is not guaranteed, and once the condition is removed, it may be necessary to reinitialize the bus as would be done upon power-up. The overcurrent limiting mechanism must be resettable without user mechanical intervention. This requirement is per Universal Serial Bus Specification Revision 2.0 (www.usb.org). There are various devices that can be used to limit this overcurrent situation. Some examples are fuses and solid-state switching. MULTIFUSE® PPTC resettable fuses offer the same protection as those devices and are able to automatically reset once the fault is removed, making the device ready for normal operation. Typical MULTIFUSE component values for the PPTC would be the MF-USMD050 or the MF-MSMD110. Actual part numbers for different applications may vary according to the resistance required and operating circuit.

Application Note

Protecting Battery Chargers

The Design Challenge:

The standard mobile phone charger consists of a transformer with some type of electronic circuitry on the output side smoothing out the signal. All low voltage transformers manufactured are required to be in accordance with EN60742 and UL 1950 manufacturing standards.

Standard EN60742 specifies safety-isolating transformers should not overheat by more than 125°C when their secondary windings are short-circuited. The occurrence of a short circuit in the output circuit will result in an increase in the circuit current. The excessive current will gradually heat up and the windings of the secondary circuit, resulting in the charger not conforming to manufacturing standards.

Model MF-MSMD110

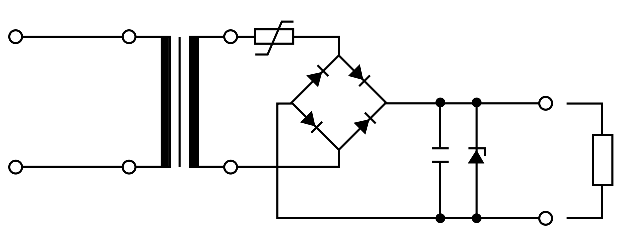


Figure 1

The Solution:

The inclusion of a Bourns Multifuse® Polymer Positive Temperature Coefficient (PPTC) in the secondary circuitry is the ideal solution. A four-decade increase in resistance is typical, and in the case of a short circuit in the secondary circuit, the Multifuse® PPTC will trip to a higher resistance. The increased resistance will ensure that the short circuit is limited to such a level that the windings will not heat up.

The circuit shown in Figure 1 has a MF-MSMD110 device integrated into the circuit, which will trip at 800 mA at 60°C, keeping a higher current from passing. Currents below 500 mA charge the majority of rechargeable battery packs so that if a charger starts to see currents in the range of 800mA, there is a problem and the current needs to be restricted.

A range of similar Multifuse® devices are available that can be matched to different charging currents.

The Benefits of PPTC Technology Include:

• ***Faster time to trip.***
A PPTC has a lower thermal mass than other solutions and heats up more rapidly. As a result, it trips into the high-resistance state quicker.

• ***Smaller size.***
PPTC products use up a smaller area on your board and are easier to design into the package.

• ***Low initial resistance.***
With their lower resistance, PPTCs make the transformer more efficient.

• ***No cycling.***
PPTC devices stay in a tripped state under a fault condition.

Lithium-ion/Lithium Polymer Battery Pack Protection

Introduction:

We have seen a rapid growth in the number of portable devices available today. This emergence of technology has resulted in a demand for lightweight, high-capacity batteries. Lithium-ion and lithium-polymer battery backs have filled the demand.

The Design Challenge:

Lithium packs are constantly charged and discharged over their life cycle. An overcharge or over-discharge results in the temperature of the battery increasing. As the electrolyte solution heats up, it may decompose. This will result in a gas being produced or metal lithium being precipitated. These events could cause either a fire or an explosion. This is why the discharging and charging of a lithium pack must be constantly monitored.

A typical protection circuit contains a protection IC that monitors the cell voltage. Two FETs, one to limit the charge current and one to monitor the discharge current. The majority of cells will also use a second level of protection to protect against failure of this electronic circuitry. This can happen as a result of a number of events such as excessive heat, faulty components, or excessive electrostatic discharge. One method to protect against these events is to use a second circuit set slightly above the primary circuit. The secondary circuit is activated by failure of the primary circuit. This means that the number of components is doubled and of course, the price is doubled.

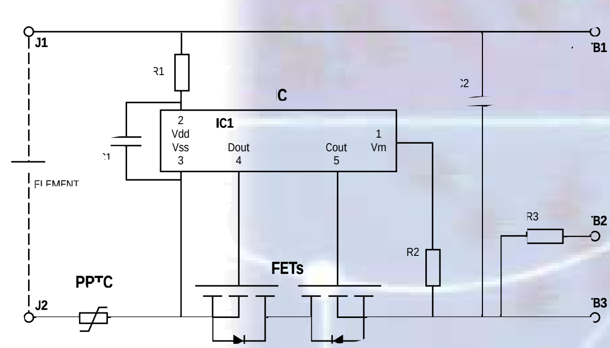


Figure 1. Typical Protection Circuit with a Multifuse device for Lithium-ion battery packs

The Solution:

Bourns Multifuse® Polymer Positive Temperature Coefficient devices are ideal for the second level of protection inside a lithium pack. The circuit illustrated by Figure 1 shows how a PPTC device can be incorporated into a battery safety circuit.

The PPTC not only acts as a second level of protection, but also improves the overall safety of the pack.

Benefits of Using the Bourns Multifuse® MF-VS Product Family:

Faster Charging Cycle

The Bourns Multifuse® MF-VS product family has been specifically designed for this application. Manufacturers of cells recommend that during charging, cell temperatures must be kept below 100°C to avoid thermal cell runaway. The designer of the pack must limit the charge current to avoid the potential of reaching this temperature.

Bourns has developed a device that will trip at 85°C. The device will trip significantly faster because of the lower trip temperature. By using the MF-VS product, circuit designers can now design for higher/faster charging cycles.

Longer Talk Times

Digital phones need a pulse current up to 1.7 amps to continue transmitting during talk time. The ability of the battery to deliver short, heavy current spikes is a function of the remaining capacity and the internal resistance of the pack. The lower the resistance of the pack, the longer it will be able to provide the necessary power to continue transmitting.

The internal resistance of the protection circuitry, therefore, has a direct relationship to the talk time capacity of the phone. Bourns Multifuse® offers the MF-VS product family as the ideal solution to help designers increase talk time capacity. The initial resistance of the Model MF-VS210 is specified between 18-30 mohms. And Bourns can now offer customized solutions with initial resistances considerably below this value.

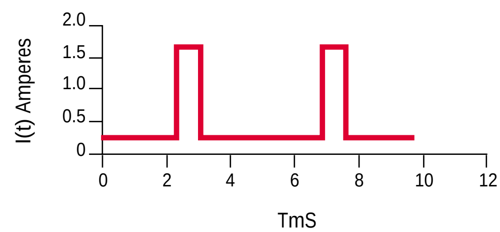


Figure 2
The GSM Wave standard transmits voice data in packets of 567 uS at a period of 4.61 mS. The current peaks vary according to signal strength and reach 1.7 amperes in fringe areas.

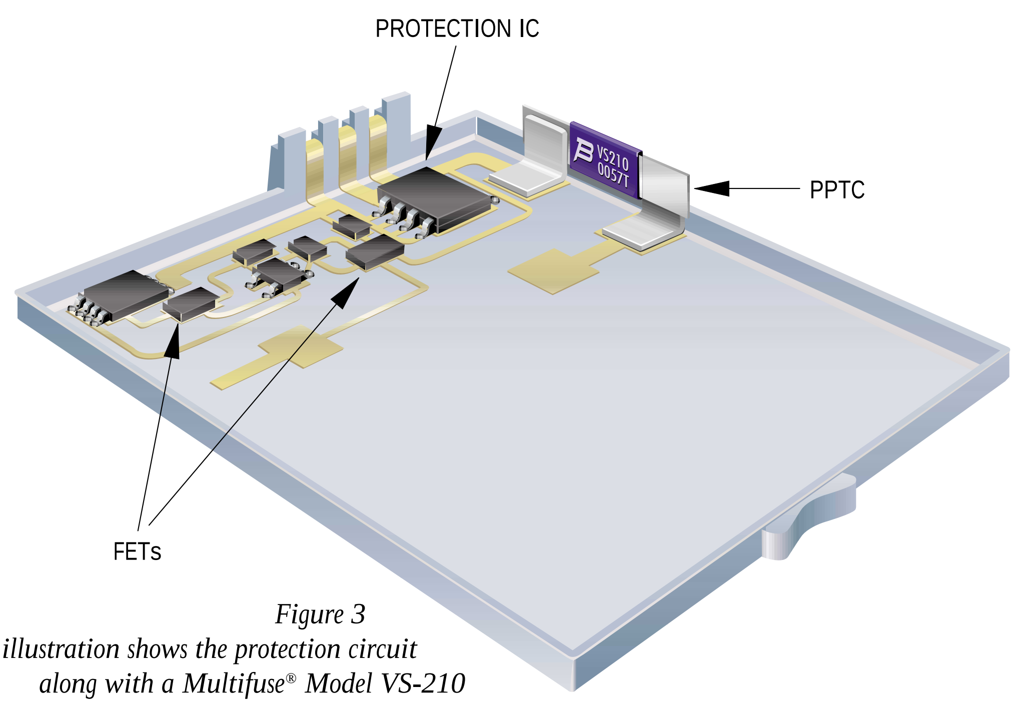


Figure 3
The above illustration shows the protection circuit along with a Multifuse® Model VS-210 integrated into a lithium-ion pack. The total resistance of the package can be reduced to levels below 100 mohms.

90V Multifuse® Positive Temperature Coefficient (PTC) Resettable Fuses in an HFC Network

The Design Challenge:

The continued development of new broadband services such as video and interactive programming is causing an ever-increasing demand for wider bandwidth. This quest for bandwidth has been responsible for the telecommunications industry's major step from copper based cabling to fiber optics. As fiber optics integrate themselves into most cable networks, they have now taken on a hybrid fiber/coax (HFC) style of architecture. HFC architecture has now become the leading choice of both Cable TV (CATV) companies and telephone service providers. Because of the similarity of the HFC architecture to their existing networks, cable companies in particular are embracing HFC as an affordable way to position themselves as telephony vendors in a competitive, multi-service future. CATV systems have a vision of providing a complete networked home package where video on demand (VOD), high speed internet and telephony will all be provided via one system: the HFC network.

HFC Architecture:

HFC architecture usually consists of a fiber trunk line carrying signals in the form of video or telephony from the headend or central office (CO), to feeder cables serving local neighborhoods. Optical nodes on the trunk line convert the signals from light in the fiber optics to radio frequencies (RF) for the copper cables. The feeder cable, a medium sized coaxial cable, provides the signals from the trunk cable to entire neighborhoods. Individual houses subscribing to the cable services have drop lines connected to the feeder cables via taps and network interface devices (NIDs) attached to the outside of their homes for cable telephony and set top boxes for video. Figure 1 below gives a basic layout of how an HFC network should look.

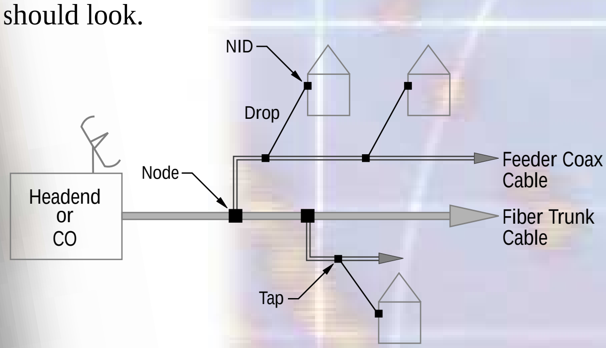


Figure 1. Hybrid fiber / coax (HFC) architecture

Cable Telephony:

Unlike cable TV where power to operate the TV is not transmitted along the cables, cable telephony requires applications power to operate the NIDs. In a cable telephony system, the cable transmits the signal information and in many cases the local operating power for the NIDs, in 60V to 90V form. Powering the local NID can be carried out in any of the following ways:

- Power can be transmitted across the center conductor of the drop cable from a power passing tap to the NID.

- Power can be transmitted on separate twisted pair wires that are bonded to the outside of the drop cable. This drop cable is sometimes called a Siamese cable, and also operates between the power passing tap and the NID.

- Powering can come from the ac supply in the home. In this case a back-up battery must also be used in order to provide emergency telephone access during power failures.

The first option above is the most common form of powering the NID. Coaxial power passing taps act as gateways from which a number of different subscribers can connect to the feeder coax cable. The power to operate the NIDs and the signals is usually separated at these taps.

The introduction of HFC has caused a shift downstream of some of the functions that were located in the headend or central office. One major example of this is the fact that the subscriber line interface card (SLIC) in an HFC is located in very close proximity to the end customer. The SLIC can be located in either the tap (on the pole), leaving the NID in the form of a passive device (see Figure 2.1), or it can be located in the NID itself, which is the most common form (see Figure 2.2). The location of the SLIC and ring generator so close to the customer causes a significant increase in power downstream. As all this equipment is located in the copper portion of the network, there is a strong potential for equipment damage if an electrical fault occurs due to a power cross on the coax.

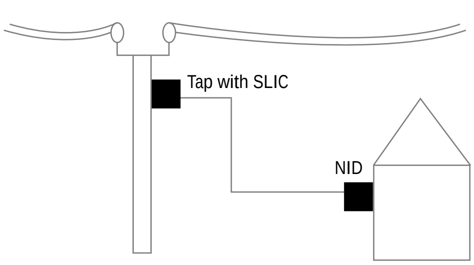


Figure 2.1. Tap with built in SLIC

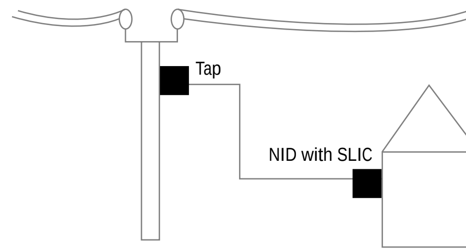


Figure 2.2. NID with built in SLIC

The Application:

Lightning strikes and power crosses are the major reasons for damage caused to telecommunications equipment. Both sources have been readily identified and various different standards exist to ensure that telecommunications equipment resists their damage. The evolution in the levels of protection is governed by international regulatory requirements including the International Telecommunication Union (ITU), UL, FCC and Telcordia GR-1089-CORE. In order to allow telecommunications equipment to comply with these standards, Bourns Inc. has introduced a wide range of overcurrent and overvoltage components including PTC resettable fuses, thyristors, gas discharge tubes, and line feed protection modules, which are designed to provide complete circuit protection against overstresses.

Article 830 in the 1999 National Electrical Code manages the network powered broadband equipment such as power passing taps. According to this code, the maximum power must be limited to 100VA within 60 seconds due to the risk high currents can pose to the unknowing subscriber. With this in mind, Bourns designed the Multifuse® MF-R/90 Series of 90V PTC resettable fuses to act as such a current limiter.

As central offices start to decentralize and shift their equipment downstream, the method of circuit protection needs some very careful consideration. PTC resettable fuses have been successful in central offices because of their unique method of resetting themselves after an overcurrent fault. As SLICs start to be found in remote locations, the cost benefit of a resettable fuse becomes amplified. The costs associated with the dispatch of service technicians to simply replace blown fuses due to transient overcurrents and the inconvenience this brings on service demanding customers can become unacceptable. Clearly if the obvious broadband benefits of the HFC network are to be realized, it must prove to be a reliable and efficient architecture. A PTC resettable fuse is an element to aid this reliability.

Bourns Multifuse® MF-R055/90 & MF-R075/90:

The potential for power crosses or induced high voltages are very real, and the network must provide adequate protection against such threats. Since each power passing tap must have power limited to 100VA within 60 seconds, the MF-R055/90 with its hold current of 550mA and maximum voltage rating of 90V, falls well within this requirement as does the MF-R075/90 with its hold current of 750mA and maximum voltage rating of 750mA.

A resettable polymer PTC fuse has some very obvious benefits in the area of cable telephony helping to protect devices from fault conditions. The fact that a PTC resets itself once the fault clears and the power cycles, eliminates the costly and timely calls of service technicians. The MF-R055/90 with its hold current of 550mA at room temperature and 350mA at 60°C suits power passing taps designed to supply single family homes. The MF-R075/90, with its hold current of 750mA at room temperature and 480mA at 60°C suits power passing taps designed to supply multi-dwelling units (MDU). The power passing tap with drop cable and resettable current limiting ability offers self-extinguishing circuit protection and is rapidly becoming the market norm.

Conclusion:

Cable telephony is rapidly becoming an integral part of a networked home, and the market for telephony services is significantly larger than that for video. Market penetration in the home and businesses is approaching 100 percent, and demand is growing sharply, driven largely by data services such as the World Wide Web. Telephony is of enormous potential value to cable companies, as these companies already have much of the necessary infrastructure in place. The growth potential for the MF-R055/90 and MF-R075/90 should mirror these demands.

Application Note

Protecting the Next Generation of Battery Packs

Introduction:

The MF-SVS product family is the next generation of Polymeric Positive Temperature Coefficient (PPTC) devices designed for battery pack protection. The product family has been designed to meet the battery pack industry's demand for a PPTC device with a lower initial resistance. A PPTC strap device is now available with a typical resistance as low as 14 mΩ.

The new product family extends the Bourns Multifuse® product portfolio of resettable fuses that offer electronic design engineers a simple and cost effective method of circuit protection in low and high voltage applications.

Applications/End Products:

Portable electronic devices require a power pack that is cost effective, reliable, and small in size. Over the years, the battery pack industry has continually improved performance while reducing the size of the average battery pack. Bourns' Multifuse® product range has kept pace with the developments in the battery pack industry with new products consistently developed offering pack designers lower resistance in a smaller package.

The new product family has been designed for use inside Li-ion, Li-Polymer and Ni-MH rechargeable battery packs. The devices are particularly suited for packs used inside high-drain current applications such as PDAs, next generation cell phones, and laptops.

Features & Benefits of the MF-SVS Product Family:

Features	Benefits
Lowest initial resistance available	Longer talk time capacity of battery pack.
Trip temperature between 80-85°C	Avoids nuisance tripping associated with PPTC devices that trip at lower temperatures. The trip temperature of 80-85°C has been used and field-tested as the standard trip temperature for the majority of battery chemistries, including Li and Ni-Mh. This optimum trip temperature gives the user the maximum possible operating temperature range without compromising the safety of the pack.
Flexible designs	Aside from our standard product family, Bourns offers custom designs to meet the requirements of each individual pack. Typical solutions are products with long leads, removing the requirement to spot weld on nickel tabs to enable the pack manufacturer to connect the PPTC into the safety circuit.
Reduced width	Our product range now includes a 3.6mm wide device that can be fitted into the slimmest battery pack.
Lead free	The product range is 100% lead-free.

Typical Resistance Values

Model Number	Typical Initial Resistance @ 23°C (Ohms)
MF-SVS230	0.014
MF-SVS210	0.016
MF-SVS175	0.023
MF-SVS170	0.023

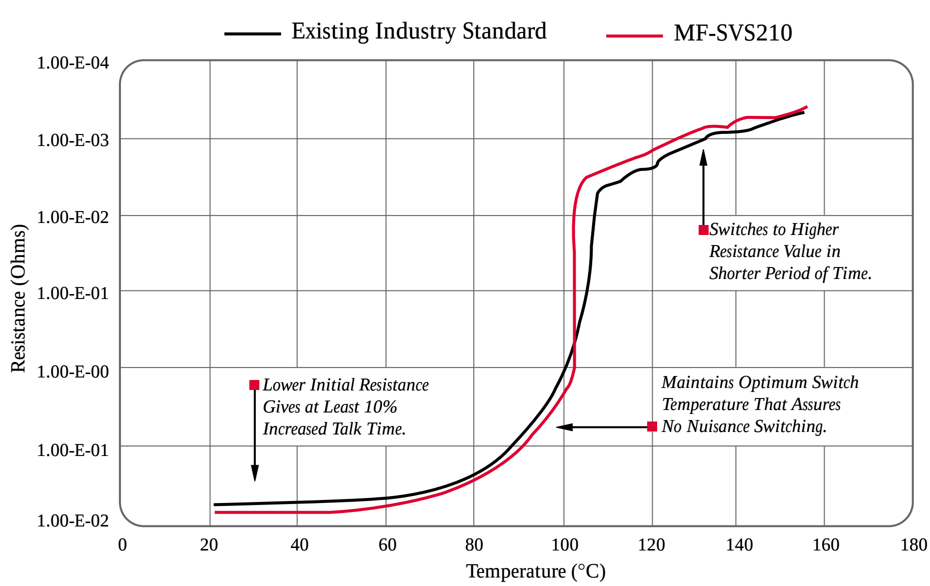
Solution Designs:

The fundamental criteria for selecting a PPTC is safety. Once this critical criterion has been fully satisfied, a designer must find Solution Designs that not just protect the pack, but also help minimize the resistance and cost of the final pack. These solutions may necessitate custom parts, and the Multifuse® product line offers custom designs to meet the requirements of individual packs.

The product family can be supplied with one or two of the leads slotted to assist in the welding procedure. As highlighted in the features and benefits section, the product can be offered with custom-designed lead lengths. A narrow product family is also available for the new generation of ultra slim packs. The Battery Pack Development Team at Bourns has the experience and capability to offer pack manufacturers unique solution designs that will enhance the technical and commercial competitiveness of their product range.

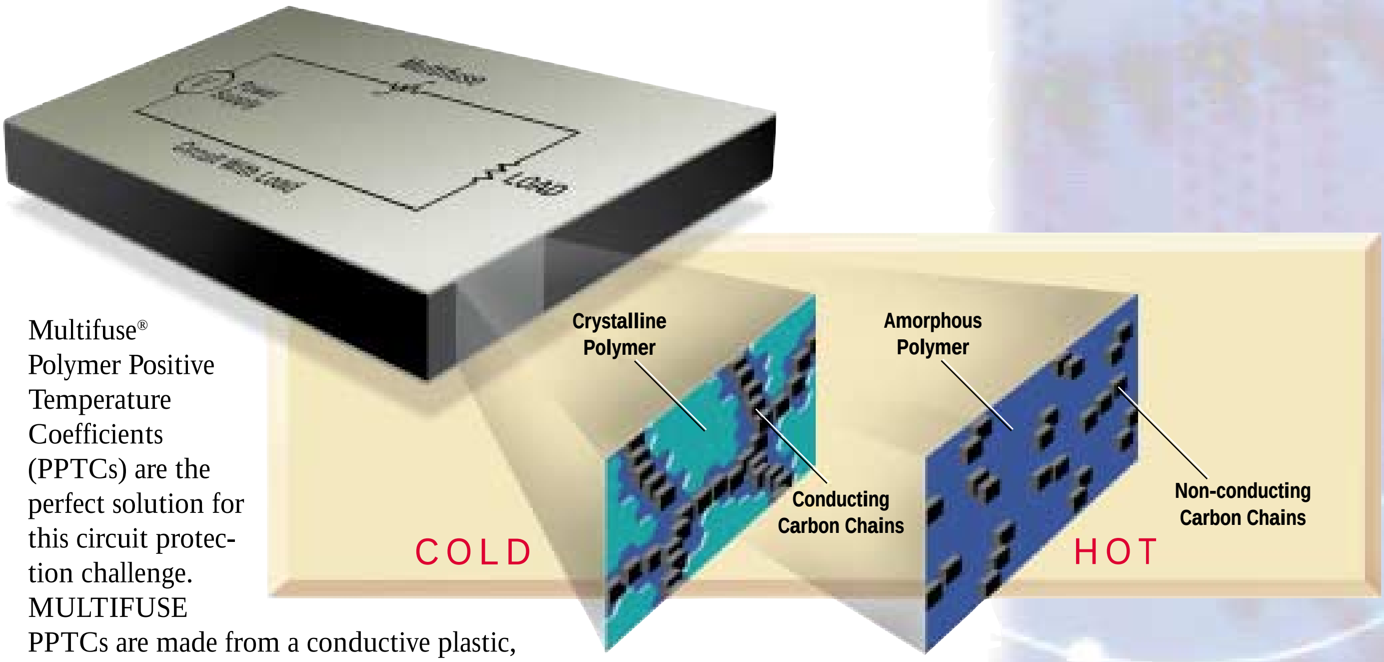
Consult your local Bourns representative for further information on Multifuse® solution designs or a full product roadmap on the development of PPTC technology for battery pack protection.

The Most Advanced Resettable Fuses for Battery Pack Protection

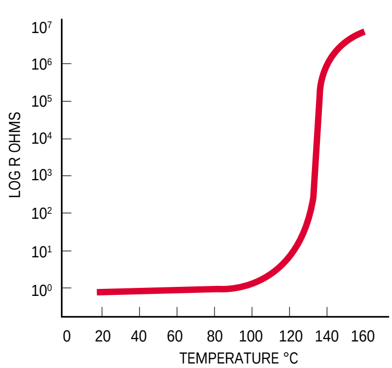


- *Typical Initial Resistance 14mohms*
- *UL & TUV Qualified*
- *Available in 3.6mm wide profile*
- *Rated to 10 Volts/100 Amps*
- *Flexible Design Options Available*

The Solution



Multifuse® Polymer Positive Temperature Coefficients (PPTCs) are the perfect solution for this circuit protection challenge. MULTIFUSE PPTCs are made from a conductive plastic, formed into thin sheets with electrodes attached to either side. The conductive plastic is manufactured from a non-conductive semi-crystalline polymer and a highly conductive carbon black. The conductive carbon black filler material in the MULTIFUSE PPTC device is extruded into the polymer. The carbon particles are packed close enough together to allow current to follow through the polymer insulator.



During fault conditions, excessive current flows through the MULTIFUSE PPTC device. I^2R heating causes the material's temperature to rise. Thermal derating of fuses is necessary for high or low ambient temperatures. As this self-heating continues, the material's temperature continues to rise until the conductive particles move apart and the resistance of the device increases exponentially.

The device remains in the high resistive current blocking state until the over fault condition is removed and the circuit is reset to its original parameters. This allows the carbon particles to rebond to one another and current to flow through the fuse.

Multifuse® Product Selection Worksheet

To select the correct Multifuse® resettable fuse, complete the information below, and refer to the relevant Multifuse product family page.

1. Determine the ***NORMAL*** operating current (I_{hold}): ________________ Amps
2. Determine the ***MAXIMUM*** circuit voltage (V_{max}): ________________ Volts
3. Determine the ***MAXIMUM*** fault current (I_{max}): ________________ Amps
4. Determine the ***OPERATING TEMPERATURE*** range min.______________ °C
   max. ______________ °C
5. Which form factor is the most suitable for the application:

Radial Leaded Through-Hole (Pages 19-24)

MF-R010 through MF-R090 ....I_{hold} of 100 mAmps - 900 mAmps and (V_{max}) of 60.0 volts
MF-R055/90 through MF-R075/90.............................I_{hold} of 0.55 Amps - 0.75 Amps and (V_{max}) of 90.0 volts
MF-RX110 through MF-RX375..................................I_{hold} of 1.10 Amps - 3.75 Amps and (V_{max}) of 60.0 volts
MF-R110 through MF-R1100 ....I_{hold} of 1.1 Amps - 11.0 Amps and (V_{max}) of 30.0 volts

Surface Mount (Pages 25-35)

MF-SM030 through MF-SM260 ....I_{hold} of 300 mAmps - 2.6 Amps
MF-SM100/33 through MF-SM185/33..I_{hold} of 1.0 Amps - 1.8 Amps
MF-MSMD010 through MF-MSMD260..I_{hold} of 140 mAmps - 2.60 Amps
MF-ESMD190 ....I_{hold} of 1.9 Amps
MF-USMD005 through MF-USMD110...I_{hold} of 0.05 Amps - 1.10 Amps

Telecom Products (Pages 36-41)

MF-R/250........................I_{hold} of 0.12 - 0.18 Amps and (V_{max}) of 60.0 volts with surge capability of 250 volts
MF-SM013/250 ....I_{hold} of 0.13 Amps with surge capability of 250 volts

Axial Leaded Battery Strap (Pages 42-52)

MF-S120 through MF-S420 ....I_{hold} of 1.2 Amps - 4.2 Amps
MF-LS070 through MF-LS340 ....I_{hold} of 0.7 Amps - 3.4 Amps
MF-LR190 through MF-LR730 ....I_{hold} of 1.9 Amps - 7.3 Amps
MF-VS170 through MF-VS210 ....I_{hold} of 1.70 Amps - 2.10 Amps
MF-VS170N through MF-VS210N..I_{hold} of 1.7 Amps - 2.1 Amps
MF-SVS170 through MF-SVS230 ....I_{hold} of 1.7 Amps - 2.3 Amps

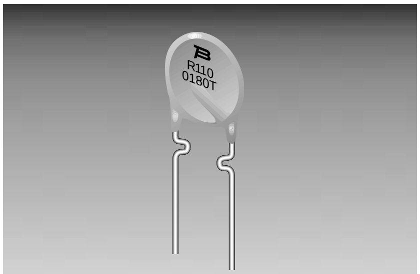
Battery Cap (Pages 53-54)

MF-AAA170 and MF-AAA210 ....I_{hold} of 1.7 Amps - 2.1 Amps

Disk (Page 55)

MF-D...Consult factory

6. Check that the maximum ratings for V_{max} and I_{max} of the product family chosen is higher than the maximum circuit voltage and fault current in the application.
7. Using the Thermal Derating Chart on the data sheets, select the Multifuse device at the maximum operating temperature with an I_{hold} greater than or equal to the normal operating current.
8. Order samples and test in the application. Lab Design Kits for most Multifuse® product lines are available. Contact your nearest Bourns sales office for more information.



BOURNS®

Features

- Radial Leaded Devices
- Cured, flame retardant epoxy polymer insulating material meets UL 94V-0 requirements
- Bulk packaging, tape and reel and Ammo-Pak available on most models
- Agency recognition:

Applications

Almost anywhere there is a low voltage power supply and a load to be protected, including:

- Computers & peripherals
- General electronics
- Automotive applications

MF-R Series - PTC Resettable Fuses

Electrical Characteristics

Model	V max. Volts	I max. Amps	I_{hold}	I_{trip}	Initial Resistance		1 Hour (R_1) Post-Trip Resistance	Max. Time To Trip		Tripped Power Dissipation
			Amperes at 23°C		Ohms at 23°C		Ohms at 23°C	Amperes at 23°C	Seconds at 23°C	Watts at 23°C
			Hold	Trip	Min.	Max.	Max.			
MF-R010	60	40	0.10	0.20	2.50	4.50	7.50	0.5	4.0	0.38
MF-R017	60	40	0.17	0.34	2.00	3.20	8.00	0.85	3.0	0.48
MF-R020	60	40	0.20	0.40	1.50	2.84	4.40	1.0	2.2	0.40
MF-R025	60	40	0.25	0.50	1.00	1.95	3.00	1.25	2.5	0.45
MF-R030	60	40	0.30	0.60	0.76	1.36	2.10	1.5	3.0	0.50
MF-R040	60	40	0.40	0.80	0.52	0.86	1.29	2.0	3.8	0.55
MF-R050	60	40	0.50	1.00	0.41	0.77	1.17	2.5	4.0	0.75
MF-R065	60	40	0.65	1.30	0.27	0.48	0.72	3.25	5.3	0.90
MF-R075	60	40	0.75	1.50	0.18	0.40	0.60	3.75	6.3	0.90
MF-R090	60	40	0.90	1.80	0.14	0.31	0.47	4.5	7.2	1.00
MF-R090-0-9	30	40	0.90	1.80	0.07	0.12	0.22	4.5	5.9	0.60
MF-R110	30	40	1.10	2.20	0.10	0.18	0.27	5.5	6.6	0.70
MF-R135	30	40	1.35	2.70	0.065	0.115	0.17	6.75	7.3	0.80
MF-R160	30	40	1.60	3.20	0.055	0.105	0.15	8.0	8.0	0.90
MF-R185	30	40	1.85	3.70	0.040	0.07	0.11	9.25	8.7	1.00
MF-R250	30	40	2.50	5.00	0.025	0.048	0.07	12.5	10.3	1.20
MF-R250-0-10	30	40	2.50	5.00	0.025	0.048	0.07	12.5	10.3	1.20
MF-R300	30	40	3.00	6.00	0.020	0.05	0.08	15.0	10.8	2.00
MF-R400	30	40	4.00	8.00	0.010	0.03	0.05	20.0	12.7	2.50
MF-R500	30	40	5.00	10.00	0.010	0.03	0.05	25.0	14.5	3.00
MF-R600	30	40	6.00	12.00	0.005	0.02	0.04	30.0	16.0	3.50
MF-R700	30	40	7.00	14.00	0.005	0.02	0.03	35.0	17.5	3.80
MF-R800	30	40	8.00	16.00	0.005	0.02	0.03	40.0	18.8	4.00
MF-R900	30	40	9.00	18.00	0.005	0.01	0.02	45.0	*20.0	4.20
MF-R1100	16	100	11.00	22.00	0.003	0.01	0.014	40.0	20.0	4.50

*Tested at 40 amps

Environmental Characteristics

Operating/Storage Temperature ....-40°C to +85°C
Maximum Device Surface Temperature
in Tripped State ....125°C
Passive Aging...+85°C, 1000 hours ....±5% typical resistance change
Humidity Aging...+85°C, 85% R.H. 1000 hours......................±5% typical resistance change
Thermal Shock ....+125°C to -55°C, 10 times..........................±10% typical resistance change
Solvent Resistance ....MIL-STD-202, Method 215 ....No change
Vibration ....MIL-STD-883C, Method 2007.1, ...No change
Condition A

Test Procedures And Requirements For Model MF-R Series

Test	Test Conditions	Accept/Reject Criteria
Visual/Mech.	Verify dimensions and materials	Per MF physical description
Resistance	In still air @ 23°C	Rmin ≤ R ≤ Rmax
Time to Trip	5 times Ihold, Vmax, 23°C	T ≤ max. time to trip (seconds)
Hold Current	30 min. at Ihold	No trip
Trip Cycle Life	Vmax, Imax, 100 cycles	No arcing or burning
Trip Endurance	Vmax, 48 hours	No arcing or burning

UL File Number ....E 174545S
CSA File Number ....CA 110338
TÜV File Number R2057213

Additional Features

- Patents pending

MF-R Series - PTC Resettable Fuses

BOURNS®

Product Dimensions (see page 21 for outline drawing)

Model	A	B	C		D	E	Physical Characteristics		
	Max.	Max.	Nom.	Tol. ±	Min.	Max.	Style	Lead Dia.	Material
MF-R010	7.4 (0.291)	12.7 (0.5)	5.1 (0.201)	0.7 (0.028)	7.6 (0.299)	3.1 (0.122)	1	0.51 (0.020)	Sn/NiCu
MF-R017	7.4 (0.291)	12.7 (0.5)	5.1 (0.201)	0.7 (0.028)	7.6 (0.299)	3.1 (0.122)	1	0.51 (0.020)	Sn/CuFe
MF-R020	7.4 (0.291)	12.7 (0.5)	5.1 (0.201)	0.7 (0.028)	7.6 (0.299)	3.1 (0.122)	1	0.51 (0.020)	Sn/CuFe
MF-R025	7.4 (0.291)	12.7 (0.5)	5.1 (0.201)	0.7 (0.028)	7.6 (0.299)	3.1 (0.122)	1	0.51 (0.020)	Sn/CuFe
MF-R030	7.4 (0.291)	13.4 (0.528)	5.1 (0.201)	0.7 (0.028)	7.6 (0.299)	3.1 (0.122)	1	0.51 (0.020)	Sn/CuFe
MF-R040	7.4 (0.291)	13.7 (0.539)	5.1 (0.201)	0.7 (0.028)	7.6 (0.299)	3.1 (0.122)	1	0.51 (0.020)	Sn/CuFe
MF-R050	7.9 (0.311)	13.7 (0.539)	5.1 (0.201)	0.7 (0.028)	7.6 (0.299)	3.1 (0.122)	1	0.51 (0.020)	Sn/Cu
MF-R065	9.7 (0.382)	15.2 (0.598)	5.1 (0.201)	0.7 (0.028)	7.6 (0.299)	3.1 (0.122)	1	0.51 (0.020)	Sn/Cu
MF-R075	10.4 (0.409)	16.0 (0.630)	5.1 (0.201)	0.7 (0.028)	7.6 (0.299)	3.1 (0.122)	1	0.51 (0.020)	Sn/Cu
MF-R090	11.7 (0.461)	16.7 (0.657)	5.1 (0.201)	0.7 (0.028)	7.6 (0.299)	3.1 (0.122)	1	0.51 (0.020)	Sn/Cu
MF-R090-0-9	7.4 (0.291)	12.2 (0.480)	5.1 (0.201)	0.7 (0.028)	7.6 (0.299)	3.0 (0.118)	2	0.51 (0.020)	Sn/CuFe
MF-R110	8.9 (0.350)	14.0 (0.551)	5.1 (0.201)	0.7 (0.028)	7.6 (0.299)	3.0 (0.118)	1	0.51 (0.020)	Sn/Cu
MF-R135	8.9 (0.350)	18.9 (0.744)	5.1 (0.201)	0.7 (0.028)	7.6 (0.299)	3.0 (0.118)	1	0.51 (0.020)	Sn/Cu
MF-R160	10.2 (0.402)	16.8 (0.661)	5.1 (0.201)	0.7 (0.028)	7.6 (0.299)	3.0 (0.118)	1	0.51 (0.020)	Sn/Cu
MF-R185	12.0 (0.472)	18.4 (0.724)	5.1 (0.201)	0.7 (0.028)	7.6 (0.299)	3.0 (0.118)	1	0.51 (0.020)	Sn/Cu
MF-R250	12.0 (0.472)	18.3 (0.720)	5.1 (0.201)	0.7 (0.028)	7.6 (0.299)	3.0 (0.118)	2	0.81 (0.032)	Sn/Cu
MF-R250-0-10	11.4 (0.449)	18.3 (0.720)	5.1 (0.201)	0.7 (0.028)	7.6 (0.299)	3.0 (0.118)	3	0.51 (0.020)	Sn/CuFe
MF-R300	12.0 (0.472)	18.3 (0.720)	5.1 (0.201)	0.7 (0.028)	7.6 (0.299)	3.0 (0.118)	2	0.81 (0.032)	Sn/Cu
MF-R400	14.4 (0.567)	24.8 (0.976)	5.1 (0.201)	0.7 (0.028)	7.6 (0.299)	3.0 (0.118)	2	0.81 (0.032)	Sn/Cu
MF-R500	17.4 (0.685)	24.9 (0.980)	10.2 (0.402)	0.7 (0.028)	7.6 (0.299)	3.0 (0.118)	2	0.81 (0.032)	Sn/Cu
MF-R600	19.3 (0.760)	31.9 (1.256)	10.2 (0.402)	0.7 (0.028)	7.6 (0.299)	3.0 (0.118)	2	0.81 (0.032)	Sn/Cu
MF-R700	22.1 (0.870)	29.8 (1.173)	10.2 (0.402)	0.7 (0.028)	7.6 (0.299)	3.0 (0.118)	2	0.81 (0.032)	Sn/Cu
MF-R800	24.2 (0.953)	32.9 (1.295)	10.2 (0.402)	0.7 (0.028)	7.6 (0.299)	3.0 (0.118)	2	0.81 (0.032)	Sn/Cu
MF-R900	24.2 (0.953)	32.9 (1.295)	10.2 (0.402)	0.7 (0.028)	7.6 (0.299)	3.0 (0.118)	2	0.81 (0.032)	Sn/Cu
MF-R1100	24.2 (0.953)	32.9 (1.295)	10.2 (0.402)	0.7 (0.028)	7.6 (0.299)	3.0 (0.118)	2	0.81 (0.032)	Sn/Cu

DIMENSIONS = $\frac{\text{MM}}{\text{(INCHES)}}$

Packaging options:

BULK: All models = 500 pcs. per bag.

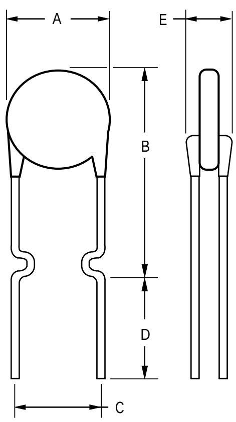
TAPE & REEL: MF-R010-MF-R160 - 12.7mm device pitch = 3000 pcs. per reel; MF-R185-MF-R400 - 25.4mm device pitch = 1500 pcs. per reel; MF-R090-0-9 & MF-R250-0-10 = 1500 pcs. per reel.

AMMO-PACK: MF-R010-MF-R160 - 12.7mm device pitch = 2000 pcs. per reel; MF-R185-MF-R400 - 25.4mm device pitch = 1000 pcs. per reel; MF-R090-0-9 & MF-R250-0-10 = 2000 pcs. per reel.

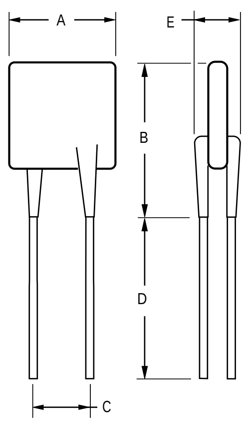
0.51 (24AWG)
0.81 (20AWG)

Product Dimensions (see page 20 for dimensions)

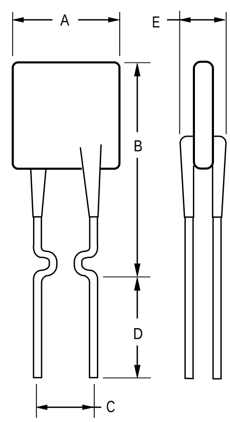
Style 1



Style 2



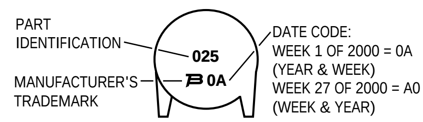
Style 3



NOTE: Kinked lead option is available for board standoff. Contact factory for details.

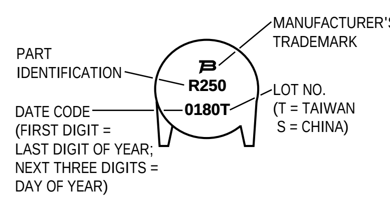
Typical Part Marking: MF-R010 - R025

Represents total content. Layout may vary.



Typical Part Marking: MF-R030 - R900

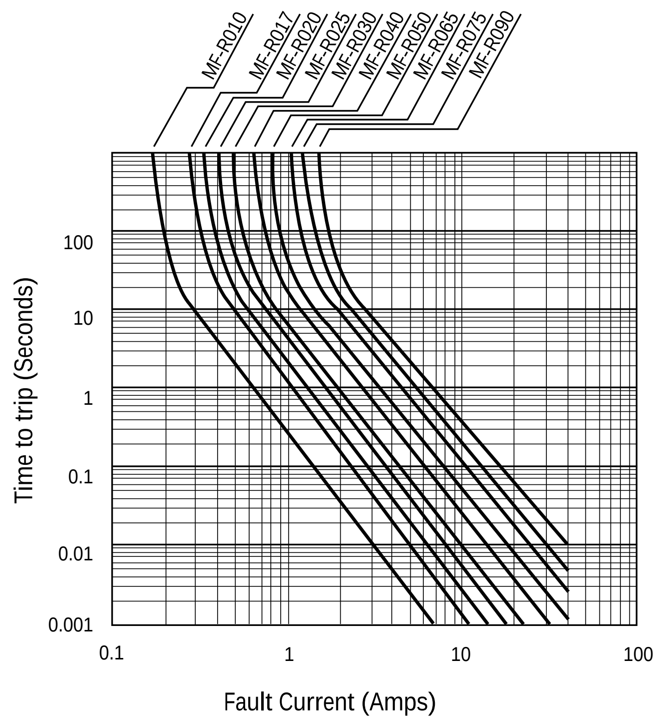
Represents total content. Layout may vary.

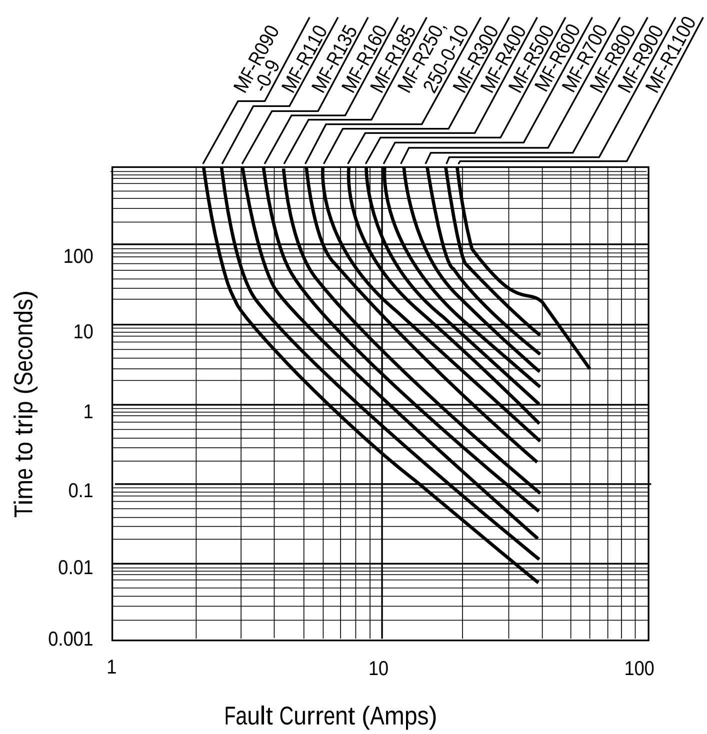


Thermal Derating Chart - I_{hold} / I_{trip} (Amps)

Model	Ambient Operating Temperature								
	-40°C	-20°C	0°C	23°C	40°C	50°C	60°C	70°C	85°C
MF-R010	0.16 / 0.32	0.14 / 0.28	0.12 / 0.24	0.10 / 0.20	0.08 / 0.16	0.07 / 0.14	0.06 / 0.12	0.05 / 0.10	0.04 / 0.08
MF-R017	0.26 / 0.52	0.23 / 0.46	0.20 / 0.40	0.17 / 0.34	0.14 / 0.28	0.12 / 0.24	0.11 / 0.22	0.09 / 0.18	0.07 / 0.14
MF-R020	0.31 / 0.62	0.27 / 0.54	0.24 / 0.48	0.20 / 0.40	0.16 / 0.32	0.14 / 0.28	0.13 / 0.26	0.11 / 0.22	0.08 / 0.16
MF-R025	0.39 / 0.78	0.34 / 0.68	0.30 / 0.60	0.25 / 0.50	0.20 / 0.40	0.18 / 0.36	0.16 / 0.32	0.14 / 0.28	0.10 / 0.20
MF-R030	0.47 / 0.94	0.41 / 0.82	0.36 / 0.72	0.30 / 0.60	0.24 / 0.48	0.22 / 0.44	0.19 / 0.38	0.16 / 0.32	0.12 / 0.24
MF-R040	0.62 / 1.24	0.54 / 1.08	0.48 / 0.96	0.40 / 0.80	0.32 / 0.64	0.29 / 0.58	0.25 / 0.50	0.22 / 0.44	0.16 / 0.32
MF-R050	0.78 / 1.56	0.68 / 1.36	0.60 / 1.20	0.50 / 1.00	0.41 / 0.82	0.36 / 0.72	0.32 / 0.64	0.27 / 0.54	0.20 / 0.40
MF-R065	1.01 / 2.02	0.88 / 1.76	0.77 / 1.54	0.65 / 1.30	0.53 / 1.06	0.47 / 0.94	0.41 / 0.82	0.35 / 0.70	0.26 / 0.52
MF-R075	1.16 / 2.32	1.02 / 2.04	0.89 / 1.78	0.75 / 1.50	0.61 / 1.22	0.54 / 1.08	0.47 / 0.94	0.41 / 0.82	0.30 / 0.60
MF-R090	1.40 / 2.80	1.22 / 2.44	1.07 / 2.14	0.90 / 1.80	0.73 / 1.46	0.65 / 1.30	0.57 / 1.14	0.49 / 0.98	0.36 / 0.72
MF-R090-0-9	1.40 / 2.80	1.22 / 2.44	1.07 / 2.14	0.90 / 1.80	0.73 / 1.46	0.65 / 1.30	0.57 / 1.14	0.49 / 0.98	0.36 / 0.72
MF-R110	1.60 / 3.20	1.43 / 2.86	1.27 / 2.54	1.10 / 2.20	0.91 / 1.82	0.85 / 1.70	0.75 / 1.50	0.67 / 1.34	0.57 / 1.14
MF-R135	1.96 / 3.92	1.76 / 3.52	1.55 / 3.10	1.35 / 2.70	1.12 / 2.24	1.04 / 2.08	0.92 / 1.84	0.82 / 1.64	0.70 / 1.40
MF-R160	2.32 / 4.64	2.08 / 4.16	1.84 / 3.68	1.60 / 3.20	1.33 / 2.66	1.23 / 2.46	1.09 / 2.18	0.98 / 1.96	0.83 / 1.66
MF-R185	2.68 / 5.36	2.41 / 4.82	2.13 / 4.26	1.85 / 3.70	1.54 / 3.08	1.42 / 2.84	1.26 / 2.52	1.13 / 2.26	0.96 / 1.92
MF-R250	3.63 / 7.26	3.25 / 6.50	2.88 / 5.76	2.50 / 5.00	2.08 / 4.16	1.93 / 3.86	1.70 / 3.40	1.53 / 3.06	1.30 / 2.60
MF-R250-0-10	3.63 / 7.26	3.25 / 6.50	2.88 / 5.76	2.50 / 5.00	2.08 / 4.16	1.93 / 3.86	1.70 / 3.40	1.53 / 3.06	1.30 / 2.60
MF-R300	4.35 / 8.70	3.90 / 7.80	3.45 / 6.90	3.00 / 6.00	2.49 / 4.98	2.31 / 4.62	2.04 / 4.08	1.83 / 3.66	1.56 / 3.12
MF-R400	5.80 / 11.6	5.20 / 10.4	4.60 / 9.20	4.00 / 8.00	3.32 / 6.64	3.08 / 6.16	2.72 / 5.44	2.44 / 4.88	2.08 / 4.16
MF-R500	7.25 / 14.5	6.50 / 13.0	5.75 / 11.5	5.00 / 10.0	4.15 / 8.30	3.85 / 7.70	3.40 / 6.80	3.05 / 6.10	2.60 / 5.20
MF-R600	8.70 / 17.4	7.80 / 15.6	6.90 / 13.8	6.00 / 12.0	4.98 / 9.96	4.62 / 9.24	4.08 / 8.16	3.66 / 7.32	3.12 / 6.24
MF-R700	10.1 / 20.3	9.10 / 18.2	8.05 / 16.1	7.00 / 14.0	5.81 / 11.6	5.39 / 10.7	4.76 / 9.52	4.27 / 9.44	3.64 / 7.28
MF-R800	11.6 / 23.2	10.4 / 20.8	9.20 / 18.4	8.00 / 16.0	6.64 / 13.2	6.16 / 12.3	5.44 / 10.8	4.88 / 9.76	4.16 / 8.32
MF-R900	13.0 / 26.1	11.7 / 23.4	10.3 / 20.7	9.00 / 18.0	7.47 / 14.9	6.93 / 12.7	6.12 / 12.2	5.49 / 10.9	4.68 / 9.36
MF-R1100	16.1 / 32.0	14.6 / 29.2	13.1 / 26.2	11.0 / 22.1	9.40 / 18.4	8.80 / 17.6	7.80 / 15.6	6.90 / 13.8	5.20 / 10.4

Typical Time to Trip at 23˚C





How to Order

MF - R 250 - __

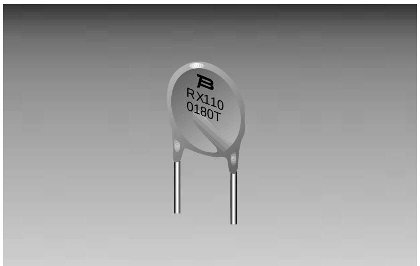
Multifuse® Product Designator

Series
- R = Radial Leaded Component

Hold Current, Ihold
010-1100 (100m Amps - 11.0 Amps)

Packaging Options
- __ = Bulk Packaging
- 2 = Tape and Reel*
- AP = Ammo-Pak*

*Packaged per EIA486-B



BOURNS®

Features

- Radial Leaded Devices
- Cured, flame retardant epoxy polymer insulating material meets UL 94V-0 requirements
- Bulk packaging, tape and reel and Ammo-Pak available on most models
- Agency recognition:

Applications

Almost anywhere there is a low voltage power supply, up to 60V and a load to be protected, including:

- Security and fire alarm systems
- Loud speakers
- Power transformers

MF-RX Series - PTC Resettable Fuses

Electrical Characteristics

Model	V max. Volts	I max. Amps	I_{hold}	I_{trip}	Initial Resistance		1 Hour (R_1) Post-Trip Resistance	Max. Time To Trip		Tripped Power Dissipation
			Amperes at 23°C		Ohms at 23°C		Ohms at 23°C	Amperes at 23°C	Seconds at 23°C	Watts at 23°C
			Hold	Trip	Min.	Max.	Max.			
MF-RX110	60	40	1.10	2.20	0.15	0.25	0.38	5.5	8.2	1.50
MF-RX135	60	40	1.35	2.70	0.12	0.19	0.30	6.75	9.6	1.70
MF-RX160	60	40	1.60	3.20	0.09	0.14	0.22	8.0	11.4	1.90
MF-RX185	60	40	1.85	3.70	0.08	0.12	0.19	9.25	12.6	2.10
MF-RX250	60	40	2.50	5.00	0.05	0.08	0.13	12.5	15.6	2.50
MF-RX300	60	40	3.00	6.00	0.04	0.06	0.10	15.0	19.8	2.80
MF-RX375	60	40	3.75	7.50	0.03	0.05	0.08	18.75	24.0	3.20

Environmental Characteristics

Operating/Storage Temperature ....-40°C to +85°C
Maximum Device Surface Temperature
in Tripped State ....125°C
Passive Aging...+85°C, 1000 hours ....±5% typical resistance change
Humidity Aging...+85°C, 85% R.H. 1000 hours......................±5% typical resistance change
Thermal Shock ....+125°C to -55°C,10 times ....±10% typical resistance change
Solvent Resistance ....MIL-STD-202, Method 215 ....No change
Vibration ....MIL-STD-883C, Method 2007.1, ...No change
Condition A

Test Procedures And Requirements For Model MF-RX Series

Test	Test Conditions	Accept/Reject Criteria
Visual/Mech.	Verify dimensions and materials	Per MF physical description
Resistance	In still air @ 23°C	Rmin ≤ R ≤ Rmax
Time to Trip	5 times Ihold, Vmax, 23°C	T ≤ max. time to trip (seconds)
Hold Current	30 min. at Ihold	No trip
Trip Cycle Life	Vmax, Imax, 100 cycles	No arcing or burning
Trip Endurance	Vmax, 48 hours	No arcing or burning

UL File Number ....E 174545S
CSA File Number ....CA 110338
TÜV File Number R2057213

Thermal Derating Chart - I_{hold} / I_{trip} (Amps)

Model	Ambient Operating Temperature								
	-40°C	-20°C	0°C	23°C	40°C	50°C	60°C	70°C	85°C
MF-RX110	1.71 / 3.42	1.50 / 3.00	1.31 / 2.62	1.10 / 2.20	0.89 / 1.78	0.79 / 1.58	0.69 / 1.38	0.59 / 1.18	0.44 / 0.88
MF-RX135	2.09 / 4.18	1.84 / 3.68	1.61 / 3.22	1.35 / 2.70	1.09 / 2.18	0.97 / 1.94	0.85 / 1.70	0.73 / 1.46	0.54 / 1.08
MF-RX160	2.48 / 4.96	2.18 / 4.36	1.90 / 3.80	1.60 / 3.20	1.30 / 2.60	1.15 / 2.30	1.01 / 2.02	0.86 / 1.72	0.64 / 1.28
MF-RX185	2.87 / 5.74	2.52 / 5.04	2.20 / 4.40	1.85 / 3.70	1.50 / 3.00	1.33 / 2.66	1.17 / 2.34	1.00 / 2.00	0.74 / 1.48
MF-RX250	3.88 / 7.76	3.40 / 6.80	2.98 / 5.96	2.50 / 5.00	2.03 / 4.06	1.80 / 3.60	1.58 / 3.16	1.35 / 2.70	1.00 / 2.00
MF-RX300	4.65 / 9.30	4.08 / 8.16	3.57 / 7.14	3.00 / 6.00	2.43 / 4.86	2.16 / 4.32	1.89 / 3.78	1.62 / 3.24	1.20 / 2.40
MF-RX375	5.81 / 11.6	5.10 / 10.2	4.46 / 8.92	3.75 / 7.50	3.04 / 6.08	2.70 / 5.40	2.36 / 4.72	2.03 / 4.06	1.50 / 3.00

Additional Features

- Resettable circuit protection
- Patents pending

MF-RX Series - PTC Resettable Fuses

BOURNS®

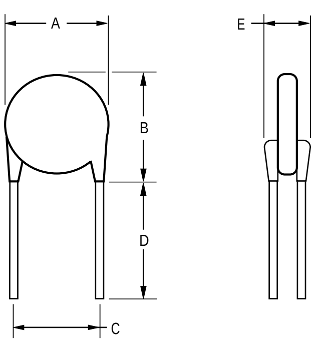
Product Dimensions

Model	A	B	C		D	E	Physical Characteristics		
	Max.	Max.	Nom.	Tol. ±	Min.	Max.	Style	Lead Dia.	Material
MF-RX110	13.0 (0.512)	18.0 (0.709)	5.1 (0.201)	0.7 (0.028)	7.6 (0.299)	3.1 (0.122)	1	0.81 (0.032)	Sn/Cu
MF-RX135	14.5 (0.571)	19.6 (0.772)	5.1 (0.201)	0.7 (0.028)	7.6 (0.299)	3.1 (0.122)	1	0.81 (0.032)	Sn/Cu
MF-RX160	16.3 (0.642)	21.3 (0.839)	5.1 (0.201)	0.7 (0.028)	7.6 (0.299)	3.1 (0.122)	1	0.81 (0.032)	Sn/Cu
MF-RX185	17.8 (0.701)	22.9 (0.902)	5.1 (0.201)	0.7 (0.028)	7.6 (0.299)	3.1 (0.122)	1	0.81 (0.032)	Sn/Cu
MF-RX250	21.3 (0.839)	26.4 (1.039)	10.2 (0.402)	0.7 (0.028)	7.6 (0.299)	3.1 (0.122)	1	0.81 (0.032)	Sn/Cu
MF-RX300	24.9 (0.980)	30.0 (1.181)	10.2 (0.402)	0.7 (0.028)	7.6 (0.299)	3.1 (0.122)	1	0.81 (0.032)	Sn/Cu
MF-RX375	28.4 (1.118)	33.5 (1.319)	10.2 (0.402)	0.7 (0.028)	7.6 (0.299)	3.1 (0.122)	1	0.81 (0.032)	Sn/Cu

Packaging options:
BULK: All models = 500 pcs. per bag.
TAPE & REEL: MF-RX110 – MF-RX160 = 1500 pcs. per reel; MF-RX185 – MF-RX375 = 1000 pcs. per reel
AMMO-PACK: MF-RX110 – MF-RX160 = 1000 pcs. per reel; MF-RX185 – MF-RX375 = 500 pcs. per reel

0.81 (20AWG)

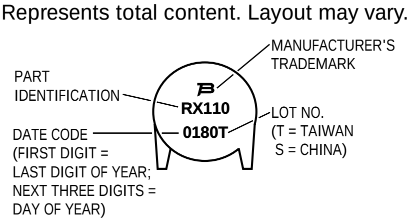
DIMENSIONS = $\frac{\text{MM}}{\text{(INCHES)}}$



NOTE: Kinked lead option is available for board standoff. Contact factory for details.

Typical Part Marking

Represents total content. Layout may vary.



How to Order

MF - RX 110 - __

Multifuse® Product Designator

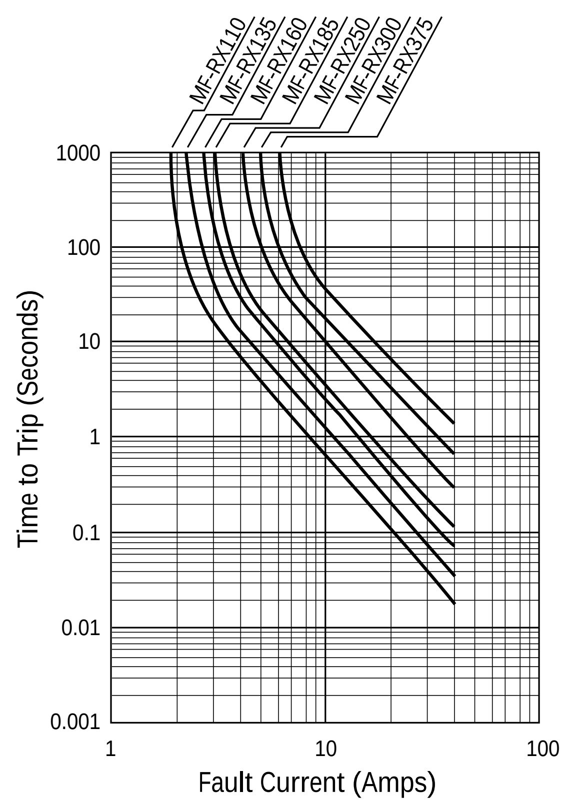
Series
RX = Radial Leaded Component

Hold Current, I_{hold}
110-375 (1.10 Amps - 3.75 Amps)

Packaging Options
- __ = Bulk Packaging
- 2 = Tape and Reel*
- AP = Ammo-Pak*

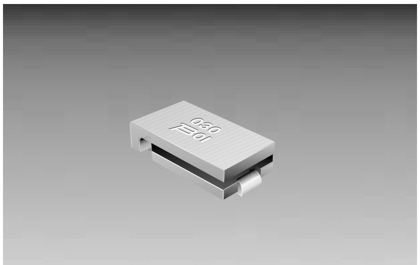
*Packaged per EIA 486-B

Typical Time to Trip at 23°C



MF-RX SERIES, REV. G, 08/01

Specifications are subject to change without notice.



BOURNS®

Features

- Surface Mount Devices
- Fully compatible with current industry standards
- Packaged per EIA 481-2 standard
- Agency recognition:
- Patents pending

Applications

Almost anywhere there is a low voltage power supply and a load to be protected, including:

- Computers & peripherals
- General electronics
- Automotive applications

MF-SM Series - PTC Resettable Fuses

Electrical Characteristics

Model	V max. Volts	I max. Amps	I_{hold}	I_{trip}	Resistance		Max. Time To Trip		Tripped Power Dissipation
			Amperes at 23 °C		Ohms at 23 °C		Amperes at 23 °C	Seconds at 23 °C	Watts at 23 °C
			Hold	Trip	$R_{Min.}$	$R_{1Max.}$		Max.	Max.
MF-SM030	60	40	0.30	0.60	0.90	4.80	1.5	3.0	1.7
MF-SM050*	60	40	0.50	1.00	0.35	1.40	2.5	4.0	1.7
MF-SM075	30	80	0.75	1.50	0.23	1.00	8.0	0.30	1.7
MF-SM100*	30	80	1.10	2.20	0.12	0.48	8.0	0.50	1.7
MF-SM125	15	100	1.25	2.50	0.07	0.25	8.0	2.0	1.7
MF-SM150	15	100	1.50	3.00	0.06	0.25	8.0	5.0	1.9
MF-SM200	15	100	2.00	4.00	0.045	0.125	8.0	12.0	1.9
MF-SM250	15	100	2.50	5.00	0.024	0.085	8.0	25.0	1.9
MF-SM260	6	100	2.60	5.20	0.025	0.075	8.0	20.0	1.7

*UL Pending

Environmental Characteristics

Operating/Storage Temperature ....-40 °C to +85 °C
Maximum Device Surface Temperature
in Tripped State..125 °C
Passive Aging ....+85 °C, 1000 hours..±5 % typical resistance change
Humidity Aging ....+85 °C, 85 % R.H. 7 days...............................±5 % typical resistance change
Thermal Shock ....MIL-STD-202F, Method 107G, ...±10 % typical resistance change
+125 °C to -55 °C,10 cycles
Vibration ....MIL-STD-883C, Method 2007.1, ...No change
Condition A

Test Procedures And Requirements For Model MF-SM Series

Test	Test Conditions	Accept/Reject Criteria
Visual/Mech.	Verify dimensions and materials	Per MF physical description
Resistance	In still air @ 23 °C	Rmin ≤ R ≤ R1max
Time to Trip	At specified current, Vmax, 23 °C	T ≤ max. time to trip (seconds)
Hold Current	30 min. at Ihold	No trip
Trip Cycle Life	Vmax, Imax, 100 cycles	No arcing or burning
Trip Endurance	Vmax, 48 hours	No arcing or burning
Solderability	MIL-STD-202F, Method 208F	95 % min. coverage

UL File Number E174545
http://www.ul.com/ Follow link to Certifications, then UL File No., enter E174545
CSA File Number................................CA110338
http://directories.csa-international.org/ Under “Certification Record” and “File Number” enter 110338-0-000
TÜV Certificate Number ....R 02057213
http://www.tuvdotcom.com/ Follow link to “other certificates”, enter File No. 2057213

Thermal Derating Chart - I_{hold} / I_{trip} (Amps)

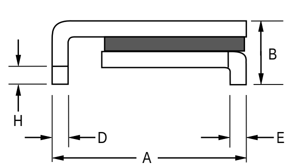
Model	Ambient Operating Temperature								
	-40 ˚C	-20 ˚C	0 ˚C	23 ˚C	40 ˚C	50 ˚C	60 ˚C	70 ˚C	85 ˚C
MF-SM030	0.45 / 0.90	0.40 / 0.80	0.35 / 0.70	0.30 / 0.60	0.25 / 0.50	0.23 / 0.46	0.20 / 0.40	0.17 / 0.34	0.14 / 0.28
MF-SM050	0.76 / 1.52	0.67 / 1.34	0.59 / 1.18	0.50 / 1.00	0.42 / 0.84	0.38 / 0.76	0.33 / 0.66	0.29 / 0.58	0.23 / 0.46
MF-SM075	1.13 / 2.26	1.01 / 2.02	0.88 / 1.76	0.75 / 1.50	0.62 / 1.24	0.56 / 1.12	0.50 / 1.00	0.44 / 0.88	0.34 / 0.68
MF-SM100	1.66 / 3.32	1.47 / 2.94	1.29 / 2.58	1.10 / 2.20	0.91 / 1.82	0.83 / 1.66	0.73 / 1.46	0.64 / 1.28	0.50 / 1.00
MF-SM125	1.89 / 3.78	1.68 / 3.36	1.46 / 2.92	1.25 / 2.50	1.04 / 2.08	0.94 / 1.88	0.83 / 1.66	0.73 / 1.46	0.56 / 1.12
MF-SM150	2.27 / 4.54	2.01 / 4.02	1.76 / 3.52	1.50 / 3.00	1.25 / 2.50	1.13 / 2.26	0.99 / 1.98	0.87 / 1.74	0.68 / 1.36
MF-SM200	3.02 / 6.04	2.68 / 5.36	2.34 / 4.68	2.00 / 4.00	1.66 / 3.32	1.50 / 3.00	1.32 / 2.64	1.16 / 2.32	0.90 / 1.80
MF-SM250	3.78 / 7.56	3.35 / 6.70	2.93 / 5.86	2.50 / 5.00	2.08 / 4.16	1.88 / 3.76	1.65 / 3.30	1.45 / 2.90	1.13 / 2.26
MF-SM260	3.64 / 7.28	3.25 / 6.50	2.91 / 5.82	2.60 / 5.20	2.26 / 4.52	2.08 / 4.16	1.95 / 3.90	1.74 / 3.48	1.48 / 2.96

Product Dimensions

Model	A		B	C	D		E		F		G		H
	Min.	Max.	Max.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
MF-SM030	6.73 (0.265)	7.98 (0.314)	3.18 (0.125)	5.44 (0.214)	0.56 (0.022)	0.71 (0.028)	0.56 (0.022)	0.71 (0.028)	2.16 (0.085)	2.41 (0.095)	0.66 (0.026)	1.37 (0.054)	0.43 (0.017)
MF-SM050	6.73 (0.265)	7.98 (0.314)	3.18 (0.125)	5.44 (0.214)	0.56 (0.022)	0.71 (0.028)	0.56 (0.022)	0.71 (0.028)	2.16 (0.085)	2.41 (0.095)	0.66 (0.026)	1.37 (0.054)	0.43 (0.017)
MF-SM075	6.73 (0.265)	7.98 (0.314)	3.18 (0.125)	5.44 (0.214)	0.56 (0.022)	0.71 (0.028)	0.56 (0.022)	0.71 (0.028)	2.16 (0.085)	2.41 (0.095)	0.66 (0.026)	1.37 (0.054)	0.43 (0.017)
MF-SM100	6.73 (0.265)	7.98 (0.314)	3.00 (0.118)	5.44 (0.214)	0.56 (0.022)	0.71 (0.028)	0.56 (0.022)	0.71 (0.028)	2.16 (0.085)	2.41 (0.095)	0.66 (0.026)	1.37 (0.054)	0.43 (0.017)
MF-SM125	6.73 (0.265)	7.98 (0.314)	3.00 (0.118)	5.44 (0.214)	0.56 (0.022)	0.71 (0.028)	0.56 (0.022)	0.71 (0.028)	2.16 (0.085)	2.41 (0.095)	0.66 (0.026)	1.37 (0.054)	0.43 (0.017)
MF-SM150	8.00 (0.315)	9.50 (0.374)	3.00 (0.118)	6.71 (0.264)	0.56 (0.022)	0.71 (0.028)	0.56 (0.022)	0.71 (0.028)	3.68 (0.145)	3.94 (0.155)	0.66 (0.026)	1.37 (0.054)	0.43 (0.017)
MF-SM200	8.00 (0.315)	9.50 (0.374)	3.00 (0.118)	6.71 (0.264)	0.56 (0.022)	0.71 (0.028)	0.56 (0.022)	0.71 (0.028)	3.68 (0.145)	3.94 (0.155)	0.66 (0.026)	1.37 (0.054)	0.43 (0.017)
MF-SM250	8.00 (0.315)	9.50 (0.374)	3.00 (0.118)	6.71 (0.264)	0.56 (0.022)	0.71 (0.028)	0.56 (0.022)	0.71 (0.028)	3.68 (0.145)	3.94 (0.155)	0.66 (0.026)	1.37 (0.054)	0.43 (0.017)
MF-SM260	6.73 (0.265)	7.98 (0.314)	3.00 (0.118)	5.44 (0.214)	0.56 (0.022)	0.71 (0.028)	0.56 (0.022)	0.71 (0.028)	2.16 (0.085)	2.41 (0.095)	0.66 (0.026)	1.37 (0.054)	0.43 (0.017)

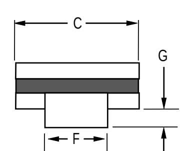
Packaging:
TAPE & REEL: MF-SM030, 050, 075, 100, 125, 260 = 2000 pcs. per reel; MF-SM150, 200, 250 = 1500 pcs. per reel.

UNIT = MM / (INCHES)



Side View

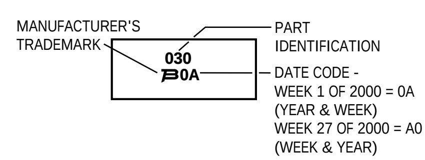
Terminal material:
Tin-plated brass



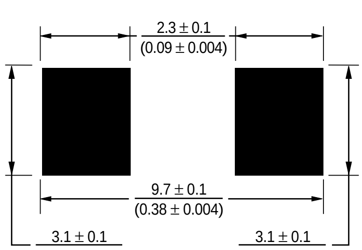
End View

Typical Part Marking

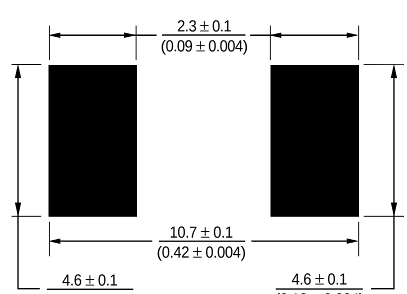
Represents total content. Layout may vary.



Recommended Pad Layout
MF-SM030, 050, 075, 100, 125, 260



Recommended Pad Layout
MF-SM150, 200, 250



How To Order

MF - SM 030 - 2

Multifuse® Product Designator

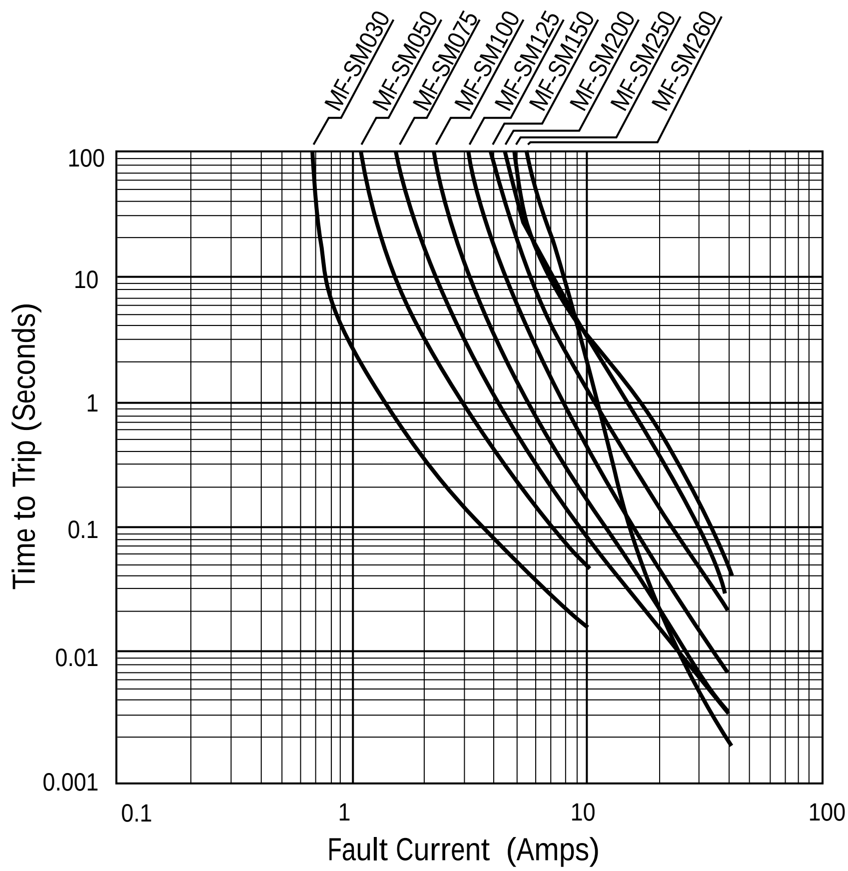
Series
SM = Surface Mount Component

Hold Current, I_{hold}
030-260 (0.30 Amps - 2.60 Amps)

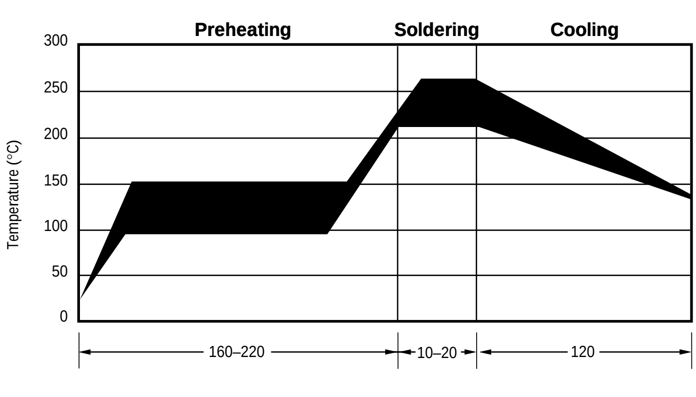
Packaging
Packaged per EIA 481-2
- 2 = Tape and Reel

Specifications are subject to change without notice.

Typical Time to Trip at 23 ˚C



Solder Reflow Recommendations



Solder reflow

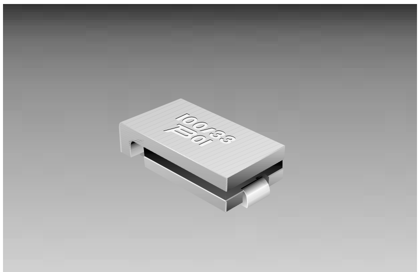
- Recommended reflow methods: IR, vapor phase oven, hot air oven.
- Devices are not designed to be wave soldered to the bottom side of the board.
- Gluing the devices is not recommended.
- Recommended maximum paste thickness is 0.25 mm (.010 inch).
- Devices can be cleaned using standard industry methods and solvents.

Note:

- If reflow temperatures exceed the recommended profile, devices may not meet the performance requirements.

Rework

- A device should not be reworked.



BOURNS®

Features

- Surface Mount Devices
- Fully compatible with current industry standards
- Packaged per EIA 481-2 standard
- Agency recognition:
- Patents pending

Applications

Almost anywhere there is a low voltage power supply and a load to be protected, including:

- IEEE 1394
- Computers & peripherals
- General electronics

MF-SM/33 Series - PTC Resettable Fuses

Electrical Characteristics

Model	V max. Volts	I max. Amps	I_{hold} Amperes at 23 °C	I_{trip} Amperes at 23 °C	Resistance Ohms at 23 °C		Max. Time To Trip		Tripped Power Dissipation Watts at 23 °C
			Hold	Trip	RMin.	R_1Max.	Amperes at 23 °C	Seconds at 23 °C	Max.
MF-SM100/33	33	40	1.1	2.20	0.12	0.41	8.0	0.5	1.7
MF-SM150/33	33	40	1.5	3.00	0.06	0.23	8.0	5.0	1.9
NEW! MF-SM185/33	33	40	1.8	3.60	0.04	0.15	8.0	5.0	1.5

Environmental Characteristics

Operating/Storage Temperature ....-40 °C to +85 °C
Maximum Device Surface Temperature
in Tripped State..125 °C
Passive Aging ....+85 °C, 1000 hours..±5 % typical resistance change
Humidity Aging ....+85 °C, 85 % R.H. 7 days................................±5 % typical resistance change
Thermal Shock ....MIL-STD-202F, Method 107G, ...±10 % typical resistance change
+125 °C to -55 °C,10 cycles
Vibration ....MIL-STD-883C, Method 2007.1, ...No change
Condition A

Test Procedures And Requirements For Model MF-SM/33 Series

Test	Test Conditions	Accept/Reject Criteria
Visual/Mech.	Verify dimensions and materials	Per MF physical description
Resistance	In still air @ 23 °C	Rmin ≤ R ≤ R1max
Time to Trip	At specified current, Vmax, 23 °C	T ≤ max. time to trip (seconds)
Hold Current	30 min. at Ihold	No trip
Trip Cycle Life	Vmax, Imax, 100 cycles	No arcing or burning
Trip Endurance	Vmax, 48 hours	No arcing or burning
Solderability	MIL-STD-202F, Method 208F	95 % min. coverage

UL File Number E174545
http://www.ul.com/ Follow link to Certifications, then UL File No., enter E174545
CSA File Number CA110338
http://directories.csa-international.org/ Under “Certification Record” and “File Number” enter 110338-0-000
TÜV Certificate Number......................R 02057213
http://www.tuvdotcom.com/ Follow link to “other certificates”, enter File No. 2057213

Thermal Derating Chart - I_{hold} (Amps)

Model	Ambient Operating Temperature								
	-40 ˚C	-20 ˚C	0 ˚C	23 ˚C	40 ˚C	50 ˚C	60 ˚C	70 ˚C	85 ˚C
MF-SM100/33	1.66	1.47	1.29	1.10	0.91	0.83	0.73	0.64	0.50
MF-SM150/33	2.27	2.01	1.76	1.50	1.25	1.13	1.00	0.87	0.68
MF-SM185/33	2.56	2.32	2.08	1.80	1.60	1.44	1.28	1.12	0.88

*I_{trip} is approximately two times I_{hold}.

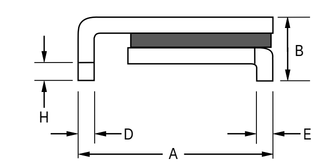
Specifications are subject to change without notice.

Product Dimensions

Model	A		B	C	D		E		F		G		H
	Min.	Max.	Max.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
MF-SM100/33	6.73 (0.265)	7.98 (0.314)	3.00 (0.118)	5.44 (0.214)	0.56 (0.022)	0.71 (0.028)	0.56 (0.022)	0.71 (0.028)	2.16 (0.085)	2.41 (0.095)	0.66 (0.026)	1.37 (0.054)	0.43 (0.017)
MF-SM150/33	8.00 (0.315)	9.50 (0.374)	3.00 (0.118)	6.71 (0.264)	0.56 (0.022)	0.71 (0.028)	0.56 (0.022)	0.71 (0.028)	3.68 (0.145)	3.94 (0.155)	0.66 (0.026)	1.37 (0.054)	0.43 (0.017)
MF-SM185/33	8.00 (0.315)	9.50 (0.374)	3.00 (0.118)	6.71 (0.264)	0.56 (0.022)	0.71 (0.028)	0.56 (0.022)	0.71 (0.028)	3.68 (0.145)	3.94 (0.155)	0.66 (0.026)	1.37 (0.054)	0.43 (0.017)

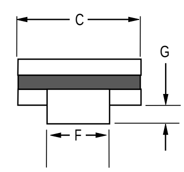
Packaging:
TAPE AND REEL - MF-SM100/33 = 2000 pcs. per reel,
MF-SM150/33, 185/33 = 1500 pcs. per reel

UNIT = $\frac{\text{MM}}{\text{(INCHES)}}$



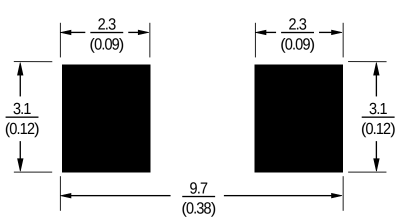
Side View

Terminal material:
Tin-plated brass

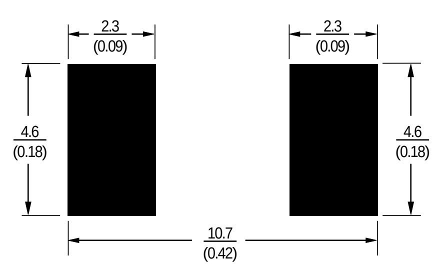


End View

Recommended Pad Layout - MF-SM100/33

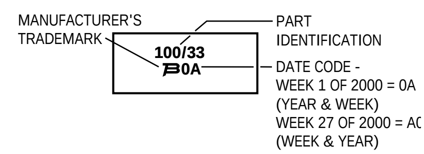


Recommended Pad Layout - MF-SM150/33



Typical Part Marking

Represents total content. Layout may vary.



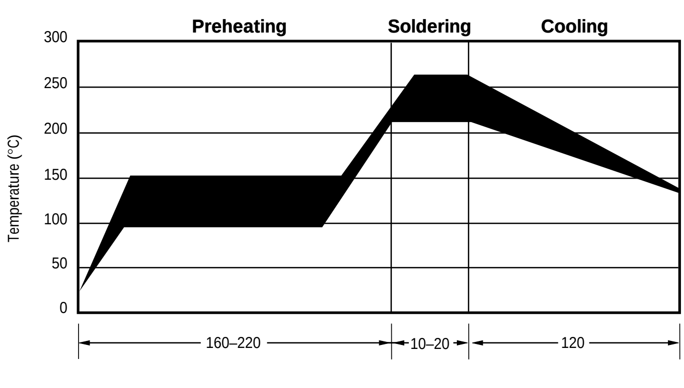
How to Order

MF - SM 100/33 - 2

Multifuse® Product Designator
Series
SM = Surface Mount Component
Hold Current, Ihold
100, 150, 185 (1.1, 1.5, 1.8 Amps)
Max. Voltage, V
Packaging Options
- 2 = Tape and Reel*

*Packaged per EIA-481-2

Solder Reflow Recommendations



Solder reflow

- Recommended reflow methods: IR, vapor phase oven, hot air oven.
- Devices are not designed to be wave soldered to the bottom side of the board.
- Gluing the devices is not recommended.
- Recommended maximum paste thickness is 0.25 mm (.010 inch).
- Devices can be cleaned using standard industry methods and solvents.

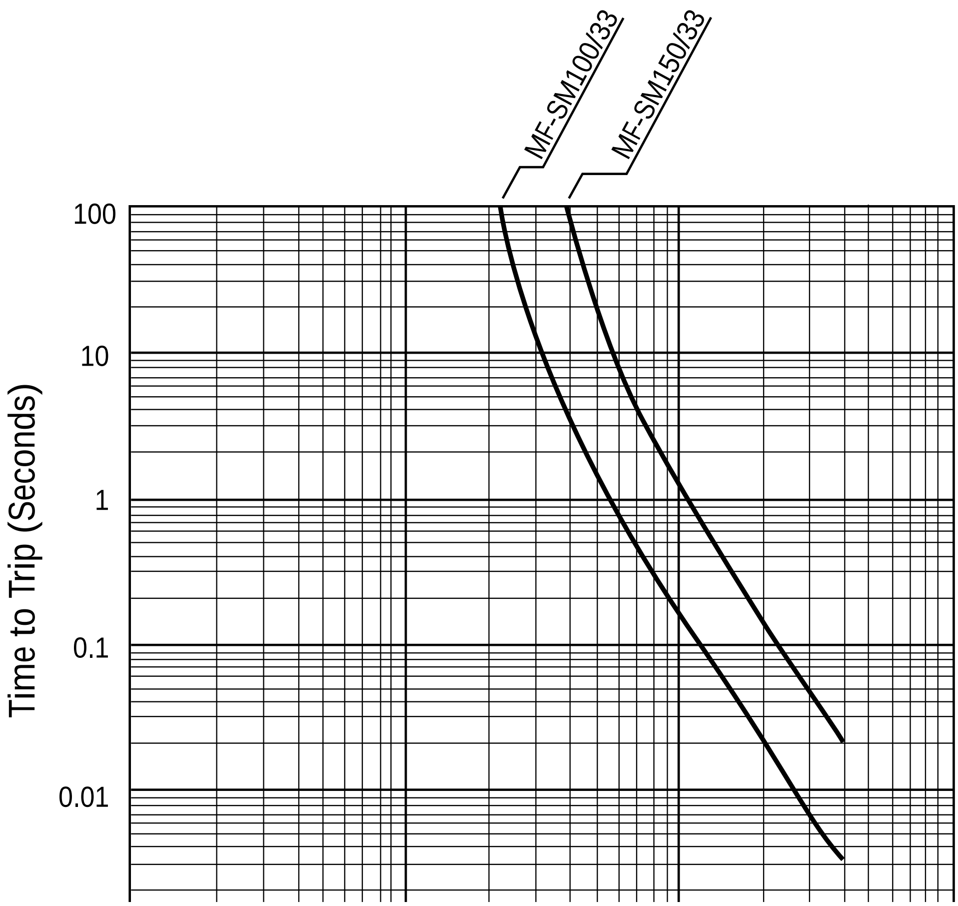
Note:

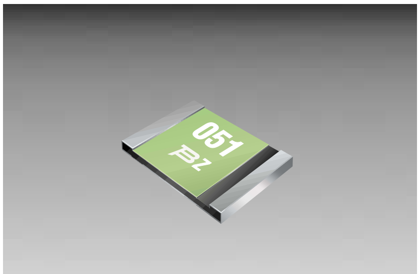
- If reflow temperatures exceed the recommended profile, devices may not meet the performance requirements.

Rework

- A device should not be reworked.

Typical Time to Trip at 23 °C





BOURNS®

Features

- Very small size 1210 footprint - 44 % smaller design than MF-MSMD Series
- Fast tripping resettable circuit protection
- Surface mount packaging for automated assembly
- Agency recognition:

Applications

- PC motherboards
- PC modems
- USB
- Analog and digital line cards
- IEEE 1394
- General electronics: Phones, fax machines, televisions, printers, video equipment

MF-USMD Series - PTC Resettable Fuses

Electrical Characteristics

	Model	V max. Volts	I max. Amps	I_{hold}	I_{trip}	Resistance		Max. Time To Trip		Tripped Power Dissipation
				Amperes at 23 °C		Ohms at 23 °C		Amperes at 23 °C	Seconds at 23 °C	Watts at 23 °C
				Hold	Trip	$R_{Min.}$	$R_{1Max.}$			Max.
	MF-USMD005	30.0	10	0.05	0.15	2.80	50.0	0.25	1.5	0.8
	MF-USMD010	30.0	10	0.10	0.30	0.80	15.0	0.5	0.6	0.8
NEW!	MF-USMD020*	30.0	10	0.20	0.40	0.40	5.00	8.0	0.02	0.8
	MF-USMD035	6.0	40	0.35	0.75	0.20	1.30	8.0	0.2	1.0
	MF-USMD050	13.2	40	0.50	1.00	0.18	0.90	8.0	0.1	1.0
	MF-USMD075	6.0	40	0.75	1.50	0.07	0.450	8.0	0.1	1.2
	MF-USMD110	6.0	40	1.10	2.20	0.05	0.210	5.0	1.0	1.2

*UL Pending

Environmental Characteristics

Operating/Storage Temperature ....-40 °C to +85 °C
Maximum Device Surface Temperature
in Tripped State ....125 °C
Passive Aging...+85 °C, 1000 hours ....±5 % typical resistance change
Humidity Aging..+85 °C, 85 % R.H. 1000 hours...................±10 % typical resistance change
Thermal Shock ....+85 °C to -40 °C, 20 times.........................±10 % typical resistance change
Solvent Resistance ....MIL-STD-202, Method 215 ....No change
Vibration ....MIL-STD-883C, Method 2007.1, ...No change
Condition A

Test Procedures And Requirements For Model MF-USMD Series

Test	Test Conditions	Accept/Reject Criteria
Visual/Mech.	Verify dimensions and materials	Per MF physical description
Resistance	In still air @ 23 °C	Rmin ≤ R ≤ R1max
Time to Trip	At specified current, Vmax, 23 °C	T ≤ max. time to trip (seconds)
Hold Current	30 min. at Ihold	No trip
Trip Cycle Life	Vmax, Imax, 100 cycles	No arcing or burning
Trip Endurance	Vmax, 48 hours	No arcing or burning
Solderability	MIL-STD-202F, Method 208F	95 % min. coverage

UL File Number E174545
http://www.ul.com/ Follow link to Certifications, then UL File No., enter E174545
CSA File Number CA110338
http://directories.csa-international.org/ Under “Certification Record” and “File Number” enter 110338-0-000
TÜV Certificate Number......................R 02057213
http://www.tuvdotcom.com/ Follow link to “other certificates”, enter File No. 2057213

Thermal Derating Chart - I_{hold} (Amps)

Model	Ambient Operating Temperature								
	-40 °C	-20 °C	0 °C	23 °C	40 °C	50 °C	60 °C	70 °C	85°C
MF-USMD005	0.08	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02
MF-USMD010	0.16	0.14	0.12	0.10	0.08	0.07	0.06	0.05	0.04
MF-USMD020	0.32	0.28	0.24	0.20	0.16	0.14	0.12	0.10	0.06
MF-USMD035	0.47	0.45	0.40	0.35	0.33	0.28	0.24	0.21	0.18
MF-USMD050	0.76	0.67	0.58	0.50	0.43	0.40	0.36	0.32	0.28
MF-USMD075	1.00	0.97	0.86	0.75	0.64	0.59	0.54	0.48	0.40
MF-USMD110	1.60	1.42	1.26	1.10	0.94	0.86	0.80	0.70	0.58

Additional Features

- Patents pending

MF-USMD Series - PTC Resettable Fuses

BOURNS®

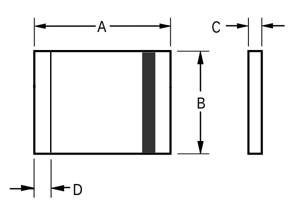
Product Dimensions

Model	A		B		C		D
	Min.	Max.	Min.	Max.	Min.	Max.	Min.
MF-USMD005	3.00 (0.118)	3.43 (0.135)	2.35 (0.093)	2.80 (0.110)	0.50 (0.020)	0.85 (0.033)	0.30 (0.012)
MF-USMD010	3.00 (0.118)	3.43 (0.135)	2.35 (0.093)	2.80 (0.110)	0.50 (0.020)	0.85 (0.033)	0.30 (0.012)
MF-USMD020	3.00 (0.118)	3.43 (0.135)	2.35 (0.093)	2.80 (0.110)	0.50 (0.020)	0.85 (0.033)	0.30 (0.012)
MF-USMD035	3.00 (0.118)	3.43 (0.135)	2.35 (0.093)	2.80 (0.110)	0.38 (0.015)	0.62 (0.025)	0.30 (0.012)
MF-USMD050	3.00 (0.118)	3.43 (0.135)	2.35 (0.093)	2.80 (0.110)	0.38 (0.015)	0.62 (0.024)	0.30 (0.012)
MF-USMD075	3.00 (0.118)	3.43 (0.135)	2.35 (0.093)	2.80 (0.110)	0.38 (0.015)	0.62 (0.025)	0.30 (0.012)
MF-USMD110	3.00 (0.118)	3.43 (0.135)	2.35 (0.093)	2.80 (0.110)	0.30 (0.012)	0.48 (0.019)	0.30 (0.012)

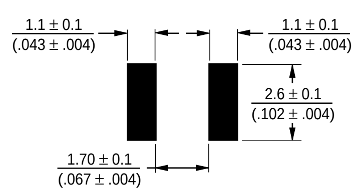
Packaging: 3000 pcs. per reel.

UNIT = $\frac{\text{MM}}{\text{(INCHES)}}$

Top and Bottom View ***Side View***



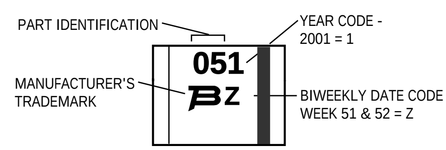
Recommended Pad Layout



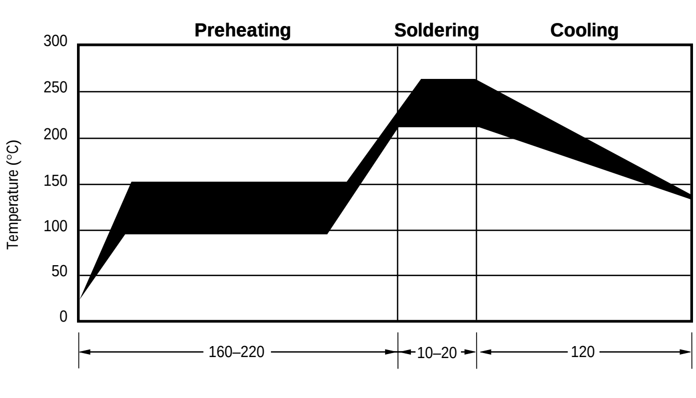
Terminal material: solder-plated copper
Termination pad solderability: Meets EIA Specification RS-186-9E, ANSI/J-STD-002 Category 3.

Typical Part Marking

Represents total content. Layout may vary.



Solder Reflow Recommendations

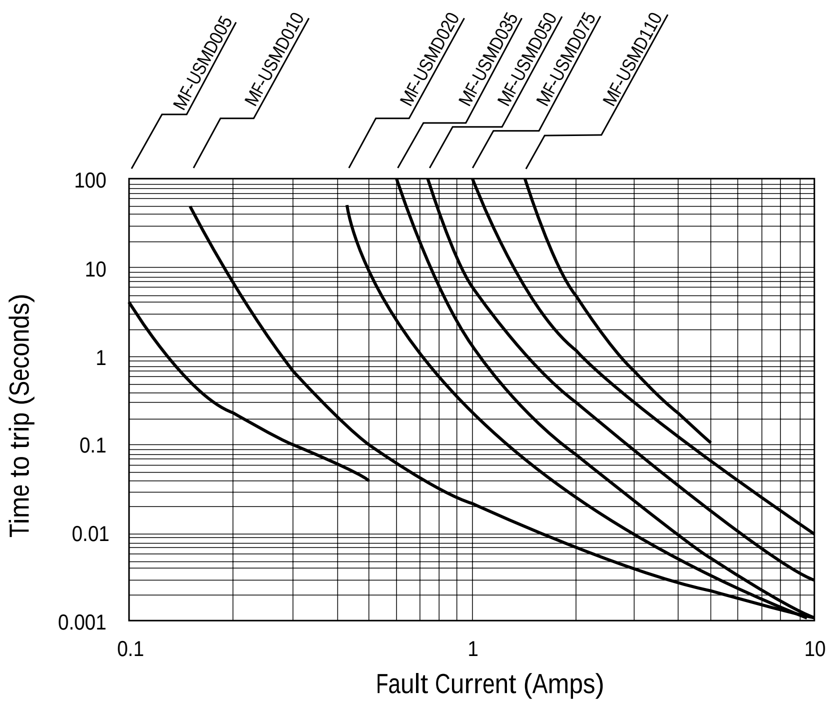


Note:

- MF-USMD models can be wave soldered and reworked.
- If reflow temperatures exceed the recommended profile, devices may not meet the performance requirements.

Specifications are subject to change without notice.

Typical Time to Trip at 23 ˚C



How to Order

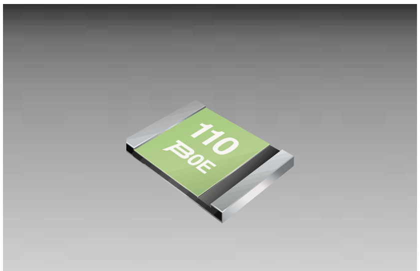
MF - USMD 005 - 2

Multifuse® Product Designator

Series
USMD = 1210 Surface Mount Component

Hold Current, I_{hold}
005-110 (0.05 Amps - 1.10 Amps)

Packaging
Packaged per EIA 481-1
-2 = Tape and Reel



BOURNS®

Features

- 4.5 mm SMD
- Fast tripping resettable circuit protection
- Surface mount packaging for automated assembly
- Reduced component size and resistance
- Agency recognition:

Applications

High Density Circuit Board Applications:

- Hard disk drives
- PC motherboards
- PC peripherals
- Point-of-sale (POS) equipment
- PCMCIA cards

MF-MSMD Series - PTC Resettable Fuses

Electrical Characteristics

	Model	V max. Volts	I max. Amps	I_{hold}	I_{trip}	Resistance		Max. Time To Trip		Tripped Power Dissipation
				Amperes at 23 °C		Ohms at 23 °C		Amperes at 23 °C	Seconds at 23 °C	Watts at 23 °C
				Hold	Trip	$R_{Min.}$	$R_{1Max.}$			Max.
	MF-MSMD010	60.0	40	0.10	0.30	0.70	15.00	0.5	1.5	1.0
	MF-MSMD014	60.0	40	0.14	0.34	0.40	6.50	1.5	0.15	1.0
	MF-MSMD020	30.0	80	0.20	0.40	0.40	6.00	6.0	0.06	1.0
NEW!	MF-MSMD030	30.0	10	0.30	0.60	0.30	3.00	8.0	0.10	1.2
	MF-MSMD050	15.0	100	0.50	1.00	0.15	1.00	8.0	0.15	1.2
	MF-MSMD075	13.2	100	0.75	1.50	0.11	0.45	8.0	0.20	1.2
NEW!	MF-MSMD075/24*	24.0	40	0.75	1.50	0.11	0.45	8.0	0.20	1.2
	MF-MSMD110	6.0	100	1.10	2.20	0.04	0.21	8.0	0.30	1.2
NEW!	MF-MSMD110/16	16.0	100	1.10	2.20	0.04	0.21	8.0	0.30	1.2
	MF-MSMD125	6.0	100	1.25	2.50	0.035	0.14	8.0	0.4	1.5
	MF-MSMD150	6.0	100	1.50	3.00	0.03	0.120	8.0	0.5	1.5
	MF-MSMD160	8.0	100	1.60	2.80	0.035	0.099	8.0	2.0	1.5
	MF-MSMD200	6.0	100	2.00	4.00	0.020	0.100	8.0	3.0	1.5
NEW!	MF-MSMD260*	6.0	100	2.60	5.20	0.015	0.080	8.0	5.0	1.5

*UL Pending

Environmental Characteristics

Operating/Storage Temperature ....-40 °C to +85 °C
Maximum Device Surface Temperature
in Tripped State ....125 °C
Passive Aging..+85 °C, 1000 hours ....±5 % typical resistance change
Humidity Aging..+85 °C, 85 % R.H. 1000 hours...................±5 % typical resistance change
Thermal Shock ....+85 °C to -40 °C, 20 times.........................±10 % typical resistance change
Solvent Resistance ....MIL-STD-202, Method 215 ....No change
Vibration ....MIL-STD-883C, Method 2007.1, Condition A ....No change

Test Procedures And Requirements For Model MF-MSMD Series

Test	Test Conditions	Accept/Reject Criteria
Visual/Mech.	Verify dimensions and materials	Per MF physical description
Resistance	In still air @ 23 °C	Rmin ≤ R ≤ R1max
Time to Trip	At specified current, Vmax, 23 °C	T ≤ max. time to trip (seconds)
Hold Current	30 min. at Ihold	No trip
Trip Cycle Life	Vmax, Imax, 100 cycles	No arcing or burning
Trip Endurance	Vmax, 48 hours	No arcing or burning
Solderability	MIL-STD-202F, Method 208F	95 % min. coverage

UL File Number E174545
http://www.ul.com/ Follow link to Certifications, then UL File No., enter E174545
CSA File Number CA110338
http://directories.csa-international.org/ Under “Certification Record” and “File Number” enter 110338-0-000
TÜV Certificate Number.....................R 02057213
http://www.tuvdotcom.com/ Follow link to “other certificates”, enter File No. 2057213

Specifications are subject to change without notice.

Additional Features

- Patents pending

MF-MSMD Series - PTC Resettable Fuses

BOURNS®

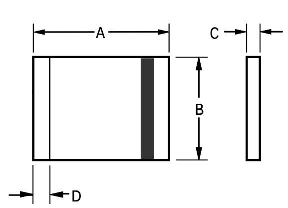
Product Dimensions

Model	A		B		C		D
	Min.	Max.	Min.	Max.	Min.	Max.	Min.
MF-MSMD010	4.37 (0.172)	4.73 (0.186)	3.07 (0.121)	3.41 (0.134)	0.56 (0.022)	0.81 (0.032)	0.30 (0.012)
MF-MSMD014	4.37 (0.172)	4.73 (0.186)	3.07 (0.121)	3.41 (0.134)	0.56 (0.022)	0.81 (0.032)	0.30 (0.012)
MF-MSMD020	4.37 (0.172)	4.73 (0.186)	3.07 (0.121)	3.41 (0.134)	0.56 (0.022)	0.81 (0.032)	0.30 (0.012)
MF-MSMD030	4.37 (0.172)	4.73 (0.186)	3.07 (0.121)	3.41 (0.134)	0.56 (0.022)	0.81 (0.032)	0.30 (0.012)
MF-MSMD050	4.37 (0.172)	4.73 (0.186)	3.07 (0.121)	3.41 (0.134)	0.38 (0.015)	0.62 (0.024)	0.30 (0.012)
MF-MSMD075	4.37 (0.172)	4.73 (0.186)	3.07 (0.121)	3.41 (0.134)	0.38 (0.015)	0.62 (0.024)	0.30 (0.012)
MF-MSMD075/24	4.37 (0.172)	4.73 (0.186)	3.07 (0.121)	3.41 (0.134)	0.38 (0.015)	0.62 (0.024)	0.30 (0.012)
MF-MSMD110	4.37 (0.172)	4.73 (0.186)	3.07 (0.121)	3.41 (0.134)	0.38 (0.015)	0.62 (0.024)	0.30 (0.012)
MF-MSMD110/16	4.37 (0.172)	4.73 (0.186)	3.07 (0.121)	3.41 (0.134)	0.38 (0.015)	0.62 (0.024)	0.30 (0.012)
MF-MSMD125	4.37 (0.172)	4.73 (0.186)	3.07 (0.121)	3.41 (0.134)	0.30 (0.012)	0.48 (0.019)	0.30 (0.012)
MF-MSMD150	4.37 (0.172)	4.73 (0.186)	3.07 (0.121)	3.41 (0.134)	0.30 (0.012)	0.48 (0.019)	0.30 (0.012)
MF-MSMD160	4.37 (0.172)	4.73 (0.186)	3.07 (0.121)	3.41 (0.134)	0.30 (0.012)	0.48 (0.019)	0.30 (0.012)
MF-MSMD200	4.37 (0.172)	4.73 (0.186)	3.07 (0.121)	3.41 (0.134)	0.30 (0.012)	0.48 (0.019)	0.30 (0.012)
MF-MSMD260	4.37 (0.172)	4.73 (0.186)	3.07 (0.121)	3.41 (0.134)	0.25 (0.010)	0.48 (0.019)	0.30 (0.012)

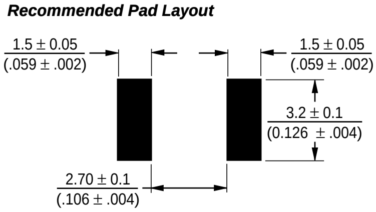
Packaging: 2000 pcs. per reel.

UNIT = MM / (INCHES)

Top and Bottom View ***Side View***

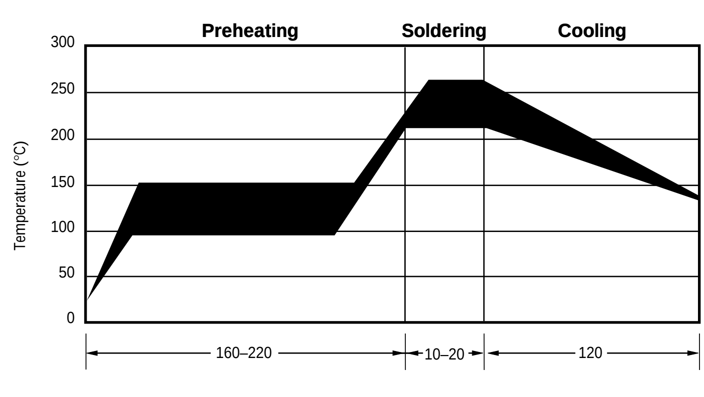


Recommended Pad Layout



Terminal material: solder-plated copper
Termination pad solderability: Meets EIA Specification RS-186-9E, ANSI/J-STD-002 Category 3.

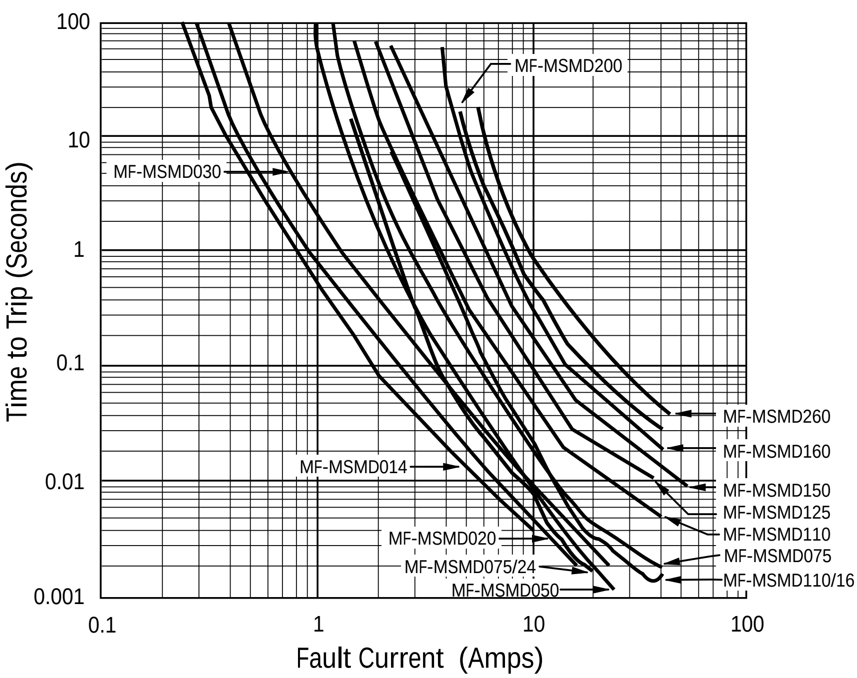
Solder Reflow Recommendations



Note:

- If reflow temperatures exceed the recommended profile, devices may not meet the performance requirements.

Typical Time to Trip at 23 °C



How to Order

MF - MSMD 075/24 - 2

Multifuse® Product Designator

Series
MSMD = 4.5 mm Surface Mount Component

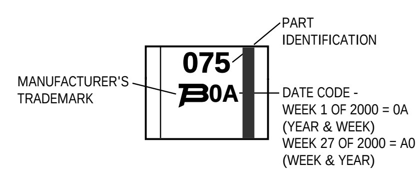
Hold Current, I_{hold}
010-260 (0.10 Amps - 2.60 Amps)

Max. Voltage, V

Packaging
Packaged per EIA 481-1
-2 = Tape and Reel

Typical Part Marking

Represents total content. Layout may vary.



Thermal Derating Chart - I_{hold} / I_{trip} (Amps)

Model	Ambient Operating Temperature								
	-40 °C	-20 °C	0 °C	23 °C	40 °C	50 °C	60 °C	70 °C	85 °C
MF-MSMD010	0.16 / 0.32	0.14 / 0.28	0.12 / 0.24	0.11 / 0.22	0.08 / 0.16	0.07 / 0.14	0.06 / 0.12	0.05 / 0.10	0.03 / 0.06
MF-MSMD014	0.23 / 0.52	0.19 / 0.45	0.17 / 0.40	0.14 / 0.34	0.12 / 0.29	0.10 / 0.25	0.09 / 0.23	0.08 / 0.21	0.06 / 0.16
MF-MSMD020	0.29 / 0.58	0.26 / 0.52	0.23 / 0.46	0.20 / 0.40	0.17 / 0.34	0.15 / 0.30	0.14 / 0.28	0.12 / 0.24	0.10 / 0.20
MF-MSMD030	0.44 / 0.88	0.39 / 0.78	0.35 / 0.70	0.30 / 0.60	0.26 / 0.52	0.23 / 0.46	0.21 / 0.42	0.18 / 0.36	0.15 / 0.30
MF-MSMD050	0.77 / 1.54	0.68 / 1.36	0.59 / 1.18	0.50 / 1.00	0.44 / 0.88	0.40 / 0.80	0.37 / 0.74	0.33 / 0.66	0.29 / 0.58
MF-MSMD075	1.15 / 2.30	1.01 / 2.02	0.88 / 1.76	0.75 / 1.50	0.65 / 1.30	0.60 / 1.20	0.55 / 1.10	0.49 / 0.98	0.43 / 0.86
MF-MSMD075/24	1.11 / 2.22	1.00 / 2.00	0.85 / 1.70	0.75 / 1.50	0.67 / 1.34	0.61 / 1.22	0.52 / 1.06	0.50 / 1.00	0.42 / 0.84
MF-MSMD110	1.59 / 3.18	1.43 / 2.86	1.26 / 2.52	1.10 / 2.20	0.95 / 1.90	0.87 / 1.74	0.80 / 1.60	0.71 / 1.42	0.60 / 1.20
MF-MSMD110/16	1.59 / 3.18	1.43 / 2.86	1.26 / 2.52	1.10 / 2.20	0.95 / 1.90	0.87 / 1.74	0.80 / 1.60	0.71 / 1.42	0.60 / 1.20
MF-MSMD125	1.80 / 3.61	1.63 / 3.25	1.43 / 2.86	1.25 / 2.50	1.08 / 2.16	0.99 / 1.98	0.91 / 1.82	0.81 / 1.62	0.68 / 1.36
MF-MSMD150	2.17 / 4.34	1.95 / 3.90	1.72 / 3.44	1.50 / 3.00	1.30 / 2.59	1.18 / 2.37	1.09 / 2.18	0.97 / 1.94	0.82 / 1.64
MF-MSMD160	2.30 / 5.00	2.20 / 4.40	1.90 / 3.80	1.60 / 2.80	1.45 / 2.90	1.30 / 2.60	1.15 / 2.30	1.03 / 2.06	0.91 / 1.82
MF-MSMD200	3.08 / 6.14	2.71 / 5.39	2.35 / 4.62	2.00 / 4.01	1.80 / 1.61	1.60 / 3.19	1.50 / 2.98	1.07 / 2.12	0.80 / 1.58
MF-MSMD260	4.00 / 7.98	3.52 / 7.01	3.06 / 6.09	2.60 / 5.15	2.34 / 4.64	2.08 / 4.13	1.95 / 3.87	1.39 / 2.74	1.04 / 2.05

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Features

- Fast tripping resettable circuit protection
- Surface mount packaging for automated assembly
- Very low internal resistance
- Patents pending
- 100 °C trip temperature
- Agency recognition:

Applications

- Battery cell protection

MF-ESMD Series - PTC Resettable Fuses

Electrical Characteristics

Model	V max. Volts	I max. Amps	I_{hold}	I_{trip}	Resistance		Max. Time To Trip		Tripped Power Dissipation
			Amperes at 23 °C		Ohms at 23 °C		Amperes at 23 °C	Seconds at 23 °C	Watts at 23 °C
			Hold	Trip	Min.	R_1 Max.			Max.
MF-ESMD190	16	100	1.9	3.8	0.010	0.08	10	2.0	1.5

Environmental Characteristics

Operating/Storage Temperature ....-40 °C to +85 °C
Maximum Device Surface Temperature
in Tripped State ....125 °C
Passive Aging...+85 °C, 1000 hours ....±5 % typical resistance change
Humidity Aging...+85 °C, 85% R.H. 1000 hours ....±5 % typical resistance change
Thermal Shock ....+85 °C to -40 °C, 20 times.........................±10 % typical resistance change
Solvent Resistance ....MIL-STD-202, Method 215 ....No change
Vibration ....MIL-STD-883C, Method 2007.1, ...No change
Condition A

Test Procedures And Requirements For Model MF-ESMD Series

Test	Test Conditions	Accept/Reject Criteria
Visual/Mech.	Verify dimensions and materials	Per MF physical description
Resistance	In still air @ 23 °C	Rmin ≤ R ≤ R1max
Time to Trip	At specified current, Vmax, 23 °C	T ≤ max. time to trip (seconds)
Hold Current	30 min. at Ihold	No trip
Trip Cycle Life	Vmax, Imax, 100 cycles	No arcing or burning
Trip Endurance	Vmax, 48 hours	No arcing or burning
Solderability	MIL-STD-202F, Method 208F	95 % min. coverage

UL File Number E174545
http://www.ul.com/ Follow link to Certifications, then UL File No., enter E174545
CSA File Number CA110338
http://directories.csa-international.org/ Under “Certification Record” and “File Number” enter 110338-0-000
TÜV Certificate Number.....................R 02057213
http://www.tuvdotcom.com/ Follow link to “other certificates”, enter File No. 2057213

Thermal Derating Chart - I_{hold} (Amps)

Model	Ambient Operating Temperature								
	-40 °C	-20 °C	0 °C	23 °C	40 °C	50 °C	60 °C	70 °C	85 °C
MF-ESMD190	3.04	2.7	2.2	1.9	1.44	1.23	1.00	0.78	0.49

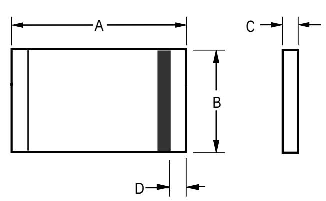
Product Dimensions

Model	A		B		C		D
	Min.	Max.	Min.	Max.	Min.	Max.	Min.
MF-ESMD190	11.25 (0.443)	11.61 (0.457)	4.83 (0.190)	5.33 (0.210)	0.33 (0.013)	0.63 (0.025)	0.51 (0.020)

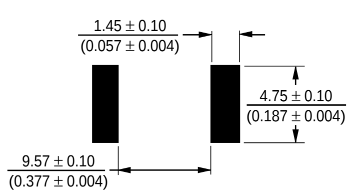
Packaging: 1500 pcs. per reel.

UNIT = MM / (INCHES)

Top and Bottom View ***Side View***

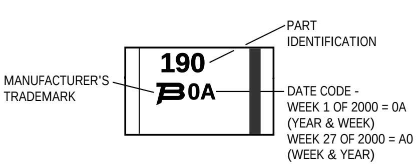


Recommended Pad Layout



Typical Part Marking

Represents total content. Layout may vary.



How to Order

MF - ESMD 190 - 2

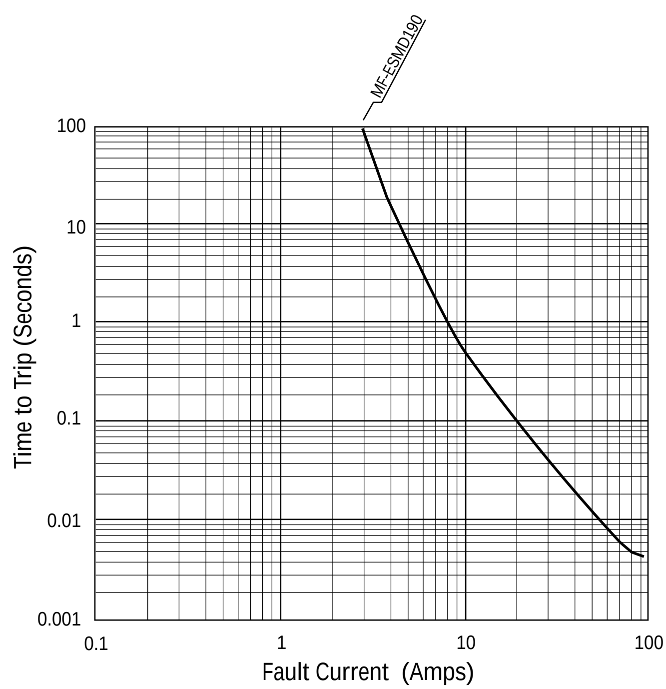
Multifuse® Product Designator

Series
ESMD = 11.5mm Surface Mount Component

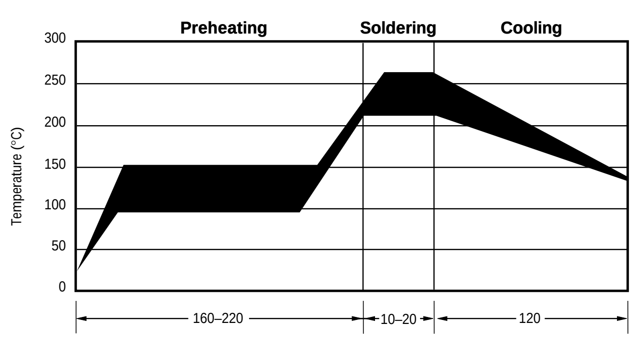
Hold Current, I_{hold}
190 (1.9 Amps)

Packaging
Packaged per EIA 481-2
-2 = Tape and Reel

Typical Time to Trip at 23 °C



Solder Reflow Recommendations



Note:
- MF-ESMD models can be wave soldered and reworked.
- If reflow temperatures exceed the recommended profile, devices may not meet the performance requirements.

MF-ESMD, REV. I, 07/02

Specifications are subject to change without notice.

Features

- Radial Leaded Devices
- Cured, flame retardant epoxy polymer insulating material meets UL 94V-0 requirements
- Bulk packaging, tape and reel and Ammo-Pak available on most models
- Agency recognition:

Applications

Almost anywhere there is a load to be protected with a voltage supply of up to 90V, including:

- Broadband cable power passing taps
- Set-top boxes

MF-R/90 Series - PTC Resettable Fuses

Electrical Characteristics

Model	V max. Volts	I max. Amps	Ihold	Itrip	Initial Resistance Values		One Hour Post-Trip Resistance Standard Trip	Maximum Time To Trip		Nominal Tripped Power Dissipation
			Amps at 23°C	Amps at 23°C	Ohms at 23°C		Ohms at 23°C	Amps at 23°C	Seconds at 23°C	Watts at 23°C
			Hold	Trip	Min.	Max.	Max.			
MF-R055/90	90	10	0.55	1.1	0.45	0.9	2.0	1.6	60	2.0
MF-R055/90U	90	10	0.55	1.1	0.45	0.9	2.0	1.6	28	2.0
MF-R075/90	90	10	0.75	1.5	0.37	0.75	1.65	2.0	60	2.5

"U" suffix indicates product without insulation coating.

Environmental Characteristics

Operating/Storage Temperature ....-40°C to +85°C
Maximum Device Surface Temperature
in Tripped State ....125°C
Passive Aging...+85°C, 1000 hours ....±5% typical resistance change
Humidity Aging...+85°C, 85% R.H. 1000 hours......................±5% typical resistance change
Thermal Shock ....+125°C to -55°C, 10 times.........................±10% typical resistance change
Solvent Resistance ....MIL-STD-202, Method 215 ....No change
Vibration...MIL-STD-883C, Method 2007.1, ...No change
Condition A

Test Procedures And Requirements For Model MF-R/90 Series

Test	Test Conditions	Accept/Reject Criteria
Visual/Mech.	Verify dimensions and materials	Per MF physical description
Resistance	In still air @ 23°C	Rmin ≤ R ≤ Rmax
Time to Trip	At specified current, Vmax, 23°C	T ≤ max. time to trip (seconds)
Hold Current	30 min. at Ihold	No trip
Trip Cycle Life	Vmax, Imax, 100 cycles	No arcing or burning
Trip Endurance	Vmax, 48 hours	No arcing or burning

UL File Number ....E 174545S
CSA File Number ....CA 110338
TÜV File Number R2057213

Thermal Derating Chart - I_{hold} / I_{trip} (Amps)

Model	Ambient Operating Temperature								
	-40°C	-20°C	0°C	23°C	40°C	50°C	60°C	70°C	85°C
MF-R055/90	0.85 / 1.7	0.75 / 1.5	0.65 / 1.3	0.55 / 1.1	0.45 / 0.9	0.4 / 0.8	0.35 / 0.7	0.3 / 0.6	0.22 / 0.44
MF-R055/90U	0.85 / 1.7	0.75 / 1.5	0.65 / 1.3	0.55 / 1.1	0.45 / 0.9	0.4 / 0.8	0.35 / 0.7	0.3 / 0.6	0.22 / 0.44
MF-R075/90	1.15 / 2.3	1.0 / 2.0	0.9 / 1.8	0.75 / 1.5	0.61 / 1.22	0.55 / 1.1	0.48 / 0.96	0.41 / 0.82	0.30 / 0.6

Specifications are subject to change without notice.

Additional Features

■ Patents pending

MF-R/90 Series - PTC Resettable Fuses

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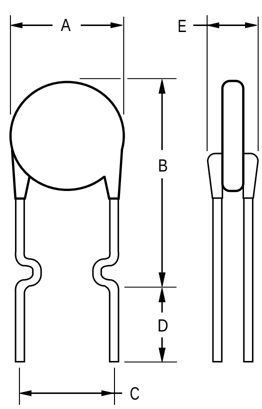
Product Dimensions

Model	A Max.	B Max.	C (Pitch) Nom.	D Min.	E Max.	Physical Characteristics Style	Lead Dia.	Material
MF-R055/90	10.9 (0.43)	14.0 (0.55)	5.1 ± 0.7 (0.201 ± 0.028)	6.3 (0.248)	3.6 (0.142)	1	0.81 (0.032)	Sn/Cu
MF-R055/90U	10.3 (0.4)	10.3 (0.4)	5.1 ± 0.7 (0.201 ± 0.028)	6.3 (0.248)	3.0 (0.118)	1	0.81 (0.032)	Sn/Cu
MF-R075/90	11.9 (0.47)	15.5 (0.61)	5.1 ± 0.7 (0.201 ± 0.028)	6.3 (0.248)	3.6 (0.142)	1	0.81 (0.032)	Sn/Cu

Packaging options:
BULK: 500 pcs. per bag. TAPE & REEL: 1500 pcs. per reel. AMMO-PACK: 1000 pcs. per pack

DIMENSIONS = MM / (INCHES)

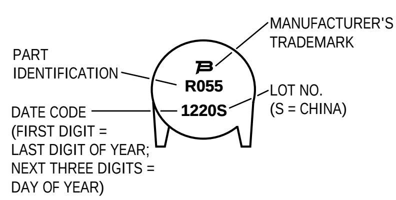
Style 1



Also available with straight leads.

Typical Part Marking

Represents total content. Layout may vary.



How to Order

MF - R 055/90 U - 0

Multifuse® Product Designator

Series
R = Radial Leaded Component

Hold Current, Ihold
055, 075 (0.55 Amps - 0.75 Amps)

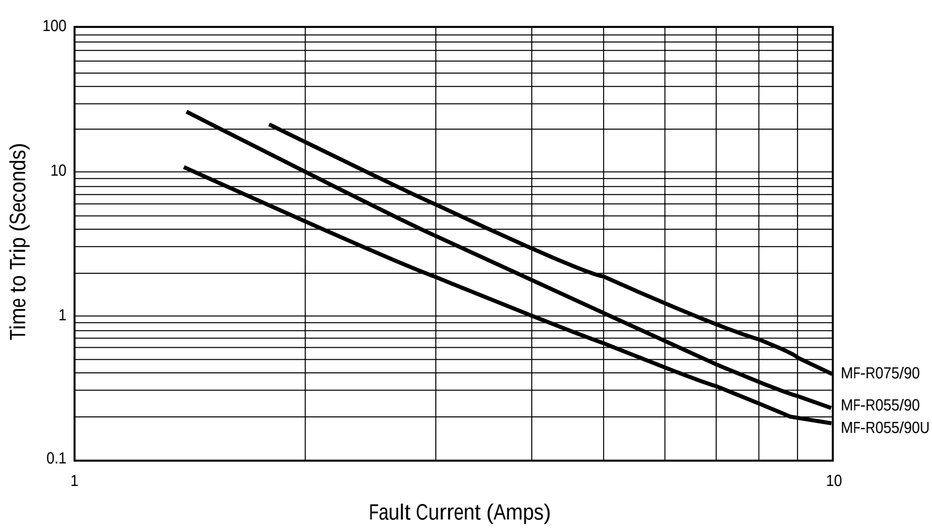
Max. Voltage, V

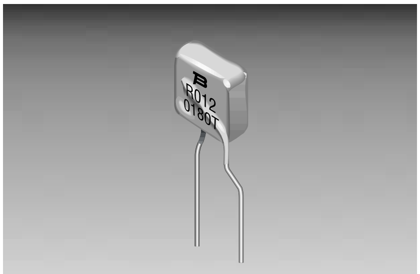
Coating
__ = Coated
U = Uncoated

Packaging Options
- 0 = Bulk Packaging
- 2 = Tape and Reel*
- AP = Ammo-Pak*

*Packaged per EIA486-B

Typical Time to Trip at 23˚C





BOURNS®

Features

- Radial Leaded Devices
- High voltage surge capabilities
- Binned and sorted resistance ranges
- Assists in meeting ITU K.20/K.21 specifications
- Withstands lightning power induction
- Agency recognition:

Applications

Used as a secondary overcurrent protection device in:

- Customer Premise Equipment (CPE)
- Central Office (CO)
- Subscriber Line Interface Cards (SLIC)

MF-R/250 Series - Telecom PTC Resettable Fuses

Electrical Characteristics

Model	Max. Operating Voltage	Max. Interrupt Ratings		Hold Current	Initial Resistance		One Hour Post-Trip Resistance
	Volts	Volts (V)	Amps (A)	Amps at 23°C	Ohms at 23°C	Ohms at 23°C	Ohms at 23°C
		Max.	Max.	I_H	Min.	Max.	
MF-R008/250U	60	250	3.0	0.08	14.0	20.0	33.0
MF-R008/250	60	250	3.0	0.08	15.0	22.0	33.0
MF-R011/250U	60	250	3.0	0.11	5.0	9.0	16.0
MF-R012/250	60	250	3.0	0.12	4.0	8.0	16.0
MF-R012/250U	60	250	3.0	0.12	6.0	10.0	16.0
MF-R014/250	60	250	3.0	0.14	3.0	6.0	12.0
MF-R014/250U	60	250	3.0	0.14	3.5	6.5	12.0

"U" suffix indicates product without insulation coating.

Environmental Characteristics

Operating/Storage Temperature ....-45°C to +85°C
Maximum Device Surface Temperature
in Tripped State..125°C
Passive Aging ....+85°C, 1000 hours ....±2% typical resistance change
+60°C, 1000 hours ±3% typical resistance change
Humidity Aging ....+85°C, 85% R.H. 500 hours ....±3% typical resistance change
Thermal Shock ....MIL-STD-202F, Method 107G, ...±10% typical resistance change
+125°C to -55°C,10 times ±15% typical resistance change
Solvent Resistance ....MIL-STD-202, Method 215B..No change
Lead Solerability ANSI/J-STD-002
Flammability ....IEC 695-2-2...No Flame for 60 secs.
Vibration ....MIL-STD-883C, Method 2007.1, Condition A..................No change

Test Procedures And Requirements For Model MF-R/250 Series

Test	Test Conditions	Accept/Reject Criteria
Visual/Mech.	Verify dimensions and materials	Per MF physical description
Resistance	In still air @ 23°C	Rmin ≤ R ≤ Rmax
Time to Trip	5 times Ihold, Vmax, 23°C	T ≤ max. time to trip (seconds)
Hold Current	30 min. at Ihold	No trip
Trip Cycle Life	Vmax, Imax, 100 cycles	No arcing or burning
Trip Endurance	Vmax, 48 hours	No arcing or burning

UL File Number ....E 174545S
CSA File Number ....CA 110338
TÜV File Number R2057213

Thermal Derating Chart - I_{hold} (Amps)

Model	Ambient Operating Temperature								
	-40°C	-20°C	0°C	23°C	40°C	50°C	60°C	70°C	85°C
MF-R008/250	0.124	0.110	0.095	0.080	0.066	0.059	0.051	0.044	0.033
MF-R011/250U	0.171	0.151	0.131	0.110	0.091	0.081	0.071	0.061	0.046
MF-R012/250	0.186	0.165	0.143	0.120	0.099	0.088	0.077	0.066	0.050
MF-R014/250	0.255	0.199	0.172	0.145	0.119	0.106	0.093	0.080	0.060
MF-R018/250	0,269	0.240	0.211	0.180	0.153	0.138	0.123	0.109	0.087

I_{trip} is approximately two times I_{hold}.

Additional Features

- Patents pending

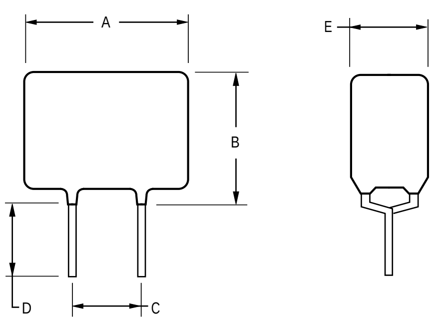
MF-R/250 Series - Telecom PTC Resettable Fuses

Product Dimensions

Model	A Max.	B Max.	C Max.	D Nom.	E Nom.	Physical Characteristics: Style	Lead Dia.	Material
MF-R008/250U	4.8 (0.189)	9.1 (0.358)	5.1 ± 0.7 (0.201 ± 0.028)	4.7 (0.185)	5.0 (0.197)	1	0.65 (0.026)	Sn/Cu
MF-R008/250	5.3 (0.209)	9.3 (0.366)	5.1 ± 0.7 (0.201 ± 0.028)	4.7 (0.185)	5.0 (0.197)	1	0.65 (0.026)	Sn/Cu
MF-R011/250U	5.3 (0.209)	9.4 (0.370)	5.1 ± 0.7 (0.201 ± 0.028)	4.7 (0.185)	5.0 (0.197)	1	0.65 (0.026)	Sn/Cu
MF-R012/250	6.5 (0.256)	11.0 (0.433)	5.1 ± 0.7 (0.201 ± 0.028)	4.7 (0.185)	5.0 (0.197)	1	0.65 (0.026)	Sn/Cu
MF-R012/250U	6.0 (0.236)	10.0 (0.394)	5.1 ± 0.7 (0.201 ± 0.028)	4.7 (0.185)	5.0 (0.197)	1	0.65 (0.026)	Sn/Cu
MF-R014/250	6.5 (0.256)	11.0 (0.433)	5.1 ± 0.7 (0.201 ± 0.028)	4.7 (0.185)	5.0 (0.197)	1	0.65 (0.026)	Sn/Cu
MF-R014/250U	6.0 (0.236)	10.0 (0.394)	5.1 ± 0.7 (0.201 ± 0.028)	4.7 (0.185)	5.0 (0.197)	1	0.65 (0.026)	Sn/Cu

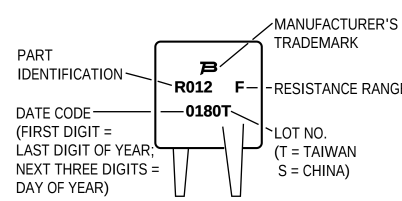
Packaging options:
BULK: 500 pcs. per bag. TAPE & REEL: 1500 pcs. per reel.

DIMENSIONS = $\frac{\text{MM}}{\text{(INCHES)}}$



Typical Part Marking

Represents total content. Layout may vary.



Specifications are subject to change without notice.

How to Order

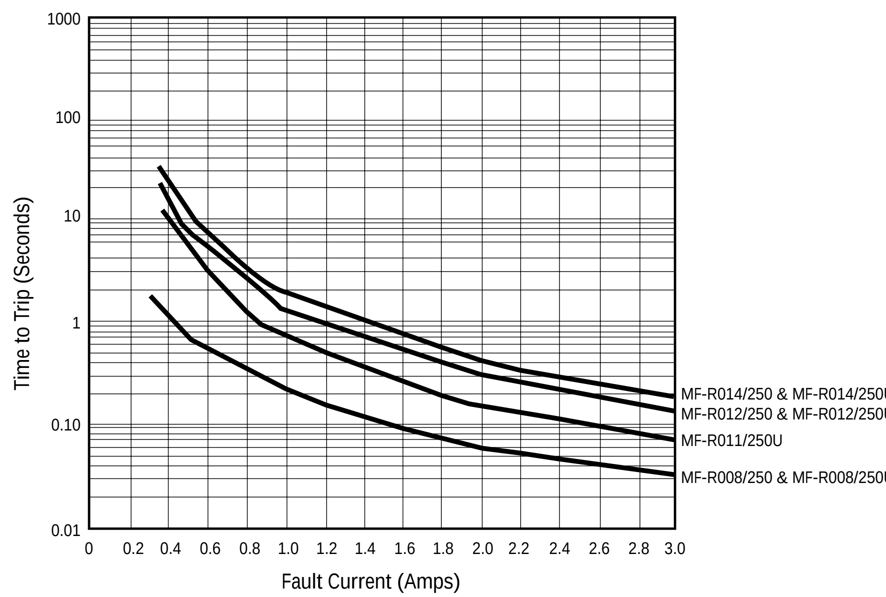
MF - R 012/250 - __ __- __

- Multifuse® Product Designator
- Series
  - R = Radial Leaded Component
  - SM = Surface Mount Component
- Hold Current, Ihold
  008-018 (0.08 - 0.18 Amps)
- Max. Interrupt Voltage, V
- Resistance Range
  Narrow resistance ranges are available on all models; consult Bourns for details.
- Resistance Sorted in Bins
  05 = 0.5 Ω
- Packaging Options
  - __ = Bulk Packaging
  - 2 = Tape and Reel*

*Packaged per EIA486-B

NOTE: All parts are also available "binned". All parts within a package will be within 0.5Ω of each other within the initial resistance range.

Typical Time to Trip at 23˚C



MF-R/250, REV. C, 08/01

Features

- Surface Mount Devices
- High voltage surge capabilities
- Binned and sorted resistance ranges
- Assists in meeting ITU K.20/K.21 specifications
- Withstands lightning power induction
- Agency recognition:

Applications

Used as a secondary overcurrent protection device in:

- Customer Premise Equipment (CPE)
- Central Office (CO)
- Subscriber Line Interface Cards (SLIC)

MF-SM013/250 - Telecom PTC Resettable Fuses

Electrical Characteristics

Model	Max. Oper. Voltage	Max. Interrupt Ratings		Hold Current	Initial Resistance		One Hour Post-Trip Resistance	Nom. Power Dissipation
	Volts	Volts (V)	Amps (A)	Amps at 23°C	Ohms at 23°C	Ohms at 23°C	Ohms at 23°C	Watts at 650V, 23°C
		Max.	Max.	I_H	Max.	Min.	Max.	
MF-SM013/250-2	60	250	3.0	0.13	6.5	12.0	20.0	3.3
MF-SM013/250-A-2	60	250	3.0	0.13	6.5	9.0	20.0	3.3
MF-SM013/250-B-2	60	250	3.0	0.13	9.0	12.0	20.0	3.3
MF-SM013/250-C-2	60	250	3.0	0.13	7.0	10.0	20.0	3.3

Environmental Characteristics

Operating/Storage Temperature ....-45°C to +85°C
Maximum Device Surface Temperature
in Tripped State...125°C
Passive Aging ....+85°C, 1000 hours ....±2% typical resistance change
+60°C, 1000 hours ±3% typical resistance change
Humidity Aging ....+85°C, 85% R.H. 500 hours ....±3% typical resistance change
Thermal Shock ....MIL-STD-202F, Method 107G, ...±10% typical resistance change
+125°C to -55°C,10 times ±15% typical resistance change
Solvent Resistance ....MIL-STD-202, Method 215B...No change
Lead Solerability ANSI/J-STD-002
Flammability ....IEC 695-2-2...No Flame for 60 secs.
Vibration ....MIL-STD-883C, Method 2007.1, Condition A..................No change

Test Procedures And Requirements For Model SM013/250 Series

Test	Test Conditions	Accept/Reject Criteria
Visual/Mech.	Verify dimensions and materials	Per MF physical description
Resistance	In still air @ 23°C	Rmin ≤ R ≤ Rmax
Time to Trip	At specified current, Vmax, 23°C	T ≤ max. time to trip (seconds)
Hold Current	30 min. at Ihold	No trip
Trip Cycle Life	Vmax, Imax, 100 cycles	No arcing or burning
Trip Endurance	Vmax, 48 hours	No arcing or burning
Solderability	MIL-STD-202F, Method 208F	95% min. coverage

UL File Number...E 174545S
CSA File Number ....CA 110338
TÜV File Number...R2057213

Thermal Derating Chart - I_{hold} / I_{trip} (Amps)

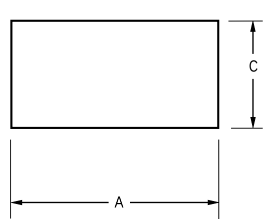
Model	Ambient Operating Temperature								
	-40°C	-20°C	0°C	23°C	40°C	50°C	60°C	70°C	85°C
MF-SM013/250-2	0.21 / 0.42	0.18 / 0.37	0.16 / 0.31	0.13 / 0.26	0.10 / 0.23	0.09 / 0.18	0.08 / 0.15	0.07 / 0.12	0.05 / 0.10
MF-SM013/250-A-2	0.21 / 0.42	0.18 / 0.37	0.16 / 0.31	0.13 / 0.26	0.10 / 0.23	0.09 / 0.18	0.08 / 0.15	0.07 / 0.12	0.05 / 0.10
MF-SM013/250-B-2	0.21 / 0.42	0.18 / 0.37	0.16 / 0.31	0.13 / 0.26	0.10 / 0.23	0.09 / 0.18	0.08 / 0.15	0.07 / 0.12	0.05 / 0.10
MF-SM013/250-C-2	0.21 / 0.42	0.18 / 0.37	0.16 / 0.31	0.13 / 0.26	0.10 / 0.23	0.09 / 0.18	0.08 / 0.15	0.07 / 0.12	0.05 / 0.10

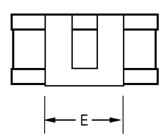
Product Dimensions

Model	A	B	C	D	E	G	H	I
	Max.	Max.	Max.	Nom.	Nom.	Nom.	Nom.	Nom.
MF-SM013/250-2	9.4 (0.370)	3.4 (0.133)	7.4 (0.291)	0.3 (0.012)	3.8 (0.149)	9.7 (0.383)	4.6 (0.18)	1.8 (0.071)
MF-SM013/250-A-2	9.4 (0.370)	3.4 (0.133)	7.4 (0.291)	0.3 (0.012)	3.8 (0.149)	9.7 (0.383)	4.6 (0.18)	1.8 (0.071)
MF-SM013/250-B-2	9.4 (0.370)	3.4 (0.133)	7.4 (0.291)	0.3 (0.012)	3.8 (0.149)	9.7 (0.383)	4.6 (0.18)	1.8 (0.071)
MF-SM013/250-C-2	9.4 (0.370)	3.4 (0.133)	7.4 (0.291)	0.3 (0.012)	3.8 (0.149)	9.7 (0.383)	4.6 (0.18)	1.8 (0.071)

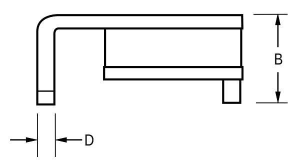
Packaging:
TAPE & REEL: 2000 pcs. per reel

DIMENSIONS = $\frac{\text{MM}}{\text{(INCHES)}}$





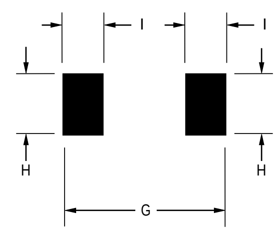
End View



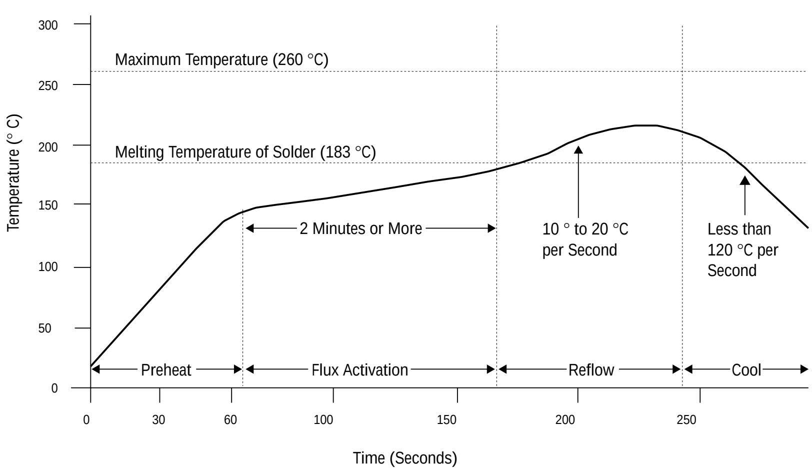
Side View

Terminal material:
Tin-plated brass

Recommended Pad Layout



Solder Reflow Recommendations



Solder reflow

- Recommended reflow methods: IR, vapor phase oven, hot air oven.
- Devices are not designed to be wave soldered to the bottom side of the board.
- Gluing the devices is not recommended.
- Recommended maximum paste thickness is 0.25 mm (.010 inch).
- Devices can be cleaned using standard industry methods and solvents.

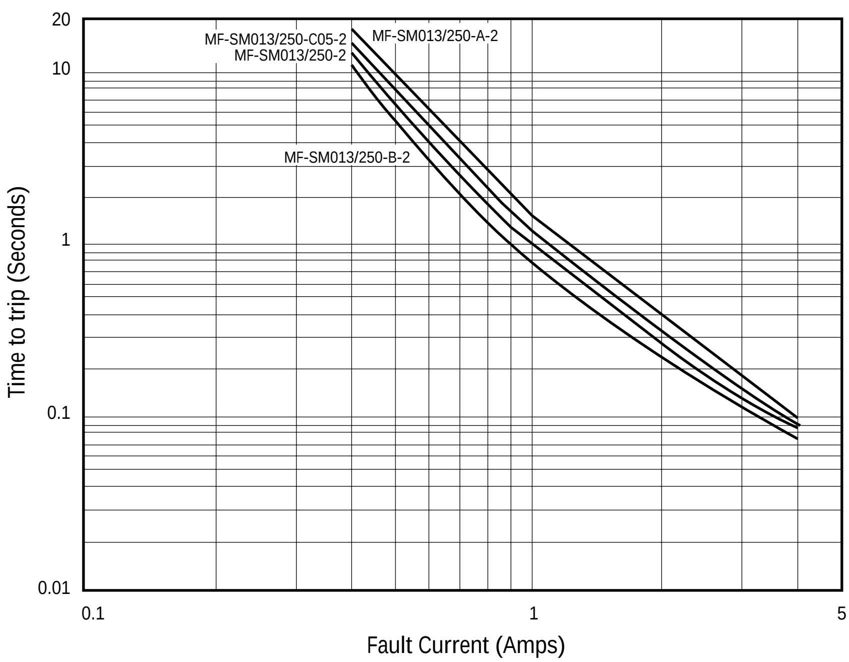
Note:

- If reflow temperatures exceed the recommended profile, devices may not meet the performance requirements.

Rework

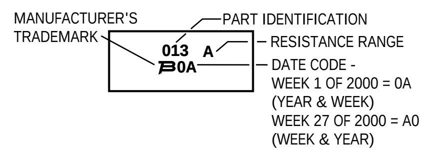
- A device should not be reworked.

Typical Time to Trip at 23°C



Typical Part Marking

Represents total content. Layout may vary.



How to Order

MF - SM 013/250 - __ __- __

Multifuse® Product Designator

Series
- R = Radial Leaded Component
- SM = Surface Mount Component

Hold Current, Ihold
013 (0.13 Amps)

Max. Interrupt Voltage, V

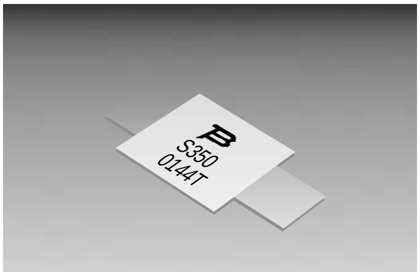
Resistance Range
- A = 6.5-9 Ω
- B = 9-12 Ω
- C = 7-10 Ω

Resistance Sorted in Bins
- 05 = 0.5 Ω

Packaging Options
- __ = Bulk Packaging
- 2 = Tape and Reel*

*Packaged per EIA486-B

NOTE: All parts are also available "binned". All parts within a package will be within 0.5Ω of each other within the initial resistance range.



BOURNS®

Features

- Axial leaded
- Fully compatible with current industry standards
- Weldable nickel terminals
- Very low internal resistance
- Agency recognition:
- Available in lead-free version

Applications

- Rechargeable Battery Pack Protection
- Provides overcurrent protection with 125°C trip temperature

MF-S Series - PTC Resettable Fuses

Electrical Characteristics

Model	V max. Volts	I max. Amps	I_{hold}	I_{trip}	Initial Resistance		1 Hour (R_1) Post-Trip Resistance	Max. Time To Trip		Tripped Power Dissipation
			Amperes at 23°C		Ohms at 23°C		Ohms at 23°C	Amperes at 23°C	Seconds at 23°C	Watts at 23°C
			Hold	Trip	Min.	Max.	Max.			
MF-S120	15	100	1.20	2.70	0.085	0.160	0.220	6	5.0	1.20
MF-S120S	15	100	1.20	2.70	0.085	0.160	0.220	6	5.0	1.20
MF-S150	15	100	1.50	3.00	0.050	0.090	0.110	8	5.0	1.30
MF-S175	15	100	1.75	3.80	0.050	0.090	0.120	9	4.0	1.50
MF-S175S	15	100	1.75	3.80	0.050	0.090	0.120	9	4.0	1.50
MF-S200	30	100	2.00	4.40	0.030	0.060	0.080	10	4.0	1.90
MF-S350	30	100	3.50	6.30	0.017	0.031	0.040	20	3.0	2.50
MF-S420	30	100	4.20	7.60	0.012	0.024	0.040	20	6.0	2.90

NOTE: Slotted lead option available on all models.

Environmental Characteristics

Operating/Storage Temperature ....-40°C to +85°C
Maximum Device Surface Temperature
in Tripped State ....125°C
Passive Aging..+85°C, 1000 hours ....±5% typical resistance change
Humidity Aging..+85°C, 85% R.H. 7 days ....±5% typical resistance change
Vibration ....MIL-STD-883C, Method 2007.1, Condition A ....No change

Test Procedures And Requirements For Model MF-S Series

Test	Test Conditions	Accept/Reject Criteria
Visual/Mech.	Verify dimensions and materials	Per MF physical description
Resistance	In still air @ 23°C	Rmin ≤ R ≤ Rmax
Time to Trip	At specified current, Vmax, 23°C	T ≤ max. time to trip (seconds)
Hold Current	30 min. at Ihold	No trip
Trip Cycle Life	Vmax, Imax, 100 cycles	No arcing or burning
Trip Endurance	Vmax, 48 hours	No arcing or burning

UL File Number ....E 174545S
CSA File Number ....CA 110338
TÜV File Number R2057213

Thermal Derating Chart - I_{hold} / I_{trip} (Amps)

Model	Ambient Operating Temperature								
	-40°C	-20°C	0°C	23°C	40°C	50°C	60°C	70°C	85°C
MF-S120	1.90 / 4.28	1.70 / 3.83	1.50 / 3.38	1.20 / 2.70	1.00 / 2.25	0.90 / 2.03	0.80 / 1.80	0.70 / 1.58	0.50 / 1.13
MF-S120S	1.90 / 4.28	1.70 / 3.83	1.50 / 3.38	1.20 / 2.70	1.00 / 2.25	0.90 / 2.03	0.80 / 1.80	0.70 / 1.58	0.50 / 1.13
MF-S150	2.20 / 4.40	2.00 / 4.00	1.80 / 3.60	1.50 / 3.00	1.30 / 2.60	1.10 / 2.20	1.00 / 2.00	0.90 / 1.80	0.70 / 1.40
MF-S175	2.50 / 5.59	2.30 / 5.14	2.00 / 4.47	1.70 / 3.80	1.50 / 3.35	1.30 / 2.91	1.20 / 2.68	1.10 / 2.46	0.90 / 2.01
MF-S175S	2.50 / 5.59	2.30 / 5.14	2.00 / 4.47	1.70 / 3.80	1.50 / 3.35	1.30 / 2.91	1.20 / 2.68	1.10 / 2.46	0.90 / 2.01
MF-S200	3.20 / 7.04	2.80 / 6.16	2.50 / 5.50	2.00 / 4.40	1.70 / 3.74	1.60 / 3.52	1.40 / 3.08	1.20 / 2.64	0.90 / 1.98
MF-S350	5.40 / 9.72	4.80 / 8.64	4.30 / 7.74	3.50 / 6.30	3.00 / 5.40	2.80 / 5.04	2.50 / 4.50	2.20 / 3.96	1.70 / 3.06
MF-S420	6.40 / 11.5	5.70 / 10.3	5.10 / 9.23	4.20 / 7.60	3.60 / 6.51	3.30 / 5.97	3.00 / 5.43	2.60 / 4.70	2.10 / 3.80

Additional Features

- Patents pending

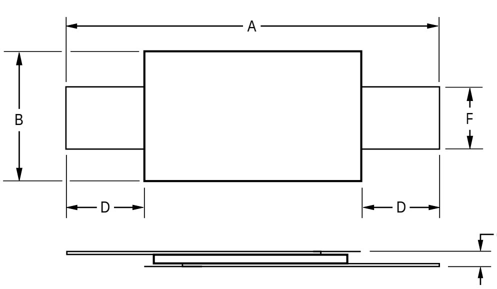
Product Dimensions

Model	A		B		C		D		F	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
MF-S120	19.9 (0.783)	22.1 (0.870)	4.9 (0.193)	5.2 (0.205)	0.6 (0.024)	1.0 (0.039)	5.5 (0.217)	7.5 (0.295)	3.8 (0.150)	4.1 (0.161)
MF-S120S	19.9 (0.783)	22.1 (0.870)	4.9 (0.193)	5.2 (0.205)	0.6 (0.024)	1.0 (0.039)	5.5 (0.217)	7.5 (0.295)	3.8 (0.150)	4.1 (0.161)
MF-S150	21.3 (0.839)	23.4 (0.921)	10.2 (0.402)	11.0 (0.433)	0.5 (0.020)	1.1 (0.043)	4.1 (0.161)	5.5 (0.217)	4.8 (0.189)	5.4 (0.213)
MF-S175	20.9 (0.823)	23.1 (0.909)	4.9 (0.193)	5.2 (0.205)	0.6 (0.024)	1.0 (0.039)	4.1 (0.161)	5.5 (0.217)	3.8 (0.150)	4.1 (0.161)
MF-S175S	20.9 (0.823)	23.1 (0.909)	4.9 (0.193)	5.2 (0.205)	0.6 (0.024)	1.0 (0.039)	4.1 (0.161)	5.5 (0.217)	3.8 (0.150)	4.1 (0.161)
MF-S200	21.3 (0.839)	23.4 (0.921)	10.2 (0.402)	11.0 (0.433)	0.5 (0.020)	1.1 (0.043)	5.0 (0.197)	7.6 (0.217)	4.8 (0.189)	5.4 (0.213)
MF-S350	28.4 (1.119)	31.8 (1.252)	13.0 (0.512)	13.5 (0.531)	0.5 (0.020)	1.1 (0.043)	6.3 (0.248)	8.9 (0.350)	6.0 (0.236)	6.6 (0.260)
MF-S420	30.6 (1.205)	32.4 (1.276)	12.9 (0.508)	13.6 (0.535)	0.5 (0.020)	1.1 (0.043)	5.0 (0.197)	7.5 (0.295)	6.0 (0.236)	6.6 (0.260)

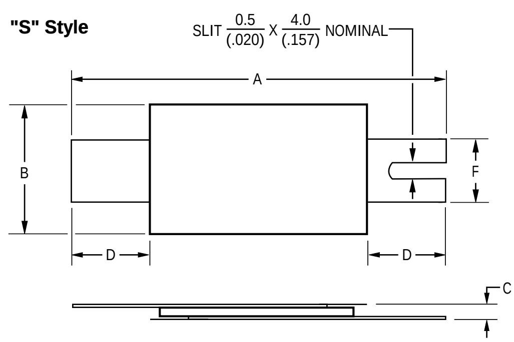
Packaging: Bulk - 500 pcs. per bag.
Tape and Reel - Consult factory.

DIMENSIONS = MM / (INCHES)

Standard Style



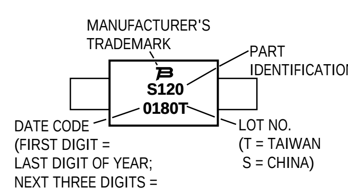
"S" Style



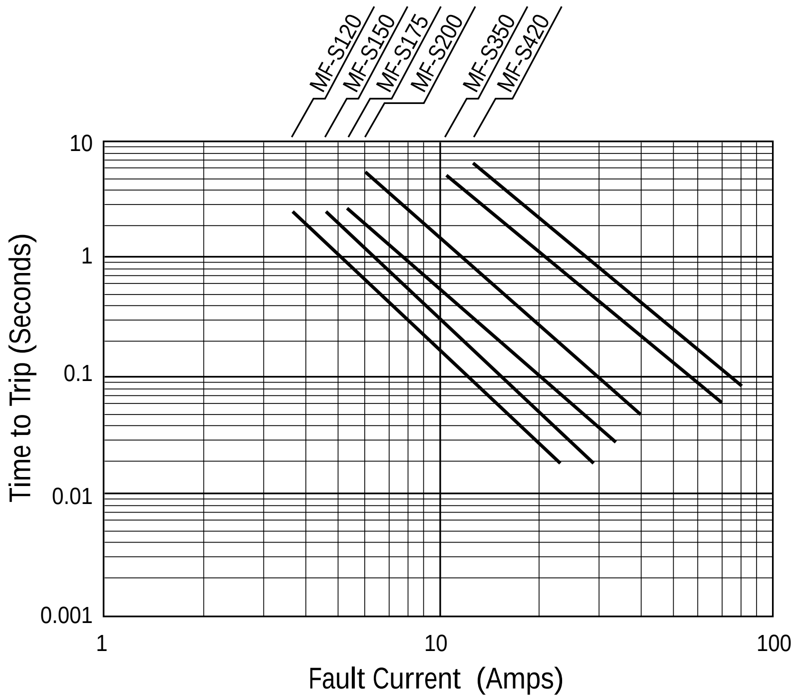
Terminal material: quarter-hard nickel

Typical Part Marking

Represents total content. Layout may vary.



Typical Time to Trip at 23°C



How To Order

MF - S 120 S - __

Multifuse® Product Designator

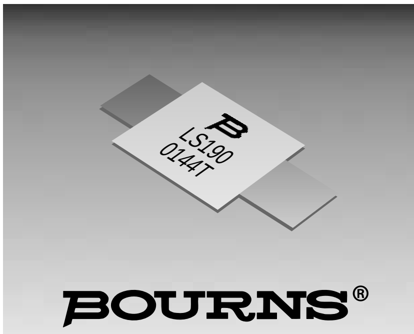
Series
S = Axial Leaded "Strap" Component

Hold Current, I_{hold}
120-420 (1.20 Amps - 4.20 Amps)

Slotted Lead Option

Packaging Options
- __ = Bulk Packaging
- 2 = Tape and Reel*

*Packaged per EIA486-B



Features

- Axial/radial leaded
- Fully compatible with current industry standards
- Weldable nickel terminals
- Very low internal resistance
- Agency recognition:

Applications

Any application that requires extra protection at elevated ambient temperatures, which the 100°C trip temperature provides.

- Rechargeable battery pack protection
- Cellular phones
- Laptop computers

MF-LS Series - PTC Resettable Fuses

Electrical Characteristics

Model	V max. Volts	I max. Amps	I_{hold} Amperes at 23°C Hold	I_{trip} Amperes at 23°C Trip	Initial Resistance Ohms at 23°C Min.	Initial Resistance Ohms at 23°C Max.	1 Hour (R_1) Post-Trip Resistance Ohms at 23°C Max.	Max. Time To Trip Amperes at 23°C	Max. Time To Trip Seconds at 23°C	Tripped Power Dissipation Watts at 23°C
MF-LS070	15	100	0.7	1.5	0.100	0.200	0.340	3.5	5.0	1.0
MF-LS070S	15	100	0.7	1.5	0.100	0.200	0.340	3.5	5.0	1.0
MF-LS100S	24	100	1.0	2.5	0.070	0.130	0.260	5	7.0	1.5
MF-LS180	24	100	1.8	3.8	0.040	0.068	0.120	9	2.9	2.0
MF-LS180L	24	100	1.8	3.8	0.040	0.068	0.120	9	2.9	2.0
MF-LS180S	24	100	1.8	3.8	0.040	0.068	0.120	9	2.9	2.0
MF-LS190	24	100	1.9	4.2	0.030	0.057	0.100	10	3.0	1.9
MF-LS190RU	15	100	1.9	4.2	0.030	0.057	0.100	10	3.0	1.9
MF-LS260	24	100	2.6	5.2	0.025	0.042	0.076	13	5.0	2.3
MF-LS300	24	100	3.0	6.3	0.015	0.031	0.055	15	4.0	2.0
MF-LS340	24	100	3.4	6.8	0.016	0.027	0.050	17	5.0	2.7

Note: Slotted option available on all models.

Environmental Characteristics

Operating/Storage Temperature ....-40°C to +85°C
Maximum Device Surface Temperature
in Tripped State ....125°C
Passive Aging..+85°C, 1000 hours ....±10% typical resistance change
Humidity Aging..+85°C, 85% R.H. 7 days ....±5% typical resistance change
Vibration ....MIL-STD-883C, Condition A ....No change

Test Procedures And Requirements For Model MF-LS Series

Test	Test Conditions	Accept/Reject Criteria
Visual/Mech.	Verify dimensions and materials	Per MF physical description
Resistance	In still air @ 23°C	Rmin ≤ R ≤ Rmax
Time to Trip	At specified current, Vmax, 23°C	T ≤ max. time to trip (seconds)
Hold Current	30 min. at Ihold	No trip
Trip Cycle Life	Vmax, Imax, 100 cycles	No arcing or burning
Trip Endurance	Vmax, 48 hours	No arcing or burning

UL File Number ....E 174545S
CSA File Number ....CA 110338
TÜV File Number R2057213

Thermal Derating Chart - I_{hold} / I_{trip} (Amps)

Model	Ambient Operating Temperature -40°C	-20°C	0°C	23°C	40°C	50°C	60°C	70°C	85°C
MF-LS070	1.20 / 2.57	1.09 / 2.33	0.85 / 1.82	0.70 / 1.50	0.50 / 1.07	0.45 / 0.96	0.35 / 0.75	0.28 / 0.60	0.16 / 0.34
MF-LS070S	1.20 / 2.57	1.09 / 2.33	0.85 / 1.82	0.70 / 1.50	0.50 / 1.07	0.45 / 0.96	0.35 / 0.75	0.28 / 0.60	0.16 / 0.34
MF-LS100S	1.80 / 4.50	1.60 / 4.00	1.40 / 3.50	1.00 / 2.50	0.80 / 2.00	0.70 / 1.75	0.60 / 1.50	0.40 / 1.00	0.20 / 0.50
MF-LS180	3.10 / 6.54	2.60 / 5.49	2.20 / 4.64	1.80 / 3.80	1.30 / 2.74	1.10 / 2.32	0.90 / 1.90	0.60 / 1.27	0.20 / 0.42
MF-LS180L	3.10 / 6.54	2.60 / 5.49	2.20 / 4.64	1.80 / 3.80	1.30 / 2.74	1.10 / 2.32	0.90 / 1.90	0.60 / 1.27	0.20 / 0.42
MF-LS180S	3.10 / 6.54	2.60 / 5.49	2.20 / 4.64	1.80 / 3.80	1.30 / 2.74	1.10 / 2.32	0.90 / 1.90	0.60 / 1.27	0.20 / 0.42
MF-LS190	3.30 / 7.29	2.80 / 6.19	2.40 / 5.31	1.90 / 4.20	1.40 / 3.09	1.20 / 2.65	1.10 / 2.43	0.70 / 1.55	0.40 / 0.88
MF-LS190RU	3.30 / 7.29	2.80 / 6.19	2.40 / 5.31	1.90 / 4.20	1.40 / 3.09	1.20 / 2.65	1.10 / 2.43	0.70 / 1.55	0.40 / 0.88
MF-LS260	4.30 / 8.60	3.70 / 7.40	3.10 / 6.20	2.60 / 5.20	1.90 / 3.80	1.60 / 3.20	1.40 / 2.80	1.10 / 2.20	0.60 / 1.20
MF-LS300	5.10 / 10.7	4.40 / 9.24	3.70 / 7.77	3.00 / 6.30	2.30 / 4.83	1.90 / 3.99	1.60 / 3.36	1.20 / 2.52	0.60 / 1.26
MF-LS340	5.50 / 11.0	4.70 / 9.40	4.00 / 8.00	3.40 / 6.80	2.60 / 5.20	2.20 / 4.40	1.90 / 3.80	1.50 / 3.00	0.80 / 1.60

Additional Features

- Patents pending
- Available in lead-free version

MF-LS Series - PTC Resettable Fuses

Product Dimensions

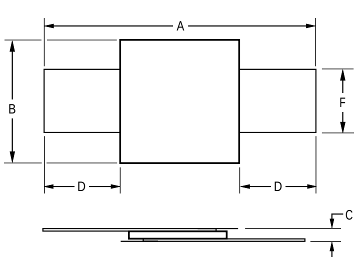
Model	A		B		C		D		F		Pkg. Style
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
MF-LS070	19.9 (0.783)	22.1 (0.870)	4.9 (0.193)	5.2 (0.205)	0.7 (0.028)	1.2 (0.047)	5.5 (0.217)	7.5 (0.295)	3.8 (0.150)	4.1 (0.161)	Std.
MF-LS070S	19.9 (0.783)	22.1 (0.870)	4.9 (0.193)	5.2 (0.205)	0.7 (0.028)	1.2 (0.047)	5.5 (0.217)	7.5 (0.295)	3.9 (0.154)	4.1 (0.161)	S
MF-LS100S	20.9 (0.823)	23.1 (0.909)	4.9 (0.193)	5.2 (0.205)	0.6 (0.024)	1.0 (0.039)	4.1 (0.161)	5.5 (0.217)	3.8 (0.150)	4.1 (0.161)	S
MF-LS180	24.0 (0.945)	26.0 (1.024)	4.9 (0.193)	5.2 (0.205)	0.6 (0.024)	1.0 (0.039)	4.1 (0.161)	5.5 (0.217)	3.8 (0.150)	4.1 (0.161)	Std.
MF-LS180L	35.0 (1.38)	37.5 (1.48)	4.9 (0.193)	5.6 (0.22)	0.6 (0.024)	1.0 (0.039)	9.6 (0.38)	10.0 (0.40)	3.8 (0.150)	4.2 (0.17)	Std.
MF-LS180S	24.0 (0.945)	26.0 (1.024)	4.9 (0.193)	5.2 (0.205)	0.6 (0.024)	1.0 (0.039)	4.1 (0.161)	5.5 (0.217)	3.8 (0.150)	4.1 (0.161)	S
MF-LS190	21.3 (0.839)	23.4 (0.921)	10.2 (0.402)	11.0 (0.433)	0.5 (0.020)	1.1 (0.043)	5.0 (0.197)	7.6 (0.299)	4.8 (0.189)	5.4 (0.213)	Std.
MF-LS190RU	19.8 (0.780)	20.8 (0.819)	13.3 (0.524)	14.3 (0.563)	0.4 (0.016)	0.76 (0.030)	8.1 (0.319)	9.5 (0.374)	3.8 (0.150)	4.1 (0.161)	RU
MF-LS260	24.0 (0.945)	26.0 (1.024)	10.8 (0.425)	11.9 (0.469)	0.6 (0.024)	1.0 (0.039)	5.0 (0.197)	7.0 (0.276)	5.9 (0.232)	6.1 (0.240)	Std.
MF-LS300	28.4 (1.118)	31.8 (1.252)	13.0 (0.512)	13.5 (0.531)	0.5 (0.020)	1.1 (0.043)	6.3 (0.248)	8.9 (0.350)	6.0 (0.236)	6.6 (0.260)	Std.
MF-LS340	24.0 (0.945)	26.0 (1.024)	14.8 (0.583)	15.9 (0.626)	0.6 (0.024)	1.0 (0.039)	4.0 (0.158)	5.0 (0.197)	6.0 (0.236)	6.1 (0.240	Std.

Packaging: Bulk - 500 pcs. per bag.
Tape and Reel - Consult factory.

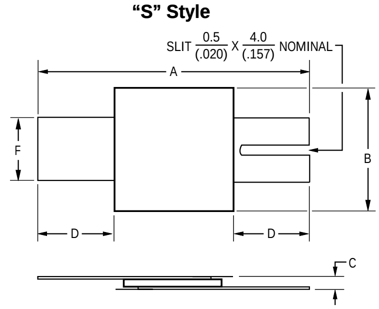
NOTE: Longer lead option available. Consult factory.

DIMENSIONS = $\frac{\text{MM}}{\text{(INCHES)}}$

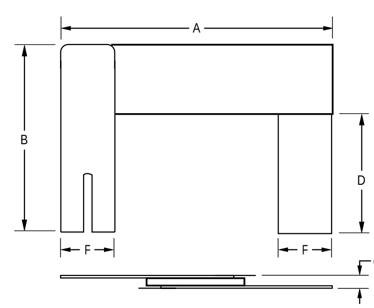
Standard Style



"S" Style



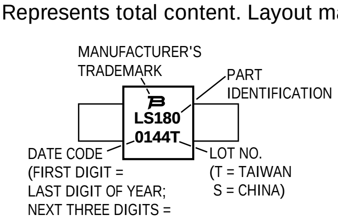
"RU" Style



Terminal material: quarter-hard nickel

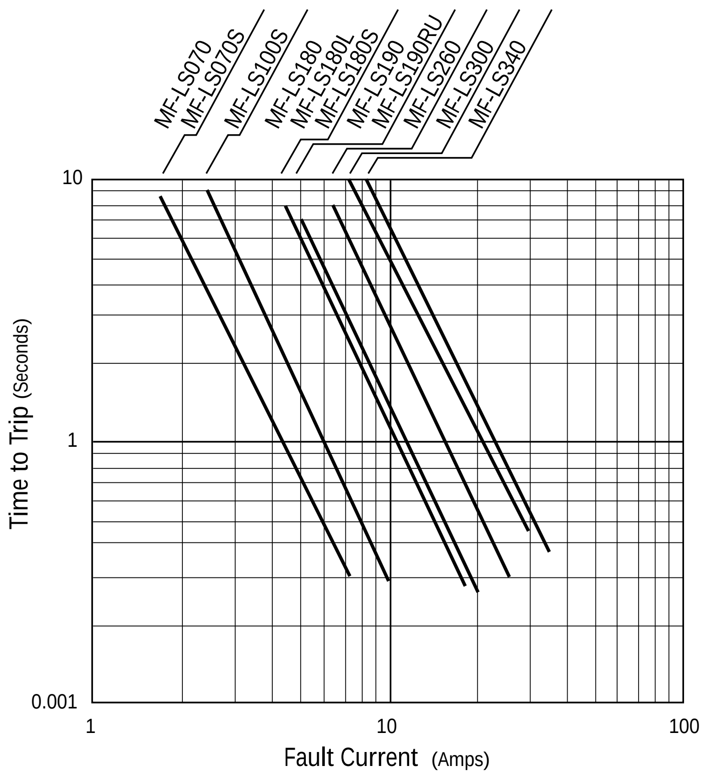
Typical Part Marking

Represents total content. Layout may vary.



Typical Time to Trip at 23˚C

MF-LS models offer trip temperatures lower than MF-S models for extra protection at elevated temperatures.



How To Order

MF - LS 100 S - __

Multifuse® Product Designator

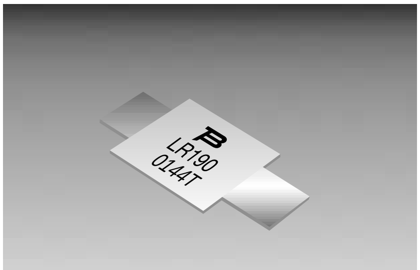
Series
LS = Axial Leaded "Strap" Component

Hold Current, I_{hold}
70-340 (0.70 Amps - 3.40 Amps)

Lead Option
S = Slotted Lead Option
RU = Radial Lead Option

Packaging Options
- __ = Bulk Packaging
- 2 = Tape and Reel*

*Packaged per EIA486-B



BOURNS®

Features

- Axial leaded
- Fully compatible with current industry standards
- Weldable nickel terminals
- Very low internal resistance
- Operating currents to 7.3 Amps
- Available in lead-free version

- Agency recognition:

Applications

- Any application that requires protection at low resistances
- Rechargeable battery packs
- Cellular phones
- Laptop computers

MF-LR Series - PTC Resettable Fuses

Electrical Characteristics

Model	V max. Volts	I max. Amps	I_{hold}	I_{trip}	Initial Resistance		1 Hour (R_1) Post-Trip Resistance	Max. Time To Trip		Tripped Power Dissipation
			Amperes At 23°C		Ohms At 23°C		Ohms At 23°C	Amperes At 23°C	Seconds At 23°C	Watts At 23°C
			Hold	Trip	Min.	Max.	Max.			
MF-LR190	15	100	1.90	3.90	0.039	0.072	0.102	9.5	5.0	1.2
MF-LR190S	15	100	1.90	3.90	0.039	0.072	0.102	9.5	5.0	1.2
MF-LR260	15	100	2.60	5.80	0.020	0.042	0.063	13.0	5.0	1.3
MF-LR260S	15	100	2.60	5.80	0.020	0.042	0.063	13.0	5.0	2.5
MF-LR380	15	100	3.80	8.30	0.013	0.026	0.037	19.0	5.0	2.5
MF-LR450	10	100	4.50	8.90	0.011	0.020	0.028	22.5	5.0	2.5
MF-LR550	10	100	5.50	10.50	0.009	0.019	0.022	27.5	5.0	2.8
MF-LR600	10	100	6.00	11.70	0.007	0.014	0.016	30.0	5.0	2.8
MF-LR730	10	100	7.3	14.1	0.006	0.012	0.015	30.0	5.0	3.3

Environmental Characteristics

Operating/Storage Temperature ....-40°C to +85°C
Maximum Device Surface Temperature
in Tripped State ....125°C
Passive Aging..+70°C, 1000 hours ....±10% typical resistance change
Humidity Aging..+85°C, 85% R.H. 7 days ....±10% typical resistance change
Vibration ....MIL-STD-883C, Condition A ....No change

Test Procedures And Requirements For Model MF-LR Series

Test	Test Conditions	Accept/Reject Criteria
Visual/Mech.	Verify dimensions and materials	Per MF physical description
Resistance	In still air @ 23°C	Rmin ≤ R ≤ Rmax
Time to Trip	At specified current, Vmax, 23°C	T ≤ max. time to trip (seconds)
Hold Current	30 min. at Ihold	No trip
Trip Cycle Life	Vmax, Imax, 100 cycles	No arcing or burning
Trip Endurance	Vmax, 48 hours	No arcing or burning

UL File Number ....E 174545S
CSA File Number ....CA 110338
TÜV File Number R2057213

Thermal Derating Chart - I_{hold} / I_{trip} (Amps)

Model	Ambient Operating Temperature								
	-40°C	-20°C	0°C	23°C	40°C	50°C	60°C	70°C	85°C
MF-LR190	2.8 / 5.7	2.5 / 5.1	2.3 / 4.7	1.9 / 3.9	1.6 / 3.3	1.5 / 3.1	1.4 / 2.9	1.2 / 2.5	1.0 / 2.1
MF-LR190S	2.8 / 5.7	2.5 / 5.1	2.3 / 4.7	1.9 / 3.9	1.6 / 3.3	1.5 / 3.1	1.4 / 2.9	1.2 / 2.5	1.0 / 2.1
MF-LR260	3.8 / 8.5	3.4 / 7.6	3.1 / 6.9	2.6 / 5.8	2.2 / 4.9	2.0 / 4.5	1.9 / 4.2	1.7 / 3.8	1.4 / 3.1
MF-LR260S	3.8 / 8.5	3.4 / 7.6	3.1 / 6.9	2.6 / 5.8	2.2 / 4.9	2.0 / 4.5	1.9 / 4.2	1.7 / 3.8	1.4 / 3.1
MF-LR380	5.5 / 12.0	4.9 / 10.7	4.4 / 9.6	3.8 / 8.3	3.3 / 7.2	3.0 / 6.6	2.8 / 6.1	2.5 / 5.5	2.1 / 4.6
MF-LR450	6.5 / 12.9	5.8 / 11.5	5.3 / 10.5	4.5 / 8.9	3.9 / 7.7	3.6 / 7.1	3.3 / 6.5	2.9 / 5.7	2.5 / 4.9
MF-LR550	8.0 / 15.3	7.1 / 13.6	6.2 / 11.8	5.5 / 10.5	4.7 / 9.0	4.3 / 8.2	4.0 / 7.6	3.6 / 6.9	3.0 / 5.7
MF-LR600	8.7 / 17.0	7.8 / 15.2	7.1 / 13.8	6.0 / 11.7	5.2 / 10.1	4.7 / 9.2	4.4 / 8.6	3.9 / 7.6	3.3 / 6.4
MF-LR730	10.6 / 20.5	9.5 / 18.3	8.6 / 16.6	7.3 / 14.1	6.3 / 12.2	5.7 / 11.0	5.4 / 10.4	4.7 / 9.1	4.0 / 7.7

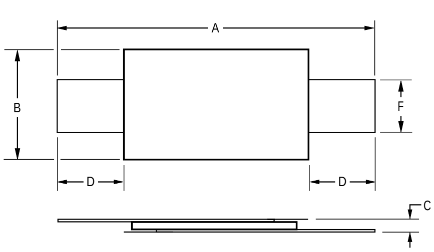
Product Dimensions

Model	A		B		C		D		F		Pkg. Style
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
MF-LR190	19.9 (0.783)	22.1 (0.870)	4.9 (0.193)	5.2 (0.205)	0.6 (0.024)	1.0 (0.039)	5.5 (0.217)	7.5 (0.295)	3.9 (0.154)	4.1 (0.161)	Std.
MF-LR190S	19.9 (0.783)	22.1 (0.870)	4.9 (0.193)	5.2 (0.205)	0.6 (0.024)	1.0 (0.039)	5.5 (0.217)	7.5 (0.295)	3.9 (0.154)	4.1 (0.161)	S
MF-LR260	20.9 (0.823)	23.1 (0.909)	4.9 (0.193)	5.2 (0.205)	0.6 (0.024)	1.0 (0.039)	4.1 (0.161)	5.5 (0.217)	3.9 (0.154)	4.1 (0.161)	Std.
MF-LR260S	20.9 (0.823)	23.1 (0.909)	4.9 (0.193)	5.2 (0.205)	0.6 (0.024)	1.0 (0.039)	4.1 (0.161)	5.5 (0.217)	3.9 (0.154)	4.1 (0.161)	S
MF-LR380	24.0 (0.945)	26.0 (1.024)	6.9 (0.272)	7.5 (0.295)	0.6 (0.024)	1.0 (0.039)	4.1 (0.161)	5.5 (0.217)	4.9 (0.193)	5.1 (0.201)	Std.
MF-LR450	24.0 (0.945)	26.0 (1.024)	9.9 (0.390)	10.5 (0.414)	0.6 (0.024)	1.0 (0.039)	5.3 (0.209)	6.7 (0.264)	5.9 (0.232)	6.1 (0.240)	Std.
MF-LR550	35.0 (1.378)	37.0 (1.457)	6.9 (0.272)	7.5 (0.295)	0.6 (0.024)	1.0 (0.039)	5.3 (0.209)	6.7 (0.264)	4.9 (0.193)	5.1 (0.201)	Std.
MF-LR600	24.0 (0.945)	26.0 (1.024)	13.9 (0.548)	14.5 (0.571)	0.6 (0.024)	1.0 (0.039)	4.1 (0.161)	5.5 (0.217)	5.9 (0.232)	6.1 (0.240)	Std.
MF-LR730	26.0 (1.024)	29.1 (1.146)	13.9 (0.548)	14.5 (0.571)	0.6 (0.024)	1.0 (0.039)	4.1 (0.161)	5.5 (0.217)	5.9 (0.232)	6.1 (0.240)	Std.

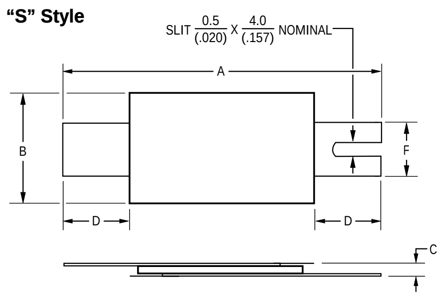
Packaging: Bulk - 500 pcs. per bag. Tape and Reel - Consult factory.

DIMENSIONS = $\frac{\text{MM}}{\text{(INCHES)}}$

Standard Style

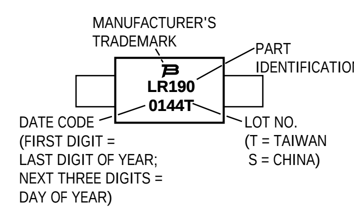


"S" Style

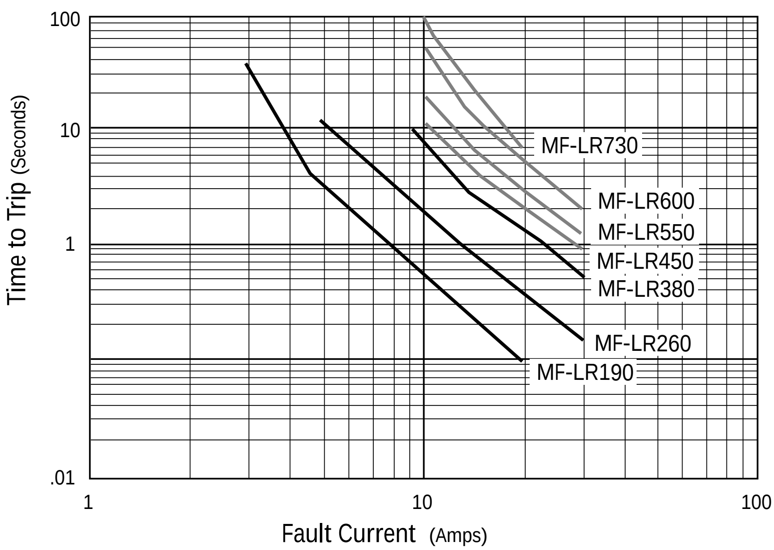


Typical Part Marking

Represents total content. Layout may vary.



Typical Time to Trip at 23˚C



How To Order

MF - LR 190 S - __

Multifuse® Product Designator

Series
LR = Axial Leaded "Strap" Component

Hold Current, I_{hold}
190-730 (1.90 Amps - 7.30 Amps)

Lead Option
S = Slotted Lead Option

Packaging Options
-__ = Bulk Packaging
-2 = Tape and Reel*

*Packaged per EIA 486-B

Features

- Axial leaded
- Fully compatible with current industry standards
- Weldable nickel terminals
- Very low internal resistance
- Low switching temperature
- 100% lead-free

Applications

- Any application that requires protection at low resistances
- Rechargeable battery packs; designed for NiMH and Li-Ion chemical characteristics
- Cellular phones
- Laptop computers

MF-VS Series - PTC Resettable Fuses

Electrical Characteristics

	Model	V max. Volts	I max. Amps	I_{hold} Amperes At 23°C	I_{trip}	Initial Resistance Ohms At 23°C			1 Hour (R_1) Post-Trip Resistance Ohms At 23°C	Max. Time To Trip Amperes At 23°C	Seconds At 23°C	Tripped Power Dissipation Watts At 23°C
				Hold	Trip	Min.	Max.	Typ.	Max.			
	MF-VS170	16	100	1.7	3.4	0.030	0.052	0.040	0.105	8.5	3.0	1.4
	MF-VS210	16	100	2.1	4.7	0.018	0.030	0.022	0.060	10.0	5.0	1.5
NEW!	**MF-VS240**	**16**	**100**	**2.4**	**5.9**	**0.014**	**0.026**	**0.020**	**0.052**	**12.0**	**6.0**	**1.9**

Environmental Characteristics

Operating/Storage Temperature ....-40°C to +85°C
Maximum Device Surface Temperature
in Tripped State ....125°C
Passive Aging...+60°C, 1000 hours ....±10% typical resistance change
Humidity Aging...+60°C, 85% R.H.1000 hours ....±10% typical resistance change
Thermal Shock ....MIL-STD-202F, Method 107G ....±5% typical resistance change
+85°C to -40°C, 10 times
Vibration ....MIL-STD-883C, ...No change
Condition A

Test Procedures And Requirements For Model MF-VS Series

Test	Test Conditions	Accept/Reject Criteria
Visual/Mech.	Verify dimensions and materials	Per MF physical description
Resistance	In still air @ 23°C	Rmin ≤ R ≤ Rmax
Time to Trip	At specified current, Vmax, 23°C	T ≤ max. time to trip (seconds)
Hold Current	30 min. at Ihold	No trip
Trip Cycle Life	Vmax, Imax, 100 cycles	No arcing or burning
Trip Endurance	Vmax, 48 hours	No arcing or burning

UL File Number ....E 174545S
CSA File Number ....CA 110338
TÜV File Number R2057213

Thermal Derating Chart - I_{hold} (Amps)

	Model	-40°C	-20°C	0°C	23°C	40°C	50°C	60°C	70°C	85°C
		Ambient Operating Temperature								
	MF-VS170	3.2	2.7	2.2	1.7	1.3	1.1	0.8	0.6	0.1
	MF-VS210	4.1	3.5	2.9	2.1	1.6	1.3	1.0	0.7	0.1
NEW!	**MF-VS240**	**4.2**	**3.6**	**3.0**	**2.4**	**1.9**	**1.5**	**1.2**	**0.8**	**0.1**

*I_{trip} is approximately two times I_{hold}.

Additional Features

- Patents pending

MF-VS Series - PTC Resettable Fuses

BOURNS®

Product Dimensions

	Model	A Min.	A Max.	B Min.	B Max.	C Min.	C Max.	D Min.	D Max.	F Min.	F Max.	Pkg. Style
	MF-VS170	16.0 (0.630)	18.0 (0.709)	4.9 (0.193)	5.5 (0.217)	0.6 (0.024)	0.9 (0.035)	4.1 (0.161)	5.8 (0.228)	3.9 (0.154)	4.1 (0.161)	Std.
	MF-VS170S	16.0 (0.630)	18.0 (0.709)	4.9 (0.193)	5.5 (0.217)	0.6 (0.024)	0.9 (0.035)	4.1 (0.161)	5.8 (0.228)	3.9 (0.154)	4.1 (0.161)	Std.
	MF-VS210	20.9 (0.823)	23.1 (0.909)	4.9 (0.193)	5.5 (0.217)	0.6 (0.024)	0.9 (0.035)	4.1 (0.161)	5.8 (0.228)	3.9 (0.154)	4.1 (0.161)	Std.
	MF-VS210L	24.0 (0.945)	26.5 (1.043)	4.9 (0.193)	5.5 (0.217)	0.6 (0.024)	0.9 (0.035)	5.0 (0.197)	7.1 (0.280)	3.9 (0.154)	4.1 (0.161)	Std.
	MF-VS210S	20.9 (0.823)	23.1 (0.909)	4.9 (0.193)	5.5 (0.217)	0.6 (0.024)	0.9 (0.035)	4.1 (0.161)	5.8 (0.228)	3.9 (0.154)	4.1 (0.161)	S
NEW!	**MF-VS240**	**24.0 (0.945)**	**26.2 (1.031)**	**4.9 (0.193)**	**5.5 (0.217)**	**0.6 (0.024)**	**0.9 (0.035)**	**4.1 (0.161)**	**5.8 (0.228)**	**3.9 (0.154)**	**4.1 (0.161)**	**Std.**
NEW!	**MF-VS240S**	**24.0 (0.945)**	**26.2 (1.031)**	**4.9 (0.193)**	**5.5 (0.217)**	**0.6 (0.024)**	**0.9 (0.035)**	**4.1 (0.161)**	**5.8 (0.228)**	**3.9 (0.154)**	**4.1 (0.161)**	**S**

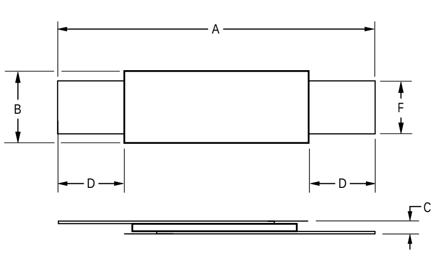
Packaging: Bulk - 500 pcs. per bag. Tape and Reel - Consult factory.

DIMENSIONS = MM / (INCHES)

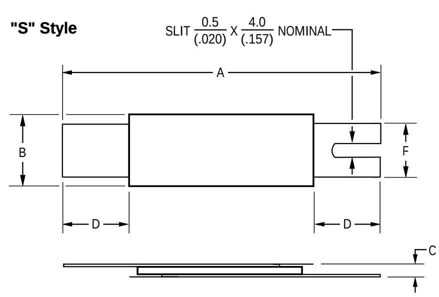
Leads: 1/4 Hardened Nickel 0.125mm (.005”) nom.

NOTE: All “S” style models available with 1 or 2 slots. The dimensions and shape of the leads can be modified to suit the battery pack design. All models are available without insulation wrapping.

Standard Style

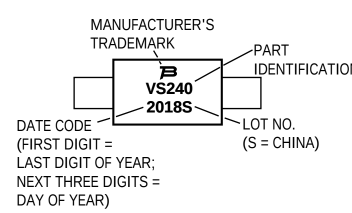


"S" Style



Typical Part Marking

Represents total content. Layout may vary.



How To Order

MF - VS 240 _ _ _ _

Multifuse® Product Designator

Series
VS = Axial Leaded “Strap” Component

Hold Current, I_{hold}
170-240 (1.7 Amps - 2.4 Amps)

Lead Option
S = Slotted Lead Option (one side)
SS = Slotted Lead Option (two sides)

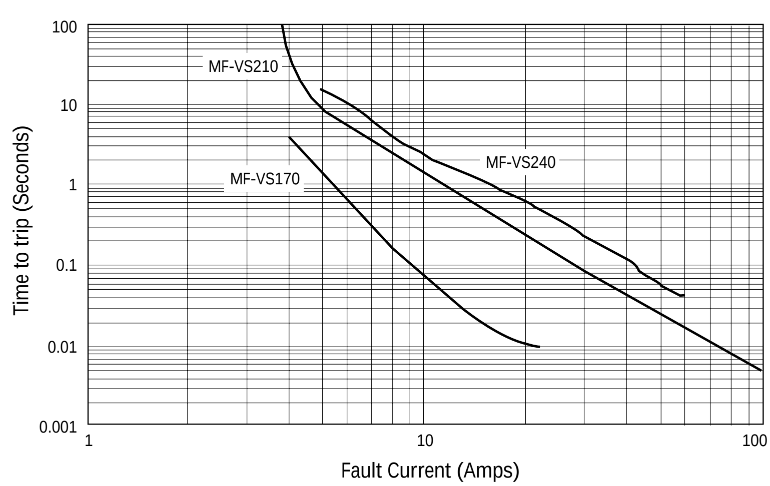
Longer Lead Option
L = Longer Leads

Insulating Option
U = Non-Insulated Option

Packaging Options
- 0 = Bulk Packaging
- 2 = Tape and Reel* (Consult factory)

*Packaged per EIA 486-B

Typical Time to Trip at 23°C



Specifications are subject to change without notice.

BOURNS®

Features

- 3.6mm narrow design axial strap
- Fully compatible with current industry standards
- Weldable nickel terminals
- Very low internal resistance
- Low switching temperature
- 100% lead-free

Applications

- Any application that requires protection at low resistances
- Rechargeable battery packs; designed for NiMH and Li-Ion chemical characteristics
- Cellular phones
- Laptop computers

MF-VSN Series - PTC Resettable Fuses

Electrical Characteristics

Model	V max.	I max.	I_{hold}	I_{trip}	Initial Resistance			1 Hour (R_1) Post-Trip Resistance	Max. Time To Trip		Tripped Power Dissipation
	Volts	Amps	Amperes At 23°C		Ohms At 23°C			Ohms At 23°C	Amperes At 23°C	Seconds At 23°C	Watts At 23°C
			Hold	Trip	Min.	Max.	Typ.	Max.			
MF-VS170N	12	100	1.7	3.4	0.030	0.052	0.040	0.105	8.5	3.0	1.4
MF-VS175NL	12	100	1.75	3.5	0.029	0.051	0.038	0.102	8.75	3.0	1.4
MF-VS210N	12	100	2.1	4.7	0.018	0.030	0.024	0.060	10.0	5.0	1.5

Environmental Characteristics

Operating/Storage Temperature ....-40°C to +85°C
Maximum Device Surface Temperature
in Tripped State ....125°C
Passive Aging...+60°C, 1000 hours ....±10% typical resistance change
Humidity Aging...+60°C, 85% R.H.1000 hours ....±10% typical resistance change
Thermal Shock ....MIL-STD-202F, Method 107G ....±5% typical resistance change
+85°C to -40°C, 10 times
Vibration ....MIL-STD-883C, ...No change
Condition A

Test Procedures And Requirements For Model MF-VSN Series

Test	Test Conditions	Accept/Reject Criteria
Visual/Mech.	Verify dimensions and materials	Per MF physical description
Resistance	In still air @ 23°C	Rmin ≤ R ≤ Rmax
Time to Trip	At specified current, Vmax, 23°C	T ≤ max. time to trip (seconds)
Hold Current	30 min. at Ihold	No trip
Trip Cycle Life	Vmax, Imax, 100 cycles	No arcing or burning
Trip Endurance	Vmax, 48 hours	No arcing or burning

UL File Number ....E 174545S
CSA File Number ....CA 110338
TÜV File Number R2057213

Thermal Derating Chart - I_{hold} (Amps)

Model	Ambient Operating Temperature			
	0°C	23°C	60°C	85°C
MF-VS170N	2.2	1.7	0.8	0.1
MF-VS175NL	2.25	1.75	0.85	0.1
MF-VS210N	2.9	2.1	1.0	0.1

I_{trip} is approximately two times I_{hold}.

Additional Features

- Patents pending

MF-VSN Series - PTC Resettable Fuses

BOURNS®

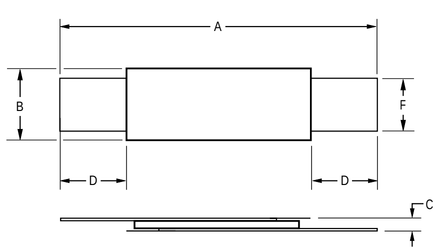
Product Dimensions

Model	A		B		C		D		F		Pkg. Style
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
MF-VS170N	22.0 (0.866)	24.0 (0.945)	3.6 (0.142)	3.9 (0.154)	0.6 (0.024)	0.9 (0.035)	4.1 (0.161)	5.8 (0.228)	2.4 (0.094)	2.6 (0.102)	Std.
MF-VS175NL	26.0 (1.024)	28.0 (1.102)	3.6 (0.142)	3.9 (0.154)	0.6 (0.024)	0.9 (0.035)	6.1 (0.240)	7.8 (0.307)	2.4 (0.094)	2.6 (0.102)	Std.
MF-VS210N	30.0 (1.181)	32.0 (1.260)	3.6 (0.142)	3.9 (0.154)	0.6 (0.024)	0.9 (0.035)	4.1 (0.161)	5.8 (0.228)	2.4 (0.094)	2.6 (0.102)	Std.

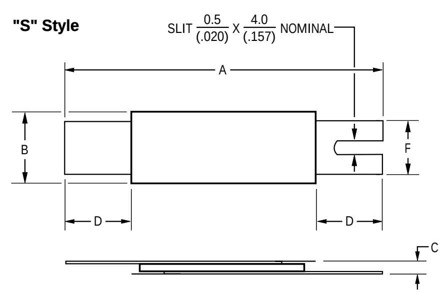
Packaging: Bulk - 500 pcs. per bag. Tape and Reel - Consult factory.
Leads: 1/4 Hardened Nickel 0.125mm (.005”) nom.
NOTE: All “S” style models available with 1 or 2 slots. The dimensions and shape of the leads can be modified to suit the battery pack design. All models are available without insulation wrapping.

DIMENSIONS = $\frac{\text{MM}}{\text{(INCHES)}}$

Standard Style

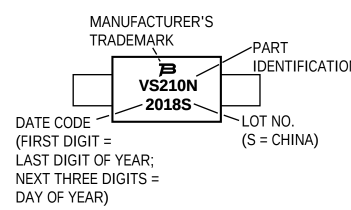


"S" Style



Typical Part Marking

Represents total content. Layout may vary.



How To Order

MF - VS 210 N _ _ _ _

Multifuse® Product Designator

Series
VS =Axial Leaded “Strap” Component

Hold Current, I_{hold}
170-210 (1.70 - 2.10 Amps)

Narrow Device Option
N = Narrow (3.6mm)

Lead Option
S = Slotted Lead Option (one side)
SS = Slotted Lead Option (two sides)

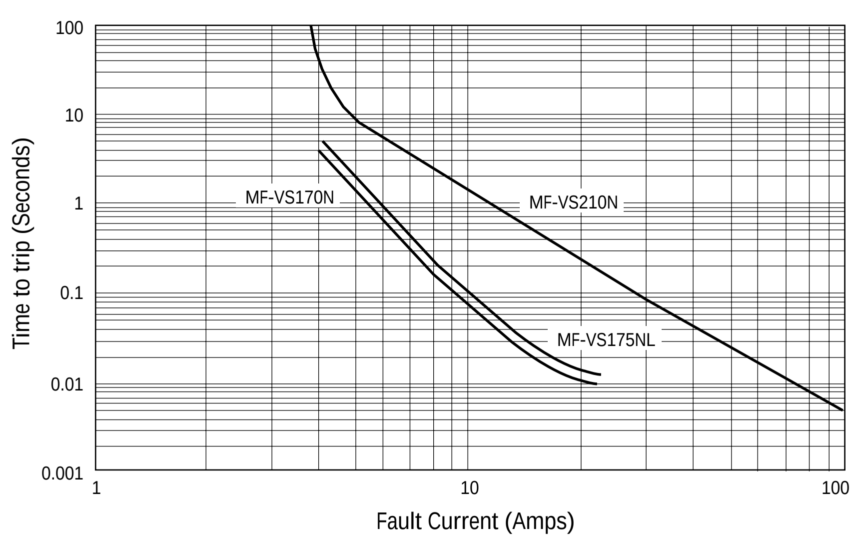
Longer Lead Option
L = Longer Leads

Insulating Option
U = Non-Insulated Option

Packaging Option
-0 = Bulk Packaging
-2 = Tape and Reel* (Consult factory)

*Packaged per EIA 486-B

Typical Time to Trip at 23°C



BOURNS®

Features

- Industry's lowest internal resistance
- Switches at optimum temperature
- Axial leaded, with flexible design options available
- Fully compatible with current industry standards
- Weldable nickel terminals
- 100% lead-free

MF-SVS Series - PTC Resettable Fuses

Electrical Characteristics

Model	V max. Volts	I max. Amps	I_{hold}	I_{trip}	Initial Resistance			1 Hour (R_1) Post-Trip Resistance	Max. Time To Trip		Tripped Power Dissipation
			Amperes at 23°C		Ohms at 23°C			Ohms at 23°C	Amperes at 23°C	Seconds at 23°C	Watts at 23°C
			Hold	Trip	Min.	Max.	Typ.	Max.			
MF-SVS170	10	100	1.7	4.1	0.018	0.032	0.023	0.064	8.5	5.0	2.1
MF-SVS175	10	100	1.75	4.2	0.017	0.030	0.022	0.060	8.5	5.0	2.1
MF-SVS210	10	100	2.1	5.0	0.010	0.020	0.016	0.040	10.5	5.0	2.4
MF-SVS230	10	100	2.3	5.2	0.010	0.018	0.014	0.036	12.5	5.0	2.6

Environmental Characteristics

Operating/Storage Temperature ....-40°C to +85°C
Maximum Device Surface Temperature
in Tripped State ....125°C
Passive Aging...+60°C, 1000 hours ....±10% typical resistance change
Humidity Aging..+60°C, 85% R.H. 1000 hours.....................±10% typical resistance change
Thermal Shock ....MIL-STD-202F, Method 107G, ...±5% typical resistance change
+85°C to -40°C, 10 times
Vibration ....MIL-STD-883C, ...No change
Condition A

Test Procedures And Requirements For Model MF-SVS Series

Test	Test Conditions	Accept/Reject Criteria
Visual/Mech.	Verify dimensions and materials	Per MF physical description
Resistance	In still air @ 23°C	Rmin ≤ R ≤ Rmax
Time to Trip	At specified current, Vmax, 23°C	T ≤ max. time to trip (seconds)
Hold Current	30 min. at Ihold	No trip
Trip Cycle Life	Vmax, Imax, 100 cycles	No arcing or burning
Trip Endurance	Vmax, 48 hours	No arcing or burning

UL File Number ....E 174545S
CSA File Number ....CA 110338
TÜV File Number R2057213

Thermal Derating Chart - I_{hold} (Amps)

Model	Ambient Operating Temperature			
	0˚C	23˚C	60˚C	80˚C
MF-SVS170	3.6	1.7	1.3	0.8
MF-SVS175	3.65	1.75	1.35	0.8
MF-SVS210	4.3	2.1	1.5	0.8
MF-SVS230	4.4	2.3	1.65	0.8

I_{trip} is approximately two times I_{hold}.

Applications

- Any battery pack application that requires protection with the lowest possible resistance:
  - Rechargeable battery packs; designed for NiMH and Li-Ion chemical characteristics
  - Cellular / cordless phone rechargeable battery packs
  - Laptop computer battery packs

MF-SVS Series - PTC Resettable Fuses

BOURNS®

Product Dimensions

Model	A		B		C		D		F	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
MF-SVS170	16.0 (0.630)	18.0 (0.709)	4.9 (0.193)	5.5 (0.216)	0.6 (0.024)	0.9 (0.035)	4.1 (0.161)	5.8 (0.228)	3.9 (0.154)	4.1 (0.161)
MF-SVS170N	22.0 (0.866)	24.0 (0.945)	3.6 (0.142)	3.9 (0.153)	0.6 (0.024)	0.9 (0.035)	4.1 (0.161)	5.8 (0.228)	2.4 (0.094)	2.6 (0.102)
MF-SVS175	16.0 (0.630)	18.0 (0.709)	4.9 (0.193)	5.5 (0.216)	0.6 (0.024)	0.9 (0.035)	4.1 (0.161)	5.8 (0.228)	3.9 (0.154)	4.1 (0.161)
MF-SVS175N	22.0 (0.866)	24.0 (0.945)	3.6 (0.142)	3.9 (0.153)	0.6 (0.024)	0.9 (0.035)	4.1 (0.161)	5.8 (0.228)	2.4 (0.094)	2.6 (0.102)
MF-SVS175NL	26.0 (1.024)	28.0 (1.102)	3.6 (0.142)	3.9 (0.153)	0.6 (0.024)	0.9 (0.035)	6.1 (0.240)	7.8 (0.307)	2.4 (0.094)	2.6 (0.102)
MF-SVS210	20.9 (0.823)	23.1 (0.909)	4.9 (0.193)	5.5 (0.216)	0.6 (0.024)	0.9 (0.035)	4.1 (0.161)	5.8 (0.228)	3.9 (0.154)	4.1 (0.161)
MF-SVS210N	30.0 (1.181)	32.0 (1.260)	3.6 (0.142)	3.9 (0.153)	0.6 (0.024)	0.9 (0.035)	4.1 (0.161)	5.8 (0.228)	2.4 (0.094)	2.6 (0.102)
MF-SVS230	20.9 (0.823)	23.1 (0.909)	4.9 (0.193)	5.5 (0.216)	0.6 (0.024)	0.9 (0.035)	4.1 (0.161)	5.8 (0.228)	3.9 (0.154)	4.1 (0.161)
MF-SVS230N	30.0 (1.181)	32.0 (1.260)	3.6 (0.142)	3.9 (0.153)	0.6 (0.024)	0.9 (0.035)	4.1 (0.161)	5.8 (0.228)	2.4 (0.094)	2.6 (0.102)

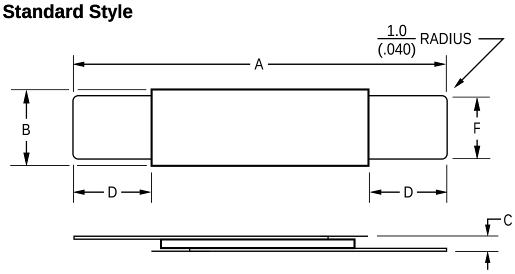
DIMENSIONS = $\frac{MM}{(INCHES)}$

Packaging: Bulk - 500 pcs. per bag. Tape and Reel - Consult factory.

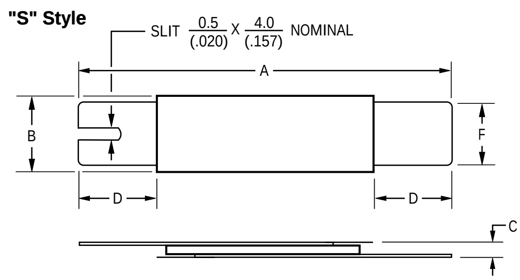
Leads: 1/4 Hardened Nickel 0.125mm (.005") nom.

NOTE: All "S" style models available with 1 or 2 slots. The dimensions and shape of the leads can be modified to suit the battery pack design. All models are available without insulation wrapping.

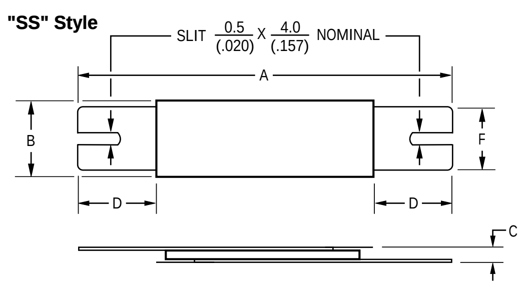
Standard Style



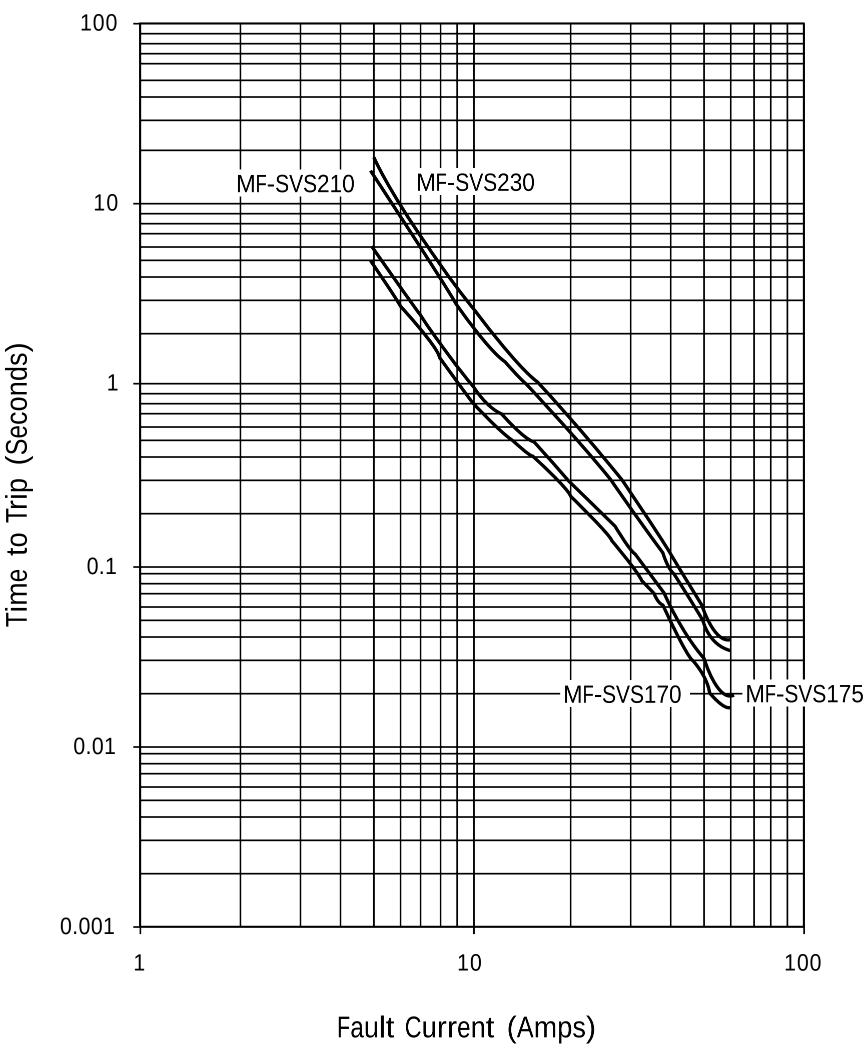
"S" Style



"SS" Style



Typical Time to Trip at 23°C



How To Order

MF - SVS 210 _ _ _ _ - _

Multifuse® Product Designator

Series
SVS = Axial Leaded "Strap" Component

Hold Current, I_{hold}
170-230 (1.70 - 2.30 Amps)

Narrow Device Option
N = Narrow (3.6mm)

Lead Option
S = Slotted Lead Option (one side)
SS = Slotted Lead Option (two sides)

Longer Lead Option
L = Longer Leads

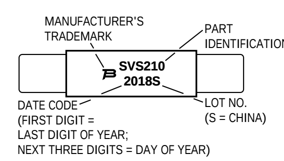
Insulating Option
U = Non-Insulated Option

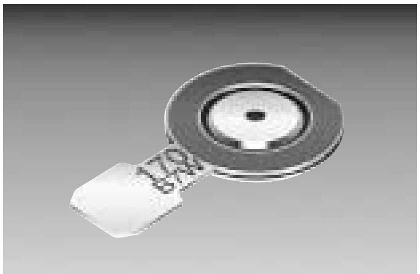
Packaging Option
-0 = Bulk Packaging
-2 = Tape and Reel* (Consult factory)

*Packaged per EIA 486-B

Typical Part Marking

Represents total content. Layout may vary.





Features

- Fast tripping resettable circuit protection
- Low internal resistance
- Patents pending
- Weldable nickel terminals
- Agency recognition:

Applications

- AAA size battery cells

BOURNS®

MF-AAA Series - PTC Resettable Fuses

Electrical Characteristics

Model	V max. Volts	I max. Amps	I_h Rated Current Amps at 23°C	Typical Current Trip Limit Amps at 0°C		Amps at 23°C		Amps at 60°C		Initial Resistance Values Ohms at 23°C		One Hour Post-Trip Resistance Standard Trip Ohms at 23°C	Maximum Time To Trip Seconds at 23°C	Nominal Tripped Power Dissipation Watts at 23°C
			Hold	Hold	Trip	Hold	Trip	Hold	Trip	Min.	R_1 Max.	Max.		
MF-AAA170	15	50	1.7	2.0	4.2	1.7	3.7	1.3	2.5	0.050	0.072	0.120	5 @ 8.5A	1.3
MF-AAA210	15	50	2.1	2.3	5.4	2.1	4.5	1.5	3.4	0.036	0.048	0.086	5 @ 10.5A	1.3

Environmental Characteristics

Operating/Storage Temperature ....-40°C to +85°C
Maximum Device Surface Temperature
in Tripped State ....125°C
Passive Aging...+85°C, 1000 hours ....±5% typical resistance change
Humidity Aging..+85°C, 85% R.H. 7 days ....±5% typical resistance change
Thermal Shock ....+85°C to -40°C, 20 times............................±10% typical resistance change
Solvent Resistance ....MIL-STD-202, Method 215 ....No change
Vibration ....MIL-STD-883C, Method A ....No change
Condition A

Test Procedures And Requirements For Model MF-AAA Series

Test	Test Conditions	Accept/Reject Criteria
Visual/Mech.	Verify dimensions and materials	Per MF physical description
Resistance	In still air @ 23°C	Rmin ≤ R ≤ Rmax
Time to Trip	Vmax, 23°C	T ≤ max. time to trip (seconds)
Hold Current	30 min. at Ihold	No trip
Trip Cycle Life	Vmax, Imax, 100 cycles	No arcing or burning
Trip Endurance	Vmax, 48 hours	No arcing or burning

UL File Number ....E 174545S
CSA File Number ....CA 110338
TÜV File Number R2057213

Thermal Derating Chart - I_{hold} (Amps)

Model	Ambient Operating Temperature								
	-40˚C	-20˚C	0˚C	23˚C	40˚C	50˚C	60˚C	70˚C	85˚C
MF-AAA170	2.45	2.21	2.00	1.70	1.56	1.44	1.30	1.19	1.08
MF-AAA210	2.03	2.20	2.30	2.10	1.90	1.71	1.50	1.37	1.29

*I_{trip} is approximately two times I_{hold}.

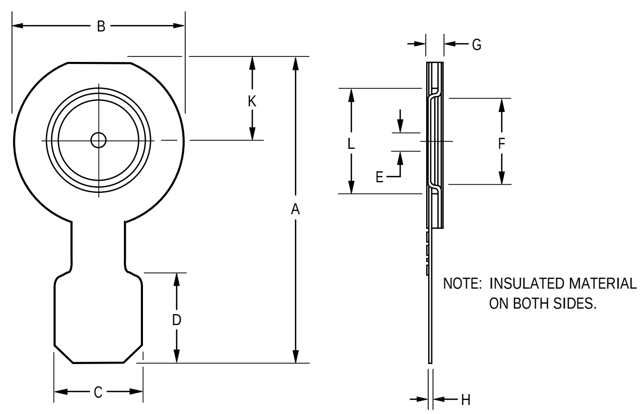
NOTE: Model MF-AAA is agency approved for 10V.

MF-AAA, REV. E, 12/00

Product Dimensions

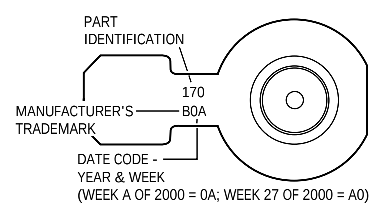
Model	A	B	C	D	E	F	G	H	K	L
MF-AAA170	16.8 ± 0.3 / (.661 ± .012)	9.8 ± 0.1 / (.386 ± .004)	5.0 ± 0.2 / (.197 ± .008)	5.0 ± 0.2 / (.197 ± .008)	1.0 MAX. / (.039 MAX.)	5.00 ± 0.3 / (.197 ± .012)	.90 MAX. / (.035 MAX.)	.15 ± .05 / (.006 ± .002)	4.5 ± 0.2 / (.177 ± .008)	6.0 ± 0.5 / (.236 ± .020)
MF-AAA210	16.8 ± 0.3 / (.661 ± .012)	9.8 ± 0.2 / (.386 ± .012)	5.0 ± 0.2 / (.197 ± .008)	5.0 ± 0.2 / (.197 ± .008)	1.0 MAX. / (.039 MAX.)	5.00 ± 0.3 / (.197 ± .012)	.90 MAX. / (.035 MAX.)	.15 ± .05 / (.006 ± .002)	4.5 ± 0.2 / (.177 ± .008)	5.0 ± 0.5 / (.197 ± .020)

DIMENSIONS = $\frac{\text{MM}}{\text{(IN)}}$



Typical Part Marking

Represents total content. Layout may vary.

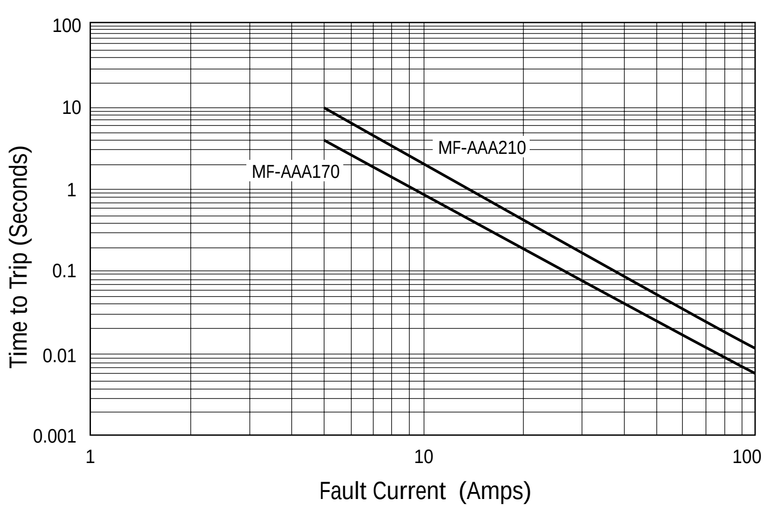


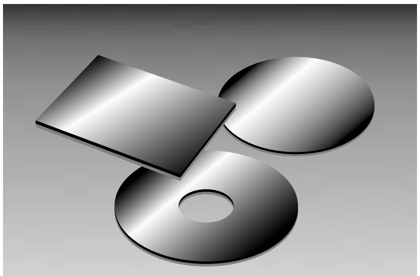
How to Order

MF - AAA 170 - 2

- Multifuse® Product Designator
- Series
  - AAA = Battery Cap Component
- Hold Current, I_{hold}
  - 170 or 210 (1.7 Amps, 2.1 Amps)
- Packaging
  - Packaged per EIA 481-1
  - -2 = Tape and Reel

Typical Time to Trip at 23°C





BOURNS®

Features

- Custom designs to meet appropriate applications
- Compatible with current industry standards
- Overcurrent and overtemperature protection
- Standard and low-temperature material
- Patents pending

Applications

- Lithium cells
- Battery cells
- Powered toys
- Motors

MF-D Series - PTC Resettable Fuses

Multifuse® Products offers a PTC resettable fuse in a disk, square or rectangular configuration for overcurrent protection in various custom applications. These products are specific to customer's design requirements and are designed by Bourns to meet customer requirements. Some typical specification information is listed below. However, all disk products are subject to the end customer verification of the product in the application. **For ordering information, contact your nearest Bourns representative.**

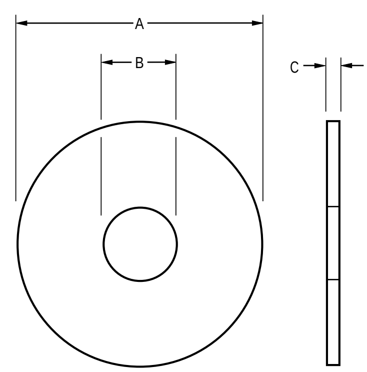
Typical Electrical Characteristics

Model	V max. Volts	I max. Amps	Ihold	Initial Resistance		Max. Time to Trip	
			Amperes at 23°C	Ohms at 23°C		Amperes at 23°C	Seconds at 23°C
			Hold	Min.	Max.		
MF-D*	15	10	2.5	0.015	0.032	5	80
MF-D*	15	20	3.5	0.015	0.032	10	10
MF-D*	15	40	5.5	0.14	0.30	10	5
MF-D*	15	50	12.2	0.007	0.017	15	15

*For ordering information, contact your nearest Bourns representative.

Product Dimensions

Model	A	B	C
MF-D	14.4 / (0.567)	6.3 / (0.248)	0.36 / (0.014) max.
MF-D	16.4 / 0.646)	10 / (0.394)	0.36 / (0.014) max.
MF-D	16.08 / (0.633)	9 / (0.354)	0.36 / (0.014) max.
MF-D	24 / (0.945)	—	0.36 / (0.014) max.



DIMENSIONS = $\frac{\text{MM}}{\text{(INCHES)}}$

TOLERANCE = ± $\frac{0.05}{(.002)}$ TYPICAL

NOTES:

1. Devices are 100% resistance tested.
2. Foil materials are Nickel-coated Copper.
3. Alternative electrical and mechanical parameters are possible. Please contact your local Bourns sales office or representative for details.
4. Operating and storage temperatures: -40 to +85°C.
5. All specifications are at 23°C unless otherwise stated.

MF-D, REV. D, 12/00

Devices taped using EIA468–B/IEC286-2 standards. See table below and Figures 1 and 2 for details.

Dimension Description	IEC Mark	EIA Mark	Dimensions Dimensions	Dimensions Tolerance
Carrier tape width	*W*	*W*	18 (.709)	-0.5/+1.0 (-0.02/+.039)
Hold down tape width		*W4*	5 (.197)	min.
Hold down tape	*W0*		No protrusion	
Top distance between tape edges	*W2*	*W6*	3 (.118)	max.
Sprocket hole position	*W1*	*W5*	9 (.354)	-0.5/+0.75 (-0.02/+0.03)
Sprocket hole diameter	*D0*	*D0*	4 (.157)	±0.2 (±.0078)
Abscissa to plane (straight lead)	*H*	*H*	18.5 (.728)	±3.0 (±.118)
Abscissa to plane (kinked lead)	*H0*	*H0*	16 (.63)	±0.5 (±.02)
Abscissa to top	*H1*	*H1*	32.2 (1.268)	max.
Overall width w/lead protrusion		*C1*	43.2 (1.7)	max.
Overall width w/o lead protrusion		*C2*	42.5 (1.673)	max.
Lead protrusion	*l1*	*L1*	1.0 (.039)	max.
Protrusion of cutout	*L*	*L*	11 (.433)	max.
Protrusion beyond hold tape	*l2*	*l2*	Not specified	
Sprocket hole pitch	*P0*	*P0*	12.7 (0.5)	±0.3 (±.012)
Pitch tolerance			20 seconds	± 1 second
Device pitch: MF-R010 – MF-R160 & MF-R/90			12.7 (0.5)	
Device pitch: MF-R185 – MF-R400			25.4 (1.0)	
Device pitch: MF-RX110 – MF-RX160			12.7 (0.5)	
Device pitch: MF-RX185 – MF-RX375			12.7 (0.5)	
Device pitch: MF-R012/250			25.4 (1.0)	
Tape thickness	*t*	*t*	0.9 (.035)	max.
Tape thickness with splice		*t1*	2.0 (.079)	max.
Splice sprocket hole alignment			0	±0.3 (±.012)
Body lateral deviation	Δh	Δh	0	±1.0 (±.039)
Body tape plane deviation	Δp	Δp	0	±1.3 (±.051)
Lead seating plane deviation	$\Delta P1$	*P1*	0	±0.7 (±.028)
Lead spacing	*F*	*F*	5.08 (0.2)	±0.8 (±.035)
Reel width	*w*	*w*	56 (2.205)	max.
Reel diameter	*d*	*a*	370 (14.57)	max.
Space between flanges less device			4.75 (.187)	±3.25 (±.128)

DIMENSIONS = $\frac{\text{MM}}{\text{(INCHES)}}$

Dimension Description	IEC Mark	EIA Mark	Dimensions			Dimensions Tolerance
Space between flanges less device			4.75 (.187)			±3.25 (±.128)
Arbor hole diameter	*f*	*c*	26 (1.024)			±12.0 (±.472)
Core diameter	*h*	*n*	80 (3.15)			max.
Box			56 (2.2)	372 (14.6)	372 (14.6)	max.
Consecutive missing places			3 maximum			
Empty places per reel			Not specified			

DIMENSIONS = $\frac{\text{MM}}{\text{(INCHES)}}$

Taped Component Dimensions

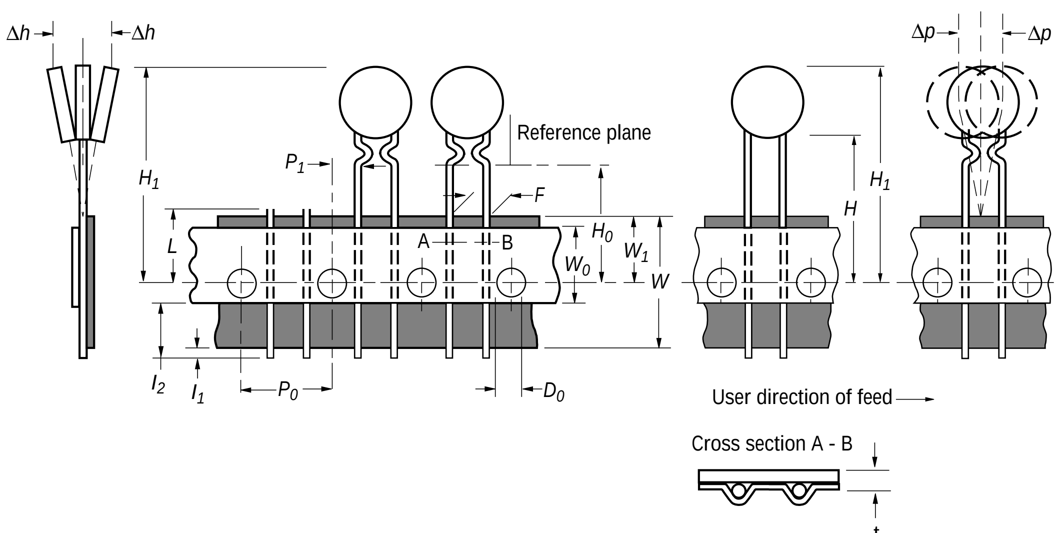


Figure 1

Reel Dimensions

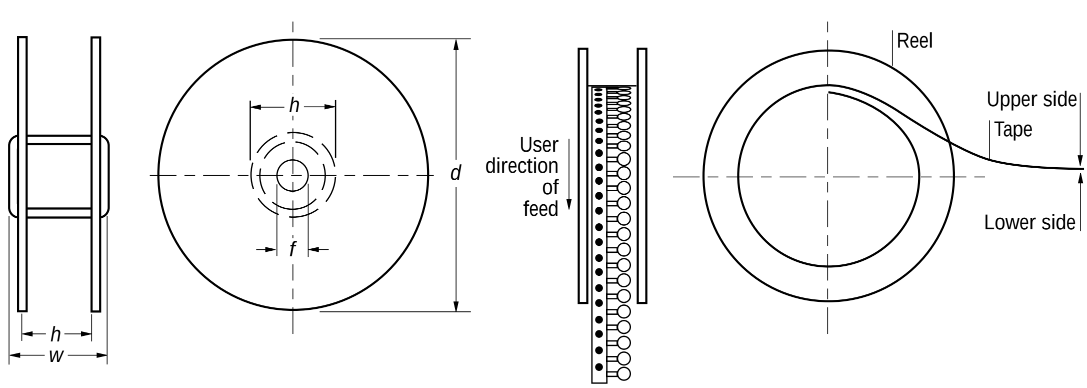


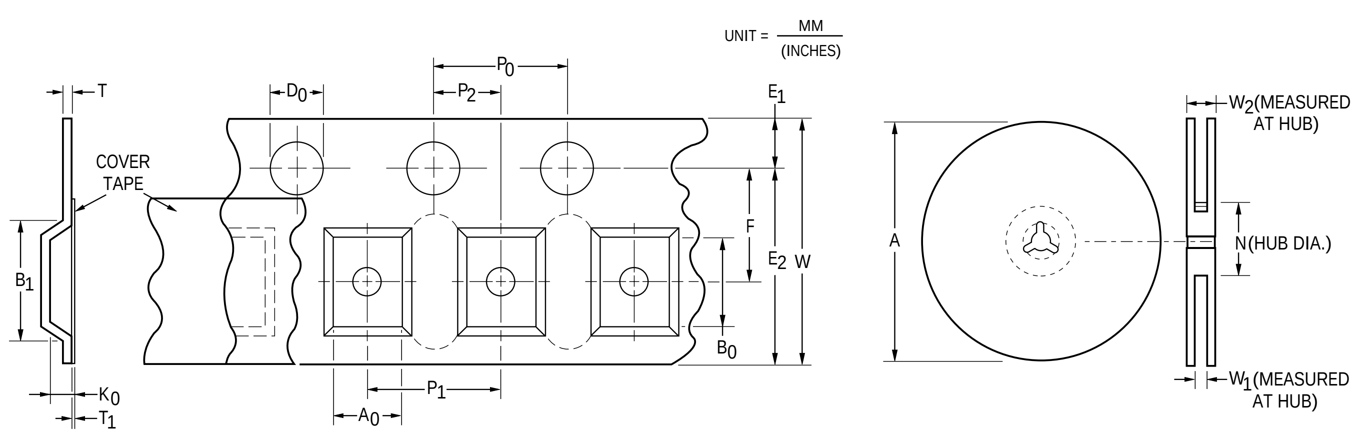
Figure 2

MF-SM, MF-SM/33 & MF-SM/250 Series Tape and Reel Specifications

BOURNS®

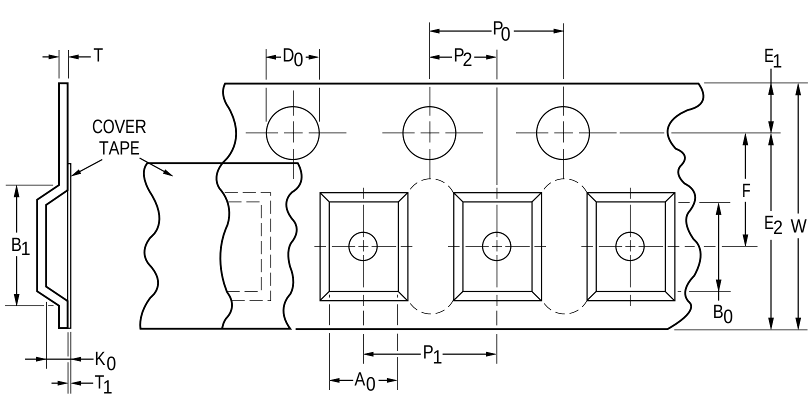
Tape Dimensions	MF-SM030, 050, 075, 100, 125, 260; MF-SM-100/33, per EIA-481-2	MF-SM150, 200, 250; MF-SM-150/33, 185/33; MF-SM013/250 per EIA 481-2
W	16.0 ± 0.3 / (0.630 ± 0.012)	16.0 ± 0.3 / (0.630 ± 0.012)
P_0	4.0 ± 0.1 / (0.157 ± 0.004)	4.0 ± 0.1 / (0.157 ± 0.004)
P_1	8.0 ± 0.1 / (0.315 ± 0.004)	12.0 ± 0.1 / (0.472 ± 0.004)
P_2	2.0 ± 0.1 / (0.079 ± 0.004)	2.0 ± 0.1 / (0.079 ± 0.004)
A_0	5.7 ± 0.1 / (0.224 ± 0.004)	6.9 ± 0.1 / (0.272 ± 0.004)
B_0	8.1 ± 0.1 / (0.319 ± 0.004)	9.6 ± 0.1 / (0.378 ± 0.004)
B_1 max.	12.1 / (0.476)	12.1 / (0.476)
D_0	1.5 + 0.1/-0.0 / (0.059 + 0.004/-0)	1.5 + 0.1/-0.0 / (0.059 + 0.004/-0)
F	7.5 ± 0.1 / (0.295 + 0.004)	7.5 ± 0.1 / (0.295 + 0.004)
E_1	1.75 ± 0.1 / (0.069 ± 0.004)	1.75 ± 0.1 / (0.069 ± 0.004)
E_2 min.	14.25 / (0.561)	14.25 / (0.561)
T max.	0.6 / (0.024)	0.6 / (0.024)
T_1 max.	0.1 / (0.004)	0.1 / (0.004)
K_0	3.4 ± 0.1 / (0.134 ± 0.004)	3.4 ± 0.1* / (0.134 ± 0.004)*
Leader min.	390 / (15.35)	390 / (15.35)
Trailer min.	160 / (6.30)	160 / (6.30)
Reel Dimensions		
A max.	360 / (14.17)	360 / (14.17)
N min.	50 / (1.97)	50 / (1.97)
W_1	16.4 + 2.0/ -0.0 / (0.646 + 0.079/-0)	16.4 + 2.0/ -0.0 / (0.646 + 0.079/-0)
W_2 max.	22.4 / (0.882)	22.4 / (0.882)

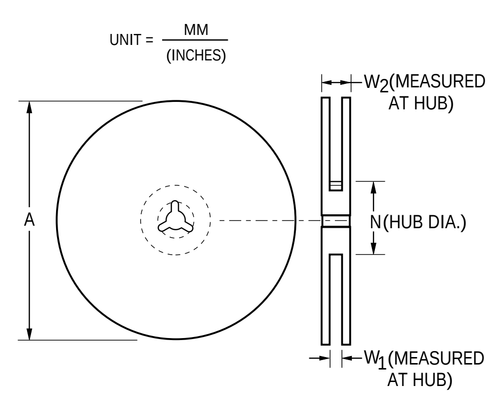
* Model MF-SM013/250 = 3.8 ± 0.1 / (0.150 ± 0.004)



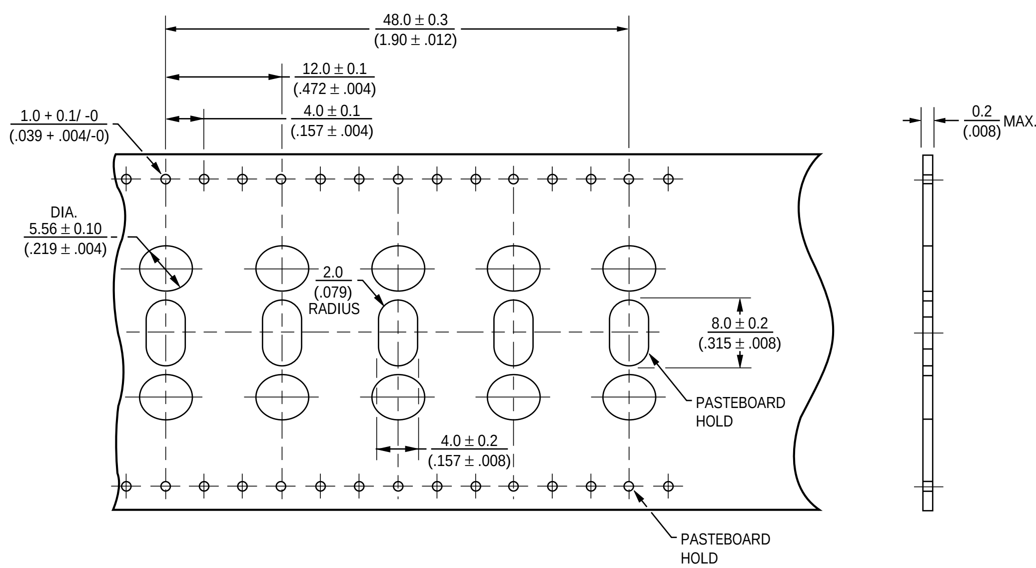
Specifications are subject to change without notice.

Tape Dimensions	MF-MSMD Series per EIA-481-1	MF-USMD Series per EIA 481-1	MF-ESMD Series per EIA 481-2
W	12.0 ± 0.30 (0.472 ± 0.012)	8.0 ± 0.30 (0.315 ± 0.012)	24.0 ± 0.3 (0.945 ± 0.012)
P_0	4.0 ± 0.10 (0.157 ± 0.004)	4.0 ± 0.10 (0.157 ± 0.004)	4.0 ± 0.1 (0.157 ± 0.004)
P_1	8.0 ± 0.10 (0.315 ± 0.004)	4.0 ± 0.10 (0.157 ± 0.004)	8.0 ± 0.1 (0.315 ± 0.004)
P_2	2.0 ± 0.05 (0.079 ± 0.002)	2.0 ± 0.05 (0.079 ± 0.002)	2.0 ± 0.1 (0.079 ± 0.004)
A_0	3.66 ± 0.15 (0.144 ± 0.006)	MF-USMD005,010,020: 2.76 ± 0.10 (0.109 ± 0.004) MF-USMD035,050,075,110: 2.93 ± 0.15 (0.115 ± 0.006)	5.65 ± 0.1 (0.222 ± 0.004)
B_0	4.98 ± 0.10 (0.196 ± 0.004)	MF-USMD005,010,020: 3.5 ± 0.1 (0.138 ± 0.004) MF-USMD035,050,075,110: 3.56 ± 0.1 (0.140 ± 0.004)	11.86 ± 0.1 (0.467 ± 0.004)
B_1 max.	5.9 (0.232)	4.35 (0.171)	20.1 (0.791)
D_0	1.5 + 0.10/-0.00 (0.059 + 0.004/-0)	1.50 + 0.1/-0.0 (0.059 + 0.004/-0)	1.5 + 0.1/-0.0 (0.059 + 0.004/-0)
F	5.5 ± 0.05 (0.217 ± 0.002)	3.5 ± 0.05 (0.138 ± 0.002)	11.5 ± 0.10 (0.453 ± 0.004)
E_1	1.75 ± 0.10 (0.069 ± 0.004)	1.75 ± 0.10 (0.069 ± 0.004)	1.75 ± 0.10 (0.069 ± 0.004)
E_2 min.	10.25 (0.404)	6.25 (0.246)	22.25 (0.876)
T max.	0.6 (0.024)	0.6 (0.024)	0.6 (0.024)
T_1 max.	0.1 (0.004)	0.1 (0.004)	0.1 (0.004)
K_0	0.95 ± 0.10 (0.037 ± 0.004)	MF-USMD005,010,020: 1.07 ± 0.10 (0.042 ± 0.004) MF-USMD035,050,075,110: 0.75 ± 0.10 (0.030 ± 0.004)	0.85 ± 0.1 (0.033 ± 0.004)
Leader min.	390 (15.35)	390 (15.35)	390 (15.35)
Trailer min.	160 (6.30)	160 (6.30)	160 (6.30)
Reel Dimensions			
A max.	185 (7.28)	185 (7.28)	360 (14.17)
N min.	50 (1.97)	50 (1.97)	60 (2.36)
W_1	12.4 + 2.0/-0.0 (0.488 + 0.079/-0.0)	8.4 + 1.5/-0.0 (0.331 + 0.059/-0)	24.4 + 2.0/ -0.0 (0.961 + 0.079/-0.0)
W_2 max.	18.4 (0.724)	14.4 (0.567)	30.4 (1.20)

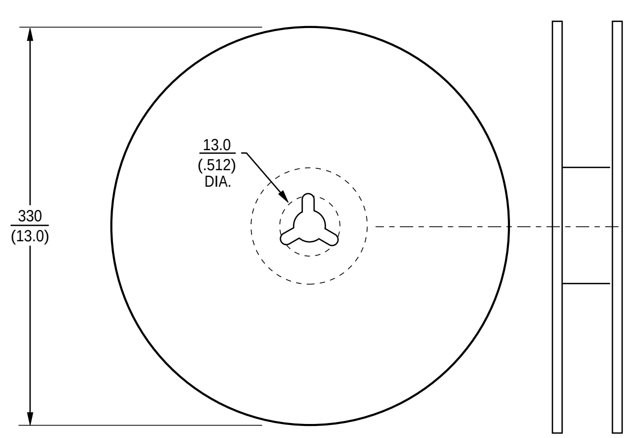




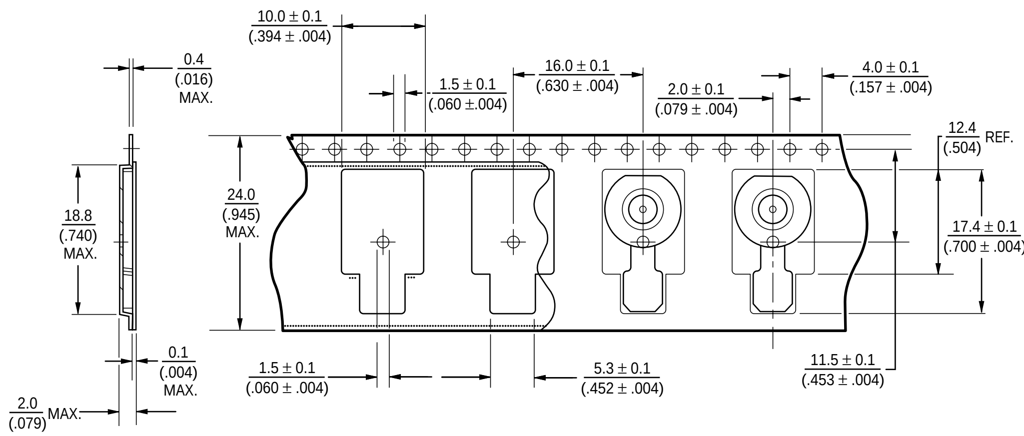
Taped Component Dimensions



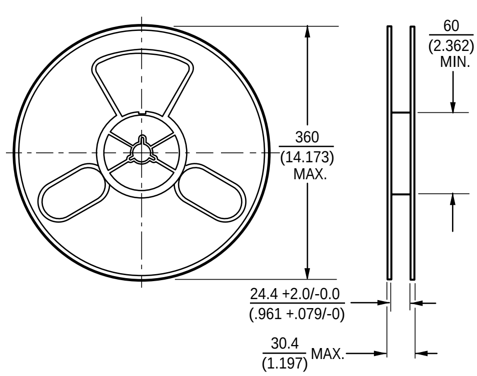
Reel Dimensions



Taped Component Dimensions



Reel Dimensions



Radial Leaded Model MF-R and MF-RX Series

Raychem PolySwitch® Model No.	Bourns Multifuse® Model No.	Maximum Voltage (V)	Maximum Current (A)
RXE010	**MF-R010**	60	40
RXE017	**MF-R017**	60	40
RXE020	**MF-R020**	60	40
RXE025	**MF-R025**	60	40
RXE030	**MF-R030**	60	40
RXE040	**MF-R040**	60	40
RXE050	**MF-R050**	60	40
RXE065	**MF-R065**	60	40
RXE075	**MF-R075**	60	40
RXE090	**MF-R090**	60	40
RXE110	**MF-RX110**	60	40
RXE135	**MF-RX135**	60	40
RXE160	**MF-RX160**	60	40
RXE185	**MF-RX185**	60	40
RXE250	**MF-RX250**	60	40
RXE300	**MF-RX300**	60	40
RXE375	**MF-RX375**	60	40
RUE090	**MF-R090-0-9**	30	40
RUE110	**MF-R110**	30	40
RUE135	**MF-R135**	30	40
RUE160	**MF-R160**	30	40
RUE185	**MF-R185**	30	40
—	**MF-R250***	30	40
RUE250**	**MF-R250-0-10****	30	40
RUE300	**MF-R300**	30	40
RUE400	**MF-R400**	30	40
RUE500	**MF-R500**	30	40
RUE600	**MF-R600**	30	40
RUE700	**MF-R700**	30	40
RUE800	**MF-R800**	30	40
RUE900	**MF-R900**	30	40

* with 20AWG wire
** with 24 AWG wire

Surface Mount Model MF-SM and MF-SM/33 Series

Raychem PolySwitch® Model No.	Bourns Multifuse® Model No.	Maximum Voltage (V)	Maximum Current (A)
SMD030	**MF-SM030**	60	10
SMD050	**MF-SM050**	30	10
SMD075	**MF-SM075**	30	40
SMD100	**MF-SM100**	15	40
SMD125	**MF-SM125**	15	40
SMD150	**MF-SM150**	15	40
SMD200	**MF-SM200**	15	40
SMD250	**MF-SM250**	15	40
SMD260	**MF-SM260**	6	40
SMD100/33	**MF-SM100/33**	33	40
SMD150/33	**MF-SM150/33**	33	40
SMD 185/33	**MF-SM185/33**	33	40

Surface Mount Model MF-USMD Series

Raychem PolySwitch® Model No.	Bourns Multifuse® Model No.	Maximum Voltage (V)	Maximum Current (A)
microSMDC005	**MF-USMD005**	30	10
microSMDC010	**MF-USMD010**	30	10
microSMDC035	**MF-USMD035***	6.0	40
microSMDC050	**MF-USMD050**	13.2	40
microSMDC075	**MF-USMD075**	6.0	40
microSMDC110	**MF-USMD110**	6.0	40

Surface Mount Model MF-MSMD Series

Raychem PolySwitch® Model No.	Bourns Multifuse® Model No.	Maximum Voltage (V)	Maximum Current (A)
miniSMDC010	**MF-MSMD010**	60	10
miniSMDC014	**MF-MSMD014**	60	10
miniSMDC020	**MF-MSMD020***	30	10
miniSMDC050	**MF-MSMD050***	15.0	40
miniSMDC075	**MF-MSMD075***	13.2	40
miniSMDC110	**MF-MSMD110**	6.0	40
miniSMDC125	**MF-MSMD125**	6.0	40
miniSMDC150	**MF-MSMD150**	6.0	40
miniSMDC160	**MF-MSMD160S**	10.0	40
miniSMDC200	**MF-MSMD200**	6.0	40
miniSMDC260	**MF-MSMD260**	6.0	40

*Please see Multifuse® data sheet for exact specifications.

Surface Mount Model MF-ESMD Series

Raychem PolySwitch® Model No.	Bourns Multifuse® Model No.	Maximum Voltage (V)	Maximum Current (A)
PSR23550	**MF-ESMD190**	16	100

Radial Leaded Telecom Model MF-R/90 Series

Raychem PolySwitch® Model No.	Bourns Multifuse® Model No.	Maximum Voltage (V)	Maximum Current (A)
BBR550	**MF-R055/90**	90	10
—	**MF-R055/90U**	90	10
BBR750	**MF-R075/90**	90	10

Radial Leaded Telecom Model MF-R/250 Series

Raychem PolySwitch® Model No.	Bourns Multifuse® Model No.	Maximum Voltage (V)	Maximum Current (A)
TR250-080U	**MF-R008/250U****	60	3
TR250-080	**MF-R008/250-B10****	60	3
TR250-110	**MF-R011/250U****	60	3
TR250-120	**MF-R012/250****	60	3
TR250-120U	**MF-R012/250U****	60	3
TR250-120U-B-0.5	**MF-R012/250U-B05****	60	3
TR250-120T-RF-B-0.5	**MF-R012/250-F05****	60	3
TR250-120-R1-B-0.5	**MF-R012/250-105****	60	3
TR250-120-R2-B-0.5	**MF-R012/250-205****	60	3
TR250-145	**MF-R014/250****	60	3
TR250-145U	**MF-R014/250U****	60	3
TR250-145-RA-B-0.5	**MF-R014/250U-B05****	60	3
TR250-180U	**—**	60	3

Surface Mount Telecom Model MF-SM013/250 Series

Raychem PolySwitch® Model No.	Bourns Multifuse® Model No.	Maximum Voltage (V)	Maximum Current (A)
TS250-130A-2	**MF-SM013/250-2***	60	3
TS250-130A-RA-2	**MF-SM013/250-A-2***	60	3
TS250-130A-RB-2	**MF-SM013/250-B-2***	60	3
TS250-130A-RC-B-0.5-2	**MF-SM013/250-C05-2***	60	3

*Please see Multifuse® Series data sheet for exact specifications.
**Nearest Bourns part number. May require engineering approval.

Axial Leaded Battery Strap Model MF-S and MF-LS Series

Raychem PolySwitch® Model No.	Bourns Multifuse® Model No.	Maximum Voltage (V)	Maximum Current (A)
SRP120	**MF-S120**	15	100
SRP120S	**MF-S120S**	15	100
—	**MF-S150**	15	100
SRP175	**MF-S175**	15	100
SRP175S	**MF-S175S**	15	100
SRP200	**MF-S200**	30	100
SRP350	**MF-S350**	30	100
SRP420	**MF-S420**	30	100
LTP070	**MF-LS070**	24	100
LTP070S	**MF-LS070S**	24	100
LTP100	**MF-LS100**	24	100
LTP100S	**MF-LS100S**	24	100
LTP180	**MF-LS180**	24	100
LTP180L	**MF-LS180L**	24	100
LTP180S	**MF-LS180S**	24	100
LTP190	**MF-LS190**	24	100
LTP190R-U	**MF-LS190RU**	15	100
LTP260	**MF-LS260**	24	100
LTP300	**MF-LS300**	24	100
LTP340	**MF-LS340**	24	100

Axial Leaded Battery Strap Model MF-LR, MF-VS and MF-VSN Series

Raychem PolySwitch® Model No.	Bourns Multifuse® Model No.	Maximum Voltage (V)	Maximum Current (A)
LR4-190	**MF-LR190**	15	100
LR4-190S	**MF-LR190S**	15	100
LR4-260	**MF-LR260**	15	100
LR4-260S	**MF-LR260S**	15	100
LR4-380	**MF-LR380**	15	100
LR4-450	**MF-LR450****	20	100
LR4-550	**MF-LR550****	20	100
LR4-600	**MF-LR600****	20	100
LR4-730	**MF-LR730****	20	100
VTP170	**MF-VS170**	16	100
VTP170SS	**MF-VS170SS**	16	100
VTP210G	**MF-VS210**	16	100
VTP210L	**MF-VS210L**	16	100
VTP210S	**MF-VS210S**	16	100
VTP210SL	**MF-VS210SL**	16	100
VTP210SS	**MF-VS210SS**	16	100
VTP240	**MF-VS240**	16	100
VTP240SU	**MF-VS240SU**	16	100
VTP175	**MF-VS175NL**	12	100
VTP175U	**MF-VS175NU**	12	100

*Nearest Bourns part number. May require engineering approval.
** Consult factory for availability.

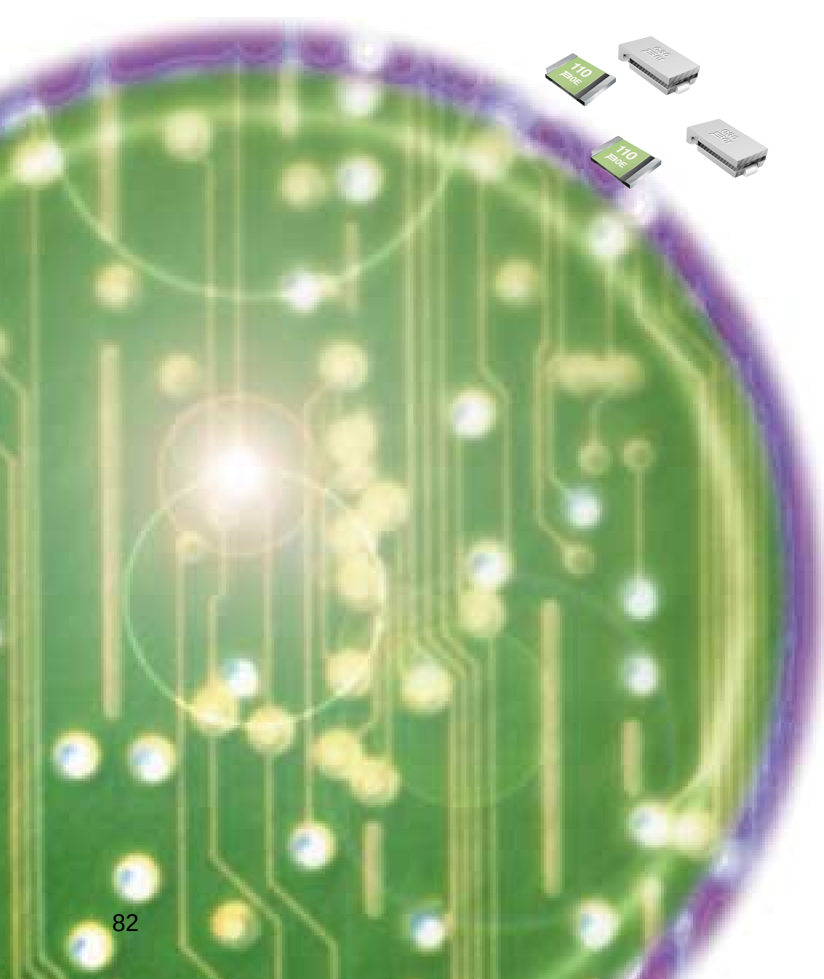
Battery Cap Model MF-AAA Series

Raychem PolySwitch® Model No.	Bourns Multifuse® Model No.	Maximum Voltage (V)	Maximum Current (A)
TAC170-09	**MF-AAA170**	15	50
TAC210	**MF-AAA210**	15	50

The most important consideration in reliability is achieving a good solder bond between a surface mount device (SMD) and substrate since the solder provides the thermal path from the chip. A good bond is less subject to thermal fatiguing and will result in improved device reliability.

The most economical method of soldering is a process in which all components are soldered simultaneously.

The Multifuse® device's material is a conductive filled polymer. In normal operation, the conductive particles in the polymer form a continuous path, which allows current to flow through the device without interruption. Typical base resistance of the device is hundreds of milliohms. When there is an overload condition, the polymer heats up internally from IΛ2R heating. When the polymer heats up to approximately 100-125°C, its molecular structure changes from semi-crystalline to amorphous. This causes a macroscopic expansion, which breaks the conductive paths. When the conductive paths are broken there is a large increase in resistance - typically several orders of magnitude. At this point, the device is in the "tripped state".



Upon cooling, the polymer reforms to its semi-crystallized state and the conductive pathways are reestablished. However, when the polymer recrystallizes it does not return immediately to the same base resistance. It does not compact as tightly as when it was pre-tripped, and therefore the post trip resistance is typically 50% higher then the initial resistance. Note the post trip resistance increase is not a cumulative effect; additional tripping will not cause increases in resistance in excess of the first trip. Further resistance recovery is possible if the device is conditioned by actively current cycling the device or passively heating the device below 85°C. Figure 1 shows the change in resistance under temperature cycling or environmental cycling. This process is similar to an environmental burn in process, which is done by many circuit board manufacturers. Over a short number of cycles, the resistance typically decreases from 1.8 to 1.5 times the initial resistance.

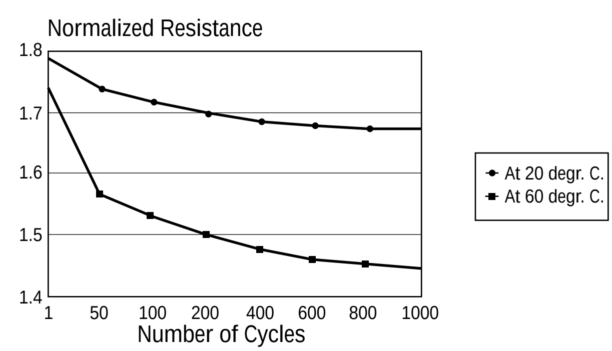


Figure 1:
Resistance recovery after passive conditioning

Reflow of Soldering

The preferred technique for mounting micro-miniature components on hybrid thick-and thin-film is the method of reflow soldering. In a reflow process, the solder paste is put on the component sites of the printed circuit board. Then the components are put on the board on the top of the solder paste. Often, a separate adhesive is used to hold the device in place until soldering takes place. The board and attached components are then heated to activate the flux, elevate the temperature of the base metals, and melt (or reflow) the solder.

Recommended substrates: Alumina or PC Board material.

Recommended metallization: Silver palladium or molymanaganese (plated with nickel or other elements to enhance solderability).

It is best to prep the substrate by either dipping the substrate in a solder bath or by screen-printing solder paste.

After the substrate is prepared, devices are placed in position with vacuum pencils. The device may be placed without special alignment procedures due to its self-aligning properties during the solder reflow process and will be held in place by surface tension.

For reliable connections, the following should be adhered to:

1. The maximum temperature of the leads or tab during the soldering cycle does not exceed 260°C.

2. The flux must affect neither components nor connectors.

3. The residue of the flux must be easily removed.

Having first been fluxed, all components are positioned on the substrate. The slight adhesive force of the flux is sufficient to keep the components in place.

Solder paste contains a flux and, therefore, has good inherent adhesive properties, which eases positioning of the components. Allow flux to dry at room temperature or in a 70°C oven. Flux should be dry to the touch.

With the components in position, the substrate is heated to a point where the solder begins to turn to an amorphous state. This can be done on a heating plate, on a conveyor belt running through an infrared tunnel, or by using vapor phase soldering.

In the vapor phase soldering process, the entire PC board is uniformly heated within a vapor phase zone at a temperature of approximately 200°C. The saturated vapor phase zone is obtained by heating an inert (inactive) fluid to the boiling point. The vapor phase is locked in place by a secondly vapor (See Figure 2). Vapor phase soldering provides uniform heating and prevents overheating.

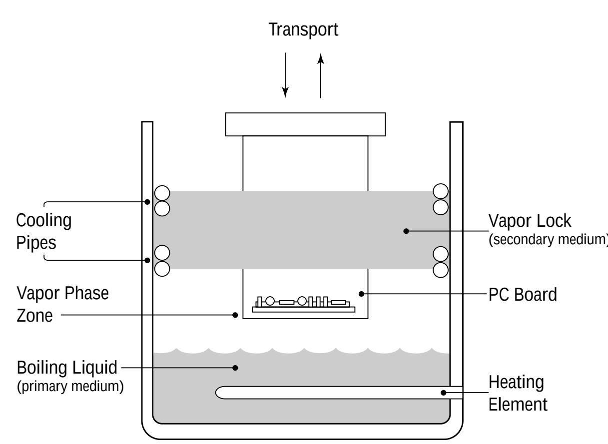


Figure 2
Principle of Vapor Phase Soldering

No matter which method of heating is used, the maximum allowed temperature must not exceed 250°C during the soldering process. For further temperature behavior during the soldering process, see Figure 3.

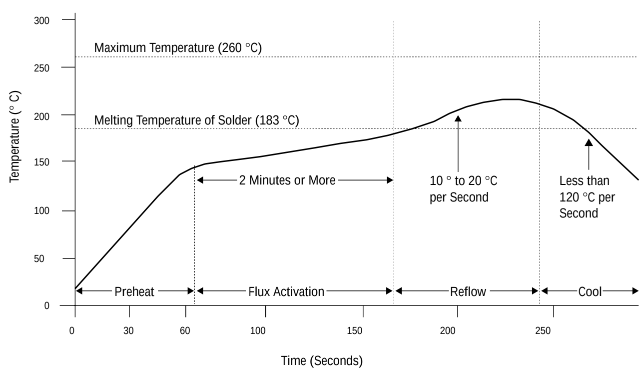


Figure 3

Reflow Soldering Profile

Reflow Soldering Regions

Region 1: Pre-heating Stage (23-150°C)

- Solvent is driven off.
- PCB and components are gradually heated up.
- Temperature gradient shall be <2.5°C/Sec.
- Pre-heating time is 30 to 90 seconds.

Region 2: Pre-heating to Reflow Stage (150-200°C)

- Flux components start activation and begin to reduce the oxides on component leads and PCB pads.
- PTCs are brought nearer to the temperature at which solder bonding can occur.
- Activated flux keeps metal surfaces from re-oxidizing.

Region 3: Reflow Stage (200-260°C)

- Paste is brought to the alloy's melting point.
- Activated flux reduces surface tension at the metal interface so metallurgical bonding occurs.

Region 4: Cool Down Stage (260-25°C)

- Assembly is cooled evenly so thermal shock to the PTCs or PCB is reduced.

The surface tension of the liquid solder tends to draw the leads of the device towards the center of the soldering area and has a correcting effect on slight mispositions. However, if the layout leaves something to be desired, the same effect can result in undesirable shifts; particularly if the soldering areas on the substrate and the components are not concentrically arranged. This problem can be solved using a standard contact pattern, which leaves sufficient scope for the self-positioning effect.

After the solder has set and cooled, the connections are visually inspected. Finally, the remnants of the flux must be removed carefully.

Use vapor degrease with an azeotrope solvent or equivalent to remove flux. Allow to dry.

After drying procedure is complete, the assembly is ready for testing and/or further processing.

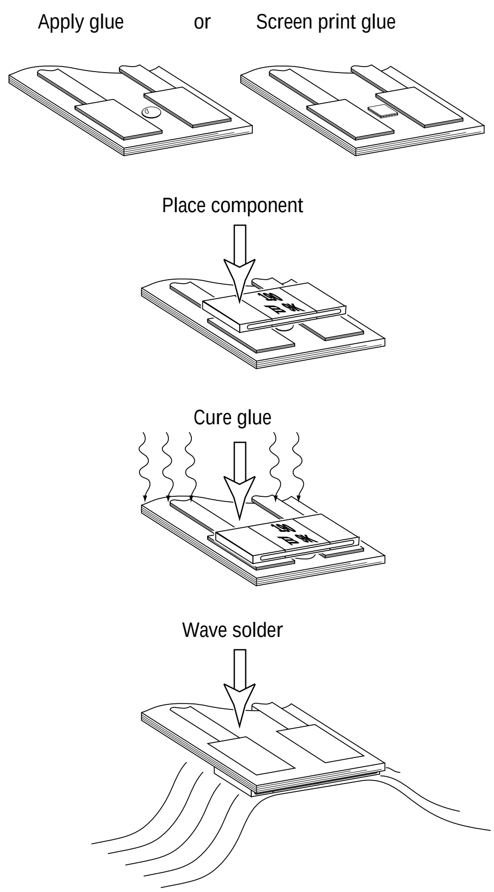


Figure 4
Reflowing Solder

Wave Soldering*

One of the benefits of surface mount technology is that devices can be mounted to both top and bottom sides of the printed circuit board. During wave soldering, components on the underneath side are actually immersed into the hot molten solder. The plastic-metal interface can be affected if left for more than 5 seconds. Most wave soldering operations occur at temperatures between 240°C to 260°C. Epoxies used for semiconductor encapsulation have glass transition temperatures between 140°C to 170°C. An integrated circuit exposed to these temperatures can risk long term functionality and reliability. However, with topside mounting (as used for DIPs) there are some factors that reduce the risk.

1) Only the tips of the leads are exposed to the solder temperature.

2) The printed circuit board acts as a heat sink and also shields the components from the temperature of the solder. Actual measurements on DIPs show that they are exposed to a temperature between 120°C to 150°C in a 5-second pass through the solder wave. This accounts for the fact that packages mounted in the conventional manner (topside only) are very reliable.

Wave soldering requires the use of fluxes to assist solderability of the components to the circuit board. In some instances, the boards and components are processed through acid cleaning prior to passing through the wave. If epoxy-metal separation has occurred, the flux and acid residues (which may be present due to inadequate cleaning) will be forced into the separation mainly by capillary action as they move away from the solder heat source. Once the package is cooled, these contaminants are now trapped inside the package and are able to diffuse with available moisture over time. It should be stressed that electrical tests performed immediately after soldering generally will give no indication of this potential problem. As time passes, however, the end result will be corrosion of the chip metallization and premature failure of the device in the field. Procedures for wave soldering PCBs with

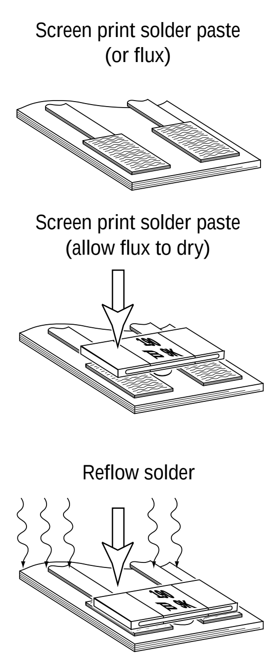


Figure 5
Wave Soldering PCBs
With Surface Mount
Devices Only

*Do not wave solder the body of the PPTC.

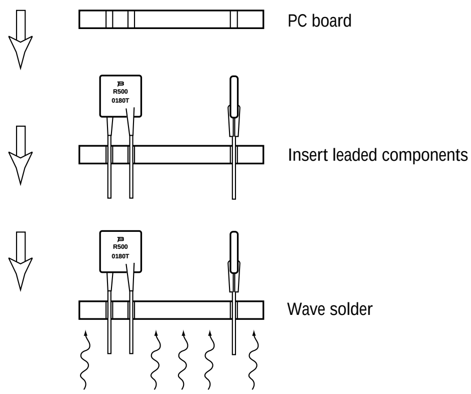


Figure 6
Wave Soldering PCBs
With Both Surface Mount
and Leaded Components

(a) surface mount devices only, and (b) both surface mount and leaded components are shown in Figures 5 and 6.

Hand Soldering

It is possible to solder the devices with a miniature hand-held soldering iron, but this method has particular drawbacks and should, therefore, be restricted to laboratory use and/or incidental repairs on production circuits. It is difficult to control the amount of heat generated and transferred to the PTC.

Pre-Heating

Pre-heating is recommended for good soldering and avoiding damage to the devices, other components and the substrate. Maximum pre-heating temperature is 160°C while the maximum pre-heating duration may be 10 seconds. However, atmospheric pre-heating is permissible for several minutes provided temperature does not exceed 125°C.

There are three different ways to preheat the printed circuit board: electric heaters, convection heating process and infrared heating process. Cost, space and personal preference are some of the parameters used when deciding which method works best in your situation.

Gluing Recommendations

Prior to wave soldering, surface mount devices (SMD) must be fixed to the PCB or substrate by means of an appropriate adhesive. The adhesive (in most cases, a multicomponent adhesive) has to fulfill the following demands:

- Uniform viscosity to ensure easy coating.
- No chemical reactions upon hardening, in order not to deteriorate the component and PC board.
- Straightforward exchange of components in case of repair.

Cleaning Recommendations

PC board or substrate cleaning in solvents is permitted at approximately 70°C to 80°C.

The soldered parts should be cleaned with azeotrope solvent followed by a solvent such as method, thhyl, or isopropyl alcohol.

Ultrasonic cleaning of surface mount components on PCBs or substrates is possible.

The following parameters are recommended when using ultrasonic cleaning:

- Cleaning agent: Isopropanol
- Bath temperature: approximately 30°C
- Duration of cleaning: maximum 30 sec.
- Ultrasonic frequency: 40 kHz
- Ultrasonic changing pressure: approximately 0.5 bar

Cleaning of the parts is best accomplished using an ultrasonic cleaner, which has approximately 20 watts of output per one liter of solvent. The solvent should be replaced on a regular basis.

Dip Soldering

This is very similar to wave soldering, but is a hand operation. The same considerations as above should be followed, particularly the time-temperature cycle, which may become operator dependent. Due to the wide process variations that may occur, this method is not recommended.

Definitions:

Agency Approvals - PTCs are recognized under the Component Program of Underwriters Laboratories to UL Thermistor Standard 1434. The devices have also been certified under the CSA Component Acceptance Program. Approvals for fuses include recognition under the Component Program of Underwriters Laboratories and the CSA Component Acceptance Program.

Ambient Temperature - Refers to the temperature of the air immediately surrounding the fuse and is not to be confused with "room temperature." The fuse ambient temperature is appreciably higher in many cases, because it is enclosed (as in a panel mount fuseholder) or mounted near other heat producing components, such as resistors, transformers, etc.

Amorphous - Without crystallization in the ultimate texture of a solid substance. Used to describe the material structure in the tripped state of a Multifuse device.

Ampere - The SI unit of measure for electrical current. The unit of electrical current or rate of flow of electrons. 1 ampere = 1 coulomb of charge/second.

Carbon Black - A conductive material used in Multifuse devices to provide a path for current flow under normal operating conditions.

Conductive Plastic - A plastic material, such as a polymer, containing conductive particles, such as carbon black, that provide a path for current flow.

Current - The flow of electric charge that transports energy from one place to another. Measured in amperes, where one ampere is the flow of 6.25 x10^18 electrons (or protons) per second.

Current, Hold (I_{hold}) - The maximum current a Multifuse device can pass without interuption.

Current, Maximum (I_{MAX}) - The maximum fault current a Multifuse device can withstand without damage at the rated voltage.

Current Rating - The nominal amperage value marked on the fuse. It is established by the manufacturer as a value of current which the fuse can be loaded to, based on a controlled set of test conditions (see Rerating).

Current, Trip (I_{trip}) - The minimum current that will switch a device from the low resistance to the high resistance state.

Date Code - A number used to let the manufacturer know the date the part was fabricated as well as the plant location.

Derating - Fuses are essentially temperature-sensitive devices. Even small variations from the controlled test conditions can greatly affect the predicted life of a fuse when it is loaded to its nominal value, usually expressed as 100% of rating. The fuse temperature generated by the current passing through the fuse increases or decreases with ambient temperature change.

Electrode - A device or material that emits or controls the flow of electricity. Nickel and Copper elements are used in Multifuse devices to aid even distribution of current across the surface of the device.

Fault Current - The peak current that flows through a device or wire during a short circuit or arc back.

Flux - A material used to promote the joining of metals in soldering. Rosin is widely used in soldering electronic parts.

Form Factor - The package that holds the chemical make-up of polymer and carbon. PPTCs are packaged in the following forms; radial, axial, surface mount chips, disks, and washers.

Fuse - A current limiting device used for protection of equipment as well as personnel. Typically a wire or chemical compound which breaks a circuit when the current exceeds a rated value.

Fuse Resistance - The resistance of a fuse is usually an insignificant part of the total circuit resistance. Since the resistance of fractional amperage fuses can be several ohms, this fact should be considered when using them in low-voltage circuits. Most fuses are manufactured from materials which have positive temperature coefficients, and therefore, it is common to refer to cold resistance and hot resistance (voltage drop at rated current), with actual operation being somewhere in between. The factory should be consulted if this parameter is critical to the design analysis. Resistance data on all of our fuses is available on request.

Hysteresis - The period between the actual beginning of the signaling of the device to trip and the actual tripping of the device.

Interrupting Rating - Also known as breaking capacity or short circuit rating, the interrupting rating is the maximum approved current which the fuse can safely interrupt at rated voltage. During a fault or short circuit condition, a fuse may receive an instantaneous overload current many times greater than its normal operating current. Safe operation requires that the fuse remain intact (no explosion or body rupture) and clear the circuit.

Leakage Current - An undesirable small value of stray current that flows through a device after the device has changed state to a high resistance mode.

Let through Current - The amount of current though a circuit after a device is signaled to trip and the device is at full operation limiting current.

Maximum Fault Current - The Interrupting Rating of a fuse must meet or exceed the Maximum Fault Current of the circuit.

Ohm - The SI unit of measure for electrical resistance. 1 ohm = 1 Volt/1 ampere.

Ohm's Law - The current in a circuit varies in direct proportion to the potential difference or emf and in inverse proportion to resistance. Current = Voltage/ Resistance. A potential difference of 1 volt across a resistance of 1 ohm produces a current of 1 ampere.

Overload Current Condition - The current level for which protection is required. Fault conditions may be specified, either in terms of current or, in terms of both current and maximum time the fault can be tolerated before damage occurs. Time-current curves should be consulted to try to match the fuse characteristic to the circuit needs, while keeping in mind that the curves are based on average data.

Polymer - a synthetic plastic material consisting of large molecules made up of a linked series of repeated simple monomers. The insulating medium used in Multifuse devices which maintains the carbon chains in suspension during overcurrent while permitting the carbon chains to form during normal operation.

Polymeric Positive Temperature Coefficient (PPTC) - A characteristic of Multifuse devices that describes a large increase in resistance as the device reaches its trip temperature.

Power - The ratio of energy per time. Power is measure in Watts, and Joules. Power = Current x Voltage. Where 1 amp x 1 volt = 1 watt.

Power Dissipation (P_d) - Power dissipated from the device while in the tripped state.

Power Surge - A sudden series of pulses or spikes in the voltage or current of a circuit. The circuit is usually protected against power surges.

Pulses - The general term "pulses" is used in this context to describe the board category of wave shapes referred to as "surge currents", "start-up currents", "inrush currents", and "transients". Electrical pulse conditions can vary considerably from one application to another. Different fuse constructions may not all react the same to a given pulse condition. Electrical pulses produce thermal cycling and possible mechanical fatigue that could affect the life of the fuse. The start-up pulse should be defined and then compared to the time-current curve and l2t rating for the fuse. Nominal melting l2t is a measure of the energy required to melt the fusing element and is pressed as "Ampere Squared Seconds" (A2 Sec.).

Resistance - A property of conductors which – depending on their material, dimensions, and temperature – determines the current produced by a given difference of potential.

Resistance, Initial (R_{Min} - R_{Max}) - The resistance range of the Multifuse devices, as received from the factory.

Resistance, Post Trip (R_{1max}) - The maximum post-trip resistance one hour after a Multifuse device has been tripped and power has been removed.

Resistance, Post Reflow (R_{1max}) - The maximum resistance one hour after a Multifuse surface mount device has been reflow soldered.

Short Circuit - An abnormal connection of relatively low resistance between two points of a circuit. The result is a flow of excess (often damaging) electrons (current) between these points.

Solder - A lead and tin alloy that melts at a low temperature and is used to make electrical connections.

Solderability - In a printed circuit board, the measure of the ability of the conductive pattern to be wetted by solder.

Soldering Recommendations - Since most fuse constructions incorporate soldered connections, caution should be used. The applications of excessive heat can reflow the solder within the fuse and change its rating. Fuses are heat-sensitive components similar to semiconductors, and the use of heat sinks during soldering is often recommended.

Spike - A short abrupt high jump, which exceeds the amplitude of a pulse.

Substrate - The mixture of polymer and carbon, which is placed between the contacts to give the component the electrical characteristics required for operation.

Temperature, Operating - The ambient temperature range in which a Multifuse device is designed to operate under rated voltage and current.

Temperature, Tripped State - The maximum device surface temperature in the tripped state.

Thermal Derating - The effect of a change in ambient temperature on the hold and trip current.

Transition Temperature - The change in temperature from the operating temperature of a circuit to the non-operating temperature.

Tripped - The PTC is said to have "tripped" when it has transitioned from the low resistance state to the high resistance state due to an overload.

Typical - Typical values are statistically determined values of a parameter of the product that specify a characteristic value based on a large product sampling.

Voltage (Volts) - The electrical potential energy per quantity of charge, measured in Volts. Voltage = (Electrical Energy/Charge) = Current x Resistance.

Voltage, Maximum (V_{Max}) - The maximum voltage a Multifuse device can withstand without damage at the rated current.

Voltage Rating - The voltage rating, as marked on a fuse, indicates that the fuse can be relied upon to safely interrupt its rated short circuit current in a circuit where the voltage is equal to, or less than, its rated voltage. This system of voltage rating is covered by N.E.C. regulations.

Watts - The SI unit of measure for power. 1 Watt = 1 Joule/Second. It is the power expended when 1 ampere of direct current flows through a resistance of 1 ohm.

Test Procedures:

Humidity Aging - a test used to determine the effects, if any, of exposure of a Multifuse device to humidity at an elevated temperature. The room temperature resistance is measured before and after conditioning the device.

Mechanical Shock - a test used to evaluate the physical effects, if any, and constructional integrity of a Multifuse device when subjected to mechanical shock. The room temperature resistance is measured before and after conditioning.

Passive Aging - a test used to determine the effects, if any, of the aging of a Multifuse device. The room temperature resistance is measured before and after conditioning the device at an elevated temperature for an extended time period.

Solvent Resistance - a test used to determine the effects, if any, on the marking and external portion of a Multifuse device by common industrial solvents.

Thermal Shock - a test used to determine the effects, if any, of a rapid and drastic change in ambient temperature on a Multifuse device. The room temperature resistance is measured before and after conditioning.

Time to Trip - a test used to determine the time it takes for a Multifuse device to trip at a given temperature and current. Normally, the time to trip is measured at $I = 5 \times I_{hold}$ and 23°C. The time to trip decreases as the fault current and/or ambient temperature is increased.

Trip Cycle Life - a test used to determine the number of trip cycles (at V_{Max} & I_{Max}) a Multifuse device will sustain without failure.

Trip Endurance - a test used to determine the duration of time a Multifuse device will sustain its maximum rated voltage in the tripped state without failure.

Vibration - a test used to evaluate the physical effects, if any, and constructional integrity of a Multifuse device when subjected to vibration. The room temperature resistance is measured before and after conditioning.

Engineering Notes:

Tripped Power Dissipation ....$P_d = I_{ss}V$

Tripped State Resistance ....$R_T = V^2/P_d$

Automatic Reset Condition....................$V^2/4R_L < P_d$

where,

I_{ss} = current flowing through the device in tripped state

V = Voltage dropped across the device in tripped state

R_L = Circuit Load Resistance

I^2t = Power ....Power generated as a result of current flow at a period of time t

V2/R = Power ....Power generated as a result of a voltage across a resistor

Degrees C to Degrees F ....#degrees C multiplied by 9/5 + 32 = Degrees F

Degrees F to Degrees C ....# degrees F multiplied by 5/9 – 32 = Degrees C

Degrees Kelvin ......# degrees C + 273 = Degree Kelvin

V = IR..Ohms Law

Principal of Operation....................mCp (ΔT/Δt)= I2R – U(T-Ta)
I = Current flowing through device
R=Resistance of device
Etc.

Resistivity ....Resistance = Resistivity (Ohm cm) x thickness (cm) / Area (cm2)

Surface Mount Chip Sizes ....1210 / 1812 / 2920

Relevant Standards:

UL

Underwriters Laboratories Inc. (UL)
E 174545S
333 Pfingsten Road
Northbrook, IL 60062
Att: Publications Stock

UL 1434 ....Standard for Thermistor-Type Devices

UL 1950 (IEC 950)..................Computer Equipment (8A-5sec. protection)

UL 603 ....Burglar Alarm Systems (8A-1min. protection)

UL 813 ....Commercial Audio Systems (8A-1 min. protection)

TUV

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R2057213
Taipei Head Office
Spring Plaza Building
14F, No. 6, Min Chuan E. Rd., Sec. 3
104 Taipei
Tel: 886.2.2516.6040

IEC 730-1/J (EN60730-1/J)............Requirements for Controls Using Thermistors

ODS

Bourns Corporate policy bans the use of any Ozone Depleting Substances (ODS) in all of its manufacturing locations. Testing to any of these ODS will be on a special arrangement basis only.

CSA

Canadian Standards Association (CSA)
CA 110338
178 Rexdale Boulevard
Rexdale, Ontario, Canada M9W 1R3
Att: Standard Sales

Component Acceptance Service NO 18A
..........PTC Thermistors Used as Overcurrent Devices

Other Multifuse Applications

EIA 481-2 ......Standard Packaging for MF-SM Series (see page 73)

EIA 481-1 ....Standard packaging for MF-MSMD Series (see page 74)

EIA 468-B/IEC286-2 ....Standard packaging for MF-R and MF-RX Series (see page 71 and 72)

IEEE 1394 ......High Performance Serial Bus Standard

USB ....Universal Serial Bus Standard

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