



Tyco Electronics
Our commitment. Your advantage.

This Catalog is intended to present application, product, and technical data to assist the user in selecting Raychem Circuit Protection devices, including PolySwitch resettable devices, fuses, PolyZen micro assemblies, 2Pro devices, ESD protection devices, SiBar thyristor surge protectors, Gas Discharge Tubes and ROV metal oxide varistor devices. However, users should independently evaluate the suitability of, and test each product for their application. Tyco Electronics Corporation makes no warranties as to the accuracy or completeness of the information in this Catalog and disclaims any liability resulting from its use. Tyco Electronics' only obligations are those in the Tyco Electronics Standard Terms and Conditions of Sale and in no case will Tyco Electronics be liable for any incidental, indirect, or consequential damages arising from the sale, resale, use, or misuse of its products.

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Table of Contents

Overview

1

Tyco Electronics Corporation	2
Raychem Circuit Protection Products	3

Application Summaries

2

Telecommunications and Networking	4
Multimedia	8
Portable Electronics	14
Sensors and Control Systems	16
Automotive	18
Appliance and HVAC	21

Application Solution Guide

22

3

Integrated Protection

PolyZen Micro Assemblies

23

4

2Pro Devices

28

5

Overvoltage Circuit Protection

ESD Protection Devices

32

6

SiBar Thyristor Surge Protectors

37

7

Gas Discharge Tubes

46

8

ROV Metal Oxide Varistors

55

9

Multi Layer Varistors

82

10

Overcurrent Circuit Protection

Fast Acting Fuses

87

11

Slow Blow Fuses

93

12

Telecom Fuses

100

13

PolySwitch Resettable Devices

14

Fundamentals	105
Product Selection Guide	107
Surface-mount Devices	109
- (picoSMD, nanoSMD, microSMD, miniSMD, midSMD, SMD, miniSMDE)	
Radial-leaded Devices	125
- (LVR, BBRF, RXEF, RTEF, RUEF, RGEF, RHEF, RUSBF)	
Automotive Devices	153
- (AGRF, AHRF, AHS, ASMD)	
Strap Battery Devices	167
- (VLR, VLP, VTP, LTP, MXP, SRP, LR4, miniSMDE)	
Telecommunications and Networking Devices	184
- (TCF, TRF, TS, TSV, TSL, TSM)	

Tyco Electronics

Our commitment. Your advantage.

Welcome to Tyco Electronics

With a 60-year history of leadership, Tyco Electronics is a US\$13.5 billion global provider of engineered electronic components for thousands of consumer and industrial products; network solutions and systems for telecommunications and energy markets; and wireless systems for critical communications, radar and defense applications. We design, manufacture and market products for customers in industries ranging from automotive, appliance, aerospace and defense to telecommunications, computers and consumer electronics. In 2007, Tyco Electronics became an independent, publicly traded company whose common stock is listed on the New York Stock Exchange (NYSE) under the ticker symbol "TEL."

We manufacture approximately 500,000 precision-engineered products – all backed by nearly 100,000 committed professionals with a singular commitment to bringing a performance advantage to every technology, product and service we provide.

Our Product Advantage

We design, manufacture, and market approximately 500,000 unique products for more than 200,000 customer locations in industries ranging from automotive, appliances, and aerospace and defense to telecommunications, public safety, computers, and consumer electronics. We bring a performance advantage to every technology, product and service we provide, including connector systems, relays, fiber optics, circuit protection devices, wire and cable, touch screens, heat shrink tubing, racks and panels, network interface devices, land mobile radios and networks, radar equipment, power systems and undersea telecommunications products and services. We are continually honing our technological edge with the goal of delivering the best products – with the highest quality – every time.

Our Technology Advantage

We invest approximately US\$600 million – or about five percent of the company's sales revenue – on research, development and engineering annually. These efforts are supported by approximately 8,000 engineers at 17 global design centers who work closely with our customers to develop applications-specific, highly engineered products and systems to satisfy customers' needs. We apply for more than 1,000 patents annually and hold more than 17,000 patents in total. Our innovation, early design involvement and materials expertise give customers a competitive advantage by delivering new functionality, and by helping them to bring better performance to existing products, deliver new products to market faster, and realize greater efficiencies in their manufacturing processes.

Our Global Advantage

We have an established manufacturing presence in over 25 countries, we operate in more than 45 countries and we serve customers in more than 150 countries. Our global coverage positions us near our customers and allows us to assist them in consolidating their supply base and lowering their production costs. In addition, we operate an expansive Global Account Management program through which we maintain close working relationships with the key customers in the markets we serve. With sales of US\$12.8 billion in fiscal 2006, we are significantly larger than many of our competitors – giving us scale and reach that generate direct dividends for our customers everywhere.

Our Employee Advantage

We have nearly 100,000 dedicated employees who are based throughout the world, with approximately 34,000 employees in China alone. By maximizing the commitment of our 8,000 engineers, and the reach of our 5,500-member sales force serving customers in more than 150 countries, we can collaborate with customers to provide highly engineered products and innovative solutions to meet their needs. Our diverse and capable management team, with an average of 22 years of electronics industry experience, is equally dedicated to creating and sustaining those powerful customer alliances – and to earning their business every day.

Raychem Circuit Protection Products

Raychem circuit protection products are a part of your everyday life. From your phone battery to your car's steering wheel we are helping to make your world safer and your electronics more reliable.

For over 25 years we have pioneered the field of polymeric positive temperature coefficient (PPTC) resettable technology with our PolySwitch product line. We developed the first patents for the use of a PPTC device as a variable resistor in circuit protection applications in the 70's and 80's. Since then, we have continued to expand our family of PolySwitch PPTC devices to include wider voltage, current, and temperature ranges in a variety of form factors.

Established as a leader in resettable circuit protection solutions, we continue to expand our product portfolio to include overcurrent, overvoltage and integrated circuit protection product lines.

Our overvoltage circuit protection products include SiBar thyristor surge protectors, gas discharge tubes (GDT), Raychem metal oxide varistors (ROV) and electrostatic discharge protectors (PESD). When used along with PolySwitch devices, these overvoltage devices can help provide a coordinated and resettable solution to assist OEMs in meeting stringent regulatory requirements and in improving equipment reliability.

Single-use fuses, such as Slow Blow Fuses, Fast Acting Fuses and Telecom Fuses, were introduced for use in applications that need to disable the circuit rather than isolate it.

Most recently we released two new integrated protection product lines – PolyZen micro-assemblies and 2Pro devices. Integrating overcurrent and overvoltage protection functions in a single device effectively reduces component count and, appropriately applied, can expand performance attributes and help improve system reliability.

Billions of our Raychem Circuit Protection devices are being used to help protect a wide range of electronic products in the computer, battery and portable electronics, consumer, automotive, industrial, home appliance and HVAC, and telecommunication markets. In addition, our leading-edge solutions continue to add value in transient overvoltage protection for telecommunications applications.

We are recognized as a leader in operational excellence and customer service. Raychem Circuit Protection products are in compliance with globally recognized ISO9000/TS16949 standards.

We offer a dedicated engineering sales force, world-wide manufacturing and design centers, and local engineering support devoted to Raychem Circuit Protection products. This helps us to think, manage, and share globally, yet act locally to meet our customer needs.

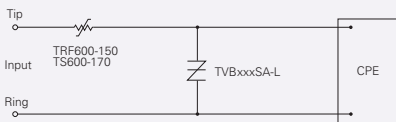
Application Summaries

UL60950 and TIA-968-A, (formerly FCC part 68) Requirements

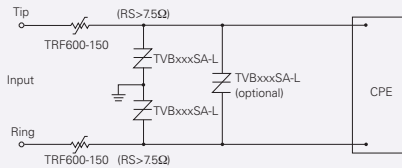
UL60950 and TIA-968-A describe electrical hazards from which Customer Premise Equipment in North America must be protected. Below are resettable circuit protection recommendations.

- TRF600, TS600, TSM600
- TVB

Suggested Arrangement to Meet TIA-968-A for an Ungrounded CPE Design



Suggested Arrangement to Meet TIA-968-A for an Grounded CPE Design

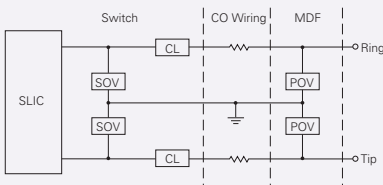


GR-1089 : North America Network Equipment

GR-1089 describes electrical hazards against which Public Switched Telephone Network equipment in North America should be protected. Below are recommended resettable circuit protection solutions.

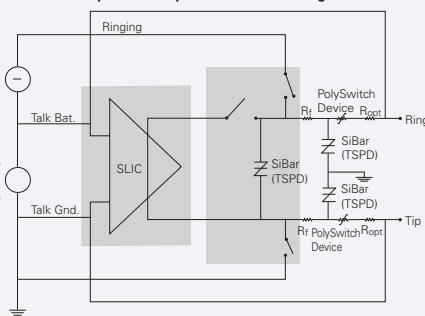
- TRF600, TS600, TSM600
- TVB

Simplified Model of Central Office End of Subscriber Loop

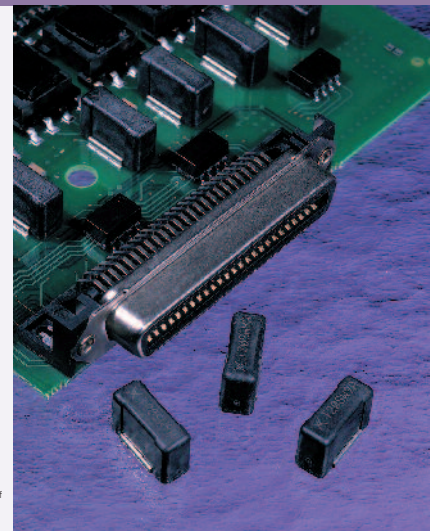


CL = Current limiting device
CO = Central office
MDF = Main distribution frame
POV = Primary overvoltage protection device
SLIC = Subscriber line interface card
SOV = Secondary overvoltage protection device

Simplified Example of a Line Card Design



The use of an optional resistance R_{opt} , and a current-sensing feedback resistor R_f is explained in Telcordia GR-1089.

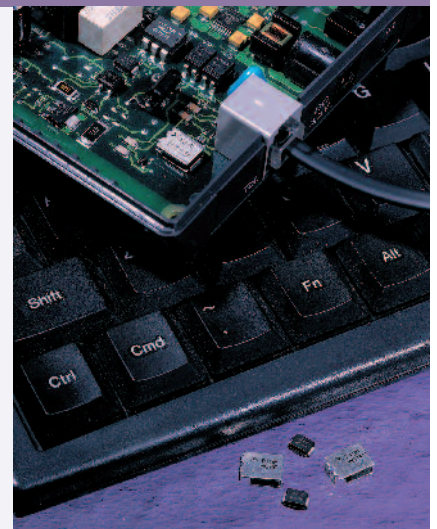
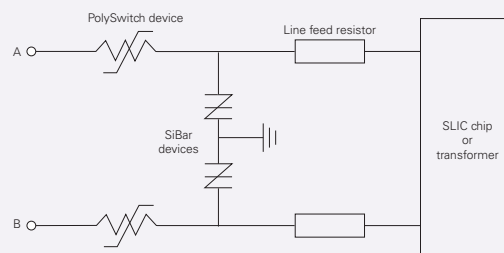


ITU-T Recommendations

ITU-T provides resistibility recommendations for central office (K.20), customer premise (K.21) and access network (K.45) equipment. Below is an overview of recommendations and resettable circuit protection solutions.

- TCF250, TRF250, TS250, TSV250
- TVB

Typical Protection System for Network Equipment

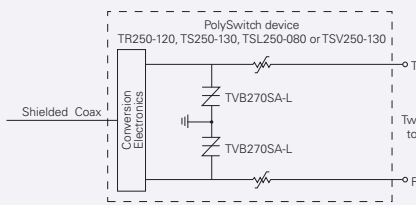


Short-haul/Intrabuilding Protection Requirements

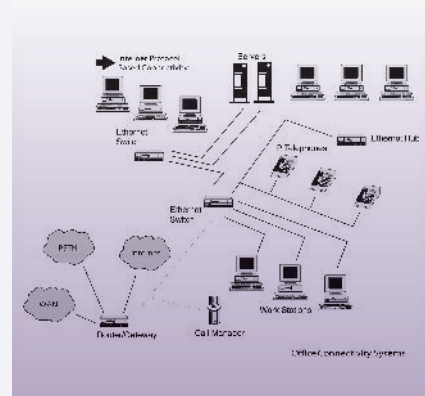
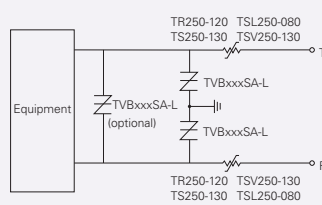
Communications equipment that is not directly connected to the Public Switched Telephone Network is subjected to lower level hazards. Circuit protection recommendations for LAN, WLL, VoIP and other intrabuilding applications.

- TRF250, TS250, TSL250, TSV250
- TVB

Fully Resettable Protection Solution for Cable-based Telephony System



Linecard or Grounded CPE Protection

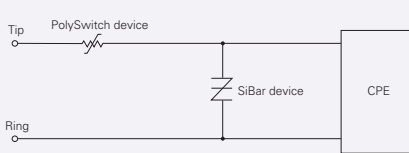


Customer Premise Equipment

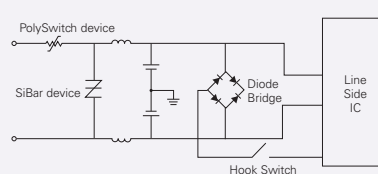
To protect subscribers against faults entering from outside wiring, CPE equipment is designed with power cross and lightning protection components. Recommended protection solutions based on regional requirements.

- RXEF • SMD
- TRF250, TRF600, TS250, TS600, TSV250, TSM600
- TVB • ROV
- FT600

Generic CPE Interface



Modem Interface

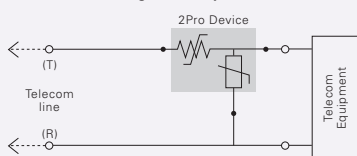


Customer Premise Equipment using 2Pro Devices

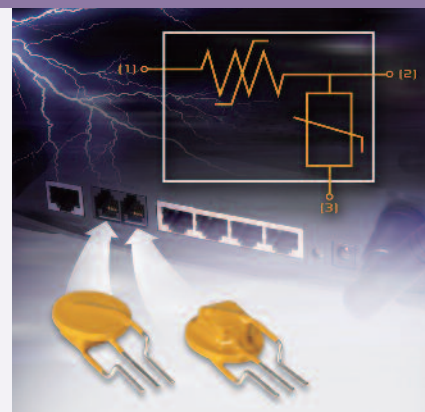
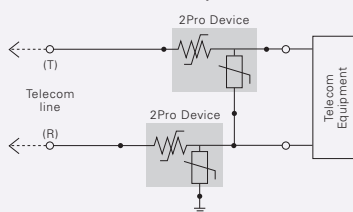
To help protect cost-sensitive PSTN (Public Switched Telephone Network) and VoIP (Voice over Internet Protocol) telephony equipment from damage caused by lightning and ESD surges, power contact and induction with AC lines. If left unprotected from these hazards, CPE (Customer Premise Equipment) may fail or may pose a safety risk for subscribers and maintenance personnel.

- 2Pro Device

Ungrounded System



Grounded System

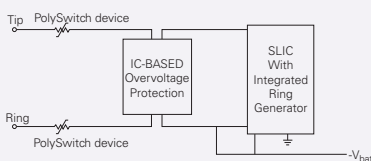


Analog Linecards

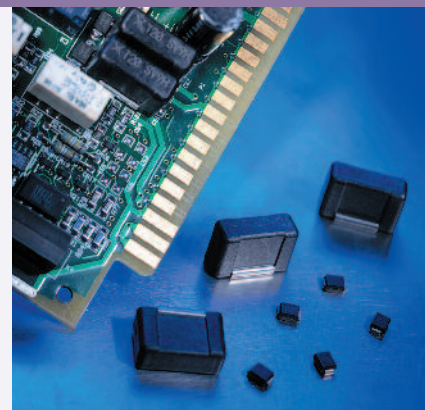
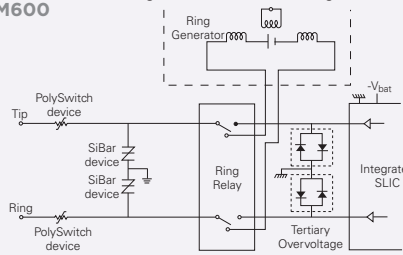
Central office line cards are subject to transient overcurrent and overvoltage faults, which may be generated from nearby power cross, power induction, and lightning events. Circuit protection recommendations based on regional agency specifications are provided.

- TRF250, TRF600, TS250, TS600, TSV250, TSM600
- TVB

Analog Linecard with Integrated Ring Generator



Analog Linecard with External Ring Generator

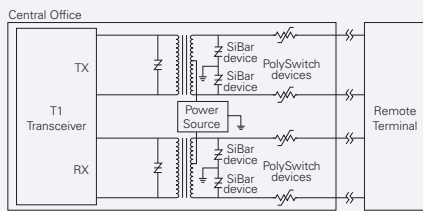


T1/E1 Equipment

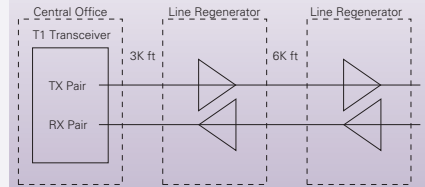
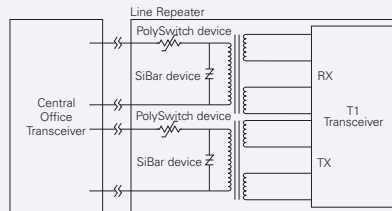
T1/E1 transmission equipment must be protected against transient power cross and lightning faults which may enter on outside plant wiring. Circuit Protection recommendations based on regional agency specifications are provided.

- TRF250, TRF600, TS250, TS600, TSV250, TSM600
- TVB
- FT600

T1/E1 Central Office Transceiver Protection



T1/E1 Line Repeater Protection

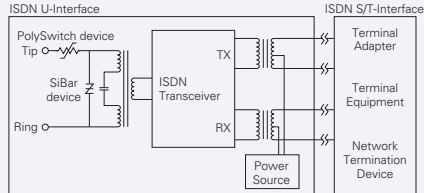


ISDN Equipment

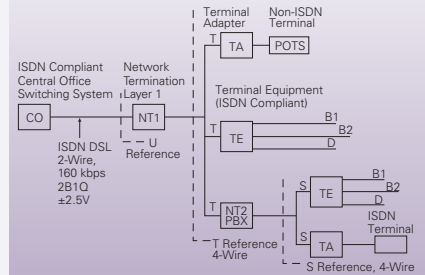
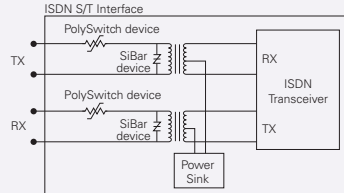
ISDN CO and CPE equipment must be protected against transient power cross and lightning faults which may enter via outside plant wiring. Circuit protection recommendations based on regional agency specifications are provided.

- TRF250, TRF600, TS250, TS600, TSV250, TSM600
- TVB

ISDN U-Interface Protection



ISDN S/T Interface Protection

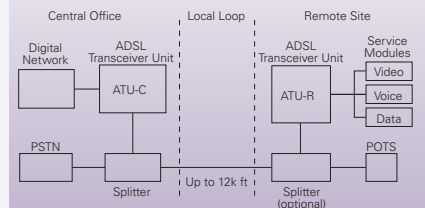
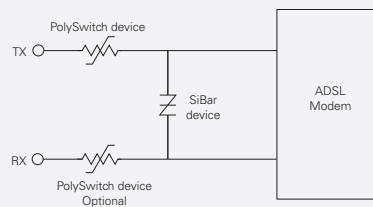


ADSL Equipment

ADSL modems and splitters must be protected against both external and intrabuilding faults. Resettable protection solutions are provided based on regional requirements.

- TRF250, TRF600, TS250, TS600, TSV250, TSM600
- TVB

ADSL Equipment Protection

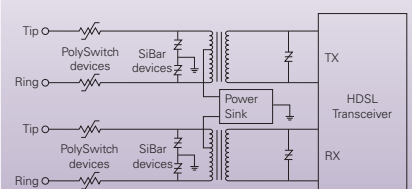


HDSL Equipment

HDSL equipment must be protected against transient power cross and lightning faults which may enter on outside plant wiring. Circuit protection recommendations based on regional agency specifications are provided.

- TRF250, TRF600, TS250, TS600, TSV250, TSM600
- TVB

HDSL Central Office/Remote Terminal



MDF Modules/Primary and Secondary Protection

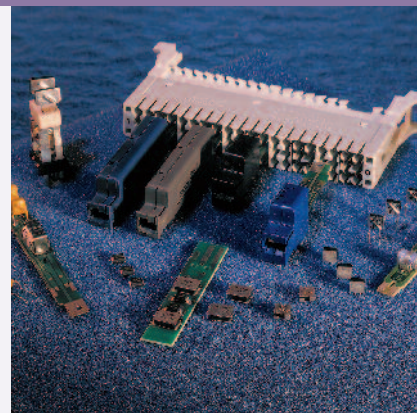
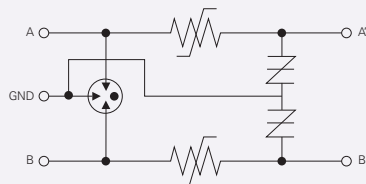
Telecom systems typically have multi-stage circuit protection. Primary protection is used closest to the “outside-world” where the highest surge withstand capability is typically needed. Secondary protection is needed to protect against hazardous power cross and lightning faults until the primary protection component activates.

Primary:

- TCF250, TRF250, TS250, TSV250
- FT600

Secondary:

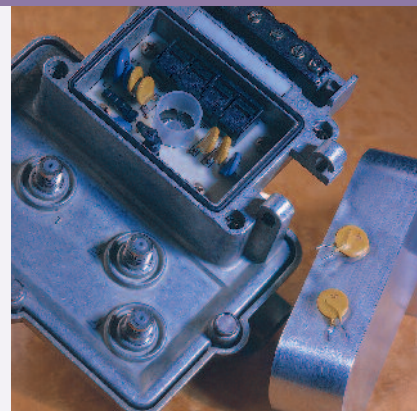
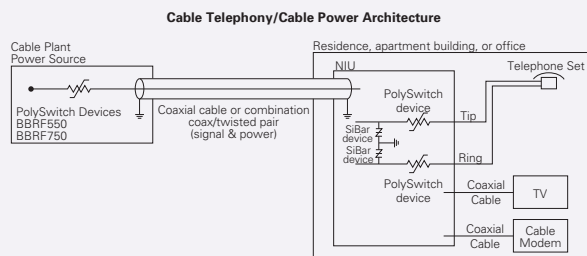
- GDT
- TVB



Cable Telephony/Cable Power Passing Tap

Cable telephony electronics that are powered via twisted pair or coaxial cable are susceptible to power faults passed through the cable plant. Protection in the power passing taps decreases the risk of these faults.

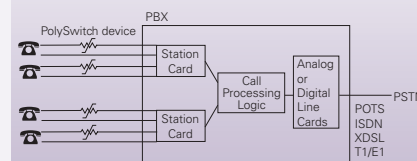
- BBRF, TRF250, TRF600, TS250, TS600, TSL250, TSV250, TSM600
- TVB
- ROV



PBX and Key Telephone Systems

Provides circuit protection recommendations to protect PBX and Key Telephone Systems against power faults and short circuits.

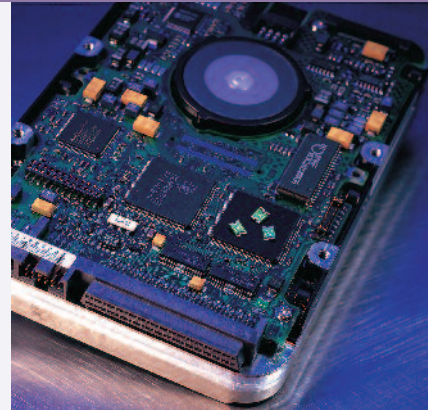
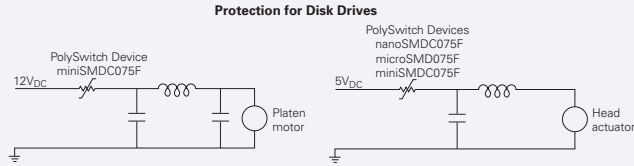
- RXEF
- miniSMD, SMD
- TRF250, TRF600, TS250, TS600, TSM600
- TVB



5V/12V Power Line Protection

The connection of a 12V line from the power supply instead of a 5V line can cause a high current inrush that can damage the other components in the circuit. Reverse polarity can cause damage to the tantalum capacitors, causing the capacitor to fail in a short-circuit mode. Applications include hard disk drives, CD-ROM, CD-RW, DVD, and other storage devices.

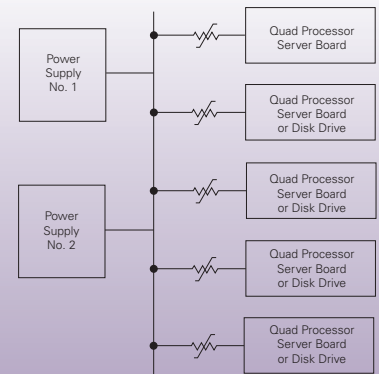
- RUEF, RUSBF
- nanoSMD, microSMD, miniSMD



Backplane and RAID Protection

Power backplane applications allow for field-serviceable and field-replaceable cards and drives to maximize the “up-time” of products. During card or drive replacements, the power on the backplane is live. Circuit protection is employed to help minimize safety risks, comply with IEC60950 Safety Requirement Clause 1.2.8.7 – Hazardous Energy Levels, and help protect against short circuits caused by incorrect insertion of cards.

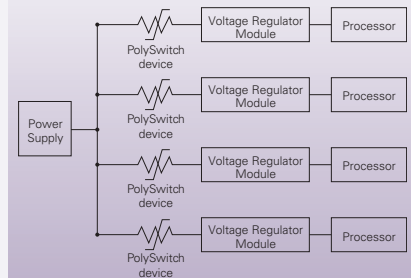
- RGEF, RXEF
- microSMD, miniSMD, SMD
- ROV



CPU Protection

Voltage regulation modules (VRMs) are used to supply power to processors. Due to load-change transients, processors can draw up to 13A. Also, during normal operation the current demand can still change by as much as 7A as processor activity levels change. These high-current immediate demands can cause components to fail. Circuit protection helps prevent the VRM from damaging the processor in the event of a VRM failure.

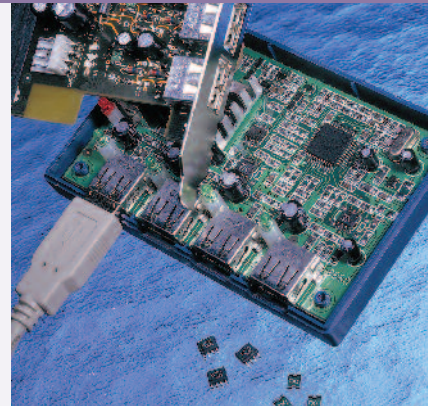
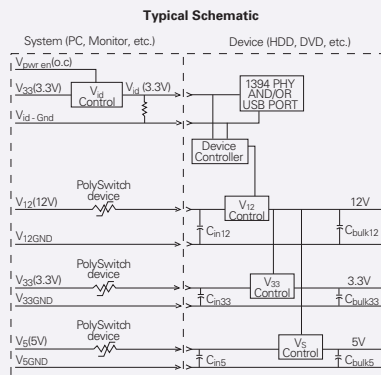
- RGEF, RUEF
- SMD



Device Bay

Due to hot-swappable bays, the device bay specification recommends overcurrent protection for high availability situations such as servers and industrial computers. An externally accessible port such as IEEE1394 or USB may also be used.

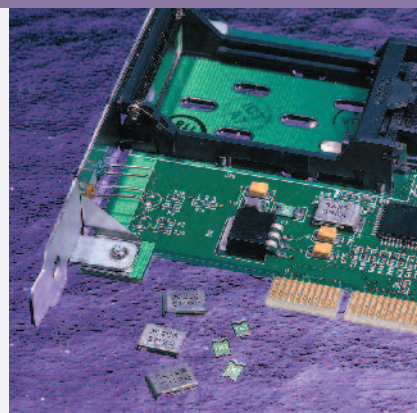
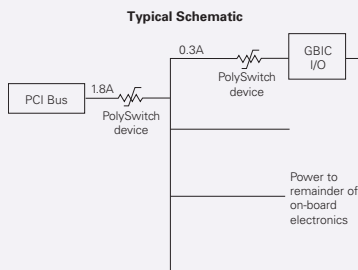
- RGEF, RUEF
- microSMD, miniSMD, SMD



Fibre Channel

A fault, such as a short circuit, during testing or hot-swapping a PCI card can cause significant damage. Incorrect insertion of the GBIC or a foreign object placed into the connector can also cause permanent damage to the system. Protection on the PCI bus input is typically used as well as a secondary protector for the GBIC I/O.

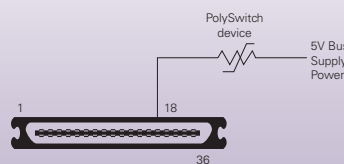
- RUEF
- miniSMD110F, miniSMD260F



IEEE 1284 Parallel Data Bus

The connector sources up to 350mA at 5V. A misconnection of the connectors or a foreign metal object placed into the connector can cause a significant overcurrent event that could damage system electronics.

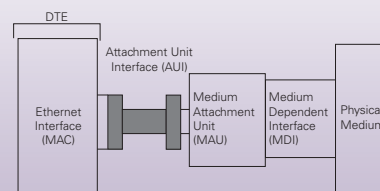
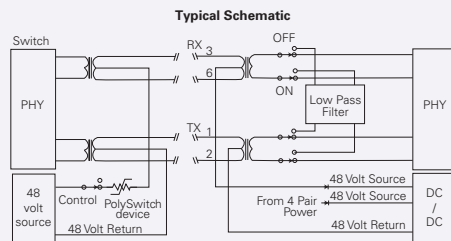
- RXEF
- nanoSMD, microSMD, miniSMD



IEEE 802.3 Ethernet LAN (incl. Powered Ethernet)

The auxiliary unit interface (AUI) consists of signal circuits, power, and ground. Per the IEEE 802.3 standard, the Voltage Plus circuit is capable of operating at 12-15 VDC for currents up to 500mA. In addition, per section 7.5.2.5, the source shall provide protection for this circuit against an overload condition. Powering IP devices such as IP phones over the Ethernet cable introduces the potential for a short circuit and/or FET failure, causing service interruption.

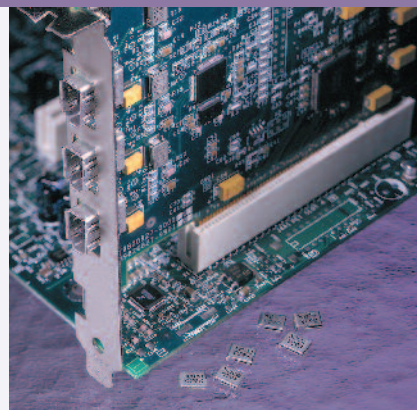
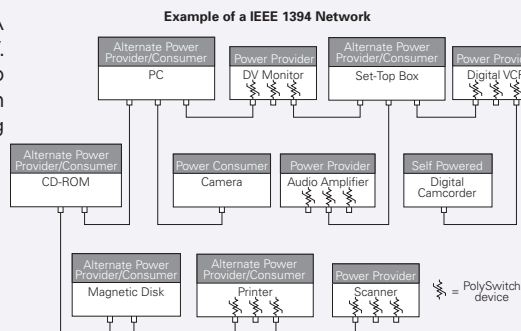
- RUEF, RXEF
- miniSMD100F/16, miniSMD075F, SMD030F-2018



IEEE 1394 FireWire, i.Link

IEEE 1394's complex power architecture provides up to 1.5A at voltages of 8-33V. PolySwitch devices help provide short-circuit protection in this high-power, hot-plugging environment.

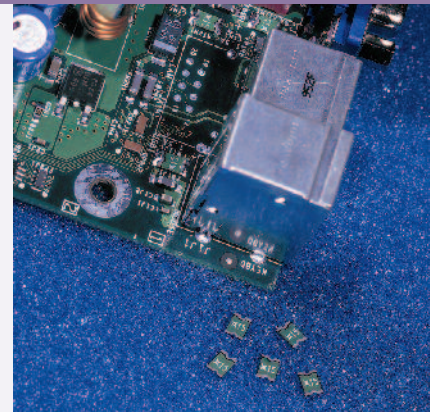
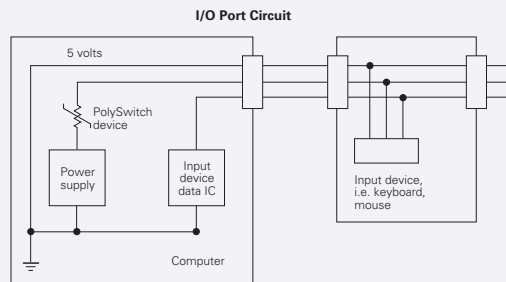
- RTEF
- SMD



I/O Ports

To meet regulatory agency requirements (UL60950), these ports must have a way of interrupting or limiting the current in the event of an overload or short circuit.

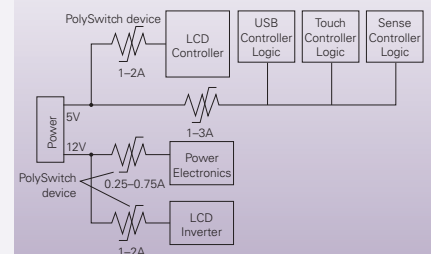
- RUEF, RUSBF
- nanoSMD, microSMD, miniSMD, SMD



LCD Monitors

Power for LCDs is supplied from the 5V and 12V buses. The LCD controller itself and the surrounding controller logic are powered from the 5V bus. The LCD inverter and the electronics on the board are powered from the 12V bus. Misconnections and mishandling during assembly or while in use can cause large overloads and short circuits in the system, damaging expensive components.

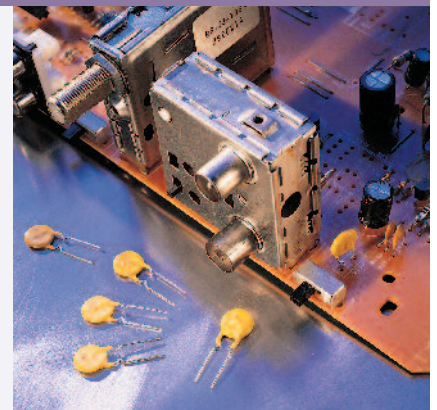
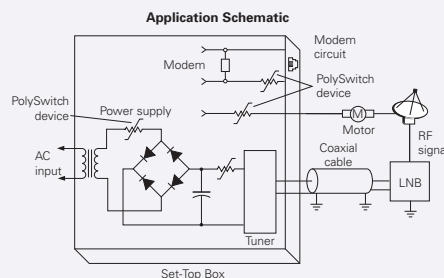
- RUEF, RXEF
- nanoSMD, microSMD, miniSMD
- Fuse



LNB Satellite Set-Tops

A short-circuit overload to the power supply can occur if the central pin in the coaxial cable connection to the receiver is bent or crushed against the connector during installation. It can also occur any time the user disconnects the antenna from the receiver.

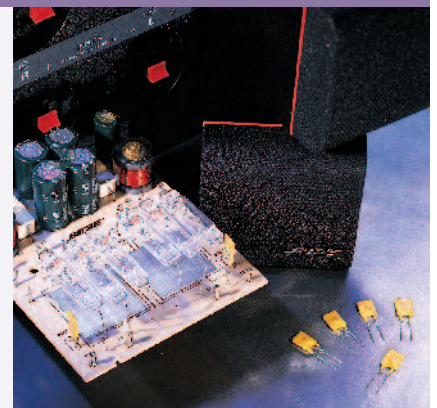
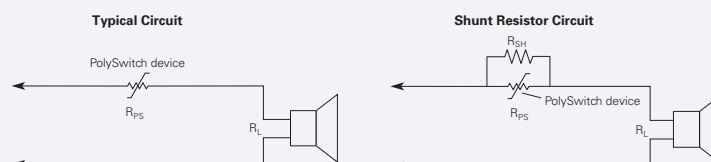
- miniSMD, SMD
- RXEF
- ROV



Loudspeakers

High-powered amplifiers used with low-powered speakers may overdrive the speaker coils with excessive power during sustained high volumes. Low-powered amplifiers may be overdriven so that clipping occurs. This causes an upward frequency shift of power that can overload the tweeters. Digital recordings, including compact discs, with their ability to reproduce high-frequency material, place extra strain on tweeters. PolySwitch devices can help the design engineer solve these problems.

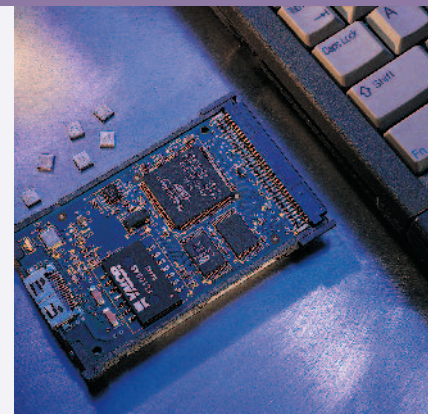
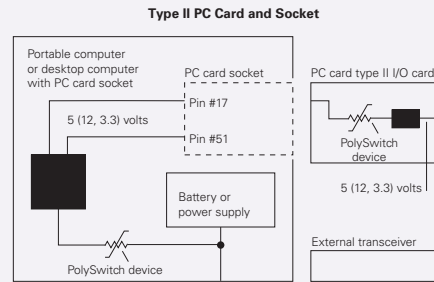
- RXEF



PC Cards and Sockets

Short circuits from external sources are the primary hazards for PC cards. The cards need protection from large current inrushes that can damage the PC card or the PC card bus.

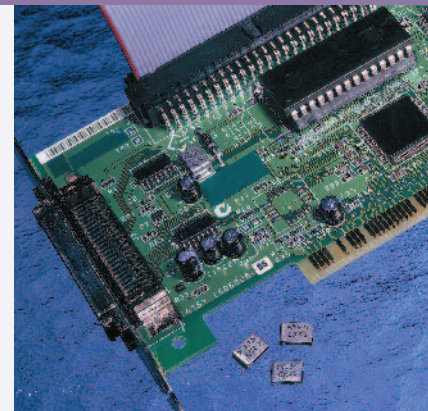
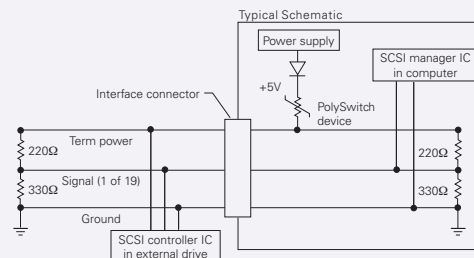
- RUEF, RUSBF
- nanoSMD, microSMD, SMD



SCSI

The SCSI bus TERMPWR line can draw significant amounts of current in a short circuit condition. A short circuit anywhere on the bus can cause the entire bus and host to crash. PolySwitch PPTC devices can be used on the SCSI controller circuit and on each connected peripheral to help protect against permanent damage.

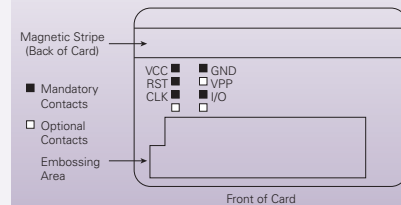
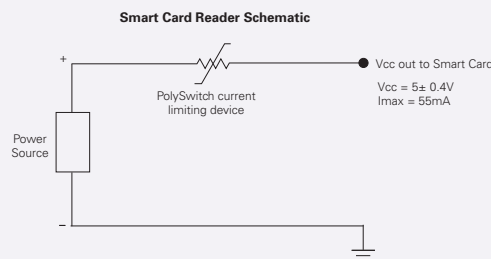
- RUEF, RXEF
- microSMD, miniSMD, SMD



Smart Card Readers

Smart cards are powered from the readers' Vcc. Defective cards or foreign objects placed into the reader can cause a short circuit and permanently damage the reader.

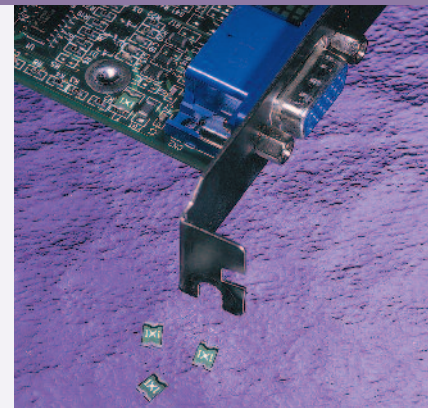
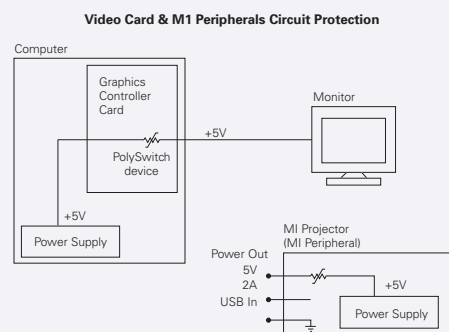
- microSMD010F



Video Ports (VESA, DDC, DVI)

PolySwitch devices help protect video ports on PCI video cards and motherboard video ports from faults on the 5V interface line in DDC circuits. These ports are designed for Energy Star compliance.

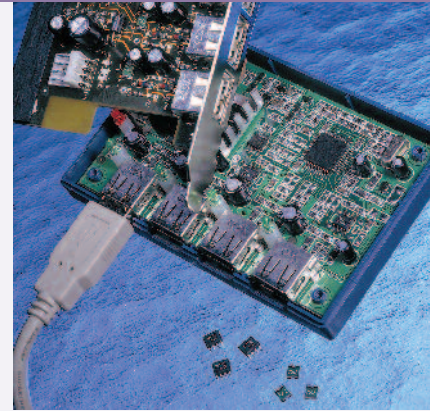
- RUEF, RUSBF
- nanoSMD, microSMD, miniSMD, SMD



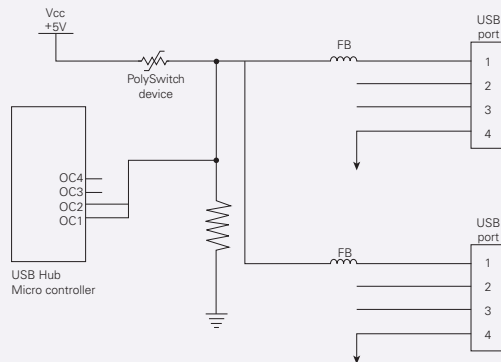
Universal Serial Bus (USB)

PolySwitch devices help provide short-circuit protection in this hot-plugging environment for USB hosts, self-powered and bus-powered hubs.

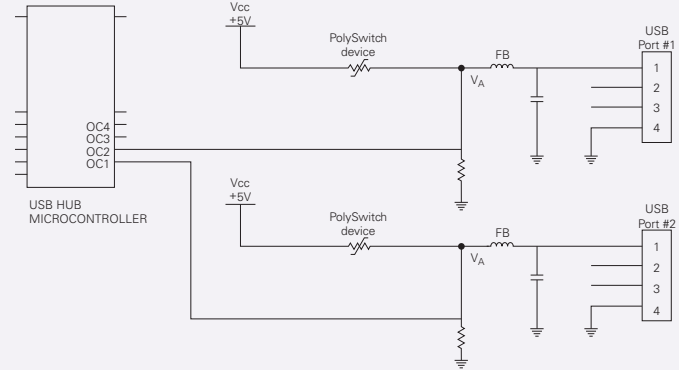
- RUEF, RUSBF
- nanoSMD, microSMD, miniSMD
- PESD



Ganged Port Protection
(two-port example)



Low-active Overcurrent Pin Fault Reporting for
Individual Port Protection

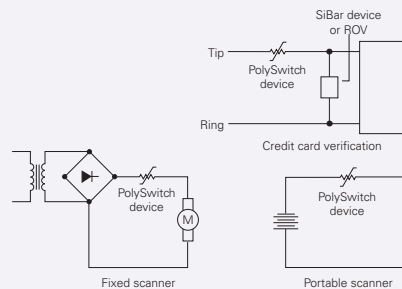


POS Equipment

Equipment connected to telephone lines can be subject to power cross, induction, and lightning surge hazards. Scanner motors and ditherers need protection against jams and stalls.

- RUEF, RXEF
- miniSMD, SMD
- TRF, TS
- SiBar
- ROV

Typical Circuits

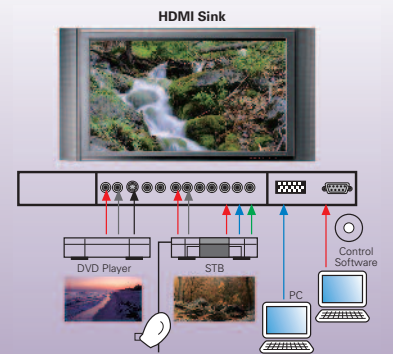
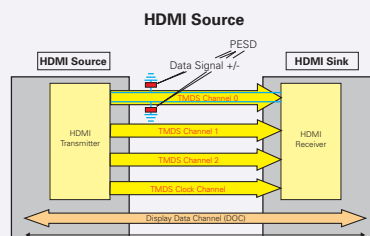


HDMI : LCD, plasma, HDTV, set top box, DVD player

HDMI (High Definition Multimedia Interface) applications such as LCD displays, Plasma displays, High Definition Television set-top boxes, and DVD players are susceptible to electrostatic discharge. To help protect the high speed TMDS lines against ESD hits, PESD devices are used 2 per line.

- PESD

Note : HDMI 1.3 reference layout, whitepaper, and testing results available upon request

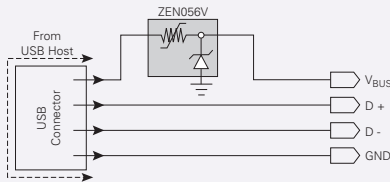


USB Peripheral Protection using PolyZen Devices

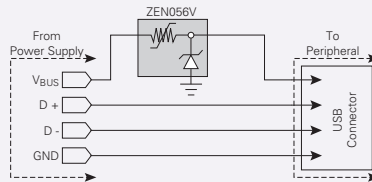
PolyZen devices help protect against damage caused by overvoltage on USB peripherals and devices on the 5V computer bus. The component helps protect sensitive follow-on electronics – such as flash memory and other 6V capable silicon – from inductive voltage spikes, incorrect power supplies, dirty power and other transients. The RoHS-compliant device offers massive power handling in a 4mm package.



Typical Circuit – USB Peripherals

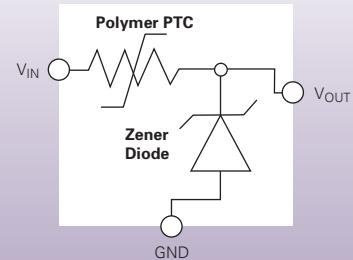


USB Power Conditioning (Host, Hub, Remote Charger)

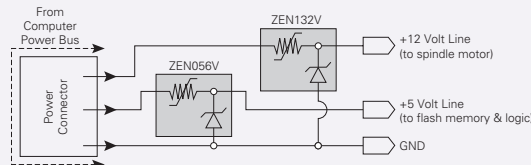


Hard Disk Drive Protection using PolyZen Devices

Designed to help protect devices on the 5V and 12V computer bus from overvoltage, inductive voltage spikes resulted from rapid change in current. The PolyZen device incorporates a stable Zener diode for precise voltage clamping and a resistively non-linear, polymer PTC layer that responds to either diode heating or overcurrent events by transitioning from a low to a high resistance state. This unique device helps manufacturers meet safety requirements and reduce warranty costs.



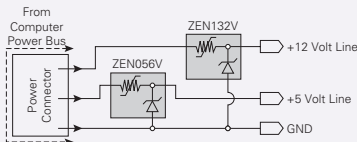
Typical Circuit – Hard Disc Drive



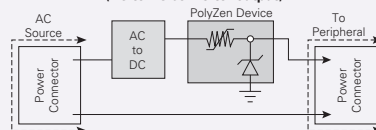
Computer Subsystems and Peripherals using PolyZen Devices

Computer electronics can be exposed to voltages well in excess of the bus voltage, and require protection for power sensitive electronics like flash memory. Voltage spikes can result from a hot disconnect of a peripheral, an internal system shutdown, or other internal power fluctuations. The PolyZen device provides coordinated protection with a component that protects like a Zener diode, but is capable of withstanding the high power fault conditions that can occur in computer electronics.

Typical Circuit – Computer Peripherals



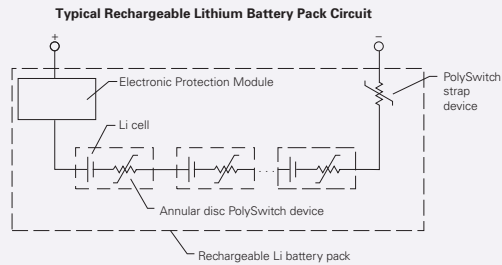
Computer Peripherals/Subsystem Power Conditioning (AC to DC converter output)



Lithium Cells and Battery Packs

External shorts, runaway charging conditions, or abusive charging can cause considerable damage to primary and secondary lithium cells. Rechargeable lithium batteries are used in notebook computers and cellular phones, as well as other portable electronic applications.

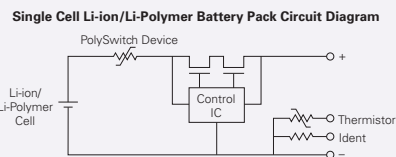
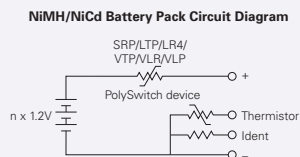
- LR4, LTP, SRP, VLR, VTP



Rechargeable Battery Pack Protection

Due to external shorts, runaway charging conditions, or abusive charging, considerable damage can be sustained in both battery cells and pack surroundings. The most common applications are nickel-cadmium (NiCd), nickel-metal-hydride (NiMH), and lithium-ion (Li-ion) battery packs for cellular phones, laptop/notebook computers, and other portable electronic applications.

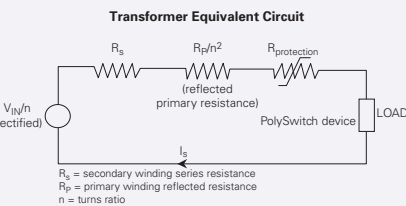
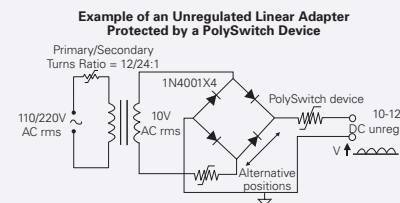
- LR4, LTP, SRP, VLR, VLP, VTP



Linear AC/DC Adapters

Linear AC/DC adapters, or "wall warts", can be used in both battery charging applications and in low cost DC power supplies for a variety of consumer equipment. Short circuits or excessive current draw can result in transformer winding overtemp. PolySwitch devices can help end products meet UL requirements.

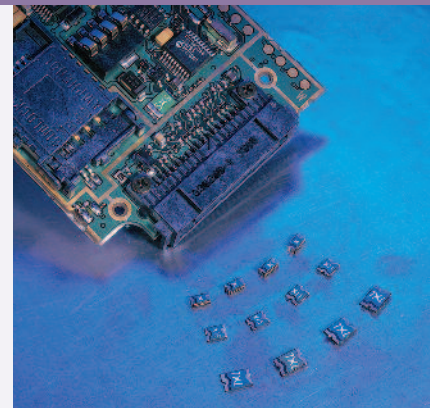
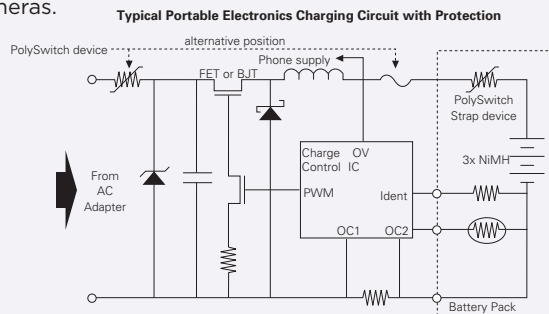
- RTEF, RUEF, RXEF
- nanoSMD, microSMD, miniSMD, SMD
- ROV



Portable Electronics Input Port Protection

The use of an incorrect or faulty adapter/charger can irreparably damage unprotected portable electronics equipment. Typical applications include cellular phones, PDAs, and digital cameras.

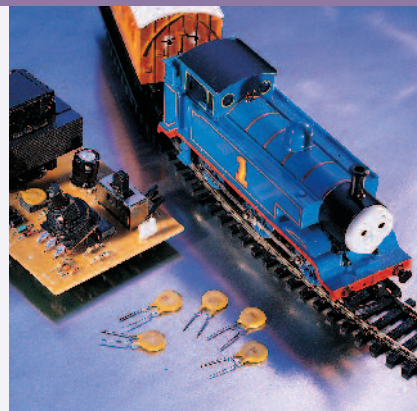
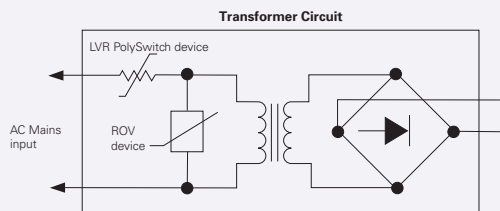
- nanoSMD, microSMD, miniSMD



Transformers

A short circuit can cause high currents, which produce high temperatures and can damage the power supply.

- RGEF, RHEF, RUEF, RXEF
- SMD
- ROV

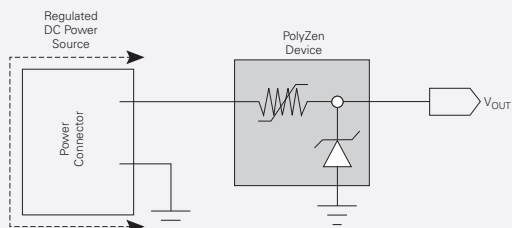


Portable Electronics Protection using PolyZen Devices

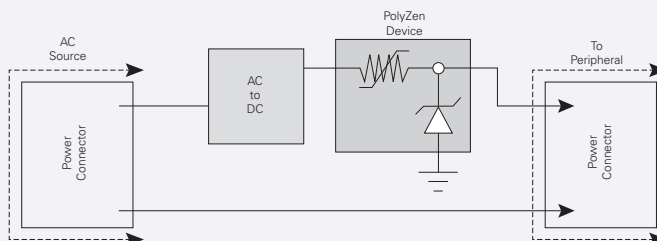
PolyZen device's unique ability to withstand high inrush currents make it suitable to protect portable electronics and other low-power DC devices such as cell phones, PDAs, MP3 players, digital cameras and USB hubs. Transient protection is particularly important for peripherals that can be powered off computer buses and automotive power buses. PolyZen devices are designed to help lock out inappropriate power supplies and are especially effective at clamping and smoothing inductive voltage spikes.



Typical Circuit – "On Board" Protection



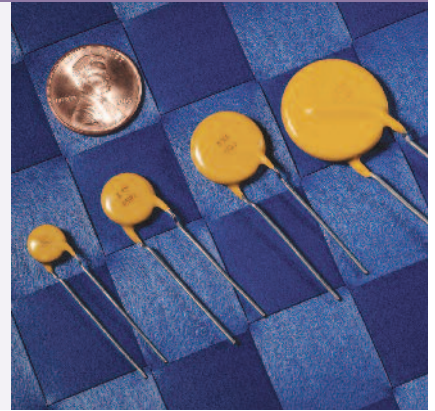
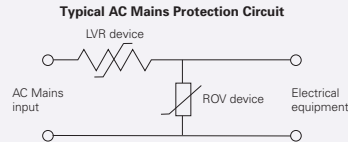
Power Conditioning (AC to DC converter output)



IEC 61000-4-5 Requirements for AC Mains Applications

Overcurrent and overvoltage protection are often considered as two separate elements during the design process. As a result, protection strategies can result in multiple component solutions that can be costly. Additionally, synergies between protection devices can be overlooked as overvoltage and overcurrent protection are often viewed as completely unrelated conditions. The PolySwitch LVR devices and Raychem Metal Oxide Varistors (ROV) offer designers a complete solution that helps enhance product protection and reliability.

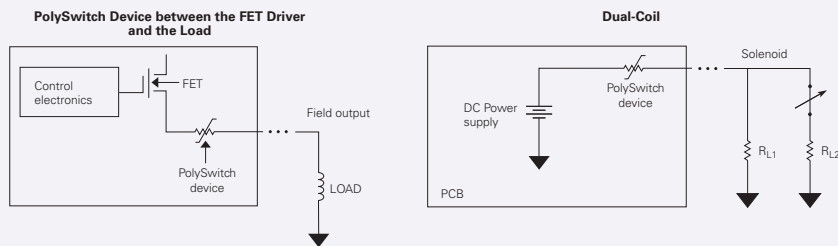
- LVR
- ROV



Electromagnetic Loads

Electromagnetic loads can be susceptible to many problems. Incorrect use of solenoids, valves, and motors can lead to device failure and circuit damage.

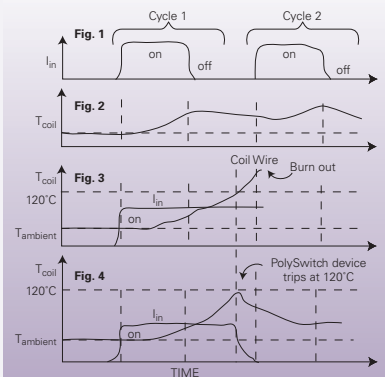
- RGEF, RUEF, RXEF
- miniSMD, SMD
- ROV



Solenoid Protection

Solenoids are used in various PC and peripheral applications such as printer feed trays and CD/CD-RW/DVD tray mechanisms. A PolySwitch device can be used to help protect the coil assembly of the solenoid when a sensor fails or if the armature fails to retract, thus causing the coil temperature to increase and burn out the coil wire.

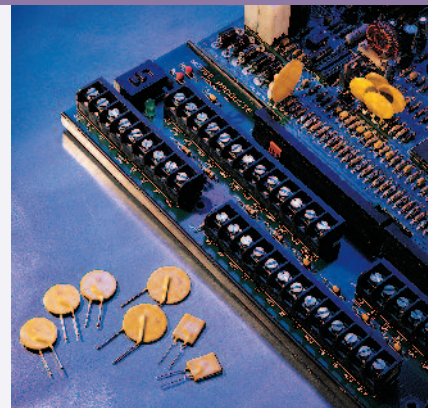
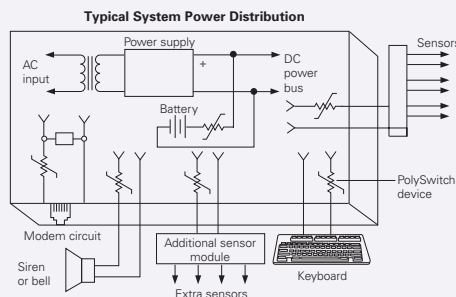
- RGEF, RHEF, RUEF, RXEF
- miniSMD, SMD
- ROV



Security and Fire Alarm Systems

Short circuits in the sensor lines, overheating of the battery, protection against telecom faults, different current requirements, and helping to meet UL864 requirements create a need for circuit protection.

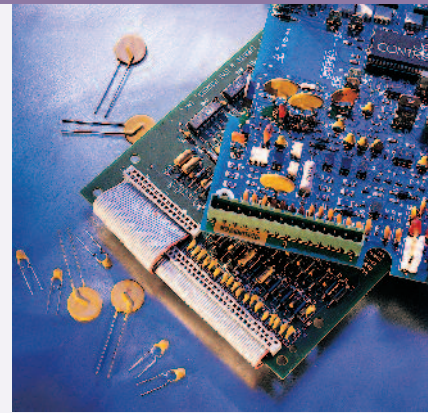
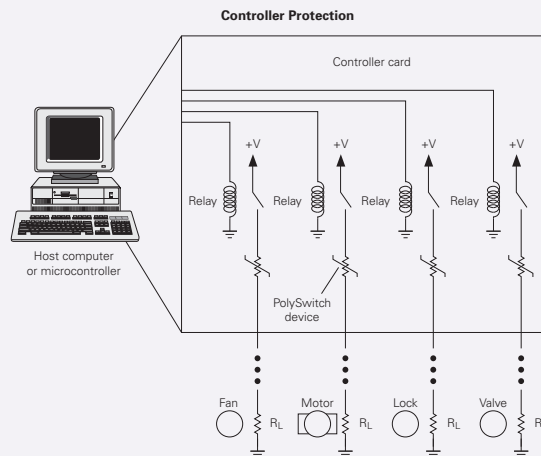
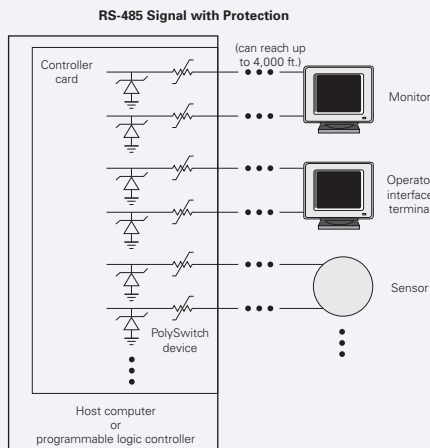
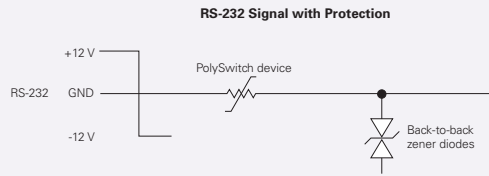
- RGEF, RUEF, RXEF
- TRF
- TVB
- ROV
- GDT



Process and Industrial Controls

Pinched cables and incorrectly installed/connected cables lead to shorts, overheating, component failures, and burned circuit board traces.

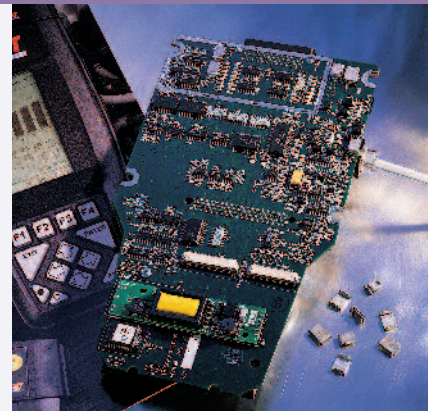
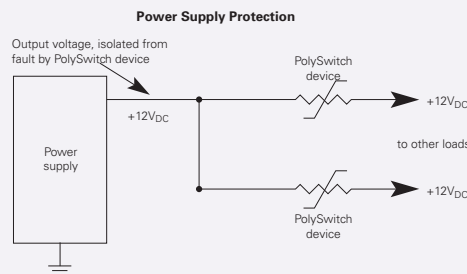
- RHEF, RTEF, RUEF, RXEF
- miniSMD, SMD
- ROV



Test and Measurement Equipment

Power supplies, communication ports, test probes, and battery packs are all vulnerable to overcurrent faults because of incorrect connections or damaged cables.

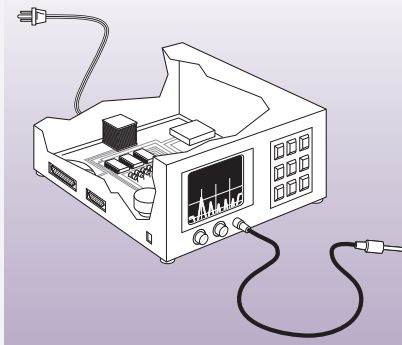
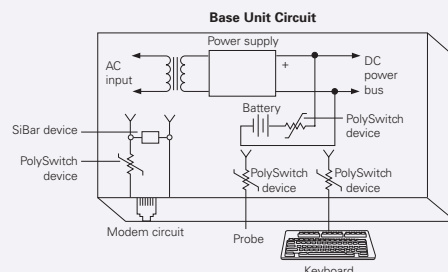
- RTEF, RUEF, RXEF
- miniSMD, SMD
- TRF
- TVB
- ROV



Medical Electronics

An electromedical device can experience overcurrent conditions in the secondary side of its internal power transformer, in one of its communication ports, and through its probes and voltage/current input terminals. A portable unit can also experience overcurrent conditions in its battery packs.

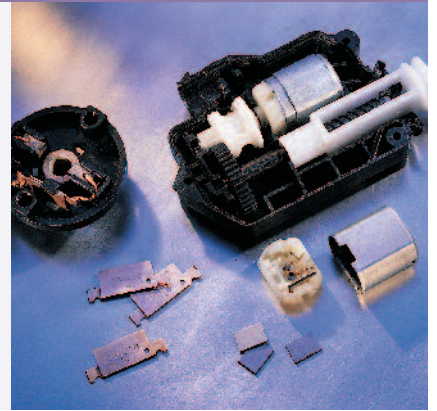
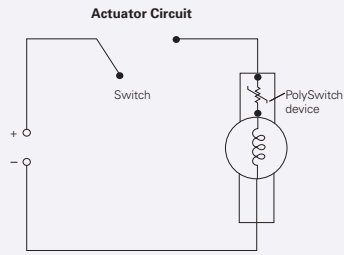
- RTEF, RUEF, RXEF
- miniSMD, SMD
- TRF
- TVB
- ROV
- GDT



Automotive Actuators & Medium-Size DC Motors

Automotive electric motors can overheat and cause damage to temperature sensitive components. To help protect these components, custom made PolySwitch and overvoltage devices can be designed for specific customer applications.

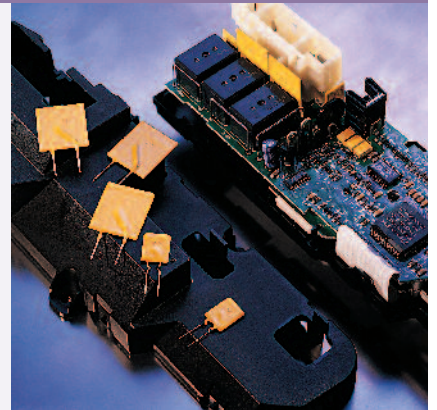
- AGRF, AHRF
- Terminal Devices
- Chip Devices
- ROV



Printed Circuit Board Trace Protection

The width of the copper traces must be reduced to provide more space for the tighter-packed and smaller printed circuit boards. These "Black Box" control modules handle a large number of high-powered accessories such as power windows, power seat adjusters, remotely controlled door locks, and radio & GPS antennae. To help protect these delicate printed circuit board traces against damage from overcurrent conditions PolySwitch resettable devices should be used.

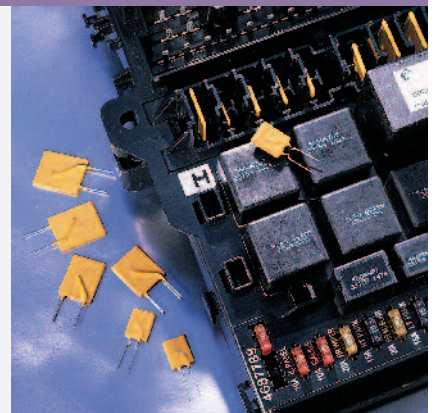
- AHRF, AGRF
- AHS, ASMD, miniSMD, nanoSMD



Automobile Harness Protection

The wiring harness architecture of automobiles has undergone considerable change due to increased vehicle electrical and electronic content. Resettable circuit protection that does not need to be driver accessible, such as PolySwitch PPTC devices, offers a number of solutions that may be used separately or in combination.

- AHRF, AGRF
- ASMD
- ROV

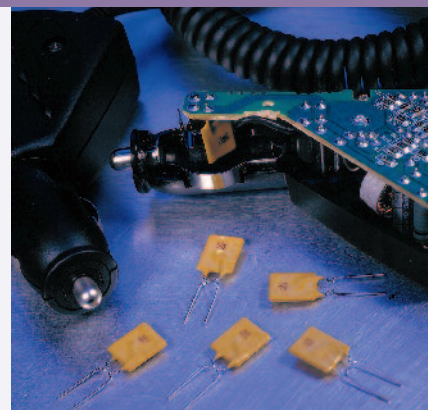
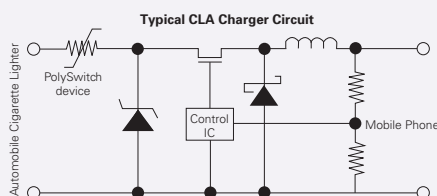


DC Cigarette Lighter & Power Plug Adapter - Charger Protection

Charger circuits for a mobile phone, an after-market hands free device, or other battery operated equipment are the types of connectors used to plug into automobile cigarette lighter power outlets. These assemblies must operate over a wide range of temperatures and charging conditions and in a harsh automotive environment.

Typically, overcurrent protection, such as a PolySwitch PPTC device, and overvoltage protection are coordinated at the input to the charger to help meet the stringent electrical requirement.

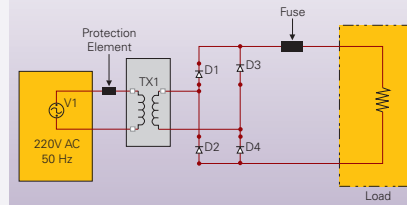
- AHRF, AGRF
- AHS, ASMD



Protecting Automotive Battery Chargers from Fault Failures

Service station and “do-it-yourself” battery chargers provide a low cost means of charging a flat or heavily discharged battery. However, when battery cables are attached incorrectly, or the clamps or clips touch each other accidentally, the resulting fault condition may cause a blown fuse or equipment damage. A PolySwitch PPTC device along with a Raychem MOV device can help prevent damage from an overcurrent situation on the secondary side.

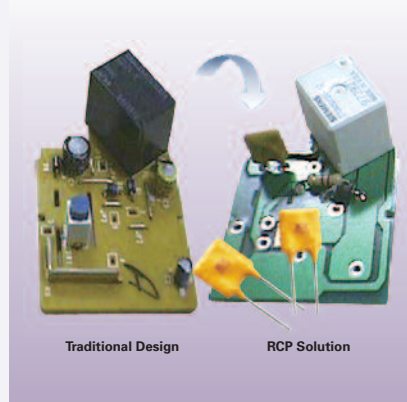
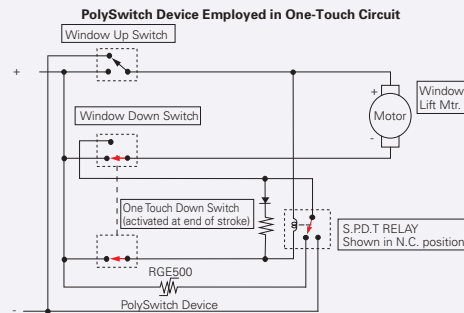
- AHRF, AGRF
- AHS, ASMD
- ROV



One-Touch-Down Circuit for Power Windows and Power Sunroofs

This One-Touch-Down circuit employs a PolySwitch PPTC device to function as both a sense component and as a switch component. This functionality allows a PolySwitch device to replace the sense resistor, comparator, driver and control circuitry used in traditional power window and sun-roof circuits. As a result, designers can achieve net cost savings through reduced component count and reduction in wire size.

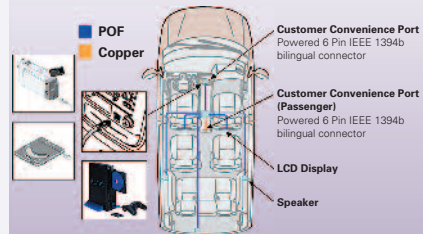
- AHRF, AGRF
- AHS, ASMD



Automotive IEEE 1394 Network

Connecting lifestyles from the home to the vehicle is an emerging trend in the automotive industry. The ability to interface consumer electronic devices and allow for quick installation in vehicles is now being facilitated through a standard global interface. In this hot-pluggable automotive environment, where the consumer is connecting and disconnecting peripherals on a powered port, the potential for short circuit damage is clearly present. PolySwitch devices can help prevent this damage.

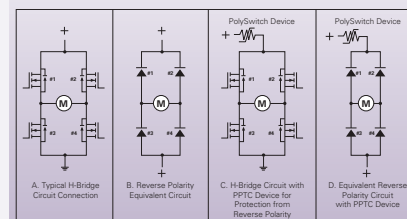
- AHS, ASMD, miniSMD, nanoSMD



H-Bridge Protection from Reverse Battery Damage

Automotive electronics must be protected from reverse polarity power sources, that may occur when jumper cables are connected to the wrong polarity of a dead or excessively discharged battery, or when a new battery is installed backwards. Without protection, excessive heating can lead to failures in electronic modules or inadvertent activation of vehicle loads such as solenoids and motors, which can lead to unsafe conditions.

- AHRF, AGRF
- AHS, ASMD
- ROV



Navigation and Infotainment System

Infotainment and navigation systems are packed with electronics and connectivity elements. Raychem Circuit protection devices help protect a wide variety of functions such as powered antennae, CAN-CAN bus lines, touch screen, USB ports, RF tuners, I/O lines, etc. Overcurrent and overvoltage protection devices help prevent system breakdown and enhance design safety.

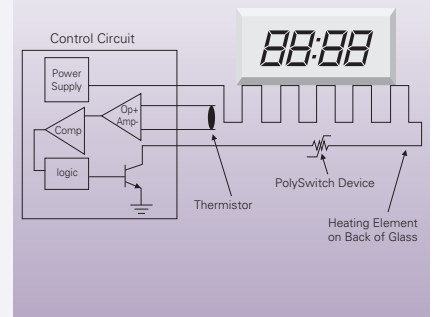
- AHRF, AGRF
- AHS, ASMD, miniSMD, nanoSMD
- ROV
- PESD
- Fuse



Liquid Crystal Display Backlight Heater Protection

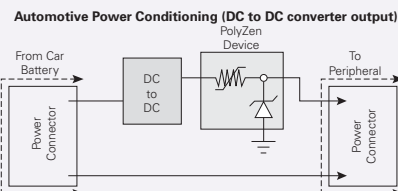
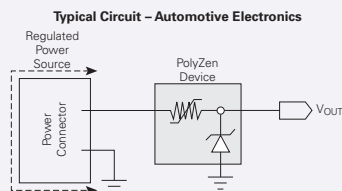
There are more and more displays designed into automobiles such as navigation systems, instrumentation displays, video and TV screens. PolySwitch PPTC devices can help protect the heater element in the back of the LCD glass from thermal runaway. A control circuitry failure will cause the PolySwitch PPTC device to thermally trip and help reduce the current flowing through the heater element.

- AHRF, AGRF
- miniSMD, nanoSMD



Automotive Electronics Protection using a PolyZen Device

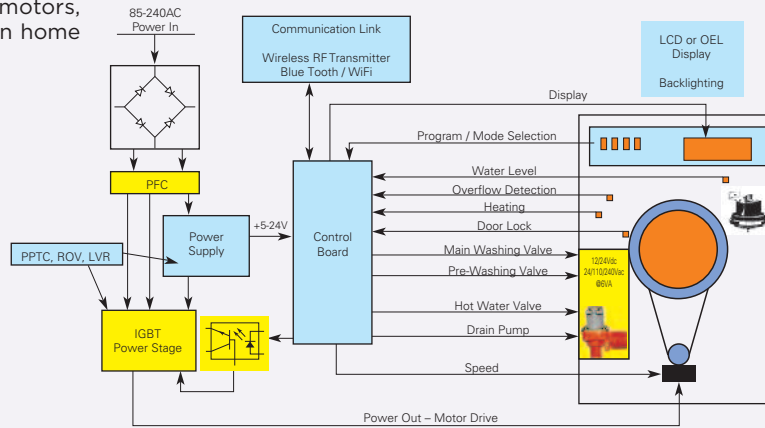
PolyZen device helps protect automotive peripherals and portable electronics that can be charged in the vehicle from damage caused by inductive voltage spikes, voltage transients, and reverse bias. The PolyZen device provides coordinated protection with a component that protects like a Zener diode, but is capable of withstanding the high power fault conditions that can occur in automotive applications.



Washing Machine

A number of Raychem Circuit Protection devices can be used to help provide overtemperature, overcurrent and overvoltage protection for the electric motors, LED displays and control electronics found in home appliances.

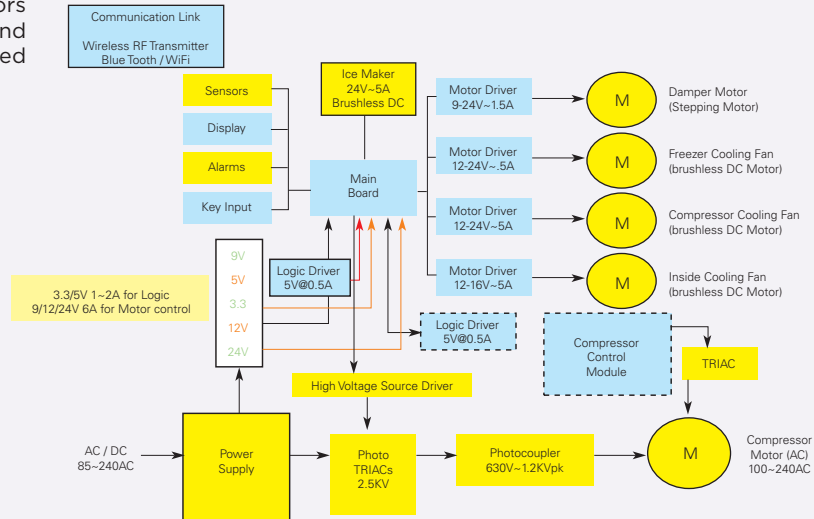
- LVR
- ROV
- Rline, SMD
- SiBar



Refrigerator / Freezer

PolySwitch devices help protect the motors and fans, controllers, touchpads, displays and interface circuitry required by sophisticated appliances.

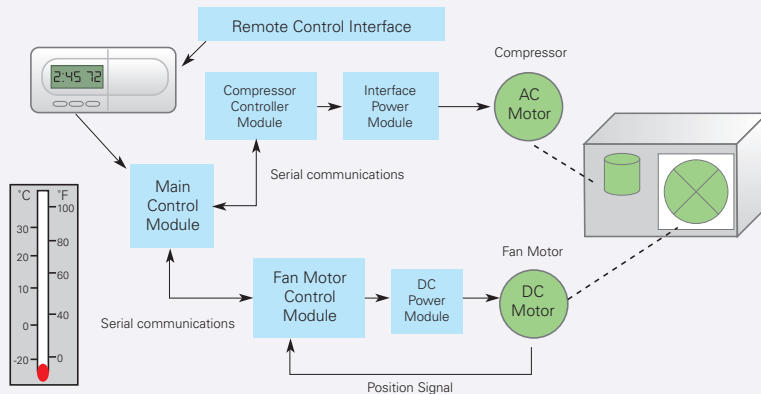
- LVR
- ROV
- Rline, SMD
- SiBar



Air Conditioning Unit

Resettable PolySwitch devices and MOVs help provide coordinated overcurrent and overvoltage protection for the motors, fans, displays and interface circuits used in modern HVAC equipment.

- LVR
- ROV
- Rline, SMD



Application Solution Guide

3

	Overcurrent Circuit Protection				Overvoltage Circuit Protection					Integrated Protection	
	PolySwitch Devices	Slow Blow Fuses	Fast Acting Fuses	Telecom Fuses	SiBar	GDT	ROV	MLV	PESD	2Pro	PolyZen
TELECOMMUNICATIONS											
Analog and digital linecards	x	x	x		x	x	x			x	
Central office equipment, linecards	x	x	x		x	x	x		x		
LAN, WAN equipment	x	x	x	x	x	x	x		x		x
MDF modules	x				x	x	x			x	
PBX, key telephone systems	x		x		x	x	x	x	x	x	
PoE (Power over Ethernet) systems	x	x			x	x	x	x	x		
Set-top boxes (cable & satellite)	x	x	x		x	x	x	x	x	x	x
Telephone, fax, modem	x	x	x	x	x	x	x	x	x	x	x
VoIP (Voice over Internet Protocol) equipment	x	x	x		x	x	x		x	x	
xDSL modems and splitters	x	x	x	x	x	x	x		x		x

CONSUMER ELECTRONICS

HDDs (Hard Disk Drives)	x	x							x		x
IEEE 1394 ports	x		x					x			
Inverters		x									
USB 2.0 & IEEE	x							x	x		x
USB flash memory modules	x							x	x		
USB hub, ports and peripherals	x							x			x
Video ports: HDMI, DVI, VGA	x		x					x	x		

PORTABLE ELECTRONICS

Audio Players/MP3	x		x					x	x		x
Battery packs	x	x	x						x		
Cell Phones and PDAs	x		x					x	x		x
Digital still cameras and video cameras	x		x					x	x		x
Portable game devices	x		x					x	x		x

INDUSTRIAL ELECTRONICS

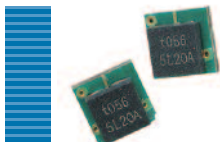
Displays	x	x	x				x		x		
Industrial controls-RS485, RS232	x	x	x			x	x	x	x		
Security systems	x	x	x		x	x	x		x	x	x
Surge suppression	x				x	x	x			x	
UPS (Uninterruptible Power Supply)	x	x	x		x	x	x				

AUTOMOTIVE ELECTRONICS

Electronic control modules	x	x	x				x	x	x		
HVAC and climate control	x	x	x				x				
Junction boxes	x						x				
Lamp protection	x						x				
Motor protection	x	x					x				
Power outlet protection	x						x	x			
Powered antennae	x						x				
Telematics powered components	x						x	x	x		x

Appliances and HVAC

Electronic PCB's and controllers	x	x	x				x	x	x	x	
Motor and compressor winding protection	x										
Power tools			x								
Transformer protection	x						x			x	



PolyZen Devices

Polymer Protected Zener Diode

PolyZen devices are polymer enhanced precision Zener diode micro-assemblies that help protect sensitive electronics from damage caused by inductive voltage spikes, voltage transients, incorrect power supplies and reverse bias.

The PolyZen micro-assembly incorporates a stable Zener diode for precise voltage clamping and a resistively non-linear, polymeric positive temperature coefficient (PPTC) layer that responds to either diode heating or overcurrent events by transitioning from a low to high resistance state.

PolyZen devices help provide resettable protection against multi-watt fault events and require only 0.7W power dissipation. In the event of sustained high power conditions, the PPTC element of the device “trips” to limit current and generate voltage drop. This functionality helps protect both the Zener and the follow-on electronics, effectively increasing the diode’s power handling capacity.



Benefits

- Helps shield downstream electronics from overvoltage and reverse bias
- Trip events shut out overvoltage and reverse bias sources
- Analog nature of trip events minimize upstream inductive spikes
- Helps reduce design costs with single component placement and minimal heat sinking requirements

Features

- Overvoltage transient suppression
- Stable V_z vs. fault current
- Time delayed, overvoltage trip
- Time delayed, reverse bias trip
- Power handling on the order of 100 watts
- Integrated device construction
- RoHS compliant

Applications

- DC power port protection for systems using barrel jacks for power input
- DC power port protection in portable electronics
- Internal overvoltage & transient suppression
- DC output voltage regulation

Figure PZ1 Typical Application Block Diagram for PolyZen Devices

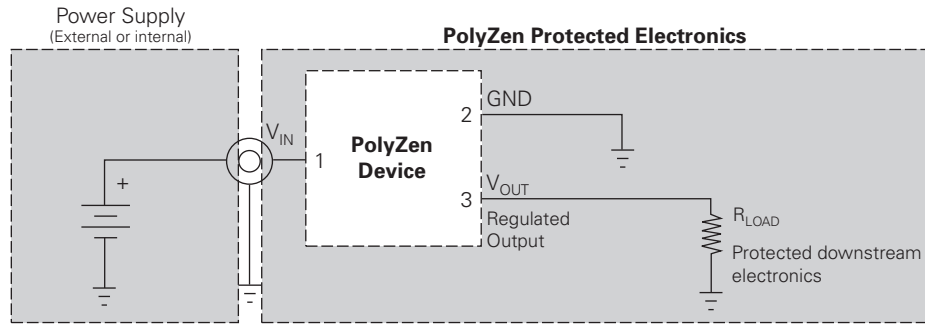


Table PZ1 Electrical Characteristics for PolyZen Devices

(Performance ratings @ 25°C unless otherwise specified)

	Part Number	V_z (V) Typical	I_{zt} (A)	I_{HOLD} @ 20°C (A)	R Typ (Ω)	R_{1Max} (Ω)	$V_{INT} Max$ @ 3A (V)	$I_{FLT} Max$ (A)	Power Dissipation (W)
coming soon	ZEN056V240A16LS	5.6	0.1	2.4	0.12	0.16	16	+10 / -40	0.7
	ZEN056V130A24LS	5.6	0.1	1.3	0.12	0.16	24	+10 / -40	0.7
coming soon	ZEN065V130A24LS	6.5	0.1	1.3	0.12	0.16	24	TBD / -40	0.7
coming soon	ZEN098V130A24LS	9.8	0.1	1.3	0.12	0.16	24	TBD / -40	0.7
coming soon	ZEN128V130A24LS	12.8	0.1	1.3	0.12	0.16	24	TBD / -40	0.7
	ZEN132V130A24LS	13.4	0.1	1.3	0.12	0.16	24	+3 / -40	0.7
coming soon	ZEN164V130A24LS	16.4	0.1	1.3	0.12	0.16	24	TBD / -40	0.7
	ZEN132V075A48LS	13.4	0.1	0.75	0.28	0.45	48	+3 / -40	0.7

Table PZ2 Definition of Terms for PolyZen Devices

V_z	Voltage out
I_{zt}	Current at which V_z is measured
I_{HOLD}	Maximum steady state I_{PTC} that will not generate a trip event at the specified temperature. Specification assumes I_{FLT} is sufficiently low so as to prevent the diode from acting as a heat source.
R Typ	Resistance between V_{IN} and V_{OUT} pins during normal operation at room temperature
R_{1MAX}	The maximum resistance between V_{IN} and V_{OUT} pins during normal operation at room temperature, one hour after first trip or after reflow soldering
I_{FLT}	Current flowing through the Zener diode
$I_{FLT} Max$	Maximum RMS fault current the diode portion of the device can withstand and remain resettable; testing is conducted at $\pm 24V$, or $\pm 48V$ with no load connected to V_{OUT} .
$V_{INT} Max$	The voltage at which typical qualification devices (98% devices, 95% confidence) survived at least 100 trip cycles and 24 hours trip endurance at the specific voltage and current I_{ptc}

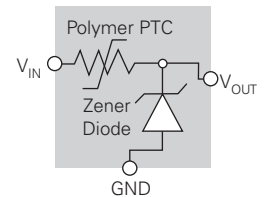


Figure PZ2-PZ7 Typical Performance Curves for PolyZen Devices

Figure PZ2

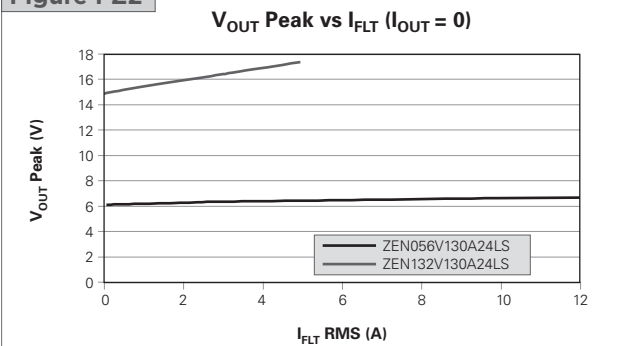


Figure PZ3

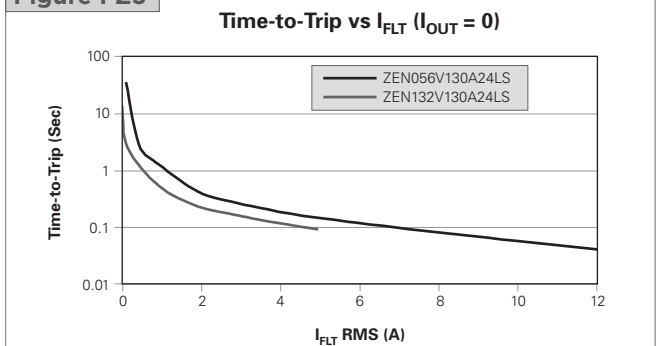
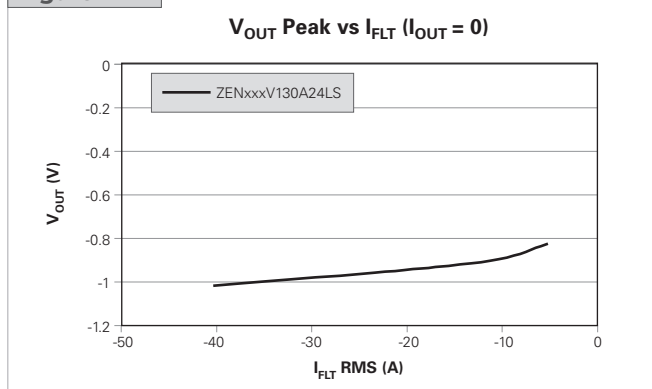
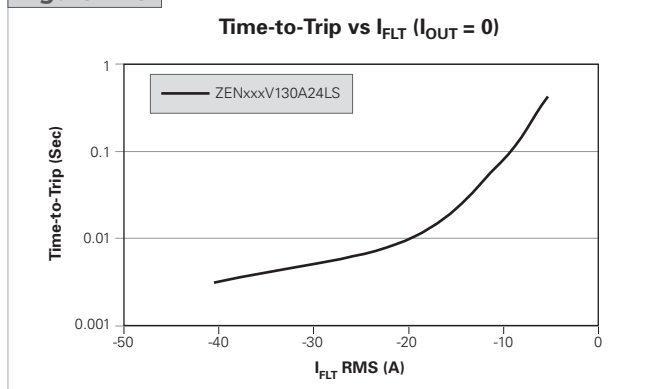
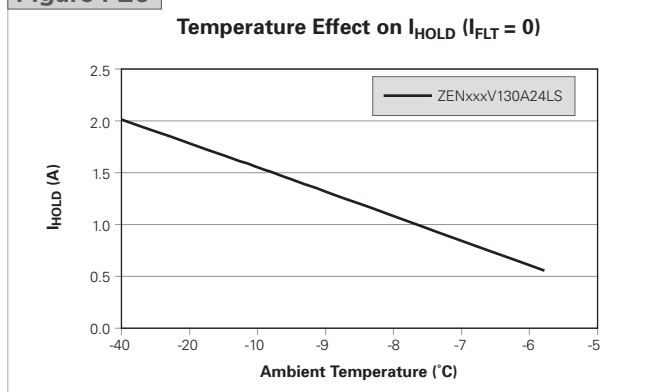
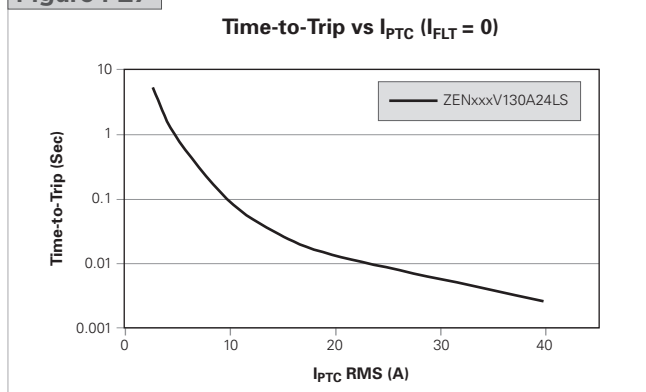


Figure PZ2-PZ7 Typical Performance Curves for PolyZen Devices

... Cont'd

Figure PZ4**Figure PZ5****Figure PZ6****Figure PZ7****Table PZ3 General Characteristics for PolyZen Devices**

Operating Temperature Range	-40° to +85°C	
Storage Temperature	-40° to +85°C	
ESD Withstand	15KV	Human Body Model
Diode Capacitance	4200pF	Typical @ 1MHz, 1V RMS
Construction	RoHS compliant	

Figure PZ8-PZ10 Basic Operation Examples for PolyZen Devices

Figure PZ8

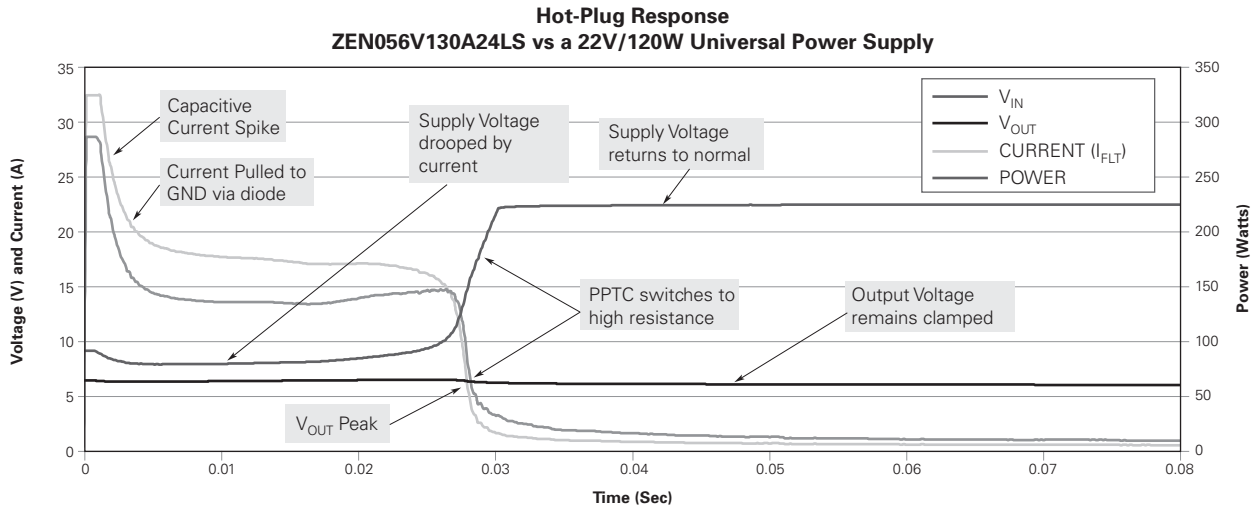


Figure PZ9

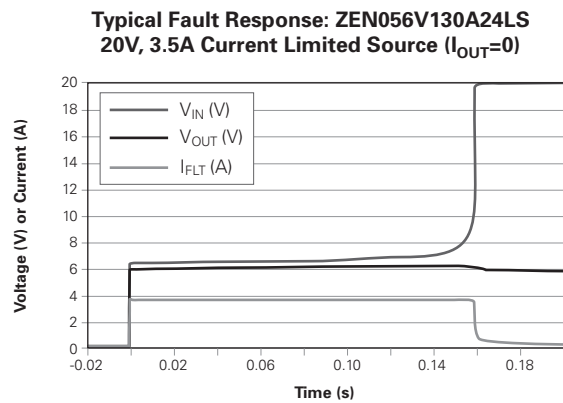


Figure PZ10

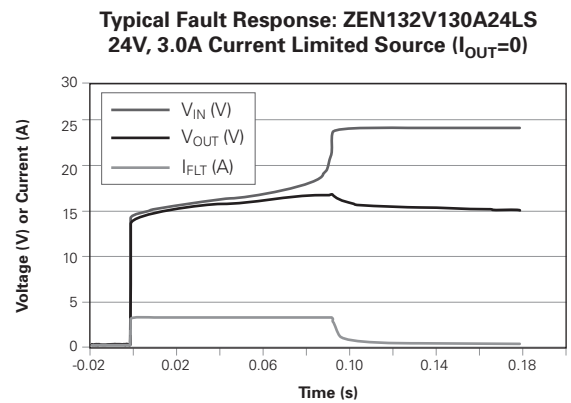


Table PZ4 Packaging and Marking Information for PolyZen Devices

Part Number	Bag Quantity	Tape & Reel Quantity	Standard Package
ZENxxxVyyyAzzLS	-	3,000	15,000

Table PZ5 Mechanical Dimensions for PolyZen Devices

	A		B		C	
	Min	Max	Min	Max	Min	Max
mm	3.85	4.15	3.85	4.15	1.7	2.1
inch	(0.150)	(0.163)	(0.152)	(0.163)	(0.067)	(0.083)

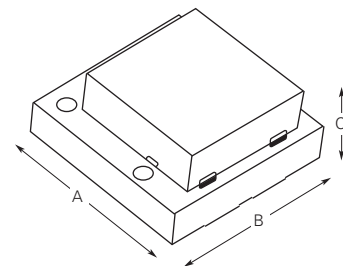
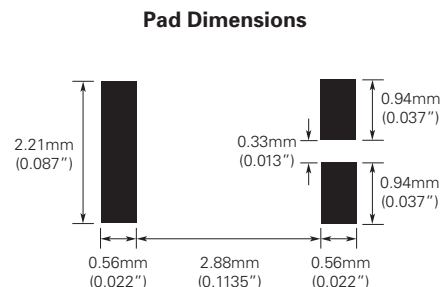
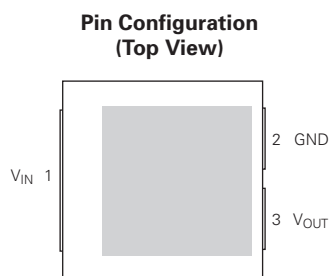
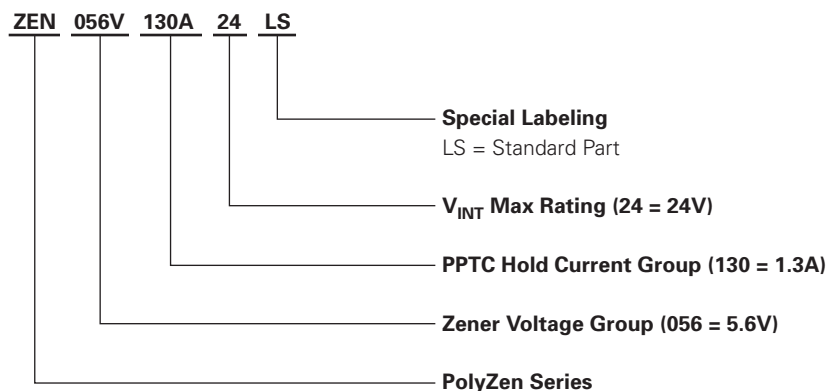
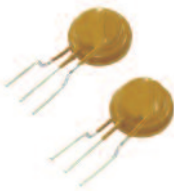


Table PZ6 Configuration Information for PolyZen Devices

Pin Number	Pin Name	Pin Function
1	V_{IN}	V_{IN} = Protected input to Zener diode
2	GND	GND = Ground
3	V_{OUT}	V_{OUT} = Zener regulated voltage output

Part Numbering System for PolyZen Devices**Warning :**

All information, including illustrations, is believed to be reliable. Users, however, should independently evaluate the suitability of each product for their application. Tyco Electronics Corporation makes no warranties as to the accuracy or completeness of the information, and disclaims any liability regarding its use. Tyco Electronics' only obligations are those in the Company's Standard Terms and Conditions of Sale for this product, and in no case will Tyco Electronics be liable for any incidental, indirect, or consequential damages arising from the sale, resale, use, or misuse of the product. Specifications are subject to change without notice. In addition, Tyco Electronics reserves the right to make changes without notification to Buyer—to materials or processing that do not affect compliance with any applicable specification.

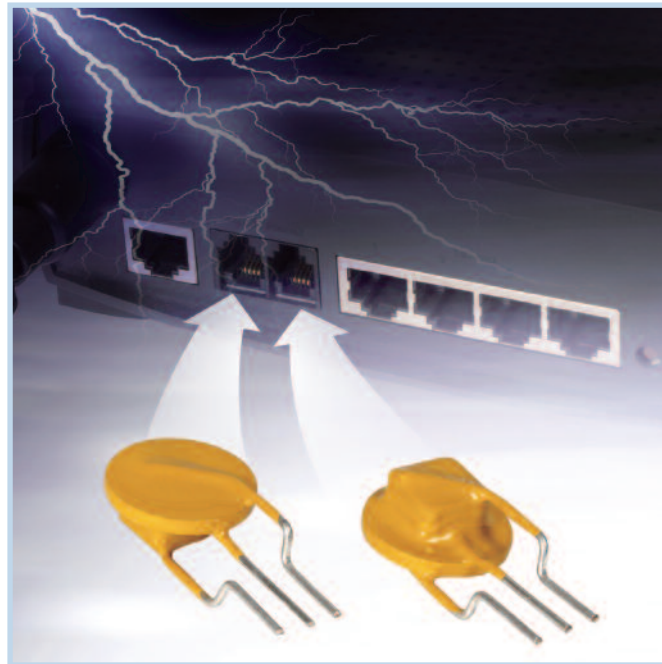


2Pro Devices

The 2Pro product is an integrated overcurrent/over-voltage protection device. The RoHS-compliant component incorporates PolySwitch PPTC (Polymeric Positive Temperature Coefficient) and metal oxide varistor technology in a single device to help reduce board space requirements and component count.

Damage to telephony communications equipment can be caused by various sources including lightning and ESD surges, power contact and induction with AC lines. The 2Pro TM2P-10271 devices help provide current limiting during overcurrent events, and voltage clamping during overvoltage events. After a fault condition is removed and power is cycled, 2Pro devices will reset so that communications equipment remains operational.

The 2Pro device helps address the need for resettable circuit protection devices for use in cost-sensitive PSTN (Public Switched Telephone Network) and VoIP (Voice over Internet Protocol) telephony equipment. The widespread use of VoIP gateways in homes and enterprise environments as the primary means of voice delivery requires the utmost safety and reliability in equipment. 2Pro circuit protection devices help manufacturers comply with global safety standards, including UL 60950, TIA-968-A, IEC 60950, and ITU-T K.20/K.21. The UL 497A listed protector also helps provide ESD protection.



Benefits

- Single device helps reduce component count and footprint
- Helps reduce warranty returns
- Helps equipment comply with surge tests per: TIA-968-A, IEC 60950, ITU-T K.20/K.21
- Helps simplify UL 60950 testing
- Helps equipment comply with UL 60950

Features

- Single overcurrent, overvoltage and ESD protection device
- Resettable overcurrent protection
- UL 497A listed protector (#E258475)
- RoHS compliant

Applications

- Cordless telephones
- VoIP gateways
- Fax machines
- Data modems
- Set-top boxes
- Security systems
- MDF modules
- Analog and ISDN linecards

Table 2P1 Electrical Characteristics for 2Pro Devices**Overcurrent (terminals 1 – 2) — Performance ratings @ 20°C**

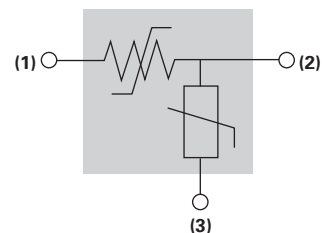
Part Number	I_{HOLD} (A)	I_{TRIP} (A)	Resistance (Ω)			Time to Trip (s)† @ 1A	
			R min.	R max.	R1 max*	Typ	Max
TM2P-10271	0.15	0.30	6.5	14.0	16.0	0.9	3

Overvoltage (terminals 2 – 3)

Part Number	Varistor Voltage V @ 1mA		DC Resistance @ 100V (M Ω)	Maximum Clamping Voltage @ 25A (V)	Rated Wattage (W)
	DC(V)	Tolerance			
TM2P-10271	270	± 10%	>10	455	0.25

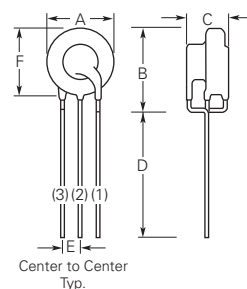
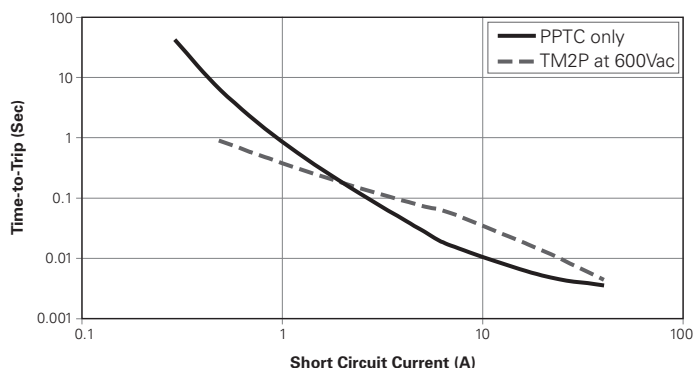
* Maximum device resistance at 20°C measured 1 hour post trip.

† Corresponds to operation below varistor voltages.

Electrical Schematic**Table 2P2 Mechanical Dimensions for 2Pro Devices**

	A		B		C		D		E	F	
	Min	Max	Min	Max	Min	Max	Min	Max	Nom	Min	Max
mm	—	12.0	—	15.0	—	6.6	6.0	—	2.5	—	12.0
inch*	—	(0.47)	—	(0.59)	—	(0.26)	(0.24)	—	(0.10)	—	(0.47)

* Rounded off approximation

**Figure 2P1 Typical Time-to-Trip at 25°C for 2Pro Devices****Table 2P3 Physical Characteristics and Environmental Specifications for 2Pro Devices****Physical Characteristics**

Lead material	Tin-plated copper, 0.33mm ² (22AWG), ø0.65mm (0.026in.)
Flammability	IEC 695-2-2 Needle flame test for 20s
Soldering characteristics	ANSI approved IPC/EIA/JEDEC J-STD-002, Category 3
Solder heat withstand	per IEC-STD 68-2-20, Test Tb, Method1A, Condition B, can withstand 10 seconds at 260°C ± 5°C

Environmental Specifications

Test	Conditions
Passive aging	60°C, 1000 hours / 85°C, 1000 hours
Humidity aging	85°C, 85% RH, 1000 hours
Active aging	60°C, 90% RH, 60Vdc bias, 1000 hours
Thermal shock	125°C, -55°C (10 times)
Solvent resistance	MIL-STD-202, Method 215K

Note: Storage conditions: 40°C max., 70% RH max., devices should remain in original sealed bag prior to use.
Devices may not meet specified values if these storage conditions are exceeded.

Table 2P4 Packaging and Marking Information for 2Pro Devices

Part Number	Bag Quantity	Tape & Reel Quantity	Standard Package	Part Marking	Agency Recognition
TM2P-10271	500	-	10,000	1027 & Batch #	UL 497A/File No. E258475
TM2P-10271-2	-	1,000	5,000	1027 & Batch #	UL 497A/File No. E258475

Table 2P5 Ordering Information for 2Pro Devices

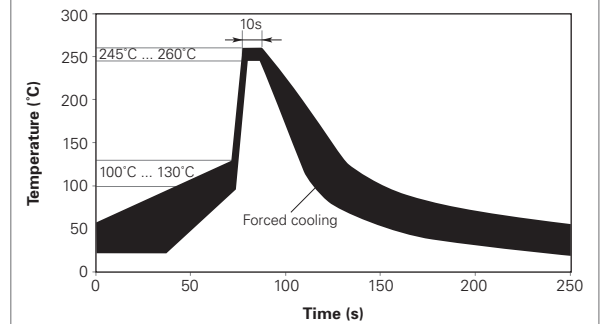
Bulk	500 pieces/bag
	10,000 pieces/box
Tape & Reel	1,000 pieces/reel
	5,000 pieces/box

Wave Soldering and Rework Recommendations for 2Pro Devices**Recommended Wave Soldering for Radial-leaded Devices**

- Soldering temperature profile
Temperature characteristic at component terminal with dual wave soldering

Rework

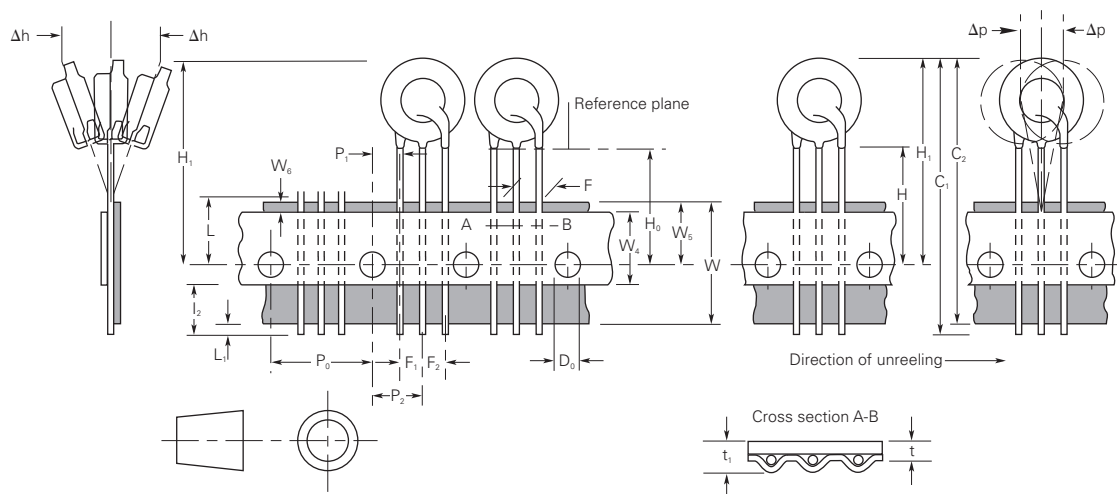
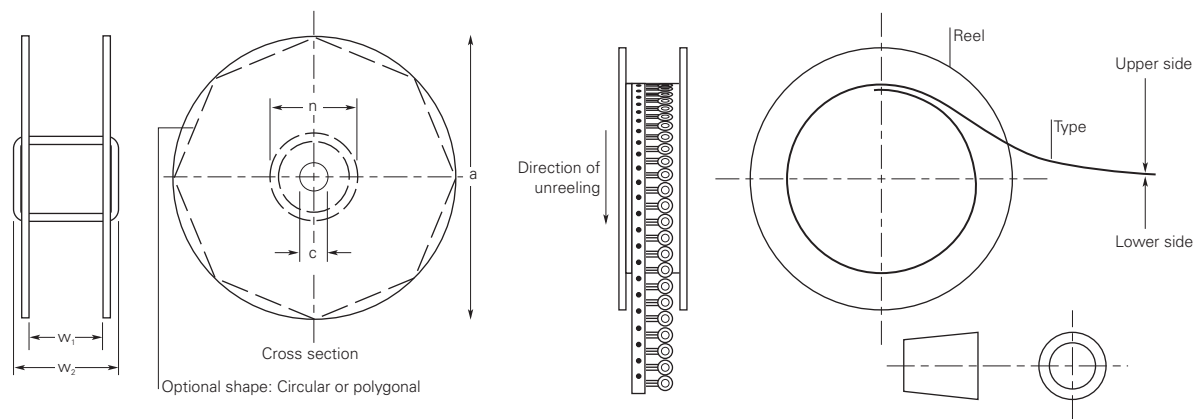
- If a device is removed from the board, it should be discarded and replaced with a new device.

Figure 2P2**Table 2P6 Tape and Reel Specifications for 2Pro Devices**

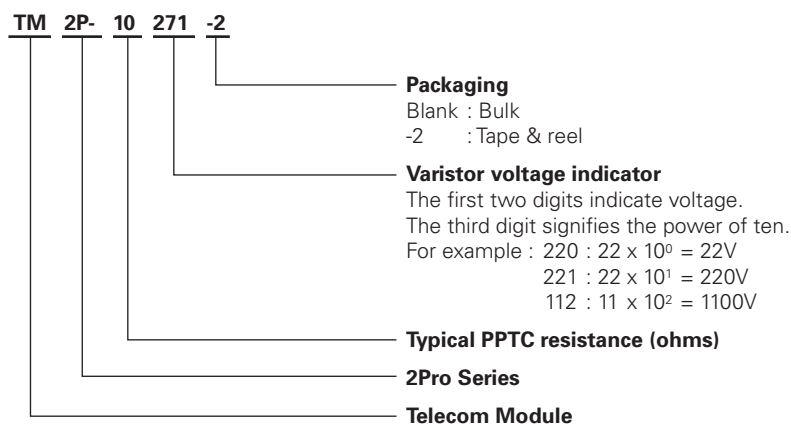
2Pro devices are available in tape and reel packaging per EIA 468-B standard. See Figures 2P3 and 2P4 for details.

Description	EIA Mark	IEC Mark	Dimension (mm)	Tolerance
Carrier tape width	W	W	18	-0.5/ +1.0
Hold down tape width	W ₄	W ₀	5	Minimum
Top distance between tape edges	W ₆	W ₂	3	Maximum
Sprocket hole position	W ₅	W ₁	9	-0.5/+0.75
Sprocket hole diameter	D ₀	D ₀	4	±0.2
Abcissa to plane (kinked lead)*	H ₀	H ₀	16	-0.5/0.6
Abcissa to top	H ₁	H ₁	32.2	Maximum
Overall width w/lead protrusion	-	C ₁	43.2	Maximum
Overall width w/o lead protrusion	-	C ₂	42.5	Maximum
Lead protrusion	L ₁	L ₁	1.0	Maximum
Protrusion of cut-out	L	L	11	Maximum
Protrusion beyond hold down tape	I ₂	I ₂	Not specified	-
Sprocket hole pitch	P ₀	P ₀	12.7	±0.3
Pitch tolerance	-	-	20 consecutive	±1
Tape thickness	t	t	0.9	Maximum
Tape thickness with splice*	t ₁	-	2.0	Maximum
Splice sprocket hole alignment	-	-	0	±0.3
Body lateral deviation	Δh	Δh	0	±0.1
Body tape plane deviation	Δp	Δp	0	±1.3
Ordinate to component center lead	P ₂	P ₂	6.35	±0.7
Lead spacing*	F ₁ ,F ₂	F ₁ ,F ₂	2.54	-0.1/+0.4
Reel width	w ₂	w	56	Maximum
Reel diameter	a	d	370	Maximum
Space between flanges	w ₁	-	51.2	Maximum
Arbor hole diameter	c	f	26	±12.0
Core diameter	n	h	80	Maximum
Box	-	-	56/372/372	Maximum
Consecutive missing pieces*	-	-	3 maximum	-
Empty places per reel*	-	-	Not specified	-

Note: *Differs from EIA specification.

Figure 2P3 EIA Referenced Taped Component Dimensions for 2Pro Devices**Figure 2P4 Reel Dimensions for 2Pro Devices**

5

Part Numbering System for 2Pro Devices**Warning :**

All information, including illustrations, is believed to be reliable. Users, however, should independently evaluate the suitability of each product for their application. Tyco Electronics Corporation makes no warranties as to the accuracy or completeness of the information, and disclaims any liability regarding its use. Tyco Electronics' only obligations are those in the Company's Standard Terms and Conditions of Sale for this product, and in no case will Tyco Electronics be liable for any incidental, indirect, or consequential damages arising from the sale, resale, use, or misuse of the product. Specifications are subject to change without notice. In addition, Tyco Electronics reserves the right to make changes without notification to Buyer—to materials or processing that do not affect compliance with any applicable specification.



ESD Protection Devices

The Raychem PESD electro-static discharge (ESD) protection devices help protect I/O ports on HDMI 1.3, portable video players, LCD plasma TV, USB 2.0, digital visual interface (DVI), and antenna switches. PESD devices shunt ESD away from sensitive circuitry in HDTV equipment, printers, laptops, cellular phones, and other portable devices.

PESD devices offer many advantages over traditional protection devices, such as Zener diodes and multi layer varistors (MLVs), which may degrade or distort the signal in high data rate circuits. Compared to transient voltage suppression (TVS) diodes and miniature gas discharge tubes (GDTs), PESD devices provide a more compact form factor and an economical solution for the shrinking profiles of today's compact information appliances.

PESD protection devices provide low capacitance, and meet transmission line pulse (TLP) testing, as well as IEC61000-4-2 testing.



6

Benefits

- Board space savings
- Help protect sensitive electronic circuits against electrostatic discharge (ESD)
- Assist equipment to pass IEC 61000-4-2, level 4 testing
- ESD protection for high frequency application (HDMI 1.3)
- Longer battery life due to low leakage current
- Suitable for high speed data transmission applications

Features

- Thick film technology
- Low capacitance (0.20 pF typical)
- Low clamping voltage
- Fast response time (< 1ns)
- Capable of withstanding numerous ESD strikes
- Compatible with standard reflow installation procedures
- Bi-directional protection

Applications

- HDMI 1.3 interfaces
- Portable video players
- LCD plasma TV
- USB 2.0 and IEEE 1394 interfaces
- Portable devices (PDA, DSC, BlueTooth...)
- Printer ports
- Satellite radios
- DVI
- Antennas
- GPS systems

Table E1 Electrical Characteristics for PESD Devices

	Continuous Max Operating Voltage	Typical Trigger Voltage*	Typical Clamping Voltage†	Typical Capacitance @1 MHz, 1V _{rms}	Typical Leakage Current	Max Leakage Current @ Max V _{DC}
Symbol	V _{DC}	V _{T(TLP)}	V _{C(TLP)}	C _p	I _{L(TYP)}	I _{L(MAX)}
Unit	V	V	V	pF	μA	μA
PESD0603-240	24	215	45	0.20	< 0.001	0.01

Notes : * TLP test method at 1kV

† Measured 30ns after pulse initiation

Typical capacitance value is also @ 0V, Max Operating Voltage bias

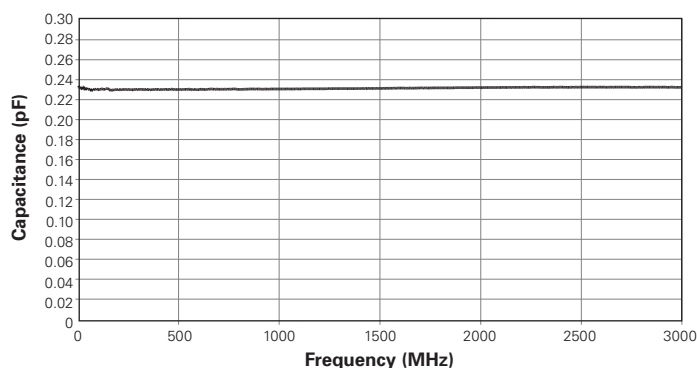
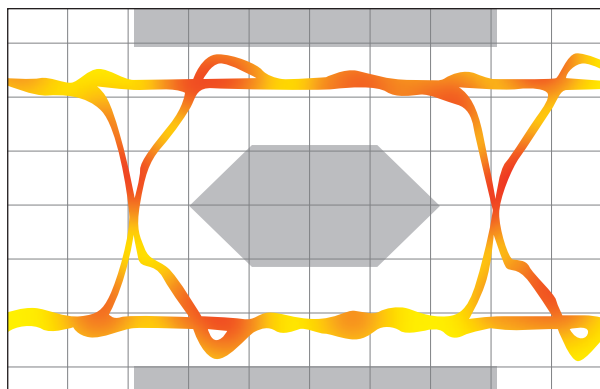
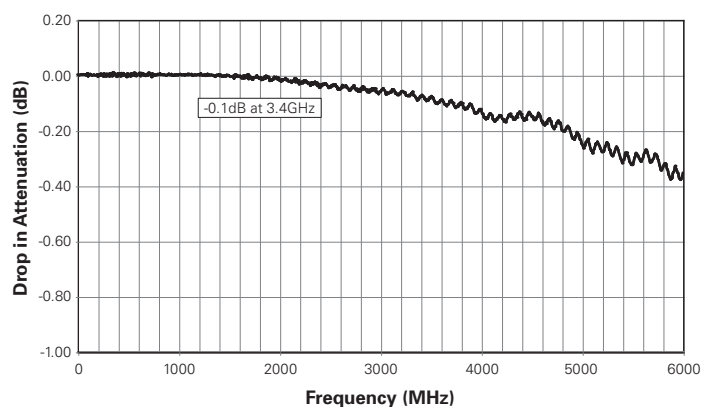
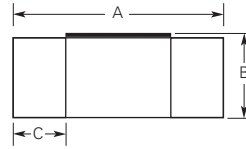
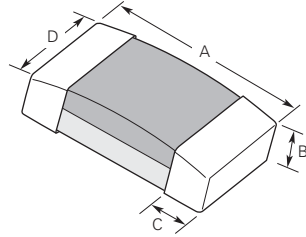
Figure E1 Capacitance vs. Frequency for PESD Devices**Figure E2** Eye Diagram Performance at 3.4 GHz for PESD Devices**Figure E3** Insertion Loss Diagram for PESD Devices

Table E2 Dimensions for PESD Devices in Millimeters (Inches)*

Part Number	Length A		Height B		Terminal Width C		Width D	
	Min	Max	Min	Max	Min	Max	Min	Max
0603-240	1.40	1.80	0.40	0.60	0.10	0.50	0.60	0.90
	(0.055)	(0.071)	(0.016)	(0.024)	(0.004)	(0.020)	(0.024)	(0.035)

*Rounded off approximation

**Table E3 Environmental Specifications for PESD Devices**

	Test Conditions	Pass / Fail Criteria
Bias Humidity Test	85°C, 85% RH, Max V_{DC} , 1000 hrs	$I_L \leq 10 \mu A$
Thermal Shock	-55°C to 125°C, 30 min dwell, 1000 cycles	$I_L \leq 10 \mu A$
Bias Heat Test	125°C, Max V_{DC} , 1000 hrs	$I_L \leq 10 \mu A$
Bias Low Temp Test	-55°C, Max V_{DC} , 1000 hrs	$I_L \leq 10 \mu A$
Solderability	230°C $\pm$ 5°C, 3 $\pm$ 1s	95% coverage
Solder Heat	260°C, 10s	90% coverage
Vibration	10 to 50Hz, 1 min cycle, 2 hrs each in X-Y-Z-direction	No physical damage
Solvent Resistance	IPA ultrasonic 300s	No physical damage
Shock	1500G 0.5 ms each, 30 shocks in X-Y-Z-direction	No physical damage

Table E4 General Characteristics for PESD Devices**PESD0603**

Storage Temperature:	-40°C to +85°C
Operating Temperature:	-55°C to +125°C
ESD Voltage Capability:	Contact discharge mode : typical 8kV, max 15kV
(tested per IEC 61000-4-2)	Air discharge mode : typical 15kV, max 25kV
ESD Pulse Withstand:	1000 pulses
(tested per IEC 61000-4-2, level 4, 8kV)	(tested per IEC 61000-4-2, level 4, contact method)

Table E5 Materials Information for PESD Devices

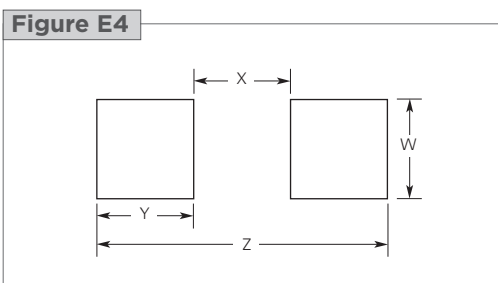
RoHS Compliant	Directive 2002/95/EC Compliant
ELV Compliant	Directive 2000/53/EC Compliant

Table E6 Recommended Pad Layout for PESD Devices in Millimeters (Inches)*

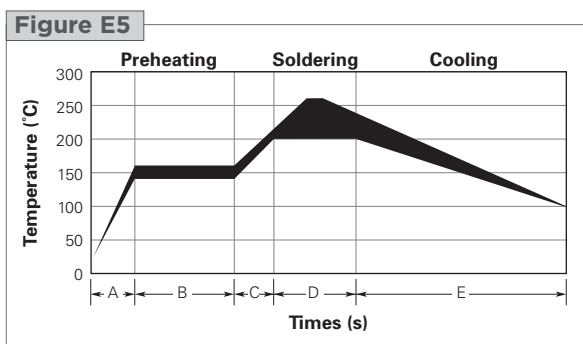
Part Number	W Ref	X Ref	Y Ref	Z Ref	Figure
PESD0603-240	0.9 min / 1.0 max	0.5 min / 0.6 max	1.0 min / 1.1 max	2.7 min / 2.8 max	E4

Note: Solder thickness 0.15 to 0.2 mm

*Rounded off approximation

**Table E7 Solder Reflow Recommendations for PESD Devices**

A	Temperature ramp up 1	From ambient to preheating temperature	30s to 60s
B	Preheating	140°C - 160°C	60s to 120s
C	Temperature ramp up 2	From preheating to main heating temperature	20s to 40s
D	Main heating	at 200°C	60s to 70s
		at 220°C	50s to 60s
		at 240°C	30s to 40s
		at 260°C	5s to 10s
E	Cooling	From main heating temperature to 100°C	max 4°C/s



Parameter Definitions for PESD Devices

Operation Voltage (V_{DC})

Defined as DC voltage, under which device is in OFF state and leakage current below certain threshold.

Leakage Current (I_L)

Current through device under Operation Voltage V_{DC}

Trigger Voltage (V_T)

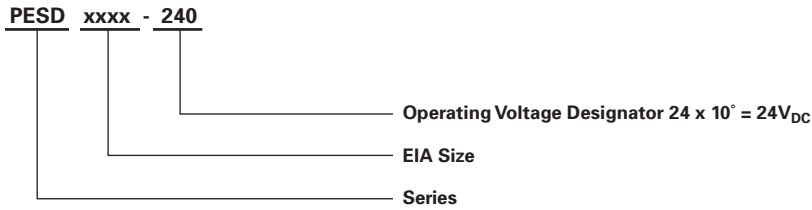
Voltage at which the device switches from the OFF to the ON state, during the IEC waveform or the TLP system

Clamping Voltage (V_C)

Voltage cross device under 8 kV per IEC or measured by TLP system. Typically measured 30 ns after initiation of the IEC ESD pulse (for TLP, both 30ns and 60ns are sometimes used)

Capacitance (C_p)

Capacitance of the device measured at 1 MHz with 0 bias and 1 Vrms signal.



Warning :

Application Limitations for PESD0603-240. This part is not intended to be used under power bus applications. Users should independently evaluate the suitability of and test each product selected for their own application.

Information furnished is believed to be accurate and reliable. However, users should independently evaluate the suitability of and test each product selected for their own applications. Tyco Electronics reserves the right to change or update, without notice, any information contained in this publication; to change, without notice, the design, construction, processing, or specification of any product; and to discontinue or limit production or distribution of any product. This publication supersedes and replaces all information previously supplied. Without expressed or written consent by an officer of Tyco Electronics Electronics, Tyco Electronics does not authorize the use of any of its products as components in nuclear facility applications, aerospace, or in critical life support devices or systems. Tyco Electronics expressly disclaims all implied warranties regarding the information contained herein, including, but not limited to, any implied warranties of merchantability or fitness for a particular purpose. Tyco Electronics only obligations are those in the Tyco Electronics Standard Terms and Conditions of Sale and in no case will Tyco Electronics be liable for any incidental, indirect, or consequential damages arising from the sale, resale, use, or misuse of its products.

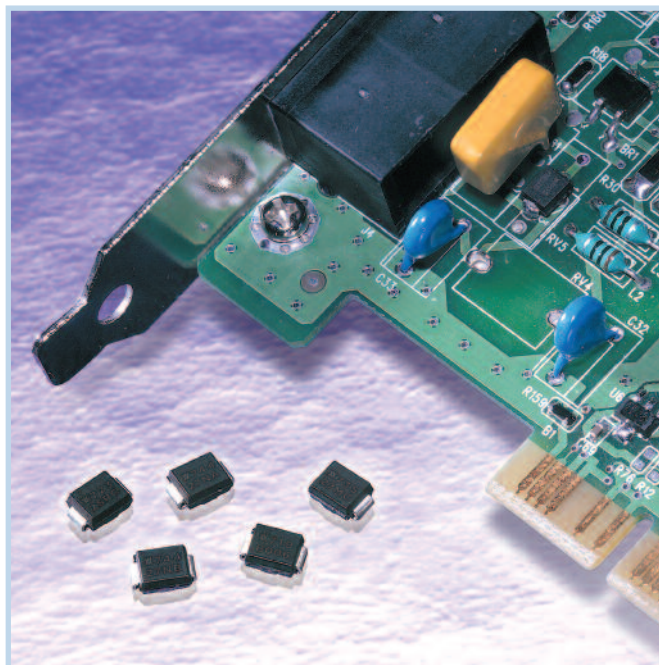


SiBar Thyristor Surge Protectors

SiBar thyristor surge protection devices help protect sensitive telecom and datacom equipment from overvoltage events, including lightning transients, and operate as shunt devices in response to a surge that exceeds the breakover voltage. When the voltage exceeds the breakover voltage the SiBar device “folds back”, creating a low-impedance path, effectively shorting out the overvoltage condition.

Compliant with major standards such as GR-1089 Core, ITU-T-K20/K21, IEC61000-4-5 and FCC part 68, and UL1950, SiBar devices provide fast, bidirectional protection on communications network equipment, including analog and digital linecards, xDSL and ISDN modems, set-top boxes, T1 equipment, Voice over IP (VoIP) and Power over Ethernet (PoE) equipment.

The SiBar thyristor's low on-state voltage allows for smaller form factor devices – as compared with clamping devices of comparable energy handling capability, and their relatively low capacitance makes them suitable for high data rate circuits.



Benefits

- Helps provide protection for sensitive telecom electronic equipment
- Low leakage current
- Low power dissipation
- Lower capacitance for high speed telecom applications
- Fast, reliable operation
- No wear-out mechanisms
- Helps designers meet worldwide telecom standards
- Helps reduce warranty and service costs
- Easy installation
- Helps improve power efficiency of equipment

Applications

- Modems
- Fax machines
- Phones
- PBX systems
- POS systems
- Analog and digital linecards (xDSL, T1/E1...)
- Other customer premise and central office network equipment requiring protection

Features

- RoHS complaint available on all parts
- Bidirectional crowbar transient voltage protection
- High off-state impedance
- Low on-state voltage
- High surge capability
- New reduced and micro capacitance devices
- New expanded voltage offerings (6V-400V)
- Short-circuit failure mode
- Surface-mount technology

Protection Application Guide for SiBar Thyristor Surge Protectors

To use this guide, follow the steps below:

1. Select your equipment type from the guide below.
2. Select the type of protection depending on the agency and regional specifications in the second column.

Application	Region/ Specification	SiBar Thyristor Surge Protectors*	Overcurrent Protection		
			Form Factor Radial-leaded	Surface-mount	Chip
Customer premises equipment, IT equipment Analog modems, V.90 modems, ISDN modems, xDSL modems, ADSL splitters, phone sets, multifunction printers, fax machines, answering machines, caller ID, internet appliances, PBX systems, POS terminals, wall plugs	North America TIA-968-A (FCC Part 68), UL60950	TVBxxx(N/R)SA-L, TVBxxx(N/M)SB-L, or TVAxxx(N/R)SA-L	TRF600-150	TS600-170F TS600-200F	
	Europe/Asia/ South America ITU K.21	TVBxxx(N/R)SA-L TVAxxx(N/R)SA-L	TRF250-120 TRF250-145 TRF250-120T TRF250-180 TRF250-183	TS250-130F TSV250-130F	
Access network equipment (†) Remote terminals, line repeaters, multiplexers, cross-connects, WAN equipment	North America Telcordia GR-1089	TVBxxx(N/M/R)SC-L	TRF600-160	TS600-170F TS600-200F TSM600-250F TSM600-400F FT600-1250‡	
	Europe/Asia/ South America ITU K.45	TVBxxx(N/R)SA-L TVAxxx(N/R)SA-L	TRF250-120 TRF250-145 TRF250-120T TRF250-180 TRF250-183	TS250-130F TSV250-130F	
Central office switching equipment (†) Analog/POTS linecards, ISDN linecards, xDSL modems, ADSL/VDSL splitters, T1/E1 linecards, multiplexers, CSU/DSU, servers	North America Telcordia GR-1089	TVBxxx(N/M/R)SC-L	TRF600-160	TSM600-250F TSM600-170F TSM600-200F TSM600-400F FT600-1250‡	
	Europe/Asia/ South America ITU K.20	TVBxxx(N/R)SA-L TVAxxx(N/R)SA-L	TRF250-120 TRF250-145 TRF250-120T TRF250-180 TRF250-183	TS250-130F TSV250-130F	TCF250-180
Primary protection modules (†) MDF modules, Network Interface Devices (NID)	North America Telcordia GR-974	N/A	TRF250-180		
	Europe/Asia/ South America ITU K.20	TVBxxx(N/M/R)Sx-L	TRF250-120T TRF250-145T TRF250-145	TS250-130F TSV250-130F	TCF250-120T TCF250-180
Short-haul/intrabuilding equipment (†) LAN equipment, VoIP cards, cable telephony NIU's, wireless local loop handsets	North America Telcordia GR-1089	TVBxxx(N/R)SA-L TVAxxx(N/R)SA-L	TRF250-120 TRF250-145 TRF250-120T	TS250-130F TSL250-080F TSV250-130F	
	Europe/Asia/ South America ITU K.21	TVBxxx(N/R)SA-L TVAxxx(N/R)SA-L	TRF250-120 TRF250-145 TRF250-180 TRF250-183	TS250-130F TSV250-130F	
LAN intrabuilding power cross protection LAN equipment, VoIP cards, IP phones		TVBxxx(N/R)SA-L TVAxxx(N/R)SA-L		TSL250-080F	
IEEE 802.3 Power over LAN protection Powered ethernet switches and terminals, IP phones, wireless LAN base stations, microcellular base stations, VoIP cards		N/A		decaSMD050F/60-2	
Cable telephony powering systems Power passing taps		N/A	BBRF550 BBRF750		

Note : This list is not exhaustive. Tyco Electronics welcomes our customers' input for additional application ideas.

* For more information on Raychem Circuit Protection PolySwitch resettable devices, refer to the telecommunications and networking devices section on page 184.

† For improved line balance in these applications, resistance-matched parts are recommended.

‡ FT600-1250 are surface mount telecom fuse devices. FT600-0500 and FT600-2000 reference also available. See FT600 section on page 100.

Table SB1 Electrical Characteristics, Part Marking and Agency Approval for SiBar Thyristor Surge Protectors

Part Number	V _{DM} Max. (V)	V _{BO} Max. (V)	I _H Min. (mA)	V _T Max. (V)	C ₁ @50V Typ. (pF)	C ₂ @ 2V Typ. (pF)	Part Marking	UL Approval
SMA 50A Standard "SA" and "NSA" Devices								
TVA170SA-L	170	265	150	4.0	20	39	170A	X
TVA170NSA-L	170	220	150	4.0	20	39	17NA	X
TVA200SA-L	200	320	150	4.0	17	33	200A	X
TVA220NSA-L	220	300	150	4.0	17	33	22NA	X
TVA270SA-L	270	365	150	4.0	16	31	270A	X
TVA275NSA-L	275	350	150	4.0	16	31	27NA	X
SMA 50A Reduced Capacitance "RSA" Devices								
TVA065RSA-L	65	88	150	4.0	20	40	A065	X
TVA090RSA-L	90	130	150	4.0	20	40	A090	X
TVA120RSA-L	120	160	150	4.0	16	30	A120	X
TVA130RSA-L	130	173	150	4.0	14	30	A130	X
TVA170RSA-L	170	220	150	4.0	14	25	A170	X
TVA190RSA-L	190	260	150	4.0	14	25	A190	X
TVA220RSA-L	220	295	150	4.0	12	25	A220	X
TVA270RSA-L	275	350	150	4.0	12	25	A270	X
TVA300RSA-L	320	400	150	4.0	12	25	A300	X
SMB 50A Standard "SA" and "NSA" Devices								
TVB058SA-L	58	77	150	4.0	43	80	058A	X
TVB058NSA-L	58	77	150	4.0	44	84	58NA	X
TVB065NSA-L	65	88	150	4.0	41	79	65NA	X
TVB075NSA-L	75	98	150	4.0	34	65	75NA	X
TVB090NSA-L	90	130	150	4.0	31	58	90NA	X
TVB120NSA-L	120	160	150	4.0	24	46	12NA	X
TVB140NSA-L	140	180	150	4.0	23	44	14NA	X
TVB170SA-L	170	265	150	4.0	18	35	170A	X
TVB170NSA-L	170	220	150	4.0	20	39	17NA	X
TVB180SA-L	180	219	150	4.0	30 (MAX)	60 (MAX)	180A	X
TVB180NSA-L	180	240	150	4.0	19	37	18NA	X
TVB190NSA-L	190	260	150	4.0	19	36	19NA	X
TVB200SA-L	200	320	150	4.0	18	35	200A	X
TVB220NSA-L	220	300	150	4.0	17	33	22NA	X
TVB270SA-L	270	365	150	4.0	15	32	270A	X
TVB275NSA-L	275	350	150	4.0	15	31	27NA	X
TVB300SA-L	300	400	150	4.0	14	27	300A	X
TVB320NSA-L	320	400	150	4.0	14	27	32NA	X
SMB 50A Reduced Capacitance "RSA" Devices								
TVB065RSA-L	65	88	150	4.0	20	40	65RA	X
TVB090RSA-L	90	130	150	4.0	20	40	90RA	X
TVB120RSA-L	120	160	150	4.0	16	30	12RA	X
TVB130RSA-L	130	173	150	4.0	14	30	13RA	X
TVB170RSA-L	170	220	150	4.0	14	25	17RA	X
TVB190RSA-L	190	260	150	4.0	14	25	19RA	X
TVB220RSA-L	220	295	150	4.0	12	25	22RA	X
TVB270RSA-L	275	350	150	4.0	12	25	27RA	X
TVB300RSA-L	320	400	150	4.0	12	25	30RA	X
SMB 80A Standard "SB" and "NSB" Devices								
TVB006SB-L	6	20	50 (TYP)	4.0	–	50 (TYP)	B006	X
TVB058NSB-L	58	77	150	4.0	67	129	58NB	X
TVB065NSB-L	65	88	150	4.0	64	123	65NB	X
TVB075NSB-L	75	98	150	4.0	63	122	75NB	X
TVB090NSB-L	90	130	150	4.0	49	95	90NB	X
TVB120NSB-L	120	160	150	4.0	38	75	12NB	X
TVB140NSB-L	140	180	150	4.0	36	70	14NB	X
TVB170NSB-L	170	220	150	4.0	29	59	17NB	X
TVB180NSB-L	180	240	150	4.0	29	59	18NB	X
TVB190NSB-L	190	260	150	4.0	28	56	19NB	X
TVB200SB-L	200	320	150	4.0	30	49	200B	X
TVB220NSB-L	220	300	150	4.0	26	52	22NB	X

Table SB1

Electrical Characteristics, Part Marking and Agency Approval for
SiBar Thyristor Surge Protectors

... Cont'd

Part Number	V _{DM} Max. (V)	V _{BO} Max. (V)	I _H Min. (mA)	V _T Max. (V)	C ₁ @50V Typ. (pF)	C ₂ @ 2V Typ. (pF)	Part Marking	UL Approval
SMB 80A Standard "SB" and "NSB" Devices								
TVB270SB-L	270	350	150	4.0	25	50	270B	X
TVB275NSB-L	275	350	150	4.0	23	47	27NB	X
TVB300SB-L	300	400	150	4.0	21	42	300B	X
TVB320NSB-L	320	400	150	4.0	22	44	32NB	X
SMB 80A Micro Capacitance "MSB" Devices								
TVB120MSB-L	120	160	150	4.0	12	25	12MB	X
TVB140MSB-L	140	180	150	4.0	12	25	14MB	X
TVB170MSB-L	170	220	150	4.0	12	25	17MB	X
TVB190MSB-L	190	260	150	4.0	12	25	19MB	X
TVB220MSB-L	220	295	150	4.0	12	25	22MB	X
TVB270MSB-L	275	350	150	4.0	12	25	27MB	X
TVB300MSB-L	320	400	150	4.0	12	25	30MB	X
SMB 100A Standard "SC" and "NSC" Devices								
TVB058NSC-L	58	77	150	4.0	114	222	57NC	X
TVB065NSC-L	65	88	150	4.0	103	198	65NC	X
TVB075NSC-L	75	98	150	4.0	90	176	75NC	X
TVB090NSC-L	90	130	150	4.0	79	154	90NC	X
TVB120NSC-L	120	160	150	4.0	72	140	12NC	X
TVB140NSC-L	140	180	150	4.0	66	130	14NC	X
TVB170SC-L	170	265	150	4.0	60	125	170C	X
TVB170NSC-L	170	220	150	4.0	48	99	17NC	X
TVB180NSC-L	180	240	150	4.0	48	97	18NC	X
TVB190NSC-L	190	260	150	4.0	44	90	19NC	X
TVB200SC-L	200	320	150	4.0	55	115	200C	X
TVB220NSC-L	220	300	150	4.0	41	81	22NC	X
TVB270SC-L	270	365	150	4.0	50	110	270C	X
TVB275NSC-L	275	350	150	4.0	38	76	27NC	X
TVB300SC-L	300	400	150	4.0	47	98	300C	X
TVB320NSC-L	320	400	150	4.0	35	71	32NC	X
SMB 100A Reduced Capacitance "RSC" Devices								
TVB006RSC-L	6	25	50 (typ)	4.0	—	75	06RC	X
TVB025RSC-L	25	40	150	4.0	—	65	25RC	X
TVB035RSC-L	35	55	150	4.0	—	55	35RC	X
TVB065RSC-L	65	88	150	4.0	45	90	65RC	X
TVB090RSC-L	90	125	150	4.0	40	80	90RC	X
TVB120RSC-L	120	160	150	4.0	35	75	12RC	X
TVB140RSC-L	140	180	150	4.0	30	65	14RC	X
TVB170RSC-L	170	220	150	4.0	30	60	17RC	X
TVB190RSC-L	190	260	150	4.0	30	60	19RC	X
TVB220RSC-L	220	295	150	4.0	30	60	22RC	X
TVB270RSC-L	275	350	150	4.0	30	60	27RC	X
TVB300RSC-L	320	400	150	4.0	25	50	30RC	X
TVB360RSC-L	360	460	150	4.0	25	50	36RC	X
TVB400RSC-L	400	540	150	4.0	20	45	40RC	X
SMB 100A Micro Capacitance "MSC" Devices								
TVB140MSC-L	140	180	150	4.0	30	60	14MC	X
TVB170MSC-L	170	220	150	4.0	25	50	17MC	X
TVB190MSC-L	190	260	150	4.0	25	45	19MC	X
TVB220MSC-L	220	295	150	4.0	20	40	22MC	X
TVB270MSC-L	275	350	150	4.0	20	40	27MC	X
TVB300MSC-L	320	400	150	4.0	20	40	30MC	X
TVB400MSC-L	400	530	150	4.0	15	30	40MC	X

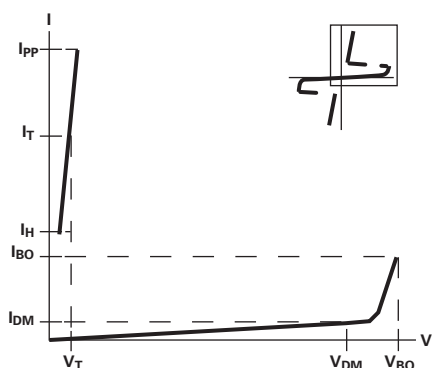
Notes : All electrical characteristics are measured at 25°C.V_{DM} measured per UL497B pulse requirements: at max. off-state leakage current (IDM) = 5μA.V_{BO} measured at 100V/μs.

Table SB2 Surge Current Rating for SiBar Thyristor Surge Protectors

	Part Number	TIA-968			Telcordia GR-1089*		IEC61000-4-5	ITU K.20/21/45*	I_{TSM} Min. (A)	di/dt (A/μs)	dV/dt (A/μs)
		Type A	Type B		I_{pp} (A) 10 x 1000μs	I_{pp} (A) 2 x 10μs	I_{pp} (A) 8 x 20μs	I_{pp} (A) 5 x 310μs (V _{OC} : 10x700μs)			
		I_{pp} (A) 5 x 320μs	I_{pp} (A) 10 x 560μs	I_{pp} (A) 10 x 160μs							
TVAxxxSA-L	90	70	100	50	150	150	90	22	500	2000	
TVAxxxNSA-L	90	70	100	50	150	150	90	22	500	2000	
TVAxxxRSA-L	65	55	75	50	100	150	65	22	500	2000	
TVB180SA-L	—	75	110	50	—	—	100	32	500	2000	
TVBxxxSA-L	90	70	100	50	150	150	90	22	500	2000	
TVBxxxNSA-L	90	70	100	50	150	150	90	22	500	2000	
TVBxxxRSA-L	65	55	75	50	100	150	65	22	500	2000	
TVB006SB-L	120	100	150	75	250	250	120	28	500	2000	
TVBxxxSB-L	100	100	150	80	250	250	100	30	500	2000	
TVBxxxNSB-L	100	100	150	80	250	250	100	30	500	2000	
TVBxxxMSB-L	120	100	150	80	250	200	120	28	500	2000	
TVBxxxSC-L	150	150	200	100	500	400	150	60	500	2000	
TVBxxxNSC-L	150	150	200	100	500	400	200	60	500	2000	
TVBxxxRSC-L	150	140	200	100	500	400	150	41	500	2000	
TVBxxxMSC-L	150	140	200	100	500	300	150	41	500	2000	

Notes : I_{TSM} : peak on-state surge current is measured at 60 Hz, one cycle.
 di/dt : critical rate-of-rise of on-state current (pulsed power amplifier $V_{max} = 600V$; $C = 30\mu F$).
 dV/dt : critical rate-of-rise of off-stage voltage (linear wave form, $V_D = \text{rated } V_{BO}$, $T_J = 25^\circ C$)

* Lightning current wave forms for applicable industry specification.

Figure SB1 Voltage-Current Characteristics for SiBar Thyristor Surge Protectors

The voltage current (V-I) is useful in depicting the electrical characteristics of the SiBar thyristor surge protectors in relation to each other.

Table SB3 Parameter Definitions for SiBar Thyristor Surge Protectors

Symbol	Parameter	Definition
V_{BO}	Breakover voltage	Maximum voltage across the device at breakdown measured under a specified voltage and current rate of rise.
I_{BO}	Breakover current	Instantaneous current flowing at the breakover voltage (V_{BO}).
I_H	Hold current	Minimum current required to maintain the device in the on-state.
I_T	On-state current	Current through the device in the on-state condition.
V_T	On-state voltage	Voltage across the device in the on-state condition at a specified current (I_T).
V_{DM}	Maximum off-state voltage	Maximum DC voltage that can be applied to the device while maintaining it in the off-state condition.
I_{DM}	Off-state current	Maximum DC value of current that results from the application of the maximum off-state voltage.
I_{PP}	Peak pulse current	Rated peak pulse current of specified amplitude and waveshape that may be applied without damage.
$di/dt, dV/dt$	Critical rate of rise of on-state current and voltage	Maximum current and voltage rate of rise the device can withstand without damage.

Figure SB2-SB5 Typical Electrical Characteristics vs. Temperature for SiBar Thyristor Surge Protectors

Figure SB2

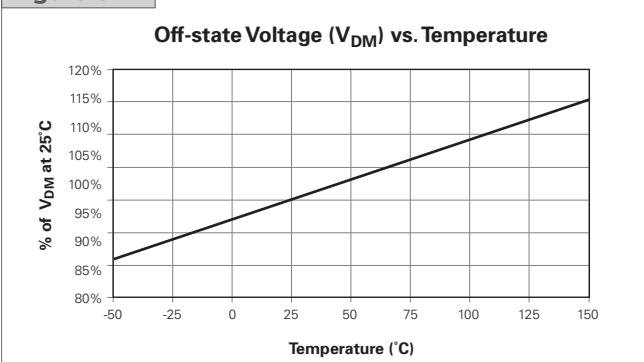


Figure SB3

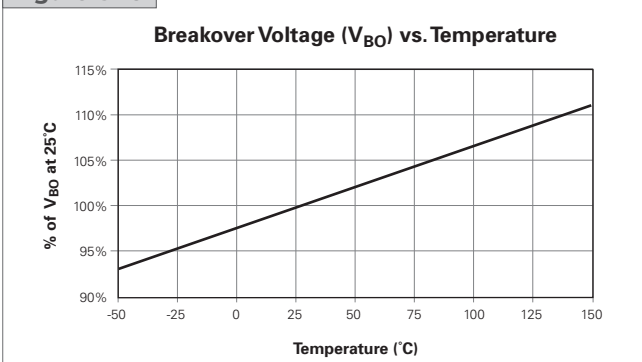


Figure SB4

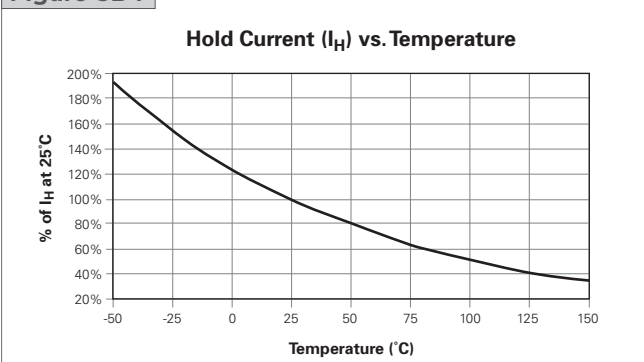


Figure SB5

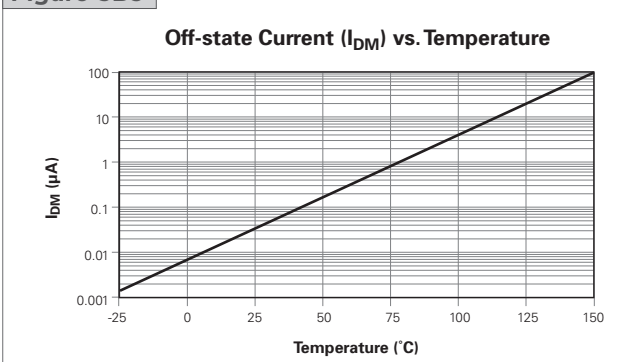


Table SB4 Dimensions for SiBar Thyristor Surge Protectors in Millimeters (Inches)

Dimension	A		B		C		D*		H		J		K		P	S	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Ref.	Min	Max
SMB Package:	4.06	4.57	3.30	3.94	1.90	2.41	1.95	2.20	0.051	0.200	0.150	0.31	0.76	1.27	0.51	5.21	5.59
TVBxxx(M/N/R)Sx-L	(0.160)	(0.180)	(0.130)	(0.155)	(0.075)	(0.095)	(0.077)	(0.087)	(0.002)	(0.008)	(0.006)	(0.012)	(0.030)	(0.050)	(0.020)	(0.205)	(0.220)
SMA Package:	4.06	4.57	2.25	2.92	1.90	2.41	1.25	1.65	0.051	0.200	0.150	0.41	0.76	1.52	0.51	4.80	5.59
TVAxix(N/R)Sx-L	(0.160)	(0.180)	(0.089)	(0.115)	(0.075)	(0.095)	(0.049)	(0.065)	(0.002)	(0.008)	(0.006)	(0.016)	(0.030)	(0.060)	(0.020)	(0.189)	(0.220)

Notes : TVA series devices use industry standard SMA package type. (JEDEC DO-214AC)
TVB series devices use industry standard SMB package type. (JEDEC DO-214AA)
All devices are bidirectional and may be oriented in either direction for installation.

* D dimension is measured within dimension P.

Figure SB6 Dimension Figure for SiBar Thyristor Surge Protectors

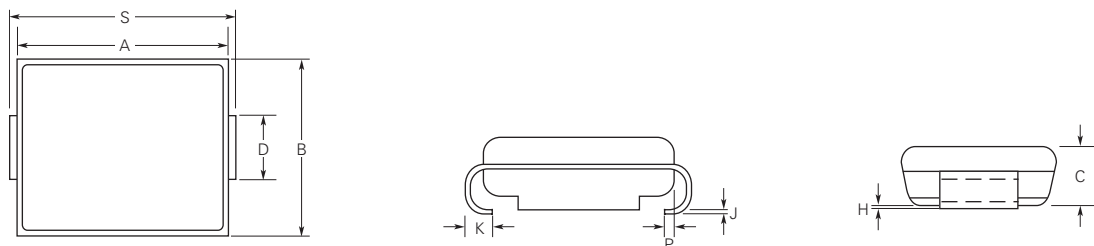


Table SB5 Physical Characteristics and Environmental Specifications for SiBar Thyristor Surge Protectors

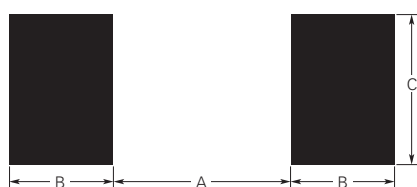
Lead material	Matte tin finish (-L devices)
Encapsulating material	Epoxy, meets UL94V-0 requirements
Solderability	per MIL-STD-750, Method 2026
Solder heat withstand	per MIL-STD-750, Method 2031
Solvent resistance	per MIL-STD-750, Method 1022
Mechanical shock	per MIL-STD-750, Method 2016
Vibration	per MIL-STD-750, Method 2056
Storage temperature (°C)	-55°C to 150°C
Operating temperature (°C)	-40°C to 125°C
Junction temperature (°C)	175°C
Maximum lead temperature for soldering purpose; for 10s (°C)	260°C

Table SB6 Reliability Tests for SiBar Thyristor Surge Protectors

Test	Conditions	Duration
High temperature, reverse bias	+100°C, 50V _{DC} bias	1000 hours
High humidity, high temperature, reverse bias	85% RH, +85°C, 50V _{DC} bias	1000 hours
High temperature storage life	+150°C	1000 hours
Temperature cycling	-65°C to +150°C, 15 minute dwell	1000 cycles
Autoclave	100% RH, +121°C, 15 PSI	96 hours

Table SB7 Packaging Information for SiBar Thyristor Surge Protectors

Part Description	Tape and Reel Quantity	Standard Package	Recommended Pad Layout (millimeters/inches)		
			Dimension A (Nom.)	Dimension B (Nom.)	Dimension C (Nom.)
TVAx _{xxx} SA-L	5,000	20,000	2.000 (0.079)	2.000 (0.079)	2.000 (0.079)
TVAx _{xxx} NSA-L	5,000	20,000	2.000 (0.079)	2.000 (0.079)	2.000 (0.079)
TVAx _{xxx} RSA-L	5,000	20,000	2.000 (0.079)	2.000 (0.079)	2.000 (0.079)
TVB _{xxx} SA-L	2,500	10,000	2.261 (0.089)	2.159 (0.085)	2.743 (0.108)
TVB _{xxx} NSA-L	2,500	10,000	2.261 (0.089)	2.159 (0.085)	2.743 (0.108)
TVB _{xxx} RSA-L	2,500	10,000	2.261 (0.089)	2.159 (0.085)	2.743 (0.108)
TVB006SB-L	2,500	10,000	2.261 (0.089)	2.159 (0.085)	2.743 (0.108)
TVB _{xxx} SB-L	2,500	10,000	2.261 (0.089)	2.159 (0.085)	2.743 (0.108)
TVB _{xxx} NSB-L	2,500	10,000	2.261 (0.089)	2.159 (0.085)	2.743 (0.108)
TVB _{xxx} MSB-L	2,500	10,000	2.261 (0.089)	2.159 (0.085)	2.743 (0.108)
TVB _{xxx} SC-L	2,500	10,000	2.261 (0.089)	2.159 (0.085)	2.743 (0.108)
TVB _{xxx} NSC-L	2,500	10,000	2.261 (0.089)	2.159 (0.085)	2.743 (0.108)
TVB _{xxx} MSC-L	2,500	10,000	2.261 (0.089)	2.159 (0.085)	2.743 (0.108)
TVB _{xxx} RSC-L	2,500	10,000	2.261 (0.089)	2.159 (0.085)	2.743 (0.108)

Figure SB7 Recommended Pad Layout for SiBar Thyristor Surge Protectors

Solder Reflow and Rework Recommendations for SiBar Thyristor Surge Protectors

SiBar thyristor devices are compatible with standard reflow and wave soldering techniques.

Solder Reflow

- Recommended reflow methods: IR, vapor phase oven, hot air oven.
- Always preheat the device to prevent excessive thermal shock and stress.
- Recommended maximum paste thickness of 0.25mm (0.010 in.).
- Devices may be cleaned using standard industry methods and solvents.

Solder Rework

- Use standard industry practices for the SiBar Thyristor Surge Protectors.

Figure SB8

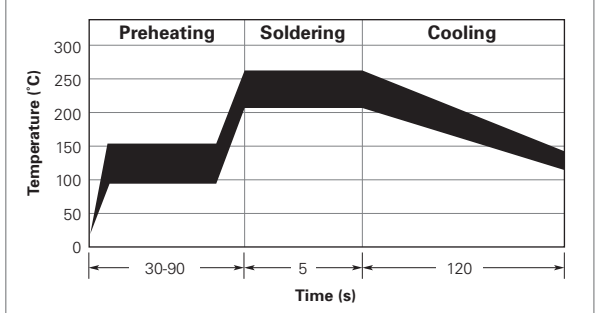


Table SB8 Tape and Reel Specifications for SiBar Thyristor Surge Protectors

SiBar thyristor devices are supplied on tape and reel per EIA481-1 standard. (See Figure SB9 and SB10 for details.)

Description	TVB Series		TVA Series	
	Dimensions (mm)	Tolerance (mm)	Dimensions (mm)	Tolerance (mm)
W	12	+/- 0.30	12	+/- 0.3
P ₀	4.0	+/- 0.10	4.0	+/- 0.10
P ₁	8.0	+/- 0.10	8.0	+/- 0.10
P ₂	2.0	+/- 0.10	2.0	+/- 0.10
A ₀	4.3	—	2.9	+/- 0.10
B ₀	6.2	—	5.59	+/- 0.10
B ₁ max.	8.2	—	8.2	—
D ₀	1.5	+ 0.1, -0.0	1.5	+ 0.1, -0
F	5.5	+/- 0.05	5.5	+/- 0.05
E ₁	1.75	+/- 0.10	1.75	+/- 0.10
E ₂ min.	9.85	—	9.85	—
T max.	0.6	—	0.6	—
T ₁ max.	0.1	—	0.1	—
K ₀ max.	2.59	+/- 0.10	2.36	+/- 0.10
Leader min.	390	—	390	—
Trailer min.	160	—	160	—

Figure SB9 EIA Referenced Taped Component Dimensions for SiBar Thyristor Surge Protectors

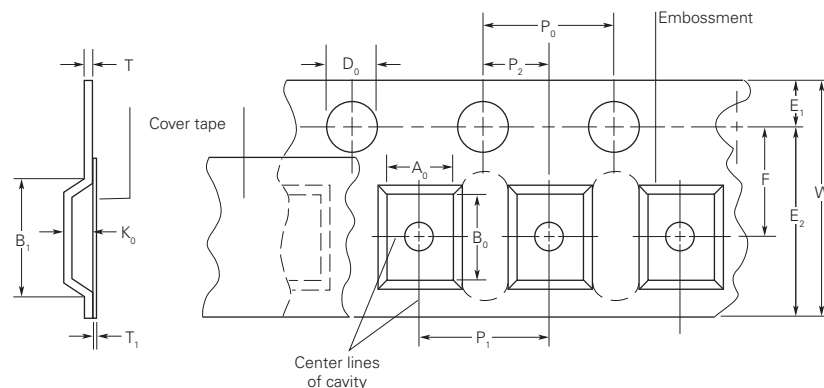
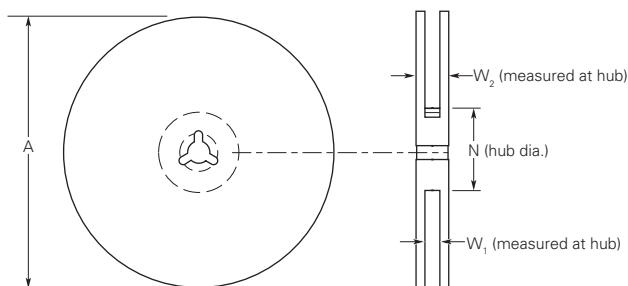
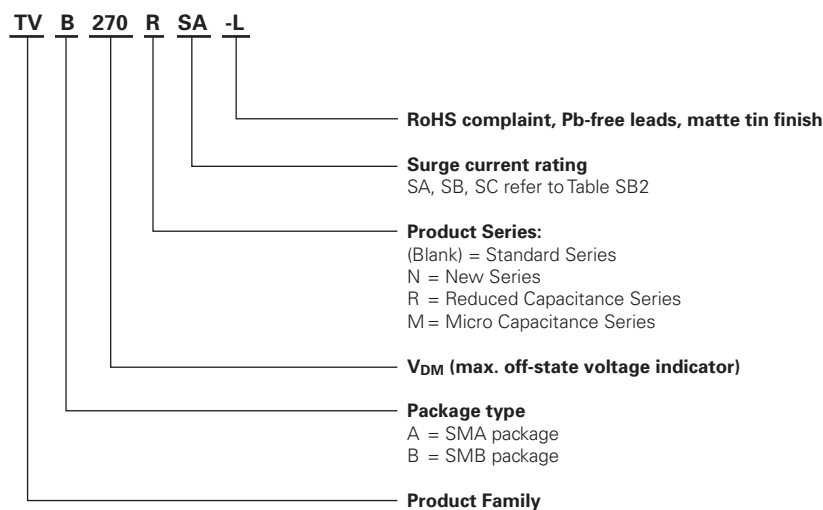


Figure SB10 EIA Referenced Reel Dimensions for SiBar Thyristor Surge Protectors**Reel Dimension**

A max.	330
N min.	50
W_1	$12.4 + 2.0, -0$
W_2 max.	18.4

**Part Numbering System for SiBar Thyristor Surge Protectors****Warning :**

- Operation beyond the maximum ratings or improper use may result in device damage and possible electrical arcing and flame.
- The devices are intended for protection against occasional overvoltage fault conditions and should not be used when repeated fault conditions or prolonged trip events are anticipated.
- Device performance can be impacted negatively if devices are handled in a manner inconsistent with recommended electronic, thermal, and mechanical procedures for electronic components.



Gas Discharge Tubes

Raychem GDTs (Gas Discharge Tubes) are placed in front of, and in parallel with, sensitive telecom equipment such as power lines, communication lines, signal lines and data transmission lines to help protect them from damage caused by transient surge voltages that may result from lightning strikes and equipment switching operations. These devices do not influence the signal in normal operation. However, in the event of an overvoltage surge, such as a lightning strike, the GDT switches to a low impedance state and diverts the energy away from the sensitive equipment.

Raychem GDTs offer a higher level of protection, compared with typical GDTs, and their fast and accurate break-over voltage makes them suitable for applications such as MDF (Main Distribution Frame) modules, high data-rate telecom applications (e.g. ADSL, VDSL), and surge protection on power lines. Their low capacitance also results in less signal distortion. When used in a coordinated circuit protection solution with PolySwitch devices, SiBar thyristor surge protection devices, and MOV (Metal Oxide Varistor) devices, they can help equipment manufacturers meet stringent safety regulatory standards.



Benefits

- Helps provide overvoltage fault protection against high energy surges
- Suitable for sensitive equipment due to excellent impulse sparkover response
- Suitable for high-frequency applications
- Highly reliable performance

Features

- RoHS compliant available on all parts
- Crowbar device with low arc-voltage
- Low capacitance and insertion loss
- High accuracy sparkover voltages for high precision designs
- Wide range of voltages and form factors
- Many devices tested per ITU K.12 recommendations
- Optional fail-short mechanism
- Various lead configurations
- Non radioactive materials

Applications

- Telecommunications
 - MDF modules, xDSL equipment, RF system protection, antenna, base stations
- Industrial and Consumer electronics, such as
 - Power supplies, Surge protectors, Alarm system

Figure G1 Two electrode devices for ungrounded circuits

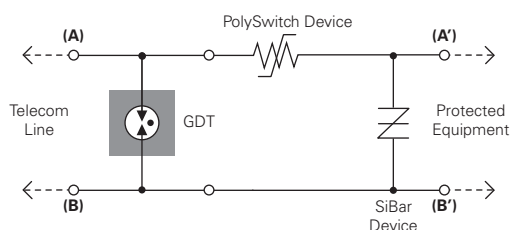


Figure G2 Three electrode devices for grounded circuits

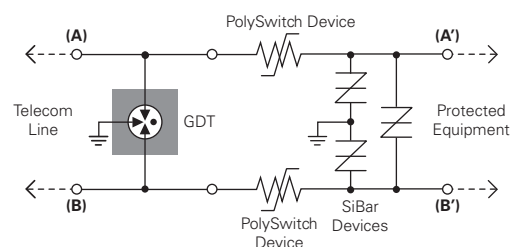


Table G1 Two Electrode Configurations for Gas Discharge Tubes**GTCx26 Miniature Two Electrode Series**

Figure 1 : without leads

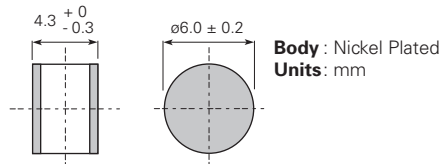
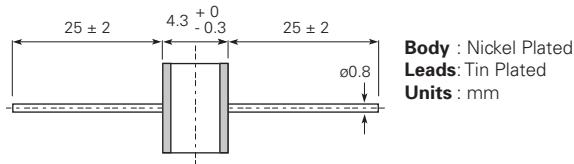


Figure 2 : with leads



Part Number	DC Sparkover Voltage	Impulse Sparkover Voltage		Insulation Resistance	Capacitance	DC Holdover Voltage	Impulse Life	Impulse Discharge Current 8/20μs		AC Discharge Current, 50Hz	
	@ 100V/s	@ 100V/μs	@ 1kV/μs	@ 100V _{DC}	@ 1MHz	Per ITU K.12	10/1000μs, 50A	Single Hit	Repeat 10 times (5 times each polarity)	Single Hit, 9 Cycles	Repeat 10 times (1s interval)
GTCN26-101M-P02-B GTCA26-101M-P02	100V ± 20%	≤ 500V	≤ 700V	≥ 10,000MΩ*	≤ 1.0pF	≤ 52V	300 times	3kA	2.5kA	20A	2.5A
GTCN26-231M-P05-B GTCA26-231M-P05	230V ± 20%	≤ 500V	≤ 700V	≥ 10,000MΩ	≤ 1.0pF	≤ 135V	300 times	10kA	5kA	20A	5A
GTCN26-351M-P05-B GTCA26-351M-P05	350V ± 20%	≤ 600V	≤ 800V	≥ 10,000MΩ	≤ 1.0pF	≤ 135V	300 times	10kA	5kA	20A	5A

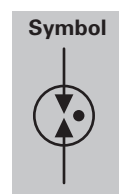
GTCx28-xxxx-P05 Standard Two Electrode Series

Figure 1 : without leads

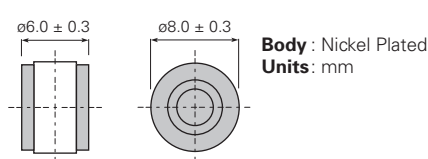
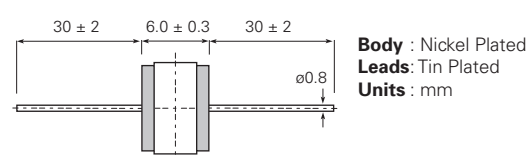


Figure 2 : with leads



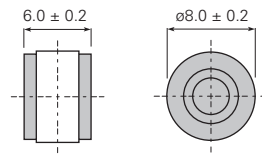
Part Number	DC Sparkover Voltage	Impulse Sparkover Voltage		Insulation Resistance	Capacitance	DC Holdover Voltage	Impulse Life	Impulse Discharge Current 8/20μs		AC Discharge Current, 50Hz	
	@ 100V/s	@ 100V/μs	@ 1kV/μs	@ 100V _{DC}	@ 1MHz	Per ITU K.12	10/1000μs, 500A	Single Hit	Repeat 10 times (5 times each polarity)	Single Hit, 9 Cycles	Repeat 10 times (1s interval)
GTCN28-750M-P05 GTCA28-750M-P05	75V ± 20%	≤ 500V	≤ 700V	≥ 10,000MΩ*	≤ 1.0pF	≤ 52V	300 times	10kA	5kA	65A	10A, 5 times
GTCN28-900M-P05 GTCA28-900M-P05	90V ± 20%	≤ 500V	≤ 700V	≥ 10,000MΩ*	≤ 1.0pF	≤ 52V	300 times	10kA	5kA	65A	10A, 5 times
GTCN28-151M-P05 GTCA28-151M-P05	150V ± 20%	≤ 500V	≤ 700V	≥ 10,000MΩ*	≤ 1.0pF	≤ 80V	300 times	10kA	5kA	65A	10A, 5 times
GTCN28-231L-P05 GTCA28-231L-P05	230V ± 15%	≤ 600V	≤ 750V	≥ 10,000MΩ	≤ 1.0pF	≤ 135V	300 times	10kA	5kA	65A	10A, 5 times
GTCN28-251L-P05 GTCA28-251L-P05	250V ± 15%	≤ 600V	≤ 800V	≥ 10,000MΩ	≤ 1.0pF	≤ 135V	300 times	10kA	5kA	65A	10A, 10 times
GTCN28-301L-P05 GTCA28-301L-P05	300V ± 15%	≤ 700V	≤ 850V	≥ 10,000MΩ	≤ 1.0pF	≤ 150V	300 times	10kA	5kA	65A	10A, 10 times
GTCN28-351L-P05 GTCA28-351L-P05	350V ± 15%	≤ 700V	≤ 850V	≥ 10,000MΩ	≤ 1.0pF	≤ 150V	300 times	10kA	5kA	65A	10A, 10 times
GTCN28-401L-P05 GTCA28-401L-P05	400V ± 15%	≤ 700V	≤ 850V	≥ 10,000MΩ	≤ 1.0pF	≤ 150V	300 times	10kA	5kA	65A	10A, 10 times
GTCN28-471L-P05 GTCA28-471L-P05	470V ± 15%	≤ 700V	≤ 850V	≥ 10,000MΩ†	≤ 1.0pF	≤ 150V	300 times	10kA	5kA	65A	10A, 10 times
GTCN28-601L-P05 GTCA28-601L-P05	600V ± 15%	≤ 800V	≤ 1,000V	≥ 10,000MΩ†	≤ 1.0pF	≤ 150V	300 times	10kA	5kA	65A	10A, 10 times
GTCN28-801L-P05 GTCA28-801L-P05	800V ± 15%	≤ 1,000V	≤ 1,200V	≥ 10,000MΩ†	≤ 1.0pF	≤ 150V	300 times	10kA	5kA	65A	10A, 10 times

* Insulation Resistance measured at 50V_{DC}† Insulation Resistance measured at 250V_{DC}
UL497B File # E179610

GTCx28-xxxx-P15 High Surge Two Electrode Series

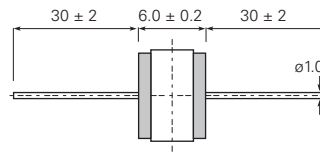


Figure 1 : without leads



Body : Nickel Plated
Units : mm

Figure 2 : with leads



Body : Nickel Plated
Leads: Tin Plated
Units : mm

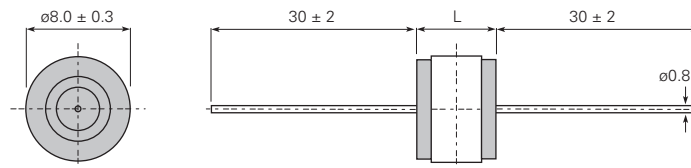
Part Number	DC Sparkover Voltage	Impulse Sparkover Voltage		Insulation Resistance	Capacitance	DC Holdover Voltage	Impulse Life	Impulse Discharge Current 8/20µs		AC Discharge Current, 50Hz	
	@ 100V/s	@ 100V/µs	@ 1kV/µs	@ 100V _{DC}	@ 1MHz	Per I.T.U. K.12	10/1000µs, 100A	Single Hit	Repeat 10 times (5 times each polarity)	Single Hit, 9 Cycles	Repeat 10 times (1s interval)
GTCN28-900M-P15	72 – 108 V	≤ 450V	≤ 500V	≥ 10,000MΩ*	≤ 1.5pF	≤ 52V	300 times	20kA	15kA	90A	20A
GTCA28-900M-P15	120 – 180V	≤ 500V	≤ 600V	≥ 10,000MΩ*	≤ 1.5pF	≤ 52V	300 times	20kA	15kA	90A	20A
GTCN28-151M-P15	184 – 280V	≤ 600V	≤ 700V	≥ 10,000MΩ	≤ 1.5pF	≤ 52V	300 times	20kA	15kA	90A	20A
GTCA28-151M-P15	200 – 300V	≤ 600V	≤ 700V	≥ 10,000MΩ	≤ 1.5pF	≤ 52V	300 times	20kA	15kA	90A	20A
GTCN28-231M-P15	280 – 420V	≤ 700V	≤ 800V	≥ 10,000MΩ	≤ 1.5pF	≤ 52V	300 times	20kA	15kA	90A	20A
GTCA28-231M-P15											
GTCN28-251M-P15											
GTCA28-251M-P15											
GTCN28-351M-P15											
GTCA28-351M-P15											

* Insulation Resistance measured at 50V_{DC}

GTCA28-xxxx-P0x High Voltage Two Electrode Series



Figure 1 : with leads



Body : Nickel Plated
Leads: Tin Plated
Units : mm

Part Number	DC Sparkover Voltage	Impulse Sparkover Voltage	Insulation Resistance	Capacitance	Impulse Life	Impulse Discharge Current 8/20µs		AC Discharge Current, 50Hz		Dimension L
	@ 100V/s	@ 100V/µs	@ 1000V _{DC}	@ 1MHz	10/1000µs, 500A	Single Hit	Repeat 10 times (5 times each polarity)	Single Hit, 9 Cycles	Repeat 10 times (1s interval)	Single (mm)
GTCA28-102M-P03	1,000V ± 20%	≤ 1,500V	≥ 10,000MΩ†	≤ 1.0pF	200 times	10kA	3kA	5A	1A	8.0 ± 0.3
GTCA28-152L-P03	1,500V ± 15%	≤ 2,200V	≥ 10,000MΩ‡	≤ 1.0pF	10 times	10kA	3kA	5A	1A	8.5 ± 0.3
GTCA28-212M-P03	2,100V ± 20%	≤ 2,700V	≥ 10,000MΩ‡	≤ 1.0pF	10 times	10kA	3kA	5A	1A	8.5 ± 0.3
GTCA28-242M-P03	2,400V ± 20%	≤ 3,000V	≥ 10,000MΩ	≤ 1.0pF	10 times	10kA	3kA	5A	1A	8.5 ± 0.3
*** GTCA28-272L-P03	2,700V ± 15%††	≤ 3,700V	≥ 10,000MΩ	≤ 1.0pF	300 times**	10kA	3kA	N/A	N/A	8.8 ± 0.3
GTCA28-302M-P01	3,000V ± 20%	≤ 4,000V	≥ 10,000MΩ	≤ 1.0pF	10 times	10kA	1kA	5A	1A	8.5 ± 0.3
††† GTCA28-312L-P03	3,100V ± 15%††	≤ 3,700V‡‡	≥ 10,000MΩ	≤ 1.0pF	300 times**	10kA	3kA	N/A	N/A	8.8 ± 0.3
GTCA28-402M-P01	4,000V ± 20%	≤ 5,000V	≥ 10,000MΩ	≤ 1.0pF	10 times	10kA	1kA	5A	1A	8.5 ± 0.3

Note: All devices UL1449: File #E223033

† Insulation Resistance measured at 250V_{DC}

‡ Insulation Resistance measured at 500V_{DC}

** Measured with 8/20µs, 100A impulse

†† DC Sparkover Voltage measured at 5kV/s

‡‡ Measured with 1kV/µs

*** GTCA28-272L-P03

UL1414: File# E223034

††† GTCA28-312L-P03

UL1414Y2: File# E223034

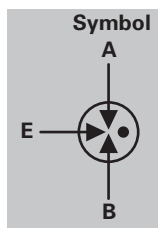
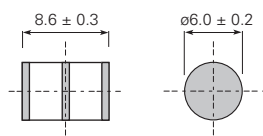
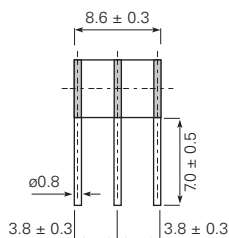
Table G2 Three Electrode Configurations for Gas Discharge Tubes**GTCx36 Miniature Three Electrode Series**

Figure 1 : without leads



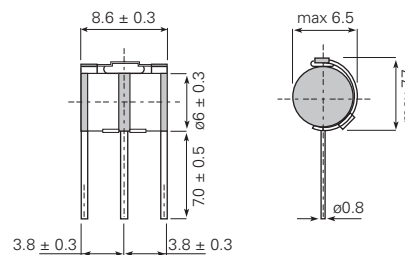
Body : Nickel Plated
Units : mm

Figure 2 : with leads



Body : Nickel Plated
Leads : Tin Plated
Units : mm

Figure 3 : with leads and fail-short mechanism



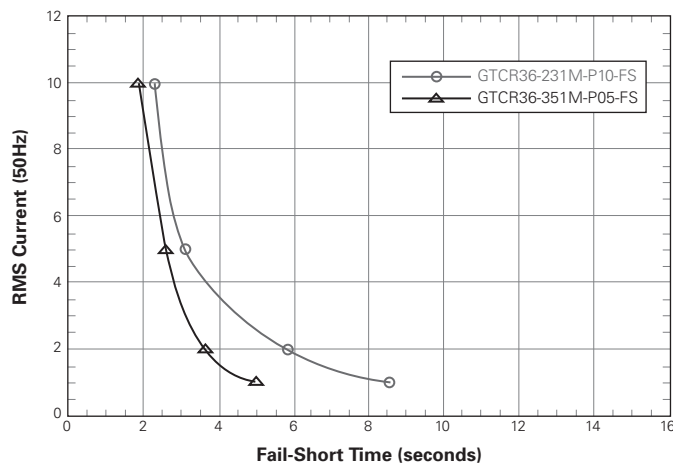
Body : Nickel Plated
Leads : Tin Plated
Units : mm

Part Number	DC Sparkover Voltage (A-E) (B-E)	Impulse Sparkover Voltage (A-E) (B-E)		Insulation Resistance	Capacitance	DC Holdover Voltage	Impulse Life (A+B-E)	Impulse Discharge Current 8/20μs (A+B-E)	AC Discharge Current, 50Hz (A+B-E)
	@ 100V/s	@ 100V/μs	@ 1kV/μs	@ 100V _{DC}	@ 1MHz	Per ITU K.12	10/1000μs, 100A	Repeat 10 times (5 times each polarity)	Repeat 5 times (1s interval)
GTCN36-900M-P05									
GTCR36-900M-P05	90V ± 20%	≤ 700V	≤ 850V	≥ 10,000MΩ*	≤ 3.0pF	≤ 52V	300 times	5kA	5A
GTCR36-900M-P05-FS									
GTCN36-231M-P10									
GTCR36-231M-P10	230V ± 20%	≤ 600V	≤ 700V	≥ 10,000MΩ	≤ 3.0pF	≤ 135V	300 times	10kA	10A
GTCR36-231M-P10-FS									
GTCN36-351M-P05									
GTCR36-351M-P05	350V ± 20%	≤ 650V	≤ 750V	≥ 10,000MΩ	≤ 3.0pF	≤ 150V	300 times	5kA	5A
GTCR36-351M-P05-FS									

* Insulation Resistance measured at 50V_{DC}
UL497B File# E179610

Figure G3 Typical Fail-short Performance for GTCx36 Series

Both electrodes simultaneously powered, each with the AC current value in the graph.



GTCx37 Three Electrode 7.5mm Diameter Series

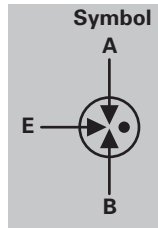
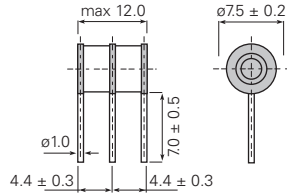
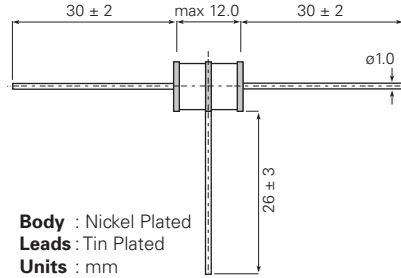


Figure 1 : with radial leads



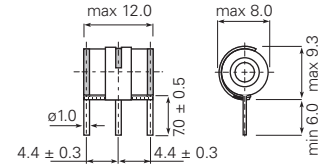
Body : Nickel Plated
Leads : Tin Plated
Units : mm

Figure 2 : with T-shape leads



Body : Nickel Plated
Leads : Tin Plated
Units : mm

Figure 3 : with fail-short mechanism



Body : Nickel Plated
Leads : Tin Plated
Units : mm

Part Number	DC Sparkover Voltage (A-E) (B-E)	Impulse Sparkover Voltage (A-E) (B-E)		Insulation Resistance	Capacitance	DC Holdover Voltage	Impulse Life (A+B-E)	Impulse Discharge Current 8/20μs (A+B-E)		AC Discharge Current, 50Hz (A+B-E)	
	@ 100V/s	@ 100V/μs	@ 1kV/μs	@ 100V _{DC}	@ 1MHz	Per ITU K.12	10/1000μs, 400A	Single Hit	Repeat 10 times (5 times each polarity)	Single 9 Cycles	Repeat 10 times (1s interval)
† GTCR37-900M-P10	90V ± 20%	≤ 700V	≤ 850V	≥ 10,000MΩ*	≤ 3.0pF	≤ 52V	300 times	20kA	10kA	130A	10A
† GTCR37-900M-P10-FS											
† GTCT37-900M-P10											
† GTCR37-151M-P10	150V ± 20%	≤ 700V	≤ 850V	≥ 10,000MΩ*	≤ 3.0pF	≤ 52V	300 times	20kA	10kA	130A	10A
† GTCR37-151M-P10-FS											
† GTCT37-151M-P10											
GTCR37-201N-P10	200V ± 25%	≤ 500V	≤ 650V	≥ 10,000MΩ	≤ 3.0pF	≤ 135V	300 times	20kA	10kA	130A	10A
GTCR37-201N-P10-FS											
† GTCT37-201N-P10											
† GTCR37-231M-P10	230V ± 20%	≤ 500V	≤ 650V	≥ 10,000MΩ	≤ 3.0pF	≤ 135V	300 times	20kA	10kA	130A	10A
† GTCR37-231M-P10-FS											
† GTCT37-231M-P10											
† GTCR37-251M-P10	250V ± 20%	≤ 500V	≤ 650V	≥ 10,000MΩ	≤ 3.0pF	≤ 135V	300 times	20kA	10kA	130A	10A
† GTCR37-251M-P10-FS											
† GTCT37-251M-P10											
† GTCR37-261M-P10	260V ± 20%	≤ 500V	≤ 650V	≥ 10,000MΩ	≤ 3.0pF	≤ 135V	300 times	20kA	10kA	130A	10A
† GTCR37-261M-P10-FS											
† GTCT37-261M-P10											
† GTCR37-301M-P10	300V ± 20%	≤ 600V	≤ 750V	≥ 10,000MΩ	≤ 3.0pF	≤ 135V	300 times	20kA	10kA	130A	10A
† GTCR37-301M-P10-FS											
† GTCT37-301M-P10											
† GTCR37-351M-P10	350V ± 20%	≤ 600V	≤ 750V	≥ 10,000MΩ	≤ 3.0pF	≤ 150V	300 times	20kA	10kA	130A	10A
† GTCR37-351M-P10-FS											
† GTCT37-351M-P10											
† GTCR37-401M-P10	400V ± 20%	≤ 700V	≤ 850V	≥ 10,000MΩ	≤ 3.0pF	≤ 150V	300 times	20kA	10kA	130A	10A
† GTCR37-401M-P10-FS											
† GTCT37-401M-P10											
GTCR37-551M-P10	550V ± 20%	≤ 850V	≤ 1,000V	≥ 10,000MΩ	≤ 3.0pF	≤ 150V	300 times	20kA	10kA	130A	10A
GTCR37-551M-P10-FS											
† GTCT37-551M-P10											

* Insulation Resistance measured at 50V_{DC}

† UL497B File# E179610

Figure G4 Typical Fail-short Performance for GTCx37 Series

Both electrodes simultaneously powered, each with the AC current value in the graph.

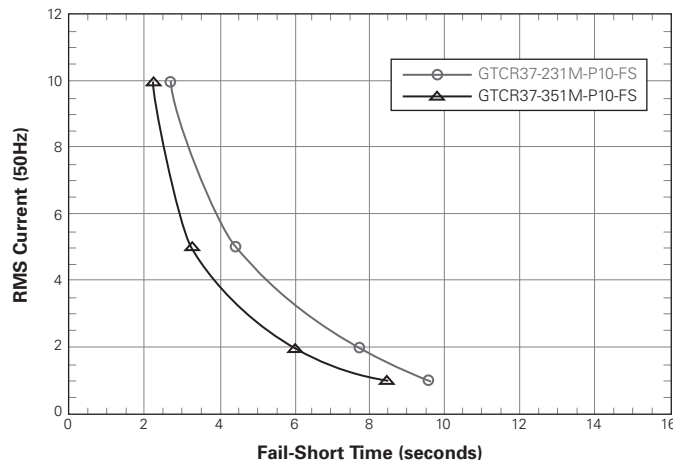
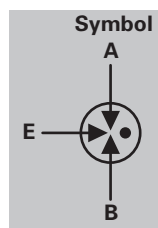
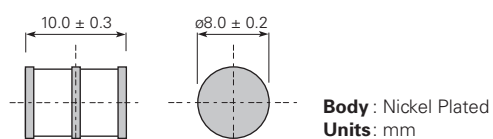
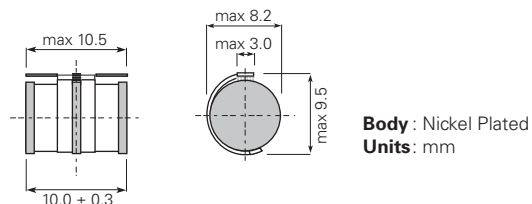
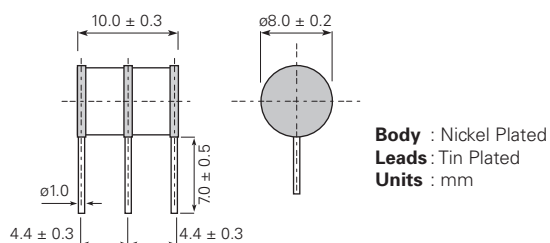
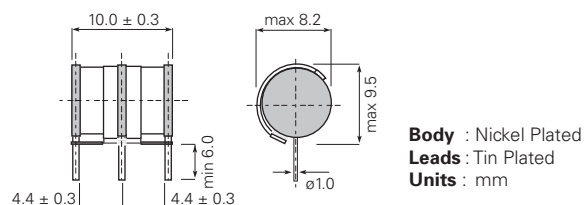


Table G2 Three Electrode Configurations for Gas Discharge Tubes

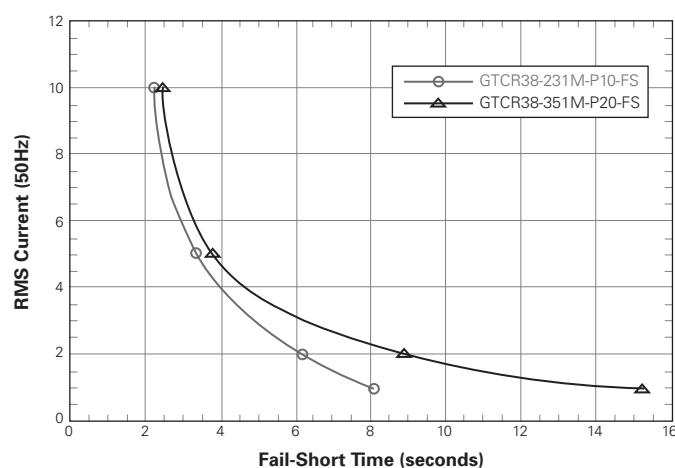
... Cont'd

GTCx38 Three Electrode P Series**Figure 1 : without leads****Figure 2 : without leads with fail-short mechanism****Figure 3 : with leads****Figure 4 : with leads and fail-short mechanism**

	DC Sparkover Voltage (A-E) (B-E)	Impulse Sparkover Voltage (A-E) (B-E)	Insulation Resistance	Capacitance	DC Holdover Voltage	Impulse Life (A+B-E)	Impulse Discharge Current 8/20µs (A+B-E)	AC Discharge Current, 50Hz (A+B-E)
Part Number	@ 100V/s	@ 1kV/µs	@ 100V _{DC}	@ 1MHz	Per ITU K.12	10/1000µs, 200A	Repeat 10 times (5 times each polarity)	Repeat 5 times (1s interval)
GTCR38-231M-P10-FS	184 - 280V	≤ 700V	≥ 10,000MΩ	≤ 3.0pF	≤ 135V	300 times	10kA	10A
GTCR38-251M-P10-FS	200 - 300V	≤ 700V	≥ 10,000MΩ	≤ 3.0pF	≤ 135V	300 times	10kA	10A
GTCN38-351M-P20								
GTCN38-351M-P20-FS	280 - 420V	≤ 900V	≥ 10,000MΩ	≤ 3.0pF	≤ 80V	300 times	20kA	20A
GTCR38-351M-P20								
GTCR38-351M-P20-FS								

Figure G5 Typical Fail-short Performance for GTCx38 Series

Both electrodes simultaneously powered, each with the AC current value in the graph.



GTCx38 Three Electrode Q Series

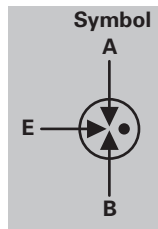


Figure 1 : without leads

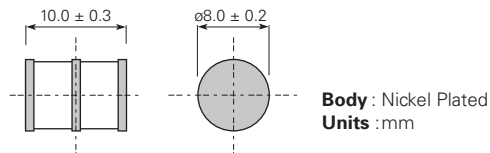


Figure 2 : without leads with fail-short mechanism

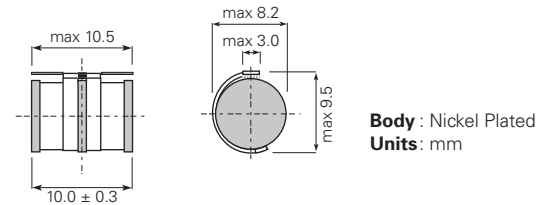


Figure 3 : with leads

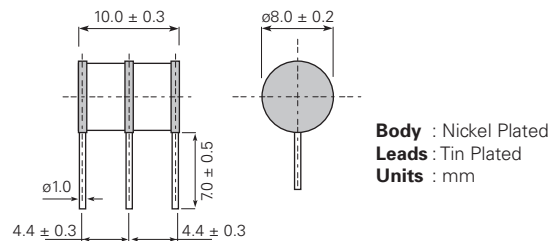
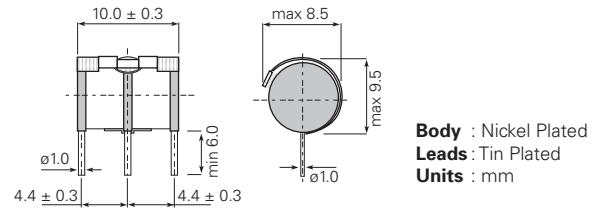


Figure 4 : with leads and fail-short mechanism



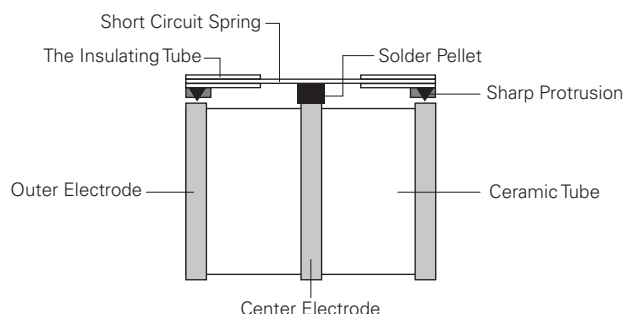
Part Number	DC Sparkover Voltage (A-E) (B-E)		Impulse Sparkover Voltage (A-E) (B-E)		Insulation Resistance	Capacitance	DC Holdover Voltage	Impulse Life (A+B-E)	Impulse Discharge Current 8/20μs (A+B-E)	AC Discharge Current, 50Hz (A+B-E)
	@ 100V/s	@ 100V/μs	@ 1kV/μs	@ 100V _{DC}	@ 100V _{DC}	@ 1MHz	Per ITU K.12	10/1000μs, 200A	Repeat 10 times (5 times each polarity)	Repeat 5 times (1s interval)*
GTCN38-900M-Q10										
GTCR38-900M-Q10-FS										
GTCN38-900M-Q10	72 - 108V	≤ 450V	≤ 500V	≥ 10,000MΩ*	≥ 10,000MΩ*	≤ 3.0pF	≤ 52V	300 times	10kA	10A
GTCR38-900M-Q10-FS										
GTCN38-151M-Q10										
GTCR38-151M-Q10-FS										
GTCN38-151M-Q10	120 - 180V	≤ 500V	≤ 600V	≥ 10,000MΩ*	≥ 10,000MΩ*	≤ 3.0pF	≤ 52V	300 times	10kA	10A
GTCR38-151M-Q10-FS										
GTCN38-231M-Q10										
GTCR38-231M-Q10-FS										
GTCN38-231M-Q10	184 - 280V	≤ 600V	≤ 700V	≥ 10,000MΩ	≥ 10,000MΩ	≤ 3.0pF	≤ 135V	300 times	10kA	10A
GTCR38-231M-Q10-FS										
GTCN38-251M-Q10										
GTCR38-251M-Q10-FS										
GTCN38-251M-Q10	200 - 300V	≤ 600V	≤ 700V	≥ 10,000MΩ	≥ 10,000MΩ	≤ 3.0pF	≤ 135V	300 times	10kA	10A
GTCR38-251M-Q10-FS										
GTCN38-351M-Q10										
GTCR38-351M-Q10-FS										
GTCN38-351M-Q10	280 - 420V	≤ 900V	≤ 1000V	≥ 10,000MΩ	≥ 10,000MΩ	≤ 3.0pF	≤ 135V	300 times	10kA	10A
GTCR38-351M-Q10-FS										
GTCN38-421M-Q10										
GTCR38-421M-Q10-FS										
GTCN38-421M-Q10	300 - 500V	≤ 900V	≤ 1000V	≥ 10,000MΩ	≥ 10,000MΩ	≤ 3.0pF	≤ 135V	300 times	10kA	10A
GTCR38-421M-Q10-FS										
GTCN38-501M-Q10										
GTCR38-501M-Q10-FS										
GTCN38-501M-Q10	400 - 600V	≤ 1100V	≤ 1200V	≥ 10,000MΩ	≥ 10,000MΩ	≤ 3.0pF	≤ 135V	300 times	10kA	10A
GTCR38-501M-Q10-FS										

* Insulation Resistance measured at 50V_{DC}
UL497B File # E179610

Fail-Short Mechanism for Gas Discharge Tubes

Fail-Short Mechanism

The Fail-Short Mechanism is a short circuit spring mounted onto a solder pellet located at the center electrode of the gas tube. Under normal operating conditions, the pellet is positioned to make the spring float 0.1 – 0.5mm above the outer electrodes. Thin tubes are used to cover the sharp metal protrusions present at each end of the spring.



When a prolonged discharge event causes the gas tube temperature to reach the melting point of the solder, the pellet softens allowing the short circuit spring to activate by forcing the protrusions through the thin insulating tubes causing them to make contact with both outer electrodes. This process results in a permanent short-circuit between all three electrodes creating a low resistance path that conducts the fault current to ground without generating a significant amount of heat.

Temperature

Operation Temperature Range

Models without Fail-Short Mechanism : -40°C/+90°C
Models with Fail-Short Mechanism : -20°C/+65°C

Storage Temperature Range

Models without Fail-Short Mechanism : -40°C/+90°C
Models with Fail-Short Mechanism : -20°C/+65°C

Packaging

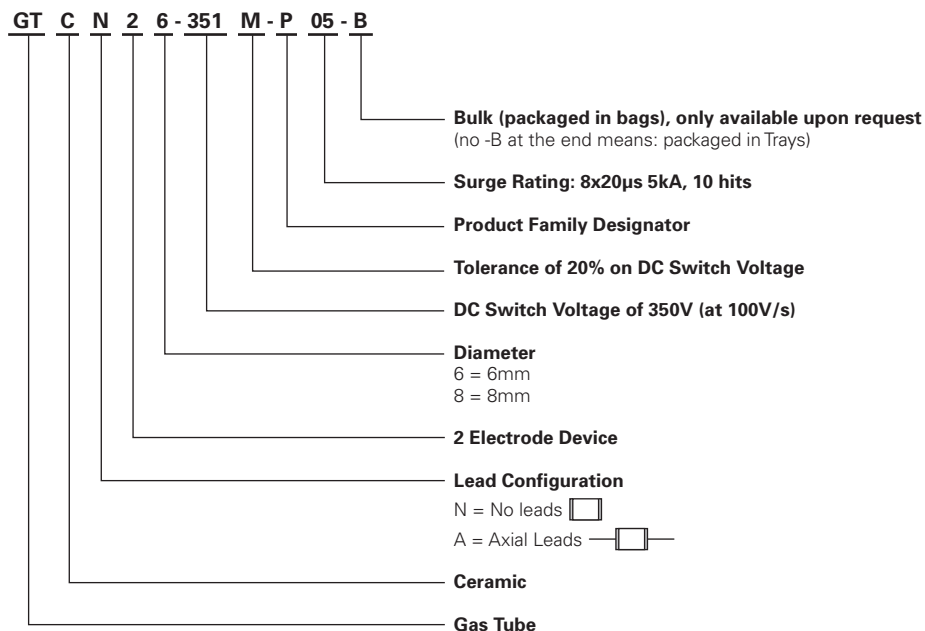
Parts are packed 100 pieces in a plastic tray or 200 pieces in a vacuum bag, ten trays or five bags (1,000 pieces) to a standard box. Standard packaging is in trays. Vacuum bag packaging is available upon request. Add "-B" at the end of the part number for parts packaged in vacuum bags.

Installation

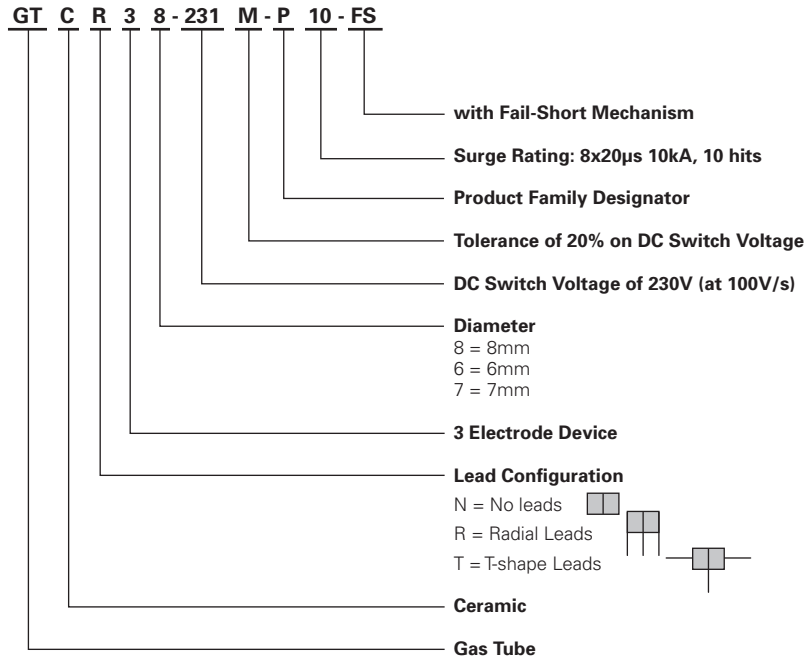
Care should be taken when installing Gas Discharge Tubes equipped with Fail-Short Mechanisms into arrester magazines, printed circuit boards, etc. Too much downward pressure may force the short circuit spring through the thin insulation tube creating a shorted condition.

Part Numbering System for Gas Discharge Tubes

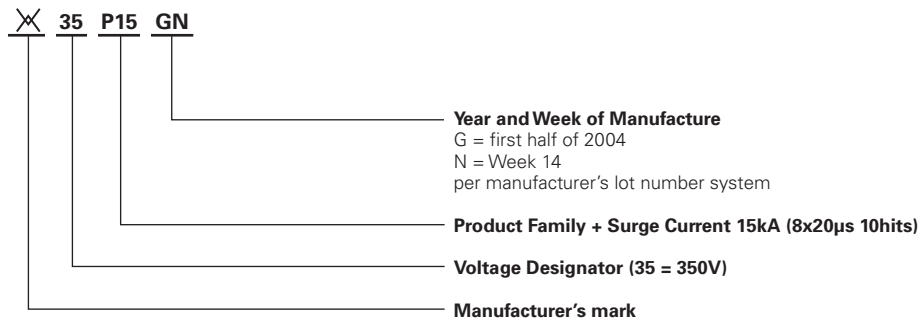
Two Electrode GDT - Example Part Number: GTCN26-351M-P05-B



Three Electrode GDT - Example Part Number: GTCR38-231M-P10-FS



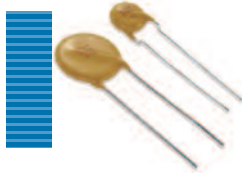
Marking Reference Guide - Example



Devices with no leads (GTCNxx-xxxx-xx), are not able to be soldered as their electrodes are Nickel plated. They should be installed by insertion into a magazine clip.


Warning :

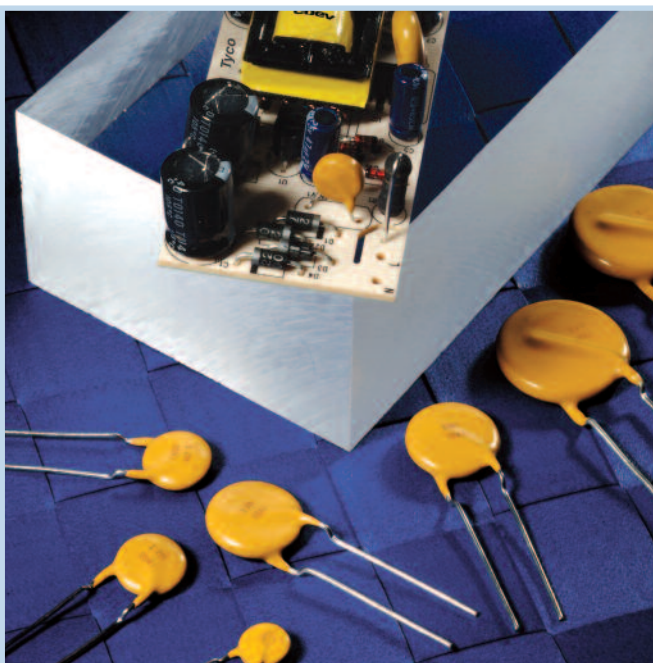
- Operation beyond the maximum ratings or improper use may result in device damage and possible electrical arcing and flame.
- The devices are intended for protection against occasional overvoltage fault conditions and should not be used when repeated fault conditions or prolonged trip events are anticipated.
- Device performance can be impacted negatively if devices are handled in a manner inconsistent with recommended electronic, thermal, and mechanical procedures for electronic components.



ROV Metal Oxide Varistors

ROV metal oxide varistors help protect power systems from damage caused by transient overvoltage faults such as lightning, power contact, and power induction. Suitable for a broad range of applications, ROV devices help protect sensitive electronic equipment from potential power surge damage by clamping high-energy, short-duration impulses.

The ROV's high current-handling and energy absorption capability, fast response and low cost make them suitable for overvoltage protection in telecom, datacom and security systems, surge strips, power supplies, control board transformers and electric motors. ROVs can also be used to help protect electrical equipment from damage caused by large voltage or power transients on the AC Mains inputs. In a coordinated circuit protection scheme the ROV can be paired with a PolySwitch over-current protection device to help improve equipment reliability and fulfill IEC-61000 test requirements.



Benefits

- Helps provide overvoltage fault protection for a wide variety of power systems
- Helps designers meet UL, CSA, and VDE standards
- Helps reduce warranty and service costs
- Low cost (\$/Joule)

Features

- RoHS Compliant
- Various diameter sizes: 5mm, 7mm, 10mm, 14mm, 20mm
- Broad varistor voltage range: 18V - 1800V
- Various surge capabilities: standard, high surge, extra high surge
- High current handling and energy absorption capability
- Fast response time
- Low leakage current
- Various lead types: straight, kinked, other special lead types
- Various packaging options: bulk, tape and reel, ammo pack

Applications

- Power systems
- Surge strips
- Security systems
- Motor protection
- Telecommunications equipment
- Automotive electrical systems
- Household appliances

Table V1 ROV Metal Oxide Varistors Quick Selection Guide**Standard Series ROV Devices**

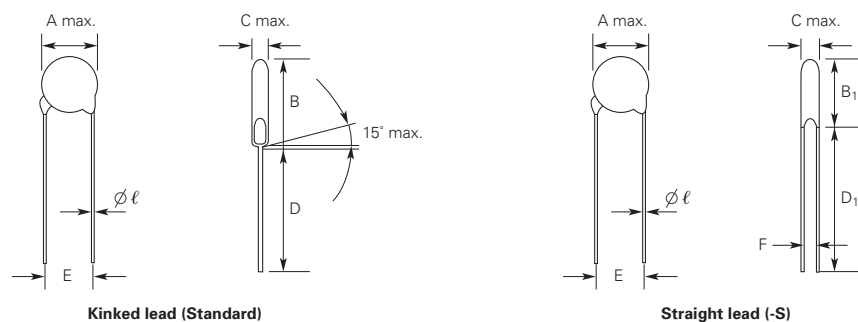
Varistor Voltage	V _{RMS AC}	Maximum Surge Current (8 x 20μs)	Rated Wattage	Energy (10 x 1000μs)	Possible Varistor Reference
18-68V	11-40V	≤100A	≤0.01W	0.6 – 2.1J	5mm series: 180M - 680K
		≤250A	≤0.02W	1.2 – 4.3J	7mm series: 180M - 680K
		≤500A	≤0.05W	2.4 – 8.5J	10mm series: 180M - 680K
		≤1000A	≤0.10W	4.7 – 17.0J	14mm series: 180M - 680K
		≤2000A	≤0.20W	7.0 – 24.0J	20mm series: 180M - 680L
82-750V	50-460V	≤400A	≤0.10W	2.8 – 22.5J	5mm series: 820K - 751K
82-820V	50-510V	≤1200A	≤0.25W	5.5 – 47.0J	7mm series: 820K - 821K
82-1800V	50-1000V	≤2500A	≤0.40W	11.0 – 174.0J	10mm series: 820K - 182K
		≤4500A	≤0.60W	22.0 – 348.0J	14mm series: 820K - 182K
		≤6500A	≤1.00W	44.0 – 695.0J	20mm series: 820K - 182K

High Surge Series (H Series) ROV Devices

Varistor Voltage	V _{RMS AC}	Maximum Surge Current (8 x 20μs)	Rated Wattage	Energy (10 x 1000μs)	Possible Varistor Reference
18-68V	11-40V	≤250A	≤0.01W	0.7 – 2.6J	5mm series: H180M - H680K
		≤500A	≤0.02W	1.5 – 5.4J	7mm series: H180M - H680K
		≤1000A	≤0.05W	2.6 – 9.8J	10mm series: H180M - H680K
		≤2000A	≤0.10W	5.2 – 20.0J	14mm series: H180M - H680K
		≤3000A	≤0.20W	13.0 – 49.0J	20mm series: H180M - H680L
82-750V	50-460V	≤800A	≤0.10W	3.5 – 29.0J	5mm series: H820K - H751K
82-820V	50-510V	≤1750A	≤0.25W	7.0 – 60.0J	7mm series: H820K - H821K
82-1800V	50-1000V	≤3500A	≤0.40W	14.0 – 155.0J	10mm series: H820K - H182K
		≤6000A	≤0.60W	28.0 – 310.0J	14mm series: H820K - H182K
		≤10000A	≤1.00W	56.0 – 1020.0J	20mm series: H820K - H182K

Extra High Surge Series (E Series) ROV Devices

Varistor Voltage	V _{RMS AC}	Maximum Surge Current (8 x 20μs)	Rated Wattage	Energy (10 x 1000μs)	Possible Varistor Reference
200-360V	130-230V	≤6500A	≤0.60W	84.0 – 151.0J	14mm series: E201K - E361K
		≤12500A	≤1.00W	168.0 – 302.0J	20mm series: E201K - E361K

Figure V1 Dimension Figures for ROV Metal Oxide Varistors**Table V2 Dimensions in Millimeters for ROV Metal Oxide Varistors**

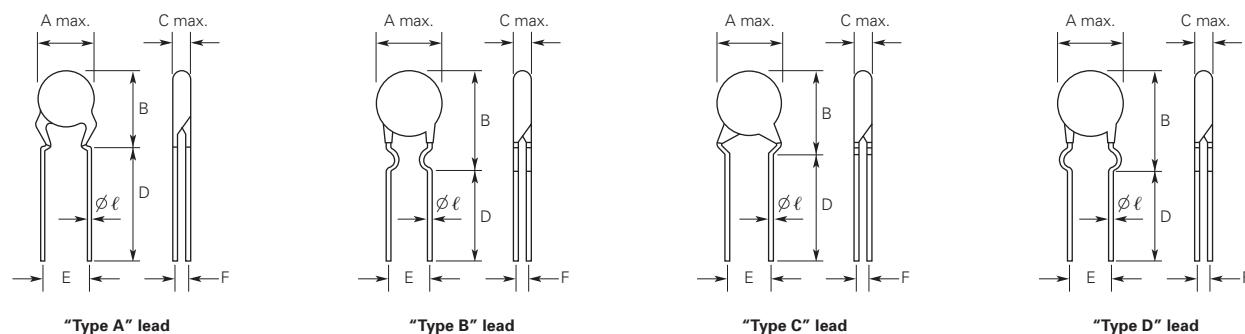
Diameter	5mm	7mm	10mm	14mm	20mm
A max.	7.5	9.0	12.5	16.5	23.0
ℓ ± 0.05	0.6	0.6	0.8	0.8	1.0
E ± 1.0	5.0	5.0	7.5	7.5	10.0
B max.	11.0	13.0	18.0	22.0	28.0
D ₁ min.	25.0	25.0	25.0	25.0	25.0
D min.	24.0	24.0	24.0	24.0	24.0

Table V2 Dimensions in Millimeters for ROV Metal Oxide Varistors

... Cont'd

C Max. F & B, Max.

Diameter Type No.	5mm			7mm			10mm			14mm			20mm		
	C max.	F±0.8	B ₁ max.	C max.	F±0.8	B ₁ max.	C max.	F±0.8	B ₁ max.	C max.	F±0.8	B ₁ max.	C max.	F±0.8	B ₁ max.
180M	4.5	0.8	10.5	4.5	0.8	12.0	4.9	0.8	15.5	5.0	0.9	19.5	5.2	0.9	26.5
220L	4.5	0.9	10.5	4.5	0.9	12.0	4.9	0.9	15.5	5.0	1.0	19.5	5.3	1.0	26.5
270K	4.7	0.9	10.5	4.7	0.9	12.0	5.1	0.9	15.5	5.2	1.1	19.5	5.4	1.1	26.5
330K	4.7	1.0	10.5	4.7	1.0	12.0	5.1	1.0	15.5	5.2	1.2	19.5	5.4	1.2	26.5
390K	4.7	1.2	10.5	4.7	1.2	12.0	5.1	1.2	15.5	5.2	1.4	19.5	5.4	1.4	26.5
470K	5.0	1.2	10.5	5.0	1.2	12.0	5.5	1.2	15.5	5.6	1.4	19.5	5.6	1.4	26.5
560K	5.0	1.4	10.5	5.0	1.4	12.0	5.5	1.4	15.5	5.6	1.6	19.5	5.6	1.6	26.5
680K	5.5	1.7	10.5	5.5	1.7	12.0	6.0	1.7	15.5	6.1	1.9	19.5	6.1	1.9	26.5
820K	3.8	0.8	10.5	3.8	0.8	12.0	4.3	0.8	15.5	4.4	1.0	19.5	4.9	1.2	26.5
101K	3.9	0.8	10.5	3.9	0.8	12.0	4.4	0.8	15.5	4.5	1.0	19.5	5.1	1.2	26.5
121K	4.1	0.9	10.5	4.1	0.9	12.0	4.5	0.9	15.5	4.6	1.1	19.5	5.3	1.3	26.5
151K	4.5	1.2	10.5	4.5	1.2	12.0	4.9	1.2	15.5	5.1	1.4	19.5	5.6	1.6	26.5
181K	4.1	1.0	10.5	4.1	1.0	12.0	4.5	1.0	15.5	4.7	1.2	19.5	5.2	1.4	26.5
201K	4.2	1.0	10.5	4.2	1.0	12.0	4.6	1.0	15.5	4.8	1.2	19.5	5.3	1.4	26.5
221K	4.3	1.1	10.5	4.3	1.1	12.0	4.7	1.1	15.5	4.9	1.3	19.5	5.4	1.5	26.5
241K	4.4	1.1	10.5	4.4	1.3	12.0	4.8	1.3	15.5	5.0	1.5	19.5	5.5	1.7	26.5
271K	4.6	1.3	10.5	4.6	1.4	12.0	5.0	1.4	15.5	5.2	1.5	19.5	5.7	1.9	26.5
301K	4.8	1.3	10.5	4.8	1.5	12.0	5.2	1.6	15.5	5.4	1.7	19.5	5.9	2.1	26.5
331K	4.9	1.3	10.5	4.9	1.5	12.0	5.3	1.6	15.5	5.5	1.7	19.5	6.0	2.1	26.5
361K	5.1	1.8	10.5	5.1	1.9	12.0	5.5	1.9	15.5	5.7	2.1	19.5	6.2	2.3	26.5
391K	5.3	2.0	11.0	5.3	2.0	12.5	5.7	2.2	16.0	5.9	2.2	20.0	6.4	2.4	26.5
431K	6.1	2.1	11.0	6.1	2.0	12.5	6.5	2.5	16.0	6.7	2.5	20.0	7.2	2.7	26.5
471K	6.4	2.2	11.0	6.4	2.3	12.5	6.8	2.6	16.0	7.0	2.7	20.0	7.5	2.9	27.0
511K	6.6	2.5	11.5	6.6	2.5	13.0	7.0	3.1	16.5	7.2	3.1	20.5	7.7	3.3	27.0
561K	6.9	2.8	11.5	6.9	2.8	13.0	7.3	3.4	16.5	7.5	3.4	20.5	8.0	3.6	27.0
621K	7.2	3.1	11.5	7.2	3.1	13.0	7.6	4.0	16.5	7.8	3.8	20.5	8.3	4.1	27.0
681K	7.5	3.4	11.5	7.5	3.4	13.0	8.0	4.4	16.5	8.2	4.1	20.5	8.7	4.4	27.0
751K	7.9	3.7	11.5	7.9	3.7	13.0	8.4	4.4	16.5	8.6	4.3	20.5	9.1	4.5	27.0
781K	—	—	—	8.1	3.9	13.0	8.6	4.6	16.5	8.8	4.6	20.5	9.3	4.8	27.0
821K	—	—	—	8.3	4.1	13.0	8.8	4.6	16.5	9.0	4.6	20.5	9.5	4.8	27.0
911K	—	—	—	—	—	—	9.4	5.4	16.5	9.6	5.4	20.5	10.1	5.7	27.0
102K	—	—	—	—	—	—	9.9	5.4	16.5	10.1	5.6	20.5	10.7	5.8	27.0
112K	—	—	—	—	—	—	10.5	5.7	16.5	10.7	6.1	20.5	11.2	6.3	27.0
182K	—	—	—	—	—	—	12.6	9.8	18.5	12.8	10.2	22.5	13.5	10.4	29.0

Figure V2 Special Lead Configurations for ROV Metal Oxide Varistors**Table V3** Dimensions in Millimeters* for ROV Metal Oxide Varistors

Lead Type	Diameter	5mm	7mm	10mm	14mm	20mm
A, C	B max.	10.0	12.0	15.0	19.0	26.0
B, D	B max.	12.0	14.0	17.0	21.0	28.0

* All other dimensions are the same as those of the (standard) kinked leads.

Table V4 Rating and Characteristics for Standard Series Specifications — 5mm Devices

	Part Number	Varistor Voltage V@1.0mA		Maximum Allowance Voltage		Maximum Clamping Voltage	Maximum Surge Current (8x20µs)		Rated Woltage	Energy (10x1000µs)	Capacitance (Typical)	Certification†
		DC (V)	Tolerance	AC (V _{RMS})	DC (V)	V@5A (V)	1 Time (A)	2 Times (A)	(W)	(J)	(pF)	
	ROV05-180M	18	±20%	11	14	40*	100	50	0.01	0.6	1121	● ■
	ROV05-220L	22	±15%	14	18	48*	100	50	0.01	0.7	1233	● ■
	ROV05-270K	27	±10%	17	22	60*	100	50	0.01	0.9	1073	● ■
	ROV05-330K	33	±10%	20	26	73*	100	50	0.01	1.1	834	● ■
	ROV05-390K	39	±10%	25	31	86*	100	50	0.01	1.2	877	● ■
	ROV05-470K	47	±10%	30	38	104*	100	50	0.01	1.5	715	● ■
	ROV05-560K	56	±10%	35	45	123*	100	50	0.01	1.8	643	● ■
	ROV05-680K	68	±10%	40	56	150*	100	50	0.01	2.1	501	● ■
	ROV05-820K	82	±10%	50	65	145	400	200	0.10	2.8	269	● ■
	ROV05-101K	100	±10%	60	85	175	400	200	0.10	3.5	263	● ■
	ROV05-121K	120	±10%	75	100	210	400	200	0.10	4.0	180	● ■
	ROV05-151K	150	±10%	95	125	260	400	200	0.10	5.5	180	● ■
	ROV05-181K	180	±10%	115	150	320	400	200	0.10	6.5	95	● ■
	ROV05-201K	200	±10%	130	170	355	400	200	0.10	7.1	85	◆ ● ▲ ■
	ROV05-221K	220	±10%	140	180	380	400	200	0.10	7.8	80	◆ ● ▲ ■
	ROV05-241K	240	±10%	150	200	415	400	200	0.10	8.4	74	◆ ● ▲ ■
	ROV05-271K	270	±10%	175	225	475	400	200	0.10	9.9	69	◆ ● ▲ ■
	ROV05-301K	300	±10%	195	250	525	400	200	0.10	10.5	65	◆ ● ▲ ■
	ROV05-331K	330	±10%	210	275	575	400	200	0.10	11.5	60	◆ ● ▲ ■
	ROV05-361K	360	±10%	230	300	620	400	200	0.10	13.0	69	◆ ● ▲ ■
	ROV05-391K	390	±10%	250	320	675	400	200	0.10	15.0	56	◆ ● ▲ ■
	ROV05-431K	430	±10%	275	350	745	400	200	0.10	16.5	47	◆ ● ▲ ■
	ROV05-471K	470	±10%	300	385	810	400	200	0.10	17.5	50	◆ ● ▲ ■
	ROV05-511K	510	±10%	320	418	880	400	200	0.10	18.5	50	◆ ● ▲ ■
	ROV05-561K	560	±10%	350	460	940	400	200	0.10	19.5	50	◆ ● ▲ ■
	ROV05-621K	620	±10%	385	505	1050	400	200	0.10	20.5	50	◆ ● ▲ ■
	ROV05-681K	680	±10%	420	560	1150	400	200	0.10	21.5	43	◆ ● ▲ ■
	ROV05-751K	750	±10%	460	615	1290	400	200	0.10	22.5	—	◆ ● ▲ ■

*The clamping voltages from 180M to 680K are tested at 1A current.

†Certification

Standard	UL1414†	UL1449 (2nd Edition)†	CSA	VDE
Title	Across-the-Line Components	Transient Voltage Surge Suppressors	Accessories and Parts for Electronic Equipment	Varistors for Use in Electronic Equipment
Symbols	◆	●	▲	■
File Number	E223034	E223033	220978	40006997

† For UL 1449 (2nd Edition), the maximum clamping voltage is measured at 500A.

Figure V3-V4

Standard Series Specifications — 5mm Devices Pulse Lifetime Ratings and V-I Characteristic Curves

Figure V3 - ROV05-180M-ROV05-680K

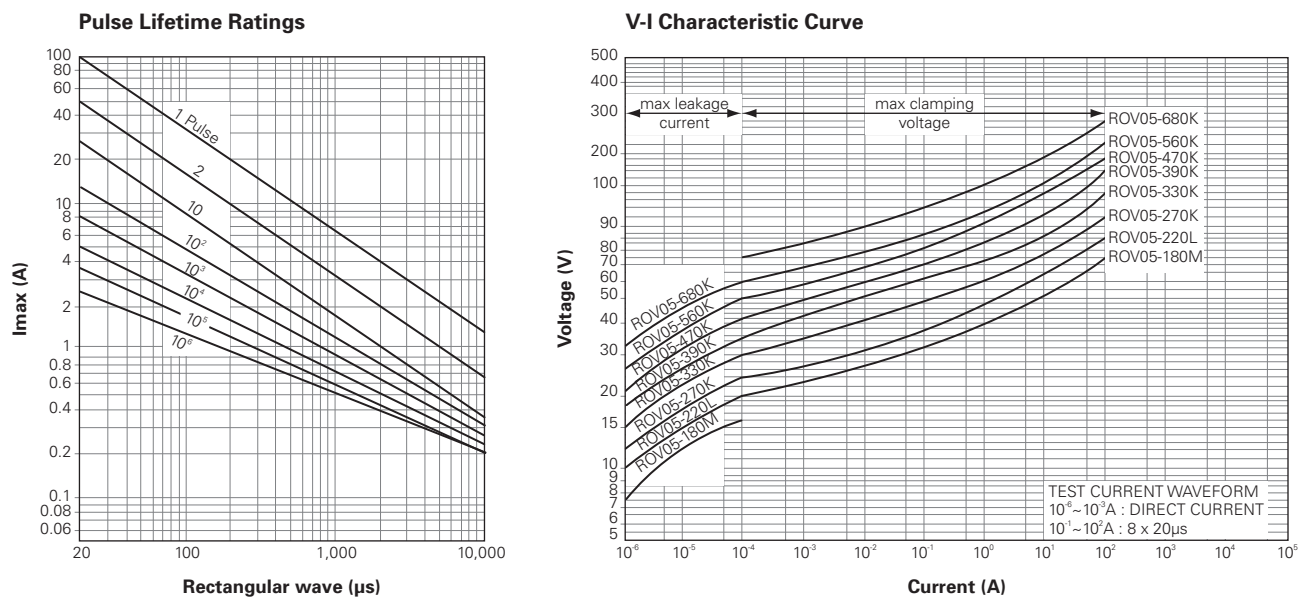


Figure V4 - ROV05-820K-ROV05-471K

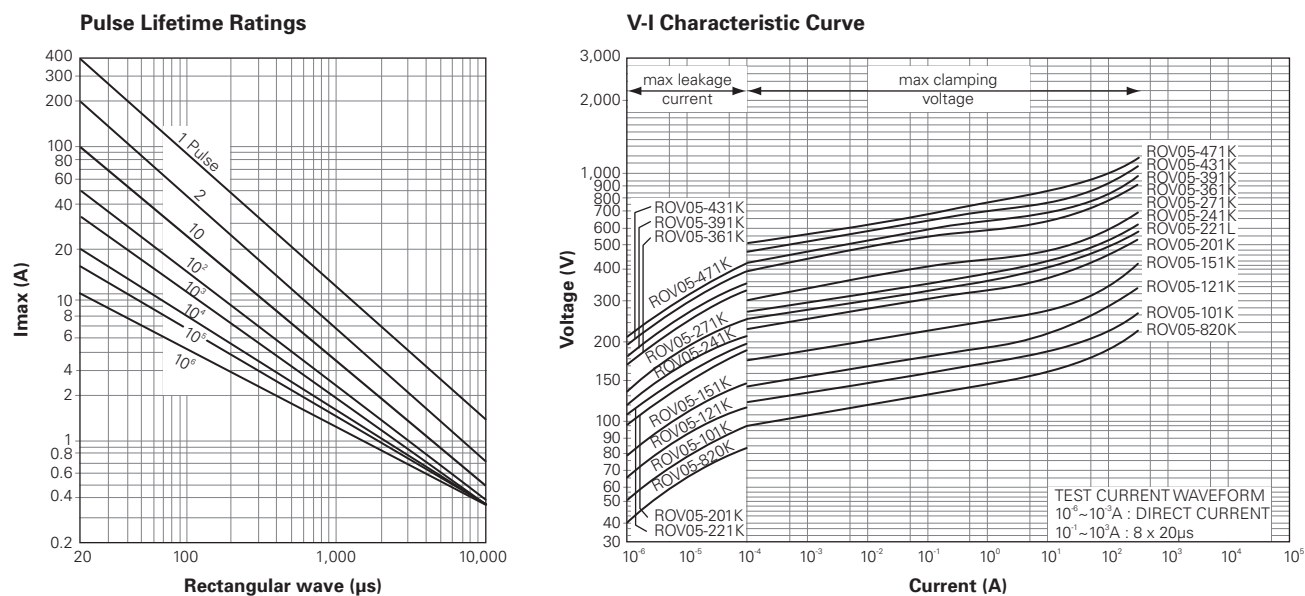


Table V5 Rating and Characteristics for Standard Series Specifications — 7mm Devices

	Part Number	Varistor Voltage V@1.0mA		Maximum Allowance Voltage		Maximum Clamping Voltage	Maximum Surge Current (8x20µs)		Rated Woltage	Energy (10x1000µs)	Capacitance (Typical)	Certification†
		DC (V)	Tolerance	AC (V _{RMS})	DC (V)	V@10A (V)	1 Time (A)	2 Times (A)	(W)	(J)	(pF)	
	ROV07-180M	18	±20%	11	14	36*	250	125	0.02	1.2	2918	● ■
	ROV07-220L	22	±15%	14	18	43*	250	125	0.02	1.4	2933	● ■
	ROV07-270K	27	±10%	17	22	53*	250	125	0.02	1.7	2344	● ■
	ROV07-330K	33	±10%	20	26	65*	250	125	0.02	2.2	1840	● ■
	ROV07-390K	39	±10%	25	31	77*	250	125	0.02	2.4	1817	● ■
	ROV07-470K	47	±10%	30	38	93*	250	125	0.02	3.0	1595	● ■
	ROV07-560K	56	±10%	35	45	110*	250	125	0.02	3.5	1333	● ■
	ROV07-680K	68	±10%	40	56	135*	250	125	0.02	4.3	1119	● ■
	ROV07-820K	82	±10%	50	65	135	1200	600	0.25	5.5	643	● ■
	ROV07-101K	100	±10%	60	85	165	1200	600	0.25	7.0	535	● ■
	ROV07-121K	120	±10%	75	100	200	1200	600	0.25	8.0	457	● ■
	ROV07-151K	150	±10%	95	125	250	1200	600	0.25	11.0	371	● ■
	ROV07-181K	180	±10%	115	150	300	1200	600	0.25	13.0	215	● ■
	ROV07-201K	200	±10%	130	170	340	1200	600	0.25	14.3	224	◆ ● ▲ ■
	ROV07-221K	220	±10%	140	180	360	1200	600	0.25	15.5	190	◆ ● ▲ ■
	ROV07-241K	240	±10%	150	200	395	1200	600	0.25	16.8	185	◆ ● ▲ ■
	ROV07-271K	270	±10%	175	225	455	1200	600	0.25	19.8	161	◆ ● ▲ ■
	ROV07-301K	300	±10%	195	250	505	1200	600	0.25	21.0	135	◆ ● ▲ ■
	ROV07-331K	330	±10%	210	275	550	1200	600	0.25	23.0	141	◆ ● ▲ ■
	ROV07-361K	360	±10%	230	300	595	1200	600	0.25	26.0	117	◆ ● ▲ ■
	ROV07-391K	390	±10%	250	320	650	1200	600	0.25	30.0	110	◆ ● ▲ ■
	ROV07-431K	430	±10%	275	350	710	1200	600	0.25	33.0	111	◆ ● ▲ ■
	ROV07-471K	470	±10%	300	385	775	1200	600	0.25	35.0	102	◆ ● ▲ ■
	ROV07-511K	510	±10%	320	418	842	1200	600	0.25	37.0	100	◆ ● ▲ ■
	ROV07-561K	560	±10%	350	460	920	1200	600	0.25	39.0	87	◆ ● ▲ ■
	ROV07-621K	620	±10%	385	505	1025	1200	600	0.25	41.0	80	◆ ● ▲ ■
	ROV07-681K	680	±10%	420	560	1120	1200	600	0.25	43.0	82	◆ ● ▲ ■
	ROV07-751K	750	±10%	460	615	1240	1200	600	0.25	45.0	74	◆ ● ▲ ■
	ROV07-781K	780	±10%	485	640	1290	1200	600	0.25	46.0	70	◆ ● ▲ ■
	ROV07-821K	820	±10%	510	670	1355	1200	600	0.25	47.0	70	◆ ● ▲ ■

* The clamping voltages from 180M to 680K are tested at 2.5A current.

†Certification

Standard	UL1414‡	UL1449 (2nd Edition)‡	CSA	VDE
Title	Across-the-Line Components	Transient Voltage Surge Suppressors	Accessories and Parts for Electronic Equipment	Varistors for Use in Electronic Equipment
Symbols	◆	●	▲	■
File Number	E223034	E223033	220978	40006997

‡ For UL 1449 (2nd Edition), the maximum clamping voltage is measured at 500A.

Figure V5-V6

Standard Series Specifications — 7mm Devices Pulse Lifetime Ratings and V-I Characteristic Curves

Figure V5 - ROV07-180M~ROV07-680K

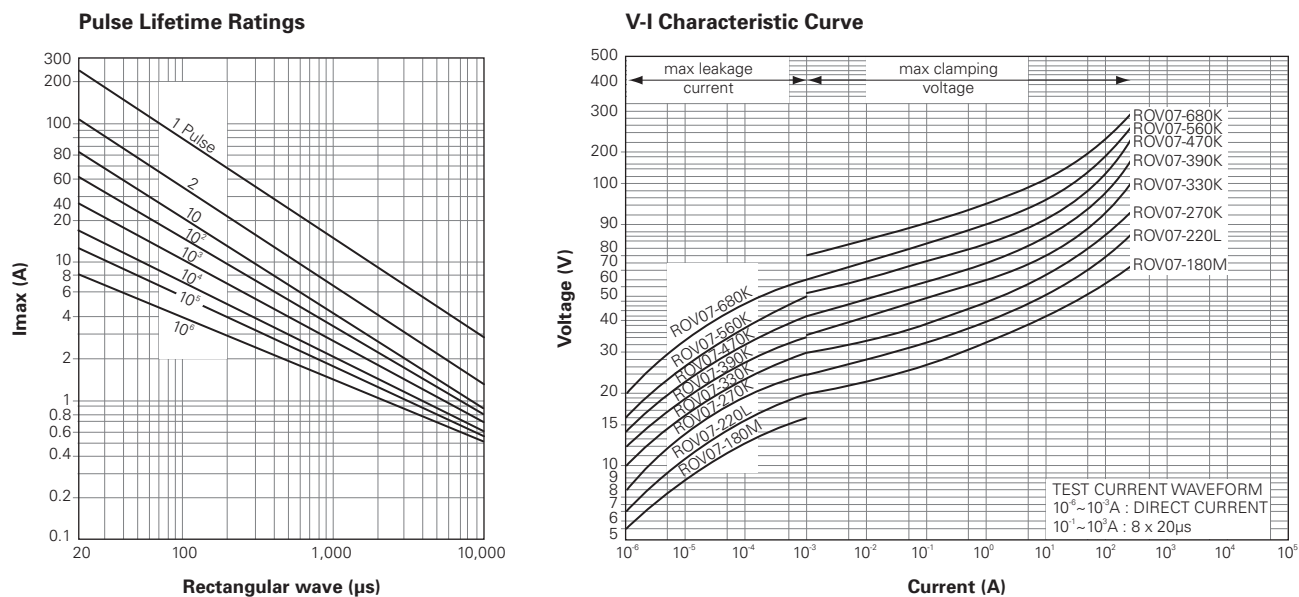


Figure V6 - ROV07-820K~ROV07-471K

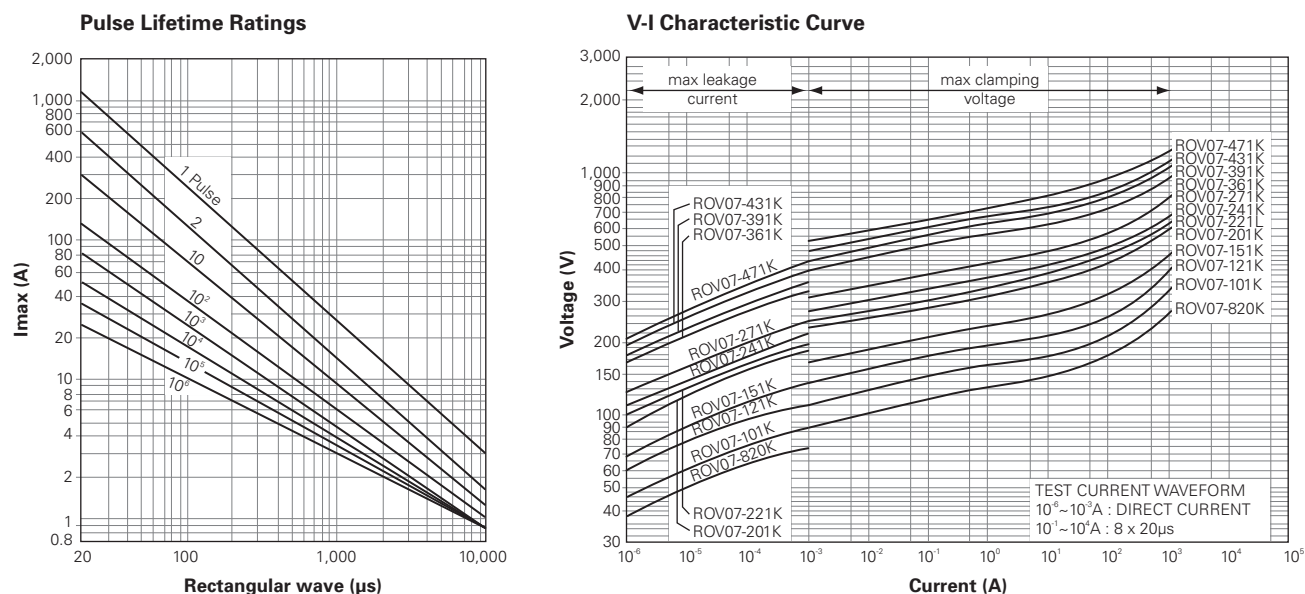


Table V6 Rating and Characteristics for Standard Series Specifications — 10mm Devices

	Part Number	Varistor Voltage V@1.0mA		Maximum Allowance Voltage		Maximum Clamping Voltage	Maximum Surge Current (8x20µs)		Rated Woltage	Energy (10x1000µs)	Capacitance (Typical)	Certification†
		DC (V)	Tolerance	AC (V _{RMS})	DC (V)	V@25A (V)	1 Time (A)	2 Times (A)	(W)	(J)	(pF)	
	ROV10-180M	18	±20%	11	14	36*	500	250	0.05	2.4	6500	● ■
	ROV10-220L	22	±15%	14	18	43*	500	250	0.05	2.7	5521	● ■
	ROV10-270K	27	±10%	17	22	53*	500	250	0.05	3.5	4742	● ■
	ROV10-330K	33	±10%	20	26	65*	500	250	0.05	4.4	4247	● ■
	ROV10-390K	39	±10%	25	31	77*	500	250	0.05	4.7	3658	● ■
	ROV10-470K	47	±10%	30	38	93*	500	250	0.05	6.0	3137	● ■
	ROV10-560K	56	±10%	35	45	110*	500	250	0.05	7.0	2900	● ■
	ROV10-680K	68	±10%	40	56	135*	500	250	0.05	8.5	2230	● ■
	ROV10-820K	82	±10%	50	65	135	2500	1250	0.40	11.0	1261	● ■
	ROV10-101K	100	±10%	60	85	165	2500	1250	0.40	14.0	1021	● ■
	ROV10-121K	120	±10%	75	100	200	2500	1250	0.40	16.0	946	● ■
	ROV10-151K	150	±10%	95	125	250	2500	1250	0.40	22.0	733	● ■
	ROV10-181K	180	±10%	115	150	300	2500	1250	0.40	26.0	483	● ■
	ROV10-201K	200	±10%	130	170	340	2500	1250	0.40	28.5	400	◆ ● ▲ ■
	ROV10-221K	220	±10%	140	180	360	2500	1250	0.40	31.0	393	◆ ● ▲ ■
	ROV10-241K	240	±10%	150	200	395	2500	1250	0.40	33.5	325	◆ ● ▲ ■
	ROV10-271K	270	±10%	175	225	455	2500	1250	0.40	39.5	334	◆ ● ▲ ■
	ROV10-301K	300	±10%	195	250	505	2500	1250	0.40	42.0	278	◆ ● ▲ ■
	ROV10-331K	330	±10%	210	275	550	2500	1250	0.40	46.0	275	◆ ● ▲ ■
	ROV10-361K	360	±10%	230	300	595	2500	1250	0.40	52.0	231	◆ ● ▲ ■
	ROV10-391K	390	±10%	250	320	650	2500	1250	0.40	60.0	247	◆ ● ▲ ■
	ROV10-431K	430	±10%	275	350	710	2500	1250	0.40	66.0	216	◆ ● ▲ ■
	ROV10-471K	470	±10%	300	385	775	2500	1250	0.40	70.0	210	◆ ● ▲ ■
	ROV10-511K	510	±10%	320	418	842	2500	1250	0.40	74.0	187	◆ ● ▲ ■
	ROV10-561K	560	±10%	350	460	920	2500	1250	0.40	78.0	186	◆ ● ▲ ■
	ROV10-621K	620	±10%	385	505	1025	2500	1250	0.40	82.0	160	◆ ● ▲ ■
	ROV10-681K	680	±10%	420	560	1120	2500	1250	0.40	86.0	156	◆ ● ▲ ■
	ROV10-751K	750	±10%	460	615	1240	2500	1250	0.40	90.0	133	◆ ● ▲ ■
	ROV10-781K	780	±10%	485	640	1290	2500	1250	0.40	92.0	117	◆ ● ▲ ■
	ROV10-821K	820	±10%	510	670	1355	2500	1250	0.40	94.0	130	◆ ● ▲ ■
	ROV10-911K	910	±10%	550	745	1500	2500	1250	0.40	102.0	111	◆ ● ▲ ■
	ROV10-102K	1000	±10%	625	825	1650	2500	1250	0.40	112.0	96	◆ ● ▲ ■
	ROV10-112K	1100	±10%	680	895	1815	2500	1250	0.40	124.0	88	◆ ● ▲ ■
	ROV10-182K	1800	±10%	1000	1465	2970	2500	1250	0.40	174.0	65	◆ ● ▲ ■

* The clamping voltages from 180M to 680K are tested at 5A current.

†Certification

Standard	UL1414‡	UL1449 (2nd Edition)‡	CSA	VDE
Title	Across-the-Line Components	Transient Voltage Surge Suppressors	Accessories and Parts for Electronic Equipment	Varistors for Use in Electronic Equipment
Symbols	◆	●	▲	■
File Number	E223034	E223033	220978	40006997

‡ For UL 1449 (2nd Edition), the maximum clamping voltage is measured at 500A.

Table V7 Rating and Characteristics for Standard Series Specifications — 14mm Devices

	Part Number	Varistor Voltage V@1.0mA		Maximum Allowance Voltage		Maximum Clamping Voltage	Maximum Surge Current (8x20µs)		Rated Woltage	Energy (10x1000µs)	Capacitance (Typical)	Certification†
		DC (V)	Tolerance	AC (V _{RMS})	DC (V)	V@50A (V)	1 Time (A)	2 Times (A)	(W)	(J)	(pF)	
	ROV14-180M	18	±20%	11	14	36*	1000	500	0.1	4.7	14898	● ■
	ROV14-220L	22	±15%	14	18	43*	1000	500	0.1	5.4	11957	● ■
	ROV14-270K	27	±10%	17	22	53*	1000	500	0.1	6.9	9731	● ■
	ROV14-330K	33	±10%	20	26	65*	1000	500	0.1	8.8	7704	● ■
	ROV14-390K	39	±10%	25	31	77*	1000	500	0.1	9.4	7622	● ■
	ROV14-470K	47	±10%	30	38	93*	1000	500	0.1	12.0	6417	● ■
	ROV14-560K	56	±10%	35	45	110*	1000	500	0.1	14.0	5184	● ■
	ROV14-680K	68	±10%	40	56	135*	1000	500	0.1	17.0	5099	● ■
	ROV14-820K	82	±10%	50	65	135	4500	2500	0.6	22.0	2965	● ■
	ROV14-101K	100	±10%	60	85	165	4500	2500	0.6	28.0	2221	● ■
	ROV14-121K	120	±10%	75	100	200	4500	2500	0.6	32.0	1742	● ■
	ROV14-151K	150	±10%	95	125	250	4500	2500	0.6	44.0	1510	● ■
	ROV14-181K	180	±10%	115	150	300	4500	2500	0.6	52.0	922	● ■
	ROV14-201K	200	±10%	130	170	340	4500	2500	0.6	57.0	845	◆ ● ▲ ■
	ROV14-221K	220	±10%	140	180	360	4500	2500	0.6	62.0	713	◆ ● ▲ ■
	ROV14-241K	240	±10%	150	200	395	4500	2500	0.6	67.0	769	◆ ● ▲ ■
	ROV14-271K	270	±10%	175	225	455	4500	2500	0.6	79.0	655	◆ ● ▲ ■
	ROV14-301K	300	±10%	195	250	505	4500	2500	0.6	84.0	650	◆ ● ▲ ■
	ROV14-331K	330	±10%	210	275	550	4500	2500	0.6	92.0	613	◆ ● ▲ ■
	ROV14-361K	360	±10%	230	300	595	4500	2500	0.6	104.0	465	◆ ● ▲ ■
	ROV14-391K	390	±10%	250	320	650	4500	2500	0.6	120.0	458	◆ ● ▲ ■
	ROV14-431K	430	±10%	275	350	710	4500	2500	0.6	132.0	454	◆ ● ▲ ■
	ROV14-471K	470	±10%	300	385	775	4500	2500	0.6	140.0	413	◆ ● ▲ ■
	ROV14-511K	510	±10%	320	418	842	4500	2500	0.6	148.0	374	◆ ● ▲ ■
	ROV14-561K	560	±10%	350	460	920	4500	2500	0.6	156.0	398	◆ ● ▲ ■
	ROV14-621K	620	±10%	385	505	1025	4500	2500	0.6	164.0	305	◆ ● ▲ ■
	ROV14-681K	680	±10%	420	560	1120	4500	2500	0.6	172.0	312	◆ ● ▲ ■
	ROV14-751K	750	±10%	460	615	1240	4500	2500	0.6	180.0	270	◆ ● ▲ ■
	ROV14-781K	780	±10%	485	640	1290	4500	2500	0.6	184.0	252	◆ ● ▲ ■
	ROV14-821K	820	±10%	510	670	1355	4500	2500	0.6	188.0	265	◆ ● ▲ ■
	ROV14-911K	910	±10%	550	745	1500	4500	2500	0.6	204.0	240	◆ ● ▲ ■
	ROV14-102K	1000	±10%	625	825	1650	4500	2500	0.6	224.0	200	◆ ● ▲ ■
	ROV14-112K	1100	±10%	680	895	1815	4500	2500	0.6	248.0	180	◆ ● ▲ ■
	ROV14-182K	1800	±10%	1000	1465	2970	4500	2500	0.6	348.0	118	◆ ● ▲ ■

* The clamping voltages from 180M to 680K are tested at 10A current.

†Certification

Standard	UL1414‡	UL1449 (2nd Edition)‡	CSA	VDE
Title	Across-the-Line Components	Transient Voltage Surge Suppressors	Accessories and Parts for Electronic Equipment	Varistors for Use in Electronic Equipment
Symbols	◆	●	▲	■
File Number	E223034	E223033	220978	40006997

‡ For UL 1449 (2nd Edition), the maximum clamping voltage is measured at 500A.

Figure V10-V12

Standard Series Specifications — 14mm Devices Pulse Lifetime Ratings and V-I Characteristic Curves

Figure V10 - ROV14-180M-ROV14-680K

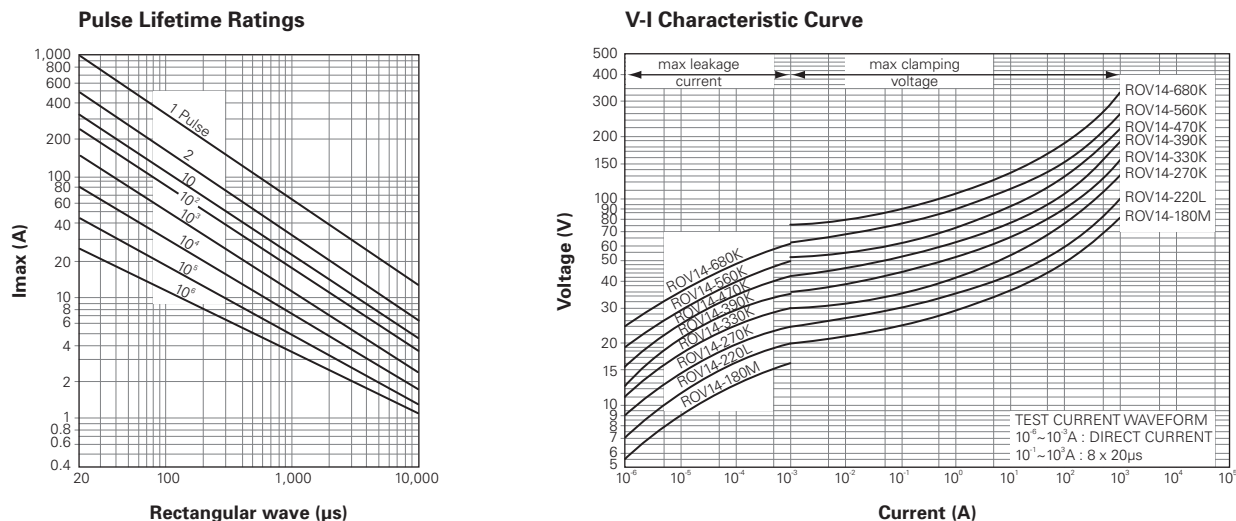


Figure V11 - ROV14-820K-ROV14-511K

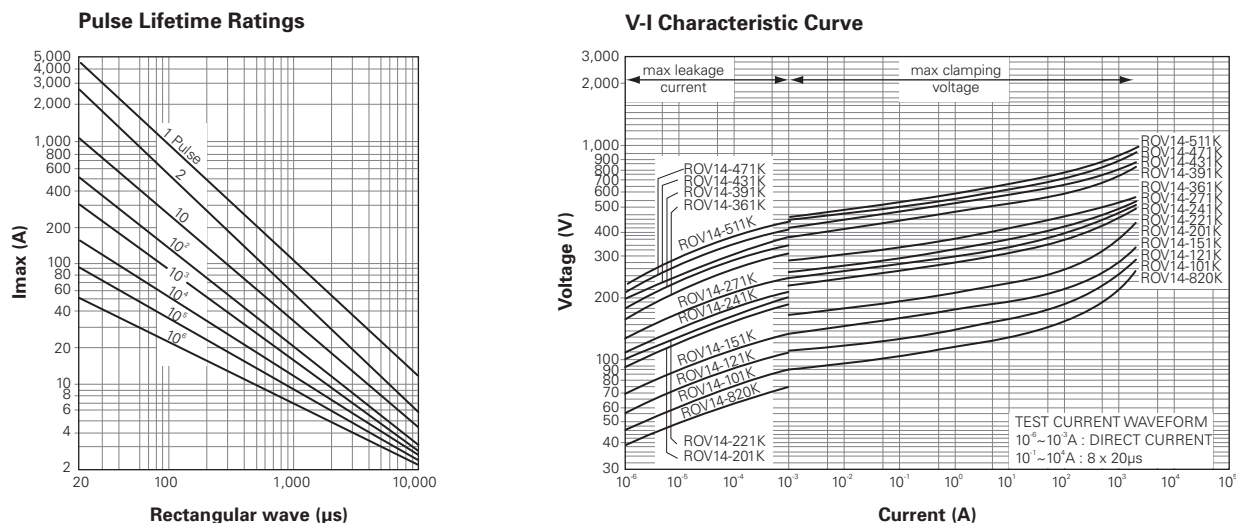


Figure V12 - ROV14-561K-ROV14-182K

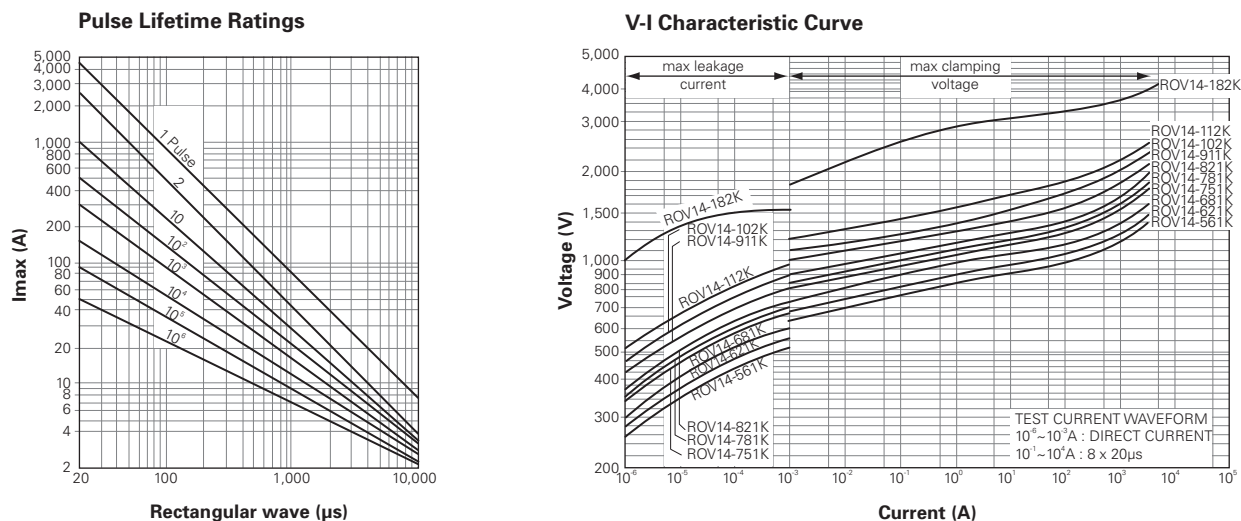


Table V8 Rating and Characteristics for Standard Series Specifications — 20mm Devices

	Part Number	Varistor Voltage V@1.0mA		Maximum Allowance Voltage		Maximum Clamping Voltage	Maximum Surge Current (8x20µs)		Rated Woltage	Energy (10x1000µs)	Capacitance (Typical)	Certification†
		DC (V)	Tolerance	AC (V _{RMS})	DC (V)	V@100A (V)	1 Time (A)	2 Times (A)	(W)	(J)	(pF)	
	ROV20-220M	22	±20%	14	18	43*	2000	1000	0.2	8.0	21200	● ■
	ROV20-270M	27	±20%	17	22	53*	2000	1000	0.2	10.0	20000	● ■
	ROV20-330M	33	±20%	20	26	65*	2000	1000	0.2	12.0	17200	● ■
	ROV20-390L	39	±15%	25	31	77*	2000	1000	0.2	14.0	15003	● ■
	ROV20-470L	47	±15%	30	38	93*	2000	1000	0.2	17.0	12080	● ■
	ROV20-560L	56	±15%	35	45	110*	2000	1000	0.2	20.0	11600	● ■
	ROV20-680L	68	±15%	40	56	135*	2000	1000	0.2	24.0	9600	● ■
	ROV20-101K	100	±10%	60	85	165	6500	4000	1.0	56.0	4000	● ■
	ROV20-121K	120	±10%	75	100	200	6500	4000	1.0	64.0	3800	● ■
	ROV20-151K	150	±10%	95	125	250	6500	4000	1.0	88.0	3000	● ■
	ROV20-181K	180	±10%	115	150	300	6500	4000	1.0	104.0	2400	● ■
	ROV20-201K	200	±10%	130	170	340	6500	4000	1.0	114.0	1829	◆ ● ▲ ■
	ROV20-221K	220	±10%	140	180	360	6500	4000	1.0	124.0	1600	◆ ● ▲ ■
	ROV20-241K	240	±10%	150	200	395	6500	4000	1.0	134.0	1422	◆ ● ▲ ■
	ROV20-271K	270	±10%	175	225	455	6500	4000	1.0	158.0	1261	◆ ● ▲ ■
	ROV20-301K	300	±10%	195	250	505	6500	4000	1.0	168.0	1100	◆ ● ▲ ■
	ROV20-331K	330	±10%	210	275	550	6500	4000	1.0	184.0	1106	◆ ● ▲ ■
	ROV20-361K	360	±10%	230	300	595	6500	4000	1.0	208.0	987	◆ ● ▲ ■
	ROV20-391K	390	±10%	250	320	650	6500	4000	1.0	240.0	975	◆ ● ▲ ■
	ROV20-431K	430	±10%	275	350	710	6500	4000	1.0	264.0	858	◆ ● ▲ ■
	ROV20-471K	470	±10%	300	385	775	6500	4000	1.0	280.0	761	◆ ● ▲ ■
	ROV20-511K	510	±10%	320	418	842	6500	4000	1.0	296.0	792	◆ ● ▲ ■
	ROV20-561K	560	±10%	350	460	920	6500	4000	1.0	312.0	679	◆ ● ▲ ■
	ROV20-621K	620	±10%	385	505	1025	6500	4000	1.0	328.0	605	◆ ● ▲ ■
	ROV20-681K	680	±10%	420	560	1120	6500	4000	1.0	344.0	553	◆ ● ▲ ■
	ROV20-751K	750	±10%	460	615	1240	6500	4000	1.0	360.0	554	◆ ● ▲ ■
	ROV20-781K	780	±10%	485	640	1290	6500	4000	1.0	368.0	481	◆ ● ▲ ■
	ROV20-821K	820	±10%	510	670	1355	6500	4000	1.0	376.0	519	◆ ● ▲ ■
	ROV20-911K	910	±10%	550	745	1500	6500	4000	1.0	408.0	444	◆ ● ▲ ■
	ROV20-102K	1000	±10%	625	825	1650	6500	4000	1.0	448.0	400	◆ ● ▲ ■
	ROV20-112K	1100	±10%	680	895	1815	6500	4000	1.0	496.0	360	◆ ● ▲ ■
	ROV20-182K	1800	±10%	1000	1465	2970	6500	4000	1.0	695.0	260	◆ ● ▲ ■

* The clamping voltages from 180M to 680K are tested at 20A current.

†Certification

Standard	UL1414‡	UL1449 (2nd Edition)‡	CSA	VDE
Title	Across-the-Line Components	Transient Voltage Surge Suppressors	Accessories and Parts for Electronic Equipment	Varistors for Use in Electronic Equipment
Symbols	◆	●	▲	■
File Number	E223034	E223033	220978	40006997

‡ For UL 1449 (2nd Edition), the maximum clamping voltage is measured at 500A.

Figure V13-V15

Standard Series Specifications — 20mm Devices Pulse Lifetime Ratings and V-I Characteristic Curves

Figure V13 - ROV20-220M-ROV20-680L

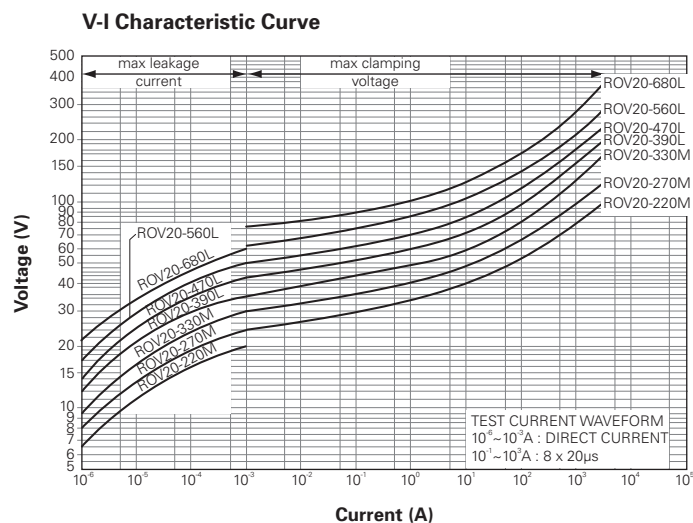
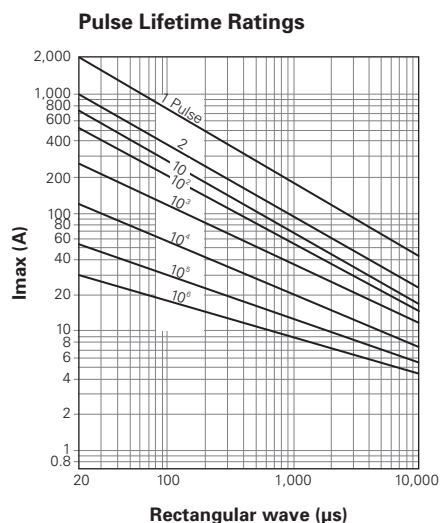


Figure V14 - ROV20-101K-ROV20-511K

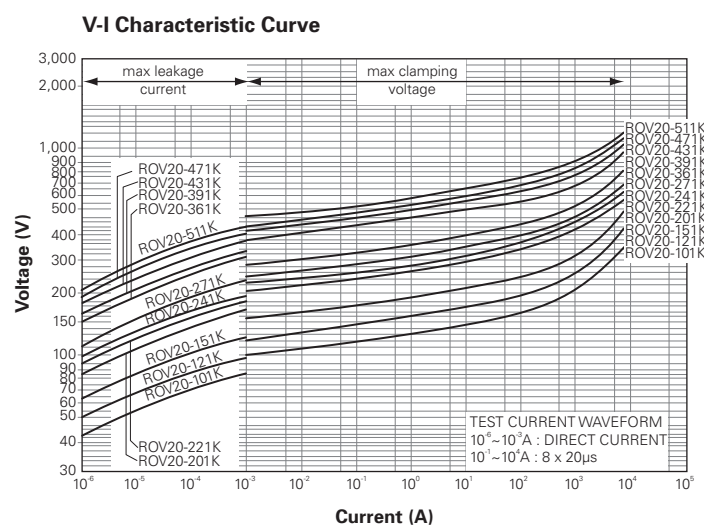
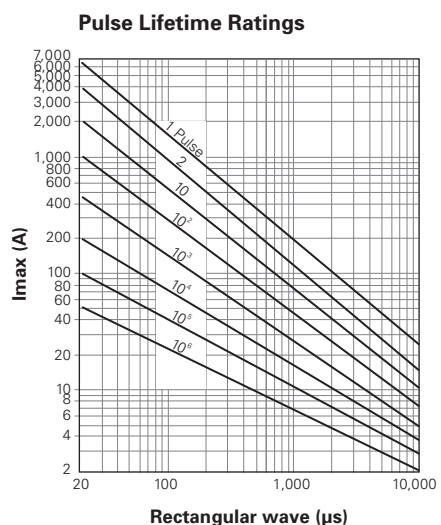


Figure V15 - ROV20-561K-ROV20-182K

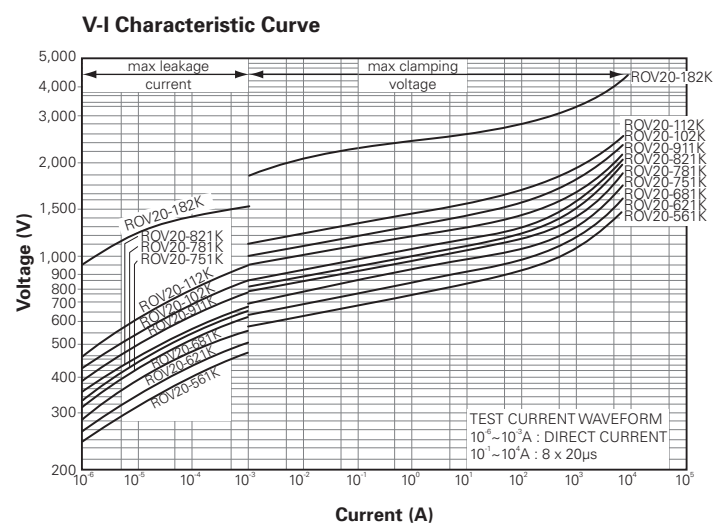
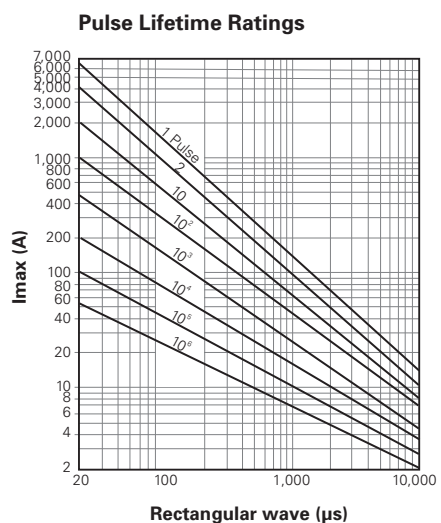


Table V9 Rating and Characteristics for H Series Specifications — 5mm Devices

	Part Number	Varistor Voltage V@1.0mA		Maximum Allowance Voltage		Maximum Clamping Voltage	Maximum Surge Current (8x20µs)		Rated Woltage	Energy (10x1000µs)	Capacitance (Typical)	Certification†
		DC (V)	Tolerance	AC (V _{RMS})	DC (V)	V@5A (V)	1 Time (A)	2 Times (A)	(W)	(J)	(pF)	
	ROV05H180M	18	±20%	11	14	40*	250	125	0.01	0.7	1120	● ■
	ROV05H220L	22	±15%	14	18	48*	250	125	0.01	0.8	1230	● ■
	ROV05H270K	27	±10%	17	22	60*	250	125	0.01	1.1	1070	● ■
	ROV05H330K	33	±10%	20	26	73*	250	125	0.01	1.3	830	● ■
	ROV05H390K	39	±10%	25	31	86*	250	125	0.01	1.5	880	● ■
	ROV05H470K	47	±10%	30	38	104*	250	125	0.01	1.8	720	● ■
	ROV05H560K	56	±10%	35	45	123*	250	125	0.01	2.2	640	● ■
	ROV05H680K	68	±10%	40	56	150*	250	125	0.01	2.6	500	● ■
	ROV05H820K	82	±10%	50	65	145	800	600	0.10	3.5	270	● ■
	ROV05H101K	100	±10%	60	85	175	800	600	0.10	4.5	260	● ■
	ROV05H121K	120	±10%	75	100	210	800	600	0.10	5.5	180	● ■
	ROV05H151K	150	±10%	95	125	260	800	600	0.10	6.5	180	● ■
	ROV05H181K	180	±10%	115	150	320	800	600	0.10	8.0	95	● ■
	ROV05H201K	200	±10%	130	170	355	800	600	0.10	8.5	85	◆ ● ▲ ■
	ROV05H221K	220	±10%	140	180	380	800	600	0.10	9.0	80	◆ ● ▲ ■
	ROV05H241K	240	±10%	150	200	415	800	600	0.10	10.5	75	◆ ● ▲ ■
	ROV05H271K	270	±10%	175	225	475	800	600	0.10	11.0	70	◆ ● ▲ ■
	ROV05H301K	300	±10%	195	250	525	800	600	0.10	12.0	65	◆ ● ▲ ■
	ROV05H331K	330	±10%	210	275	575	800	600	0.10	13.0	60	◆ ● ▲ ■
	ROV05H361K	360	±10%	230	300	620	800	600	0.10	16.0	70	◆ ● ▲ ■
	ROV05H391K	390	±10%	250	320	675	800	600	0.10	17.0	55	◆ ● ▲ ■
	ROV05H431K	430	±10%	275	350	745	800	600	0.10	20.0	45	◆ ● ▲ ■
	ROV05H471K	470	±10%	300	385	810	800	600	0.10	21.0	50	◆ ● ▲ ■
	ROV05H511K	510	±10%	320	418	880	800	600	0.10	22.0	50	◆ ● ▲ ■
	ROV05H561K	560	±10%	350	460	940	800	600	0.10	25.0	50	◆ ● ▲ ■
	ROV05H621K	620	±10%	385	505	1050	800	600	0.10	27.0	50	◆ ● ▲ ■
	ROV05H681K	680	±10%	420	560	1150	800	600	0.10	28.0	40	◆ ● ▲ ■
	ROV05H751K	750	±10%	460	615	1290	800	600	0.10	29.0	—	◆ ● ▲ ■

* The clamping voltages from 180M to 680K are tested at 1A current.

†Certification

Standard	UL1414‡	UL1449 (2nd Edition)‡	CSA	VDE
Title	Across-the-Line Components	Transient Voltage Surge Suppressors	Accessories and Parts for Electronic Equipment	Varistors for Use in Electronic Equipment
Symbols	◆	●	▲	■
File Number	E223034	E223033	220978	40006997

‡ For UL 1449 (2nd Edition), the maximum clamping voltage is measured at 500A.

Figure V16-V17 H Series Specifications — 5mm Devices
Pulse Lifetime Ratings and V-I Characteristic Curves

Figure V16 - ROV05H180M-ROV05H680K

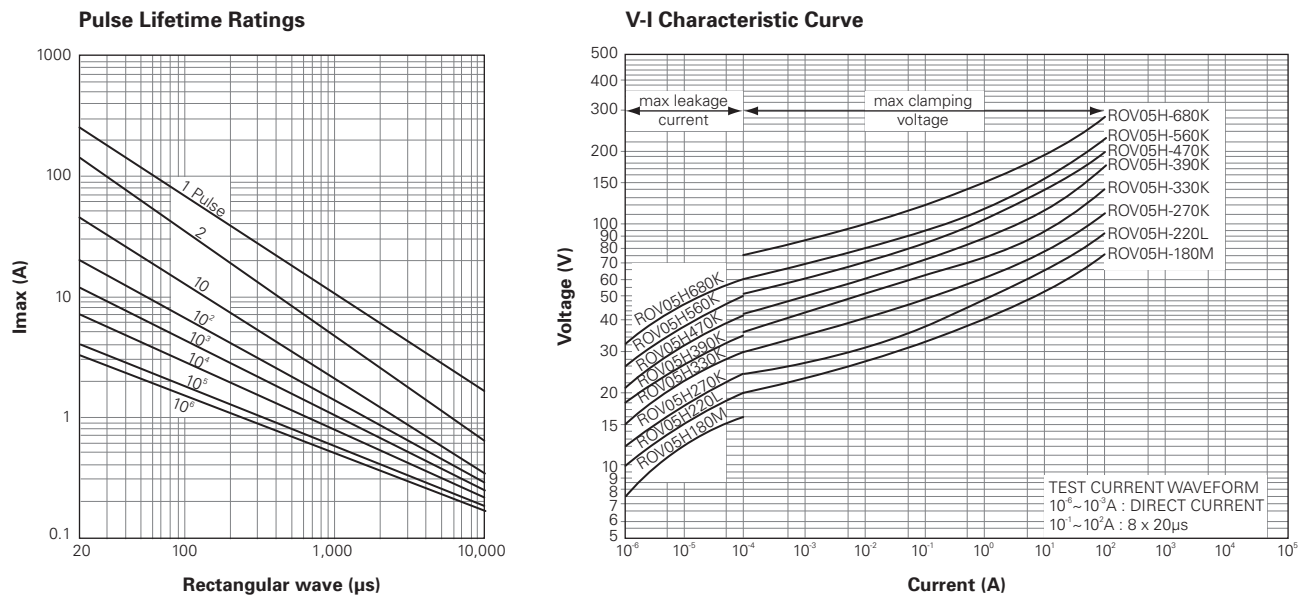


Figure V17 - ROV05H820K-ROV05H471K

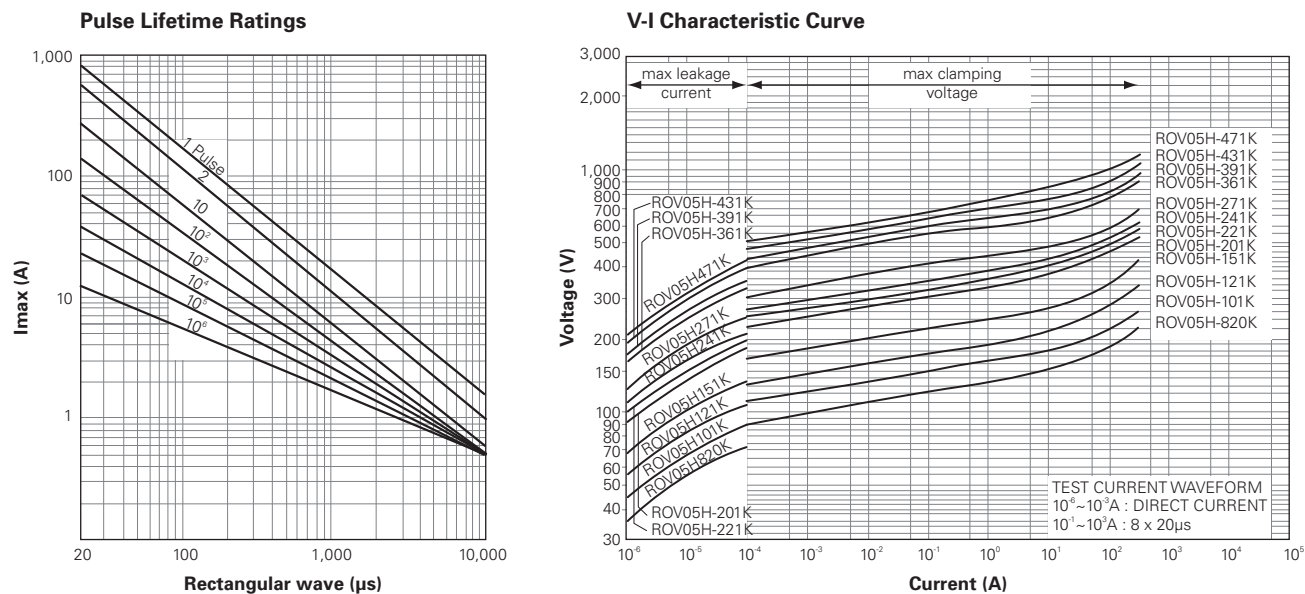


Table V10 Rating and Characteristics for H Series Specifications — 7mm Devices

	Part Number	Varistor Voltage V@1.0mA		Maximum Allowance Voltage		Maximum Clamping Voltage	Maximum Surge Current (8x20µs)		Rated Woltage	Energy (10x1000µs)	Capacitance (Typical)	Certification†
		DC (V)	Tolerance	AC (V _{RMS})	DC (V)	V@10A (V)	1 Time (A)	2 Times (A)	(W)	(J)	(pF)	
	ROV07H180M	18	±20%	11	14	36*	500	250	0.02	1.5	2920	● ■
	ROV07H220L	22	±15%	14	18	43*	500	250	0.02	1.7	2930	● ■
	ROV07H270K	27	±10%	17	22	53*	500	250	0.02	2.1	2340	● ■
	ROV07H330K	33	±10%	20	26	65*	500	250	0.02	2.8	1840	● ■
	ROV07H390K	39	±10%	25	31	77*	500	250	0.02	3.0	1820	● ■
	ROV07H470K	47	±10%	30	38	93*	500	250	0.02	3.8	1600	● ■
	ROV07H560K	56	±10%	35	45	110*	500	250	0.02	4.4	1330	● ■
	ROV07H680K	68	±10%	40	56	135*	500	250	0.02	5.4	1120	● ■
	ROV07H820K	82	±10%	50	65	135	1750	1250	0.25	7.0	640	● ■
	ROV07H101K	100	±10%	60	85	165	1750	1250	0.25	9.0	540	● ■
	ROV07H121K	120	±10%	75	100	200	1750	1250	0.25	11.0	460	● ■
	ROV07H151K	150	±10%	95	125	250	1750	1250	0.25	13.0	370	● ■
	ROV07H181K	180	±10%	115	150	300	1750	1250	0.25	16.0	220	● ■
	ROV07H201K	200	±10%	130	170	340	1750	1250	0.25	17.5	220	◆ ● ▲ ■
	ROV07H221K	220	±10%	140	180	360	1750	1250	0.25	19.0	190	◆ ● ▲ ■
	ROV07H241K	240	±10%	150	200	395	1750	1250	0.25	21.0	190	◆ ● ▲ ■
	ROV07H271K	270	±10%	175	225	455	1750	1250	0.25	24.0	160	◆ ● ▲ ■
	ROV07H301K	300	±10%	195	250	505	1750	1250	0.25	26.0	140	◆ ● ▲ ■
	ROV07H331K	330	±10%	210	275	550	1750	1250	0.25	28.0	140	◆ ● ▲ ■
	ROV07H361K	360	±10%	230	300	595	1750	1250	0.25	32.0	120	◆ ● ▲ ■
	ROV07H391K	390	±10%	250	320	650	1750	1250	0.25	35.0	110	◆ ● ▲ ■
	ROV07H431K	430	±10%	275	350	710	1750	1250	0.25	40.0	110	◆ ● ▲ ■
	ROV07H471K	470	±10%	300	385	775	1750	1250	0.25	42.0	100	◆ ● ▲ ■
	ROV07H511K	510	±10%	320	418	842	1750	1250	0.25	45.0	100	◆ ● ▲ ■
	ROV07H561K	560	±10%	350	460	920	1750	1250	0.25	51.0	85	◆ ● ▲ ■
	ROV07H621K	620	±10%	385	505	1025	1750	1250	0.25	54.0	80	◆ ● ▲ ■
	ROV07H681K	680	±10%	420	560	1120	1750	1250	0.25	56.0	80	◆ ● ▲ ■
	ROV07H751K	750	±10%	460	615	1240	1750	1250	0.25	58.0	75	◆ ● ▲ ■
	ROV07H781K	780	±10%	485	640	1290	1750	1250	0.25	59.0	70	◆ ● ▲ ■
	ROV07H821K	820	±10%	510	670	1355	1750	1250	0.25	60.0	70	◆ ● ▲ ■

* The clamping voltages from 180M to 680K are tested at 2.5A current.

†Certification

Standard	UL1414‡	UL1449 (2nd Edition)‡	CSA	VDE
Title	Across-the-Line Components	Transient Voltage Surge Suppressors	Accessories and Parts for Electronic Equipment	Varistors for Use in Electronic Equipment
Symbols	◆	●	▲	■
File Number	E223034	E223033	220978	40006997

‡ For UL 1449 (2nd Edition), the maximum clamping voltage is measured at 500A.

Figure V18-V19 H Series Specifications — 7mm Devices
Pulse Lifetime Ratings and V-I Characteristic Curves

Figure V18 - ROV07H180M-ROV07H680K

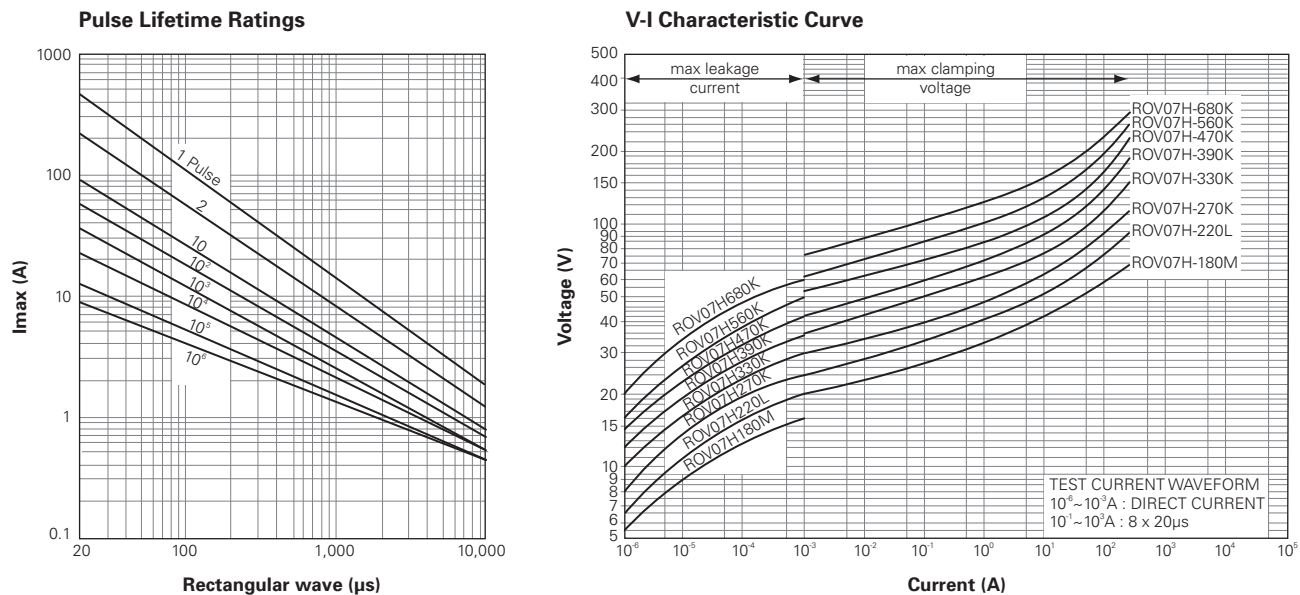


Figure V19 - ROV07H820K-ROV07H471K

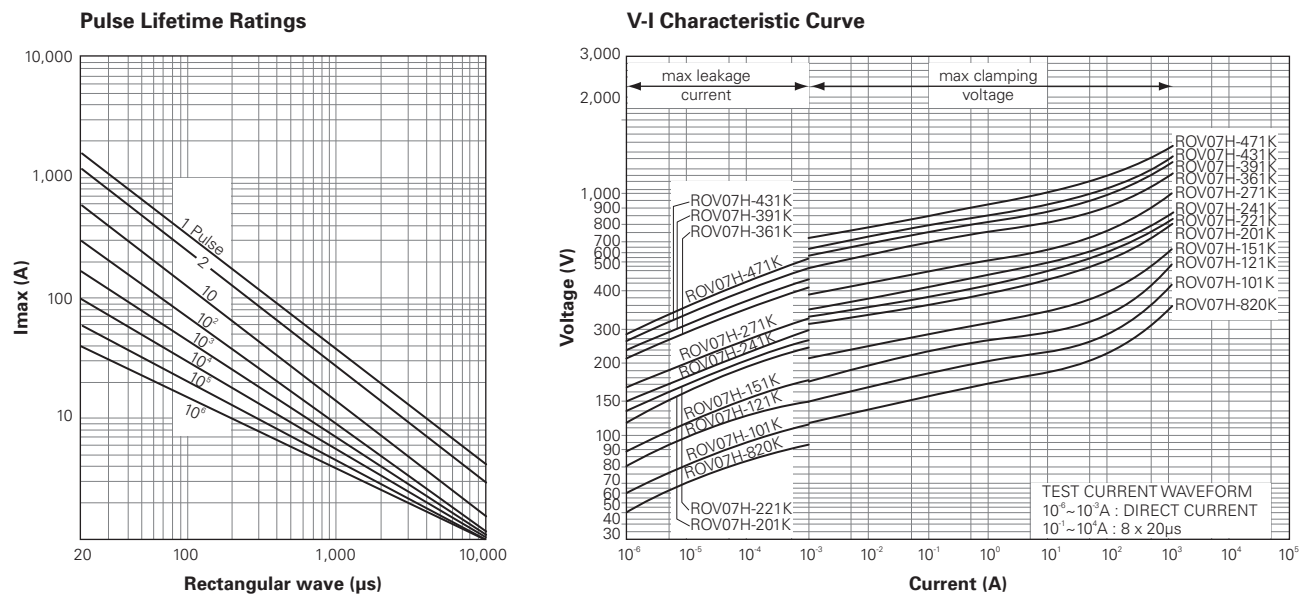


Table V11 Rating and Characteristics for H Series Specifications — 10mm Devices

	Part Number	Varistor Voltage V@1.0mA		Maximum Allowance Voltage		Maximum Clamping Voltage	Maximum Surge Current (8x20µs)		Rated Woltage	Energy (10x1000µs)	Capacitance (Typical)	Certification†
		DC (V)	Tolerance	AC (V _{RMS})	DC (V)	V@25A (V)	1 Time (A)	2 Times (A)	(W)	(J)	(pF)	
	ROV10H180M	18	±20%	11	14	36*	1000	500	0.05	2.6	6500	● ■
	ROV10H220L	22	±15%	14	18	43*	1000	500	0.05	3.2	5520	● ■
	ROV10H270K	27	±10%	17	22	53*	1000	500	0.05	3.9	4740	● ■
	ROV10H330K	33	±10%	20	26	65*	1000	500	0.05	4.8	4250	● ■
	ROV10H390K	39	±10%	25	31	77*	1000	500	0.05	5.6	3660	● ■
	ROV10H470K	47	±10%	30	38	93*	1000	500	0.05	6.8	3140	● ■
	ROV10H560K	56	±10%	35	45	110*	1000	500	0.05	8.1	2900	● ■
	ROV10H680K	68	±10%	40	56	135*	1000	500	0.05	9.8	2230	● ■
	ROV10H820K	82	±10%	50	65	135	3500	2500	0.40	14.0	1260	● ■
	ROV10H101K	100	±10%	60	85	165	3500	2500	0.40	18.0	1020	● ■
	ROV10H121K	120	±10%	75	100	200	3500	2500	0.40	22.0	950	● ■
	ROV10H151K	150	±10%	95	125	250	3500	2500	0.40	25.0	730	● ■
	ROV10H181K	180	±10%	115	150	300	3500	2500	0.40	32.0	480	● ■
	ROV10H201K	200	±10%	130	170	340	3500	2500	0.40	35.0	400	◆ ● ▲ ■
	ROV10H221K	220	±10%	140	180	360	3500	2500	0.40	39.0	390	◆ ● ▲ ■
	ROV10H241K	240	±10%	150	200	395	3500	2500	0.40	42.0	330	◆ ● ▲ ■
	ROV10H271K	270	±10%	175	225	455	3500	2500	0.40	49.0	330	◆ ● ▲ ■
	ROV10H301K	300	±10%	195	250	505	3500	2500	0.40	52.0	280	◆ ● ▲ ■
	ROV10H331K	330	±10%	210	275	550	3500	2500	0.40	58.0	280	◆ ● ▲ ■
	ROV10H361K	360	±10%	230	300	595	3500	2500	0.40	65.0	230	◆ ● ▲ ■
	ROV10H391K	390	±10%	250	320	650	3500	2500	0.40	70.0	250	◆ ● ▲ ■
	ROV10H431K	430	±10%	275	350	710	3500	2500	0.40	80.0	220	◆ ● ▲ ■
	ROV10H471K	470	±10%	300	385	775	3500	2500	0.40	85.0	210	◆ ● ▲ ■
	ROV10H511K	510	±10%	320	418	842	3500	2500	0.40	92.0	190	◆ ● ▲ ■
	ROV10H561K	560	±10%	350	460	920	3500	2500	0.40	102.0	190	◆ ● ▲ ■
	ROV10H621K	620	±10%	385	505	1025	3500	2500	0.40	107.0	160	◆ ● ▲ ■
	ROV10H681K	680	±10%	420	560	1120	3500	2500	0.40	112.0	160	◆ ● ▲ ■
	ROV10H751K	750	±10%	460	615	1240	3500	2500	0.40	115.0	130	◆ ● ▲ ■
	ROV10H781K	780	±10%	485	640	1290	3500	2500	0.40	116.0	120	◆ ● ▲ ■
	ROV10H821K	820	±10%	510	670	1355	3500	2500	0.40	118.0	130	◆ ● ▲ ■
	ROV10H911K	910	±10%	550	745	1500	3500	2500	0.40	127.0	110	◆ ● ▲ ■
	ROV10H102K	1000	±10%	625	825	1650	3500	2500	0.40	140.0	95	◆ ● ▲ ■
	ROV10H112K	1100	±10%	680	895	1815	3500	2500	0.40	155.0	90	◆ ● ▲ ■
	ROV10H182K	1800	±10%	1000	1465	2970	3500	2500	0.40	247.0	62	◆ ● ▲ ■

* The clamping voltages from 180M to 680K are tested at 5A current.

†Certification

Standard	UL1414‡	UL1449 (2nd Edition)‡	CSA	VDE
Title	Across-the-Line Components	Transient Voltage Surge Suppressors	Accessories and Parts for Electronic Equipment	Varistors for Use in Electronic Equipment
Symbols	◆	●	▲	■
File Number	E223034	E223033	220978	40006997

‡ For UL 1449 (2nd Edition), the maximum clamping voltage is measured at 500A.

Figure V20-V22 H Series Specifications — 10mm Devices
Pulse Lifetime Ratings and V-I Characteristic Curves

Figure V20 - ROV10H180M-ROV10H680K

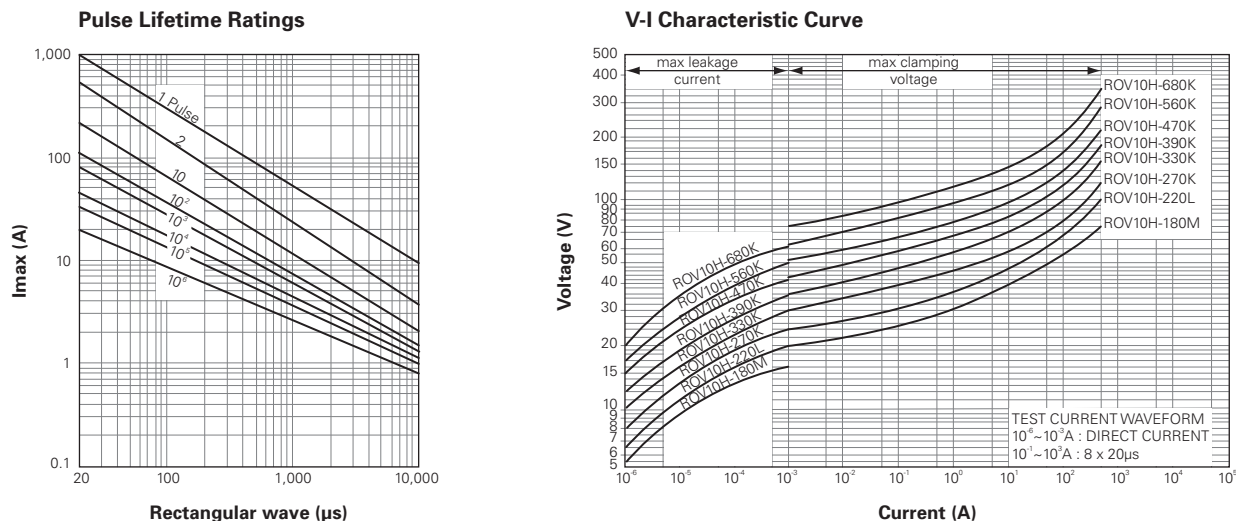


Figure V21 - ROV10H820K-ROV10H511K

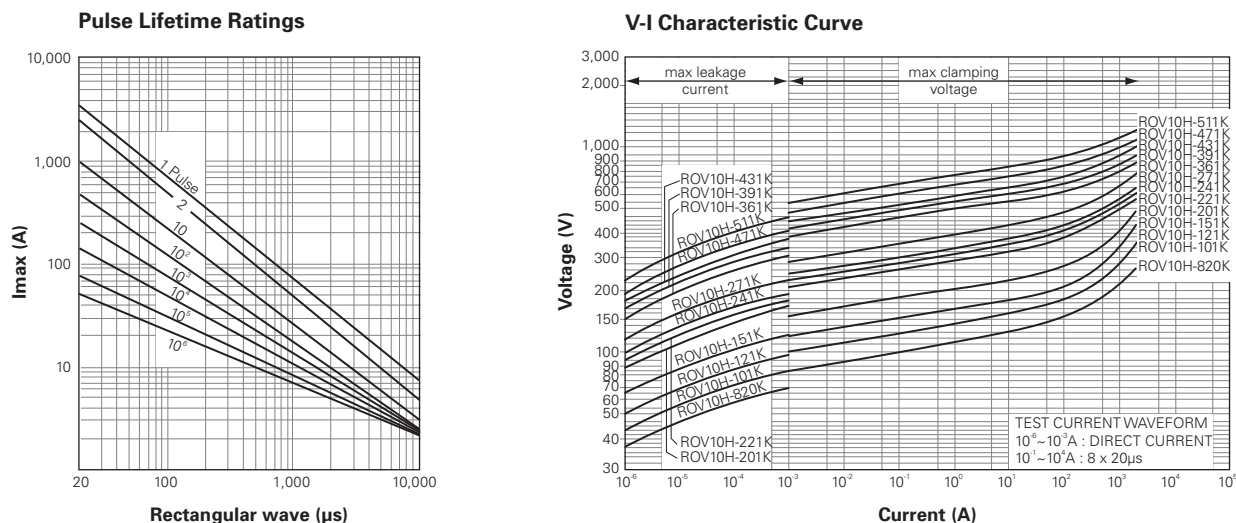


Figure V22 - ROV10H561K-ROV10H182K

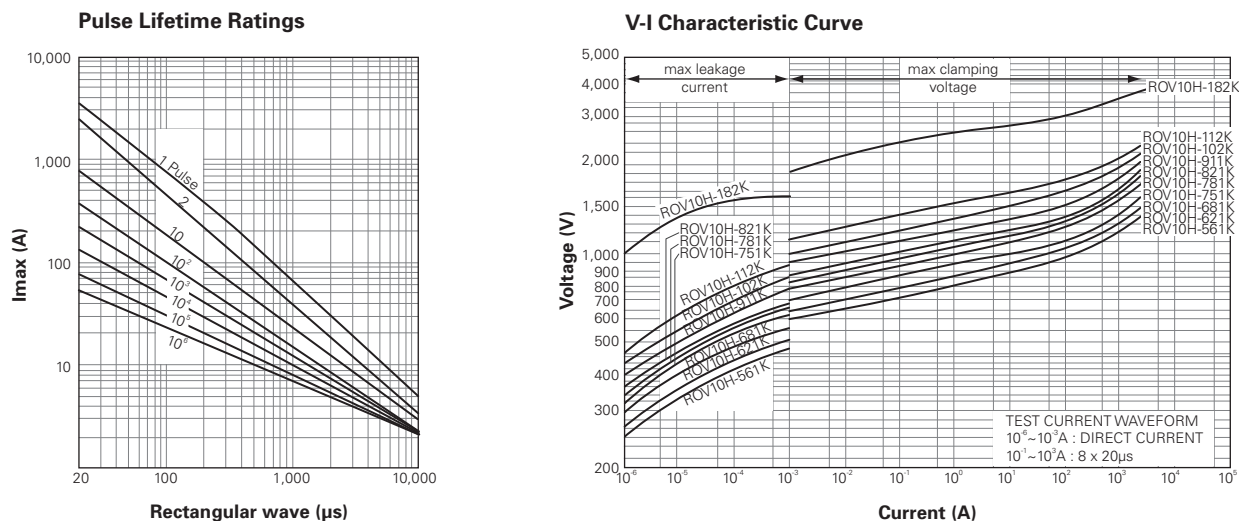


Table V12 Rating and Characteristics for H Series Specifications — 14mm Devices

	Part Number	Varistor Voltage V@1.0mA		Maximum Allowance Voltage		Maximum Clamping Voltage	Maximum Surge Current (8x20µs)		Rated Woltage	Energy (10x1000µs)	Capacitance (Typical)	Certification†
		DC (V)	Tolerance	AC (V _{RMS})	DC (V)	V@50A (V)	1 Time (A)	2 Times (A)	(W)	(J)	(pF)	
	ROV14H180M	18	±20%	11	14	36*	2000	1000	0.1	5.2	14890	● ■
	ROV14H220L	22	±15%	14	18	43*	2000	1000	0.1	6.3	11960	● ■
	ROV14H270K	27	±10%	17	22	53*	2000	1000	0.1	7.8	9730	● ■
	ROV14H330K	33	±10%	20	26	65*	2000	1000	0.1	9.5	7700	● ■
	ROV14H390K	39	±10%	25	31	77*	2000	1000	0.1	11.0	7620	● ■
	ROV14H470K	47	±10%	30	38	93*	2000	1000	0.1	14.0	6420	● ■
	ROV14H560K	56	±10%	35	45	110*	2000	1000	0.1	16.0	5180	● ■
	ROV14H680K	68	±10%	40	56	135*	2000	1000	0.1	20.0	5100	● ■
	ROV14H820K	82	±10%	50	65	135	6000	4500	0.6	28.0	2970	● ■
	ROV14H101K	100	±10%	60	85	165	6000	4500	0.6	36.0	2220	● ■
	ROV14H121K	120	±10%	75	100	200	6000	4500	0.6	44.0	1740	● ■
	ROV14H151K	150	±10%	95	125	250	6000	4500	0.6	53.0	1510	● ■
	ROV14H181K	180	±10%	115	150	300	6000	4500	0.6	65.0	920	● ■
	ROV14H201K	200	±10%	130	170	340	6000	4500	0.6	70.0	840	◆ ● ▲ ■
	ROV14H221K	220	±10%	140	180	360	6000	4500	0.6	78.0	710	◆ ● ▲ ■
	ROV14H241K	240	±10%	150	200	395	6000	4500	0.6	84.0	770	◆ ● ▲ ■
	ROV14H271K	270	±10%	175	225	455	6000	4500	0.6	99.0	650	◆ ● ▲ ■
	ROV14H301K	300	±10%	195	250	505	6000	4500	0.6	105.0	650	◆ ● ▲ ■
	ROV14H331K	330	±10%	210	275	550	6000	4500	0.6	115.0	610	◆ ● ▲ ■
	ROV14H361K	360	±10%	230	300	595	6000	4500	0.6	130.0	470	◆ ● ▲ ■
	ROV14H391K	390	±10%	250	320	650	6000	4500	0.6	140.0	460	◆ ● ▲ ■
	ROV14H431K	430	±10%	275	350	710	6000	4500	0.6	155.0	450	◆ ● ▲ ■
	ROV14H471K	470	±10%	300	385	775	6000	4500	0.6	175.0	420	◆ ● ▲ ■
	ROV14H511K	510	±10%	320	418	842	6000	4500	0.6	190.0	370	◆ ● ▲ ■
	ROV14H561K	560	±10%	350	460	920	6000	4500	0.6	205.0	400	◆ ● ▲ ■
	ROV14H621K	620	±10%	385	505	1025	6000	4500	0.6	215.0	300	◆ ● ▲ ■
	ROV14H681K	680	±10%	420	560	1120	6000	4500	0.6	225.0	310	◆ ● ▲ ■
	ROV14H751K	750	±10%	460	615	1240	6000	4500	0.6	230.0	270	◆ ● ▲ ■
	ROV14H781K	780	±10%	485	640	1290	6000	4500	0.6	233.0	250	◆ ● ▲ ■
	ROV14H821K	820	±10%	510	670	1355	6000	4500	0.6	235.0	260	◆ ● ▲ ■
	ROV14H911K	910	±10%	550	745	1500	6000	4500	0.6	255.0	240	◆ ● ▲ ■
	ROV14H102K	1000	±10%	625	825	1650	6000	4500	0.6	283.0	200	◆ ● ▲ ■
	ROV14H112K	1100	±10%	680	895	1815	6000	4500	0.6	310.0	180	◆ ● ▲ ■
	ROV14H182K	1800	±10%	1000	1465	2970	6000	4500	0.6	510.0	121	◆ ● ▲ ■

* The clamping voltages from 180M to 680K are tested at 10A current.

†Certification

Standard	UL1414‡	UL1449 (2nd Edition)‡	CSA	VDE
Title	Across-the-Line Components	Transient Voltage Surge Suppressors	Accessories and Parts for Electronic Equipment	Varistors for Use in Electronic Equipment
Symbols	◆	●	▲	■
File Number	E223034	E223033	220978	40006997

‡ For UL 1449 (2nd Edition), the maximum clamping voltage is measured at 500A.

Figure V23-V25 H Series Specifications — 14mm Devices
Pulse Lifetime Ratings and V-I Characteristic Curves

Figure V23 - ROV14H180M-ROV14H680K

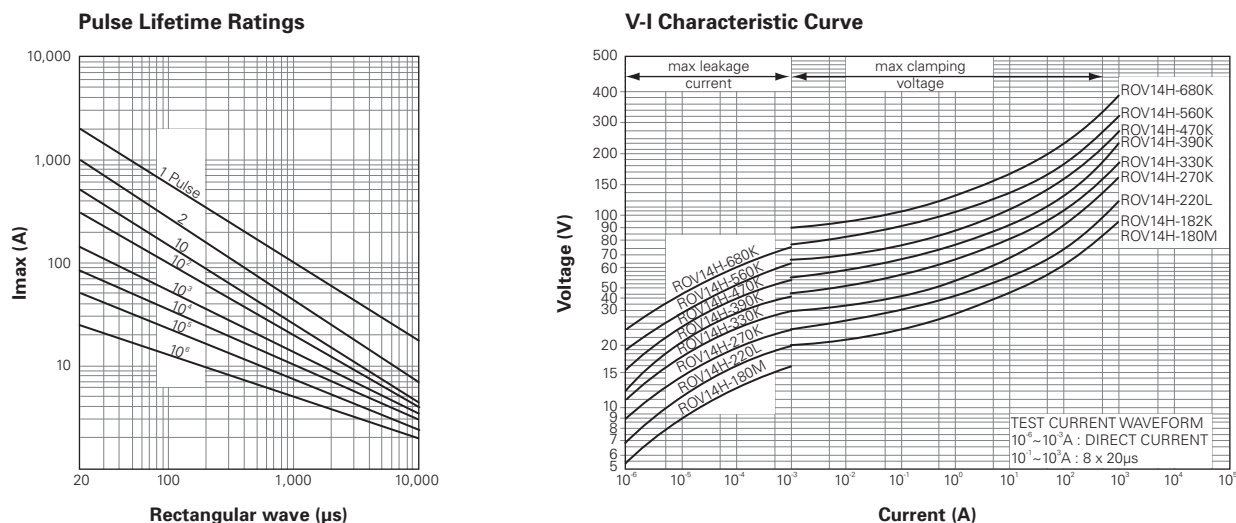


Figure V24 - ROV14H820K-ROV14H511K

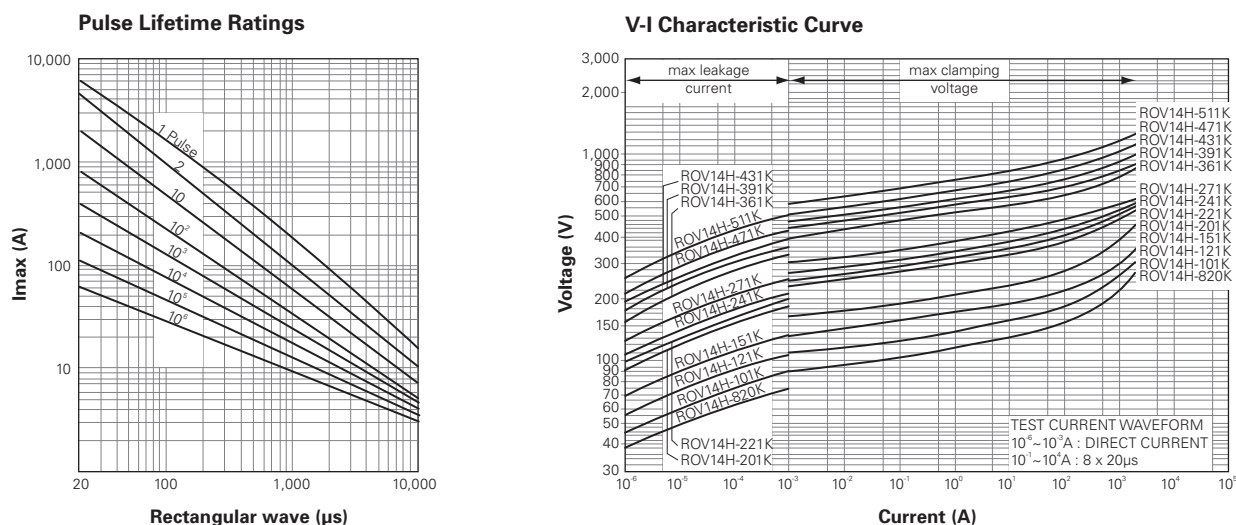


Figure V25 - ROV14H561K-ROV14H182K

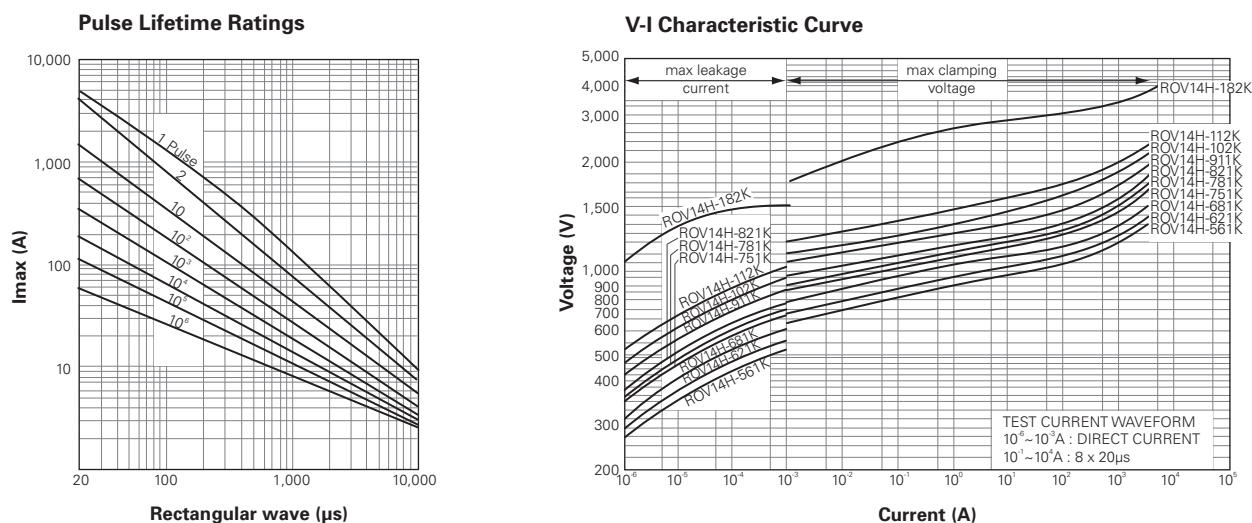


Table V13 Rating and Characteristics for H Series Specifications — 20mm Devices

	Part Number	Varistor Voltage V@1.0mA		Maximum Allowance Voltage		Maximum Clamping Voltage	Maximum Surge Current (8x20µs)		Rated Woltage	Energy (10x1000µs)	Capacitance (Typical)	Certification†
		DC (V)	Tolerance	AC (V _{RMS})	DC (V)	V@100A (V)	1 Time (A)	2 Times (A)	(W)	(J)	(pF)	
	ROV20H220M	22	±20%	14	18	43*	3000	2000	0.2	16.0	21200	● ■
	ROV20H270M	27	±20%	17	22	53*	3000	2000	0.2	19.0	20000	● ■
	ROV20H330M	33	±20%	20	26	65*	3000	2000	0.2	24.0	17200	● ■
	ROV20H390L	39	±15%	25	31	77*	3000	2000	0.2	28.0	15000	● ■
	ROV20H470L	47	±15%	30	38	93*	3000	2000	0.2	34.0	12100	● ■
	ROV20H560L	56	±15%	35	45	110*	3000	2000	0.2	41.0	11600	● ■
	ROV20H680L	68	±15%	40	56	135*	3000	2000	0.2	49.0	9600	● ■
	ROV20H101K	100	±10%	60	85	165	10000	6500	1.0	72.0	4000	● ■
	ROV20H121K	120	±10%	75	100	200	10000	6500	1.0	88.0	3800	● ■
	ROV20H151K	150	±10%	95	125	250	10000	6500	1.0	106.0	3000	● ■
	ROV20H181K	180	±10%	115	150	300	10000	6500	1.0	130.0	2400	● ■
	ROV20H201K	200	±10%	130	170	340	10000	6500	1.0	140.0	1830	◆ ● ▲ ■
	ROV20H221K	220	±10%	140	180	360	10000	6500	1.0	155.0	1600	◆ ● ▲ ■
	ROV20H241K	240	±10%	150	200	395	10000	6500	1.0	168.0	1420	◆ ● ▲ ■
	ROV20H271K	270	±10%	175	225	455	10000	6500	1.0	190.0	1260	◆ ● ▲ ■
	ROV20H301K	300	±10%	195	250	505	10000	6500	1.0	210.0	1100	◆ ● ▲ ■
	ROV20H331K	330	±10%	210	275	550	10000	6500	1.0	228.0	1110	◆ ● ▲ ■
	ROV20H361K	360	±10%	230	300	595	10000	6500	1.0	255.0	990	◆ ● ▲ ■
	ROV20H391K	390	±10%	250	320	650	10000	6500	1.0	275.0	980	◆ ● ▲ ■
	ROV20H431K	430	±10%	275	350	710	10000	6500	1.0	303.0	860	◆ ● ▲ ■
	ROV20H471K	470	±10%	300	385	775	10000	6500	1.0	350.0	760	◆ ● ▲ ■
	ROV20H511K	510	±10%	320	418	842	10000	6500	1.0	382.0	790	◆ ● ▲ ■
	ROV20H561K	560	±10%	350	460	920	10000	6500	1.0	410.0	680	◆ ● ▲ ■
	ROV20H621K	620	±10%	385	505	1025	10000	6500	1.0	420.0	600	◆ ● ▲ ■
	ROV20H681K	680	±10%	420	560	1120	10000	6500	1.0	430.0	550	◆ ● ▲ ■
	ROV20H751K	750	±10%	460	615	1240	10000	6500	1.0	440.0	550	◆ ● ▲ ■
	ROV20H781K	780	±10%	485	640	1290	10000	6500	1.0	450.0	480	◆ ● ▲ ■
	ROV20H821K	820	±10%	510	670	1355	10000	6500	1.0	460.0	520	◆ ● ▲ ■
	ROV20H911K	910	±10%	550	745	1500	10000	6500	1.0	510.0	440	◆ ● ▲ ■
	ROV20H102K	1000	±10%	625	825	1650	10000	6500	1.0	566.0	400	◆ ● ▲ ■
	ROV20H112K	1100	±10%	680	895	1815	10000	6500	1.0	620.0	360	◆ ● ▲ ■
	ROV20H182K	1801	±11%	1000	1465	2970	10000	6500	1.0	1020.0	250	◆ ● ▲ ■

* The clamping voltages from 180M to 680K are tested at 20A current.

†Certification

Standard	UL1414‡	UL1449 (2nd Edition)‡	CSA	VDE
Title	Across-the-Line Components	Transient Voltage Surge Suppressors	Accessories and Parts for Electronic Equipment	Varistors for Use in Electronic Equipment
Symbols	◆	●	▲	■
File Number	E223034	E223033	220978	40006997

‡ For UL 1449 (2nd Edition), the maximum clamping voltage is measured at 500A.

Figure V26-V28

H Series Specifications — 20mm Devices

Pulse Lifetime Ratings and V-I Characteristic Curves

Figure V26 - ROV20H220M-ROV20H680L

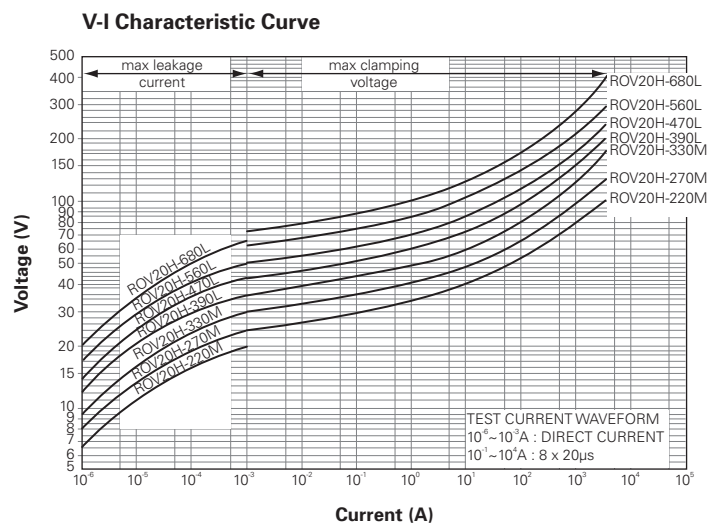
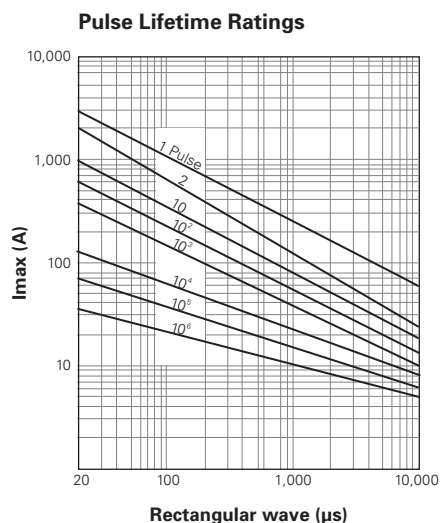


Figure V27 - ROV20H101K-ROV20H511K

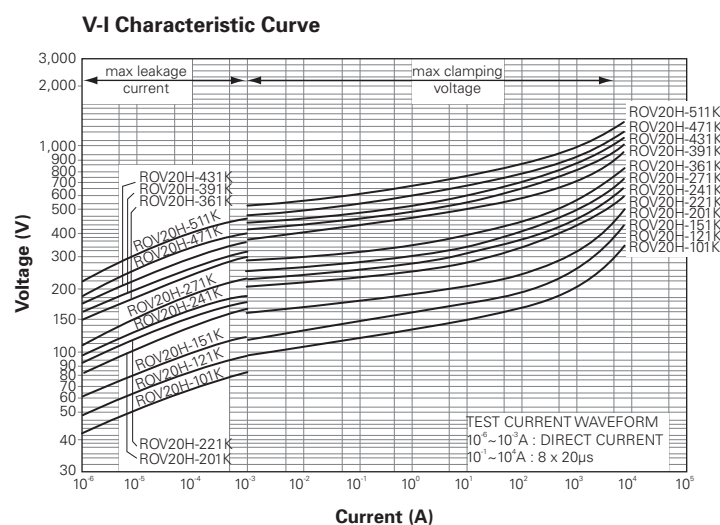
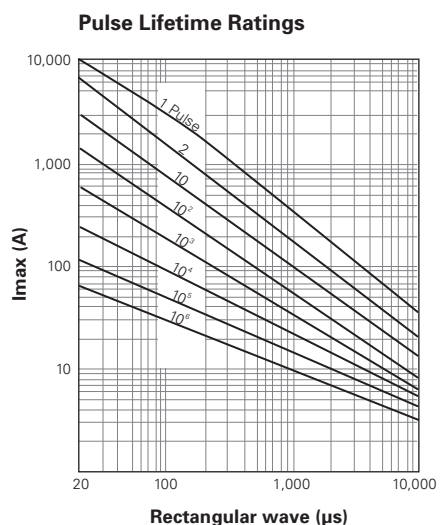


Figure V28 - ROV20H561K-ROV20H182K

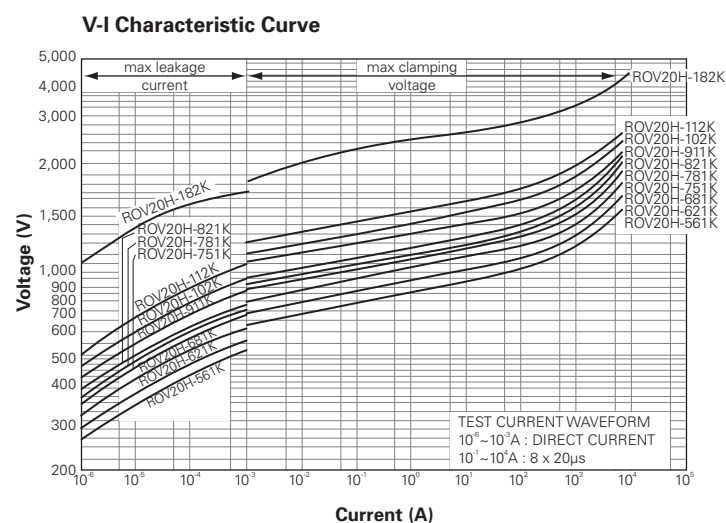
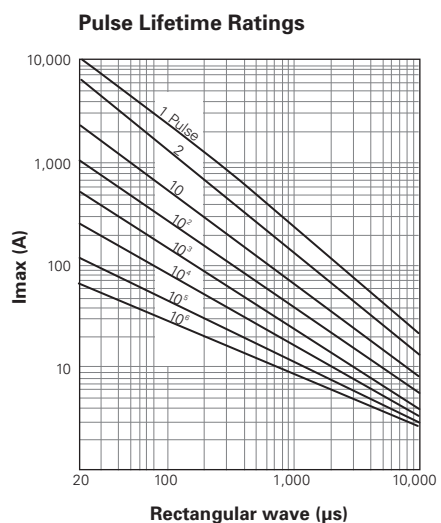


Table V14 Rating and Characteristics for E Series Specifications — 14mm Devices

	Part Number	Varistor Voltage V@1.0mA		Maximum Allowance Voltage		Maximum Clamping Voltage	Maximum Surge Current (8x20μs)		Rated Waltage	Energy (10x1000μs)	Capacitance (Typical)	Certification†
		DC (V)	Tolerance	AC (V _{RMS})	DC (V)	V@50A (V)	1 Time (A)	2 Times (A)	(W)	(J)	(pF)	
	ROV14E201K	200	±10%	130	170	340	6500	6000	0.6	84.0	840	● ▲
	ROV14E221K	220	±10%	140	180	360	6500	6000	0.6	93.0	710	● ▲
	ROV14E241K	240	±10%	150	200	395	6500	6000	0.6	101.0	770	● ▲
	ROV14E271K	270	±10%	175	225	455	6500	6000	0.6	113.0	—	—
	ROV14E301K	300	±10%	195	250	505	6500	6000	0.6	126.0	—	—
	ROV14E331K	330	±10%	210	275	550	6500	6000	0.6	138.0	—	—
	ROV14E361K	360	±10%	230	300	595	6500	6000	0.6	151.0	—	—

Table V15 Rating and Characteristics for E Series Specifications — 20mm Devices

	Part Number	Varistor Voltage V@1.0mA		Maximum Allowance Voltage		Maximum Clamping Voltage	Maximum Surge Current (8x20μs)		Rated Waltage	Energy (10x1000μs)	Capacitance (Typical)	Certification†
		DC (V)	Tolerance	AC (V _{RMS})	DC (V)	V@100A (V)	1 Time (A)	2 Times (A)	(W)	(J)	(pF)	
	ROV20E201K	200	±10%	130	170	340	12500	10000	1.0	168.0	1830	● ▲
	ROV20E221K	220	±10%	140	180	360	12500	10000	1.0	186.0	1600	● ▲
	ROV20E241K	240	±10%	150	200	395	12500	10000	1.0	202.0	1420	● ▲
	ROV20E271K	270	±10%	175	225	455	12500	10000	1.0	227.0	—	—
	ROV20E301K	300	±10%	195	250	505	12500	10000	1.0	252.0	—	—
	ROV20E331K	330	±10%	210	275	550	12500	10000	1.0	277.0	—	—
	ROV20E361K	360	±10%	230	300	595	12500	10000	1.0	302.0	—	—

†Certification

Standard	UL1414†	UL1449 (2nd Edition)†	CSA	VDE
Title	Across-the-Line Components	Transient Voltage Surge Suppressors	Accessories and Parts for Electronic Equipment	Varistors for Use in Electronic Equipment
Symbols	◆	●	▲	■
File Number	E223034	E223033	220978	40006997

† For UL 1449 (2nd Edition), the maximum clamping voltage is measured at 500A.

Mechanical and Environmental Tests for ROV Metal Oxide Varistors**Humidity**

The part is subjected to 40±2°C, 90 to 95% R.H. for 1000 hours without load and then stored at room temperature and ambient humidity for 1 to 2 hours. The change of V_B , (ΔV_B), is then measured and must meet the requirement of $\Delta V_B / V_B \leq \pm 5\%$, where V_B is the initial value.

Impulse Life

The maximum surge current (8 x 20μs) listed in this catalog is applied 1000 times continuously with an interval of 30 seconds at room temperature. The change of V_B , (ΔV_B), is then measured and must meet the requirement of $\Delta V_B / V_B \leq \pm 10\%$, where V_B is the initial value.

Low Temperature Storage

The part is subjected to -40±2°C without load for 1000 hours and then stored at room temperature and ambient humidity for 1 to 2 hours. The change of V_B , (ΔV_B), is then measured and must meet the requirement of $\Delta V_B / V_B \leq \pm 5\%$, where V_B is the initial value.

High Temperature Load

After the Maximum Allowable Voltage is applied at 85±2°C for 1000 hours, the part is stored at room temperature and ambient humidity for 1 to 2 hours. The change of V_B , (ΔV_B), is then measured and must meet the requirement of $\Delta V_B / V_B \leq \pm 10\%$, where V_B is the initial value.

High Temperature Storage

The part is subjected to 125±2°C for 1000 hours in a drying oven without load and then stored at room temperature and ambient humidity for 1 to 2 hours. The change of V_B , (ΔV_B), is then measured and must meet the requirement of $\Delta V_B / V_B \leq \pm 5\%$, where V_B is the initial value.

Mechanical and Environmental Tests for ROV Metal Oxide Varistors

... Cont'd

Maximum Voltage

The specified voltage is applied between the terminals of the part for 1 minute. No mechanical damage should be noticeable.

	Test Voltage (AC)
Dielectric Withstand	2500 _{VRMS}

Terminal Pull Strength

After gradually applying the load specified below and keeping the unit fixed for 10 ± 1 s, no mechanical damage should be noticeable.

Terminal Diameter	Loading Weight in Pull Strength
0.6mm	10N (1.02Kg)
0.8mm	10N (1.02Kg)
1.0mm	20N (2.04Kg)

Terminal Bending Strength

The device is secured with one terminal in vertical position and the weight specified below is applied to the other terminal. The terminal is gradually bent by 90° in one direction, then 90° in the opposite direction and again back to the original position. This is repeated two times. No mechanical damage should be noticeable.

Terminal Diameter	Loading Weight in Pull Strength
0.6mm	5N (0.51Kg)
0.8mm	5N (0.51Kg)
1.0mm	10N (1.02Kg)

Vibration

The device is subjected to a simple harmonic motion of 0.75mm amplitude with 1.5mm maximum total excursion between limits. A 10-55Hz frequency scan is traversed in 1 minute. This motion is applied for a period of 2 hours in each of 3 mutually perpendicular directions. No mechanical damage should be noticeable.

Solderability

After dipping the terminal to a depth of approximately 3mm from the body in a soldering bath of $235 \pm 5^\circ\text{C}$ for 2 ± 0.5 s, the terminal is visually examined. Approximately 95% of the terminals should be uniformly covered with new solder.

Resistance to Soldering Heat

The terminal is dipped into a soldering bath with a temperature of $260 \pm 5^\circ\text{C}$ to a point of 2~2.5mm from the body of the unit. It is held there for 10 ± 1 s (5 Standard series: 5 ± 1 s) and then stored at room temperature and normal humidity for 1 to 2 hours. The change of V_B , ($\Delta V_B/B$), is then measured and must meet the requirement of $\Delta V_B/V_B \leq \pm 5\%$, (where V_B is the initial value) with no noticeable mechanical damage.

Damp Heat Load

The device is subjected to $40 \pm 2^\circ\text{C}$, 90 to 95% R.H. and the maximum allowable voltage for 1000 hours and then stored at room temperature and ambient humidity for 1 to 2 hours. The change of V_B , ($\Delta V_B/B$), is then measured and must meet the requirement of $\Delta V_B/V_B \leq 10\%$, where V_B is the initial value.

Temperature Cycle

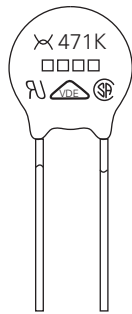
The following temperature cycle is repeated 5 times:

1. $-40 \pm 3^\circ\text{C}$ for 30 ± 3 minutes
2. Room temperature for 15 ± 3 minutes
3. $125 \pm 2^\circ\text{C}$ for 30 ± 3 minute.
4. Room temperature for 15 ± 3 minutes

Afterwards, the part is stored at room temperature and ambient humidity for 1 to 2 hours. The change of V_B , ($\Delta V_B/B$), is then measured and must meet the requirement of $\Delta V_B/V_B \leq \pm 5\%$, (where V_B is the initial value) with no noticeable mechanical damage.

Figure V29-V30 Marking and Packaging Specifications for ROV Metal Oxide Varistors

Figure V29 - Marking



X : Manufacturer's mark
 47 : Varistor Voltage
 K : Varistor Voltage
 0000 : Lot Identification

Figure V30 - Packaging in Millimeters

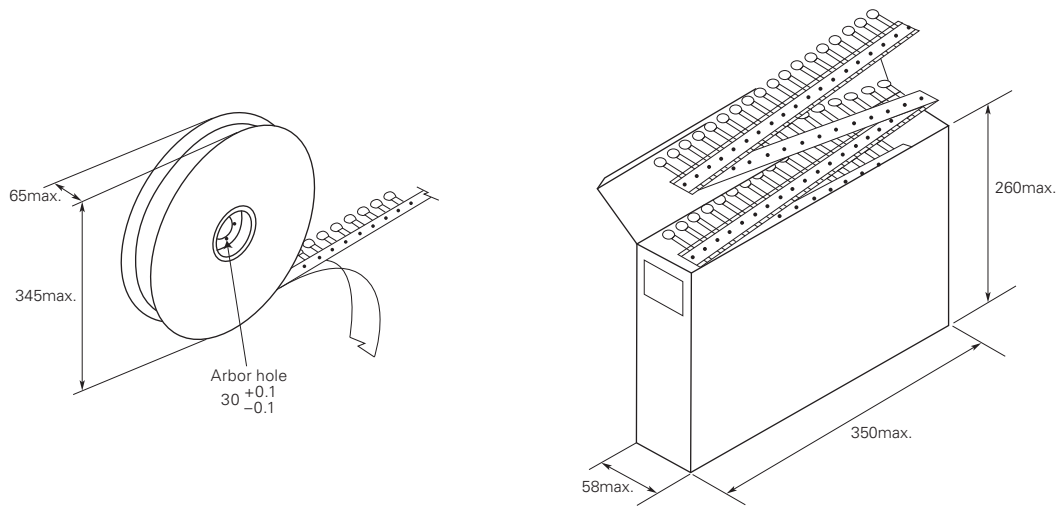


Table V16 Packaging Quantity in Pieces for ROV Metal Oxide Varistors

Part Number	Series														
	5mm			7mm			10mm			14mm			20mm		
	Bulk (Box)	Reel	Ammo	Bulk (Box)	Reel	Ammo	Bulk (Box)	Reel	Ammo	Bulk (Box)	Reel	Ammo	Bulk (Box)	Reel	Ammo
180M	5000	1500	1500	5000	1500	1500	2500	1000	500	1500	750	500	—	—	—
220M~470K	5000	1500	1500	5000	1500	1500	2500	1000	500	1500	750	500	150	500	500
560K~680K	5000	1500	1000	5000	1500	1000	2500	1000	500	1500	750	500	150	500	500
820K	5000	1500	1500	5000	1500	1500	2500	1000	500	1500	750	500	—	—	—
101K~331K	5000	1500	1500	5000	1500	1500	2500	1000	500	1500	750	500	150	500	500
360K~391K	5000	1500	1000	5000	1500	1000	2500	1000	500	1500	750	500	150	500	500
431K~471K	5000	1500	1000	5000	1000	1000	2000	750	500	1500	750	500	150	500	500
511K~681K	4000	1000	1000	4000	1000	1000	1500	500	500	750	500	500	150	500	500
751K	4000	1000	1000	4000	1000	1000	1500	500	500	750	500	500	150	—	—
781K~911K	—	—	—	—	—	—	1500	500	500	750	500	500	150	—	—
911K~112K	—	—	—	—	—	—	1500	500	500	750	—	—	150	—	—
182K	—	—	—	—	—	—	750	—	—	450	—	—	75	—	—

Packaging	Bulk (box)	Reel	Reel (14mm, 20mm)	Ammo (5mm, 7mm)	Ammo (10mm, 14mm) 180K-471K	Ammo (10mm, 14mm) 471K-751K	Ammo (20mm) 180K-751K
Box size (mm)	290 x 155 x 110	350 x 350 x 108	350 x 350 x 74	330 x 240 x 46	343 x 210 x 52	343 x 260 x 52	343 x 220 x 58
Carton size (mm)	310 x 328 x 250	371 x 371 x 590	370 x 370 x 468	350 x 500 x 270	363 x 440 x 250	363 x 540 x 250	363 x 460 x 250
One carton with	4 Boxes	5 Boxes (10 reels)	6 Boxes (6 reels)	10 Boxes	8 Boxes	8 Boxes	8 Boxes

Part Numbering System for ROV Metal Oxide Varistors

ROV 14 — 220 L -S -10 1 -2

Packaging

No suffix = Bulk
 -2 = Tape & reel
 -AP = Ammo pack

Lead Diameter

No suffix = standard diameter (see table V2 on page 56 and 57)
 6 = 0.6mm
 8 = 0.8mm
 1 = 1.0mm

Lead Spacing

No suffix = standard spacing (see table V2 on page 56 and 57)
 -5 = 5mm
 -7 = 7.5mm
 -10 = 10mm

Lead Configuration

No suffix = Kinked lead
 -S = Straight lead
 -A = Inside crimp "Type A"
 -B = Inside crimp "Type B"
 -C = Outside crimp "Type C"
 -D = Outside crimp "Type D"

Varistor Voltage Tolerance

K = $\pm 10\%$
 L = $\pm 15\%$
 M = $\pm 20\%$

Varistor Voltage Indicator

The first two digits indicate voltage.
 The third digit signifies the power of ten.
 For example:
 220: $22 \times 10^0 = 22V$
 221: $22 \times 10^1 = 220V$
 112: $11 \times 10^2 = 1100V$

Surge Series

— = Standard series (Standard surge series)
 H = H series (High surge series)
 E = E series (Extra surge series)

Diameter of Disc

05 = 5mm
 07 = 7mm
 10 = 10mm
 14 = 14mm
 20 = 20mm

Manufacturer Series



Warning :

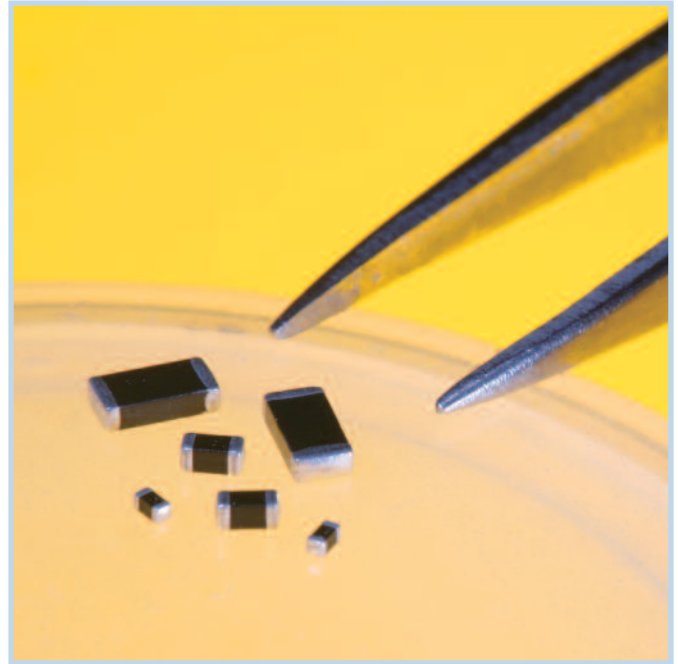
- Operation beyond the maximum ratings or improper use may result in device damage and possible electrical arcing and flame.
- The Devices are intended for protection against occasional overvoltage fault conditions and should not be used when repeated fault conditions or prolonged trip events are anticipated.
- Device performance can be impacted negatively if devices are handled in a manner inconsistent with recommended electronic, thermal, and mechanical procedures for electronic components.



Multi Layer Varistors

Multi Layer Varistors are small, leadless, surface mount packages made of multiple layers of Zinc Oxide, with electrodes between them. They are used to help protect integrated circuits and other sensitive equipment. Their small size is suitable for high density printed circuit boards.

Tyco Electronics Circuit Protection also offers the “E” series which is a family of low capacitance MLVs. They provide ESD protection in high data rate applications.



Benefits

- Standard series to help to protect sensitive equipment against typical ESD events, EMC and EOS (Electrical Over Stress) events and transients
- “E” series to help to protect sensitive equipment against typical ESD events
- Cost efficient assembly and protection
- Resistance to standard wave solder fluxes, provides excellent solderability
- Space savings
- Longer battery life due to low leakage current

Features

- Bidirectional clamping
- Compatible with standard surface mount methods
- Low and stable leakage current
- Low clamping voltage
- Quick response time (<1ns)
- High transient current capability
- “E” series low capacitance
- RoHS Compliant

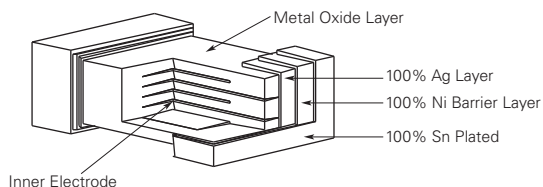
Applications

Standard series: ESD, EMC and EOS protection of:

- Computer I/O ports and interfaces (USB, IEEE 1394, etc...)
- Portable devices
- Automotive electronic circuits
- Telecom equipment
- Medical instruments

“E” series: ESD protection of:

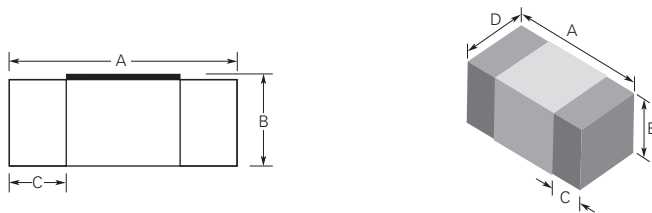
- High speed Computer I/O ports and interfaces (USB, IEEE 1394, etc...)
- Portable devices
- Telecom equipment

Figure VM1 Construction for Multi Layer Varistors**Table VM1 Dimensions for Multi Layer Varistors in Millimeters (Inches)****Multi Layer Varistors Standard Series**

Part Number	Length A		Height B		Terminal Width C		Width D	
	min	max	min	max	min	max	min	max
Size 0402 (1005mm)								
MLV0402-080M-C221	0.85 (0.033)	1.15 (0.045)	0.4 (0.016)	0.6 (0.024)	0.1 (0.004)	0.4 (0.016)	0.4 (0.016)	0.6 (0.024)
MLV0402-250K-C400	0.85 (0.033)	1.15 (0.045)	0.4 (0.016)	0.6 (0.024)	0.1 (0.004)	0.4 (0.016)	0.4 (0.016)	0.6 (0.024)
Size 0603 (1608mm)								
MLV0603-130M-C201	1.4 (0.060)	1.8 (0.070)	0.6 (0.024)	1.0 (0.040)	0.1 (0.004)	0.5 (0.020)	0.6 (0.024)	1.0 (0.040)
Size 1206 (3216mm)								
MLV1206-700K	3.0 (0.118)	3.4 (0.134)	— —	1.7 (0.067)	0.25 (0.010)	0.75 (0.030)	1.4 (0.060)	1.8 (0.070)

Multi Layer Varistors “E” Series

Part Number	Length A		Height B		Terminal Width C		Width D	
	min	max	min	max	min	max	min	max
Size 0402 (1005mm)								
MLV0402-180-E030	0.85 (0.033)	1.15 (0.045)	0.4 (0.016)	0.6 (0.024)	0.1 (0.004)	0.4 (0.016)	0.4 (0.016)	0.6 (0.024)
MLV0402-120-E120	0.85 (0.033)	1.15 (0.045)	0.4 (0.016)	0.6 (0.024)	0.1 (0.004)	0.4 (0.016)	0.4 (0.016)	0.6 (0.024)

Figure VM2 Dimension Figures for Multi Layer Varistors**Table VM2 Recommended Pad Layout for Multi Layer Varistors in Millimeters (Inches)**

Part Number	Chip Size	A	B	C
MLV0402 & MLV0603	0402 (1005)	0.35 (0.014)	0.75 (0.030)	0.85 (0.033)
	0603 (1608)	0.50 (0.020)	0.76 (0.030)	1.02 (0.040)
MLV1206	1206 (3216)	4.06 (0.160)	1.65 (0.065)	1.02 (0.040)

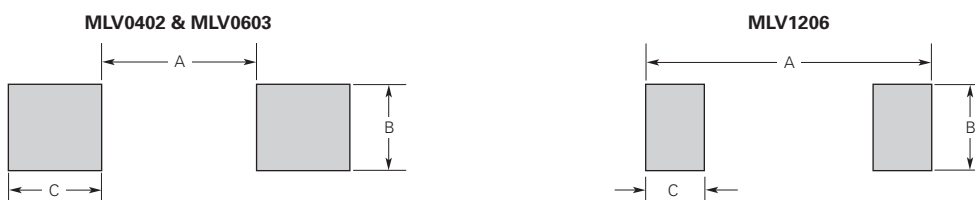
Figure VM3 Pad Layout Figures for Multi Layer Varistors

Table VM3 Electrical Characteristics for Multi Layer Varistors @ (25 ± 5°C)**Multi Layer Varistors Standard Series**

	Varistor Voltage	Maximum Working Voltage		Clamping Voltage	Peak Current	Max Transient Energy	Typical Capacitance [†]
Symbol	Vv	V _{RMS}	V _{DC}	V _c	I _{Max}	W _{Max}	Cp
Units	V	V	V (Max)	V	A (Min)	J (Max)	pF
Test Conditions	@ 1mA DC	<10μA	<10μA	@ 1A 8/20μs	8/20μs	10/1000μs	@ 1MHz
MLV0402-080M-C221	8 ± 20%	4	5.5	20	20	0.05	220
MLV0402-250K-C400	25 ± 10%	14	18	50	20	0.05	40
MLV0603-130M-C201	13.5 ± 20 %	7	9	30	30	0.1	200
MLV1206-700K	70 ± 10 %	40*	56*	120	200	1	180

* Test Conditions < 50μA

† Cp - Device capacitance measured with zero volt bias and 1V_{RMS} signal.**Multi Layer Varistors “E” Series**

	Maximum Working Voltage	Typical Clamping Voltage [‡]	Leakage Current	Typical Capacitance
Symbol	V _{DC}	V _c	I _L	Cp
Units	V (Max)	V	μA (Max)	pF
Test Conditions	< 10μA	IEC Pulse	@12V	@ 1MHz
MLV0402-180-E030	18	350	<1	3
MLV0402-120-E120	12	100	<1	12

‡ Measure per IEC61000-4-2, 8kV contact discharge, 30 ns after initiation of the ESD pulse.

Table VM4 General Characteristics and Environmental Specifications for Multi Layer Varistors**MLV0402 & MLV0603****General Characteristics**

Operating Temperature:	-40 to +85°C
Storage Temperature:	-40 to +85°C

Environmental Specifications

Characteristics	Specifications	Test Conditions
Bias Humidity	$\Delta V_v / V_v \leq \pm 10\%$	90% RH, 40°C, maximum working Voltage V _{DC} , 1000 hours
Thermal Shock	$\Delta V_v / V_v \leq \pm 10\%$	-40°C to +85°C, 30 min. cycle, 5 cycles
Full Load Voltage	$\Delta V_v / V_v \leq \pm 10\%$	Maximum working Voltage V _{DC} , 85°C, 1000 hours
Solderability	95% Coverage	230°C, 3s
Solder Heat Resistance	90% Coverage	260°C, 10s

MLV1206**General Characteristics**

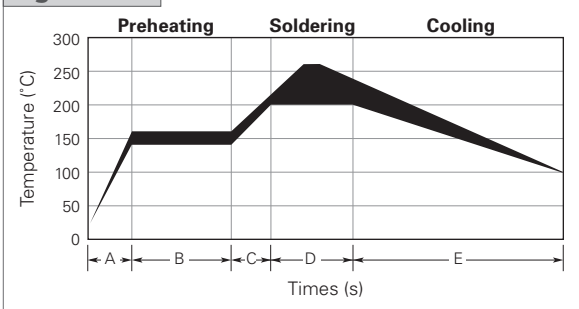
Operating Temperature:	-55 to +125°C
Storage Temperature:	-55 to +150°C

Environmental Specifications

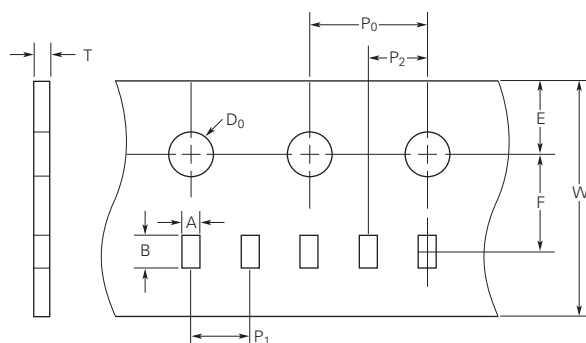
Characteristics	Specifications	Test Conditions
Bias Humidity	$\Delta V_v / V_v \leq \pm 10\%$	90% RH, 40°C, maximum working Voltage V _{DC} , 1000 hours
Thermal Shock	$\Delta V_v / V_v \leq \pm 10\%$	-55°C to +125°C, 30 min. cycle, 5 cycles
Full Load Voltage	$\Delta V_v / V_v \leq \pm 10\%$	Maximum working Voltage V _{DC} , 125°C, 1000 hours
Solderability	95% Coverage	230°C, 3s
Solder Heat Resistance	90% Coverage	260°C, 10s

Table VM5 Solder Reflow Recommendations for Multi Layer Varistors

A	Temperature ramp up 1	From ambient to preheating temperature	30s to 60s
B	Preheating	140°C - 160°C	60s to 120s
C	Temperature ramp up 2	From preheating to main heating temperature	20s to 40s
D	Main heating	at 200°C at 220°C at 240°C at 260°C	60s to 70s 50s to 60s 30s to 40s 5s to 10s
E	Cooling	From main heating temperature to 100°C	max 4°C/s

Figure VM4**Table VM6 Tape and Reel Specifications for Multi Layer Varistors**

Description	MLV0402		MLV0603		MLV1206	
	Dimensions (mm)	Tolerance (mm)	Dimensions (mm)	Tolerance (mm)	Dimensions (mm)	Tolerance (mm)
A	0.62	±0.03	0.90	±0.20	1.90	±0.20
B	1.12	±0.03	1.80	±0.20	3.50	±0.20
W	8.00	±0.30	8.00	±0.30	8.00	±0.30
E	1.75	±0.05	1.75	±0.10	1.75	±0.10
F	3.50	±0.05	3.50	±0.05	3.50	±0.05
P ₀	4.00	±0.10	4.00	±0.10	4.00	±0.10
P ₁	2.00	±0.05	4.00	±0.10	4.00	±0.10
P ₂	2.00	±0.05	2.00	±0.05	2.00	±0.05
D ₀	1.50	±0.10	1.50	±0.10	1.50	±0.10
T	0.60	±0.05	0.95	±0.05	0.95	±0.05

Figure VM5 Referenced Taped Component Dimensions for Multi Layer Varistors**Figure VM6 Reel Dimensions for Multi Layer Varistors****Reel Dimension**

A	178.0 ± 2.0
B	2.0 ± 0.5
C	13.0 ± 0.5
D	21.0 ± 0.8
E	62.0 ± 1.5
F	9.0 ± 0.5
G	13.0 ± 1.0

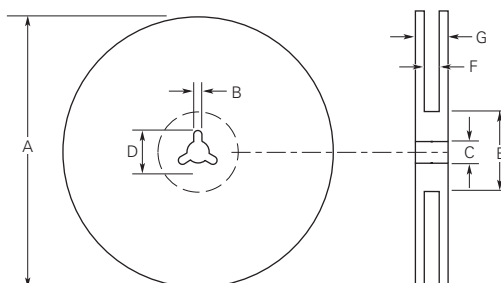


Table VM7 Packaging Specifications for Multi Layer Varistors

Chip Size	Parts Quantity per reel
0402 (1005)	10,000
0603 (1608)	4,000
1206 (3216)	4,000

Part Numbering System for Multi Layer Varistors**Multi Layer Varistors Standard Series****MLV 0402 - 080 M - CXXX****Capacitance**

C = Capacitance (Standard Series)

XXX = Capacitance value

221: $22 \times 10^1 = 220\text{pF}$ **Tolerance**K = $\pm 10\%$ L = $\pm 15\%$ M = $\pm 20\%$ **Varistor Voltage(Vv) Denominator**

The first two digits indicate voltage.

The third digit signifies the power of ten.

For example:

080: $8 \times 10^0 = 8\text{V}$

...

700: $70 \times 10^0 = 70\text{V}$ **EIA Size****Manufacturer Series**

MLV = Multi Layer Varistors

Multi Layer Varistors "E" Series**MLV 0402 - 120 - EXXX****Capacitance**

E = Capacitance ("E" Series for low capacitance devices)

XXX = Capacitance value

030: $3 \times 10^0 = 3\text{pF}$ 120: $12 \times 10^0 = 12\text{pF}$ **Operating Voltage Denominator**

The first two digits indicate voltage.

The third digit signifies the power of ten.

For example:

180: $18 \times 10^0 = 18\text{V}$ 120: $12 \times 10^0 = 12\text{V}$ **EIA Size****Manufacturer Series**

MLV = Multi Layer Varistors

**Warning :**

- Operation beyond the maximum ratings or improper use may result in device damage and possible electrical arcing and flame.
- The Devices are intended for protection against occasional overvoltage fault conditions and should not be used when repeated fault conditions or prolonged trip events are anticipated.
- Device performance can be impacted negatively if devices are handled in a manner inconsistent with recommended electronic, thermal, and mechanical procedures for electronic components.

Fast Acting Fuses

Fast-acting fuses help provide overcurrent protection on systems using DC power sources up to 63V_{DC}. The fuse's monolithic, multilayer design provides the highest hold current in the smallest footprint, reduces diffusion-related aging, improves product reliability and resilience, and enhances high temperature performance in a wide range of circuit designs.

These RoHS-compliant surface mount devices offer strong arc suppression characteristics and facilitate the development of more reliable, high-performance consumer electronics such as laptops, multimedia devices, cell phones, and other portable electronics.



Benefits

- Small size with high current ratings
- Excellent temperature stability
- High reliability and resilience
- Strong arc suppression characteristics

Features

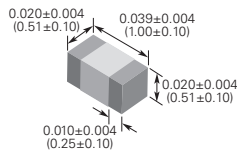
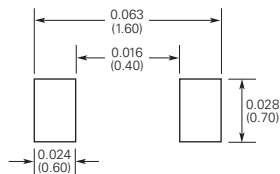
- RoHS compliant
- Monolithic, multilayer design
- High temperature performance
- -55°C to +125°C operating range

Applications

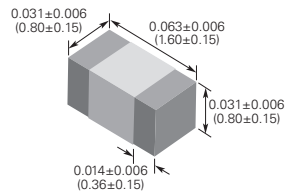
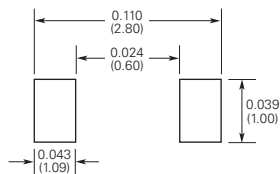
- | | | |
|-------------------|------------------------|----------------|
| • Laptops | • Printers | • Game systems |
| • Digital cameras | • DVD players | • LCD monitors |
| • Cell phones | • Portable electronics | • Scanners |

Table FF1 Clear Time Characteristics for Fast Acting Fuses

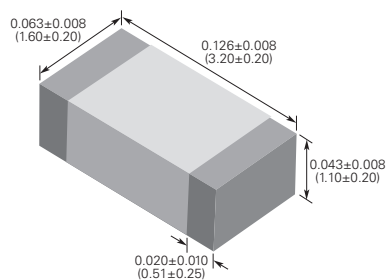
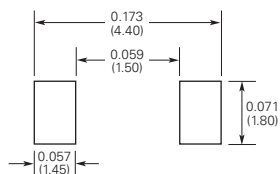
% of rated current	Clear time at 25°C
100%	4 hours min.
250%	5 seconds max.
400%	0.05 seconds max.

Table FF2 Typical Electrical Characteristics, Dimensions and Recommended Pad Layout for Fast Acting Fuses**0402 (1005mm) Fast Acting Surface-mount Chip Fuses****Shape and Dimensions**
Inch (mm)**Recommended Pad Layout**
Inch (mm)

Part Number	Typical Electrical Characteristics		Max Interrupt Ratings	
	Rated Current (A)	Nominal Cold DCR* (Ω)	Voltage (V _{DC})	Current (A)
0402SFF050F/24	0.50	0.380	24	35
0402SFF075F/24	0.75	0.210	24	35
0402SFF100F/24	1.00	0.120	24	35
0402SFF150F/24	1.50	0.056	24	35
0402SFF200F/24	2.00	0.035	24	35
0402SFF300F/24	3.00	0.021	24	35
0402SFF400F/24	4.00	0.014	24	35

0603 (1608mm) Fast Acting Surface-mount Chip Fuses**Shape and Dimensions**
Inch (mm)**Recommended Pad Layout**
Inch (mm)

Part Number	Typical Electrical Characteristics		Max Interrupt Ratings	
	Rated Current (A)	Nominal Cold DCR* (Ω)	Voltage (V _{DC})	Current (A)
0603SFF050F/32	0.50	0.485	32	50
0603SFF075F/32	0.75	0.254	32	50
0603SFF100F/32	1.00	0.131	32	50
0603SFF150F/32	1.50	0.059	32	35
0603SFF200F/32	2.00	0.044	32	35
0603SFF250F/32	2.50	0.032	32	35
0603SFF300F/32	3.00	0.025	32	35
0603SFF350F/32	3.50	0.024	32	35
0603SFF400F/32	4.00	0.018	32	35
0603SFF500F/32	5.00	0.013	32	35
0603SFF600F/24	6.00	0.010	24	35

1206 (3216mm) Fast Acting Surface-mount Chip Fuses**Shape and Dimensions**
Inch (mm)**Recommended Pad Layout**
Inch (mm)

Part Number	Typical Electrical Characteristics		Max Interrupt Ratings	
	Rated Current (A)	Nominal Cold DCR* (Ω)	Voltage (V _{DC})	Current (A)
1206SFF050F/63	0.50	0.500	63	50
1206SFF075F/63	0.75	0.330	63	50
1206SFF100F/63	1.00	0.220	63	50
1206SFF150F/63	1.50	0.120	63	50
1206SFF175F/63	1.75	0.100	63	50
1206SFF200F/63	2.00	0.050	63	50
1206SFF250F/32	2.50	0.035	32	50
1206SFF300F/32	3.00	0.031	32	50
1206SFF400F/32	4.00	0.022	32	45
1206SFF500F/32	5.00	0.015	32	45
1206SFF600F/24	6.00	0.013	24	45
1206SFF700F/24	7.00	0.011	24	45
1206SFF800F/24	8.00	0.008	24	45

* Measured at ≤10% of rated current and 25°C ambient temperature

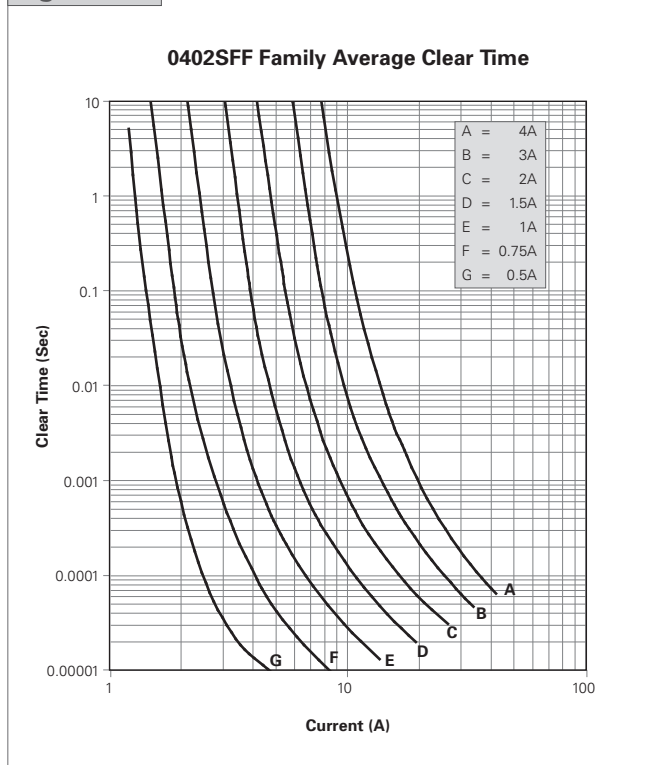
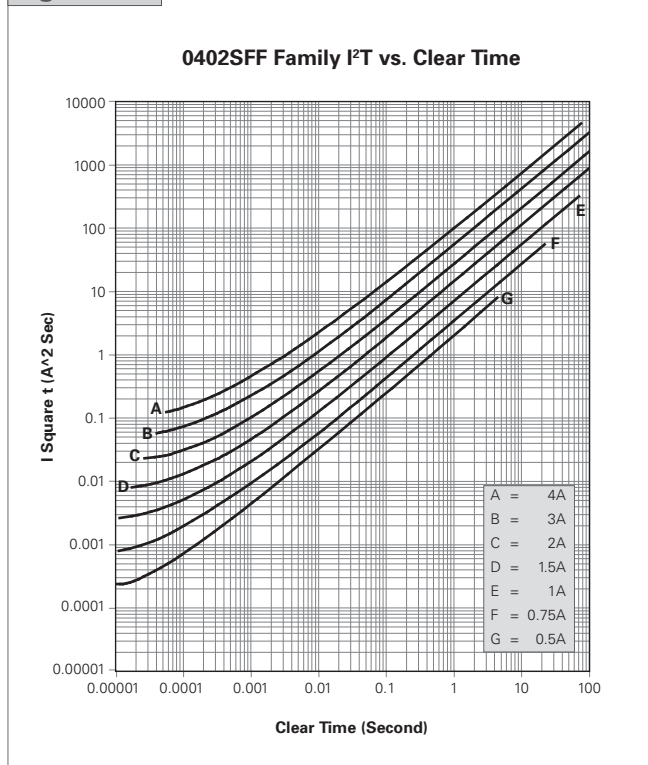
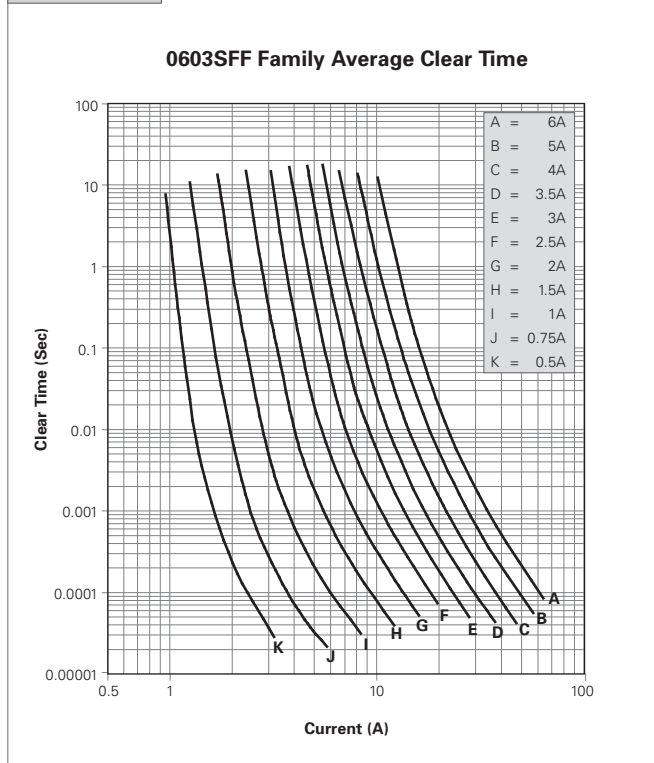
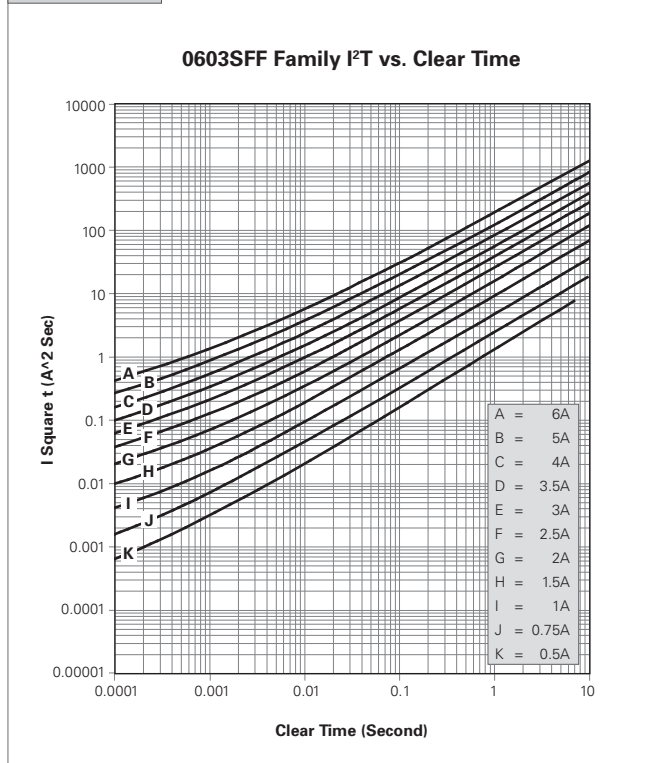
Figure FF1-FF6 Family Average Clear Time**Figure FF1****Figure FF2****Figure FF3****Figure FF4**

Figure FF5

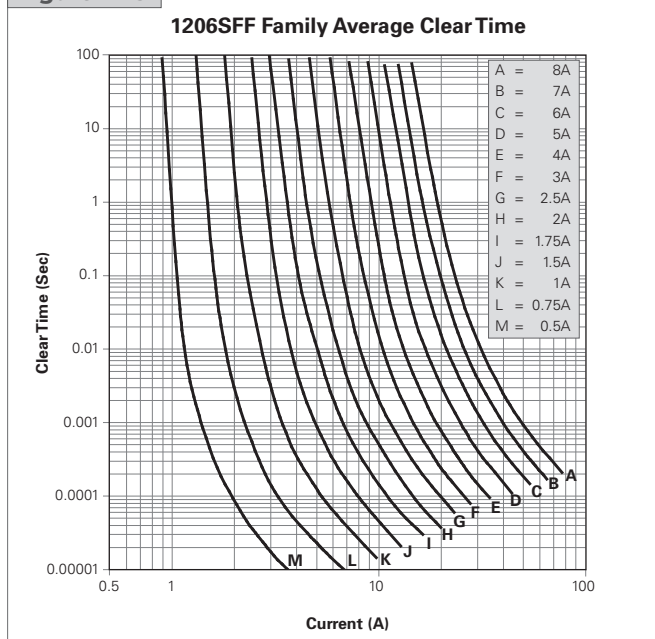


Figure FF6

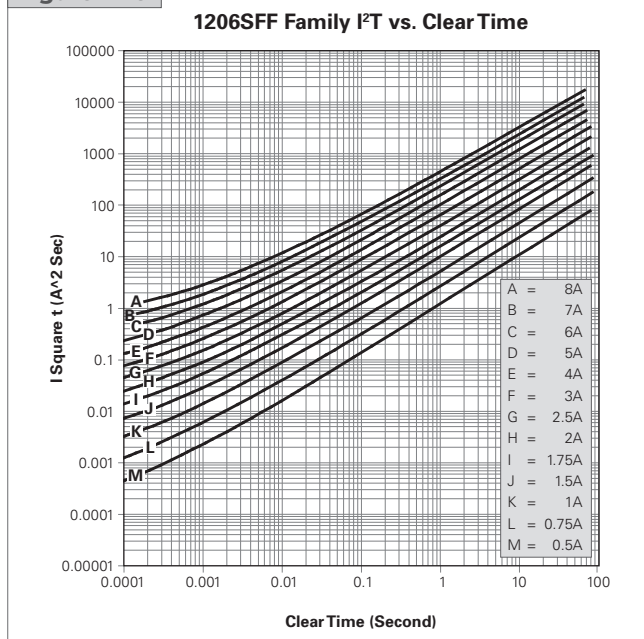


Table FF3 Environmental Specifications for Fast Acting Fuses

Operating Temperature	-55°C to +125°C
Mechanical Vibration	Withstands 5-3000 Hz at 30 Gs when evaluated per Method 204 of MIL-STD-202
Mechanical Shock	Withstands 1500 Gs, 0.5 millisecond half-sine pulses when evaluated per Method 213 of MIL-STD-202
Thermal Shock	Withstands 100 cycles from -65°C to +125°C when evaluated per Method 107 of MIL-STD-202
Resistance to Soldering Heat	Withstands 60 seconds at +260°C when evaluated per Method 210 of MIL-STD-202
Solderability	Meets 95% minimum coverage requirement when evaluated per Method 208 of MIL-STD-202
Moisture Resistance	Withstands 10 cycles when evaluated per Method 106 of MIL-STD-202
Salt Spray	Withstands 48-hour exposure when evaluated per Method 101 of MIL-STD-202

Table FF4 Material Specifications for Fast Acting Fuses

Construction Body Material	Ceramic
Termination Material	Silver, Nickel, Tin
Fuse Element	Silver
Terminal Strength	Hanging test: 0603: 0.5kg 30 seconds; 1206 1.5kg, 30 seconds; 0402 part types meet 2-pound push test

Figure FF7 Thermal Derating Current for Fast Acting Fuses

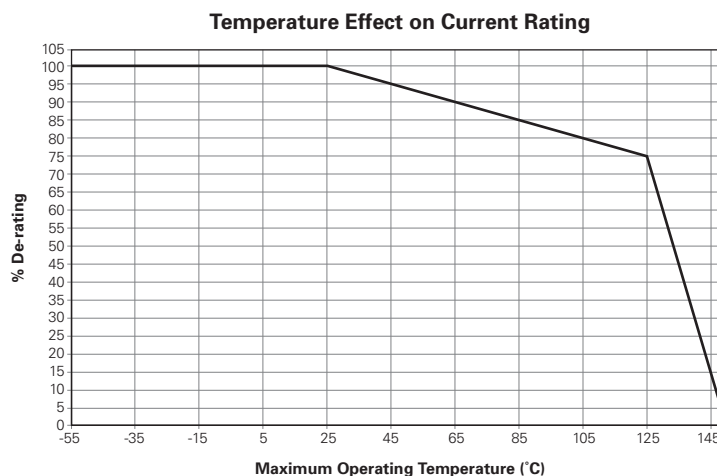


Table FF5 Electrical Specifications for Fast Acting Fuses

Insulation Resistance after Opening	20,000Ω minimum @ rated voltage. Fuse clearing under low voltage conditions may result in lower post-clearing insulation values. Under normal fault conditions values. Under normal fault conditions Raychem fuses provide sufficient insulation resistance for circuit protection.
Current Carrying Capacity	Withstands 100% rated current at +25°C ambient for 4 hours when evaluated per MIL-PRF-23419

Table FF6 Packaging Information for Fast Acting Fuses

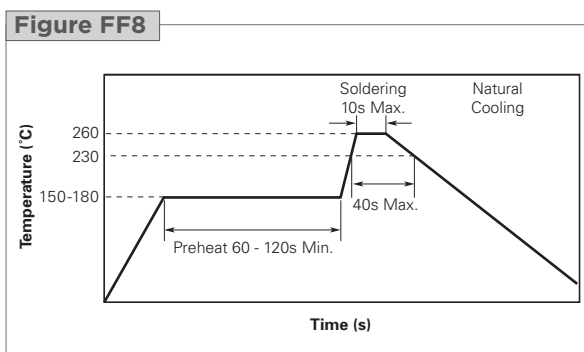
Size	Reel Quantity (pcs)	Reel Diameter	Reel Width	Carrier Tape Size	Tape Type	Reels per Outside Shipment Box	Outside Shipment Boxes per Overpack
0402 (1005)	10,000	178mm white plastic	9.0 ± 0.5mm	8.00 ± 0.10mm	Paper	5	5
0603 (1608)	4,000	178mm white plastic	9.0 ± 0.5mm	8.00 ± 0.10mm	Plastic	5	5
1206 (3216)	3,000	178mm white plastic	9.0 ± 0.5mm	8.00 ± 0.10mm	Plastic	5	5

Agency Approvals for Fast Acting Fuses

UL File # E197536

Recommended Soldering Temperature Profile for Fast Acting Fuses**Recommended conditions for hand soldering:**

- Preheating: 150°C, 60s (min)
Appropriate temperature (max) of soldering iron tip/soldering time (max):
280°C /10s or 350°C / 3s
Maximum temperature of soldering iron tip/soldering time:
350°C /9s or 400°C / 8s
- Using hot air rework station that can reflow the solder on both terminations at the same time is strongly recommended, do not directly contact the chip termination with the tip of soldering iron.

**Table FF7 Tape and Reel Material Characteristics for Fast Acting Fuses**

Tolerance X ± 1mm; 0.X ± 0.5mm; 0.XX ± 0.2mm

Performance	Testing Method	Range	
		Min	Max
M.V.R.	ASTM D1238	3.60	4.40
Vicat Softening Temperature	ASTM D1525	97.8	-
Elasticity at Break	ASTM D638	50.0	-

Table FF8 Tape and Reel Specifications for Fast Acting Fuses

Mark	Dimension in inches (mm)					
	0402 (1005)		0603 (1608)		1206 (3216)	
E ₁	0.069±0.004	(1.75±0.10)	0.069±0.004	(1.75±0.10)	0.069±0.004	(1.75±0.10)
F	0.138±0.002	(3.50±0.05)	0.138±0.002	(3.50±0.05)	0.138±0.002	(3.50±0.05)
W	0.318±0.004	(8.00±0.10)	0.318±0.004	(8.00±0.10)	0.318±0.004	(8.00±0.10)
P ₁	0.079±0.004	(2.00±0.10)	0.157±0.004	(4.00±0.10)	0.157±0.004	(4.00±0.10)
P ₀	0.157±0.004	(4.00±0.10)	0.157±0.004	(4.00±0.10)	0.157±0.004	(4.00±0.10)
P ₂	0.040±0.002	(1.00±0.05)	0.079±0.002	(2.00±0.05)	0.079±0.002	(2.00±0.05)
D ₀	0.059±0.004	(1.50+0.10/-0.00)	0.059±0.004	(1.50+0.10/-0.00)	0.059±0.004	(1.50+0.10/-0.00)
D ₁	-	-	-	-	0.039 max	(1.00 max)
t	0.009±0.001	(0.23±0.02)	0.009±0.001	(0.23±0.02)	0.009±0.001	(0.23±0.02)
A ₀	0.026±0.004	(0.67±0.10)	0.038±0.004	(0.96±0.10)	0.071±0.004	(1.80±0.10)
B ₀	0.046±0.004	(1.17±0.10)	0.071±0.004	(1.80±0.10)	0.138±0.004	(3.50±0.10)
K ₀	0.025±0.004	(0.63±0.10)	0.037±0.004	(0.94±0.10)	0.048±0.004	(1.20±0.10)

Figure FF9 Taped Component Dimensions for Fast Acting Fuses

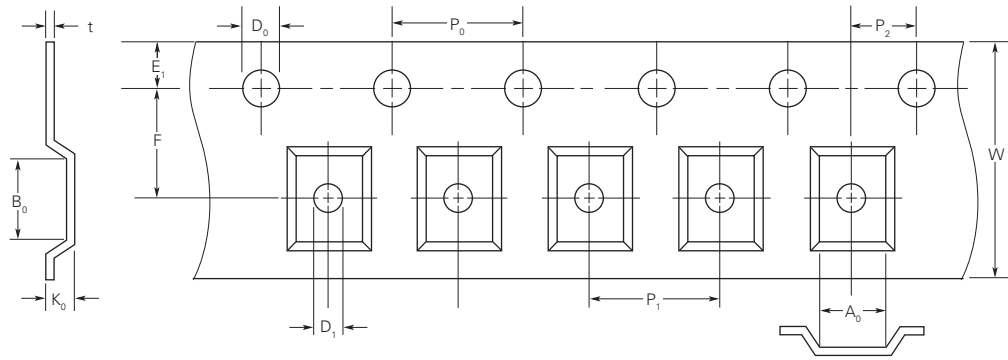
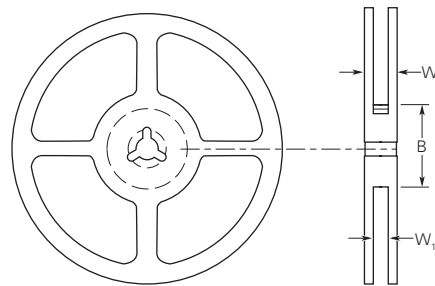
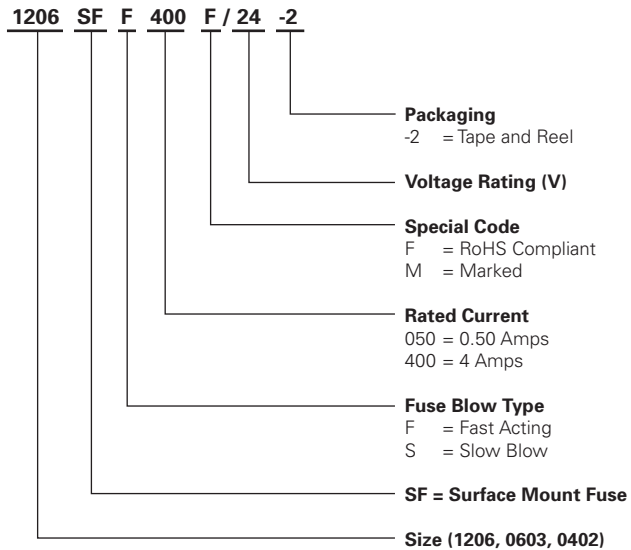


Figure FF10 Reel Dimensions for Fast Acting Fuses

Dimension Description	Mark	Dimensions (mm)
Hub outer diameter	B	60
Reel inside width	W ₁	9
Reel outside width	W ₂	11.4
Tape width		8



Part Numbering System for Fast Acting Fuses



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Slow Blow Fuses

Available in industry standard 1206 and 0603 chip sizes, Raychem Slow Blow fuses help provide overcurrent protection on systems that experience large and frequent current surges as part of their normal operation.

The Slow Blow fuse's monolithic, multilayer design helps provide some of the highest current ratings available in the 1206 and 0603 footprints and enhances high temperature performance in a wide range of circuit protection designs. The devices' small size, high reliability and strong arc suppression characteristics make them suitable for overcurrent protection of power supplies, capacitor filter banks, LCD (Liquid Crystal Display) backlight inverters, electric motors and portable electronics.



Benefits

- Time delayed design prevents nuisance openings in pulsed and high inrush current applications
- Small size with high current ratings
- Strong arc suppression characteristics

Features

- RoHS compliant
- Monolithic multilayer design
- High temperature performance
- -55°C to +125°C operating temperature range

Applications

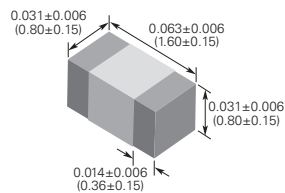
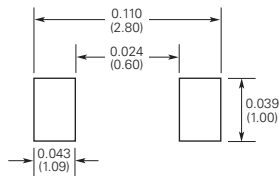
- | | | |
|------------------------|-----------------------------|-------------------|
| • Small motors systems | • Power over Ethernet (POE) | • Computer drives |
| • Portable electronics | • Test equipment | • Displays |
| • Input power ports | • POL Converter Protection | • Printers |

Table FS1 Clear Time Characteristics for Slow Blow Fuses**0603SFS Series**

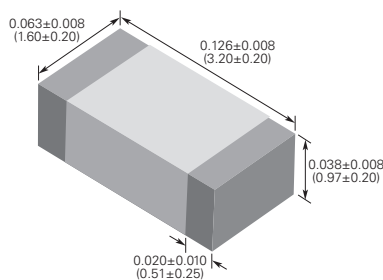
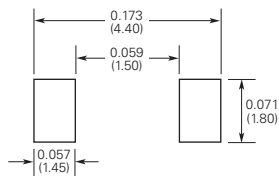
% of rated current	Clear time at 25°C	
100%	4 hours (min.)	
200%	1 second (min.)	120 seconds (max.)
300%	0.1 second (min.)	3 seconds (max.)
800% (1.0A-1.5A)	0.0005 second (min.)	0.05 seconds (max.)
800% (2.0A-5.0A)	0.001 second (min.)	0.05 seconds (max.)

1206SFS Series

% of rated current	Clear time at 25°C	
100%	4 hours (min.)	
200%	1 second (min.)	120 seconds (max.)
300%	0.1 second (min.)	3 seconds (max.)
800%	0.002 second (min.)	0.05 seconds (max.)

Table FS2 Typical Electrical Characteristics, Dimensions and Recommended Pad Layout for Slow Blow Fuses**0603 (1608mm) Slow Blow Surface-mount Chip Fuses****Shape and Dimensions**
Inch (mm)**Recommended Pad Layout**
Inch (mm)**Typical Electrical Characteristics****Max Interrupt Ratings**

Part Number	Typical Electrical Characteristics			Max Interrupt Ratings	
	Rated Current (A)	Nominal Cold DCR (Ω)*	Nominal I ² t (A ² sec)†	Voltage (V _{DC})	Current (A)
0603SFS100F/32	1.0	0.200	0.093	32	40
0603SFS150F/32	1.5	0.100	0.18	32	40
0603SFS200F/32	2.0	0.052	0.32	32	40
0603SFS250F/32	2.5	0.041	0.63	32	40
0603SFS300F/32	3.0	0.031	0.87	32	40
0603SFS350F/32	3.5	0.021	1.20	32	40
0603SFS400F/32	4.0	0.017	2.30	32	40
0603SFS450F/32	4.5	0.015	2.70	32	40
0603SFS500F/32	5.0	0.013	3.20	32	40

1206 (3216mm) Slow Blow Surface-mount Chip Fuses**Shape and Dimensions**
Inch (mm)**Recommended Pad Layout**
Inch (mm)**Typical Electrical Characteristics****Max Interrupt Ratings**

Part Number	Typical Electrical Characteristics			Max Interrupt Ratings	
	Rated Current (A)	Nominal Cold DCR (Ω)*	Nominal I ² t (A ² sec)†	Voltage (V _{DC})	Current (A)
1206SFS100F/63	1.0	0.360	0.11	63	50
1206SFS125F/63	1.25	0.200	0.22	63	50
1206SFS150F/63	1.5	0.150	0.23	63	50
1206SFS200F/63	2.0	0.082	0.63	63	50
1206SFS250F/32	2.5	0.070	0.90	32	50
1206SFS300F/32	3.0	0.032	1.20	32	50
1206SFS350F/32	3.5	0.028	1.60	32	50
1206SFS400F/32	4.0	0.024	2.20	32	50
1206SFS450F/32	4.5	0.020	3.60	32	50
1206SFS500F/32	5.0	0.016	5.30	32	50
1206SFS550F/24	5.5	0.014	6.40	24	50
1206SFS600F/24	6.0	0.011	8.50	24	60
1206SFS700F/24	7.0	0.010	10.00	24	60
1206SFS800F/24	8.0	0.009	16.90	24	60

* Measured at ≤10% of rated current and 25°C ambient temperature

† Melting I²t at 0.001 sec clear time

Figure FS1-FS4 Family Average Clear Time

Figure FS1

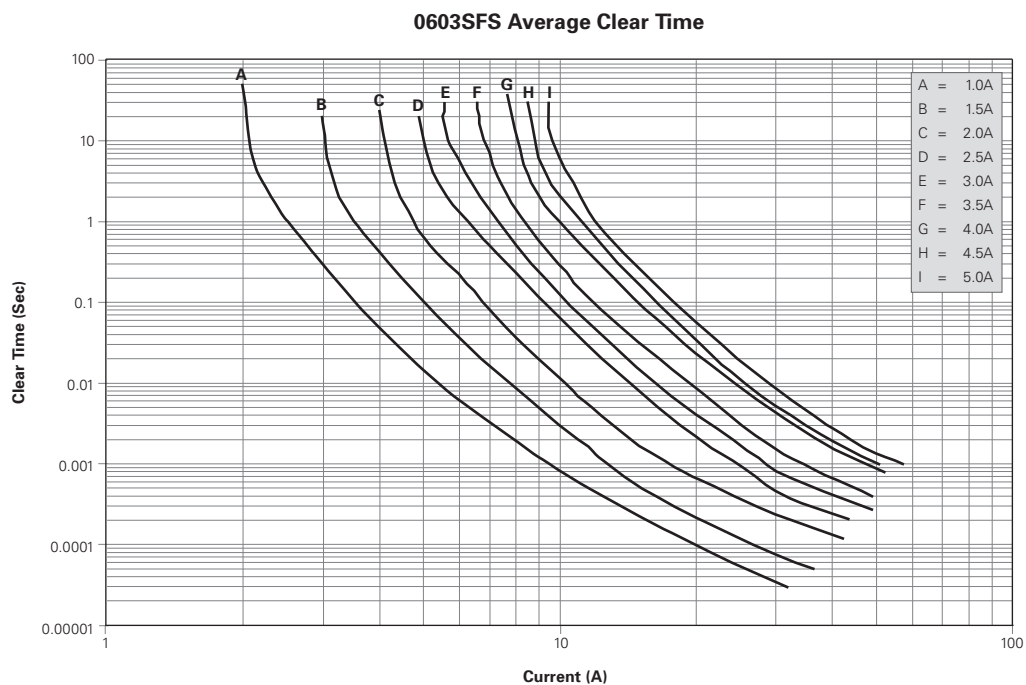
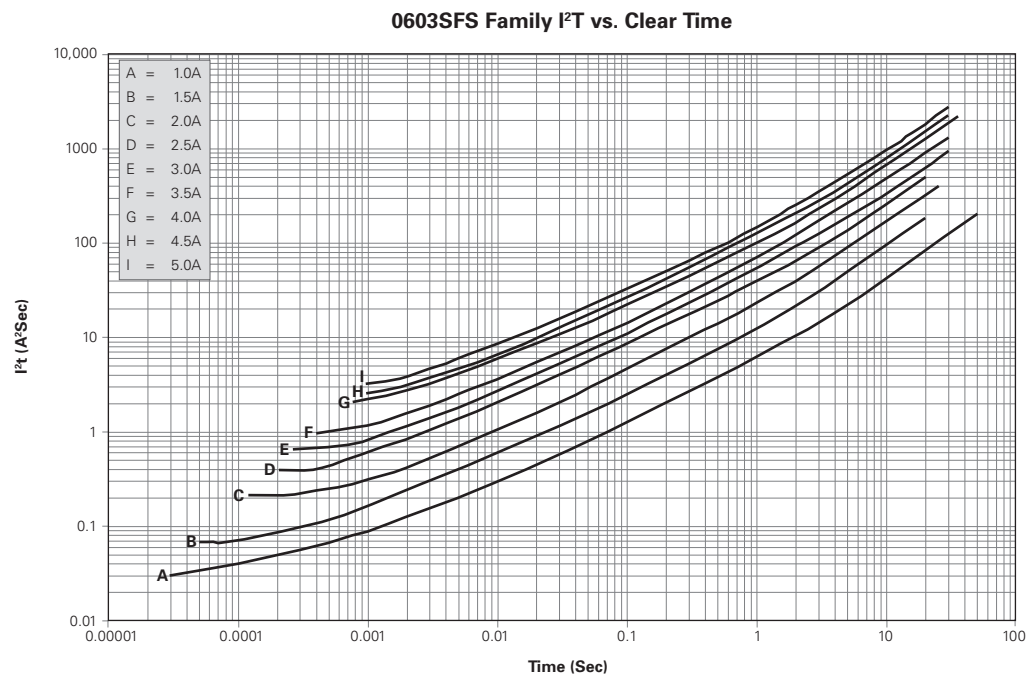


Figure FS2



Note: Curves are typical

Figure FS3

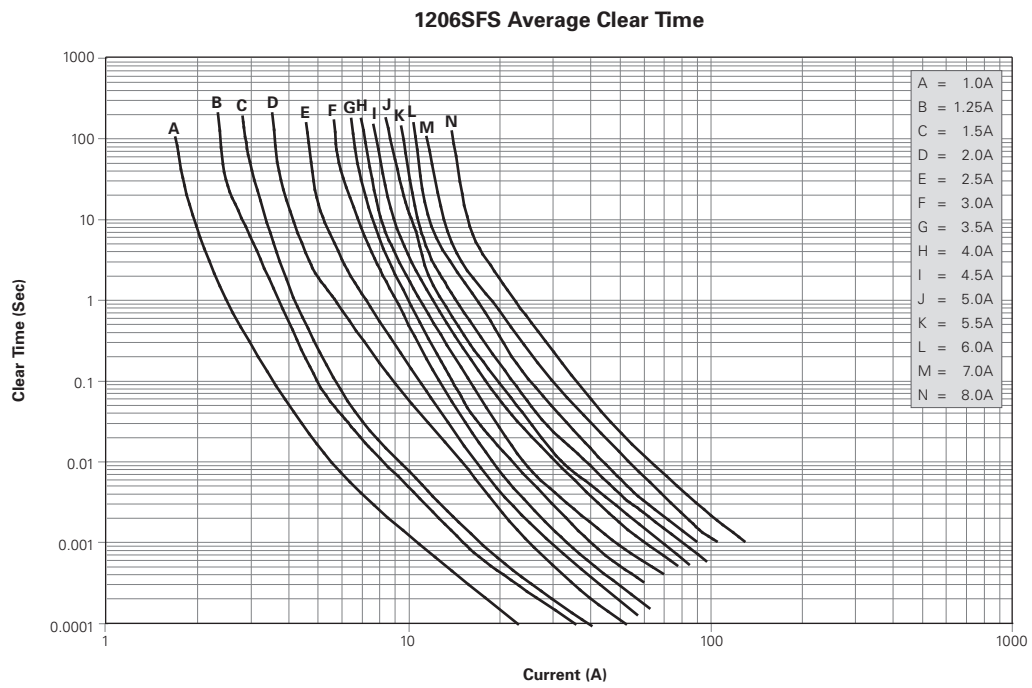
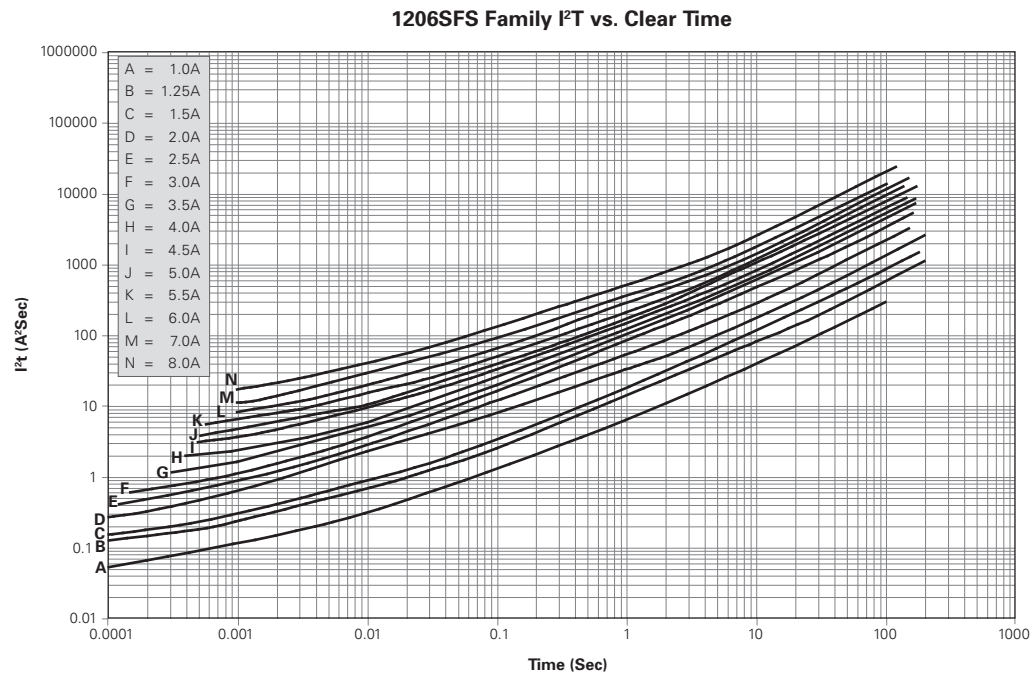


Figure FS4



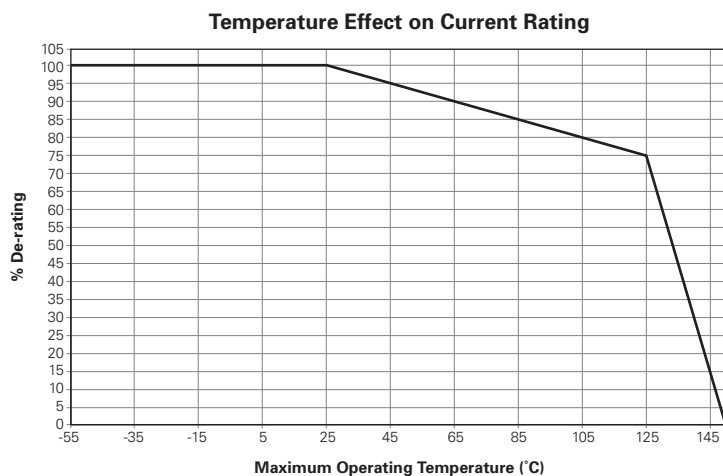
Note: Curves are typical

Table FS3 Environmental Specifications for Slow Blow Fuses

Operating Temperature	-55°C to +125°C
Mechanical Vibration	Withstands 5-3000 Hz at 30 Gs when evaluated per Method 204 of MIL-STD-202
Mechanical Shock	Withstands 1500 Gs, 0.5 millisecond half-sine pulses when evaluated per Method 213 of MIL-STD-202
Thermal Shock	Withstands 100 cycles from -65°C to +125°C when evaluated per Method 107 of MIL-STD-202
Resistance to Soldering Heat	Withstands 60 seconds at +260°C when evaluated per Method 210 of MIL-STD-202
Solderability	Meets 95% minimum coverage requirement when evaluated per Method 208 of MIL-STD-202
Moisture Resistance	Withstands 10 cycles when evaluated per Method 106 of MIL-STD-202
Salt Spray	Withstands 48-hour exposure when evaluated per Method 101 of MIL-STD-202

Table FS4 Material Specifications for Slow Blow Fuses

Construction Body Material	Ceramic
Termination Material	Silver, Nickel, Tin
Fuse Element	Silver
Terminal Strength: Hanging test	1.5kg, 30 seconds

Figure FS5 Thermal Derating Current for Slow Blow Fuses**Table FS5 Electrical Specifications for Slow Blow Fuses**

Insulation Resistance after Opening	20,000Ω minimum @ rated voltage. Fuse clearing under low voltage conditions may result in lower post-clearing insulation values. Under normal fault conditions Raychem fuses provide sufficient insulation resistance for circuit protection.
Current Carrying Capacity	Withstands 100% rated current at +25°C ambient for 4 hours when evaluated per MIL-PRF-23419

Table FS6 Packaging Information for Slow Blow Fuses

Size	Reel Quantity (pcs)	Reel Diameter	Reel Width	Carrier Tape Size	Tape Type	Reels per Outside Shipment Box	Outside Shipment Boxes per Overpack
0603 (1608)	4,000	178mm white plastic	9.0 ± 0.5mm	8.00 ± 0.10mm	Plastic	5	5
1206 (3216)	3,000	178mm white plastic	9.0 ± 0.5mm	8.00 ± 0.10mm	Plastic	5	5

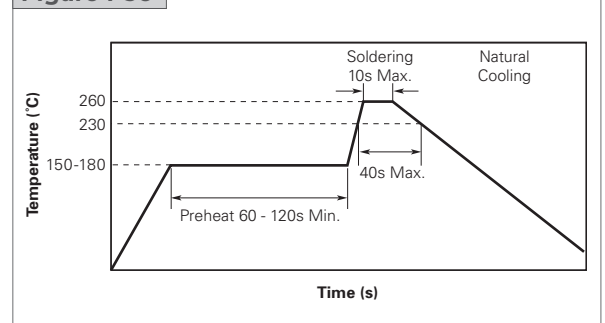
Agency Approvals for Slow Blow Fuses

UL

File # E197536

Recommended Soldering Temperature Profile for Slow Blow Fuses**Recommended conditions for hand soldering:**

- Preheating: 150°C, 60s (min)
Appropriate temperature (max) of soldering iron tip/soldering time (max):
280°C /10s or 350°C / 3s
Maximum temperature of soldering iron tip/soldering time:
350°C /9s or 400°C / 8s
- Using hot air rework station that can reflow the solder on both terminations at the same time is strongly recommended, do not directly contact the chip termination with the tip of soldering iron.

Figure FS6**Table FS7 Tape and Reel Material Characteristics for Slow Blow Fuses**

Tolerance X ± 1mm; 0.X ± 0.5mm; 0.XX ± 0.2mm

Performance	Testing Method	Range	
		Min	Max
M.V.R.	ASTM D1238	3.60	4.40
Vicat Softening Temperature	ASTM D1525	97.8	-
Elasticity at Break	ASTM D638	50.0	-

Table FS8 Tape and Reel Specifications for Slow Blow Fuses

Mark	Dimension in inches (mm)			
	0603 (1608)		1206 (3216)	
E ₁	0.069±0.004	(1.75±0.10)	0.069±0.004	(1.75±0.10)
F	0.138±0.002	(3.50±0.05)	0.138±0.002	(3.50±0.05)
W	0.318±0.004	(8.00±0.10)	0.318±0.004	(8.00±0.10)
P ₁	0.157±0.004	(4.00±0.10)	0.157±0.004	(4.00±0.10)
P ₀	0.157±0.004	(4.00±0.10)	0.157±0.004	(4.00±0.10)
P ₂	0.079±0.002	(2.00±0.05)	0.079±0.002	(2.00±0.05)
D ₀	0.059±0.004	(1.50+0.10/-0.00)	0.059±0.004	(1.50+0.10/-0.00)
D ₁	-	-	0.039 max	(1.00 max)
t	0.009±0.001	(0.23±0.02)	0.009±0.001	(0.23±0.02)
A ₀	0.038±0.004	(0.96±0.10)	0.071±0.004	(1.80±0.10)
B ₀	0.071±0.004	(1.80±0.10)	0.138±0.004	(3.50±0.10)
K ₀	0.037±0.004	(0.94±0.10)	0.048±0.004	(1.20±0.10)

Figure FS7 Taped Component Dimensions for Slow Blow Fuses

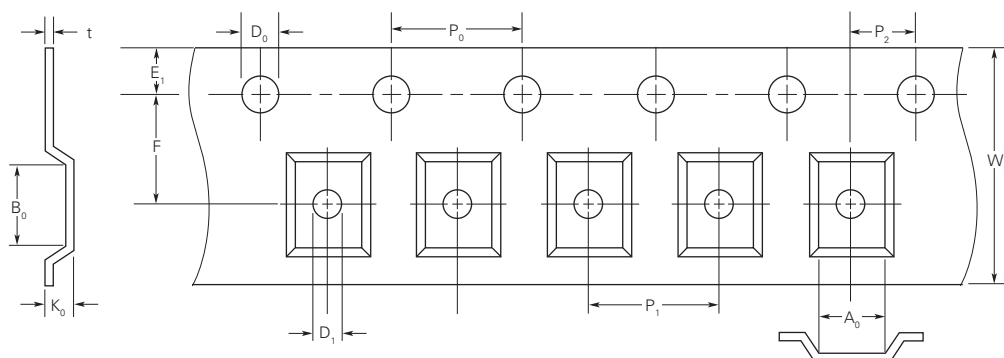
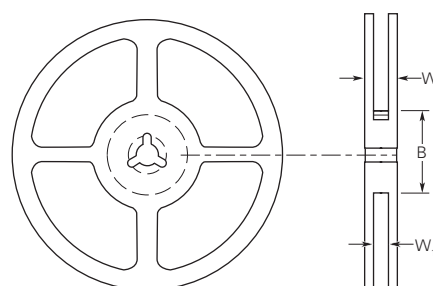
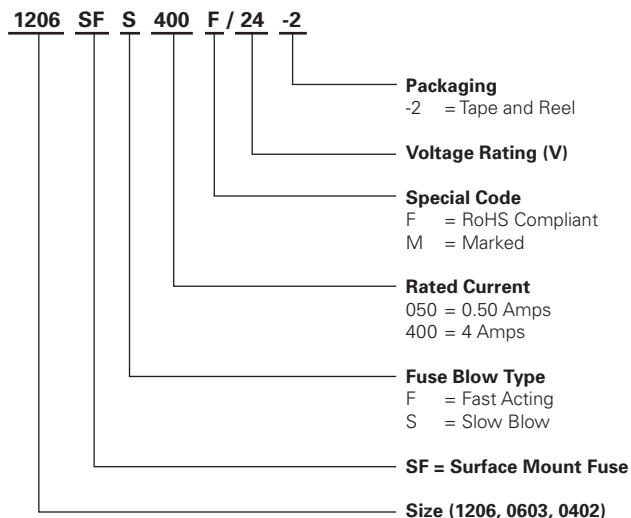


Figure FS8 Reel Dimensions for Slow Blow Fuses

Dimension Description	Mark	Dimensions (mm)
Hub outer diameter	B	60
Reel inside width	W ₁	9
Reel outside width	W ₂	11.4
Tape width		8

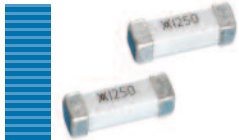


Part Numbering System for Slow Blow Fuses



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Telecom Fuses

The FT600 fuse series helps telecommunications equipment manufacturers comply with North American overcurrent protection requirements, including Telcordia GR-1089, TIA-968-A (formerly FCC Part 68), and UL60950 3rd edition.

Raychem telecom fuses offer low temperature-rise performance under sneak current fault events to help prevent damage to circuit traces or multilayer boards, and their low profile and small footprint make them suitable for high-density and space-constrained applications.

When used in conjunction with SiBar thyristor surge suppression devices, FT600 fuses help designers implement a coordinated overcurrent/overvoltage solution and comply with regulatory standards.



Benefits

- High density placement in multi-port system designs
- Improved temperature rise performance over other similar Surface-mount fuse devices under sneak-current testing
- The FT600 in conjunction with a SiBar overvoltage protection device, assists designers in meeting regulatory standards with no additional series components

Features

- Low profile and small footprint
- The lightning robust surface-mount fuse offers over-current protection in case of power fault events
- Enables the design of equipment complying with applicable telecom specifications including UL60950, TIA-968-A (formerly FCC Part 68), and Telcordia GR-1089
- Low resistance

Applications

- ADSL, ADSL2, ADSL2plus, SHDSL, VDSL linecards and modems
- T1/E1 systems
- Twisted-pair telecom ports requiring Telcordia GR-1089, UL60950 and FCC Part TIA-968-A (formerly FCC Part 68) compliance

Protection Application Guide for Telecommunications and Networking Devices

To use this guide, follow the steps below:

1. Select your equipment type from the guide below.
2. Use the Key Device Selection Criteria (time-to-open, surface temperature) to determine best suitability for your application.
3. Use Agency Specification / Selection Guide to select a specific part number for each application based on the agency requirements.

Application	Specification	Key Device Selection Criteria		
		Faster Time-To-Open	Cooler Surface Temperature	SiBar Thyristor Surge Protectors*
Customer premises equipment, IT equipment Analog modems, V.90 modems, ISDN modems, xDSL modems, ADSL splitters, phone sets, fax machines, answering machines, caller ID, internet appliances, PBX systems, POS terminals, wall plugs	UL 60950 TIA-968-A	FT600-0500 FT600-1250	FT600-2000	TVBxxx(N/M/R)SC-L
Access network equipment Remote terminals, line repeaters, multiplexers, cross-connects, WAN equipment	Telcordia GR-1089 TIA-968-A	FT600-1250	FT600-2000	TVBxxx(N/M/R)SC-L
Central office switching equipment Analog/POTS linecards, ISDN linecards, xDSL modems, ADSL/VDSL splitters, T1/E1 linecards, multiplexers, CSU/DSU, servers	Telcordia GR-1089 TIA-968-A	FT600-1250	FT600-2000	TVBxxx(N/M/R)SC-L

Note: This list is not exhaustive. Tyco Electronics welcomes our customers' input for additional application ideas for overcurrent protection of telecom applications.

* Refer to the SiBar product section on page 37 for more information.

Agency Specification/Selection Guide for FT600 Devices

Use the guide below to select FT600 devices appropriate for use in your application. The following pages contain specifications for part numbers recommended below. FT600 devices enable telecommunication equipment to meet the applicable protection requirements of these industry specifications. Refer to individual agency specifications for test procedures and circuit schematics. Users should independently evaluate the suitability of, and test each product for their application.

Family	Product	Lightning	Power Cross
FT600	FT600-0500	TIA-968-A (formerly FCC Part 68) - Type A & B	UL60950, 3rd Ed. – 600V _{AC} , 40A
	FT600-1250	Telcordia GR-1089 – Level 1 and 2	Telcordia GR-1089 – 600 V _{AC} , 40A
	FT600-2000	TIA-968-A	UL60950

Notes: FT600-1250 and FT600-2000 assist equipment in complying with Telcordia GR-1089 specifications. In-circuit testing is strongly recommended. The FT600-0500, FT600-1250 and FT600-2000 help meet the UL60950 Power Cross and FCC TIA-968-A 68 lightning surge requirements. Note that Type A tests allow for an overcurrent protection component to fuse open during the surge.

Table FT1 Interrupt Voltage and Current Ratings for FT600 Devices

Part Number	Ampere Rating (A)	Voltage Rating (V)	Typical Resistance (Ω)	Typical I ² t (A ² S)*
FT600-0500	0.50	250	0.50	1
FT600-1250	1.25	250	0.10	16
FT600-2000	2.00	250	0.05	18

Note: The FT600-xxxx devices carry 100% of rated current for 4 hours minimum and 250% of rated current for 1 second minimum, 120 seconds maximum. Resistance measured at 10% of rated current.

* I²t is calculated at 10 ms or less.

Figure FT1 Thermal Derating Curve (Normalized) for FT600 Devices

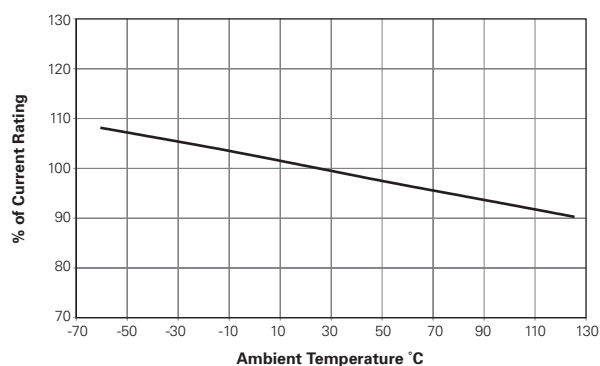


Table FT2 Dimensions for FT600 Devices in Millimeters (Inches)

Part Number	A		B		C		Figure
	Min	Max	Min	Max	Min	Max	
FT600-0500	—	10.2 (0.402)	—	3.1 (0.122)	—	3.1 (0.122)	FT2
FT600-1250	—	10.2 (0.402)	—	3.1 (0.122)	—	3.1 (0.122)	FT2
FT600-2000	—	10.2 (0.402)	—	3.1 (0.122)	—	3.1 (0.122)	FT2

Figure FT2 Dimension Figures for FT600 Devices

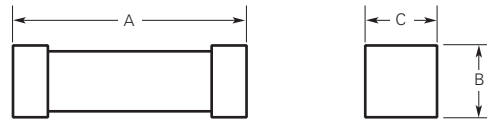


Figure FT3 Typical Time-to-open Characteristics (at 20°C) for FT600 Devices

FT600

A = FT600-0500

B = FT600-1250

C = FT600-2000

Figure FT3

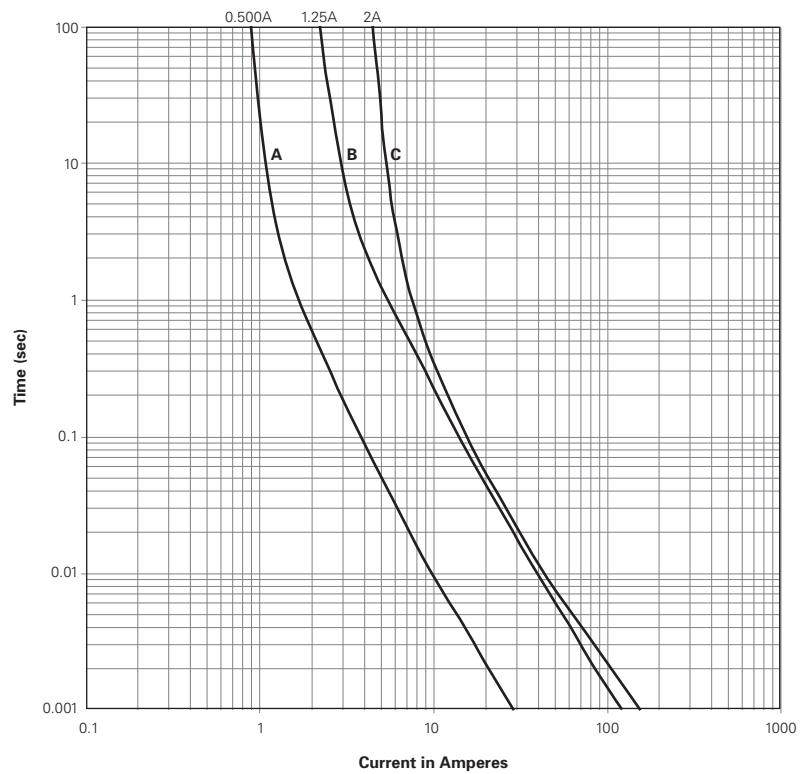


Table FT3 Physical Characteristics and Environmental Specifications for FT600 Devices

Physical Characteristics	
Terminal material	Silver-plated brass*
Body material	Ceramic
Termination solderability	Per IEC-60127-4
*FT600 devices use high Pb content solder for internal construction. They are RoHS compliant.	
Environmental Specifications	
Test	Conditions
Solder heat withstand	Per MIL-STD-202, Method 210, Test Condition J
Solvent resistance	Per MIL-STD-202F, Method 215J
Storage temperature	-40/+85°C
Storage humidity	Per MIL-STD-202F, Method 106F

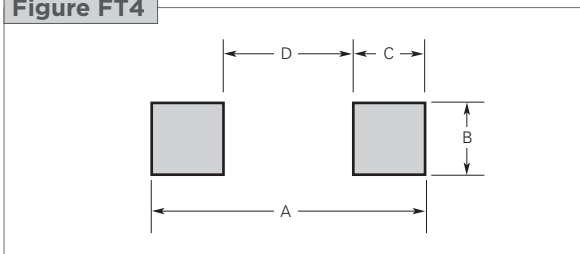
Table FT4 Packaging and Marking Information for FT600 Devices

Part Number	Bag Quantity	Tape & Reel Quantity	Standard Package Quantity	Part Marking	Agency Recognition
FT600-0500-2	—	2,500	10,000	500	UL, CSA
FT600-1250-2	—	2,500	10,000	1250	UL, CSA
FT600-2000-2	—	2,500	10,000	2000	UL, CSA

Note: The -2 designates tape and reel, the package style for this product.

Table FT5 Recommended Pad Layouts for FT600 Devices in millimeters (inches) Nominal

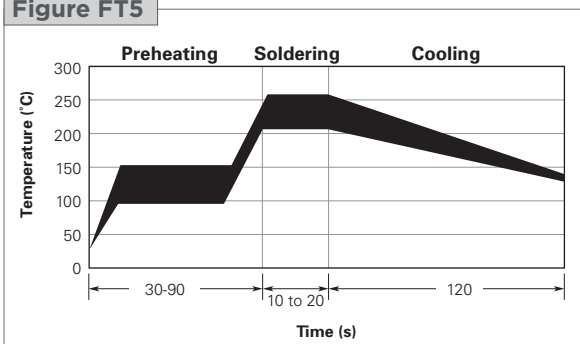
Device	A	B	C	D	Figure for Dimensions
FT600-0500	12.6 (0.496)	4.0 (0.157)	3.7 (0.145)	5.2 (0.204)	FT4
FT600-1250	12.6 (0.496)	4.0 (0.157)	3.7 (0.145)	5.2 (0.204)	FT4
FT600-2000	12.6 (0.496)	4.0 (0.157)	3.7 (0.145)	5.2 (0.204)	FT4

Figure FT4**Solder Reflow and Rework Recommendations for FT600 Devices****Solder Reflow**

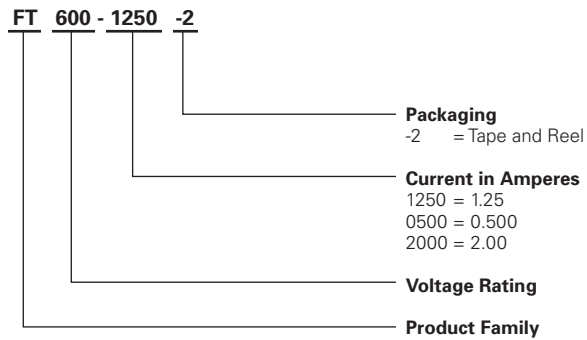
- Recommended reflow methods: IR, vapor phase oven, hot air oven
- Devices can be cleaned using standard industry methods and solvents

Rework

- If a device is removed from the board, it should be discarded and replaced by a new device

Figure FT5

Part Numbering System for FT600 Devices



Warning :

All information, including illustrations, is believed to be reliable. Users, however, should independently evaluate the suitability of each product for their application. Tyco Electronics Corporation makes no warranties as to the accuracy or completeness of the information, and disclaims any liability regarding its use. Tyco Electronics' only obligations are those in the Company's Standard Terms and Conditions of Sale for this product, and in no case will Tyco Electronics be liable for any incidental, indirect, or consequential damages arising from the sale, resale, use, or misuse of the product. Specifications are subject to change without notice. In addition, Tyco Electronics reserves the right to make changes without notification to Buyer—to materials or processing that do not affect compliance with any applicable specification.

PolySwitch Resettable Devices Fundamentals

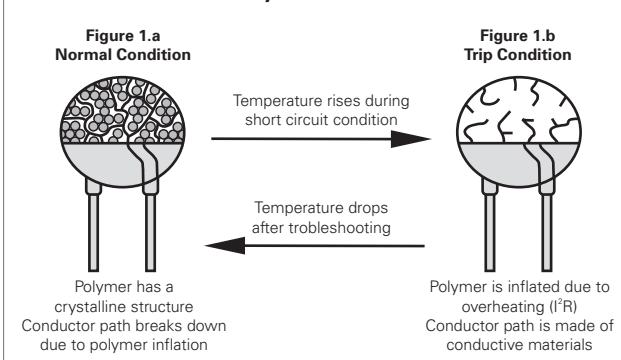
Overview

PolySwitch PPTC (Polymeric Positive Temperature Coefficient) devices help protect against harmful overcurrent surges and overtemperature faults. Like traditional fuses, these devices limit the flow of dangerously high current during fault conditions. The PolySwitch device, however, resets after the fault is cleared and power to the circuit is removed, thereby helping to reduce warranty, service and repair costs.

PolySwitch circuit protection devices are made from a composite of semi-crystalline polymer and conductive particles. At normal temperature, the conductive particles form low-resistance networks in the polymer (Figure 1). However, if the temperature rises above the device's switching temperature (T_{Sw}) either from high current through the part or from an increase in the ambient temperature, the crystallites in the polymer melt and become amorphous. The increase in volume during melting of the crystalline phase separates the conductive particles resulting in a large non-linear increase in the resistance of the device.

Figure 1

How a PolySwitch Device works



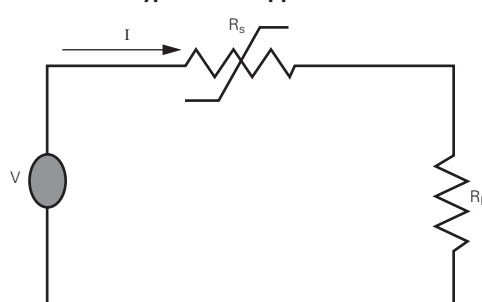
Overcurrent Protection using a Polymeric PTC Device

The PolySwitch device is a series element in a circuit. The PPTC device protects the circuit by going from a low-resistance to a high-resistance state in response to an overcurrent condition, as shown in Figure 2. This is referred to as “tripping” the device.

In normal operation the device has a resistance that is much lower than the remainder of the circuit. In response to an overcurrent condition, the device increases in resistance (trips), reducing the current in the circuit to a value that can be safely carried by any of the circuit elements. This change is the result of a rapid increase in the temperature of the device, caused by I^2R heating.

Figure 2

Typical PTC Application



Principles of operation

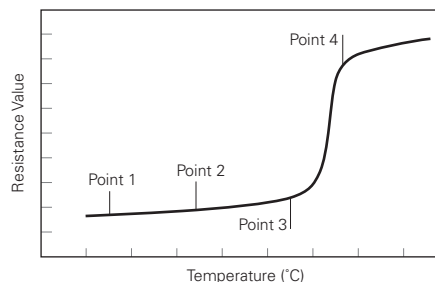
PolySwitch device operation is based on an overall energy balance. Under normal operating conditions, the heat generated by the device and the heat lost by the device to the environment are in balance at a relatively low temperature, as shown in Point 1 of Figure 3.

If the current through the device is increased while the ambient temperature is kept constant, the temperature of the device increases. Further increases in either current, ambient temperature, or both will cause the device to reach a temperature where the resistance rapidly increases, as shown in Point 3 of Figure 3.

Any further increase in current or ambient temperature will cause the device to generate heat at a rate greater than the rate at which heat can be dissipated, thus causing the device to heat up rapidly. At this stage, a very large increase in resistance occurs for a very small change in temperature, between points 3 and 4 of Figure 3. This is the normal operating region for a device in the tripped state. This large change in resistance causes a corresponding decrease in the current flowing in the circuit. This relation holds until the device resistance reaches the upper knee of the curve (Point 4 of Figure 3). As long as the applied voltage remains at this level, the device will remain in the tripped state (that is, the device will remain latched in its protective state). Once the voltage is decreased and the power is removed the device will reset.

Figure 3

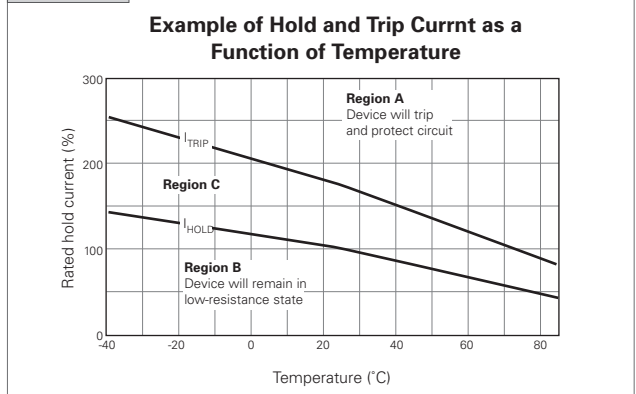
Example of Operating Curve for Polymeric PTC Device



Example of Hold and Trip Current as a Function of Temperature

Figure 4 illustrates the hold- and trip-current behavior of PolySwitch devices as a function of temperature. One such curve can be defined for each available device. Region A describes the combinations of current and temperature at which the PolySwitch device will trip (go into the high-resistance state) and protect the circuit. Region B describes the combinations of current and temperature at which the PolySwitch device will allow for normal operation of the circuit. In Region C, it is possible for the device to either trip or remain in the low-resistance state (depending on individual device resistance).

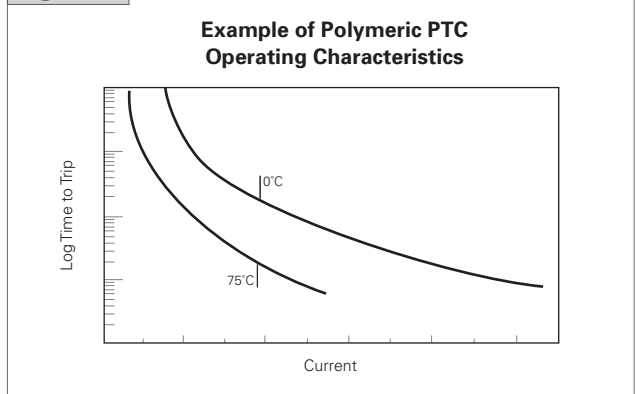
Figure 4



Operating Characteristics of Polymeric PTC

Figure 5 shows a typical pair of operating curves for a PolySwitch device in still air at 0°C and 75°C. The curves are different because the heat required to trip the device comes both from electrical I^2R heating and from the device environment. At 75°C the heat input from the environment is substantially greater than it is at 0°C, so the additional I^2R needed to trip the device is correspondingly less, resulting in a lower trip current at a given trip time (or a faster trip at given trip current).

Figure 5

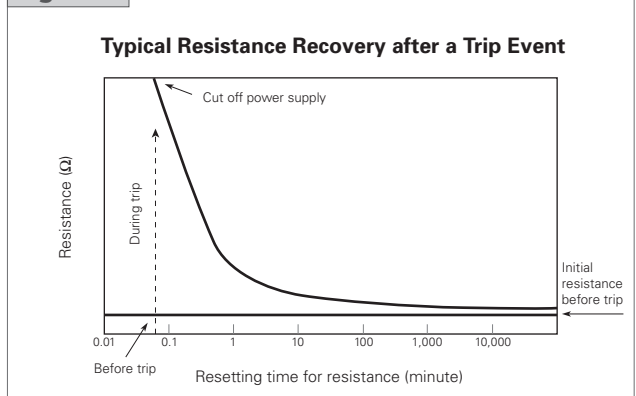


Typical Resistance Recovery after a Trip Event

Figure 6 shows typical behavior of a PolySwitch device that is tripped and then allowed to cool. This figure illustrates how, even after a number of hours, the device resistance is still greater than the initial resistance. Over an extended period of time, device resistance will continue to fall and will eventually approach initial resistance.

However, since this time can be days, months, or years, it is not practical to expect that the device resistance will reach the original value for operation purposes. Therefore, when PolySwitch devices are chosen R_{1MAX} should be taken into consideration when determining hold current. R_{1MAX} is the resistance of the device one hour after the thermal event.

Figure 6



PolySwitch Resettable Devices

Product Selection Guide

Table 1 PolySwitch Device Characteristics

PolySwitch Family	V _{Max} Operating (V _{DC})	V _{Max} Interrupt (V _{RMS})	I _H (A)	Temp. Range	Form Factor	Agency Spec.	Application
LVR	240V	265V	0.05 to 2A	-20 to 85°C	Radial-leaded	UL, CSA, TÜV	Line Voltage
LVR/L	120V	135V	0.75 to 2A	-20 to 85°C	Radial-leaded	UL, CSA, TÜV	Line Voltage
RGEF	16V	-	2.5 to 14.0A	-40 to 85°C	Radial-leaded	UL, CSA, TÜV	General Electronics
RHEF	16 to 30V	-	0.5 to 15A	-40 to 125°C	Radial-leaded	UL, CSA, TÜV	General Electronics
RTEF	33V	-	1.2 to 1.9A	-40 to 85°C	Radial-leaded	UL, CSA, TÜV	General Electronics
RUEF	30V	-	0.9 to 9.0A	-40 to 85°C	Radial-leaded	UL, CSA, TÜV	General Electronics
RXEF	60 to 72V	-	0.05 to 3.75A	-40 to 85°C	Radial-leaded	UL, CSA, TÜV	General Electronics
RUSBF	6 to 16V	-	0.75 to 2.5A	-40 to 85°C	Radial-leaded	UL, CSA, TÜV	Computer/General Electronics
microSMD	6 to 30V	-	0.5 to 2.00A	-40 to 85°C	Surface-mount	UL, CSA, TÜV	Computer/General Electronics
midSMD	6 to 60V	-	0.3 to 2.0A	-40 to 85°C	Surface-mount	UL, CSA, TÜV	Computer/General Electronics
miniSMDC	6 to 60V	-	0.14 to 2.6A	-40 to 85°C	Surface-mount	UL, CSA, TÜV	Computer/General Electronics
miniSMDE	16V	-	1.9A	-40 to 85°C	Surface-mount	UL, CSA, TÜV	Computer/General Electronics
nanoSMDC	6V	-	1.5A	-40 to 85°C	Surface-mount	UL, CSA, TÜV	Computer/General Electronics
picoSMD	6V	-	0.35A	-40 to 85°C	Surface-mount	UL	Computer/General Electronics
SMD	6 to 60V	-	0.3 to 3.0A	-40 to 85°C	Surface-mount	UL, CSA, TÜV	Computer/General Electronics
SMD2	15 to 33V	-	1.5 to 2.5A	-40 to 85°C	Surface-mount	UL, CSA, TÜV	Computer/General Electronics
AGRF	16V	-	4.0 to 14.0A	-40 to 85°C	Radial-leaded	-	Automotive
AHRF	16 to 30V	-	2.0 to 15A	-40 to 125°C	Radial-leaded	-	Automotive
AHS	16V	-	0.80 to 1.6A	-40 to 125°C	Surface-mount	-	Automotive
ASMD	16 to 30V	-	0.23 to 1.97A	-40 to 85°C	Surface-mount	-	Automotive
BBRF	99V	-	0.55 to 0.75A	-40 to 85°C	Radial-leaded	UL, CSA	Telecom & Networking
TCF	60V	250V	0.12 to 0.18A	-40 to 85°C	Chip	-	Telecom & Networking
TRF250	60 to 100V	250V	0.08 to 0.183A	-40 to 85°C	Radial-leaded	UL, CSA, TÜV	Telecom & Networking
TRF600	250V	600V	0.15 to 0.16A	-40 to 85°C	Radial-leaded	UL, CSA, TÜV	Telecom & Networking
TS250/TSV250	60V	250V	0.13A	-40 to 85°C	Surface-mount	UL, CSA, TÜV	Telecom & Networking
TSL250	80V	250V	0.08A	-40 to 85°C	Surface-mount	UL, CSA, TÜV	Telecom & Networking
TS600/TSM600	60 to 250V	600V	0.17 to 0.40A	-40 to 85°C	Surface-mount	UL, CSA, TÜV	Telecom & Networking
MXP	6V	-	1.9A	-40 to 85°C	Axial-leaded	UL, CSA, TÜV	Battery
LR4	15 to 20V	-	1.7 to 13.0A	-40 to 85°C	Axial-leaded	UL, CSA, TÜV	Battery
LTP	15 to 24V	-	0.7 to 3.4A	-40 to 85°C	Axial-leaded	UL, CSA, TÜV	Battery
SRP	15 to 30V	-	1.2 to 4.2A	-40 to 85°C	Axial-leaded	UL, CSA, TÜV	Battery
VLP	16V	-	2.1 to 2.7A	-40 to 85°C	Axial-leaded	UL, CSA, TÜV	Battery
VLR	12V	-	1.7 to 2.3A	-40 to 85°C	Axial-leaded	UL, CSA, TÜV	Battery
VTP	16V	-	1.1 to 2.4A	-40 to 85°C	Axial-leaded	UL, CSA, TÜV	Battery

Table 2 Thermal Derating

PolySwitch Family	-40°C	-20°C	0°C	20°C	25°C	30°C	40°C	50°C	60°C	70°C	85°C	125°C
LVR005-055	-	1.48	1.24	1.00	0.99	0.93	0.82	0.72	0.60	0.51	0.35	-
LVR075-200	-	1.69	1.34	1.00	0.99	0.95	0.88	0.80	0.73	0.66	0.55	-
LVR/L	-	1.43	1.21	1.00	0.99	0.95	0.86	0.78	0.70	0.62	0.50	-
RGEF	1.54	1.37	1.21	1.04	1.00	0.96	0.88	0.79	0.71	0.63	0.50	-
RHEF	1.50	1.35	1.19	1.04	1.00	0.96	0.88	0.81	0.73	0.65	0.54	0.23
RTEF	1.48	1.32	1.16	1.00	0.96	0.92	0.84	0.76	0.68	0.60	0.48	-
RUEF	1.48	1.32	1.16	1.00	0.96	0.92	0.84	0.76	0.68	0.60	0.48	-
RXEF	1.56	1.37	1.19	1.00	0.95	0.91	0.82	0.72	0.63	0.54	0.40	-
RUSBF	1.41	1.27	1.14	1.00	0.97	0.93	0.87	0.80	0.73	0.66	0.56	-
microSMD	1.45	1.30	1.15	1.00	0.96	0.93	0.85	0.78	0.70	0.63	0.51	-
midSMD	1.41	1.27	1.14	1.00	0.97	0.93	0.87	0.80	0.73	0.66	0.56	-
miniSMD	1.45	1.30	1.15	1.00	0.96	0.93	0.85	0.78	0.70	0.63	0.51	-
nanoSMD	1.56	1.39	1.15	1.04	1.00	0.96	0.87	0.79	0.70	0.61	0.49	-
picoSMD	1.45	1.30	1.15	1.00	0.96	0.93	0.85	0.78	0.70	0.63	0.51	-
SMD	1.45	1.30	1.15	1.00	0.96	0.93	0.85	0.78	0.70	0.63	0.51	-
AGRF	1.54	1.37	1.21	1.04	1.00	0.96	0.88	0.79	0.71	0.63	0.50	-
AHRF	1.50	1.35	1.19	1.04	1.00	0.96	0.88	0.81	0.73	0.65	0.54	0.23
AHS	1.41	1.28	1.16	1.03	1.00	0.97	0.91	0.84	0.78	0.72	0.62	0.37
ASMD	1.59	1.41	1.23	1.05	1.00	0.95	0.86	0.77	0.68	0.59	0.45	-

Table 2 Thermal Derating

... Cont'd

PolySwitch Family	-40°C	-20°C	0°C	20°C	25°C	30°C	40°C	50°C	60°C	70°C	85°C	125°C
BBRF	1.56	1.37	1.19	1.00	0.95	0.91	0.82	0.72	0.63	0.54	0.40	-
TCF	1.54	1.36	1.18	1.00	0.96	0.91	0.82	0.73	0.64	0.55	0.42	-
TRF(except TRF250-180U)	1.54	1.36	1.18	1.00	0.96	0.91	0.82	0.73	0.64	0.55	0.42	-
TRF250-180U	1.48	1.32	1.16	1.00	0.96	0.92	0.84	0.76	0.68	0.60	0.48	-
TS	1.54	1.36	1.18	1.00	0.96	0.91	0.82	0.73	0.64	0.55	0.42	-
MXP	1.99	1.68	1.37	1.07	1.00	0.91	0.76	0.61	0.45	0.30	0.07	-
LR4	1.41	1.27	1.14	1.00	0.97	0.93	0.87	0.80	0.73	0.66	0.56	-
LTP	1.72	1.48	1.24	1.00	0.94	0.88	0.76	0.64	0.52	0.40	0.22	-
SRP	1.47	1.31	1.16	1.00	0.96	0.92	0.85	0.77	0.69	0.61	0.50	-
VLP	1.88	1.67	1.43	1.05	1.00	0.95	0.76	0.62	0.48	0.33	0.04	-
VLR	2.05	1.70	1.41	1.08	1.00	0.92	0.74	0.59	0.41	0.18	-	-
VTP	1.88	1.67	1.43	1.05	1.00	0.95	0.76	0.62	0.48	0.33	0.04	-

Selection steps from the Catalog**Step 1. Determine your circuit's parameters**

You will need to determine the following parameters of your circuit:

Maximum ambient operating temperature

Normal operating current

Maximum operating voltage

Maximum interrupt current

Step 2. Select a PolySwitch device that will accommodate the circuit's maximum ambient temperature and normal operating current.

Use the Thermal Derating [hold Current (A) at Ambient Temperature (°C)] table and choose the temperature that most closely matches the circuit's maximum ambient temperature. Look down that column to find the value equal to or greater than the circuit's normal operating current. Now look to the far left of that row to find the part family or part for the PolySwitch device that will best accommodate the circuit.

Step 3. Compare the selected device's maximum electrical ratings with the circuit's maximum operating voltage and interrupt current.

Use the Electrical Characteristics table to verify the part you selected in Step 2 will handle your circuit's maximum operating voltage and interrupt current. Find the device's maximum operating voltage (V_{max}) and maximum interrupt current (I_{max}). Ensure that V_{max} and I_{max} are greater than or equal to the circuit's maximum operating voltage and maximum interrupt current.

Step 4. Determine time-to-trip

Time-to-trip is the amount of time it takes for a device to switch to a high-resistance state once a fault current has been applied across the device. Identifying the PolySwitch device's time-to-trip is important in order to provide the desired protection capabilities. If the device you choose trips too fast, undesired or nuisance tripping will occur. If the device trips too slowly, the components being protected may be damaged before the device switches to a high-resistance state.

Use the Typical Time-to-trip Curves at 20°C to determine if the PolySwitch device's time-to-trip is too fast or too slow for the circuit. If it is go back to Step 2 and choose an alternate device.

Step 5. Verify ambient operating temperature

Ensure that your application's minimum and maximum ambient temperatures are within the operating temperature of the PolySwitch device. Most PolySwitch devices have an operating temperature range from -40°C to 85°C with some exception to 125°C.

Step 6. Verify the PolySwitch device dimensions

Use the Dimensions table to compare the dimensions of the PolySwitch device you selected with the application's space considerations.

Definitions of terms

I_H	the maximum steady state current at 20°C that can be passed through a PolySwitch device without causing the device to trip
I_T	the minimum current that will cause the PolySwitch device to trip at 20°C
V_{max}	the maximum voltage that can safely be dropped across a PolySwitch device in its tripped state also called: Maximum Device Voltage, Maximum Voltage, V_{max} , Max Interrupt Voltage
I_{max}	the maximum fault current that can safely be used to trip a PolySwitch device
P_D	the power (in watts) dissipated by a PolySwitch device in its tripped state
R_{max}	the maximum resistance prior to the trip of PolySwitch device
R_{min}	the minimum resistance prior to the trip of PolySwitch device
R_{1max}	the maximum resistance of a PolySwitch device at 20°C 1 hour after being tripped or after reflow soldering. Also called: Maximum Resistance
$R_{Tripped TYP}$	the typical resistance of PolySwitch 1 hour after the initial trip and reset

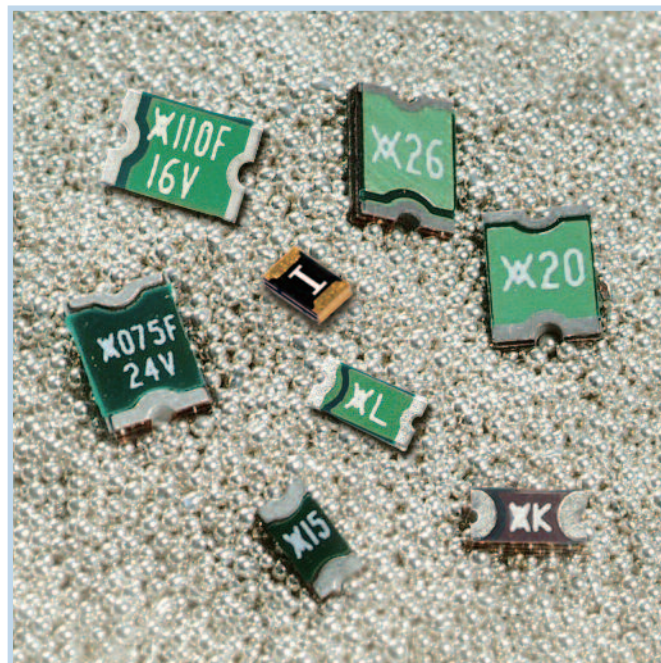


PolySwitch Resettable Devices Surface-mount Devices

Originally introduced more than 15 years ago, PolySwitch surface-mount devices are now the preferred circuit protection method for computer, consumer, multimedia, portable, and automotive electronics applications.

In an effort to reduce the size and cost of surface mount devices, we introduced the miniSMD product series in 1995. Subsequently, we developed the microSMD, nanoSMD and picoSMD family of products. The picoSMD series reduced the device size to a 2012mm (0805 mils) foot print, one fourth the size of the popular miniSMD series.

Recent additions to the PolySwitch surface-mount series include 24V miniSMD 4532mm (1812 mils), 60V decaSMD 5050mm (2018 mils), and 2.0A microSMD 3225mm (1210 mils) devices.



Benefits

- Smaller size saves board space and cost
- Many product choices give engineers more design flexibility
- Compatible with high-volume electronics assembly
- Assists in meeting regulatory requirements
- Higher voltage ratings allow use in new applications

Features

- RoHS compliant
- Broadest range of resettable devices available in the industry
- Current ratings from 0.05 to 3A
- Voltage ratings from 6V computer and electronic applications to 60V telecom applications
- Agency recognition: UL, CSA, TÜV
- Small footprint
- Fast time-to-trip
- Low resistance

Applications

- | | | |
|------------------------|---------------------------|-----------------------|
| • Computer | • Game machines | • Automotive |
| • Portable electronics | • Telephony and broadband | • Industrial controls |
| • Multimedia | • Mobile phones | • Battery |

Protection Application Selection Table for Surface-mount Devices

- The table below lists PolySwitch devices and SiBar devices typically used in these applications.
- Specifications for the suggested device part numbers can be found in this section.
- Once a part has been selected, the user should evaluate and test each product for the intended application.

Protection Application	Additional Comments	Overcurrent Overvoltage	PolySwitch Resettable Devices - Key Selection Criteria		
			Small Size	Low Resistance	Fast Time-to-trip (Temperature Protection)
AC adapter input power	use w/ Zener & triac		SMD250F	SMD250F	SMD200F
Battery pack protection			nanoSMDC150F	miniSMDC260F	miniSMDE190F
Charger protection			nanoSMDC050F	miniSMDC110F/16	nanoSMDC075F
CPU/IC protection			nanoSMDC110F	nanoSMDC150F	nanoSMDC075F
Data acquisition/sensor			microSMD005F	-	microSMD005F
DC input/output power	≤6V		nanoSMDC075F	nanoSMDC150F	nanoSMDC050F/13.2
	≤12V		miniSMDC075F	miniSMDC110F/16	miniSMDC075F
DDC			nanoSMDC075F	nanoSMDC110F	nanoSMDC050F/13.2
Device Bay system	DB12, DB20		miniSMDC200F	miniSMDC260F	miniSMDC200F
	DB32		miniSMDC260F	SMD300F	miniSMDC200F
Ethernet/Lan			nanoSMDC050F/13.2	miniSMDC110F/16	nanoSMDC075F
Fan			microSMD035F	microSMD050F	microSMD035F
HDMI			picoSMD035F	picoSMD035F	picoSMD035F
IEEE 802.3af	VOIP		decaSMDC050F/60	decaSMDC050F/60	decaSMDC050F/60
IEEE-1394	power provider		SMD100F/33	SMD185F	SMD100F/33
	alt. power provider		SMD185F	SMD185F	SMD150F/33
	self-powered		SMD185F	SMD185F	SMD150F/33
LCD inverter			nanoSMDC050F/13.2	miniSMDC110F/16	nanoSMDC075F
LCD screen power			nanoSMDC050F/13.2	nanoSMDC050F/13.2	microSMD035F
LNB (Low Noise Block)			SMD075F	SMD075F	SMD050F
Motor	≤6V		nanoSMDC110F	nanoSMDC150F	microSMD075F
	≤13.2V		miniSMDC075F	miniSMDC110F/16	miniSMDC075F
PS/2 mouse/keyboard			nanoSMDC075F	nanoSMDC110F	nanoSMDC050F/13.2
Signal - data communication	≤6V		nanoSMDC075F	nanoSMDC075F	nanoSMDC075F
	≤13.2V		miniSMDC050F	miniSMDC075F	miniSMDC020F
	≤30V		SMD030F-2018	SMD075F	SMD050F
SCSI			nanoSMDC110F	nanoSMDC150F	nanoSMDC075F
Smart card reader			microSMD010F	microSMD035F	microSMD005F
Telecom - modem	Digital line	OC	miniSMDC014F	miniSMDC014F	miniSMDC014F
		OV	TVBxxx(N/M/R)SC-L*	TVBxxx(N/M/R)SC-L*	TVBxxx(N/M/R)SC-L*
Telecom - PBX	Subscriber	OC	miniSMDC014F	miniSMDC014F	miniSMDC014F
Temperature sensor	CPU		nanoSMDC050F/13.2	nanoSMDC075F	nanoSMDC050F/13.2
USB	Individual Port		nanoSMDC075F	nanoSMDC110F	nanoSMDC050F/13.2
	2 port ganged		nanoSMDC150F	miniSMDC150F	miniSMDC125F
	3 port ganged		miniSMDC200F	miniSMDC200F	miniSMDC200F

Note : This list is not exhaustive. Tyco Electronics welcomes our customers' input for additional application ideas for PolySwitch resettable devices.

*Refer to the SiBar product section on page 37 for more information.

Table S1 Product Series: Size, Current Rating, Voltage Rating/Maximum Resistance for Surface-mount Devices

	picoSMD	nanoSMD	microSMD	miniSMD	midSMD	SMD	SMD2	miniSMDE	decaSMD
Size mm (mils)	2012 (0805)	3216 (1206)	3225 (1210)	4532 (1812)	5050 (2018)	7555 (2920)	8763 (3425)	11550 (4420)	5050 (2018)
Hold Current (A)	-	-	-	-	-	-	-	-	-
0.050	-	-	30V _{DC} /50Ω	-	-	-	-	-	-
0.100	-	-	30V _{DC} /15Ω	-	-	-	-	-	-
0.120	-	48V _{DC} /6.50Ω	-	-	-	-	-	-	-
0.140	-	-	-	60V _{DC} /6.00Ω	-	-	-	-	-
0.160	-	48V _{DC} /5.00Ω	-	-	-	-	-	-	-
0.200	-	24V _{DC} /3.30Ω	-	30V _{DC} /3.30Ω	-	-	-	-	-
0.300	-	-	-	-	60V _{DC} /2.30Ω	60V _{DC} /4.80Ω	-	-	-
0.350	6V _{DC} /1.40Ω	16V _{DC} /1.50Ω	6V _{DC} /1.30Ω	-	-	-	-	-	-
0.500	-	13.2V _{DC} /0.80Ω	13.2V _{DC} /0.90Ω	24V _{DC} /1.00Ω	-	60V _{DC} /1.40Ω	-	-	60V _{DC} /1.10Ω
0.750	-	6V _{DC} /0.40Ω	6V _{DC} /0.40Ω	13.2V _{DC} /0.45Ω	-	30V _{DC} /1.00Ω	-	-	-
	-	-	-	24V _{DC} /0.29Ω	-	60V _{DC} /1.00Ω	-	-	-
1.000	-	6V _{DC} /1.50Ω	-	-	15V _{DC} /0.40Ω	30V _{DC} /0.48Ω	-	-	-
	-	-	-	-	-	33V _{DC} /0.41Ω	-	-	-
1.100	-	6V _{DC} /0.20Ω	6V _{DC} /0.21Ω	8V _{DC} /0.21Ω	-	-	-	-	-
	-	-	-	16V _{DC} /0.18Ω	-	-	-	-	-
	-	-	-	24V _{DC} /0.18Ω	-	-	-	-	-
1.200	-	-	-	-	-	16V _{DC} /0.34Ω	-	-	-
1.250	-	-	-	6V _{DC} /0.14Ω	-	15V _{DC} /0.25Ω	-	-	-
	-	-	-	16V _{DC} /0.14Ω	-	-	-	-	-
1.500	-	6V _{DC} /0.11Ω	6V _{DC} /0.11Ω	6V _{DC} /0.11Ω	15V _{DC} /0.18Ω	-	15V _{DC} /0.25Ω	-	-
	-	-	-	12V _{DC} /0.11Ω	-	-	33V _{DC} /0.23Ω	-	-
	-	-	-	24V _{DC} /0.12Ω	-	-	-	-	-
1.600	-	-	-	9V _{DC} /0.10Ω	-	-	16V _{DC} /0.15Ω	-	-
1.750	-	-	6V _{DC} /0.08Ω	-	-	-	-	-	-
1.850	-	-	-	-	-	-	33V _{DC} /0.165Ω	-	-
1.900	-	-	-	-	-	-	-	16V _{DC} /0.08Ω	-
2.000	-	6V _{DC} /0.07Ω*	6V _{DC} /0.06Ω	8V _{DC} /0.07Ω	6V _{DC} /0.10Ω	-	15V _{DC} /0.125Ω	-	-
2.500	-	-	-	-	-	-	15V _{DC} /0.85Ω	-	-
2.600	-	-	-	6V _{DC} /0.043Ω	-	6V _{DC} /0.075Ω	-	-	-
	-	-	-	12V _{DC} /0.047Ω	-	-	-	-	-
	-	-	-	13.2V _{DC} /0.50Ω	-	-	-	-	-
	-	-	-	16V _{DC} /0.05Ω	-	-	-	-	-
3.000	-	-	-	-	-	6V _{DC} /0.048Ω	-	-	-

Table S2 Thermal Derating for Surface-mount Devices [Hold Current (A) at Ambient Temperature (°C)]

		Maximum Ambient Temperature											
Part Number		-40°C	-20°C	0°C	20°C	25°C	40°C	50°C	60°C	70°C	80°C	85°C	125°C
 picoSMD Series													
Size 2012 mm/0805 mils													
 picoSMD035F		0.58	0.51	0.44	0.35	0.32	0.31	0.28	0.24	0.21	0.18	0.16	-
 nanoSMD Series													
Size 3216 mm/1206 mils													
nanoSMD012F		0.20	0.17	0.15	0.13	0.12	0.11	0.10	0.09	0.08	0.07	0.07	-
nanoSMD016F		0.21	0.20	0.18	0.16	0.16	0.14	0.13	0.12	0.11	0.10	0.09	-
nanoSMD020F		0.34	0.30	0.26	0.22	0.20	0.17	0.15	0.13	0.11	0.09	0.08	-
nanoSMD035F		0.58	0.51	0.44	0.38	0.35	0.31	0.28	0.24	0.21	0.18	0.16	-
nanoSMD050F/13.2		0.78	0.69	0.61	0.52	0.50	0.44	0.39	0.35	0.30	0.25	0.24	-
nanoSMD075F		1.15	1.04	0.92	0.78	0.75	0.69	0.63	0.58	0.51	0.46	0.43	-
nanoSMD110F		1.64	1.46	1.30	1.10	1.06	0.92	0.83	0.80	0.65	0.56	0.52	-
nanoSMD150F		2.20	1.99	1.77	1.55	1.50	1.34	1.23	1.10	1.01	0.90	0.84	-
 nanoSMD200F*		3.56	3.08	2.60	2.12	2.00	1.79	1.64	1.50	1.36	1.21	1.14	-

* Data is preliminary

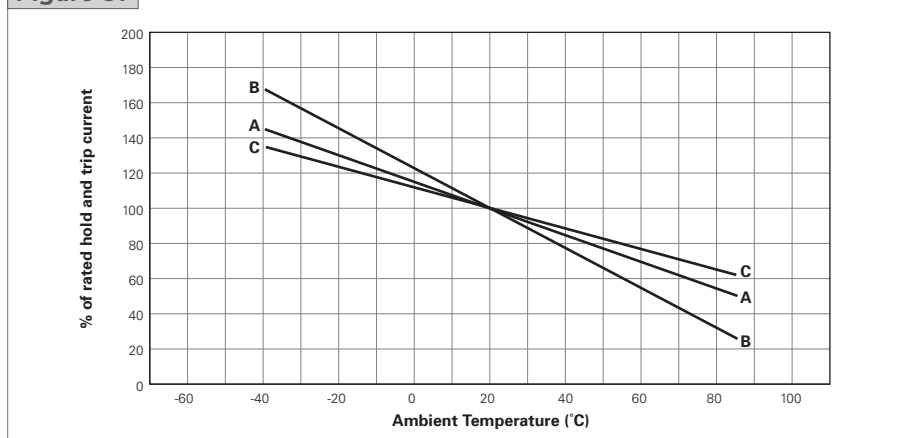
Table S2 Thermal Derating for Surface-mount Devices
[Hold Current (A) at Ambient Temperature (°C)]

... Cont'd

Part Number	Maximum Ambient Temperature											
	-40°C	-20°C	0°C	20°C	25°C	40°C	50°C	60°C	70°C	80°C	85°C	125°C
microSMD Series Size 3225 mm/1210 mils												
microSMD005F	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.02	0.02	-
microSMD010F	0.15	0.13	0.12	0.10	0.10	0.09	0.08	0.06	0.06	0.05	0.05	-
microSMD035F	0.51	0.46	0.40	0.35	0.34	0.30	0.27	0.24	0.22	0.19	0.18	-
microSMD050F	0.76	0.66	0.58	0.50	0.48	0.42	0.38	0.35	0.29	0.25	0.23	-
microSMD075F	1.10	0.97	0.86	0.75	0.72	0.64	0.58	0.55	0.47	0.42	0.39	-
microSMD110F	1.60	1.42	1.26	1.10	1.06	0.94	0.86	0.80	0.70	0.62	0.58	-
microSMD150F	2.30	2.02	1.76	1.50	1.43	1.24	1.11	1.00	0.85	0.72	0.65	-
microSMD175F	2.80	2.45	2.10	1.75	1.70	1.55	1.45	1.35	1.25	1.15	1.10	-
NEW microSMD200F	2.60	2.44	2.35	2.00	1.96	1.78	1.67	1.50	1.45	1.15	1.10	-
miniSMDC Series Size 4532 mm/1812 mils												
miniSMDC014F	0.23	0.20	0.17	0.14	0.13	0.11	0.10	0.09	0.07	0.06	0.05	-
miniSMDC020F	0.30	0.27	0.23	0.20	0.19	0.17	0.15	0.13	0.12	0.10	0.09	-
miniSMDC050F	0.59	0.57	0.55	0.50	0.48	0.45	0.43	0.35	0.30	0.25	0.23	-
miniSMDC075F	1.10	0.99	0.87	0.75	0.72	0.63	0.57	0.49	0.45	0.39	0.35	-
miniSMDC075F/24	1.50	1.25	1.00	0.75	0.73	0.65	0.60	0.55	0.50	0.45	0.43	-
miniSMDC110F	1.60	1.45	1.28	1.10	1.07	0.92	0.83	0.71	0.66	0.57	0.52	-
miniSMDC110F/16	1.68	1.49	1.30	1.10	1.05	0.92	0.83	0.75	0.64	0.55	0.50	-
miniSMDC110F/24	2.00	1.70	1.40	1.10	1.06	0.95	0.88	0.80	0.73	0.65	0.61	-
miniSMDC125F	2.00	1.69	1.47	1.25	1.17	1.03	0.92	0.90	0.69	0.58	0.53	-
miniSMDC125F/16	2.00	1.69	1.47	1.25	1.17	1.03	0.92	0.90	0.69	0.58	0.53	-
miniSMDC150F	2.30	2.05	1.77	1.50	1.44	1.23	1.09	0.95	0.82	0.68	0.61	-
miniSMDC150F/12	2.40	2.10	1.80	1.50	1.44	1.25	1.13	1.00	0.88	0.75	0.69	-
miniSMDC150F/24	2.10	1.90	1.70	1.50	1.44	1.25	1.13	1.00	0.88	0.75	0.69	-
miniSMDC160F	2.50	2.19	1.89	1.60	1.53	1.31	1.16	1.10	0.95	0.79	0.71	-
miniSMDC200F	2.60	2.44	2.22	2.00	1.96	1.78	1.67	1.50	1.45	1.34	1.29	-
miniSMDC260F	3.40	3.16	2.80	2.60	2.54	2.32	2.18	2.00	1.90	1.76	1.69	-
miniSMDC260F/12	3.40	3.16	3.00	2.60	2.54	2.32	2.18	2.00	1.90	1.76	1.69	-
miniSMDC260F/13.2	3.40	3.16	3.00	2.60	2.54	2.32	2.18	2.00	1.90	1.76	1.69	-
NEW miniSMDC260F/16	3.50	3.20	3.00	2.60	2.53	2.30	2.15	2.00	1.85	1.70	1.63	-
miniSMDE Series Size 11550 mm/4420 mils												
miniSMDE190F	3.16	2.74	2.20	1.90	1.74	1.48	1.27	1.10	0.80	0.50	0.35	-
midSMD Series Size 5050 mm/2018 mils												
SMD030F-2018	0.48	0.42	0.35	0.30	0.28	0.24	0.21	0.17	0.15	0.12	0.10	-
decaSMDC050F/60	1.00	0.85	0.70	0.55	0.53	0.45	0.40	0.35	0.30	0.25	0.23	-
SMD100F-2018	1.59	1.43	1.20	1.10	1.03	0.94	0.85	0.72	0.69	0.61	0.57	-
SMD150F-2018	2.21	1.97	1.70	1.50	1.43	1.26	1.15	1.00	0.91	0.79	0.73	-
SMD200F-2018	2.81	2.54	2.27	2.00	1.93	1.73	1.59	1.46	1.32	1.19	1.12	-
SMD Series Size 7555 mm/2920 mils												
SMD030F	0.44	0.39	0.32	0.30	0.28	0.26	0.23	0.19	0.18	0.17	0.15	-
SMD050F	0.73	0.65	0.55	0.50	0.47	0.43	0.39	0.33	0.31	0.28	0.26	-
SMD075F	1.11	0.99	0.84	0.75	0.71	0.63	0.57	0.49	0.45	0.39	0.36	-
SMD075F/60	1.11	0.99	0.84	0.75	0.71	0.63	0.57	0.49	0.45	0.39	0.36	-
SMD100F	1.59	1.43	1.20	1.10	1.03	0.94	0.85	0.72	0.69	0.61	0.57	-
SMD100F/33	1.48	1.35	1.20	1.10	1.06	0.98	0.91	0.83	0.79	0.73	0.69	-
SMDH120	2.34	1.96	1.58	1.20	1.15	1.02	0.92	0.83	0.74	0.65	0.60	0.26
SMD125F	1.89	1.68	1.50	1.25	1.21	1.04	0.93	0.85	0.71	0.61	0.55	-
SMD260F	3.82	3.41	2.90	2.60	2.45	2.19	1.99	1.70	1.58	1.38	1.28	-
SMD300F	4.13	3.75	3.30	3.00	2.87	2.62	2.43	2.25	2.00	1.87	1.78	-
SMD2 Series Size 8763 mm/3425 mils												
SMD150F	2.30	2.04	1.80	1.50	1.45	1.23	1.10	0.99	0.83	0.70	0.63	-
SMD150F/33	2.30	2.04	1.80	1.50	1.45	1.23	1.10	0.99	0.83	0.70	0.63	-
SMDH160	2.14	1.96	1.78	1.60	1.56	1.42	1.33	1.24	1.15	1.06	1.02	0.44
SMD185F	2.54	2.29	2.20	1.85	1.80	1.55	1.43	1.31	1.19	1.06	1.00	-
SMD200F	3.01	2.67	2.30	2.00	1.90	1.66	1.50	1.30	1.16	0.99	0.91	-
SMD250F	3.72	3.31	2.80	2.50	2.35	2.09	1.89	1.60	1.48	1.28	1.18	-

Figure S1 Thermal Derating Curve for Surface-mount Devices

- A =** picoSMD / nanoSMD /
microSMD / miniSMD /
decaSMD and SMD
- B =** miniSMDE190F
- C =** SMDH120 and SMDH160

Figure S1

Table S3 Electrical Characteristics for Surface-mount Devices at Room Temperature

	Part Number	I _H (A)	I _T (A)	V _{DC} ^{Max} (V)	I _{Max} (A)	P _D Max (W)	Max. Time-to-Trip (A) (S)		R _{Min} (Ω)	R ₁ Max (Ω)	Figure for Dimensions
	picoSMD Series										
	Size 2012 mm/0805 mils										
NEW	picoSMD035F	0.35	0.75	6	20	0.60	3.50	0.10	0.42	1.40	S6
	nanoSMDC Series										
	Size 3216 mm/1206 mils										
	nanoSMDC012F	0.12	0.39	48	10	0.50	1.00	0.20	1.40	6.50	S2
	nanoSMDC016F	0.16	0.45	48	10	0.50	1.00	0.30	1.10	5.00	S2
	nanoSMDC020F	0.20	0.42	24	100	0.60	8.00	0.10	0.65	3.30	S2
	nanoSMDC035F	0.35	0.75	16	20	0.60	3.50	0.10	0.45	1.40	S2
	nanoSMDC050F/13.2	0.50	1.10	13.2	100	0.80	8.00	0.10	0.20	0.80	S2
	nanoSMDC075F	0.75	1.50	6	100	0.80	8.00	0.10	0.12	0.40	S2
	nanoSMDC110F	1.10	2.20	6	100	0.80	8.00	0.10	0.07	0.20	S2
	nanoSMDC150F	1.50	3.00	6	100	0.80	8.00	0.30	0.04	0.11	S2
coming soon	nanoSMDC200F*	2.00	4.00	6	100	1.00	8.00	TBD	0.02	0.07	S2
	microSMD Series										
	Size 3225 mm/1210 mils										
	microSMD005F	0.05	0.15	30	10	1.00	0.25	1.50	3.60	50.00	S3
	microSMD010F	0.10	0.25	30	10	0.80	0.50	1.00	2.10	15.00	S2
	microSMD035F	0.35	0.75	6	40	0.80	8.00	0.20	0.32	1.30	S2
	microSMD050F	0.50	1.00	13.2	40	0.80	8.00	0.05	0.25	0.90	S2
	microSMD075F	0.75	1.50	6	40	0.80	8.00	0.10	0.11	0.40	S2
	microSMD110F	1.10	2.20	6	40	0.80	8.00	0.20	0.07	0.21	S2
	microSMD150F	1.50	3.00	6	40	0.80	8.00	1.00	0.04	0.11	S2
	microSMD175F	1.75	3.50	6	40	0.80	8.00	0.80	0.025	0.08	S2
NEW	microSMD200F	2.00	4.00	6	100	0.80	8.00	2.50	0.020	0.06	S2
	miniSMDC Series										
	Size 4532 mm/1812 mils										
	miniSMDC014F	0.14	0.28	60	10	0.75	8.00	0.008	1.50	6.00	S2
	miniSMDC020F	0.20	0.40	30	10	0.80	8.00	0.02	0.60	3.30	S2
	miniSMDC050F	0.50	1.00	24	100	0.80	8.00	0.15	0.15	1.00	S2
	miniSMDC075F	0.75	1.50	13.2	100	1.00	8.00	0.20	0.11	0.45	S2
	miniSMDC075F/24	0.75	1.50	24	40	0.80	8.00	0.30	0.09	0.29	S2
	miniSMDC110F	1.10	2.20	8	100	1.20	8.00	0.30	0.04	0.21	S2
	miniSMDC110F/16	1.10	2.20	16	100	0.80	8.00	0.30	0.06	0.18	S2
	miniSMDC110F/24	1.10	2.20	24	20	0.80	8.00	0.50	0.06	0.18	S2
	miniSMDC125F	1.25	2.50	6	100	0.80	8.00	0.40	0.05	0.14	S2
	miniSMDC125F/16	1.25	2.50	16	100	0.80	8.00	0.40	0.05	0.14	S2
	miniSMDC150F	1.50	3.00	6	100	0.80	8.00	0.50	0.04	0.11	S2
	miniSMDC150F/12	1.50	2.80	12	100	0.80	8.00	0.50	0.04	0.11	S2
	miniSMDC150F/24	1.50	3.00	24	20	1.00	8.00	1.50	0.04	0.12	S2
	miniSMDC160F	1.60	3.20	9	100	0.80	8.00	1.00	0.03	0.10	S2
	miniSMDC200F	2.00	4.00	8	100	1.00	8.00	5.00	0.02	0.07	S2
	miniSMDC260F	2.60	5.00	6	100	1.00	8.00	7.00	0.015	0.043	S2

* Data is preliminary

Table S3 Electrical Characteristics for Surface-mount Devices at Room Temperature

... Cont'd

	Part Number	I _H (A)	I _T (A)	V _{Max} (V _{DC})	I _{Max} (A)	P _{D Max} (W)	Max. Time-to-Trip (A) (S)		R _{Min} (Ω)	R _{1 Max} (Ω)	Figure for Dimensions	
	miniSMDC Series Size 4532 mm/1812 mils											
	miniSMDC260F/12	2.60	5.00	12	100	1.00	8.00	5.00	0.015	0.047	S2	
	miniSMDC260F/13.2	2.60	5.00	13.2	100	1.20	8.00	5.00	0.015	0.050	S2	
	miniSMDC260F/16	2.60	5.00	16	100	1.20	8.00	5.00	0.015	0.050	S2	
NEW												
	miniSMDE Series Size 11550 mm/4420 mils											
	miniSMDE190F	1.90	3.80	16	100	1.50	10.00	2.00	0.024	0.08	S2	
	midSMD Series Size 5050 mm/2018 mils											
	SMD030F-2018	0.30	0.80	60	20	0.90	1.50	1.50	0.50	2.30	S4	
	decaSMD050F/60	0.55	1.10	60	10	1.00	8.00	0.10	0.40	1.10	S2	
	SMD100F-2018	1.10	2.20	15	40	1.40	8.00	0.50	0.10	0.40	S4	
	SMD150F-2018	1.50	3.00	15	40	1.80	8.00	1.00	0.07	0.18	S4	
	SMD200F-2018	2.00	4.20	6	40	1.50	8.00	3.00	0.048	0.10	S4	
	SMD Series Size 7555 mm/2920 mils											
	SMD030F	0.30	0.60	60	10	1.70	1.50	3.00	1.20	4.80	S5	
	SMD050F	0.50	1.00	60	10	1.70	2.50	4.00	0.35	1.40	S5	
	SMD075F	0.75	1.50	30	40	1.70	8.00	0.30	0.35	1.00	S5	
	SMD075F/60	0.75	1.50	60	10	1.70	8.00	0.30	0.35	1.00	S5	
	SMD100F	1.10	2.20	30	40	1.70	8.00	0.50	0.12	0.48	S5	
	SMD100F/33	1.10	2.20	33	40	1.70	8.00	0.50	0.12	0.41	S5	
	SMDH120	1.20	2.30	16	50	2.00	8.00	2.00	0.15	0.34	S5	
	SMD125F	1.25	2.50	15	40	1.70	8.00	2.00	0.07	0.25	S5	
	SMD260F	2.60	5.20	6	40	1.70	8.00	20.00	0.025	0.075	S5	
	SMD300F	3.00	6.00	6	40	1.50	8.00	35.00	0.015	0.048	S5	
		SMD2 Devices Size 8763 mm/3425 mils										
		SMD150F	1.50	3.00	15	40	1.90	8.00	5.00	0.06	0.25	S5
		SMD150F/33	1.50	3.00	33	40	1.90	8.00	5.00	0.08	0.23	S5
SMDH160		1.60	3.20	16	70	2.20	8.00	15.00	0.05	0.15	S5	
SMD185F		1.85	3.60	33	40	1.50	8.00	5.00	0.065	0.165	S5	
SMD200F		2.00	4.00	15	40	1.90	8.00	12.00	0.05	0.125	S5	
SMD250F		2.50	5.00	15	40	1.90	8.00	25.00	0.035	0.085	S5	

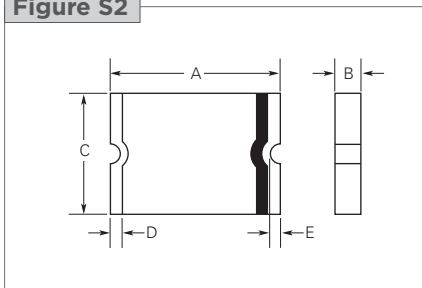
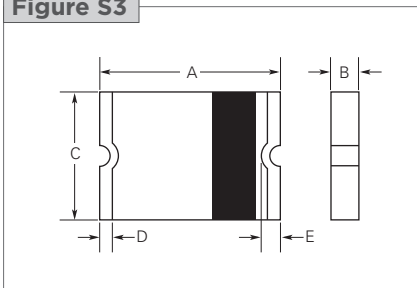
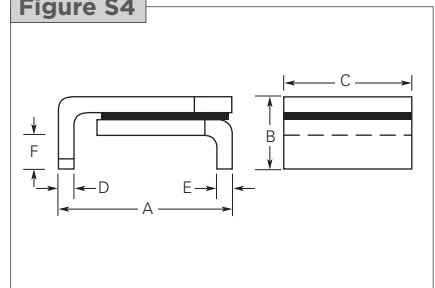
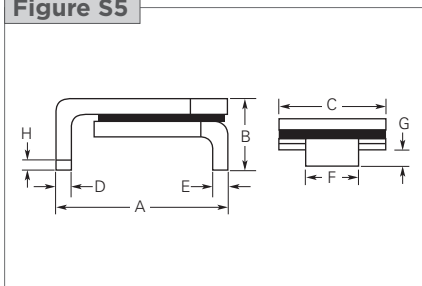
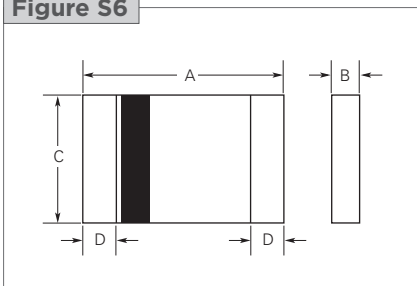
Figure S2-S6 Dimension Figures for Surface-mount Devices
Figure S2

Figure S3

Figure S4

Figure S5

Figure S6


Table S4 Dimensions for Surface-mount Devices in Millimeters (Inches)

	Part Number	A		B		C		D		E		F		G		H		Figure
		min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	
	picoSMD Series																	
	Size 2012 mm/0805 mils																	
	picoSMD035F	1.80	2.21	0.38	0.81	1.17	1.45	0.15	0.60	-	-	-	-	-	-	-	-	S6
		(0.071)	(0.087)	(0.015)	(0.032)	(0.046)	(0.057)	(0.006)	(0.024)	-	-	-	-	-	-	-	-	
	nanoSMDC Series																	
	Size 3216 mm/1206 mils																	
	nanoSMDC012F	3.00	3.40	0.62	1.00	1.37	1.80	0.25	0.75	0.076	-	-	-	-	-	-	-	S2
		(0.118)	(0.134)	(0.024)	(0.039)	(0.054)	(0.071)	(0.010)	(0.030)	(0.003)	-	-	-	-	-	-	-	
	nanoSMDC016F	3.00	3.40	0.62	1.00	1.37	1.80	0.25	0.75	0.076	-	-	-	-	-	-	-	S2
		(0.118)	(0.134)	(0.024)	(0.039)	(0.054)	(0.071)	(0.010)	(0.030)	(0.003)	-	-	-	-	-	-	-	
	nanoSMDC020F	3.00	3.40	0.38	0.64	1.37	1.80	0.25	0.75	0.076	-	-	-	-	-	-	-	S2
		(0.118)	(0.134)	(0.015)	(0.025)	(0.054)	(0.071)	(0.010)	(0.030)	(0.003)	-	-	-	-	-	-	-	
	nanoSMDC035F	3.00	3.40	0.38	0.64	1.37	1.80	0.25	0.75	0.076	-	-	-	-	-	-	-	S2
		(0.118)	(0.134)	(0.015)	(0.025)	(0.054)	(0.071)	(0.010)	(0.030)	(0.003)	-	-	-	-	-	-	-	
	nanoSMDC050F/13.2	3.00	3.40	0.38	0.64	1.37	1.80	0.25	0.75	0.076	-	-	-	-	-	-	-	S2
		(0.118)	(0.134)	(0.015)	(0.025)	(0.054)	(0.071)	(0.010)	(0.030)	(0.003)	-	-	-	-	-	-	-	
	nanoSMDC075F	3.00	3.40	0.28	0.48	1.37	1.80	0.25	0.75	0.076	-	-	-	-	-	-	-	S2
		(0.118)	(0.134)	(0.011)	(0.019)	(0.054)	(0.071)	(0.010)	(0.030)	(0.003)	-	-	-	-	-	-	-	
	nanoSMDC110F	3.00	3.40	0.28	0.67	1.37	1.80	0.25	0.75	0.076	-	-	-	-	-	-	-	S2
		(0.118)	(0.134)	(0.011)	(0.026)	(0.054)	(0.071)	(0.010)	(0.030)	(0.003)	-	-	-	-	-	-	-	
	nanoSMDC150F	3.00	3.40	0.55	0.89	1.37	1.80	0.25	0.75	0.076	-	-	-	-	-	-	-	S2
		(0.118)	(0.134)	(0.022)	(0.035)	(0.054)	(0.071)	(0.010)	(0.030)	(0.003)	-	-	-	-	-	-	-	
	nanoSMDC200F*	3.00	3.40	0.68	1.25	1.37	1.80	0.25	0.75	0.076	-	-	-	-	-	-	-	S2
		(0.118)	(0.134)	(0.027)	(0.049)	(0.054)	(0.071)	(0.010)	(0.030)	(0.003)	-	-	-	-	-	-	-	
	microSMD Series																	
	Size 3225 mm/1210 mils																	
	microSMD005F	3.0	3.43	0.50	0.85	2.35	2.80	0.25	0.75	0.076	-	-	-	-	-	-	-	S3
		(0.118)	(0.135)	(0.019)	(0.034)	(0.092)	(0.110)	(0.010)	(0.030)	(0.003)	-	-	-	-	-	-	-	
	microSMD010F	3.0	3.43	0.50	0.85	2.35	2.80	0.25	0.75	0.076	-	-	-	-	-	-	-	S2
		(0.118)	(0.135)	(0.019)	(0.034)	(0.092)	(0.110)	(0.010)	(0.030)	(0.003)	-	-	-	-	-	-	-	
	microSMD035F	3.0	3.43	0.38	0.62	2.35	2.80	0.25	0.75	0.076	-	-	-	-	-	-	-	S2
		(0.118)	(0.135)	(0.015)	(0.025)	(0.092)	(0.110)	(0.010)	(0.030)	(0.003)	-	-	-	-	-	-	-	
	microSMD050F	3.0	3.43	0.38	0.62	2.35	2.80	0.25	0.75	0.076	-	-	-	-	-	-	-	S2
		(0.118)	(0.135)	(0.015)	(0.025)	(0.092)	(0.110)	(0.010)	(0.030)	(0.003)	-	-	-	-	-	-	-	
	microSMD075F	3.0	3.43	0.38	0.62	2.35	2.80	0.25	0.75	0.076	-	-	-	-	-	-	-	S2
		(0.118)	(0.135)	(0.015)	(0.025)	(0.092)	(0.110)	(0.010)	(0.030)	(0.003)	-	-	-	-	-	-	-	
	microSMD110F	3.0	3.43	0.28	0.48	2.35	2.80	0.25	0.75	0.076	-	-	-	-	-	-	-	S2
		(0.118)	(0.135)	(0.011)	(0.019)	(0.092)	(0.110)	(0.010)	(0.030)	(0.003)	-	-	-	-	-	-	-	
	microSMD150F	3.0	3.43	0.51	1.22	2.35	2.80	0.25	0.75	0.076	-	-	-	-	-	-	-	S2
		(0.118)	(0.135)	(0.020)	(0.048)	(0.092)	(0.110)	(0.010)	(0.030)	(0.003)	-	-	-	-	-	-	-	
	microSMD175F	3.0	3.43	0.40	0.76	2.35	2.80	0.25	0.75	0.076	-	-	-	-	-	-	-	S2
		(0.118)	(0.135)	(0.016)	(0.030)	(0.092)	(0.110)	(0.010)	(0.030)	(0.003)	-	-	-	-	-	-	-	
	microSMD200F	3.0	3.43	0.79	1.17	2.35	2.80	0.25	0.75	0.076	-	-	-	-	-	-	-	S2
		(0.118)	(0.135)	(0.031)	(0.046)	(0.092)	(0.110)	(0.010)	(0.030)	(0.003)	-	-	-	-	-	-	-	
	miniSMDC Series																	
	Size 4532 mm/1812 mils																	
	miniSMDC014F	4.37	4.73	0.635	0.89	3.07	3.41	0.25	0.95	0.20	-	-	-	-	-	-	-	S2
		(0.172)	(0.186)	(0.025)	(0.035)	(0.121)	(0.134)	(0.010)	(0.040)	(0.008)	-	-	-	-	-	-	-	
	miniSMDC020F	4.37	4.73	0.635	0.89	3.07	3.41	0.25	0.95	0.20	-	-	-	-	-	-	-	S2
		(0.172)	(0.186)	(0.025)	(0.035)	(0.121)	(0.134)	(0.010)	(0.040)	(0.008)	-	-	-	-	-	-	-	
	miniSMDC050F	4.37	4.73	0.38	0.62	3.07	3.41	0.25	0.95	0.20	-	-	-	-	-	-	-	S2
		(0.172)	(0.186)	(0.015)	(0.025)	(0.121)	(0.134)	(0.010)	(0.040)	(0.008)	-	-	-	-	-	-	-	
	miniSMDC075F	4.37	4.73	0.38	0.62	3.07	3.41	0.25	0.95	0.20	-	-	-	-	-	-	-	S2
		(0.172)	(0.186)	(0.015)	(0.025)	(0.121)	(0.134)	(0.010)	(0.040)	(0.008)	-	-	-	-	-	-	-	
	miniSMDC075F/24	4.37	4.83	0.81	1.46	3.07	3.41	0.25	0.95	0.20	-	-	-	-	-	-	-	S2
		(0.172)	(0.190)	(0.032)	(0.057)	(0.121)	(0.134)	(0.010)	(0.040)	(0.008)	-	-	-	-	-	-	-	
	miniSMDC110F	4.37	4.73	0.38	0.62	3.07	3.41	0.25	0.95	0.20	-	-	-	-	-	-	-	S2
		(0.172)	(0.186)	(0.015)	(0.025)	(0.121)	(0.134)	(0.010)	(0.040)	(0.008)	-	-	-	-	-	-	-	
	miniSMDC110F/16	4.37	4.83	0.28	0.48	3.07	3.41	0.25	0.95	0.20	-	-	-	-	-	-	-	S2
		(0.172)	(0.190)	(0.011)	(0.019)	(0.121)	(0.134)	(0.010)	(0.040)	(0.008)	-	-	-	-	-	-	-	
	miniSMDC110F/24	4.37	4.83	0.81	1.46	3.07	3.41	0.25	0.95	0.20	-	-	-	-	-	-	-	S2
		(0.172)	(0.190)	(0.032)	(0.057)	(0.121)	(0.134)	(0.010)	(0.040)	(0.008)	-	-	-	-	-	-	-	
	miniSMDC125F	4.37	4.73	0.28	0.48	3.07	3.41	0.25	0.95	0.20	-	-	-	-	-	-	-	S2
		(0.172)	(0.186)	(0.011)	(0.019)	(0.121)	(0.134)	(0.010)	(0.040)	(0.008)	-	-	-	-	-	-	-	
	miniSMDC125F/16	4.37	4.83	0.28	0.48	3.07	3.41	0.25	0.95	0.20	-	-	-	-	-	-	-	S2
		(0.172)	(0.190)	(0.011)	(0.019)	(0.121)	(0.134)	(0.010)	(0.040)	(0.008)	-	-	-	-	-	-	-	
	miniSMDC150F	4.37	4.73	0.28	0.48	3.07	3.41	0.25	0.95	0.20	-	-	-	-	-	-	-	S2
		(0.172)	(0.186)	(0.011)	(0.019)	(0.121)	(0.134)	(0.010)	(0.040)	(0.008)	-	-	-	-	-	-	-	
	miniSMDC150F/12	4.37	4.83	0.28	0.48	3.07	3.41	0.25	0.95	0.20	-	-	-	-	-	-	-	S2
		(0.172)	(0.190)	(0.011)	(0.019)	(0.121)	(0.134)	(0.010)	(0.040)	(0.008)	-	-	-	-	-	-	-	

* Data is preliminary

Table S4 Dimensions for Surface-mount Devices in Millimeters (Inches)

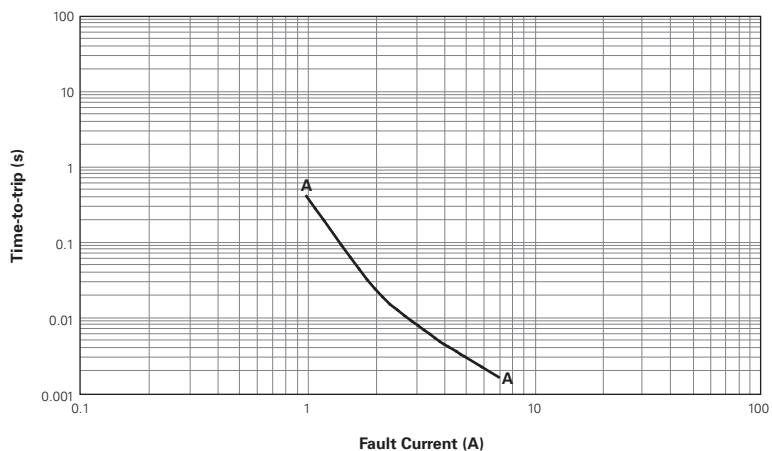
... Cont'd

	Part Number	A		B		C		D		E		F		G		H		Figure
		min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	
	miniSMDC Series Size 4532 mm/1812 mils																	
	miniSMDC150F/24	4.37 (0.172)	4.83 (0.190)	1.00 (0.040)	1.94 (0.077)	3.07 (0.121)	3.41 (0.134)	0.25 (0.010)	0.95 (0.040)	0.20 (0.008)	-	-	-	-	-	-	S2	
	miniSMDC160F	4.37 (0.172)	4.73 (0.186)	0.28 (0.011)	0.48 (0.019)	3.07 (0.121)	3.41 (0.134)	0.25 (0.010)	0.95 (0.040)	0.20 (0.008)	-	-	-	-	-	-	S2	
	miniSMDC200F	4.37 (0.172)	4.73 (0.186)	0.51 (0.020)	1.22 (0.048)	3.07 (0.121)	3.41 (0.134)	0.25 (0.010)	0.95 (0.040)	0.20 (0.008)	-	-	-	-	-	-	S2	
	miniSMDC260F	4.37 (0.172)	4.73 (0.186)	0.48 (0.019)	0.78 (0.031)	3.07 (0.121)	3.41 (0.134)	0.25 (0.010)	0.95 (0.040)	0.20 (0.008)	-	-	-	-	-	-	S2	
	miniSMDC260F/12	4.37 (0.172)	4.83 (0.190)	0.76 (0.030)	1.25 (0.050)	3.07 (0.121)	3.41 (0.134)	0.25 (0.010)	0.95 (0.040)	0.20 (0.008)	-	-	-	-	-	-	S2	
	miniSMDC260F/13.2	4.37 (0.172)	4.83 (0.190)	1.02 (0.042)	1.52 (0.060)	3.07 (0.121)	3.41 (0.134)	0.25 (0.010)	0.95 (0.040)	0.20 (0.008)	-	-	-	-	-	-	S2	
	miniSMDC260F/16	4.37 (0.172)	4.83 (0.190)	1.02 (0.042)	1.52 (0.060)	3.07 (0.121)	3.41 (0.134)	0.25 (0.010)	0.95 (0.040)	0.20 (0.008)	-	-	-	-	-	-	S2	
	miniSMDE Series Size 11550 mm/4420 mils																	
	miniSMDE190F	11.15 (0.439)	11.51 (0.453)	0.33 (0.013)	0.53 (0.021)	4.83 (0.190)	5.33 (0.210)	0.51 (0.020)	1.02 (0.040)	0.381 (0.015)	-	-	-	-	-	-	S2 -	
	midSMD Series Size 5050 mm/2018 mils																	
	SMD030F-2018	4.72 (0.186)	5.44 (0.214)	-	1.78 (0.070)	4.22 (0.166)	4.93 (0.194)	0.25 (0.010)	0.36 (0.014)	0.25 (0.010)	0.36 (0.014)	0.30 (0.012)	0.46 (0.018)	-	-	-	S4 -	
	decaSMDC050F/60	4.70 (0.185)	5.31 (0.209)	0.63 (0.025)	0.89 (0.035)	4.19 (0.165)	4.81 (0.189)	0.25 (0.010)	0.95 (0.040)	0.25 (0.010)	-	-	-	-	-	-	S2 -	
	SMD100F-2018	4.72 (0.186)	5.44 (0.214)	-	1.52 (0.060)	4.22 (0.166)	4.93 (0.194)	0.25 (0.010)	0.36 (0.014)	0.25 (0.010)	0.36 (0.014)	0.30 (0.012)	0.46 (0.018)	-	-	-	S4 -	
	SMD150F-2018	4.72 (0.186)	5.44 (0.214)	-	1.52 (0.060)	4.22 (0.166)	4.93 (0.194)	0.25 (0.010)	0.36 (0.014)	0.25 (0.010)	0.36 (0.014)	0.30 (0.012)	0.46 (0.018)	-	-	-	S4 -	
	SMD200F-2018	4.72 (0.186)	5.44 (0.214)	-	1.52 (0.060)	4.22 (0.166)	4.93 (0.194)	0.25 (0.010)	0.36 (0.014)	0.25 (0.010)	0.36 (0.014)	0.30 (0.012)	0.46 (0.018)	-	-	-	S4 -	
	SMD Series Size 7555 mm/2920 mils																	
	SMD030F	6.73 (0.265)	7.98 (0.314)	-	3.18 (0.125)	4.80 (0.19)	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)	S5 -	
	SMD050F	6.73 (0.265)	7.98 (0.314)	-	3.18 (0.125)	4.80 (0.19)	5.44 (0.214)	0.56 (0.022)	0.71 (0.028)	0.20 (0.008)	0.30 (0.012)	2.16 (0.085)	2.41 (0.095)	0.66 (0.026)	1.37 (0.054)	0.43 (0.017)	S5 -	
	SMD075F	6.73 (0.265)	7.98 (0.314)	-	3.18 (0.125)	4.80 (0.19)	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)	S5 -	
	SMD075F/60	6.73 (0.265)	7.98 (0.314)	-	3.18 (0.125)	4.80 (0.19)	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)	S5 -	
	SMD100F	6.73 (0.265)	7.98 (0.314)	-	3.00 (0.118)	4.80 (0.19)	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)	S5 -	
	SMD100F/33	6.73 (0.265)	7.98 (0.314)	-	3.00 (0.118)	4.80 (0.19)	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)	S5 -	
	SMDH120	6.73 (0.265)	7.98 (0.314)	-	3.00 (0.118)	4.80 (0.19)	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)	S5 -	
	SMD125F	6.73 (0.265)	7.98 (0.314)	-	3.00 (0.118)	4.80 (0.19)	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)	S5 -	
	SMD260F	6.73 (0.265)	7.98 (0.314)	-	3.00 (0.118)	4.80 (0.19)	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)	S5 -	
	SMD300F	6.73 (0.265)	7.98 (0.314)	-	3.00 (0.118)	4.80 (0.19)	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)	S5 -	
	SMD2 Devices Size 8763 mm/3425 mils																	
	SMD150F	8.00 (0.315)	9.40 (0.370)	-	3.00 (0.118)	6.00 (0.236)	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)	S5 -	
	SMD150F/33	8.00 (0.315)	9.40 (0.370)	-	3.00 (0.118)	6.00 (0.236)	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)	S5 -	
	SMDH160	8.00 (0.315)	9.40 (0.370)	-	3.00 (0.118)	6.00 (0.236)	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)	S5 -	
	SMD185F	8.00 (0.315)	9.40 (0.370)	-	3.00 (0.118)	6.00 (0.236)	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)	S5 -	
	SMD200F	8.00 (0.315)	9.40 (0.370)	-	3.00 (0.118)	6.00 (0.236)	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)	S5 -	
	SMD250F	8.00 (0.315)	9.40 (0.370)	-	3.00 (0.118)	6.00 (0.236)	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)	S5 -	

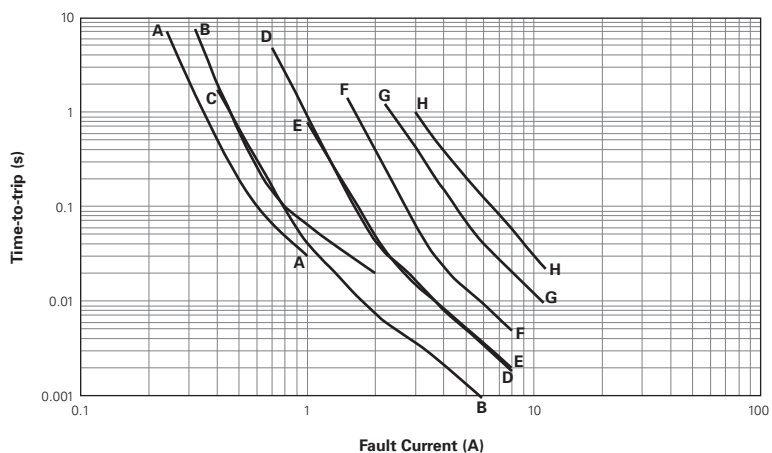
Figure S7-S13 Typical Time-to-trip Curves at 20 °C for Surface-mount Devices

picoSMDxxxF

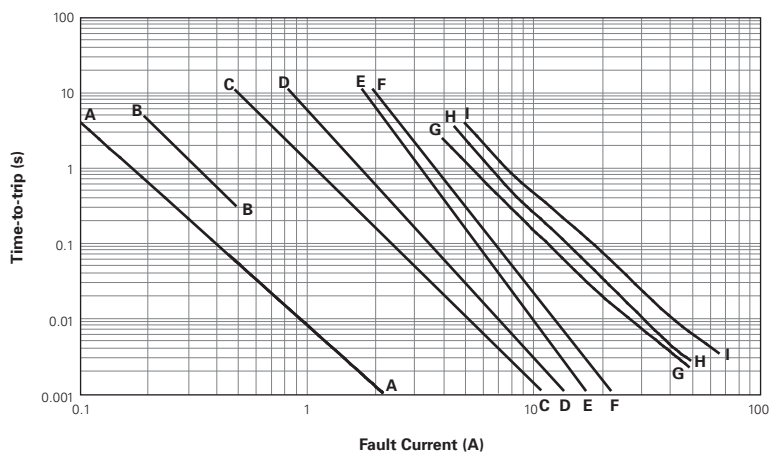
A = picoSMD035F

Figure S7

nanoSMDCxxxF

A = nanoSMDC012F
B = nanoSMDC016F
C = nanoSMDC020F
D = nanoSMDC035F
E = nanoSMDC050F/13.2
F = nanoSMDC075F
G = nanoSMDC110F
H = nanoSMDC150F

Figure S8

microSMDxxxF

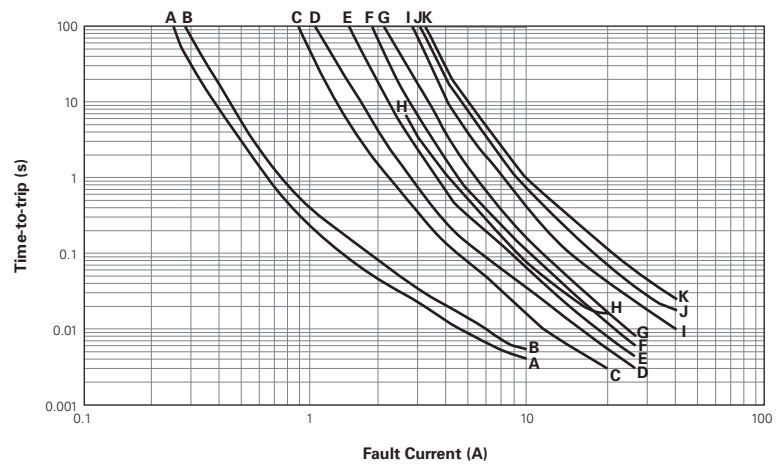
A = microSMD005F
B = microSMD010F
C = microSMD035F
D = microSMD050F
E = microSMD075F
F = microSMD110F
G = microSMD150F
H = microSMD175F
I = microSMD200F

Figure S9


miniSMDCxxxF and miniSMDExxxF

- A = miniSMDC014F
- B = miniSMDC020F
- C = miniSMDC050F
- D = miniSMDC075F, miniSMDC075F/24
- E = miniSMDC110F, miniSMDC110F/16, miniSMDC110F/24
- F = miniSMDC125F, miniSMDC125F/16
- G = miniSMDC150F, miniSMDC150F/12, miniSMDC150F/24
- H = miniSMDC160F
- I = miniSMDC200F
- J = miniSMDE190F
- K = miniSMDC260F, miniSMDC260F/12, miniSMDC260F/13.2, miniSMDC260F/16

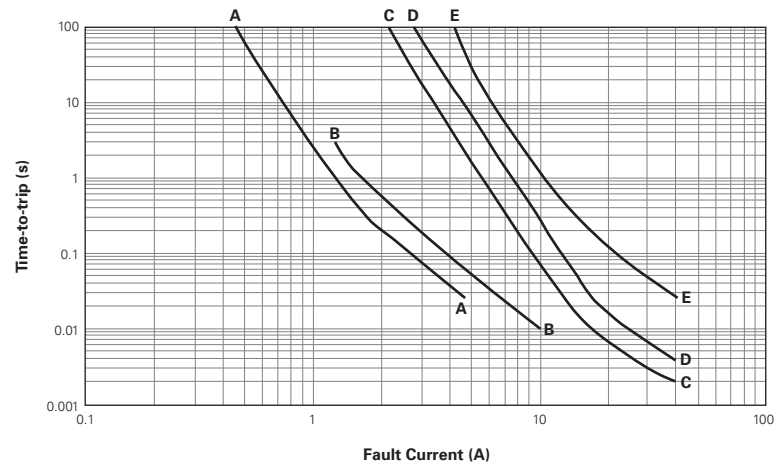
Figure S10



midSMD

- A = SMD030F-2018
- B = decaSMD050F/60
- C = SMD100F-2018
- D = SMD150F-2018
- E = SMD200F-2018

Figure S11



SMDxxxF

- A = SMD030F
- B = SMD050F
- C = SMD075F, SMD075F/60
- D = SMDH120
- E = SMD100F, SMD100F/33
- F = SMD125F
- G = SMD260F
- H = SMD300F

Figure S12

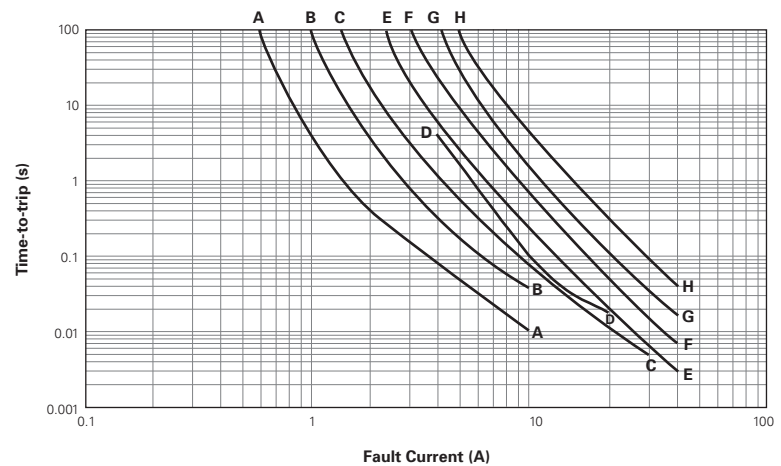
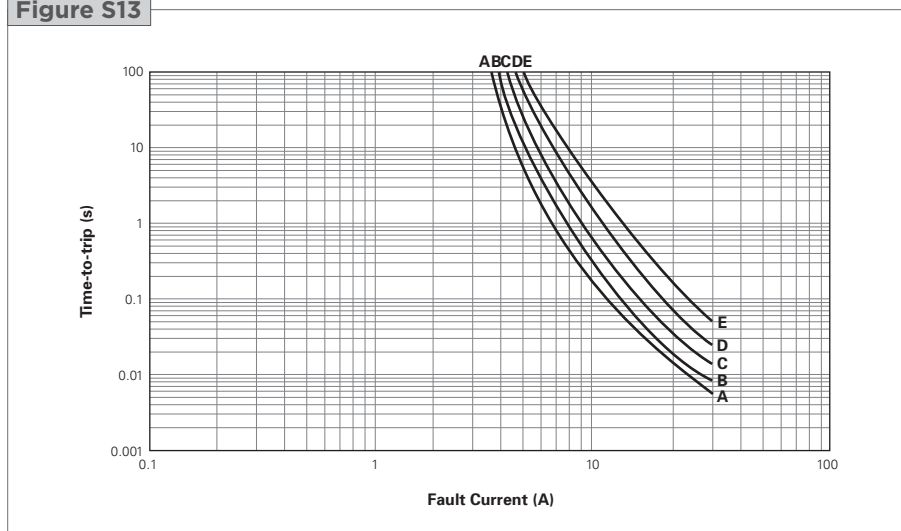


Figure S7-S13 Typical Time-to-trip Curves at 20 °C for Surface-mount Devices

... Cont'd

SMD2xxxF

- A = SMD150F, SMD150F/33
- B = SMDH160
- C = SMD185F
- D = SMD200F
- E = SMD250F

Figure S13

Table S5 Physical Characteristics and Environmental Specifications for Surface-mount Devices
 Operating temperature range -40°C to 85°C, -40°C to 125°C for SMDH120 and SMDH160

Physical Characteristics

Terminal pad material	100% matte tin with nickel underplate; gold with nickel underplate for picoSMD
Soldering characteristics	ANSI/J-STD-002 Category 3 for picoSMD, nanoSMD, microSMD and miniSMD series ANSI/J-STD-002 Category 1 for SMD series
Solder heat withstand	per IEC-STD 68-2-20, Test Tb, Section 5, Method 1A
Flammability resistance	per IEC 695-2-2 Needle Flame Test for 20 sec.
Recommended storage conditions	40°C max, 70% R.H. max; devices may not meet specified ratings if storage conditions are exceeded.
Moisture sensitivity	Level 2a, per IPC/JEDEC J-STD 020C

Environmental Specifications

Test	Test Method	Conditions	Resistance Change
Storage Life	Raychem PS300, Section 5.3.2	60°C, 1000 hours	±3% typical
		85°C, 1000 hours	±5% typical
Humidity aging	Raychem PS300, Section 5.3.1	85°C, 85% RH, 100 hours	±1.2% typical
Thermal shock	MIL-STD-202, Method 107G	85°C, -40°C (20 times)	-33% typical
		125°C, -55°C (10 times)	-33% typical
Vibration	MIL-STD-883C	per MIL-STD-883C	No change
Solvent resistance	Raychem PS300, Section 5.2.2	Freon	No change
		Trichloroethane	No change
		Hydrocarbons	No change

Table S6 Packaging and Marking Information for Surface-mount Devices

... Cont'd

Recommended Pad Layout Figures [mm(In.)]								
Part Number	Tape & Reel Quantity	Standard Package	Part Marking	Dimension A (Nom.)	Dimension B (Nom.)	Dimension C (Nom.)	Agency Recognition	
 picoSMD Series Size 2012 mm/0805 mils								
NEW	picoSMD035F	4,000	20,000	TBD	1.50 (0.060)	1.17(0.046)	1.00(0.040)	UL, CSA, TÜV
 nanoSMDC Series Size 3216 mm/1206 mils								
	nanoSMDC012F	3,000	15,000	P	1.60 (0.063)	1.00 (0.039)	2.00 (0.079)	UL, CSA
	nanoSMDC016F	3,000	15,000	N	1.60 (0.063)	1.00 (0.039)	2.00 (0.079)	UL, CSA, TÜV
	nanoSMDC020F	3,000	15,000	02	1.60 (0.063)	1.00 (0.039)	2.00 (0.079)	UL, CSA, TÜV
	nanoSMDC035F	3,000	15,000	03	1.60 (0.063)	1.00 (0.039)	2.00 (0.079)	UL, CSA, TÜV
	nanoSMDC050F/13.2	3,000	15,000	M	1.60 (0.063)	1.00 (0.039)	2.00 (0.079)	UL, CSA, TÜV
	nanoSMDC075F	3,000	15,000	L	1.60 (0.063)	1.00 (0.039)	2.00 (0.079)	UL, CSA, TÜV
	nanoSMDC110F	3,000	15,000	K	1.60 (0.063)	1.00 (0.039)	2.00 (0.079)	UL, CSA, TÜV
	nanoSMDC150F	3,000	15,000	15	1.60 (0.063)	1.00 (0.039)	2.00 (0.079)	UL, CSA, TÜV
coming soon	nanoSMDC200F*	TBD	TBD	TBD	1.60 (0.063)	1.00 (0.039)	2.00 (0.079)	Pending
 microSMD Series Size 3225 mm/1210 mils								
	microSMD005F	4,000	20,000	05	2.50 (0.098)	1.00 (0.039)	2.00 (0.079)	UL, CSA, TÜV
	microSMD010F	4,000	20,000	10	2.50 (0.098)	1.00 (0.039)	2.00 (0.079)	UL, CSA, TÜV
	microSMD035F	4,000	20,000	3	2.50 (0.098)	1.00 (0.039)	2.00 (0.079)	UL, CSA, TÜV
	microSMD050F	4,000	20,000	50	2.50 (0.098)	1.00 (0.039)	2.00 (0.079)	UL, CSA, TÜV
	microSMD075F	4,000	20,000	75	2.50 (0.098)	1.00 (0.039)	2.00 (0.079)	UL, CSA, TÜV
	microSMD110F	4,000	20,000	11	2.50 (0.098)	1.00 (0.039)	2.00 (0.079)	UL, CSA, TÜV
	microSMD150F	4,000	20,000	15	2.50 (0.098)	1.00 (0.039)	2.00 (0.079)	UL, CSA, TÜV
	microSMD175F	4,000	20,000	17	2.50 (0.098)	1.00 (0.039)	2.00 (0.079)	UL, CSA, TÜV
NEW	microSMD200F	3,000	15,000	20	2.50 (0.098)	1.00 (0.039)	2.00 (0.079)	UL, CSA, TÜV
 miniSMDC Series Size 4532 mm/1812 mils								
	miniSMDC014F	2,000	10,000	14	2.95 (0.114)	1.68 (0.066)	3.10 (0.122)	UL, CSA, TÜV
	miniSMDC020F	2,000	10,000	2	2.95 (0.114)	1.68 (0.066)	3.10 (0.122)	UL, CSA, TÜV
	miniSMDC050F	2,000	10,000	5	2.95 (0.114)	1.68 (0.066)	3.10 (0.122)	UL, CSA, TÜV
	miniSMDC075F	2,000	10,000	7	2.95 (0.114)	1.68 (0.066)	3.10 (0.122)	UL, CSA, TÜV
	miniSMDC075F/24	1,500	7,500	075F 24V	2.95 (0.114)	1.68 (0.066)	3.10 (0.122)	UL, CSA, TÜV
	miniSMDC110F	2,000	10,000	1	2.95 (0.114)	1.68 (0.066)	3.10 (0.122)	UL, CSA, TÜV
	miniSMDC110F/16	2,000	10,000	110F 16V	2.95 (0.114)	1.68 (0.066)	3.10 (0.122)	UL, CSA, TÜV
	miniSMDC110F/24	1,500	7,500	110F 24V	2.95 (0.114)	1.68 (0.066)	3.10 (0.122)	UL, CSA, TÜV
	miniSMDC125F	2,000	10,000	12	2.95 (0.114)	1.68 (0.066)	3.10 (0.122)	UL, CSA, TÜV
	miniSMDC125F/16	2,000	10,000	125F 16V	2.95 (0.114)	1.68 (0.066)	3.10 (0.122)	UL, CSA, TÜV
	miniSMDC150F	2,000	10,000	15	2.95 (0.114)	1.68 (0.066)	3.10 (0.122)	UL, CSA, TÜV
	miniSMDC150F/12	2,000	10,000	150F 12V	2.95 (0.114)	1.68 (0.066)	3.10 (0.122)	UL, CSA, TÜV
	miniSMDC150F/24	1,000	5,000	150F 24V	2.95 (0.114)	1.68 (0.066)	3.10 (0.122)	UL, CSA, TÜV
	miniSMDC160F	2,000	10,000	16	2.95 (0.114)	1.68 (0.066)	3.10 (0.122)	UL, CSA, TÜV
	miniSMDC200F	2,000	10,000	20	2.95 (0.114)	1.68 (0.066)	3.10 (0.122)	UL, CSA, TÜV
	miniSMDC260F	2,000	10,000	260F	2.95 (0.114)	1.68 (0.066)	3.10 (0.122)	UL, CSA, TÜV
	miniSMDC260F/12	1,500	7,500	260F 12V	2.95 (0.114)	1.68 (0.066)	3.10 (0.122)	UL, CSA, TÜV
	miniSMDC260F/13.2	1,500	7,500	260F 13.2	2.95 (0.114)	1.68 (0.066)	3.10 (0.122)	UL, CSA, TÜV
NEW	miniSMDC260F/16	1,500	7,500	260F 16V	2.95 (0.114)	1.68 (0.066)	3.10 (0.122)	UL, CSA, TÜV
 miniSMDE Series Size 11550 mm/4420 mils								
	miniSMDE190F	5,000	20,000	19	4.75 (0.187)	1.45 (0.057)	9.57 (0.377)	UL, CSA, TÜV
 midSMD Series Size 5050 mm/2018 mils								
	SMD030F-2018	4,000	20,000	A03F	4.60 (0.18)	1.50 (0.059)	3.40 (0.134)	UL, CSA, TÜV
	decaSMDC050F/60	1,000	5,000	050F 60V	4.32 (0.17)	1.40 (0.055)	3.61 (0.142)	UL, CSA, TÜV
	SMD100F-2018	4,000	20,000	A10F	4.60 (0.18)	1.50 (0.059)	3.40 (0.134)	UL, CSA, TÜV
	SMD150F-2018	4,000	20,000	A15F	4.60 (0.18)	1.50 (0.059)	3.40 (0.134)	UL, CSA, TÜV
	SMD200F-2018	4,000	20,000	A20F	4.60 (0.18)	1.50 (0.059)	3.40 (0.134)	UL, CSA, TÜV

* Data is preliminary

Table S6 Packaging and Marking Information for Surface-mount Devices

... Cont'd

Part Number	Tape & Reel Quantity	Standard Package	Part Marking	Recommended Pad Layout Figures [mm(In.)]			Agency Recognition
				Dimension A (Nom.)	Dimension B (Nom.)	Dimension C (Nom.)	
 SMD Series Size 7555 mm/2920 mils							
SMD030F	2,000	10,000	030F	3.10 (0.12)	2.30 (0.09)	5.10 (0.201)	UL, CSA, TÜV
SMD050F	2,000	10,000	050F	3.10 (0.12)	2.30 (0.09)	5.10 (0.201)	UL, CSA, TÜV
SMD075F	2,000	10,000	075F	3.10 (0.12)	2.30 (0.09)	5.10 (0.201)	UL, CSA, TÜV
SMD075F/60	2,000	10,000	756F	3.10 (0.12)	2.30 (0.09)	5.10 (0.201)	UL, CSA, TÜV
SMD100F	2,000	10,000	100F	3.10 (0.12)	2.30 (0.09)	5.10 (0.201)	UL, CSA, TÜV
SMD100F/33	2,000	10,000	103F	3.10 (0.12)	2.30 (0.09)	5.10 (0.201)	UL, CSA, TÜV
SMDH120	2,000	10,000	H12	3.10 (0.12)	2.30 (0.09)	5.10 (0.201)	UL, CSA
SMD125F	2,000	10,000	125F	3.10 (0.12)	2.30 (0.09)	5.10 (0.201)	UL, CSA, TÜV
SMD260F	2,000	10,000	260F	3.10 (0.12)	2.30 (0.09)	5.10 (0.201)	UL, CSA, TÜV
SMD300F	2,000	10,000	300F	3.10 (0.12)	2.30 (0.09)	5.10 (0.201)	UL, CSA, TÜV
 SMD2 Devices Size 8763 mm/3425 mils							
SMD150F	1,500	7,500	150F	4.60 (0.18)	2.30 (0.09)	6.10 (0.240)	UL, CSA, TÜV
SMD150F/33	1,500	7,500	153F	4.60 (0.18)	2.30 (0.09)	6.10 (0.240)	UL, CSA, TÜV
SMDH160	1,500	7,500	160F	4.60 (0.18)	2.30 (0.09)	6.10 (0.240)	UL, CSA
SMD185F	1,500	7,500	185F	4.60 (0.18)	2.30 (0.09)	6.10 (0.240)	UL, CSA, TÜV
SMD200F	1,500	7,500	200F	4.60 (0.18)	2.30 (0.09)	6.10 (0.240)	UL, CSA, TÜV
SMD250F	1,500	7,500	250F	4.60 (0.18)	2.30 (0.09)	6.10 (0.240)	UL, CSA, TÜV

Figure S14 Recommended Pad Layout for Surface-mount Devices**Agency Recognition for Surface-mount Devices**

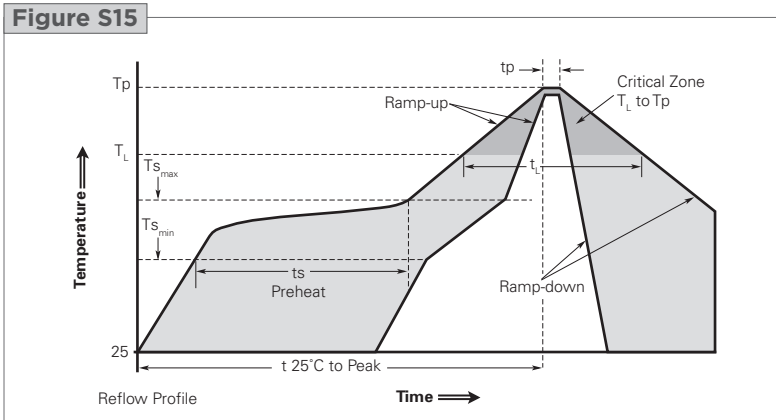
UL	File # E74889 for all surface-mount devices
CSA	File # CA78165 for all surface-mount devices
TÜV	Certificate # R72072068 for picoSMD series
	Certificate # R72041439 for nanoSMD series
	Certificate # R72041438 for microSMD and miniSMD series
	Certificate # R72041867 for decaSMD series
	Certificate # R72041427 for SMD series
	Certificate # R72072048 for SMDH series

Solder Reflow and Rework Recommendation for Surface-mount Devices

Classification Reflow Profiles

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Average Ramp-Up Rate ($T_{s_{max}}$ to T_p)	3°C/second max.	3°C/second max.
Preheat		
• Temperature Min ($T_{s_{min}}$)	100°C	150°C
• Temperature Max ($T_{s_{max}}$)	150°C	200°C
• Time ($t_{s_{min}}$ to $t_{s_{max}}$)	60-120 seconds	60-180 seconds
Time maintained above:		
• Temperature (T_L)	183°C	217°C
• Time (t_L)	60-150 seconds	60-150 seconds
Peak/Classification Temperature (T_p)	260°C	260°C
Time within 5°C of actual Peak		
Temperature (t_p)	10-30 seconds	20-40 seconds
Ramp-Down Rate	6°C/second max.	6°C/second max.
Time 25°C to Peak Temperature	6 minutes max.	8 minutes max.

Note: All temperatures refer to topside of the package, measured on the package body surface.



Solder Reflow

- Recommended reflow methods:
 - IR
 - Hot air
 - Nitrogen
- Recommended maximum paste thickness:
 - picoSMD, nanoSMD, microSMD and miniSMD series: 0.25mm (0.010 inch)
 - SMD series: 0.38mm (0.015 inch)
- Devices can be cleaned using standard methods and aqueous solvents.
- We believe the optimum conditions for forming acceptable solder fillets occur when a reasonable amount of solder paste is placed underneath each device's via. As such, we request that customers comply with our recommended solder pad layouts.
- We request that customer board layouts refrain from placing raised features (e.g. vias, nomenclature, traces, etc.) underneath PolySwitch devices. It is possible that raised features could negatively impact solderability performance of our devices.

Rework

- picoSMD, nanoSMD, microSMD and miniSMD series: standard industry practices. Please also avoid direct contact to the device.
- SMD series: rework should be confined to removal of the installed product and replacement with a fresh device.

Table S7 Tape and Reel Specifications for Surface-mount Devices (in Millimeters)

Description	picoSMD EIA 481-1	nanoSMD EIA 481-1	microSMD EIA 481-1	miniSMD EIA 481-1	miniSMDE190 EIA 481-2	midSMD EIA 481-2	SMD EIA 481-2	SMD2 EIA 481-2
W	8.0 ± 0.30	8.0 ± 0.30	8.0 ± 0.30	12.0 ± 0.30	24.0 ± 0.30	16.0 ± 0.30	16.0 ± 0.30	16.0 ± 0.30
P ₀	4.0 ± 0.10	4.0 ± 0.10	4.0 ± 0.10	4.0 ± 0.10	4.0 ± 0.10	4.0 ± 0.10	4.0 ± 0.10	4.0 ± 0.10
P ₁	4.0 ± 0.10	4.0 ± 0.10	4.0 ± 0.10	8.0 ± 0.10	8.0 ± 0.10	8.0 ± 0.10	8.0 ± 0.10	12.0 ± 0.10
P ₂	2.0 ± 0.05	2.0 ± 0.05	2.0 ± 0.05	2.0 ± 0.05	2.0 ± 0.10	2.0 ± 0.10	2.0 ± 0.10	2.0 ± 0.10
A ₀	Table S8	1.95 ± 0.10	2.9 ± 0.10	Table S8	5.70 ± 0.10	5.11 ± 0.15	5.6 ± 0.23	6.9 ± 0.23
B ₀	Table S8	3.50 ± 0.10	3.50 ± 0.10	Table S8	11.90 ± 0.10	5.6 ± 0.23	8.1 ± 0.15	9.6 ± 0.15
B ₁ max.	4.35	4.35	4.35	8.2	20.1	12.1	12.1	12.1
D ₀	1.55 ± .05	1.55 ± .05	1.55 ± .05	1.5 + 0.10/- .00	1.55 ± .05	1.5 + 0.10/- .00	1.5 + 0.10/- .00	1.5 + 0.10/- .00
F	3.50 ± 0.05	3.50 ± 0.05	3.50 ± 0.05	5.50 ± 0.05	11.50 ± 0.10	7.50 ± 0.10	7.50 ± 0.10	7.50 ± 0.10
E ₁	1.75 ± 0.10	1.75 ± 0.10	1.75 ± 0.10	1.75 ± 0.10	1.75 ± 0.10	1.75 ± 0.10	1.75 ± 0.10	1.75 ± 0.10
E ₂ min.	6.25	6.25	6.25	10.25	22.25	14.25	14.25	14.25
T max.	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
T ₁ max.	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
K ₀	Table S8	0.89 ± 0.10	Table S8	Table S8	0.95 ± 0.10	1.8 ± 0.15	3.2 ± 0.15	3.4 ± 0.15
Leader min.	390	390	390	390	400	400	400	400
Trailer min.	160	160	160	160	160	160	160	160

Table S8 Tape and Reel Specifications for Surface-mount Devices (in Millimeters)

	All nanoSMD series except			All microSMD series except		All miniSMD series and miniSMD200F	miniSMD075F/24 miniSMD110F/24 miniSMD260F/12 miniSMD260F/13.2		
	picoSMD035F	nanoSMD150F	nanoSMD150F	microSMD200F	microSMD200F	miniSMD260F	miniSMD260F/16	miniSMD150F/24	decaSMD050F/60
A ₀	1.70 ± 0.1	1.95 ± 0.1	1.95 ± 0.10	2.9 ± 0.1	2.90 ± 0.1	3.5 ± 0.1	3.7 ± 0.1	3.70 ± 0.1	5.0 ± 0.1
B ₀	2.45 ± 0.1	3.50 +0.1/-0.08	3.53 ± 0.07	3.5 ± 0.1	3.50 ± 0.1	5.1 ± 0.1	4.9 ± 0.1	4.90 ± 0.1	5.4 ± 0.1
K ₀	0.86 ± 0.1	0.89 ± 0.1	0.94 ± 0.05	0.9 ± 0.1	1.27 ± 0.1	0.9 ± 0.1	1.4 ± 0.1	1.78 ± 0.1	1.7 ± 0.1

Table S9 Reel Dimensions for Surface-mount Devices (in Millimeters)

	pico/nano/microSMD	miniSMD	miniSMDE190	midSMD	SMD	SMD2
A max.	185	185	330	330	330	330
N min.	50	50	60	50	50	50
W ₁	8.4 + 1.5/- .00	12.4 + 2.0/- .00	24.4 + 2.0/- .00	16.4 + 2.0/- .00	16.4 + 2.0/- .00	16.4 + 2.0/- .00
W ₂ max.	14.4	18.4	30.4	22.4	22.4	22.4

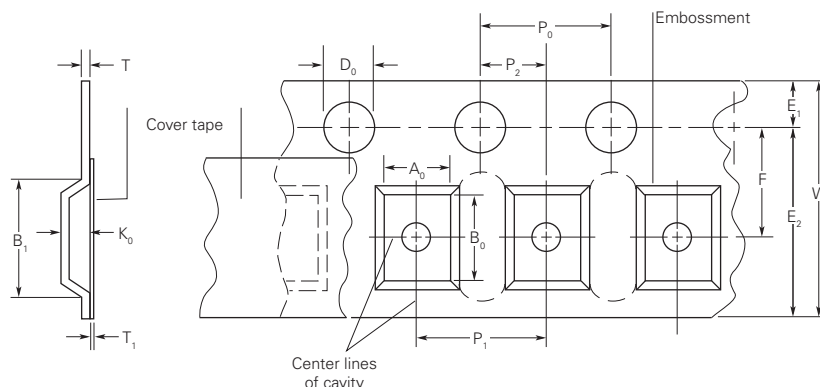
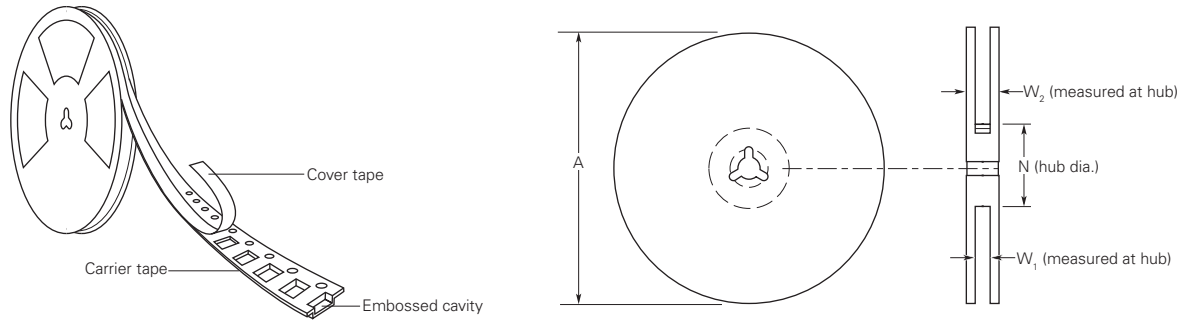
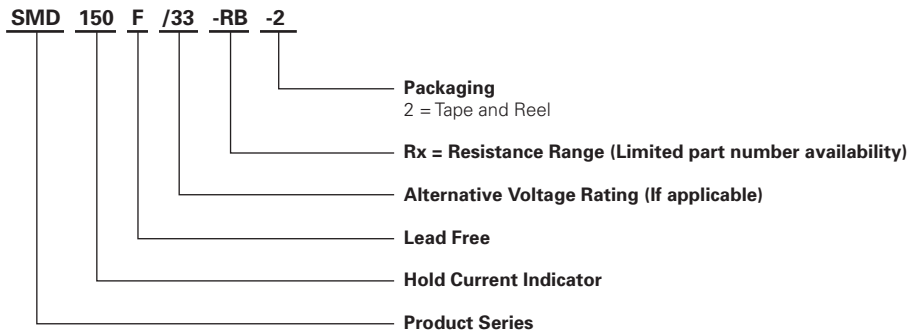
Figure S16 EIA Taped Component Dimensions for Surface-mount Devices


Figure S17 EIA Reel Dimensions for Surface-mount Devices

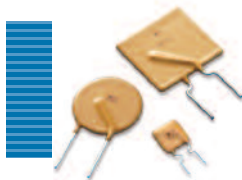


Part Numbering System for Surface-mount Devices



Warning :

- Operation beyond the maximum ratings or improper use may result in device damage and possible electrical arcing and flame.
- The devices are intended for protection against occasional overcurrent or overtemperature fault conditions and should not be used when repeated fault conditions or prolonged trip events are anticipated.
- Contamination of the PPTC material with certain silicon based oils or some aggressive solvents can adversely impact the performance of the devices.
- Device performance can be impacted negatively if devices are handled in a manner inconsistent with recommended electronic, thermal, and mechanical procedures for electronic components.
- Operation in circuit with a large inductance can generate a circuit voltage ($L \, di/dt$) above the rated voltage of the PolySwitch resettable device.

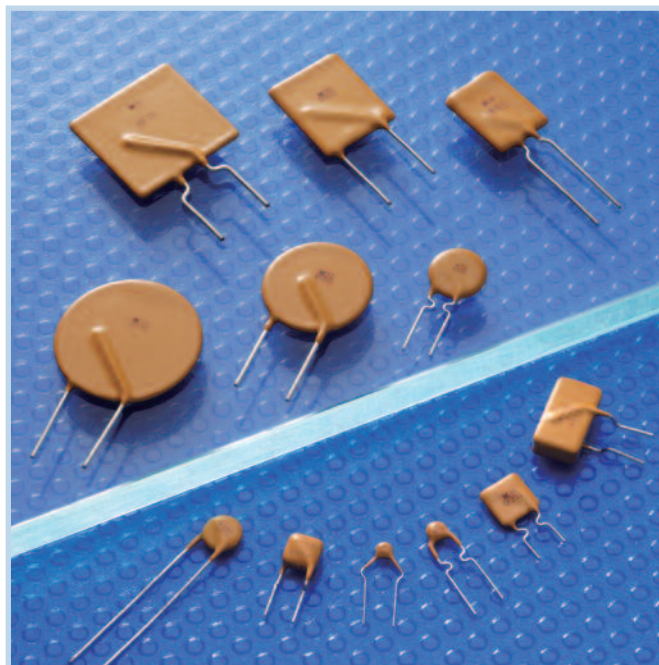


PolySwitch Resettable Devices

Radial-leaded Devices

Our PolySwitch radial-leaded products represent the most comprehensive and complete set of PPTC products available in the industry today.

- AGRF and AHRF series qualified per PS400 derived from AECQ200 for automotive applications
- RGEF series for hold currents up to 14A
- RHEF series for flatter thermal derating and operating temperatures up to 125°C
- RUEF series for balance of voltage rating (30V) and hold current (up to 9A)
- RUSBF series for fast time-to-trip and low-resistance computer applications
- RTEF series for IEEE-1394 applications
- RXEF series for low hold currents (down to 50mA) and high voltage rating (up to 72V)
- LVR/LVRL series for line voltage applications up to a continuous operating voltage of 265V_{AC}/135V_{AC}
- BBRF series for cable telephone applications
- Now offering RoHS versions of all products



Benefits

- Many product choices give engineers more design flexibility
- Compatible with high-volume electronics assembly
- Assists in meeting regulatory requirements
- Higher voltage ratings allow use in new applications

Features

- Broadest range of radial-leaded resettable devices available in the industry
- Current ratings from 50mA to 15A
- Voltage ratings from 6V (computer and electronic applications) to 265V_{AC} line voltage applications
- Agency recognition : UL, CSA, TÜV
- Fast time-to-trip
- Low resistance

Applications

- | | | |
|-----------------------------|----------------------------------|---------------------------------|
| • Satellite video receivers | • USB hub, ports and peripherals | • Phones |
| • Industrial controls | • IEEE1394 ports | • Fax machines |
| • Transformers | • CD-ROMs | • Analog and digital line cards |
| • Computer motherboards | • Game machines | • Printers |
| • Modems | • Battery packs | |

Protection Application Selection Guide for Radial-leaded Devices

The guide below lists PolySwitch devices that are typically used in these applications.

Specifications for the suggested device part numbers can be found in this section.

Once a part number has been selected, the user should evaluate and test each product for its intended application.

PolySwitch Resettable Devices — Key Selection Criteria

Protection Application	Small Size	Flatter Derating	Lower Current Higher Voltage
Electromagnetic loads	RGEF (<16V), RUEF (<30V)	RHEF (<16V)	RXEF (<72V)
Halogen lighting	RGEF (<16V), RUEF (<30V)	RHEF (<16V)	RXEF (<72V)
Lighting ballast	RXEF (<72V), BBRF (<99V)		LVR (<265V _{AC}), LVRL(<135V _{AC})
Loudspeakers	RXEF (<72V)		RXEF (<72V)
Medical equipment	RGEF (<16V), RUEF (<30V)	RHEF (<16V)	RXEF (<72V)
MOSFET devices	RGEF (<16V), RUEF (<30V)	RHEF (<16V)	RXEF (<72V)
Motors, fans and blowers	RXEF (<72V), RGEF (<16V)	RHEF (<16V)	LVR (<265V _{AC}), LVRL(<135V _{AC})
POS equipment	RXEF (<72V), RUEF (<30V)		
Process and industrial controls	RXEF (<72V), RUEF (<30V)		
Satellite video receivers	RGEF (<16V), RUEF (<30V)	RHEF (<16V)	RXEF (<72V)
Security and fire alarm systems	RGEF (<16V), RUEF (<30V)	RHEF (<16V)	RXEF (<72V), LVR (<265V _{AC}), LVRL(<135V _{AC})
Test and measurement equipment	RGEF (<16V), RUEF (<30V)	RHEF (<16V)	RXEF (<72V), LVR (<265V _{AC}), LVRL(<135V _{AC})
Transformers	RGEF (<16V), RUEF (<30V)	RHEF (<16V)	RXEF (<72V), LVR (<265V _{AC}), LVRL(<135V _{AC})
DDC computer and consumer electronics	RUEF (<30V)		
IEEE-1394 computer and consumer electronics	RTEF (<33V)		
Mouse and keyboard	RUEF (<30V)		
SCSI	RUEF (<30V)		
USB	RUSBF (<16V)		
Traces and printed circuit board protection	RGEF (<16V), RUEF (<30V)	RHEF (<16V)	RXEF (<72V)

Note : This list is not exhaustive. Tyco Electronics welcomes customer's input for additional application ideas for PolySwitch resettable devices.

Table R1 Product Series - Current Rating, Voltage Rating / Typical Resistance for Radial-leaded Devices

Voltage Rating	LVR 265V _{AC}	LVRL 135V _{AC}	BBRF 99V	RXEF 72V	RXEF 60V	RTEF 33V	RUEF 30V	RGEF 16V	RHEF 16V	RHEF 30V	RUSBF 16V	RUSBF 6V
Hold Current (A)												
0.050	25.00Ω	—	—	—	9.20Ω	—	—	—	—	—	—	—
0.080	9.800Ω	—	—	—	—	—	—	—	—	—	—	—
0.100	—	—	—	—	3.50Ω	—	—	—	—	—	—	—
0.110	—	—	—	—	—	—	—	—	—	—	—	—
0.120	4.800Ω	—	—	—	—	—	—	—	—	—	—	—
0.145	—	—	—	—	—	—	—	—	—	—	—	—
0.150	—	—	—	—	—	—	—	—	—	—	—	—
0.160	3.400Ω	—	—	—	—	—	—	—	—	—	—	—
0.170	—	—	—	—	4.30Ω	—	—	—	—	—	—	—
0.180	—	—	—	—	—	—	—	—	—	—	—	—
0.200	—	—	—	2.290Ω	—	—	—	—	—	—	—	—
0.250	1.700Ω	—	—	1.600Ω	—	—	—	—	—	—	—	—
0.300	—	—	—	1.110Ω	—	—	—	—	—	—	—	—
0.330	1.000Ω	—	—	—	—	—	—	—	—	—	—	—
0.400	0.800Ω	—	—	0.710Ω	—	—	—	—	—	—	—	—
0.500	—	—	—	0.640Ω	—	—	—	—	—	0.68Ω	—	—
0.550	0.590Ω	—	1.05Ω	—	—	—	—	—	—	—	—	—
0.650	—	—	—	0.400Ω	—	—	—	—	—	—	—	—
0.700	—	—	—	—	—	—	—	—	—	0.42Ω	—	—
0.750	0.400Ω	0.325Ω	0.58Ω	0.325Ω	—	—	—	—	—	—	—	0.140Ω
0.900	—	—	—	0.255Ω	—	—	0.095Ω	—	—	—	0.100Ω	—
1.000	0.276Ω	0.224Ω	—	—	—	—	—	—	—	0.24Ω	—	—
1.100	—	—	—	0.200Ω	—	—	0.075Ω	—	—	—	0.075Ω	—
1.200	—	—	—	—	—	0.097Ω	—	—	—	—	—	0.080Ω

Table R1

Product Series - Current Rating, Voltage Rating / Typical Resistance for Radial-leaded Devices

... Cont'd

Voltage Rating	LVR 265V _{AC}	LVRL 135V _{AC}	BBRF 99V	RXEF 72V	RXEF 60V	RTEF 33V	RUEF 30V	RGEF 16V	RHEF 16V	RHEF 30V	RUSBF 16V	RUSBF 6V
Hold Current (A)												
1.250	0.209Ω	0.148Ω	—	—	—	—	—	—	—	—	—	—
1.350	—	0.138Ω	—	0.155Ω	—	0.080Ω	0.060Ω	—	—	—	0.060Ω	—
1.550	—	—	—	—	—	—	—	—	—	—	—	0.058Ω
1.600	—	—	—	0.115Ω	—	—	0.050Ω	—	—	—	0.050Ω	—
1.850	—	—	—	0.100Ω	—	—	0.045Ω	—	—	—	0.045Ω	—
1.900	—	—	—	—	—	0.054Ω	—	—	—	—	—	—
2.000	0.110Ω	0.431Ω	—	—	—	—	—	—	0.0610Ω	—	—	—
2.500	—	—	—	0.065Ω	—	—	0.030Ω	0.0380Ω	—	—	0.030Ω	—
3.000	—	—	—	0.050Ω	—	—	0.035Ω	0.0514Ω	0.0430Ω	—	—	—
3.750	—	—	—	0.040Ω	—	—	—	—	—	—	—	—
4.000	—	—	—	—	—	—	0.020Ω	0.0300Ω	0.0320Ω	—	—	—
4.500	—	—	—	—	—	—	—	—	0.0290Ω	—	—	—
5.000	—	—	—	—	—	—	0.020Ω	0.0192Ω	—	—	—	—
5.500	—	—	—	—	—	—	—	—	0.0200Ω	—	—	—
6.000	—	—	—	—	—	—	0.013Ω	0.0145Ω	0.0175Ω	—	—	—
6.500	—	—	—	—	—	—	—	—	0.0144Ω	—	—	—
7.000	—	—	—	—	—	—	0.013Ω	0.0105Ω	0.0132Ω	—	—	—
7.500	—	—	—	—	—	—	—	—	0.0120Ω	—	—	—
8.000	—	—	—	—	—	—	0.013Ω	0.0086Ω	0.0110Ω	—	—	—
9.000	—	—	—	—	—	—	0.008Ω	0.0070Ω	0.0100Ω	—	—	—
10.00	—	—	—	—	—	—	—	0.0056Ω	0.0083Ω	—	—	—
11.00	—	—	—	—	—	—	—	0.0050Ω	0.0073Ω	—	—	—
12.00	—	—	—	—	—	—	—	0.0046Ω	—	—	—	—
13.00	—	—	—	—	—	—	—	—	0.0055Ω	—	—	—
14.00	—	—	—	—	—	—	—	0.0040Ω	0.0050Ω	—	—	—
15.00	—	—	—	—	—	—	—	—	0.0050Ω	—	—	—

Table R2

Thermal Derating for Radial-leaded Devices
[Hold Current (A) at Ambient Temperature (°C)]

Part Number	Maximum Ambient Temperature										
	-40°C	-20°C	0°C	20°C	25°C	40°C	50°C	60°C	70°C	85°C	125°C
LVR/LVRL 240V_{AC} / 120V_{AC}											
LVR005	—	0.08	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.02	—
LVR008	—	0.12	0.10	0.08	0.08	0.07	0.06	0.05	0.04	0.03	—
LVR012	—	0.18	0.15	0.12	0.12	0.10	0.09	0.07	0.06	0.04	—
LVR016	—	0.24	0.20	0.16	0.16	0.13	0.11	0.10	0.08	0.05	—
LVR025	—	0.38	0.32	0.25	0.25	0.21	0.18	0.15	0.13	0.09	—
LVR033	—	0.50	0.42	0.33	0.33	0.27	0.23	0.20	0.17	0.11	—
LVR040	—	0.61	0.51	0.40	0.40	0.33	0.28	0.24	0.20	0.14	—
LVR055	—	0.80	0.68	0.55	0.54	0.46	0.40	0.35	0.29	0.22	—
NEW LVR075	—	1.23	0.98	0.75	0.74	0.60	0.56	0.49	0.45	0.41	—
NEW LVR100	—	1.65	1.30	1.00	0.94	0.80	0.75	0.65	0.60	0.55	—
NEW LVR125	—	1.55	1.63	1.25	1.20	1.00	0.94	0.81	0.75	0.69	—
NEW LVR200	—	3.30	2.60	2.00	1.97	1.60	1.50	1.30	1.20	1.10	—
NEW LVRL075	—	1.08	0.93	0.75	0.74	0.64	0.57	0.51	0.44	0.35	—
NEW LVRL100	—	1.40	1.19	1.00	0.94	0.82	0.73	0.65	0.57	0.45	—
NEW LVRL125	—	1.80	1.53	1.25	1.20	1.04	0.94	0.83	0.73	0.60	—
NEW LVRL135	—	2.00	1.65	1.35	1.29	1.12	1.01	0.90	0.78	0.65	—
NEW LVRL200	—	3.05	2.55	2.00	1.97	1.72	1.55	1.39	1.22	0.98	—
BBRF 99V											
BBRF550	0.85	0.75	0.65	0.55	—	0.45	0.40	0.35	0.30	0.22	—
BBRF750	1.15	1.00	0.90	0.75	—	0.61	0.55	0.48	0.41	0.30	—
RXEF 60V											
RXEF005	0.078	0.068	0.06	0.05	0.048	0.04	0.035	0.032	0.027	0.02	—
RXEF010	0.160	0.140	0.11	0.10	0.096	0.08	0.072	0.067	0.050	0.04	—
RXEF017	0.260	0.230	0.21	0.17	0.160	0.14	0.120	0.110	0.090	0.07	—

Table R2 Thermal Derating for Radial-leaded Devices
[Hold Current (A) at Ambient Temperature (°C)]

... Cont'd

Part Number	Maximum Ambient Temperature										
	-40°C	-20°C	0°C	20°C	25°C	40°C	50°C	60°C	70°C	85°C	125°C
RXEF 72V											
RXEF020	0.31	0.27	0.24	0.20	0.19	0.16	0.14	0.13	0.11	0.08	—
RXEF025	0.39	0.34	0.30	0.25	0.24	0.20	0.18	0.16	0.14	0.10	—
RXEF030	0.47	0.41	0.36	0.30	0.29	0.24	0.22	0.20	0.16	0.12	—
RXEF040	0.62	0.54	0.48	0.40	0.38	0.32	0.29	0.25	0.22	0.16	—
RXEF050	0.78	0.68	0.60	0.50	0.48	0.41	0.36	0.32	0.27	0.20	—
RXEF065	1.01	0.88	0.77	0.65	0.62	0.53	0.47	0.41	0.35	0.26	—
RXEF075	1.16	1.02	0.89	0.75	0.72	0.61	0.54	0.47	0.41	0.30	—
RXEF090	1.40	1.22	1.07	0.90	0.86	0.73	0.65	0.57	0.49	0.36	—
RXEF110	1.71	1.50	1.31	1.10	1.06	0.89	0.79	0.69	0.59	0.44	—
RXEF135	2.09	1.84	1.61	1.35	1.30	1.09	0.97	0.85	0.73	0.54	—
RXEF160	2.48	2.18	1.90	1.60	1.54	1.30	1.15	1.01	0.86	0.64	—
RXEF185	2.87	2.52	2.20	1.85	1.78	1.50	1.33	1.17	1.00	0.74	—
RXEF250	3.88	3.40	2.98	2.50	2.40	2.03	1.80	1.58	1.35	1.00	—
RXEF300	4.65	4.08	3.57	3.00	2.88	2.43	2.16	1.89	1.62	1.20	—
RXEF375	5.81	5.10	4.46	3.75	3.60	3.04	2.70	2.36	2.03	1.50	—
RTEF 33V											
RTEF120	1.74	1.56	1.38	1.20	1.16	1.00	0.92	0.82	0.73	0.60	—
RTEF135	1.96	1.76	1.55	1.35	1.31	1.12	1.04	0.92	0.82	0.68	—
RTEF190	2.76	2.47	2.19	1.90	1.84	1.58	1.50	1.29	1.16	0.95	—
RUEF 30V											
RUEF090	1.31	1.17	1.04	0.90	0.87	0.75	0.69	0.61	0.55	0.47	—
RUEF110	1.60	1.43	1.27	1.10	1.07	0.91	0.85	0.75	0.67	0.57	—
RUEF135	1.96	1.76	1.55	1.35	1.31	1.12	1.04	0.92	0.82	0.70	—
RUEF160	2.32	2.08	1.84	1.60	1.55	1.33	1.23	1.09	0.98	0.83	—
RUEF185	2.68	2.41	2.13	1.85	1.79	1.54	1.42	1.26	1.13	0.96	—
RUEF250	3.63	3.25	2.88	2.50	2.43	2.08	1.93	1.70	1.53	1.30	—
RUEF300	4.35	3.90	3.45	3.00	2.91	2.49	2.31	2.04	1.83	1.56	—
RUEF400	5.80	5.20	4.60	4.00	3.88	3.32	3.08	2.72	2.44	2.08	—
RUEF500	7.25	6.50	5.75	5.00	4.85	4.15	3.85	3.40	3.05	2.60	—
RUEF600	8.70	7.80	6.90	6.00	5.82	4.98	4.62	4.08	3.66	3.12	—
RUEF700	10.15	9.10	8.05	7.00	6.79	5.81	5.39	4.76	4.27	3.64	—
RUEF800	11.60	10.40	9.20	8.00	7.76	6.64	6.16	5.44	4.88	4.16	—
RUEF900	13.05	11.70	10.35	9.00	8.73	7.47	6.93	6.12	5.49	4.68	—
RHEF 30V - High Temperature											
RHEF050	0.68	0.62	0.56	0.51	0.50	0.44	0.40	0.36	0.34	0.28	0.12
RHEF070	0.95	0.87	0.79	0.72	0.70	0.62	0.56	0.51	0.47	0.39	0.17
RHEF100	1.36	1.24	1.13	1.03	1.00	0.89	0.80	0.73	0.67	0.56	0.24
RUSBF 16V											
RUSBF090	1.31	1.17	1.04	0.90	0.87	0.75	0.69	0.61	0.55	0.47	—
RUSBF110	1.60	1.43	1.27	1.10	1.07	1.00	0.92	0.75	0.67	0.57	—
RUSBF135	1.96	1.76	1.55	1.35	1.31	1.12	1.04	0.92	0.82	0.70	—
RUSBF160	2.32	2.08	1.84	1.60	1.55	1.33	1.23	1.09	0.98	0.83	—
RUSBF185	2.68	2.41	2.13	1.85	1.79	1.54	1.42	1.26	1.13	0.96	—
RUSBF250	3.63	3.25	2.88	2.50	2.43	2.08	1.93	1.70	1.53	1.30	—
RGEF 16V											
RGEF250	3.7	3.3	3.0	2.6	2.5	2.2	2.0	1.3	1.6	1.2	—
RGEF300	4.4	4.0	3.6	3.1	3.0	2.6	2.4	2.1	1.9	1.4	—
RGEF400	5.9	5.3	4.8	4.1	4.0	3.5	3.2	2.8	2.5	1.9	—
RGEF500	7.3	6.6	6.0	5.2	5.0	4.4	4.0	3.6	3.1	2.4	—
RGEF600	8.8	8.0	7.2	6.2	6.0	5.2	4.8	4.2	3.8	2.8	—
RGEF700	10.3	9.3	8.4	7.3	7.0	6.2	5.6	5.0	4.4	3.3	—
RGEF800	11.7	10.7	9.6	8.3	8.0	6.9	6.4	5.6	5.1	3.7	—
RGEF900	13.2	11.9	10.7	9.4	9.0	7.9	7.2	6.4	5.6	4.2	—
RGEF1000	14.7	13.3	12.0	10.3	10.0	8.7	8.0	7.0	6.3	4.7	—
RGEF1100	16.1	14.6	13.1	11.5	11.0	9.7	8.8	7.8	6.9	5.2	—
RGEF1200	17.6	16.0	14.4	12.4	12.0	10.4	9.6	8.4	7.6	5.6	—
RGEF1400	20.5	18.7	16.8	14.5	14.0	12.1	11.2	9.8	8.9	6.5	—

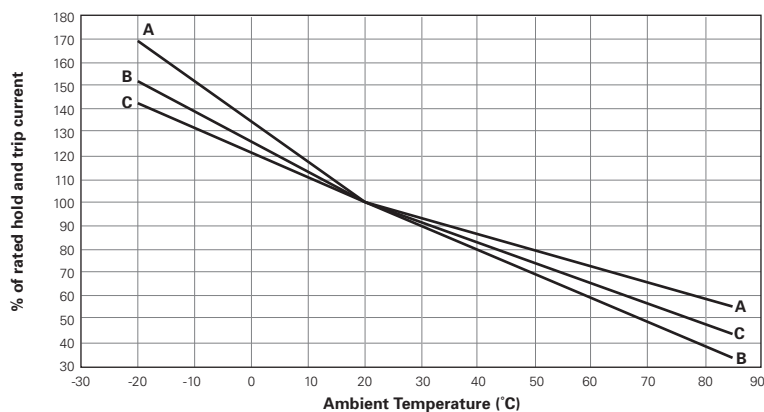
Table R2 Thermal Derating for Radial-leaded Devices
[Hold Current (A) at Ambient Temperature (°C)]

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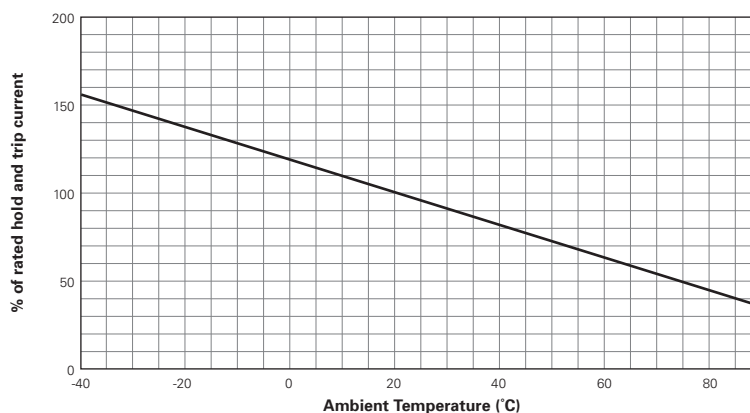
Part Number	Maximum Ambient Temperature										
	-40°C	-20°C	0°C	20°C	25°C	40°C	50°C	60°C	70°C	85°C	125°C
RHEF											
16V - High Temperature											
RHEF200	2.71	2.49	2.26	2.06	2.00	1.77	1.60	1.46	1.34	1.11	0.49
NEW RHEF300	4.07	3.74	3.41	3.09	3.00	2.65	2.40	2.21	2.00	1.66	0.74
RHEF400	5.57	5.11	4.65	4.22	4.00	3.62	3.29	3.01	2.73	2.27	1.01
RHEF450	6.10	5.60	5.10	4.60	4.50	4.00	3.60	3.30	3.00	2.50	1.10
NEW RHEF550	7.47	6.86	6.24	5.66	5.50	4.85	4.41	4.04	3.66	3.05	1.36
RHEF600	8.20	7.50	6.80	6.20	6.00	5.30	4.90	4.40	4.00	3.30	1.50
RHEF650	8.80	8.10	7.40	6.70	6.50	5.70	5.30	4.80	4.30	3.60	1.60
NEW RHEF700	9.51	8.73	7.95	7.20	7.00	6.17	5.61	5.15	4.66	3.88	1.73
RHEF750	10.20	9.40	8.60	7.70	7.50	6.60	6.10	5.60	5.00	4.10	1.90
NEW RHEF800	10.87	9.98	9.08	8.23	8.00	7.06	6.41	5.88	5.33	4.43	1.97
RHEF900	12.21	11.19	10.16	9.26	9.00	7.97	7.20	6.56	6.04	5.01	2.19
RHEF1000	13.60	12.50	11.40	10.30	10.00	8.80	8.10	7.40	6.60	5.50	2.50
NEW RHEF1100	14.94	13.72	12.49	11.31	11.00	9.70	8.82	8.09	7.32	6.09	2.71
RHEF1300	17.70	16.30	14.80	13.40	13.00	11.40	10.50	9.60	8.60	7.20	3.30
NEW RHEF1400	19.01	17.46	15.89	14.40	14.00	12.35	11.22	10.29	9.32	7.76	3.45
RHEF1500	20.40	18.80	17.10	15.50	15.00	13.20	12.10	11.10	9.90	8.30	3.80
RUSBF											
6V											
RUSBF075	1.05	0.95	0.85	0.75	0.73	0.65	0.60	0.55	0.50	0.43	—
RUSBF120	1.69	1.52	1.36	1.20	1.16	1.04	0.96	0.88	0.80	0.68	—
RUSBF155	2.17	1.96	1.75	1.55	1.50	1.34	1.24	1.14	1.03	0.88	—

Figure R1-R5 Thermal Derating Curve for Radial-leaded Devices

- A = LVR075-LVR200**
B = LVRL075-LVRL200
C = LVR005-LVR055

Figure R1


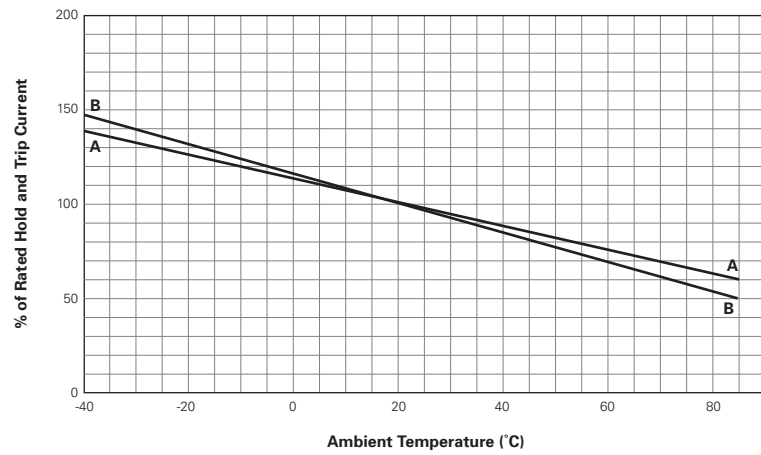
RXEF and BBRF

Figure R2


A = RUSBF075,
RUSBF120,
RUSBF155

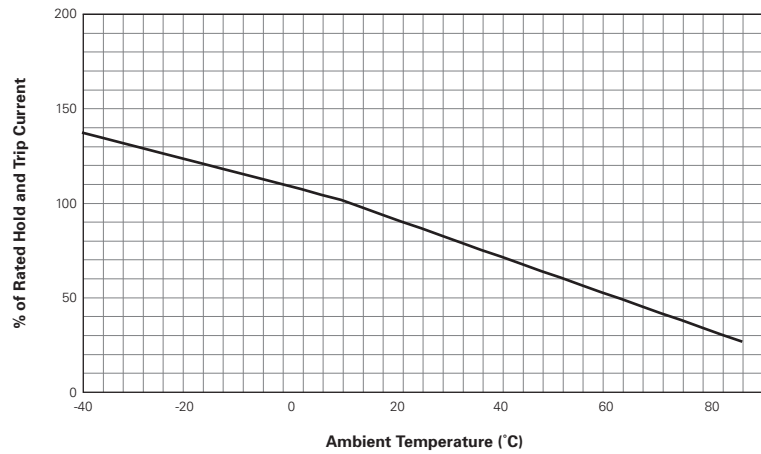
B = RUEF,
RTEF,
and all other
RUSBF

Figure R3



RHEF

Figure R4



RGEF

Figure R5

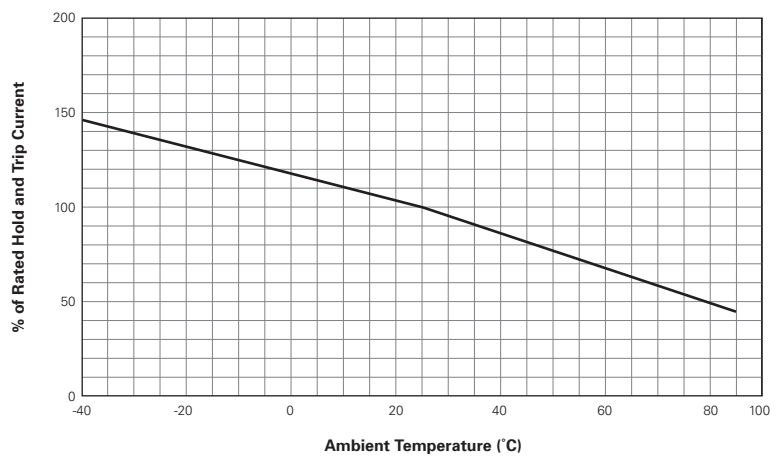


Table R3 Electrical Characteristics for Radial-leaded Devices

	Part Number	I _H (A)	I _T (A)	V _{Max} (V)	V _{Max} Interrupt (V _{AC})	I _{Max} (A)	P _D TYP (W)	Max. Time-to-trip (A) (s)		R _{Min} (Ω)	R _{Max} (Ω)	R ₁ Max (Ω)	Lead Size [mm (AWG)]
NEW	LVR/LVRL 240V _{AC} /120V _{AC}												
	LVR005K	0.05	0.12	240	265	1.0	0.7	0.25	15.0	18.50	31.00	65.00	[0.51mm(24)]
	LVR005S	0.05	0.12	240	265	1.0	0.7	0.25	15.0	18.50	31.00	65.00	[0.51mm(24)]
	LVR008K	0.08	0.19	240	265	1.2	0.8	0.40	15.0	7.40	12.00	26.00	[0.51mm(24)]
	LVR008S	0.08	0.19	240	265	1.2	0.8	0.40	15.0	7.40	12.00	26.00	[0.51mm(24)]
	LVR012K	0.12	0.30	240	265	1.2	1.0	0.60	15.0	3.00	6.50	12.00	[0.51mm(24)]
	LVR012S	0.12	0.30	240	265	1.2	1.0	0.60	15.0	3.00	6.50	12.00	[0.51mm(24)]
	LVR016K	0.16	0.37	240	265	2.0	1.4	0.80	15.0	2.50	4.10	7.80	[0.51mm(24)]
	LVR016S	0.16	0.37	240	265	2.0	1.4	0.80	15.0	2.50	4.10	7.80	[0.51mm(24)]
	LVR025K	0.25	0.56	240	265	3.5	1.5	1.25	18.5	1.30	2.10	3.80	[0.64mm(22)]
	LVR025S	0.25	0.56	240	265	3.5	1.5	1.25	18.5	1.30	2.10	3.80	[0.64mm(22)]
	LVR033K	0.33	0.74	240	265	4.5	1.7	1.65	21.0	0.77	1.24	2.60	[0.64mm(22)]
	LVR033S	0.33	0.74	240	265	4.5	1.7	1.65	21.0	0.77	1.24	2.60	[0.64mm(22)]
	LVR040K	0.40	0.90	240	265	5.5	2.0	2.00	24.0	0.60	0.97	1.90	[0.64mm(22)]
	LVR040S	0.40	0.90	240	265	5.5	2.0	2.00	24.0	0.60	0.97	1.90	[0.64mm(22)]
	LVR055K	0.55	1.25	240	265	7.0	3.4	2.75	26.0	0.45	0.73	1.45	[0.81mm(20)]
	LVR055S	0.55	1.25	240	265	7.0	3.4	2.75	26.0	0.45	0.73	1.45	[0.81mm(20)]
	NEW	LVR075S	0.75	1.50	240	265	7.5	2.6	3.75	18.0	0.32	0.48	0.84
NEW	LVR100S	1.00	2.00	240	265	10.0	2.9	5.00	21.0	0.22	0.33	0.58	[0.81mm(20)]
NEW	LVR125S	1.25	2.50	240	265	12.5	3.3	6.25	23.0	0.17	0.18	0.44	[0.81mm(20)]
NEW	LVR200S	2.00	4.00	240	265	20.0	4.5	10.00	28.0	0.09	0.13	0.22	[0.81mm(20)]
NEW	LVRL075S	0.75	1.52	120	135	7.5	1.8	3.75	14.0	0.25	0.40	0.69	[0.81mm(20)]
NEW	LVRL100S	1.00	2.00	120	135	10.0	2.2	5.00	13.6	0.18	0.27	0.47	[0.81mm(20)]
NEW	LVRL125S	1.25	2.50	120	135	12.5	2.0	6.25	18.0	0.12	0.18	0.32	[0.81mm(20)]
NEW	LVRL135S	1.35	2.70	120	135	13.5	2.8	6.75	20.0	0.11	0.17	0.30	[0.81mm(20)]
NEW	LVRL200S	2.00	4.20	120	135	20.0	3.9	10.00	36.0	0.08	0.12	0.21	[0.81mm(20)]
	Part Number	I _H (A)	I _T (A)	V _{Max} (V)	V _{Max} Interrupt (V _{AC})	I _{Max} (A)	P _D TYP (W)	Max. Time-to-trip (A) (s)		R _{Min} (Ω)	R _{Max} (Ω)	R ₁ Max (Ω)	Lead Size [mm ² (AWG)]
NEW	BBRF 99V												
	BBRF550	0.55	1.10	99	—	20	1.5	1.60	60	0.8	1.30	1.95	[0.520mm ² (20)]
	BBRF750	0.75	1.50	99	—	20	1.5	2.00	60	0.4	0.75	1.20	[0.520mm ² (20)]
NEW	RXEF 60V												
	RXEF005	0.05	0.10	60	—	40	0.22	0.25	5.0	7.3	11.10	20.00	[0.128mm ² (26)]
	RXEF010	0.10	0.20	60	—	40	0.38	0.50	4.0	2.5	4.50	7.50	[0.205mm ² (24)]
	RXEF017	0.17	0.34	60	—	40	0.48	0.85	3.0	3.3	5.21	8.00	[0.205mm ² (24)]
NEW	RXEF 72V												
	RXEF020	0.20	0.40	72	—	40	0.41	1.00	2.2	1.83	2.75	4.40	[0.205mm ² (24)]
	RXEF025	0.25	0.50	72	—	40	0.45	1.25	2.5	1.25	1.95	3.00	[0.205mm ² (24)]
	RXEF030	0.30	0.60	72	—	40	0.49	1.50	3.0	0.88	1.33	2.10	[0.205mm ² (24)]
	RXEF040	0.40	0.80	72	—	40	0.56	2.00	3.8	0.55	0.86	1.29	[0.205mm ² (24)]
	RXEF050	0.50	1.00	72	—	40	0.77	2.50	4.0	0.50	0.77	1.17	[0.205mm ² (24)]
	RXEF065	0.65	1.30	72	—	40	0.88	3.25	5.3	0.31	0.48	0.72	[0.205mm ² (24)]
	RXEF075	0.75	1.50	72	—	40	0.92	3.75	6.3	0.25	0.40	0.60	[0.205mm ² (24)]
	RXEF090	0.90	1.80	72	—	40	0.99	4.50	7.2	0.20	0.31	0.47	[0.205mm ² (24)]
	RXEF110	1.10	2.20	72	—	40	1.50	5.50	8.2	0.15	0.25	0.38	[0.520mm ² (20)]
	RXEF135	1.35	2.70	72	—	40	1.70	6.75	9.6	0.12	0.19	0.30	[0.520mm ² (20)]
	RXEF160	1.60	3.20	72	—	40	1.90	8.00	11.4	0.09	0.14	0.22	[0.520mm ² (20)]
	RXEF185	1.85	3.70	72	—	40	2.10	9.25	12.6	0.08	0.12	0.19	[0.520mm ² (20)]
	RXEF250	2.50	5.00	72	—	40	2.50	12.50	15.6	0.05	0.08	0.13	[0.520mm ² (20)]
	RXEF300	3.00	6.00	72	—	40	2.80	15.00	19.8	0.04	0.06	0.10	[0.520mm ² (20)]
RXEF375	3.75	7.50	72	—	40	3.20	18.75	24.0	0.03	0.05	0.08	[0.520mm ² (20)]	
NEW	RTEF 33V												
	RTEF120	1.20	2.30	33	—	40	0.78	6.00	3.50	0.074	0.120	0.180	[0.205mm ² (24)]
	RTEF135	1.35	2.50	33	—	40	0.84	6.75	4.50	0.059	0.100	0.143	[0.205mm ² (24)]
	RTEF190	1.90	3.00	33	—	40	0.90	9.50	3.50	0.045	0.063	0.092	[0.205mm ² (24)]
NEW	RUEF 30V												
	RUEF090	0.90	1.80	30	—	100	0.60	4.50	5.90	0.070	0.12	0.22	[0.205mm ² (24)]
	RUEF110	1.10	2.20	30	—	100	0.70	5.50	6.60	0.070	0.10	0.17	[0.205mm ² (24)]
	RUEF135	1.35	2.70	30	—	100	0.80	6.75	7.30	0.040	0.08	0.13	[0.205mm ² (24)]
	RUEF160	1.60	3.20	30	—	100	0.90	8.00	8.00	0.030	0.07	0.11	[0.205mm ² (24)]
	RUEF185	1.85	3.70	30	—	100	1.00	9.25	8.70	0.030	0.06	0.09	[0.205mm ² (24)]
	RUEF250	2.50	5.00	30	—	100	1.20	12.50	10.3	0.020	0.04	0.07	[0.205mm ² (24)]

Table R3 Electrical Characteristics for Radial-leaded Devices

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	Part Number	I _H (A)	I _T (A)	V _{Max} (V)	V _{Max} Interrupt (V _{AC})	I _{Max} (A)	P _D TYP (W)	Max. Time-to-trip (A) (s)		R _{Min} (Ω)	R _{Max} (Ω)	R ₁ Max (Ω)	Lead Size [mm ² (AWG)]	
	RUEF 30V													
	RUEF300	3.0	6.0	30	—	100	2.0	15.0	10.8	0.020	0.050	0.08	[0.520mm ² (20)]	
	RUEF400	4.0	8.0	30	—	100	2.5	20.0	12.7	0.010	0.030	0.05	[0.520mm ² (20)]	
	RUEF500	5.0	10.0	30	—	100	3.0	25.0	14.5	0.010	0.030	0.05	[0.520mm ² (20)]	
	RUEF600	6.0	12.0	30	—	100	3.5	30.0	16.0	0.005	0.020	0.04	[0.520mm ² (20)]	
	RUEF700	7.0	14.0	30	—	100	3.8	35.0	17.5	0.005	0.020	0.03	[0.520mm ² (20)]	
	RUEF800	8.0	16.0	30	—	100	4.0	40.0	18.8	0.005	0.013	0.02	[0.520mm ² (20)]	
	RUEF900	9.0	18.0	30	—	100	4.2	45.0	20.0	0.005	0.010	0.02	[0.520mm ² (20)]	
	RHEF* 30V - High Temperature													
	RHEF050	0.5	0.9	30	—	40	0.9	2.5	2.5	0.480	0.780	1.10	[0.205mm ² (24)]	
	RHEF070	0.7	1.4	30	—	40	1.4	3.5	3.2	0.300	0.540	0.80	[0.205mm ² (24)]	
	RHEF100	1.0	1.8	30	—	40	1.4	5.0	5.2	0.180	0.300	0.43	[0.205mm ² (24)]	
	RUSBF 16V													
	RUSBF090	0.90	1.8	16	—	40	0.6	8.0	1.2	0.070	0.120	0.180	[0.205mm ² (24)]	
	RUSBF110	1.10	2.2	16	—	40	0.7	8.0	2.3	0.050	0.095	0.140	[0.205mm ² (24)]	
	RUSBF135	1.35	2.7	16	—	40	0.8	8.0	4.5	0.040	0.074	0.112	[0.205mm ² (24)]	
	RUSBF160	1.60	3.2	16	—	40	0.9	8.0	9.0	0.030	0.061	0.110	[0.205mm ² (24)]	
	RUSBF185	1.85	3.7	16	—	40	1.0	8.0	10.0	0.030	0.051	0.090	[0.205mm ² (24)]	
	RUSBF250	2.50	5.0	16	—	40	1.2	8.0	40.0	0.020	0.036	0.060	[0.205mm ² (24)]	
	RGEF* 16V													
	RGEF250	2.5	4.7	16	—	100	1.0	12.5	5.0	0.0220	0.0350	0.0530	[0.205mm ² (24)]	
	RGEF300	3.0	5.1	16	—	100	2.3	15.0	1.0	0.0380	0.0645	0.0975	[0.520mm ² (20)]	
	RGEF400	4.0	6.8	16	—	100	2.4	20.0	1.7	0.0210	0.0390	0.0600	[0.520mm ² (20)]	
	RGEF500	5.0	8.5	16	—	100	2.6	25.0	2.0	0.0150	0.0240	0.0340	[0.520mm ² (20)]	
	RGEF600	6.0	10.2	16	—	100	2.8	30.0	3.3	0.0100	0.0190	0.0280	[0.520mm ² (20)]	
	RGEF700	7.0	11.9	16	—	100	3.0	35.0	3.5	0.0077	0.0131	0.0200	[0.520mm ² (20)]	
	RGEF800	8.0	13.6	16	—	100	3.0	40.0	5.0	0.0056	0.0110	0.0175	[0.520mm ² (20)]	
	RGEF900	9.0	15.3	16	—	100	3.3	45.0	5.5	0.0047	0.0091	0.0135	[0.520mm ² (20)]	
	RGEF1000	10.0	17.0	16	—	100	3.6	50.0	6.0	0.0040	0.0070	0.0102	[0.520mm ² (20)]	
	RGEF1100	11.0	18.7	16	—	100	3.7	55.0	7.0	0.0037	0.0060	0.0089	[0.520mm ² (20)]	
	RGEF1200	12.0	20.4	16	—	100	4.2	60.0	7.5	0.0033	0.0057	0.0086	[0.823mm ² (18)]	
	RGEF1400	14.0	23.8	16	—	100	4.6	70.0	9.0	0.0026	0.0043	0.0064	[0.823mm ² (18)]	
		RHEF* 16V - High Temperature												
RHEF200		2.0	3.8	16	—	100	1.4	10.0	4.3	0.0450	0.07400	0.1100	[0.205mm ² (24)]	
NEW		RHEF300	3.0	6.0	16	—	100	3.0	15.0	5.0	0.0330	0.05300	0.0790	[0.520mm ² (20)]
		RHEF400	4.0	7.5	16	—	100	3.3	20.0	5.0	0.0240	0.04000	0.0600	[0.520mm ² (20)]
		RHEF450	4.5	7.8	16	—	100	3.6	22.5	3.0	0.0220	0.03600	0.0540	[0.520mm ² (20)]
NEW		RHEF550	5.5	10.0	16	—	100	3.5	27.5	6.0	0.0150	0.02500	0.0370	[0.520mm ² (20)]
		RHEF600	6.0	10.8	16	—	100	4.1	30.0	5.0	0.0130	0.02150	0.0320	[0.520mm ² (20)]
		RHEF650	6.5	12.0	16	—	100	4.1	32.5	5.5	0.0110	0.01750	0.0260	[0.520mm ² (20)]
NEW		RHEF700	7.0	13.0	16	—	100	4.0	35.0	7.0	0.0100	0.01640	0.0250	[0.520mm ² (20)]
		RHEF750	7.5	13.1	16	—	100	4.5	37.5	7.0	0.0094	0.01530	0.0220	[0.520mm ² (20)]
NEW		RHEF800	8.0	15.0	16	—	100	4.2	40.0	8.0	0.0080	0.01350	0.0200	[0.520mm ² (20)]
		RHEF900	9.0	16.5	16	—	100	5.0	45.0	10.0	0.0074	0.01200	0.0170	[0.520mm ² (20)]
NEW		RHEF1000	10.0	18.5	16	—	100	5.3	50.0	9.0	0.0062	0.01050	0.0150	[0.520mm ² (20)]
		RHEF1100	11.0	20.0	16	—	100	5.5	55.0	11.0	0.0055	0.00900	0.0130	[0.520mm ² (20)]
		RHEF1300	13.0	24.0	16	—	100	6.9	65.0	13.0	0.0041	0.00690	0.0100	[0.823mm ² (18)]
NEW	RHEF1400	14.0	27.0	16	—	100	6.9	70.0	13.0	0.0030	0.00600	0.0090	[0.823mm ² (18)]	
	RHEF1500	15.0	28.0	16	—	100	7.0	75.0	20.0	0.0032	0.00613	0.0092	[0.823mm ² (18)]	
	RUSBF 6V													
	RUSBF075	0.75	1.30	6	—	40	0.3	8.0	0.4	0.110	0.1750	0.23	[0.205mm ² (24)]	
	RUSBF120	1.20	2.00	6	—	40	0.6	8.0	0.5	0.070	0.0975	0.14	[0.205mm ² (24)]	
	RUSBF155	1.55	2.65	6	—	40	0.6	7.8	2.2	0.040	0.0705	0.10	[0.205mm ² (24)]	

Notes:

- I_H : Hold current: maximum current device will pass without interruption in 20°C still air.
- I_T : Trip current: minimum current that will switch the device from low resistance to high resistance in 20°C still air.
- V_{Max} : Maximum continuous voltage device can withstand without damage at rated current.
- V_{Max} Interrupt : Under specified conditions this is the highest voltage that can be applied to the device at the maximum current.
- I_{Max} : Maximum fault current device can withstand without damage at rated voltage.
- P_D : Power dissipated from device when in the tripped state in 20°C still air.
- R_{Min} : Minimum resistance of device as supplied at 20°C unless otherwise specified.
- R_{Max} : Maximum resistance of device as supplied at 20°C unless otherwise specified.
- R₁Max : Maximum resistance of device when measured one hour post reflow (surface-mount device) or one hour post trip (radial-leaded device) at 20°C unless otherwise specified.

* Electrical characteristics determined at 25°C

Figure R6-R18 Dimension Figures for Radial-leaded Devices

Figure R6

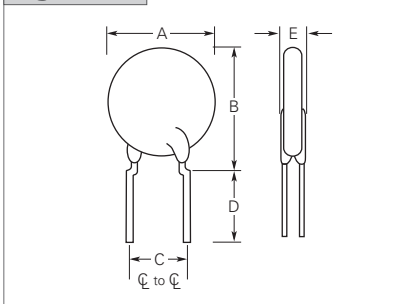


Figure R7

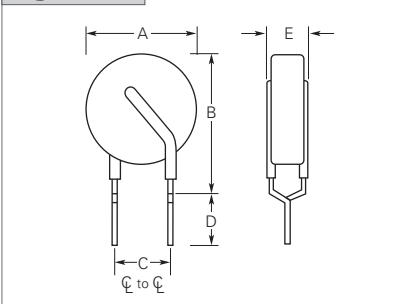


Figure R8

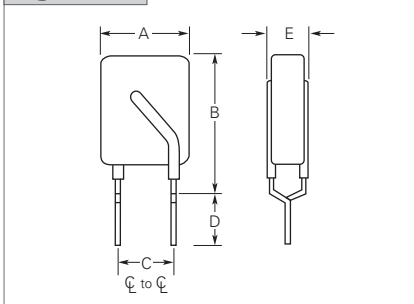


Figure R9

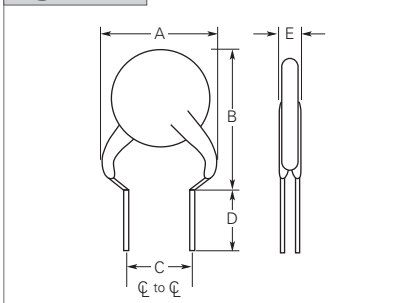


Figure R10

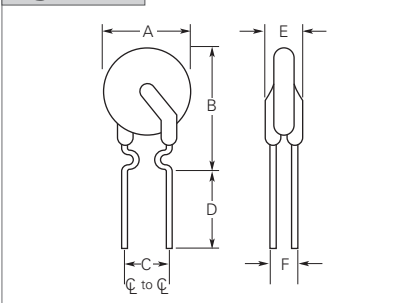


Figure R11

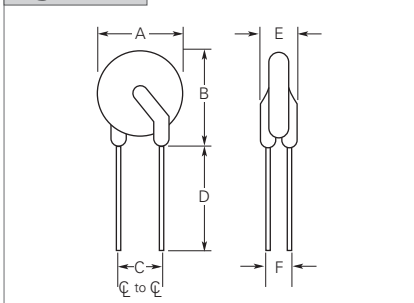


Figure R12

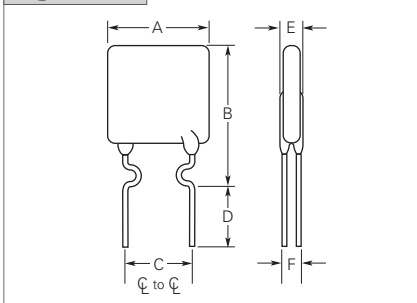


Figure R13

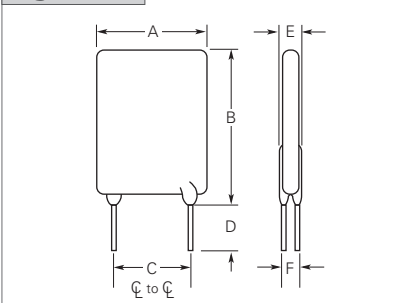


Figure R14

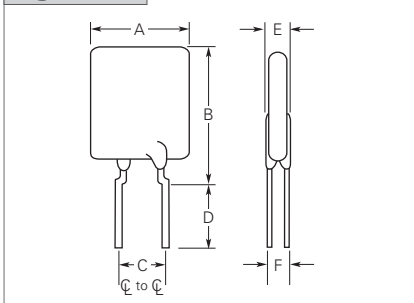


Figure R15

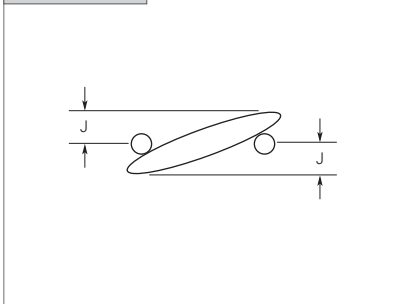


Figure R16

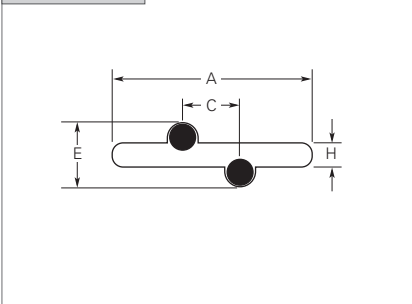


Figure R17

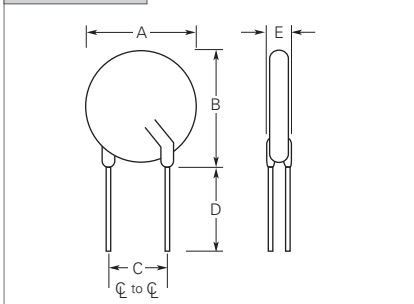


Figure R18

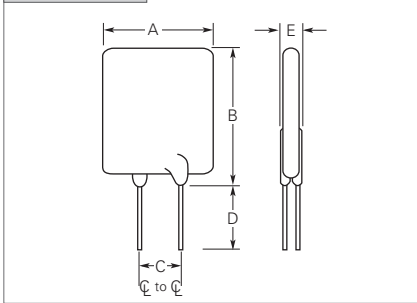


Table R4 Dimensions for Radial-leaded Devices in Millimeters (Inches)

		A		B		C		D		E		F	H	J	Figure	
Part Number		min	max	min	max	min	max	min	max	min	max	TYP	TYP	TYP		
	LVR/LVRL 240V _{AC} /120V _{AC}															
	LVR005K	—	8.3 (0.33)	—	12.9 (0.51)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.8 (0.15)	—	—	—	R7	
	LVR005S	—	8.3 (0.33)	—	10.7 (0.43)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.8 (0.15)	—	—	—	R17	
	LVR008K	—	8.3 (0.33)	—	12.9 (0.51)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.8 (0.15)	—	—	—	R7	
	LVR008S	—	8.3 (0.33)	—	10.7 (0.43)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.8 (0.15)	—	—	—	R17	
	LVR012K	—	8.3 (0.33)	—	12.9 (0.51)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.8 (0.15)	—	—	—	R7	
	LVR012S	—	8.3 (0.33)	—	10.7 (0.43)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.8 (0.15)	—	—	—	R17	
	LVR016K	—	9.9 (0.39)	—	13.8 (0.54)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.8 (0.15)	—	—	—	R7	
	LVR016S	—	9.9 (0.39)	—	12.5 (0.50)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.8 (0.15)	—	—	—	R17	
	LVR025K	—	9.6 (0.38)	—	18.8 (0.74)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.8 (0.15)	—	—	—	R8	
	LVR025S	—	9.6 (0.38)	—	17.4 (0.69)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.8 (0.15)	—	—	—	R18	
	LVR033K	—	11.4 (0.45)	—	19.0 (0.75)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.8 (0.15)	—	—	—	R8	
	LVR033S	—	11.4 (0.45)	—	16.5 (0.65)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.8 (0.15)	—	—	—	R18	
	LVR040K	—	11.5 (0.46)	—	20.9 (0.82)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.8 (0.15)	—	—	—	R8	
	LVR040S	—	11.5 (0.46)	—	19.5 (0.77)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.8 (0.15)	—	—	—	R18	
	LVR055K	—	14.0 (0.55)	—	22.4 (0.88)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	4.1 (0.16)	—	—	—	R8	
	LVR055S	—	14.0 (0.55)	—	21.7 (0.85)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	4.1 (0.16)	—	—	—	R18	
	NEW	LVR075S	—	11.5 (0.45)	—	23.4 (0.92)	4.1 (0.16)	6.1 (0.24)	5.1 (0.20)	—	—	4.8 (0.19)	—	—	—	R18
	NEW	LVR100S	—	18.7 (0.74)	—	24.4 (0.96)	8.9 (0.35)	11.4 (0.45)	5.1 (0.20)	—	—	5.1 (0.20)	—	—	—	R17
	NEW	LVR125S	—	21.2 (0.84)	—	27.4 (1.08)	8.9 (0.35)	11.4 (0.45)	5.1 (0.20)	—	—	5.3 (0.21)	—	—	—	R17
	NEW	LVR200S	—	24.9 (0.98)	—	33.8 (1.33)	8.9 (0.35)	11.4 (0.45)	5.1 (0.20)	—	—	6.1 (0.24)	—	—	—	R18
	NEW	LVRL075S	—	10.9 (0.43)	—	17.0 (0.67)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	4.1 (0.16)	—	—	—	R18
	NEW	LVRL100S	—	11.5 (0.45)	—	20.1 (0.79)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	4.1 (0.16)	—	—	—	R18
	NEW	LVRL125S	—	14.0 (0.55)	—	21.7 (0.85)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	4.1 (0.16)	—	—	—	R18
	NEW	LVRL135S	—	16.3 (0.64)	—	21.7 (0.85)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	4.1 (0.16)	—	—	—	R18
	NEW	LVRL200S	—	23.5 (0.93)	—	31.8 (1.25)	9.4 (0.37)	10.9 (0.43)	7.6 (0.30)	—	—	4.1 (0.16)	—	—	—	R18
		BBRF 99V														
		BBRF550	—	10.9 (0.43)	—	14.0 (0.55)	4.3 (0.17)	5.8 (0.23)	7.6 (0.3)	—	—	3.6 (0.14)	—	1.37 (0.054)	1.2 (0.05)	R6, R15, R16
BBRF750		—	11.9 (0.47)	—	15.5 (0.61)	4.3 (0.17)	5.8 (0.23)	7.6 (0.3)	—	—	3.6 (0.14)	—	1.37 (0.054)	1.2 (0.05)	R6, R15, R16	

Table R4 Dimensions for Radial-leaded Devices in Millimeters (Inches)

... Cont'd

Part Number	A		B		C		D		E		F	H	J	Figure
	min	max	min	max	min	max	min	max	min	max	TYP.	TYP.	TYP.	
														
RXEF005	—	8.0 (0.32)	—	8.3 (0.33)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	1.07 (0.042)	1.0 (0.04)	R9, R15, R16
RXEF010	—	7.4 (0.29)	—	11.6 (0.46)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	1.07 (0.042)	1.0 (0.04)	R10, R15, R16
RXEF017	—	7.4 (0.29)	—	12.7 (0.50)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	1.68 (0.066)	1.7 (0.07)	R10, R15, R16
														
RXEF020	—	7.4 (0.29)	—	11.7 (0.46)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	1.17 (0.046)	1.0 (0.04)	R10, R15, R16
RXEF025	—	7.4 (0.29)	—	12.7 (0.50)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	1.17 (0.046)	1.0 (0.04)	R10, R15, R16
RXEF030	—	7.4 (0.29)	—	12.7 (0.50)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	1.17 (0.046)	1.0 (0.04)	R10, R15, R16
RXEF040	—	7.6 (0.30)	—	13.5 (0.53)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	1.17 (0.046)	1.2 (0.05)	R10, R15, R16
RXEF050	—	7.9 (0.31)	—	13.7 (0.54)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	1.17 (0.046)	1.2 (0.05)	R10, R15, R16
RXEF065	—	9.4 (0.37)	—	14.5 (0.57)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	1.17 (0.046)	1.5 (0.06)	R10, R15, R16
RXEF075	—	10.2 (0.40)	—	15.2 (0.60)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	1.17 (0.046)	1.5 (0.06)	R10, R15, R16
RXEF090	—	11.2 (0.44)	—	15.8 (0.62)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	1.17 (0.046)	1.5 (0.06)	R10, R15, R16
RXEF110	—	12.8 (0.50)	—	17.5 (0.69)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	1.37 (0.054)	1.2 (0.05)	R11, R15, R16
RXEF135	—	14.5 (0.57)	—	19.1 (0.75)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	1.37 (0.054)	1.2 (0.05)	R11, R15, R16
RXEF160	—	16.3 (0.64)	—	20.8 (0.82)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	1.37 (0.054)	1.5 (0.06)	R11, R15, R16
RXEF185	—	17.5 (0.69)	—	22.4 (0.88)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	1.37 (0.054)	1.5 (0.06)	R11, R15, R16
RXEF250	—	20.8 (0.82)	—	25.4 (1.00)	9.4 (0.37)	10.9 (0.43)	7.6 (0.30)	—	—	3.0 (0.12)	—	1.37 (0.054)	1.7 (0.07)	R11, R15, R16
RXEF300	—	23.9 (0.94)	—	28.6 (1.13)	9.4 (0.37)	10.9 (0.43)	7.6 (0.30)	—	—	3.0 (0.12)	—	1.37 (0.054)	1.7 (0.07)	R11, R15, R16
RXEF375	—	27.2 (1.07)	—	31.8 (1.25)	9.4 (0.37)	10.9 (0.43)	7.6 (0.30)	—	—	3.0 (0.12)	—	1.37 (0.054)	1.7 (0.07)	R11, R15, R16
														
RTEF120	—	7.4 (0.29)	—	12.2 (0.48)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	0.89 (0.035)	0.8 (0.03)	R12, R15, R16
RTEF135	—	7.4 (0.29)	—	14.2 (0.56)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	0.89 (0.035)	0.8 (0.03)	R12, R15, R16
RTEF190	—	8.9 (0.35)	—	13.5 (0.53)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	0.89 (0.035)	1.0 (0.04)	R12, R15, R16
														
RUEF090	—	7.4 (0.29)	—	12.2 (0.48)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	0.89 (0.035)	0.8 (0.03)	R12, R15, R16
RUEF110	—	7.4 (0.29)	—	14.2 (0.56)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	0.89 (0.035)	0.8 (0.03)	R12, R15, R16
RUEF135	—	8.9 (0.35)	—	13.5 (0.53)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	0.89 (0.035)	1.0 (0.04)	R12, R15, R16
RUEF160	—	8.9 (0.35)	—	15.2 (0.60)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	0.89 (0.035)	1.0 (0.04)	R12, R15, R16
RUEF185	—	10.2 (0.40)	—	15.7 (0.62)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	0.89 (0.035)	1.0 (0.04)	R12, R15, R16
RUEF250	—	11.4 (0.45)	—	18.3 (0.72)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	0.89 (0.035)	1.2 (0.05)	R12, R15, R16
RUEF300	—	11.4 (0.45)	—	16.5 (0.65)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	1.19 (0.047)	1.5 (0.06)	R13, R15, R16

Table R4 Dimensions for Radial-leaded Devices in Millimeters (Inches)

... Cont'd

Part Number	A		B		C		D		E		F	H	J	Figure
	min	max	min	max	min	max	min	max	min	max	TYP	TYP	TYP	
RUEF 30V														
RUEF400	—	14.0 (0.55)	—	19.3 (0.76)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	1.19 (0.047)	1.7 (0.07)	R13, R15, R16
RUEF500	—	14.0 (0.55)	—	24.1 (0.95)	9.4 (0.37)	10.9 (0.43)	7.6 (0.30)	—	—	3.0 (0.12)	—	1.19 (0.047)	1.0 (0.04)	R13, R15, R16
RUEF600	—	16.5 (0.65)	—	24.1 (0.95)	9.4 (0.37)	10.9 (0.43)	7.6 (0.30)	—	—	3.0 (0.12)	—	1.19 (0.047)	1.0 (0.04)	R13, R15, R16
RUEF700	—	19.1 (0.75)	—	25.9 (1.02)	9.4 (0.37)	10.9 (0.43)	7.6 (0.30)	—	—	3.0 (0.12)	—	1.19 (0.047)	1.2 (0.05)	R13, R15, R16
RUEF800	—	21.6 (0.85)	—	28.4 (1.12)	9.4 (0.37)	10.9 (0.43)	7.6 (0.30)	—	—	3.0 (0.12)	—	1.19 (0.047)	1.5 (0.06)	R13, R15, R16
RUEF900	—	24.1 (0.95)	—	29.0 (1.14)	9.4 (0.37)	10.9 (0.43)	7.6 (0.30)	—	—	3.0 (0.12)	—	1.19 (0.047)	1.5 (0.06)	R13, R15, R16
RHEF 30V - High Temperature														
RHEF050	—	7.4 (0.29)	—	12.7 (0.50)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	1.2 (0.05)	—	—	R10, R15 R16
RHEF070	—	6.9 (0.27)	—	10.8 (0.43)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	1.2 (0.05)	1.24 (0.049)	1.2 (0.05)	R12, R15, R16
RHEF100	—	9.7 (0.38)	—	13.6 (0.54)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	—	—	R10, R15 R16
RUSBF 16V														
RUSBF090	—	7.4 (0.29)	—	12.2 (0.48)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.1 (0.12)	—	0.89 (0.035)	0.8 (0.03)	R12, R15, R16
RUSBF110	—	7.4 (0.29)	—	14.2 (0.56)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	0.89 (0.035)	0.8 (0.03)	R12, R15, R16
RUSBF135	—	8.9 (0.35)	—	13.5 (0.53)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	0.89 (0.035)	1.0 (0.04)	R12, R15, R16
RUSBF160	—	8.9 (0.35)	—	15.2 (0.60)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	0.89 (0.035)	1.0 (0.04)	R12, R15, R16
RUSBF185	—	10.2 (0.40)	—	15.7 (0.62)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	0.89 (0.035)	1.0 (0.04)	R12, R15, R16
RUSBF250	—	11.4 (0.45)	—	18.3 (0.72)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	—	0.89 (0.035)	1.2 (0.05)	R12, R15, R16
RGEF 16V														
RGEF250	—	8.9 (0.35)	—	12.8 (0.50)	4.3 (0.17)	5.8 (0.23)	3.18 (0.13)	6.18 (0.24)	—	3.0 (0.12)	1.2 (0.05)	1.24 (0.049)	1.2 (0.05)	R12, R15, R16
RGEF300	6.1 (0.24)	7.1 (0.28)	6.1 (0.24)	11.0 (0.43)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	2.0 (0.08)	3.0 (0.12)	1.2 (0.05)	1.24 (0.049)	1.2 (0.05)	R13, R15, R16
RGEF400	7.9 (0.31)	8.9 (0.35)	7.9 (0.31)	12.8 (0.50)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	2.0 (0.08)	3.0 (0.12)	1.2 (0.05)	1.24 (0.049)	1.4 (0.06)	R13, R15, R16
RGEF500	9.4 (0.37)	10.4 (0.41)	9.4 (0.37)	14.3 (0.56)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	2.0 (0.08)	3.0 (0.12)	1.2 (0.05)	1.24 (0.049)	1.6 (0.06)	R13, R15, R16
RGEF600	9.7 (0.38)	10.7 (0.42)	12.2 (0.48)	17.1 (0.67)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	2.0 (0.08)	3.0 (0.12)	1.2 (0.05)	1.24 (0.049)	1.6 (0.06)	R13, R15, R16
RGEF700	10.2 (0.40)	11.2 (0.44)	14.7 (0.58)	19.7 (0.78)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	2.0 (0.08)	3.0 (0.12)	1.2 (0.05)	1.24 (0.049)	1.7 (0.07)	R13, R15, R16
RGEF800	11.7 (0.46)	12.7 (0.50)	16.0 (0.63)	20.9 (0.82)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	2.0 (0.08)	3.0 (0.12)	1.2 (0.05)	1.24 (0.049)	1.8 (0.07)	R13, R15, R16
RGEF900	13.0 (0.51)	14.0 (0.55)	16.8 (0.66)	21.7 (0.85)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	2.0 (0.08)	3.0 (0.12)	1.2 (0.05)	1.24 (0.049)	2.0 (0.08)	R13, R15, R16
RGEF1000	15.5 (0.61)	16.5 (0.65)	21.1 (0.83)	25.2 (0.99)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	2.0 (0.08)	3.0 (0.12)	1.2 (0.05)	1.24 (0.049)	2.0 (0.08)	R13, R15, R16
RGEF1100	16.5 (0.65)	17.5 (0.69)	21.1 (0.83)	26.0 (1.02)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	2.0 (0.08)	3.0 (0.12)	1.2 (0.05)	1.24 (0.049)	2.4 (0.09)	R13, R15, R16
RGEF1200	16.4 (0.65)	17.5 (0.69)	22.6 (0.89)	28.0 (1.10)	9.4 (0.37)	10.9 (0.43)	7.6 (0.30)	—	2.3 (0.09)	3.5 (0.14)	1.4 (0.06)	1.45 (0.057)	1.5 (0.06)	R13, R15, R16
RGEF1400	22.4 (0.88)	23.5 (0.925)	22.6 (0.89)	27.9 (1.10)	9.4 (0.37)	10.9 (0.43)	7.6 (0.30)	—	2.3 (0.09)	3.5 (0.14)	1.4 (0.06)	1.45 (0.057)	1.9 (0.08)	R13, R15, R16

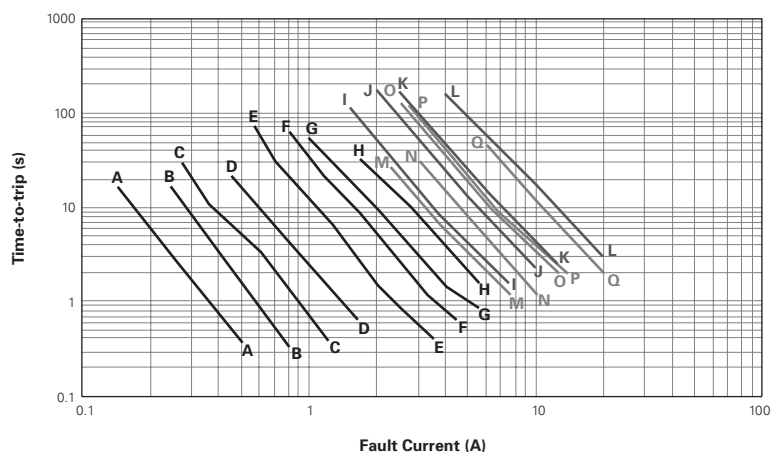
Table R4 Dimensions for Radial-leaded Devices in Millimeters (Inches)

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	Part Number	A		B		C		D		E		F	H	J	Figure
		min	max	min	max	min	max	min	max	min	max	TYP.	TYP.	TYP.	
RHEF															
16V - High Temperature															
	RHEF200	—	9.4 (0.37)	—	14.4 (0.57)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.1 (0.12)	—	—	—	R10, R15, R16
NEW	RHEF300	—	8.8 (0.35)	—	13.8 (0.55)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	1.2 (0.05)	—	—	R14, R15 R16
	RHEF400	—	10.0 (0.39)	—	15.0 (0.59)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	1.2 (0.05)	1.24 (0.049)	1.6 (0.06)	R14, R15, R16
	RHEF450	—	10.4 (0.41)	—	15.6 (0.61)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	1.2 (0.05)	1.24 (0.049)	1.6 (0.06)	R14, R15, R16
NEW	RHEF550	—	11.2 (0.44)	—	18.9 (0.74)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	1.2 (0.05)	—	—	R14, R15 R16
	RHEF600	—	11.2 (0.44)	—	21.0 (0.83)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	1.2 (0.05)	1.24 (0.049)	1.7 (0.067)	R14, R15, R16
	RHEF650	—	12.7 (0.50)	—	22.2 (0.88)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	1.2 (0.05)	1.24 (0.049)	1.8 (0.07)	R14, R15, R16
NEW	RHEF700	—	14.0 (0.55)	—	21.9 (0.86)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	1.2 (0.05)	—	—	R14, R15 R16
	RHEF750	—	14.0 (0.55)	—	23.5 (0.93)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	1.2 (0.05)	1.24 (0.049)	2.0 (0.08)	R14, R15, R16
NEW	RHEF800	—	16.5 (0.65)	—	22.5 (0.88)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	1.2 (0.05)	—	—	R14, R15 R16
	RHEF900	—	16.5 (0.65)	—	25.7 (1.01)	4.3 (0.17)	5.8 (0.23)	7.6 (0.30)	—	—	3.0 (0.12)	1.2 (0.05)	—	—	R14, R15 R16
	RHEF1000	—	17.5 (0.69)	—	26.5 (1.04)	9.4 (0.37)	10.9 (0.43)	7.6 (0.30)	—	—	3.0 (0.12)	1.2 (0.05)	1.24 (0.049)	1.5 (0.06)	R14, R15, R16
NEW	RHEF1100	—	21.0 (0.83)	—	26.1 (1.03)	9.4 (0.37)	10.9 (0.43)	7.6 (0.30)	—	—	3.0 (0.12)	1.2 (0.05)	—	—	R14, R15 R16
	RHEF1300	—	23.5 (0.925)	—	28.7 (1.13)	9.4 (0.37)	10.9 (0.43)	7.6 (0.30)	—	—	3.6 (0.14)	1.4 (0.06)	1.45 (0.057)	1.9 (0.084)	R14, R15, R16
NEW	RHEF1400	—	23.5 (0.925)	—	28.6 (1.13)	9.4 (0.37)	10.9 (0.43)	7.6 (0.30)	—	—	3.6 (0.14)	1.4 (0.06)	—	—	R14, R15 R16
	RHEF1500	—	23.5 (0.925)	—	28.7 (1.13)	9.4 (0.37)	10.9 (0.43)	7.6 (0.30)	—	—	3.6 (0.14)	1.4 (0.06)	1.45 (0.057)	1.9 (0.084)	R14, R15, R16
															
RUSBF															
6V															
	RUSBF075	—	6.9 (0.27)	—	11.4 (0.45)	4.3 (0.17)	5.9 (0.23)	7.6 (0.30)	—	—	3.1 (0.12)	—	0.91 (0.036)	1.0 (0.04)	R10, R15, R16
	RUSBF120	—	6.9 (0.27)	—	11.7 (0.46)	4.3 (0.17)	5.9 (0.23)	7.6 (0.30)	—	—	3.1 (0.12)	—	0.91 (0.036)	1.0 (0.04)	R10, R15, R16
	RUSBF155	—	6.9 (0.27)	—	11.7 (0.46)	4.3 (0.17)	5.9 (0.23)	7.6 (0.30)	—	—	3.1 (0.12)	—	0.91 (0.036)	1.0 (0.04)	R10, R15, R16

Figure R19-R25 Typical Time-to-trip curves at 20°C for Radial-leaded Devices
LVR/LVRL

A = LVR005	M = LVRL075
B = LVR008	N = LVRL100
C = LVR012	O = LVRL125
D = LVR016	P = LVRL135
E = LVR025	Q = LVRL200
F = LVR033	
G = LVR040	
H = LVR055	
I = LVR075	
J = LVR100	
K = LVR125	
L = LVR200	

Figure R19


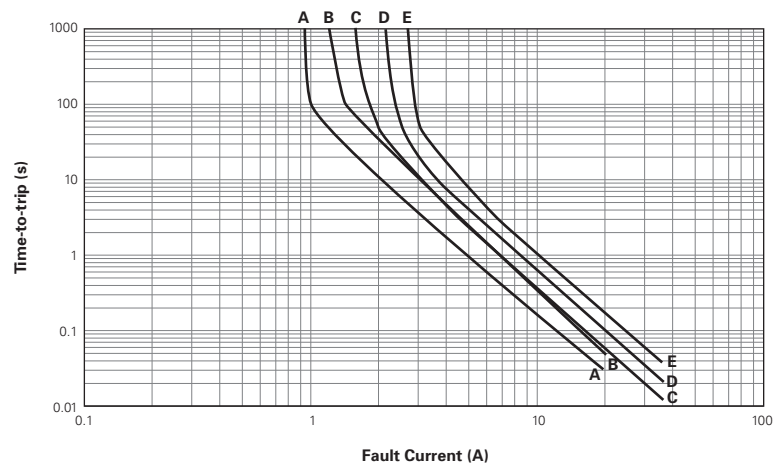
BBRF

A = BBRF550
B = BBRF750

RTEF

C = RTEF120
D = RTEF135
E = RTEF190

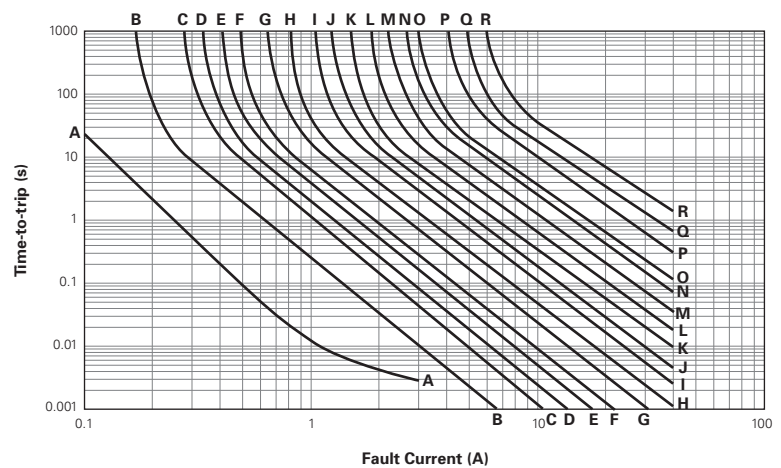
Figure R20



RXEF

A = RXEF005	J = RXEF075
B = RXEF010	K = RXEF090
C = RXEF017	L = RXEF110
D = RXEF020	M = RXEF135
E = RXEF025	N = RXEF160
F = RXEF030	O = RXEF185
G = RXEF040	P = RXEF250
H = RXEF050	Q = RXEF300
I = RXEF065	R = RXEF375

Figure R21



RUEF

A = RUEF090	H = RUEF400
B = RUEF110	I = RUEF500
C = RUEF135	J = RUEF600
D = RUEF160	K = RUEF700
E = RUEF185	L = RUEF800
F = RUEF250	M = RUEF900
G = RUEF300	

Figure R22

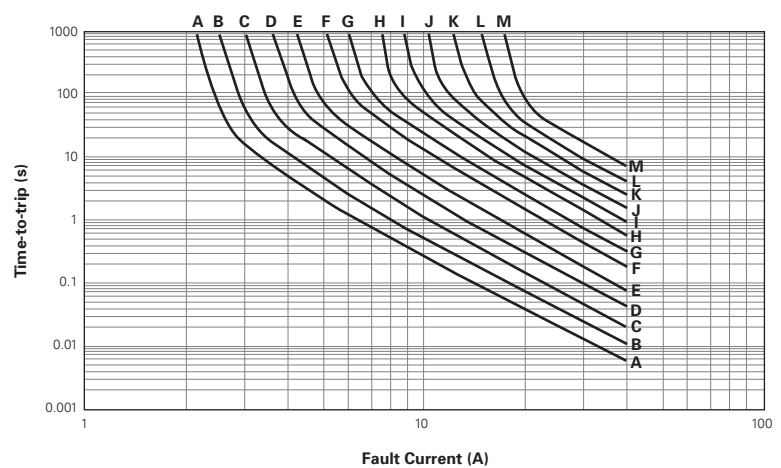
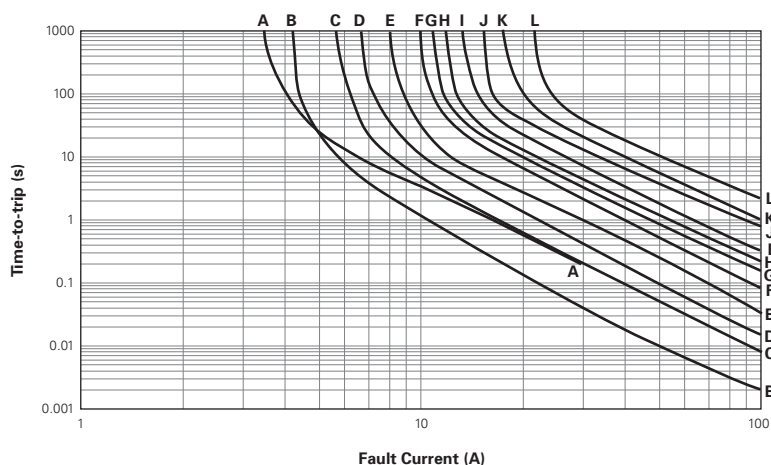


Figure R19-R25 Typical Time-to-trip curves at 20°C for Radial-leaded Devices

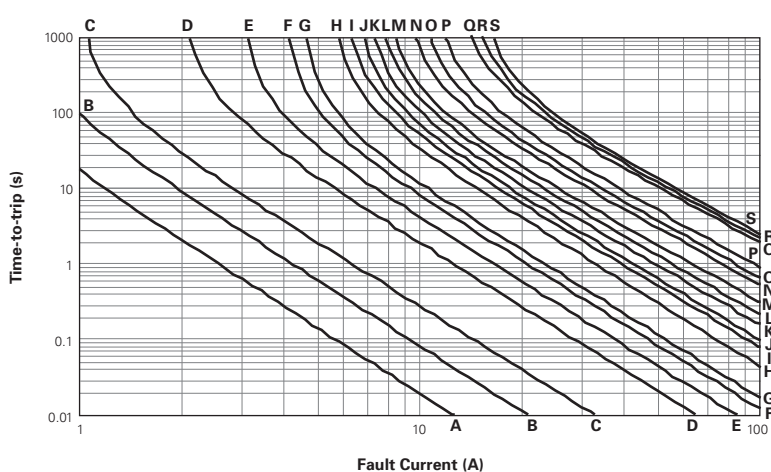
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RGEF (data at 25°C)

- A = RGEF250
- B = RGEF300
- C = RGEF400
- D = RGEF500
- E = RGEF600
- F = RGEF700
- G = RGEF800
- H = RGEF900
- I = RGEF1000
- J = RGEF1100
- K = RGEF1200
- L = RGEF1400

Figure R23

RHEF (data at 25°C)

- A = RHEF050
- B = RHEF070
- C = RHEF100
- D = RHEF200
- E = RHEF300
- F = RHEF400
- G = RHEF450
- H = RHEF550
- I = RHEF600
- J = RHEF650
- K = RHEF700
- L = RHEF750
- M = RHEF800
- N = RHEF900
- O = RHEF1000
- P = RHEF1100
- Q = RHEF1300
- R = RHEF1400
- S = RHEF1500

Figure R24

RUSBF

- A = RUSBF075
- B = RUSBF090
- C = RUSBF110
- D = RUSBF120
- E = RUSBF135
- F = RUSBF155
- G = RUSBF160
- H = RUSBF185
- I = RUSBF250

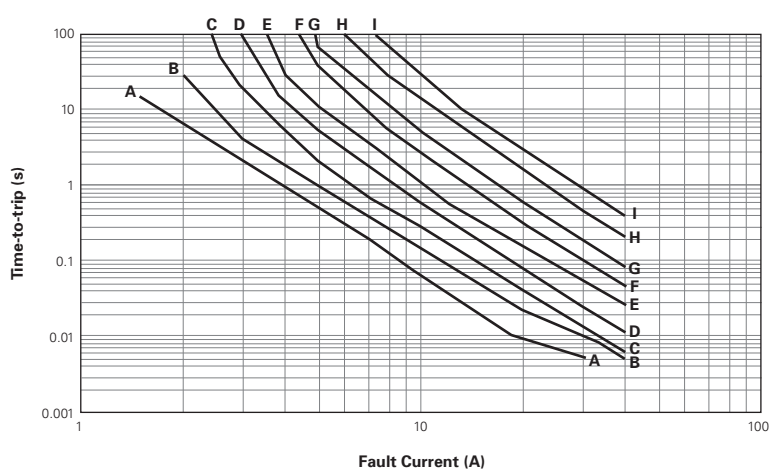
Figure R25


Table R5 Physical Characteristics and Environmental Specifications for Radial-leaded Devices**LVR/LVRL****Physical Characteristics**

Lead material	LVR005-016 : Tin-plated copper, 0.205mm ² (24AWG), ø0.51mm (0.020in.)
	LVR025-040 : Tin-plated copper, 0.32mm ² (22AWG), ø0.64mm (0.025in.)
	LVR055-200 : Tin-plated copper, 0.52mm ² (20AWG), ø0.81mm (0.032in.)
	LVRL : Tin-plated copper, 0.52mm ² (20AWG), ø0.81mm (0.032in.)
Soldering characteristics	Solderability per ANSI/J-STD-002 Category 3
Solder heat withstand	Per IEC-STD 68-2-20, Test Tb, Method 1A, Condition B, can withstand 10 seconds at 260°C ±5°C
Insulating material	LVR005-055 : Cured, flame-retardant epoxy polymer, meets UL 94V-0
	LVR075-200 : Cured, flame-retardant modified silicone, meets UL 94V-0
	LVRL : Cured, flame-retardant epoxy polymer, meets UL 94V-0

Devices are not designed to be placed through a reflow process.

Environmental Specifications

Test	Conditions	Resistance Change
Passive aging	70°C, 1000 hours	±5%
	85°C, 1000 hours	±5%
Humidity aging	85°C, 85%RH, 1000 hours	±5%
Thermal Shock	85°C, -40°C (10 times)	±5%
Solvent resistance	MIL-STD-202, Method 215F	No change

BBRF**Physical Characteristics**

Lead material	Tin-plated copper, 0.52mm ² (20AWG), ø0.81mm (0.032in.)
Soldering characteristics	Solderability per ANSI/J-STD-002 Category 3
Solder heat withstand	per IEC-STD 68-2-20, Test Tb, Method 1A, Condition B, can withstand 10 seconds at 260°C ±5°C
Insulating material	Cured, flame-retardant epoxy polymer; meets UL 94V-0

Devices are not designed to be placed through a reflow process.

Environmental Specifications

Test	Conditions	Resistance Change
Passive aging	70°C, 1000 hours	±5%
	85°C, 1000 hours	±5%
Humidity aging	85°C, 85%RH, 1000 hours	±5%
Thermal Shock	85°C, -40°C (10 times)	±5%
Solvent resistance	MIL-STD-202, Method 215F	No change

RXEF**Physical Characteristics**

Lead material	RXEF005 : Tin-plated nickel-copper alloy, 0.128mm ² (26AWG), ø0.40mm (0.016in.)
	RXEF010 : Tin-plated nickel-copper alloy, 0.205mm ² (24AWG), ø0.51mm (0.020in.)
	RXEF017 to 040 : Tin-plated copper-clad steel, 0.205mm ² (24AWG), ø0.51mm (0.020in.)
	RXEF050 to 090 : Tin-plated copper, 0.205mm ² (24AWG), ø0.51mm (0.020in.)
	RXEF110 to 375 : Tin-plated copper, 0.52mm ² (20AWG), ø0.81mm (0.032in.)
Soldering characteristics	Solderability per ANSI/J-STD-002 Category 3 RXEF005, RXEF010 meet ANSI/J-STD-002 Category 1
Solder heat withstand	RXEF017- RXEF025: per IEC-STD 68-2-20, Test Tb, Method 1a, condition a; can withstand 5 seconds at 260°C ±5°C All other sizes: per IEC-STD 68-2-20, Test Tb, Method 1a, condition b; can withstand 5 seconds at 260°C ±5°C
Insulating material	Cured, flame-retardant epoxy polymer; meets UL 94V-0

Devices are not designed to be placed through a reflow process.

Environmental Specifications

Test	Conditions	Resistance Change
Passive aging	-40°C, 1000 hours	±5%
	85°C, 1000 hours	±5%
Humidity aging	85°C, 85%RH, 1000 hours	±10%
Thermal Shock	85°C, -40°C (10 times)	±10%
Solvent resistance	MIL-STD-202, Method 215F	No change

Table R5 Physical Characteristics and Environmental Specifications for Radial-leaded Devices ... Cont'd**RTEF****Physical Characteristics**

Lead material	Tin-plated copper-clad steel, 0.205mm ² (24AWG), ø0.51mm (0.020in.)
Soldering characteristics	Solderability per ANSI/J-STD-002 Category 3
Solder heat withstand	per IEC-STD 68-2-20, Test Tb, Method 1A, Condition B; can withstand 10 seconds at 260°C ±5°C
Insulating material	Cured, flame-retardant epoxy polymer; meets UL 94V-0

Environmental Specifications

Test	Conditions	Resistance Change
Passive aging	70°C, 1000 hours	±5%
	85°C, 1000 hours	±5%
Humidity aging	85°C, 85%RH, 1000 hours	±5%
Thermal Shock	85°C, -40°C (10 times)	±5%
Solvent resistance	MIL-STD-202, Method 215F	No change

RUEF**Physical Characteristics**

Lead material	RUEF090 to RUEF250: Tin-plated copper-clad steel, 0.205mm ² (24AWG)
	RUEF300 to RUEF900: Tin-plated copper, 0.52mm ² (20AWG), ø0.81mm (0.032in.)
Soldering characteristics	Solderability per ANSI/J-STD-002 Category 3
Solder heat withstand	per IEC-STD 68-2-20, Test Tb, Method 1A, Condition B, can withstand 10 seconds at 260°C ±5°C
Insulating material	Cured, flame-retardant epoxy polymer; meets UL 94V-0

Devices are not designed to be placed through a reflow process.

Environmental Specifications

Test	Conditions	Resistance Change
Passive aging	70°C, 1000 hours	±5%
	85°C, 1000 hours	±5%
Humidity aging	85°C, 85%RH, 1000 hours	±5%
Thermal Shock	85°C, -40°C (10 times)	±5%
Solvent resistance	MIL-STD-202, Method 215F	No change

RUSBF**Physical Characteristics**

Lead material	RUSBF075: Tin-plated nickel-copper alloy, 0.205mm ² (24AWG), ø0.51mm/0.020in.
	RUSBF090 to RUSBF250: Tin-plated copper clad-steel, 0.205mm ² (24AWG), ø0.51mm/0.020in.
Soldering characteristics	Solderability per ANSI/J-STD-002 Category 3 except RUSBF075 meet ANSI/J-STD-002 Category 1
Solder heat withstand	RUSBF120: per IEC-STD 68-2-20, Test Tb, Method 1A, Condition A; can withstand 5 seconds at 260°C ±5°C All others: per IEC-STD 68-2-20, Test Tb, Method 1A, Condition B; can withstand 10 seconds at 260°C ±5°C
Insulating material	Cured, flame-retardant epoxy polymer; meets UL 94V-0

Devices are not designed to be placed through a reflow process.

Environmental Specifications

Test	Conditions	Resistance Change
Passive aging	70°C, 1000 hours	±5%
	85°C, 1000 hours	±5%
Humidity aging	85°C, 85%RH, 1000 hours	±5%
Thermal Shock	85°C, -40°C (10 times)	±5%
Solvent resistance	MIL-STD-202, Method 215F	No change

RGEF
Physical Characteristics

Lead material	RGEF300 to RGEF1100 : Tin-plated copper, 0.52mm ² (20AWG), ø0.81mm/0.032in. RGEF1200 to RGEF1400 : Tin-plated copper, 0.82mm ² (18AWG), ø1.0mm/0.04in.
Soldering characteristics	Solderability per ANSI/J-STD-002 Category 3
Solder heat withstand	RGEF300 and RGEF400: per IEC 68-2-20, Test Tb, Method 1a, condition a; can withstand 5 seconds at 260°C ±5°C RGEF500 to RGEF1400: per IEC 68-2-20, Test Tb, Method 1a, condition b; can withstand 10 seconds at 260°C ±5°C
Insulating material	Cured, flame-retardant epoxy polymer; meets UL 94V-0

Devices are not designed to be placed through a reflow process.

Environmental Specifications

Test	Conditions	Resistance Change
Passive aging	-40°C, 1000 hours	±5%
	85°C, 1000 hours	±5%
Humidity aging	85°C, 85%RH, 1000 hours	±5%
Thermal Shock	85°C, -40°C (10 times)	±5%
Solvent resistance	MIL-STD-202, Method 215F	No change

RHEF
Physical Characteristics

Lead material	RHEF050 to RHEF200 : Tin-plated copper clad steel, 0.205mm ² (24AWG), ø0.51mm/0.020in. RHEF300 to RHEF1100 : Tin-plated copper, 0.52mm ² (20AWG), ø0.81mm/0.032in. RHEF1300 to RHEF1500 : Tin-plated copper, 0.82mm ² (18AWG), ø1.0mm/0.04in.
Soldering characteristics	Solderability per ANSI/J-STD-002 Category 3
Solder heat withstand	per IEC 68-2-20, Test Tb, Method 1A, Condition B; can withstand 10 seconds at 260°C ±5°C
Insulating material	Cured, flame-retardant epoxy polymer; meets UL 94V-0

Devices are not designed to be placed through a reflow process.

Environmental Specifications

Test	Conditions	Resistance Change
Passive aging	70°C, 1000 hours	±5%
	85°C, 1000 hours	±5%
Humidity aging	85°C, 85%RH, 1000 hours	±5%
Thermal Shock	125°C, -40°C (10 times)	±5%
Solvent resistance	MIL-STD-202, Method 215F	No change

Notes:

Storage conditions: 40°Cmax., 70% RH max.; devices should remain in original sealed bags prior to use. Devices may not meet specified values if these storage conditions are exceeded. For the TR devices series, see the telecommunications and networking devices section on page 184.

Agency Recognitions for Radial-leaded Devices

UL	File # E74889
CSA	File # CA78165
TÜV	Certificate number available on request (per IEC 60730-1).

Table R6 Packaging and Marking Information for Radial-leaded Devices

Part Number	Bag Quantity	Tape & Reel Quantity	Ammo Pack Quantity	Standard Package Quantity	Part Marking	Agency Recognition
LVR/LVRL 240V_{AC}/120V_{AC}						
LVR005K	500	—	—	10,000	L005	UL, CSA, TÜV
LVR005K-2	—	2,000	—	10,000	L005	UL, CSA, TÜV
LVR005S	500	—	—	10,000	L005	UL, CSA, TÜV
LVR005S-2	—	2,000	—	10,000	L005	UL, CSA, TÜV
LVR008K	500	—	—	10,000	L008	UL, CSA, TÜV
LVR008K-2	—	2,000	—	10,000	L008	UL, CSA, TÜV
LVR008S	500	—	—	10,000	L008	UL, CSA, TÜV
LVR008S-2	—	2,000	—	10,000	L008	UL, CSA, TÜV
LVR012K	500	—	—	10,000	L012	UL, CSA, TÜV
LVR012K-2	—	2,000	—	10,000	L012	UL, CSA, TÜV
LVR012S	500	—	—	10,000	L012	UL, CSA, TÜV
LVR012S-2	—	2,000	—	10,000	L012	UL, CSA, TÜV
LVR016K	500	—	—	10,000	L016	UL, CSA, TÜV
LVR016K-2	—	2,000	—	10,000	L016	UL, CSA, TÜV
LVR016S	500	—	—	10,000	L016	UL, CSA, TÜV
LVR016S-2	—	2,000	—	10,000	L016	UL, CSA, TÜV
LVR025K	500	—	—	10,000	L025	UL, CSA, TÜV
LVR025K-2	—	2,000	—	10,000	L025	UL, CSA, TÜV
LVR025S	500	—	—	10,000	L025	UL, CSA, TÜV
LVR025S-2	—	2,000	—	10,000	L025	UL, CSA, TÜV
LVR033K	500	—	—	10,000	L033	UL, CSA, TÜV
LVR033K-2	—	2,000	—	10,000	L033	UL, CSA, TÜV
LVR033S	500	—	—	10,000	L033	UL, CSA, TÜV
LVR033S-2	—	2,000	—	10,000	L033	UL, CSA, TÜV
LVR040K	500	—	—	10,000	L040	UL, CSA, TÜV
LVR040K-2	—	2,000	—	10,000	L040	UL, CSA, TÜV
LVR040S	500	—	—	10,000	L040	UL, CSA, TÜV
LVR040S-2	—	2,000	—	10,000	L040	UL, CSA, TÜV
LVR055K	500	—	—	10,000	L055	UL, CSA, TÜV
LVR055S	500	—	—	10,000	L055	UL, CSA, TÜV
NEW LVR075S	500	—	—	10,000	L075	UL, CSA, TÜV
NEW LVR100S	500	—	—	10,000	L100	UL, CSA, TÜV
NEW LVR125S	500	—	—	10,000	L125	UL, CSA, TÜV
NEW LVR200S	500	—	—	10,000	L200	UL, CSA, TÜV
NEW LVRL075S	500	—	—	10,000	L075	UL, CSA, TÜV
NEW LVRL100S	500	—	—	10,000	L100	UL, CSA, TÜV
NEW LVRL125S	500	—	—	10,000	L125	UL, CSA, TÜV
NEW LVRL135S	500	—	—	10,000	L135	UL, CSA, TÜV
NEW LVRL200S	250	—	—	5,000	L200	UL, CSA, TÜV
BBRF 99V						
BBRF550	500	—	—	10,000	BF550	UL, CSA
BBRF550-2	—	1,500	—	7,500	BF550	UL, CSA
BBRF750	500	—	—	10,000	BF750	UL, CSA
BBRF750-2	—	1,500	—	7,500	BF750	UL, CSA
RXEF 60V						
RXEF005	500	—	—	10,000	—	UL, CSA, TÜV
RXEF005-2	—	3,000	—	15,000	—	UL, CSA, TÜV
RXEF005-AP	—	—	2,000	10,000	—	UL, CSA, TÜV
RXEF010	500	—	—	10,000	XF010	UL, CSA, TÜV
RXEF010-2	—	3,000	—	15,000	XF010	UL, CSA, TÜV
RXEF010-AP	—	—	2,000	10,000	XF010	UL, CSA, TÜV
RXEF017	500	—	—	10,000	XF017	UL, CSA, TÜV
RXEF017-2	—	2,500	—	12,500	XF017	UL, CSA, TÜV
RXEF017-AP	—	—	2,000	10,000	XF017	UL, CSA, TÜV

Table R6 Packaging and Marking Information for Radial-leaded Devices

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Part Number	Bag Quantity	Tape & Reel Quantity	Ammo Pack Quantity	Standard Package Quantity	Part Marking	Agency Recognition
 RXEF 72V						
RXEF020	500	—	—	10,000	XF020	UL, CSA, TÜV
RXEF020-2	—	3,000	—	15,000	XF020	UL, CSA, TÜV
RXEF020-AP	—	—	2,000	10,000	XF020	UL, CSA, TÜV
RXEF025	500	—	—	10,000	XF025	UL, CSA, TÜV
RXEF025-2	—	3,000	—	15,000	XF025	UL, CSA, TÜV
RXEF025-AP	—	—	2,000	10,000	XF025	UL, CSA, TÜV
RXEF030	500	—	—	10,000	XF030	UL, CSA, TÜV
RXEF030-2	—	3,000	—	15,000	XF030	UL, CSA, TÜV
RXEF030-AP	—	—	2,000	10,000	XF030	UL, CSA, TÜV
RXEF040	500	—	—	10,000	XF040	UL, CSA, TÜV
RXEF040-2	—	3,000	—	15,000	XF040	UL, CSA, TÜV
RXEF040-AP	—	—	2,000	10,000	XF040	UL, CSA, TÜV
RXEF050	500	—	—	10,000	XF050	UL, CSA, TÜV
RXEF050-2	—	3,000	—	15,000	XF050	UL, CSA, TÜV
RXEF050-AP	—	—	2,000	10,000	XF050	UL, CSA, TÜV
RXEF065	500	—	—	10,000	XF065	UL, CSA, TÜV
RXEF065-2	—	3,000	—	15,000	XF065	UL, CSA, TÜV
RXEF065-AP	—	—	2,000	10,000	XF065	UL, CSA, TÜV
RXEF075	500	—	—	10,000	XF075	UL, CSA, TÜV
RXEF075-2	—	3,000	—	15,000	XF075	UL, CSA, TÜV
RXEF075-AP	—	—	2,000	10,000	XF075	UL, CSA, TÜV
RXEF090	500	—	—	10,000	XF090	UL, CSA, TÜV
RXEF090-2	—	3,000	—	15,000	XF090	UL, CSA, TÜV
RXEF090-AP	—	—	2,000	10,000	XF090	UL, CSA, TÜV
RXEF110	500	—	—	10,000	XF110	UL, CSA, TÜV
RXEF110-2	—	1,500	—	7,500	XF110	UL, CSA, TÜV
RXEF110-AP	—	—	1,000	5,000	XF110	UL, CSA, TÜV
RXEF135	500	—	—	10,000	XF135	UL, CSA, TÜV
RXEF135-2	—	1,500	—	7,500	XF135	UL, CSA, TÜV
RXEF135-AP	—	—	1,000	5,000	XF135	UL, CSA, TÜV
RXEF160	500	—	—	10,000	XF160	UL, CSA, TÜV
RXEF160-2	—	1,500	—	7,500	XF160	UL, CSA, TÜV
RXEF160-AP	—	—	1,000	5,000	XF160	UL, CSA, TÜV
RXEF185	500	—	—	10,000	XF185	UL, CSA, TÜV
RXEF185-2	—	1,500	—	7,500	XF185	UL, CSA, TÜV
RXEF185-AP	—	—	1,000	5,000	XF185	UL, CSA, TÜV
RXEF250	250	—	—	5,000	XF250	UL, CSA, TÜV
RXEF250-2	—	1,000	—	5,000	XF250	UL, CSA, TÜV
RXEF250-AP	—	—	1,000	5,000	XF250	UL, CSA, TÜV
RXEF300	250	—	—	5,000	XF300	UL, CSA, TÜV
RXEF300-2	—	1,000	—	5,000	XF300	UL, CSA, TÜV
RXEF300-AP	—	—	1,000	5,000	XF300	UL, CSA, TÜV
RXEF375	250	—	—	5,000	XF375	UL, CSA, TÜV
 RTEF 33V						
RTEF120	500	—	—	10,000	TF120	UL, CSA, TÜV
RTEF120-2	—	3,000	—	15,000	TF120	UL, CSA, TÜV
RTEF120-AP	—	—	2,000	10,000	TF120	UL, CSA, TÜV
RTEF135	500	—	—	10,000	TF135	UL, CSA, TÜV
RTEF135-2	—	3,000	—	15,000	TF135	UL, CSA, TÜV
RTEF135-AP	—	—	2,000	10,000	TF135	UL, CSA, TÜV
RTEF190	500	—	—	10,000	TF190	UL, CSA, TÜV
RTEF190-2	—	3,000	—	15,000	TF190	UL, CSA, TÜV
RTEF190-AP	—	—	2,000	10,000	TF190	UL, CSA, TÜV

Table R6 Packaging and Marking Information for Radial-leaded Devices

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Part Number	Bag Quantity	Tape & Reel Quantity	Ammo Pack Quantity	Standard Package Quantity	Part Marking	Agency Recognition
 RUEF 30V						
RUEF090	500	—	—	10,000	UF090	UL, CSA, TÜV, CQC
RUEF090-2	—	3,000	—	15,000	UF090	UL, CSA, TÜV, CQC
RUEF090-AP	—	—	2,000	10,000	UF090	UL, CSA, TÜV, CQC
RUEF110	500	—	—	10,000	UF110	UL, CSA, TÜV, CQC
RUEF110-2	—	3,000	—	15,000	UF110	UL, CSA, TÜV, CQC
RUEF110-AP	—	—	2,000	10,000	UF110	UL, CSA, TÜV, CQC
RUEF135	500	—	—	10,000	UF135	UL, CSA, TÜV, CQC
RUEF135-2	—	3,000	—	15,000	UF135	UL, CSA, TÜV, CQC
RUEF135-AP	—	—	2,000	10,000	UF135	UL, CSA, TÜV, CQC
RUEF160	500	—	—	10,000	UF160	UL, CSA, TÜV, CQC
RUEF160-2	—	3,000	—	15,000	UF160	UL, CSA, TÜV, CQC
RUEF160-AP	—	—	2,000	10,000	UF160	UL, CSA, TÜV, CQC
RUEF185	500	—	—	10,000	UF185	UL, CSA, TÜV, CQC
RUEF185-2	—	3,000	—	15,000	UF185	UL, CSA, TÜV, CQC
RUEF185-AP	—	—	2,000	10,000	UF185	UL, CSA, TÜV, CQC
RUEF250	500	—	—	10,000	UF250	UL, CSA, TÜV, CQC
RUEF250-2	—	3,000	—	15,000	UF250	UL, CSA, TÜV, CQC
RUEF250-AP	—	—	2,000	10,000	UF250	UL, CSA, TÜV, CQC
RUEF300	500	—	—	10,000	UF300	UL, CSA, TÜV, CQC
RUEF300-2	—	2,500	—	12,500	UF300	UL, CSA, TÜV, CQC
RUEF300-AP	—	—	1,000	5,000	UF300	UL, CSA, TÜV, CQC
RUEF400	500	—	—	10,000	UF400	UL, CSA, TÜV, CQC
RUEF400-2	—	1,500	—	7,500	UF400	UL, CSA, TÜV, CQC
RUEF400-AP	—	—	1,000	5,000	UF400	UL, CSA, TÜV, CQC
RUEF500	250	—	—	5,000	UF500	UL, CSA, TÜV, CQC
RUEF500-2	—	1,500	—	7,500	UF500	UL, CSA, TÜV, CQC
RUEF500-AP	—	—	1,000	5,000	UF500	UL, CSA, TÜV, CQC
RUEF600	250	—	—	5,000	UF600	UL, CSA, TÜV, CQC
RUEF600-2	—	1,000	—	5,000	UF600	UL, CSA, TÜV, CQC
RUEF600-AP	—	—	1,000	5,000	UF600	UL, CSA, TÜV, CQC
RUEF700	250	—	—	5,000	UF700	UL, CSA, TÜV, CQC
RUEF700-2	—	1,000	—	5,000	UF700	UL, CSA, TÜV, CQC
RUEF700-AP	—	—	1,000	5,000	UF700	UL, CSA, TÜV, CQC
RUEF800	250	—	—	5,000	UF800	UL, CSA, TÜV, CQC
RUEF800-2	—	1,000	—	5,000	UF800	UL, CSA, TÜV, CQC
RUEF800-AP	—	—	1,000	5,000	UF800	UL, CSA, TÜV, CQC
RUEF900	250	—	—	5,000	UF900	UL, CSA, TÜV, CQC
RUEF900-2	—	1,000	—	4,000	UF900	UL, CSA, TÜV, CQC
RUEF900-AP	—	—	1,000	4,000	UF900	UL, CSA, TÜV, CQC
 RHEF 30V - High Temperature						
RHEF050	500	—	—	10,000	HF0.5	UL, CSA, TÜV
RHEF050-2	—	2,500	—	12,500	HF0.7	UL, CSA, TÜV
RHEF070	500	—	—	10,000	HF0.7	UL, CSA, TÜV
RHEF070-2	—	2,500	—	12,500	HF0.7	UL, CSA, TÜV
RHEF100	500	—	—	10,000	HF1.0	UL, CSA, TÜV
RHEF100-2	—	3,000	—	15,000	HF1.0	UL, CSA, TÜV
 RUSBF 16V						
RUSBF090	500	—	—	10,000	RF090	UL, CSA, TÜV
RUSBF090-2	—	3,000	—	15,000	RF090	UL, CSA, TÜV
RUSBF090-AP	—	—	2,000	10,000	RF090	UL, CSA, TÜV
RUSBF110	500	—	—	10,000	RF110	UL, CSA, TÜV
RUSBF110-2	—	3,000	—	15,000	RF110	UL, CSA, TÜV
RUSBF110-AP	—	—	2,000	10,000	RF110	UL, CSA, TÜV

Table R6 Packaging and Marking Information for Radial-leaded Devices

... Cont'd

Part Number	Bag Quantity	Tape & Reel Quantity	Ammo Pack Quantity	Standard Package Quantity	Part Marking	Agency Recognition
 RUSBF						
16V						
RUSBF135	500	—	—	10,000	RF135	UL, CSA, TÜV
RUSBF135-2	—	3,000	—	15,000	RF135	UL, CSA, TÜV
RUSBF135-AP	—	—	2,000	10,000	RF135	UL, CSA, TÜV
RUSBF160	500	—	—	10,000	RF160	UL, CSA, TÜV
RUSBF160-2	—	3,000	—	15,000	RF160	UL, CSA, TÜV
RUSBF160-AP	—	—	2,000	10,000	RF160	UL, CSA, TÜV
RUSBF185	500	—	—	10,000	RF185	UL, CSA, TÜV
RUSBF185-2	—	3,000	—	15,000	RF185	UL, CSA, TÜV
RUSBF185-AP	—	—	2,000	10,000	RF185	UL, CSA, TÜV
RUSBF250	500	—	—	10,000	RF250	UL, CSA, TÜV
RUSBF250-2	—	3,000	—	15,000	RF250	UL, CSA, TÜV
RUSBF250-AP	—	—	2,000	10,000	RF250	UL, CSA, TÜV
 RGEF						
16V						
RGEF250	500	—	—	10,000	GF250	UL, CSA, TÜV
RGEF250-2	—	3,000	—	15,000	GF250	UL, CSA, TÜV
RGEF250-AP	—	—	2,000	10,000	GF250	UL, CSA, TÜV
RGEF300	500	—	—	10,000	GF300	UL, CSA, TÜV
RGEF300-2	—	2,500	—	12,500	GF300	UL, CSA, TÜV
RGEF300-AP	—	—	2,000	10,000	GF300	UL, CSA, TÜV
RGEF400	500	—	—	10,000	GF400	UL, CSA, TÜV
RGEF400-2	—	2,500	—	12,500	GF400	UL, CSA, TÜV
RGEF400-AP	—	—	2,000	10,000	GF400	UL, CSA, TÜV
RGEF500	500	—	—	10,000	GF500	UL, CSA, TÜV
RGEF500-2	—	2,000	—	10,000	GF500	UL, CSA, TÜV
RGEF500-AP	—	—	2,000	10,000	GF500	UL, CSA, TÜV
RGEF600	500	—	—	10,000	GF600	UL, CSA, TÜV
RGEF600-2	—	2,000	—	10,000	GF600	UL, CSA, TÜV
RGEF600-AP	—	—	2,000	10,000	GF600	UL, CSA, TÜV
RGEF700	500	—	—	10,000	GF700	UL, CSA, TÜV
RGEF700-2	—	1,500	—	7,500	GF700	UL, CSA, TÜV
RGEF700-AP	—	—	1,500	7,500	GF700	UL, CSA, TÜV
RGEF800	500	—	—	10,000	GF800	UL, CSA, TÜV
RGEF800-2	—	1,000	—	5,000	GF800	UL, CSA, TÜV
RGEF800-AP	—	—	1,000	5,000	GF800	UL, CSA, TÜV
RGEF900	500	—	—	10,000	GF900	UL, CSA, TÜV
RGEF900-2	—	1,000	—	5,000	GF900	UL, CSA, TÜV
RGEF900-AP	—	—	1,000	5,000	GF900	UL, CSA, TÜV
RGEF1000	250	—	—	5,000	GF1000	UL, CSA, TÜV
RGEF1000-2	—	1,000	—	5,000	GF1000	UL, CSA, TÜV
RGEF1000-AP	—	—	1,000	5,000	GF1000	UL, CSA, TÜV
RGEF1100	250	—	—	5,000	GF1100	UL, CSA, TÜV
RGEF1100-2	—	1,000	—	5,000	GF1100	UL, CSA, TÜV
RGEF1100-AP	—	—	1,000	5,000	GF1100	UL, CSA, TÜV
RGEF1200	250	—	—	5,000	GF1200	UL, CSA, TÜV
RGEF1200-2	—	1,000	—	5,000	GF1200	UL, CSA, TÜV
RGEF1200-AP	—	—	1,000	5,000	GF1200	UL, CSA, TÜV
RGEF1400	250	—	—	5,000	GF1400	UL, CSA, TÜV
RGEF1400-2	—	1,000	—	5,000	GF1400	UL, CSA, TÜV
RGEF1400-AP	—	—	1,000	5,000	GF1400	UL, CSA, TÜV
 RHEF						
16V - High Temperature						
RHEF200	500	—	—	10,000	HF2	UL, CSA, TÜV
RHEF200-2	—	2,500	—	12,500	HF2	UL, CSA, TÜV
RHEF200-AP	—	—	2,500	12,500	HF2	UL, CSA, TÜV
 RHEF300	500	—	—	10,000	HF3	UL, CSA, TÜV
RHEF300-2	—	2,000	—	10,000	HF3	UL, CSA, TÜV

Table R6 Packaging and Marking Information for Radial-leaded Devices

... Cont'd

Part Number	Bag Quantity	Tape & Reel Quantity	Ammo Pack Quantity	Standard Package Quantity	Part Marking	Agency Recognition
 RHEF 16V - High Temperature						
RHEF300-AP	—	—	2,000	10,000	HF3	UL, CSA, TÜV
RHEF400	500	—	—	10,000	HF4	UL, CSA, TÜV
RHEF400-2	—	1,500	—	7,500	HF4	UL, CSA, TÜV
RHEF400-AP	—	—	1,500	7,500	HF4	UL, CSA, TÜV
RHEF450	500	—	—	10,000	HF4.5	UL, CSA, TÜV
RHEF450-2	—	1,500	—	7,500	HF4.5	UL, CSA, TÜV
RHEF450-AP	—	—	1,500	7,500	HF4.5	UL, CSA, TÜV
NEW RHEF550	500	—	—	10,000	HF5.5	UL, CSA, TÜV
RHEF550-2	—	2,000	—	10,000	HF5.5	UL, CSA, TÜV
RHEF550-AP	—	—	2,000	10,000	HF5.5	UL, CSA, TÜV
RHEF600	500	—	—	10,000	HF6	UL, CSA, TÜV
RHEF600-2	—	1,500	—	7,500	HF6	UL, CSA, TÜV
RHEF600-AP	—	—	1,500	7,500	HF6	UL, CSA, TÜV
RHEF650	500	—	—	10,000	HF6.5	UL, CSA, TÜV
RHEF650-2	—	1,500	—	7,500	HF6.5	UL, CSA, TÜV
RHEF650-AP	—	—	1,500	7,500	HF6.5	UL, CSA, TÜV
NEW RHEF700	500	—	—	10,000	HF7	UL, CSA, TÜV
RHEF700-2	—	1,500	—	7,500	HF7	UL, CSA, TÜV
RHEF700-AP	—	—	1,500	7,500	HF7	UL, CSA, TÜV
RHEF750	500	—	—	10,000	HF7.5	UL, CSA, TÜV
RHEF750-2	—	1,000	—	5,000	HF7.5	UL, CSA, TÜV
RHEF750-AP	—	—	1,000	5,000	HF7.5	UL, CSA, TÜV
NEW RHEF800	500	—	—	10,000	HF8	UL, CSA, TÜV
RHEF800-2	—	1,000	—	5,000	HF8	UL, CSA, TÜV
RHEF800-AP	—	—	1,000	5,000	HF8	UL, CSA, TÜV
RHEF900	250	—	—	5,000	HF9	UL, CSA, TÜV
RHEF900-2	—	1,000	—	5,000	HF9	UL, CSA, TÜV
RHEF900-AP	—	—	1,000	5,000	HF9	UL, CSA, TÜV
RHEF1000	250	—	—	5,000	HF10	UL, CSA, TÜV
RHEF1000-2	—	1,000	—	5,000	HF10	UL, CSA, TÜV
RHEF1000-AP	—	—	1,000	5,000	HF10	UL, CSA, TÜV
NEW RHEF1100	250	—	—	5,000	HF11	UL, CSA, TÜV
RHEF1100-2	—	1,000	—	5,000	HF11	UL, CSA, TÜV
RHEF1100-AP	—	—	1,000	5,000	HF11	UL, CSA, TÜV
RHEF1300	250	—	—	5,000	HF13	UL, CSA, TÜV
RHEF1300-2	—	1,000	—	5,000	HF13	UL, CSA, TÜV
RHEF1300-AP	—	—	1,000	5,000	HF13	UL, CSA, TÜV
NEW RHEF1400	250	—	—	5,000	HF14	UL, CSA, TÜV
RHEF1400-2	—	1,000	—	5,000	HF14	UL, CSA, TÜV
RHEF1400-AP	—	—	1,000	5,000	HF14	UL, CSA, TÜV
RHEF1500	250	—	—	5,000	HF15	UL, CSA, TÜV
RHEF1500-2	—	1,000	—	5,000	HF15	UL, CSA, TÜV
RHEF1500-AP	—	—	1,000	5,000	HF15	UL, CSA, TÜV
 RUSBF 6V						
RUSBF075	500	—	—	10,000	RF075	UL, CSA, TÜV
RUSBF075-2	—	3,000	—	15,000	RF075	UL, CSA, TÜV
RUSBF075-AP	—	—	2,500	12,500	RF075	UL, CSA, TÜV
RUSBF120	500	—	—	10,000	RF120	UL, CSA, TÜV
RUSBF120-2	—	3,000	—	15,000	RF120	UL, CSA, TÜV
RUSBF120-AP	—	—	2,000	10,000	RF120	UL, CSA, TÜV
RUSBF155	500	—	—	10,000	RF155	UL, CSA, TÜV
RUSBF155-2	—	3,000	—	15,000	RF155	UL, CSA, TÜV
RUSBF155-AP	—	—	2,000	10,000	RF155	UL, CSA, TÜV

Table R7 Tape and Reel Specifications for Radial-leaded Devices

LVR, RXEF and BBRF devices are available in tape and reel packaging per EIA468-B/IEC60286-2 standards.
See Figures R26 and R27 for details.

Description	EIA Mark	Dimension (mm)	Tolerance
Carrier tape width	W	18	-0.5/+1.0
Hold-down tape width	W ₄	11	Minimum
Top distance between tape edges	W ₆	3	Maximum
Sprocket hole position	W ₅	9	-0.5/+0.75
Sprocket hole diameter	D ₀	4	± 0.2
Abscissa to plane (straight lead) RXEF110 to RXEF300, LVR005 to LVR016	H	18.5	± 2.5
Abscissa to plane (kinked lead) RXEF010 to RXEF090, BBRF550, BBRF750, LVR005 to LVR016	H ₀	16.0	± 0.5
Abscissa to top RXEF010 to RXEF090, BBRF550, BBRF750, LVR005 to LVR016	H ₁	32.2	Maximum
Abscissa to top* RXEF110 to RXEF300	H ₁	47.5	Maximum
Overall width with lead protrusion RXEF010 to RXEF090, BBRF550, BBRF750, LVR005 to LVR016	C ₁	43.2	Maximum
Overall width with lead protrusion* RXEF110 to RXEF300	C ₁	58	Maximum
Overall width without lead protrusion RXEF010 to RXEF090, BBRF550, BBRF750, LVR005 to LVR016	C ₂	42.5	Maximum
Overall width without lead protrusion* RXEF110 to RXEF300	C ₂	57	Maximum
Lead protrusion	L ₁	1.0	Maximum
Protrusion of cut-out	L	11.0	Maximum
Protrusion beyond hold-down tape	I ₂	Not specified	—
Sprocket hole pitch	P ₀	12.7	± 0.3
Device pitch RXEF010 to RXEF090, BBRF550, BBRF750, LVR005 to LVR016	—	12.7	± 0.3
Device pitch RXEF110 to RXEF300	—	25.4	± 0.61
Pitch tolerance	—	20 consecutive	± 1
Tape thickness	t	0.9	Maximum
Overall tape and lead thickness RXEF010 to RXEF090, LVR005 to LVR016	t ₁	1.5	Maximum
Overall tape and lead thickness RXEF110 to RXEF300, BBRF550, BBRF750*	t ₁	2.3	Maximum
Splice sprocket hole alignment	—	0	± 0.3
Body lateral deviation	Δh	0	± 1.0
Body tape plane deviation	Δp	0	± 1.3
Ordinate to adjacent component lead RXEF010 to RXEF090, BBRF550, BBRF750, LVR005 to LVR016	P ₁	3.81	± 0.7
Ordinate to adjacent component lead RXEF110 to RXEF300	P ₁	7.62	± 0.7
Lead spacing* RXEF010 to RXEF185, BBRF550, BBRF750, LVR005 to LVR016	F	5.08	+0.75/-0.5
Lead spacing* RXEF250 to RXEF300	F	10.2	+0.75/-0.5
Reel width RXEF010 to RXEF090, LVR005 to LVR016	w ₂	56.0	Maximum
Reel width* RXEF110 to RXEF300	w ₂	63.5	Maximum
Reel diameter	a	370.0	Maximum
Space between flanges less device	w ₁	4.75	± 3.25
Arbor hold diameter	c	26.0	± 12.0
Core diameter*	n	91.0	Maximum
Box	—	64/372/362	Maximum
Consecutive missing places	—	None	—
Empty places per reel	—	0.1%	Maximum

*Differs from EIA specification.

Table R7 Tape and Reel Specifications for Radial-leaded Devices

... Cont'd

LVR, RUEF, RTEF and RUSBF devices are available in tape and reel packaging per EIA468-B/IEC60286-2 standards. See Figures R26 and R27 for details.

Description	EIA Mark	Dimension (mm)	Tolerance
Carrier tape width	W	18	-0.5/+1.0
Hold-down tape width	W ₄	11	Minimum
Top distance between tape edges	W ₆	3	Maximum
Sprocket hole position	W ₅	9	-0.5/+0.75
Sprocket hole diameter	D ₀	4	± 0.2
Abscissa to plane (straight lead)* RUEF300 to RUEF900, LVR025 to LVR055	H	18.5	± 2.5
Abscissa to plane (kinked lead) RUSBF075 to RUSBF250, RUEF090 to RUEF250, RTEF120 to RTEF190, LVR025 to LVR055	H ₀	16.0	± 0.5
Abscissa to top RUSBF075 to RUSBF250, RUEF090 to RUEF300, RTEF120 to RTEF190	H ₁	32.2	Maximum
Abscissa to top* RUEF400 to RUEF900, LVR025 to LVR055	H ₁	45.0	Maximum
Overall width w/lead protrusion RUSBF075 to RUSBF250, RUEF090 to RUEF300, RTEF120 to RTEF190	C ₁	43.2	Maximum
Overall width w/ lead protrusion RUEF400 to RUEF900, LVR025 to LVR055	C ₁	56	Maximum
Overall width w/o lead protrusion RUSBF075 to RUSBF250, RUEF090 to RUEF300, RTEF120 to RTEF190	C ₂	42.5	Maximum
Overall width w/o lead protrusion RUEF400 to RUEF900, LVR025 to LVR055	C ₂	56	Maximum
Lead protrusion	L ₁	1.0	Maximum
Protrusion of cut-out	L	11	Maximum
Protrusion beyond hold-down tape	I ₂	Not specified	—
Sprocket hole pitch	P ₀	12.7	± 0.3
Device pitch RUSBF075 to RUSBF250, RUEF090 to RUEF300, RTEF120 to RTEF190, LVR025 to LVR040	—	12.7	± 0.3
Device pitch RUEF400 to RUEF900, LVR055	—	25.4	± 0.6
Pitch tolerance	—	20 consecutive	± 1
Tape thickness	t	0.9	Maximum
Overall tape and lead thickness RUSBF075 to RUSBF250, RUEF090 to RUEF250, RTEF120 to RTEF190, LVR025 to LVR040	t ₁	1.5	Maximum
Overall tape and lead thickness* RUEF300 to RUEF900, LVR055	t ₁	2.3	Maximum
Splice sprocket hole alignment	—	0	± 0.3
Body lateral deviation	Δh	0	± 1.0
Body tape plane deviation	Δp	0	± 1.3
Ordinate to adjacent component lead RUSBF075 to RUSBF250, RUEF090 to RUEF300, RTEF120 to RTEF190, LVR025 to LVR055	P ₁	3.81	± 0.7
Ordinate to adjacent component lead RUEF400 to RUEF900	P ₁	7.62	± 0.7
Lead spacing* RUSBF075 to RUSBF250, RUEF090 to RUEF400, RTEF120 to RTEF190, LVR025 to LVR040	F	5.08	+0.75/-0.5
Lead spacing* RUEF500 to RUEF900	F	10.2	+0.75/-0.5
Reel width RUEF090 to RUEF400, RUSBF075 to RUSBF250, RTEF120 to RTEF190, LVR025 to LVR040	w ₂	56.0	Maximum
Reel width RUEF500* to RUEF900, LVR055	w ₂	63.5	Maximum
Reel diameter	a	370.0	Maximum
Space between flanges less device	w ₁	4.75	± 3.25
Arbor hold diameter	c	26.0	± 12.0
Core diameter*	n	91.0	Maximum
Box	—	64/372/362	Maximum
Consecutive missing places	—	None	—
Empty places per reel	—	0.1%	Maximum

*Differs from EIA specification.

Table R7 Tape and Reel Specifications for Radial-leaded Devices

... Cont'd

RGEF and RHEF devices are available in tape and reel packaging per EIA468-B/IEC60286-2 standards.
See Figures R26 and R27 for details.

Description	EIA Mark	Dimension (mm)	Tolerance
Carrier tape width	W	18	-0.5/+1.0
Hold-down tape width	W_4	11	Minimum
Top distance between tape edges	W_6	3	Maximum
Sprocket hole position	W_5	9	-0.5/+0.75
Sprocket hole diameter	D_0	4	± 0.2
Abscissa to plane (straight lead) RGEF250 to RGEF1400	H	18.5	± 2.5
Abscissa to plane (kinked lead) RHEF050 to RHEF1500	H_0	16.0	± 0.5
Abscissa to top RGEF250 to RGEF600, RHEF050 to RHEF450	H_1	32.2	Maximum
Abscissa to top* RGEF700 to RGEF1400, RHEF600 to RHEF1500	H_1	45.0	Maximum
Overall width w/lead protrusion RGEF250 to RGEF600, RHEF050 to RHEF450	C_1	43.2	Maximum
Overall width w/lead protrusion RGEF700 to RGEF1400, RHEF600 to RHEF1500	C_1	55	Maximum
Overall width w/o lead protrusion RGEF250 to RGEF600, RHEF050 to RHEF450	C_2	42.5	Maximum
Overall width w/o lead protrusion RGEF700 to RGEF1400, RHEF600 to RHEF1500	C_2	54	Maximum
Lead protrusion	L_1	1.0	Maximum
Protrusion of cut-out	L	11	Maximum
Protrusion beyond hold-down tape	l_2	Not specified	—
Sprocket hole pitch	P_0	12.7	± 0.3
Device pitch RGEF250 to RGEF700, RHEF050 to RHEF600	—	25.4	± 0.61
Device pitch RGEF800 to RGEF1400, RHEF650 to RHEF1500	—	25.4	± 0.6
Pitch tolerance	—	20 consecutive	± 1
Tape thickness	t	0.9	Maximum
Overall tape and lead thickness* RGEF250 to RGEF1100, RHEF050 to RHEF1000	t_1	2.0	Maximum
Overall tape and lead thickness* RGEF1200 to RGEF1400, RHEF1300, RHEF1500	t_1	2.3	Maximum
Splice sprocket hole alignment	—	0	± 0.3
Body lateral deviation	Δh	0	± 1.0
Body tape plane deviation	Δp	0	± 1.3
Ordinate to adjacent component lead RGEF300 to RGEF1100, RHEF400 to RHEF750	P_1	3.81	± 0.7
Ordinate to adjacent component lead RGEF1200 to RGEF1400, RHEF1000 to RHEF1500	P_1	7.62	± 0.7
Lead spacing* RGEF250 to RGEF1100, RHEF050 to RHEF900	F	5.08	+0.75/-0.5
Lead spacing* RGEF1200 to RGEF1400, RHEF1000 to RHEF1500	F	10.2	+ 0.75/-0.5
Reel width RGEF250 to RGEF600, RHEF050 to RHEF450	w_2	56.0	Maximum
Reel width* RGEF600 to RGEF1400 & RHEF600 to RHEF1500	w_2	63.5	Maximum
Reel diameter	a	370.0	Maximum
Space between flanges less device*	w_1	4.75	± 3.25
Arbor hold diameter	c	26.0	± 12.0
Core diameter*	n	91.0	Maximum
Box	—	64/372/362	Maximum
Consecutive missing places	—	None	—
Empty places per reel	—	0.1%	Maximum

*Differs from EIA specification.

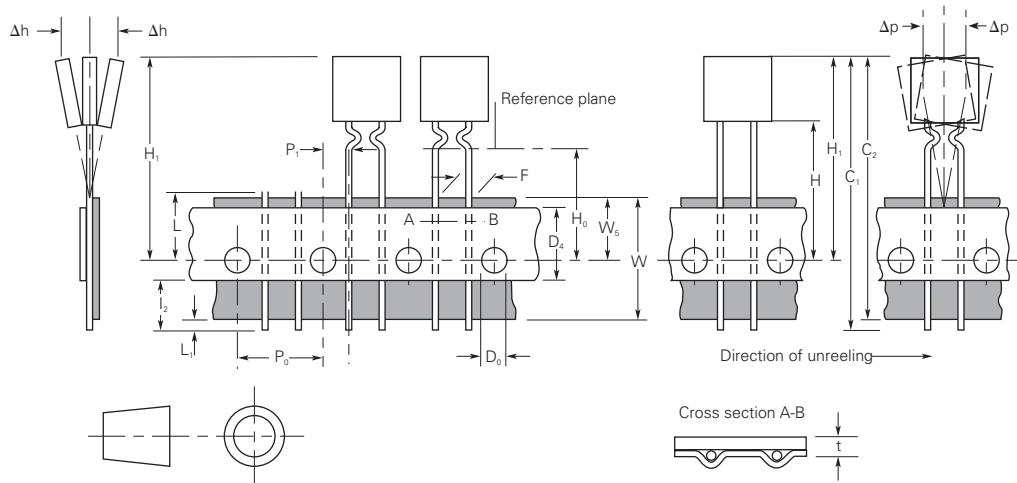
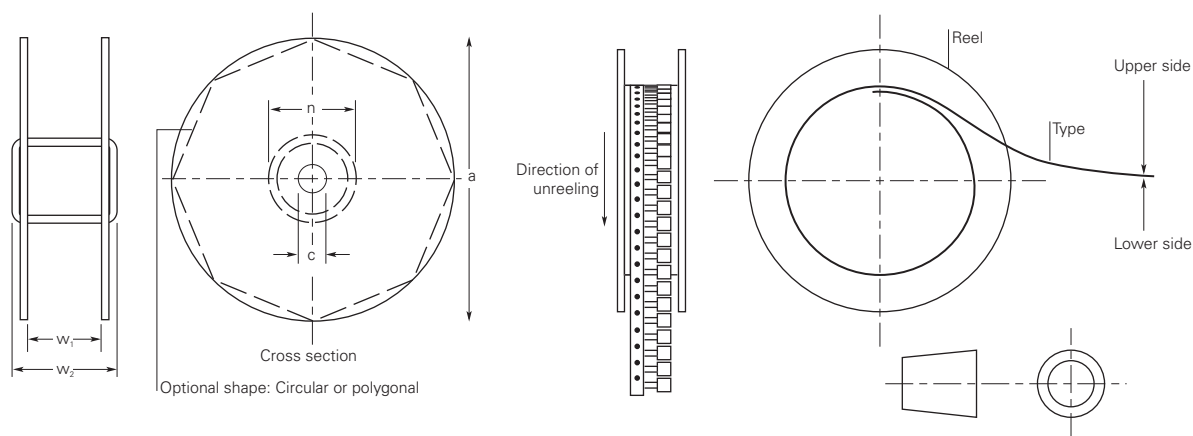
Figure R26 EIA Referenced Taped Component Dimensions for Radial-leaded Devices


Figure R27 EIA Referenced Reel Dimensions for Radial-leaded Devices

Part Numbering System for Radial-leaded Devices
RUEF 250 U 2
Packaging

Blank = Packaged in bags
-1 = 25.4mm (1.0 inch) minimum lead length
-2 = Tape and reel
-AP = Ammo pack
-X.X = Special lead cut length (inch)

Modifier

K = Standard kinked lead
B = Special kinked lead
S = Straight lead
U = Uncoated device

Hold Current Indicator
Product Series

An "F" at the end of product series indicates Pb-free version of product.

LVR 075 S 2
Packaging

Blank = Packaged in bags
-1 = 25.4mm (1.0 inch) minimum lead length
-2 = Tape and reel
-X.X = Special lead cut length (inch)

Modifier

K = Standard kinked lead
S = Straight lead

Hold Current Indicator
Product Series

LVR = 240V rated
LVRL = 120V rated



Warning : Application Limitations for the LVR Product Line

- 1) Users should independently evaluate the suitability of and test each product selected for their own application.
- 2) This product should not be used in an application where the maximum interrupt voltage or maximum interrupt current in a fault condition. Operation beyond the maximum ratings or improper use may result in device damage and possible electrical arcing and flame.
- 3) A PPTC device is not a fuse - it is a nonlinear thermistor that limits current. Because under a fault condition all PPTC devices go into a high resistance state but not open circuit, hazardous voltage may be present at PPTC locations.
- 4) The devices are intended for protection against occasional overcurrent or overtemperature fault conditions and should not be used when repeated fault conditions or prolonged trip events are anticipated.
- 5) In most applications, power must be removed and the fault condition cleared in order to reset a PPTC device. However, under certain unusual conditions, a PPTC device may automatically reset. Accordingly, PPTC devices should not be used in an application where an automatic reset could create a safety hazard, such as garbage disposals and blenders, appropriate qualification testing should be performed.
- 6) It is the responsibility of the user to determine the need for back up or fail safe protection to prevent damage that may occur in the event of abnormal function or failure of the PPTC device.
- 7) Operation in circuits with a large inductance can generate a circuit voltage ($L di/dt$) above the rated voltage of a PPTC device.
- 8) Devices are not recommended for reflow soldering.
- 9) Device performance can be impacted negatively if devices are handled in a manner inconsistent with recommended electronic, thermal, or mechanical procedures for electronic components.
- 10) PPTC devices are not recommended to be installed in applications where the device is constrained such that its PPTC properties are inhibited, for example in rigid potting materials or in rigid housings, which lack adequate clearance to accommodate device expansion.
- 11) Contamination of the PPTC material with certain silicone-based oils or some aggressive solvents can adversely impact the performance of the devices.



Warning :

- Operation beyond the maximum ratings or improper use may result in device damage and possible electrical arcing and flame.
- The devices are intended for protection against occasional overcurrent or overtemperature fault conditions and should not be used when repeated fault conditions or prolonged trip events are anticipated.
- Contamination of the PPTC material with certain silicon based oils or some aggressive solvents can adversely impact the performance of the devices.
- Device performance can be impacted negatively if devices are handled in a manner inconsistent with recommended electronic, thermal, and mechanical procedures for electronic components.
- Operation in circuit with a large inductance can generate a circuit voltage ($L di/dt$) above the rated voltage of the PolySwitch resettable device.



PolySwitch Resettable Devices Automotive Devices

We have provided PPTC resettable devices for the automotive industry for over 25 years. With the advent of TS16949 and our continued involvement in the automotive industry, we developed automotive specific versions of our PolySwitch PPTC devices (AHS, ASMD, AHRF and AGRF). These products are qualified and sold under PS400 specification which is derived from AEC-Q200, the standard for electronic components used in the automotive industry. The key difference between these product families and other protection devices in the Raychem Circuit Protection product portfolio is the qualification process followed according to a series of rigorous tests related to the automotive environment. As a result, they are characterized by specific additional values determined post automotive related testing.



Benefits

- Expertise from the world's leading resettable overcurrent protection manufacturer
- High quality/reliability products from the world's largest passive component manufacturer
- Worldwide team dedicated to support automotive applications
- Wide range of dedicated automotive surface-mount and radial-leaded resettable overcurrent devices
- High performance transient voltage protection devices

Features

- Overcurrent and overvoltage circuit protection devices
- Resettable and single-use overcurrent devices
- Wide range of form factor and termination methods
- Products meet applicable automotive industry standards
- Devices compatible with high-volume electronics assembly

Applications

- Motor and motor circuit protection including power door-locks, mirrors, lumbar pumps, seats, sunroofs and windows
- Electronic Control Unit (ECU) I/O protection
- Heating Ventilation and Cooling (HVAC) motor and I/O protection
- Telematics, infotainment and navigations systems
- Liquid Crystal Display (LCD) back-light heaters
- Power and cigarette lighter outlets, plugs and adapter/chargers
- Powered networks and busses
- Air-flow detection and overcurrent protection in HVAC and cooling fan systems
- Stall detection in express window and sunroof circuits
- Power distribution, electrical centers and junction box resettable overcurrent protection
- Wire downsizing
- Motor Electromagnetic Interference (EMI) suppression
- Electrostatic Discharge (ESD) damage protection
- Load dump and other transient voltage protection

Table A1 Product Series - Current Rating, Voltage Rating / Typical Resistance for Automotive Devices

Voltage Rating	AGRF 16V	AHRF 16V	AHRF 30V	AHS 16V	ASMD 16V	ASMD 30V	ASMD 60V
Hold Current (A)							
0.30	—	—	—	—	—	—	0.23Ω
0.50	—	—	0.565Ω	—	—	—	0.90Ω
0.70	—	—	0.385Ω	—	—	—	—
0.75	—	—	—	—	—	0.60Ω	—
0.80	—	—	—	0.25Ω	—	—	—
1.00	—	—	0.225Ω	—	—	0.30Ω	—
1.25	—	—	—	—	0.16Ω	—	—
1.50	—	—	—	—	0.14Ω	—	—
1.60	—	—	—	0.10Ω	—	—	—
2.00	—	0.0565Ω	—	—	0.09Ω	—	—
2.50	—	—	—	—	0.06Ω	—	—
3.00	—	0.0410Ω	—	—	—	—	—
4.00	0.0300Ω	0.0305Ω	—	—	—	—	—
4.50	—	0.0290Ω	—	—	—	—	—
5.00	0.0192Ω	—	—	—	—	—	—
5.50	—	0.0190Ω	—	—	—	—	—
6.00	0.0145Ω	0.0180Ω	—	—	—	—	—
6.50	—	0.0140Ω	—	—	—	—	—
7.00	0.0105Ω	0.0126Ω	—	—	—	—	—
7.50	—	0.0120Ω	—	—	—	—	—
8.00	0.0086Ω	0.0104Ω	—	—	—	—	—
9.00	0.0070Ω	0.0100Ω	—	—	—	—	—
10.00	0.0056Ω	0.0083Ω	—	—	—	—	—
11.00	0.0050Ω	0.0069Ω	—	—	—	—	—
12.00	0.0046Ω	—	—	—	—	—	—
13.00	—	0.0055Ω	—	—	—	—	—
14.00	0.0040Ω	0.0050Ω	—	—	—	—	—
15.00	—	0.0050Ω	—	—	—	—	—

Table A2 Thermal Derating for Automotive Devices
[Hold Current (A) at Ambient Temperature (°C)]

		Maximum Ambient Temperature										
Part Number		-40°C	-20°C	0°C	20°C	25°C	40°C	50°C	60°C	70°C	85°C	125°C
 AGRF 16V — Radial-leaded												
AGRF400		5.9	5.3	4.8	4.1	4.0	3.5	3.2	2.8	2.5	1.9	—
AGRF500		7.3	6.6	6.0	5.2	5.0	4.4	4.0	3.6	3.1	2.4	—
AGRF600		8.8	8.0	7.2	6.2	6.0	5.2	4.8	4.2	3.8	2.8	—
AGRF700		10.3	9.3	8.4	7.3	7.0	6.2	5.6	5.0	4.4	3.3	—
AGRF800		11.7	10.7	9.6	8.3	8.0	6.9	6.4	5.6	5.1	3.7	—
AGRF900		13.2	11.9	10.7	9.4	9.0	7.9	7.2	6.4	5.6	4.2	—
AGRF1000		14.7	13.3	12.0	10.3	10.0	8.7	8.0	7.0	6.3	4.7	—
AGRF1100		16.1	14.6	13.1	11.5	11.0	9.7	8.8	7.8	6.9	5.2	—
AGRF1200		17.6	16.0	14.4	12.4	12.0	10.4	9.6	8.4	7.6	5.6	—
AGRF1400		20.5	18.7	16.8	14.5	14.0	12.1	11.2	9.8	8.9	6.5	—
 AHRF (High Temperature) 30V — Radial-leaded												
 AHRF050		0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.4	0.3	0.3	0.1
 AHRF070		1.0	0.9	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.2
 AHRF100		1.4	1.2	1.1	1.0	1.0	0.9	0.8	0.7	0.7	0.6	0.2
 AHRF (High Temperature) 16V — Radial-leaded												
 AHRF200		2.7	2.5	2.3	2.1	2.00	1.8	1.6	1.5	1.3	1.1	0.5
 AHRF300		4.1	3.7	3.4	3.1	3.00	2.7	2.4	2.2	2.0	1.7	0.7
 AHRF400		5.6	5.1	4.7	4.2	4.00	3.6	3.3	3.0	2.7	2.3	1.0
AHRF450		6.1	5.6	5.1	4.6	4.50	4.0	3.6	3.3	3.0	2.5	1.1
 AHRF550		7.5	6.9	6.2	5.7	5.50	4.9	4.4	4.0	3.7	3.1	1.4

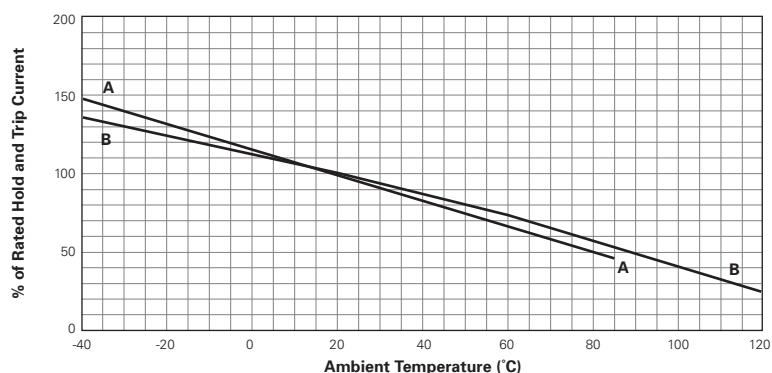
Table A2 Thermal Derating for Automotive Devices
[Hold Current (A) at Ambient Temperature (°C)] ... Cont'd

Part Number	Maximum Ambient Temperature										
	-40°C	-20°C	0°C	20°C	25°C	40°C	50°C	60°C	70°C	85°C	125°C
AHRF (High Temperature) 16V — Radial-leaded											
AHRF600	8.2	7.5	6.8	6.2	6.00	5.3	4.9	4.4	4.0	3.3	1.5
AHRF650	8.8	8.1	7.4	6.7	6.50	5.7	5.3	4.8	4.3	3.6	1.6
NEW AHRF700	9.5	8.7	8.0	7.2	7.00	6.2	5.6	5.2	4.7	3.9	1.7
AHRF750	10.2	9.4	8.6	7.7	7.50	6.6	6.1	5.6	5.0	4.1	1.9
NEW AHRF800	10.9	10.0	9.1	8.2	8.00	7.1	6.4	5.9	5.3	4.4	2.0
NEW AHRF900	12.2	11.2	10.2	9.3	9.00	8.0	7.2	6.6	6.0	5.0	2.2
AHRF1000	13.6	12.5	11.4	10.3	10.00	8.8	8.1	7.4	6.6	5.5	2.5
NEW AHRF1100	14.9	13.7	12.5	11.3	11.00	9.7	8.8	8.1	7.3	6.1	2.7
AHRF1300	17.7	16.3	14.8	13.4	13.00	11.4	10.5	9.6	8.6	7.2	3.3
NEW AHRF1400	19.0	17.5	15.9	14.4	14.00	12.4	11.2	10.3	9.3	7.8	3.5
NEW AHRF1500	20.4	18.8	17.1	15.5	15.00	13.2	12.1	11.1	9.9	8.3	3.8
AHS (High Temperature) 16V — Surface-mount											
AHS080-2018	1.20	1.04	0.90	0.80	0.77	0.68	0.62	0.60	0.53	0.46	0.26
AHS160	2.15	1.96	1.78	1.60	1.55	1.42	1.33	1.24	1.15	1.01	0.64
ASMD 16-60V — Surface-mount											
ASMD030F	0.35	0.31	0.27	0.23	0.22	0.19	0.17	0.15	0.13	0.11	—
ASMD050F	0.59	0.53	0.46	0.39	0.37	0.33	0.29	0.26	0.23	0.18	—
ASMD075F	0.91	0.81	0.71	0.60	0.58	0.50	0.45	0.40	0.35	0.28	—
ASMD100F	1.37	1.22	1.06	0.90	0.86	0.76	0.68	0.60	0.52	0.41	—
ASMD125F	1.58	1.40	1.23	1.04	1.00	0.87	0.78	0.70	0.60	0.48	—
ASMD150F	1.93	1.70	1.50	1.27	1.22	1.07	0.95	0.85	0.74	0.58	—
ASMD200F	2.63	2.34	2.04	1.73	1.66	1.45	1.30	1.16	1.00	0.80	—
ASMD250F	3.00	2.66	2.32	1.97	1.89	1.65	1.48	1.32	1.14	0.91	—

Figure A1-A2 Thermal Derating Curves for Automotive Devices

A = AGRF
B = AHRF

Figure A1



A = ASMD
B = AHS

Figure A2

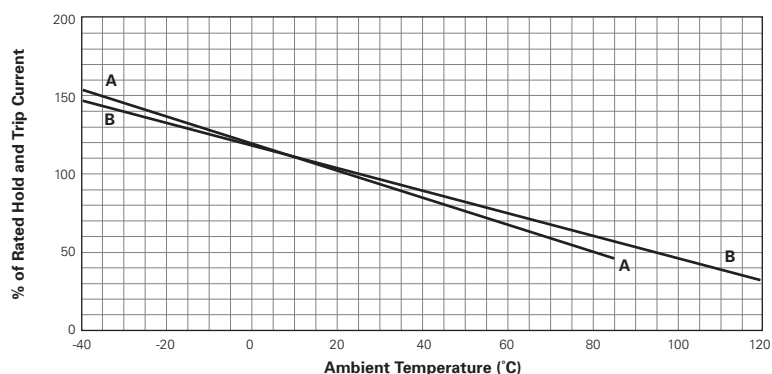
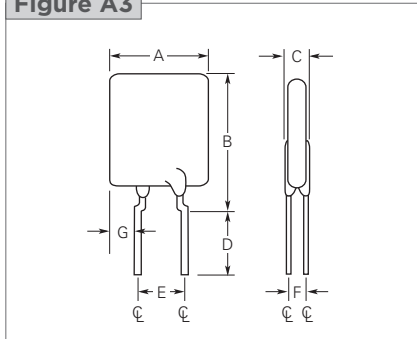
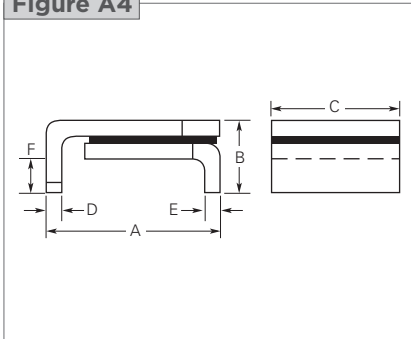
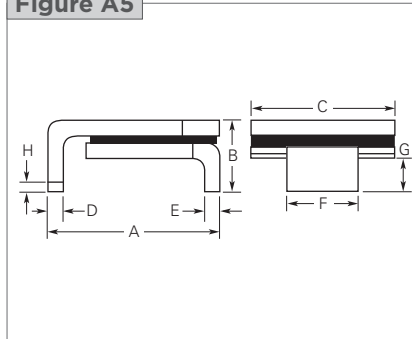
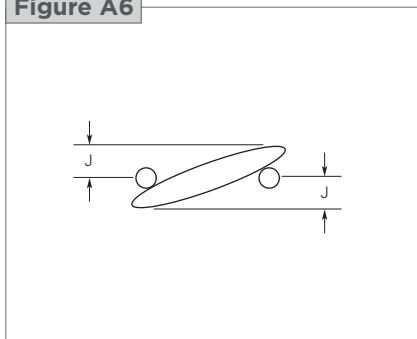
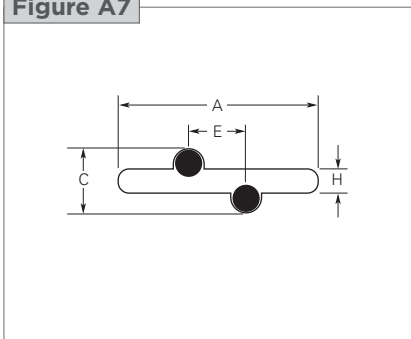
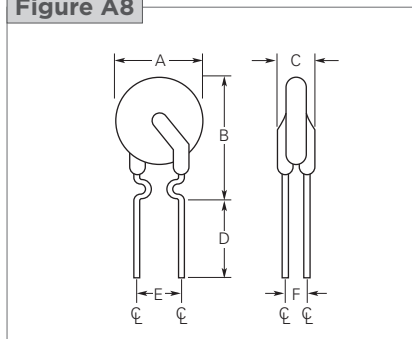


Table A3 Electrical Characteristics for Automotive Devices

Part Number	I _H (A)@ R _{1Max}	I _H (A)@ R _{aMax}	I _T (A)	V _{Max} (V _{DC})	I _{Max} (A)	P _D TYP(W)	Max. Time-to-trip		R _{Min} (Ω)	R _{1Max} (Ω)	R _{aMax} (Ω)	Figure for Dimensions
AGRF 16V — Radial-leaded												
AGRF400	4.0	3.0	7.6	16	100	2.5	20.0	2.0	0.0186	0.0610	0.0850	A3, A6, A7
AGRF500	5.0	4.3	9.4	16	100	2.7	25.0	2.5	0.0140	0.0340	0.0480	A3, A6, A7
AGRF600	6.0	5.3	10.7	16	100	2.8	30.0	3.5	0.0095	0.0280	0.0320	A3, A6, A7
AGRF700	7.0	6.5	13.2	16	100	3.0	35.0	4.0	0.0066	0.0200	0.0220	A3, A6, A7
AGRF800	8.0	7.6	15.0	16	100	3.2	40.0	5.5	0.0049	0.0175	0.0181	A3, A6, A7
AGRF900	9.0	8.6	16.5	16	100	3.4	45.0	6.0	0.0041	0.0135	0.0140	A3, A6, A7
AGRF1000	10.0	9.6	18.5	16	100	3.6	50.0	7.0	0.0034	0.0102	0.0106	A3, A6, A7
AGRF1100	11.0	10.5	20.3	16	100	3.7	55.0	7.5	0.0033	0.0089	0.0093	A3, A6, A7
AGRF1200	12.0	11.5	22.1	16	100	4.2	60.0	8.0	0.0030	0.0086	0.0091	A3, A6, A7
AGRF1400	14.0	13.0	27.3	16	100	4.6	70.0	9.0	0.0022	0.0064	0.0067	A3, A6, A7
AHRF (High Temperature) 30V — Radial-leaded												
NEW AHRF050	0.5	0.5	1.0	30	40	0.9	2.5	3.0	0.3500	1.100	1.100	A6, A7, A8
NEW AHRF070	0.7	0.7	1.4	30	40	1.4	3.5	3.2	0.2300	0.800	0.800	A3, A6, A7
NEW AHRF100	1.0	1.0	1.9	30	40	1.4	5.0	6.2	0.1500	0.430	0.430	A6, A7, A8
AHRF (High Temperature) 16V — Radial-leaded												
NEW AHRF200	2.0	2.0	3.8	16	100	1.4	10.0	4.8	0.0390	0.110	0.110	A6, A7, A8
NEW AHRF300	3.0	3.0	6.5	16	100	3.0	15.0	5.0	0.0290	0.079	0.079	A3, A6, A7
NEW AHRF400	4.0	4.0	7.4	16	100	3.3	20.0	5.0	0.0210	0.060	0.060	A3, A6, A7
AHRF450	4.5	4.5	8.7	16	100	3.6	22.5	4.0	0.0170	0.054	0.054	A3, A6, A7
NEW AHRF550	5.5	5.5	10.0	16	100	3.5	27.5	6.0	0.0130	0.037	0.037	A3, A6, A7
AHRF600	6.0	6.0	12.0	16	100	4.1	30.0	6.5	0.0100	0.032	0.032	A3, A6, A7
AHRF650	6.5	6.5	13.7	16	100	4.3	32.5	7.0	0.0090	0.026	0.026	A3, A6, A7
NEW AHRF700	7.0	7.0	13.1	16	100	4.0	35.0	7.0	0.0087	0.025	0.025	A3, A6, A7
AHRF750	7.5	7.5	14.8	16	100	4.5	37.5	8.0	0.0074	0.022	0.022	A3, A6, A7
NEW AHRF800	8.0	8.0	15.0	16	100	4.2	40.0	8.0	0.0072	0.020	0.020	A3, A6, A7
NEW AHRF900	9.0	9.0	18.5	16	100	5.0	45.0	11.5	0.0061	0.017	0.017	A3, A6, A7
AHRF1000	10.0	10.0	20.5	16	100	5.3	50.0	10.5	0.0051	0.015	0.015	A3, A6, A7
NEW AHRF1100	11.0	11.0	21.2	16	100	5.5	55.0	11.0	0.0048	0.013	0.013	A3, A6, A7
AHRF1300	13.0	13.0	27.0	16	100	6.9	65.0	15.0	0.0034	0.010	0.010	A3, A6, A7
NEW AHRF1400	14.0	14.0	28.3	16	100	6.9	70.0	15.5	0.0029	0.009	0.009	A3, A6, A7
NEW AHRF1500	15.0	15.0	33.0	16	100	7.0	75.0	20.0	0.0027	0.0092	0.0092	A3, A6, A7
AHS (High Temperature) 16V — Surface-mount												
AHS080-2018	0.80	0.80	2.00	16	70	1.5	8.0	9.0	0.130	0.550	0.550	A4
AHS160	1.60	1.60	3.20	16	70	2.2	8.0	15.0	0.050	0.150	0.150	A5
ASMD 16-60V — Surface-mount												
ASMD030F	0.23	0.23	0.59	60	10	1.1	1.15	12.0	0.980	4.800	4.800	A5
ASMD050F	0.39	0.39	0.98	60	10	1.7	1.95	20.0	0.290	1.400	1.400	A5
ASMD075F	0.60	0.60	1.48	30	40	1.1	3.00	20.0	0.290	1.000	1.000	A5
ASMD100F	0.90	0.90	2.16	30	40	1.1	4.50	20.0	0.098	0.480	0.480	A5
ASMD125F	1.04	1.04	2.46	16	40	1.1	5.20	20.0	0.057	0.250	0.250	A5
ASMD150F	1.27	1.27	2.95	16	40	1.2	6.35	25.0	0.049	0.250	0.250	A5
ASDM200F	1.73	1.73	3.93	16	40	1.2	8.65	30.0	0.050	0.120	0.120	A5
ASMD250F	1.97	1.97	5.00	16	40	1.2	9.85	30.0	0.035	0.085	0.085	A5

Notes:

- I_H : Hold current: maximum current device will pass without interruption in 25°C, unless otherwise specified (20°C for ASMD).
- I_T : Trip current: minimum current that will switch the device from low resistance to high resistance in 25°C still air, unless otherwise specified.
- V_{Max} : Maximum voltage device can withstand without damage at rated current.
- I_{Max} : Maximum fault current device can withstand without damage at rated voltage.
- P_D : Power dissipated from device when in the tripped state in 25°C still air, unless otherwise specified.
- R_{1Max} : Maximum resistance of device when measured one hour post reflow (surface-mount device) or one hour post trip (radial-leaded device) at 25°C unless otherwise specified.
- R_{aMin} : Minimum functional resistance of device after being subjected to the stresses described in PS400 at 25°C, unless otherwise specified.
- R_{aMax} : Maximum functional resistance of device after being subjected to the stresses described in PS400 at 25°C, unless otherwise specified.
- R_{Min} : Minimum resistance of device as supplied at 25°C, unless otherwise specified.

Figure A3-A8 Dimension Figures for Automotive Devices
Figure A3

Figure A4

Figure A5

Figure A6

Figure A7

Figure A8

Table A4 Dimensions for Automotive Devices in Millimeters (Inches)

	Part Number	A		B		C		D		E		F		G		H	J	Figure
		min	max	min	max	min	max	min	max	min	max	min	max	min	max	TYP.	max.	
	AGRF																	
	16V — Radial-leaded																	
	AGRF400	—	8.9 (0.35)	—	14.1 (0.56)	—	3.0 (0.12)	7.6 (0.3)	—	4.3 (0.17)	5.8 (0.20)	1.2 (0.15)	—	—	3.10 (0.120)	1.24 (0.049)	1.4 (0.06)	A3, A6, A7
	AGRF500	—	10.4 (0.41)	—	15.6 (0.61)	—	3.0 (0.12)	7.6 (0.3)	—	4.3 (0.17)	5.8 (0.20)	1.2 (0.05)	—	—	3.94 (0.155)	1.24 (0.049)	1.6 (0.06)	A3, A6, A7
	AGRF600	—	10.7 (0.42)	—	18.4 (0.73)	—	3.0 (0.12)	7.6 (0.3)	—	4.3 (0.17)	5.8 (0.20)	1.2 (0.05)	—	—	4.07 (0.160)	1.24 (0.049)	1.6 (0.06)	A3, A6, A7
	AGRF700	—	11.2 (0.44)	—	21.0 (0.73)	—	3.0 (0.12)	7.6 (0.3)	—	4.3 (0.17)	5.8 (0.20)	1.2 (0.05)	—	—	4.49 (0.177)	1.24 (0.049)	1.7 (0.07)	A3, A6, A7
	AGRF800	—	12.7 (0.50)	—	22.2 (0.88)	—	3.0 (0.12)	7.6 (0.3)	—	4.3 (0.17)	5.8 (0.20)	1.2 (0.05)	—	—	5.08 (0.200)	1.24 (0.049)	1.8 (0.07)	A3, A6, A7
	AGRF900	—	14.0 (0.55)	—	23.0 (0.91)	—	3.0 (0.12)	7.6 (0.3)	—	4.3 (0.17)	5.8 (0.20)	1.2 (0.05)	—	—	5.69 (0.224)	1.24 (0.049)	2.0 (0.08)	A3, A6, A7
	AGRF1000	—	16.51 (0.65)	—	25.7 (1.01)	—	3.0 (0.12)	7.6 (0.3)	—	4.3 (0.17)	5.8 (0.20)	1.2 (0.05)	—	—	6.96 (0.274)	1.24 (0.049)	2.0 (0.08)	A3, A6, A7
	AGRF1100	—	17.5 (0.69)	—	26.5 (1.04)	—	3.0 (0.12)	7.6 (0.3)	—	4.3 (0.17)	5.8 (0.20)	1.2 (0.05)	—	—	7.47 (0.294)	1.24 (0.049)	2.4 (0.09)	A3, A6, A7
	AGRF1200	—	17.5 (0.69)	—	28.8 (1.14)	—	3.5 (0.14)	7.6 (0.3)	—	9.4 (0.37)	10.9 (0.43)	1.4 (0.06)	—	—	4.83 (0.190)	1.45 (0.057)	1.5 (0.06)	A3, A6, A7
	AGRF1400	—	23.5 (0.925)	—	28.7 (1.13)	—	3.5 (0.14)	7.6 (0.3)	—	9.4 (0.37)	10.9 (0.43)	1.4 (0.06)	—	—	7.82 (0.308)	1.45 (0.057)	1.9 (0.07)	A3, A6, A7
	AHRF (High Temperature)																	
	30V — Radial-leaded																	
	AHRF050	—	7.4 (0.29)	—	12.7 (0.50)	—	3.3 (0.13)	7.6 (0.30)	—	4.3 (0.17)	5.8 (0.23)	1.2 (0.05)	—	—	—	1.24 (0.049)	1.6 (0.06)	A6, A7, A8
	AHRF070	—	6.9 (0.27)	—	10.8 (0.43)	—	3.3 (0.13)	7.6 (0.30)	—	4.3 (0.17)	5.8 (0.23)	1.2 (0.05)	—	—	—	1.24 (0.049)	1.6 (0.06)	A3, A6, A7
	AHRF100	—	9.7 (0.38)	—	13.6 (0.54)	—	3.0 (0.12)	7.6 (0.30)	—	4.3 (0.17)	5.8 (0.23)	1.2 (0.05)	—	—	—	1.24 (0.049)	1.6 (0.06)	A6, A7, A8

Table A4 Dimensions for Automotive Devices in Millimeters (Inches)

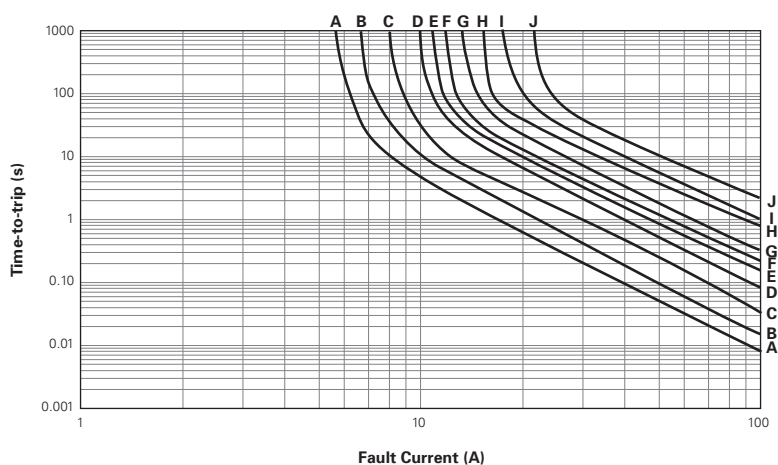
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		A		B		C		D		E		F		G		H		J		
Part Number		min	max	min	max	min	max	min	max	min	max	min	max	min	max	TYP	max.	Figure		
	AHRF (High Temperature)																			
	16V — Radial-leaded																			
NEW	AHRF200	—	9.4 (0.37)	—	14.4 (0.57)	—	3.0 (0.12)	7.6 (0.30)	—	4.3 (0.17)	5.8 (0.23)	1.2 (0.05)	—	—	—	1.24 (0.049)	1.6 (0.06)	A6, A7, A8		
NEW	AHRF300	—	8.8 (0.35)	—	13.8 (0.55)	—	3.0 (0.12)	7.6 (0.30)	—	4.3 (0.17)	5.8 (0.23)	1.2 (0.05)	—	—	—	1.24 (0.049)	1.6 (0.06)	A3, A6, A7		
NEW	AHRF400	—	10.0 (0.39)	—	15.0 (0.59)	—	3.0 (0.12)	7.6 (0.30)	—	4.3 (0.17)	5.8 (0.23)	1.2 (0.05)	—	—	—	1.24 (0.049)	1.6 (0.06)	A3, A6, A7		
	AHRF450	—	10.4 (0.41)	—	15.6 (0.61)	—	3.0 (0.12)	7.6 (0.30)	—	4.3 (0.17)	5.8 (0.23)	1.2 (0.05)	—	—	3.94 (0.155)	1.24 (0.049)	1.6 (0.06)	A3, A6, A7		
NEW	AHRF550	—	11.2 (0.44)	—	18.9 (0.74)	—	3.0 (0.12)	7.6 (0.30)	—	4.3 (0.17)	5.8 (0.23)	1.2 (0.05)	—	—	—	1.24 (0.049)	1.6 (0.06)	A3, A6, A7		
	AHRF600	—	11.2 (0.44)	—	21.0 (0.73)	—	3.0 (0.12)	7.6 (0.30)	—	4.3 (0.17)	5.8 (0.23)	1.2 (0.05)	—	—	4.49 (0.177)	1.24 (0.049)	1.7 (0.07)	A3, A6, A7		
	AHRF650	—	12.7 (0.50)	—	22.2 (0.88)	—	3.0 (0.12)	7.6 (0.30)	—	4.3 (0.17)	5.8 (0.23)	1.2 (0.05)	—	—	5.08 (0.200)	1.24 (0.049)	1.8 (0.07)	A3, A6, A7		
NEW	AHRF700	—	14.0 (0.55)	—	21.9 (0.86)	—	3.0 (0.12)	7.6 (0.30)	—	4.3 (0.17)	5.8 (0.23)	1.2 (0.05)	—	—	—	1.24 (0.049)	1.6 (0.06)	A3, A6, A7		
	AHRF750	—	14.0 (0.55)	—	23.5 (0.93)	—	3.0 (0.12)	7.6 (0.30)	—	4.3 (0.17)	5.8 (0.23)	1.2 (0.05)	—	—	5.69 (0.224)	1.24 (0.049)	2.0 (0.08)	A3, A6, A7		
NEW	AHRF800	—	16.5 (0.65)	—	22.5 (0.88)	—	3.0 (0.12)	7.6 (0.30)	—	4.3 (0.17)	5.8 (0.23)	1.2 (0.05)	—	—	—	1.24 (0.049)	1.6 (0.06)	A3, A6, A7		
NEW	AHRF900	—	16.5 (0.65)	—	25.7 (1.01)	—	3.0 (0.12)	7.6 (0.30)	—	4.3 (0.17)	5.8 (0.23)	1.2 (0.05)	—	—	—	—	—	A3, A6, A7		
	AHRF1000	—	17.5 (0.69)	—	26.5 (1.04)	—	3.0 (0.12)	7.6 (0.30)	—	9.4 (0.37)	10.9 (0.43)	1.2 (0.05)	—	—	7.47 (0.294)	1.24 (0.049)	1.5 (0.06)	A3, A6, A7		
NEW	AHRF1100	—	21.0 (0.83)	—	26.1 (1.03)	—	3.0 (0.12)	7.6 (0.30)	—	9.4 (0.37)	10.9 (0.43)	1.2 (0.05)	—	—	—	1.24 (0.049)	1.6 (0.06)	A3, A6, A7		
	AHRF1300	—	23.5 (0.925)	—	28.7 (1.13)	—	3.5 (0.14)	7.6 (0.30)	—	9.4 (0.37)	10.9 (0.43)	1.4 (0.06)	—	—	7.82 (0.308)	1.45 (0.057)	1.9 (0.08)	A3, A6, A7		
NEW	AHRF1400	—	23.5 (0.93)	—	28.7 (1.13)	—	3.6 (0.14)	7.6 (0.30)	—	9.4 (0.37)	10.9 (0.43)	1.4 (0.06)	—	—	—	1.24 (0.049)	1.6 (0.06)	A3, A6, A7		
NEW	AHRF1500	—	23.5 (0.93)	—	28.7 (1.13)	—	3.5 (0.14)	7.6 (0.30)	—	9.4 (0.37)	10.9 (0.43)	1.4 (0.06)	—	—	7.82 (0.308)	—	—	A3, A6, A7		

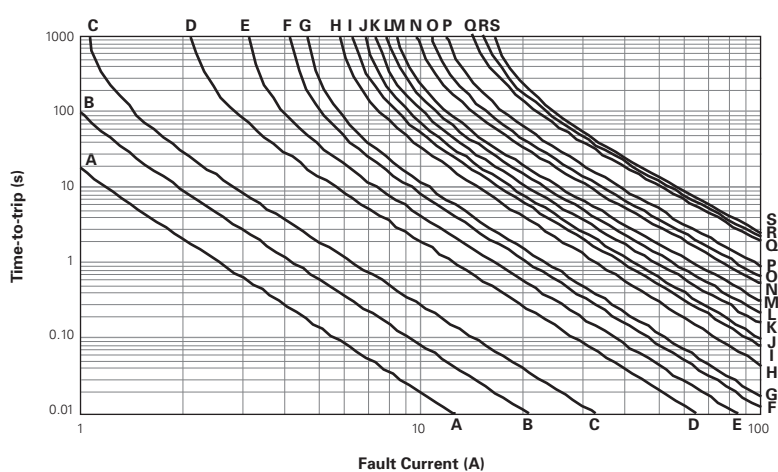
Part Number	A		B		C		D		E		F		G		H		Figure
	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	
 AHS (High Temperature) 16V — Surface-mount																	
AHS080-2018	4.72 (0.186)	5.44 (0.214)	—	1.52 (0.060)	4.22 (0.166)	4.93 (0.194)	0.25 (0.010)	0.36 (0.014)	0.25 (0.010)	0.36 (0.014)	0.30 (0.012)	0.46 (0.018)	—	—	—	—	A4
AHS160	8.00 (0.315)	9.40 (0.370)	—	3.00 (0.118)	6.0 (0.24)	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)	—	A5
 ASMD 16-60V — Surface-mount																	
ASMD030F	6.73 (0.265)	7.98 (0.314)	—	3.18 (0.125)	4.8 (0.19)	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)	—	A5
ASMD050F	6.73 (0.265)	7.98 (0.314)	—	3.18 (0.125)	4.8 (0.19)	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)	—	A5
ASMD075F	6.73 (0.265)	7.98 (0.314)	—	3.18 (0.125)	4.8 (0.19)	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)	—	A5
ASMD100F	6.73 (0.265)	7.98 (0.314)	—	3.00 (0.118)	4.8 (0.19)	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)	—	A5
ASMD125F	6.73 (0.265)	7.98 (0.314)	—	3.00 (0.118)	4.8 (0.19)	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)	—	A5
ASMD150F	8.00 (0.315)	9.40 (0.370)	—	3.00 (0.118)	6.0 (0.24)	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)	—	A5
ASMD200F	8.00 (0.315)	9.40 (0.370)	—	3.00 (0.118)	6.0 (0.24)	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)	—	A5
ASMD250F	8.00 (0.315)	9.40 (0.370)	—	3.00 (0.118)	6.0 (0.24)	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)	—	A5

Figure A9-A12 Typical Time-to-trip at 25°C for Automotive Devices
AGRF

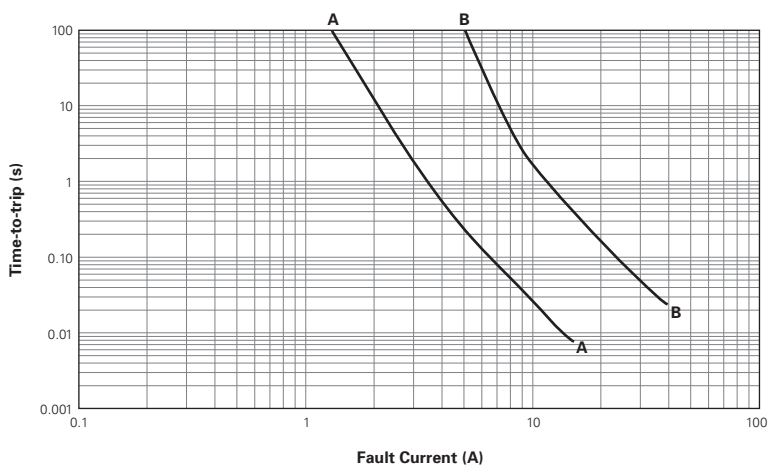
- A = AGRF400
- B = AGRF500
- C = AGRF600
- D = AGRF700
- E = AGRF800
- F = AGRF900
- G = AGRF1000
- H = AGRF1100
- I = AGRF1200
- J = AGRF1400

Figure A9

AHRF

- A = AHRF050
- B = AHRF070
- C = AHRF100
- D = AHRF200
- E = AHRF300
- F = AHRF400
- G = AHRF450
- H = AHRF550
- I = AHRF600
- J = AHRF650
- K = AHRF700
- L = AHRF750
- M = AHRF800
- N = AHRF900
- O = AHRF1000
- P = AHRF1100
- Q = AHRF1300
- R = AHRF1400
- S = AHRF1500

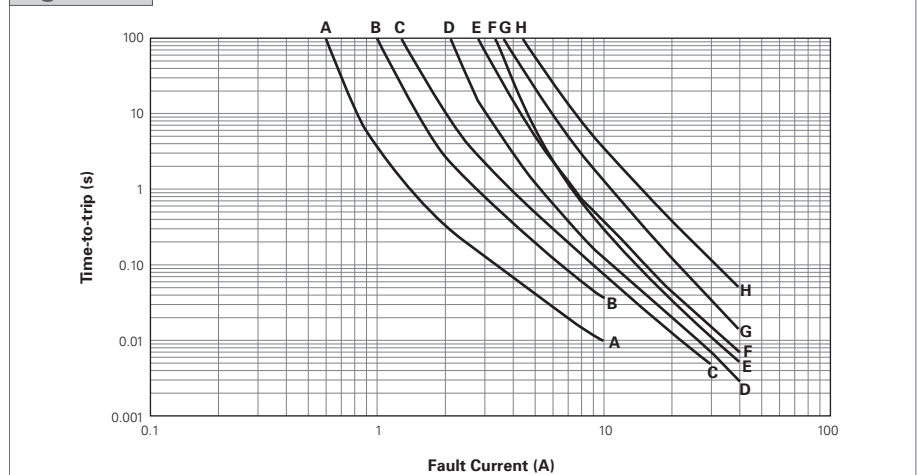
Figure A10

AHS

- A = AHS080-2018
- B = AHS160

Figure A11


ASMD

- A = ASMD030F
 B = ASMD050F
 C = ASMD075F
 D = ASMD100F
 E = ASMD125F
 F = ASMD150F
 G = ASMD200F
 H = ASMD250F

Figure A12**Table A5 Physical Characteristics and Environmental Specifications for Automotive Devices****AGRF****Physical Characteristics**

Lead material	AGRF400 to AGRF1100 : Tin Plated Copper, 0.52mm ² (20AWG) ø 0.8 mm/0.032in AGRF1200 to AGRF1400 : Tin Plated Copper, 0.82mm ² (18AWG) ø 1.0mm/0.040in
Soldering characteristics	Solderability per ANSI/J-STD-002 Category 3
Solder heat withstand	AGRF400: per IEC68-2-20 Test Tb, Method 1A, Condition A: can withstand 5 seconds at 260°C ± 5°C AGRF500-AGRF1400: per IEC68-2-20 Test Tb, Method 1A, Condition B: can withstand 10 seconds at 260°C ± 5°C
Insulating material	Cured, flame-retardant epoxy polymer; meets UL 94V-0

Note: See PS400 for other physical characteristics
 Devices are not designed to be placed through a reflow process.

Environmental Specifications

Test	Conditions	Resistance Change
Passive aging	70°C, 1000 hours	±5%
	85°C, 1000 hours	±5%
Humidity aging	85°C, 85% RH, 1000 hours	±5%
Thermal shock	85°C, -40°C (10 times)	±5%
Solvent resistance	MIL-STD-202, Method 215F	No change

Note: See PS400 for other environmental specifications

AHRF**Physical Characteristics**

Lead material	AHRF050 to AHRF200 : Tin-plated Copper Clad Steel, 0.205mm ² (24 AWG), ø 0.51mm/0.020in AHRF300 to AHRF1100 : Tin-plated copper 0.52mm ² (20 AWG), ø 0.81mm/0.032 in AHRF1300 to AHRF1500 : Tin-plated copper 0.82mm ² (18 AWG), ø 1.0mm/0.04 in
Soldering characteristics	Solderability per ANSI/J-STD 002 Category 3
Solder heat withstand	per IEC 68-2-20, Test Tb, Method 1A, Condition B; can withstand 10 seconds at 260°C ± 5°C
Insulating material	Cured, flame-retardant epoxy polymer; meets UL 94V-0 requirements

Note: See PS400 for other physical characteristics
 Devices are not designed to be placed through a reflow process.

Environmental Specifications

Test	Conditions	Resistance Change
Passive aging	70°C, 1000 hours	±5%
	85°C, 1000 hours	±5%
Humidity aging	85°C, 85% RH, 1000 hours	±5%
Thermal shock	125°C, -40°C (10 times)	±5%
Solvent resistance	MIL-STD-202, Method 215F	No change

Note: See PS400 for other environmental specifications

Table A5 Physical Characteristics and Environmental Specifications for Automotive Devices ... Cont'd

AHS		
Physical Characteristics		
Lead material	Tin-plated brass to MIL-T-10727B	
Soldering characteristics	Solderability per ANSI-J-STD-002 Category 1	
Solder heat withstand	per IEC-STD 68-2-20, Test Tb, Section 5, Method 1A	
Flammability	per IEC 695-2-2 Needle flame test for 20 seconds	
Note: See PS400 for other physical characteristics		
Environmental Specifications		
Test	Conditions	Resistance Change
Passive aging	70°C, 1000 hours	±3% Typical
	85°C, 1000 hours	±5% Typical
Humidity aging	85°C, 85% RH, 1000 hours	±1.2% Typical
Thermal shock	125°C, -40°C (20 times)	-33% Typical
Solvent resistance	Freon	No change
	Trichloroethane	No change
	Hydrocarbons	No change
Note: See PS400 for other environmental specifications		

ASMD		
Physical Characteristics		
Terminal pad material	98% + Tin-plated Brass	
Soldering characteristics	Solderability per ANSI-J-STD-002 Category 1	
Solder heat withstand	per IEC-STD 68-2-20, Test Tb, Section 5, Method 1A	
Flammability resistance	per IEC 695-2-2 Needle flame test for 20 seconds	
Recommended storage conditions	40°C max, 70% RH max; devices may not meet specified ratings if storage conditions are exceeded	
Note: See PS400 for other physical characteristics		
Environmental Specifications		
Test	Conditions	Resistance Change
Passive aging	60°C, 1000 hours	±3% typical
	85°C, 1000 hours	±5% typical
Humidity aging	85°C, 85% RH, 100 hours	±1.2% typical
Thermal shock	85°C, -40°C (20 times)	-33% typical
	125°C, -55°C (10 times)	-33% typical
Solvent resistance	Freon	No change
	Trichloroethane	No change
	Hydrocarbons	No change
Note: See PS400 for other environmental specifications		

Table A6 Packaging and Marking Information for Automotive Devices

Part Number	Bag Quantity	Tape & Reel Quantity	Ammo Pack Quantity	Standard Package Quantity	Part Marking	Agency Recognition
AGRF						
Radial-leaded						
AGRF400	500	—	—	10,000	GF4	*
AGRF400-2	—	2,500	—	12,500	GF4	*
AGRF400-AP	—	—	2,000	10,000	GF4	*
AGRF500	500	—	—	10,000	GF5	*
AGRF500-2	—	2,000	—	10,000	GF5	*
AGRF500-AP	—	—	2,000	10,000	GF5	*
AGRF600	500	—	—	10,000	GF6	*
AGRF600-2	—	2,000	—	10,000	GF6	*
AGRF600-AP	—	—	2,000	10,000	GF6	*

* These devices have been designed for use in automotive applications.

For commercial alternatives to these product series please see the radial-leaded devices section on page 125 or surface-mount devices section on page 109.

Table A6 Packaging and Marking Information for Automotive Devices

... Cont'd

Part Number	Bag Quantity	Tape & Reel Quantity	Ammo Pack Quantity	Standard Package Quantity	Part Marking	Agency Recognition
 AGRF Radial-leaded						
AGRF700	500	—	—	10,000	GF7	*
AGRF700-2	—	1,500	—	7,500	GF7	*
AGRF700-AP	—	—	1,500	7,500	GF7	*
AGRF800	500	—	—	10,000	GF8	*
AGRF800-2	—	1,000	—	5,000	GF8	*
AGRF800-AP	—	—	1,000	5,000	GF8	*
AGRF900	500	—	—	10,000	GF9	*
AGRF900-2	—	1,000	—	5,000	GF9	*
AGRF900-AP	—	—	1,000	5,000	GF9	*
AGRF1000	250	—	—	5,000	GF10	*
AGRF1000-2	—	1,000	—	5,000	GF10	*
AGRF1000-AP	—	—	1,000	5,000	GF10	*
AGRF1100	250	—	—	5,000	GF11	*
AGRF1100-2	—	1,000	—	5,000	GF11	*
AGRF1100-AP	—	—	1,000	5,000	GF11	*
AGRF1200	250	—	—	5,000	GF12	*
AGRF1200-2	—	1,000	—	5,000	GF12	*
AGRF1200-AP	—	—	1,000	5,000	GF12	*
AGRF1400	250	—	—	5,000	GF14	*
AGRF1400-2	—	1,000	—	5,000	GF14	*
AGRF1400-AP	—	—	1,000	5,000	GF14	*
 AHRF (High Temperature) Radial-leaded						
 AHRF050	500	—	—	10,000	HF0.5	*
AHRF050-2	—	2,500	—	12,500	HF0.7	*
AHRF050-AP	—	—	2,500	12,500	HF0.7	*
 AHRF070	500	—	—	10,000	HF0.7	*
AHRF070-2	—	2,500	—	12,500	HF0.7	*
AHRF070-AP	—	—	2,500	12,500	HF0.7	*
 AHRF100	500	—	—	10,000	HF1.0	*
AHRF100-2	—	2,500	—	12,500	HF1.0	*
AHRF100-AP	—	—	2,500	12,500	HF1.0	*
 AHRF200	500	—	—	10,000	HF2	*
AHRF200-2	—	2,500	—	12,500	HF2	*
AHRF200-AP	—	—	2,500	12,500	HF2	*
 AHRF300	500	—	—	10,000	HF3	*
AHRF300-2	—	2,000	—	10,000	HF3	*
AHRF300-AP	—	—	2,000	10,000	HF3	*
 AHRF400	500	—	—	10,000	HF4	*
AHRF400-2	—	1,500	—	7,500	HF4	*
AHRF400-AP	—	—	1,500	7,500	HF4	*
AHRF450	500	—	—	10,000	HF4.5	*
AHRF450-2	—	1,500	—	7,500	HF4.5	*
AHRF450-AP	—	—	1,500	7,500	HF4.5	*
 AHRF550	500	—	—	10,000	HF5.5	*
AHRF550-2	—	2,000	—	10,000	HF5.5	*
AHRF550-AP	—	—	2,000	10,000	HF5.5	*
AHRF600	500	—	—	10,000	HF6	*
AHRF600-2	—	2,000	—	10,000	HF6	*
AHRF600-AP	—	—	2,000	10,000	HF6	*
AHRF650	500	—	—	10,000	HF6.5	*
AHRF650-2	—	1,500	—	7,500	HF6.5	*
AHRF650-AP	—	—	1,500	7,500	HF6.5	*
 AHRF700	500	—	—	10,000	HF7	*
AHRF700-2	—	1,500	—	7,500	HF7	*

* These devices have been designed for use in automotive applications.

For commercial alternatives to these product series please see the radial-leaded devices section on page 125 or surface-mount devices section on page 109.

Table A6 Packaging and Marking Information for Automotive Devices

... Cont'd

Part Number	Bag Quantity	Tape & Reel Quantity	Ammo Pack Quantity	Standard Package Quantity	Part Marking	Agency Recognition
AHRF (High Temperature)						
Radial-leaded						
AHRF700-AP	—	—	1,500	7,500	HF7	*
AHRF750	500	—	—	10,000	HF7.5	*
AHRF750-2	—	1,000	—	5,000	HF7.5	*
AHRF750-AP	—	—	1,000	5,000	HF7.5	*
NEW AHRF800	500	—	—	10,000	HF8	*
AHRF800-2	—	1,000	—	5,000	HF8	*
AHRF800-AP	—	—	1,000	5,000	HF8	*
NEW AHRF900	250	—	—	5,000	HF9	*
AHRF900-2	—	1,000	—	5,000	HF9	*
AHRF900-AP	—	—	1,000	5,000	HF9	*
AHRF1000	250	—	—	5,000	HF10	*
AHRF1000-2	—	1,000	—	5,000	HF10	*
AHRF1000-AP	—	—	1,000	5,000	HF10	*
NEW AHRF1100	250	—	—	5,000	HF11	*
AHRF1100-2	—	1,000	—	5,000	HF11	*
AHRF1100-AP	—	—	1,000	5,000	HF11	*
AHRF1300	250	—	—	5,000	HF13	*
AHRF1300-2	—	1,000	—	5,000	HF13	*
AHRF1300-AP	—	—	1,000	5,000	HF13	*
NEW AHRF1400	250	—	—	5,000	HF14	*
AHRF1400-2	—	1,000	—	5,000	HF14	*
AHRF1400-AP	—	—	1,000	5,000	HF14	*
NEW AHRF1500	250	—	—	5,000	HF15	*
AHRF1500-2	—	1,000	—	5,000	HF15	*
AHRF1500-AP	—	—	1,000	5,000	HF15	*

				Recommended Pad Layouts [mm(in)] See Figure A13]			
Part Number	Tape & Reel Quantity	Standard Package Quantity	Part Marking	Dimension A (min*/nom)	Dimension B (nom.)	Dimension C (nom.)	Agency Recognition
AHS (High Temperature)							
Surface-mount							
AHS080-2018	4,000	20,000	H08	4.6 (0.18)	1.5 (0.09)	3.4 (0.134)	*
AHS160	1,500	7,500	160	4.6 (0.18)	2.3 (0.09)	6.1 (0.240)	*
ASMD							
Surface-mount							
ASMD030F	2,000	10,000	030F	3.1 (0.12)	2.3 (0.09)	5.1 (0.201)	*
ASMD050F	2,000	10,000	050F	3.1 (0.12)	2.3 (0.09)	5.1 (0.201)	*
ASMD075F	2,000	10,000	075F	3.1 (0.12)	2.3 (0.09)	5.1 (0.201)	*
ASMD100F	2,000	10,000	100F	3.1 (0.12)	2.3 (0.09)	5.1 (0.201)	*
ASMD125F	2,000	10,000	125F	3.1 (0.12)	2.3 (0.09)	5.1 (0.201)	*
ASMD150F	1,500	7,500	150F	4.6 (0.18)	2.3 (0.09)	6.1 (0.240)	*
ASMD200F	1,500	7,500	200F	4.6 (0.18)	2.3 (0.09)	6.1 (0.240)	*
ASMD250F	1,500	7,500	250F	4.6 (0.18)	2.3 (0.09)	6.1 (0.240)	*

* These devices have been designed for use in automotive applications.

For commercial alternatives to these product series please see the radial-leaded devices section on page 125 or surface-mount devices section on page 109.

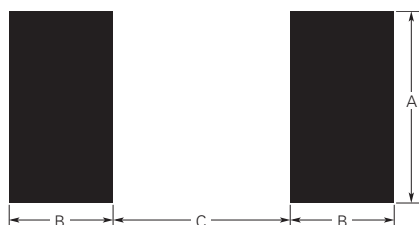
Figure A13 Recommended Pad Layout for Automotive Devices


Table A7 Tape and Reel Specifications for AGRF/AHRF Automotive Devices

AGRF and AHRF devices are available in tape and reel packaging per EIA468-B/IEC286-2 and EIA 481-2 standards.
See Figures A14 and A15 for details.

Description	EIA Mark	Dimension (mm)	Tolerance
Carrier tape width	W	18.0	-0.5/+1.0
Hold down tape width	W_4	11.0	Minimum
Top distance between tape edges	W_6	3.0	Maximum
Sprocket hole position	W_5	9.0	-0.5/+0.75
Sprocket hole diameter	D_0	4.0	± 0.2
Abscissa to plane	H_0	16.0	± 0.5
Abscissa to top AGRF500 to AGRF600 & AHRF450	H_1	32.2	Maximum
Abscissa to top AGRF700 to AGRF1400 & AHRF600 to AHRF1300*	H_1	45.0	Maximum
Overall width w/lead protrusion AGRF400 to AGRF600 & AHRF450	C_1	43.2	Maximum
Overall width w/lead protrusion AGRF700 to AGRF1400 & AHRF600 to AHRF1300	C_1	55.0	Maximum
Overall width w/o lead protrusion AGRF400 to AGRF600 & AHRF450	C_2	42.5	Maximum
Overall width w/o lead protrusion AGRF700 to AGRF1400 & AHRF600 to AHRF1300	C_2	54.0	Maximum
Lead protrusion	L_1	1.0	Maximum
Protrusion of cut-out	L	11.0	Maximum
Protrusion beyond hold-down tape	l_2	Not specified	—
Sprocket hole pitch	P_0	12.7	± 0.3
Device pitch AGRF400 to AGRF700, AHRF450 to AHRF600	—	12.7	± 0.3
Device pitch AGRF800 to AGRF1400, AHRF650 to AHRF1300	—	25.4	± 0.6
Pitch tolerance	—	20 consec.	± 0.1
Tape thickness	t	0.9	Maximum
Overall tape and lead thickness AGRF400 to AGRF1100, AHRF450 to AHRF1000*	t_1	2.0	Maximum
Overall tape and lead thickness AGRF1200 to AGRF1400, AHRF1300*	t_1	2.3	Maximum
Splice sprocket hole alignment	—	0	± 0.3
Body lateral deviation	Δh	0	± 1.0
Body tape plane deviation	Δp	0	± 1.3
Ordinate to adjacent component lead AGRF400 to AGRF1100, AHRF450 to AHRF750	P_1	3.81	± 0.7
Ordinate to adjacent component lead AGRF1200 to AGRF1400, AHRF1000 to AHRF1300	P_1	7.62	± 0.7
Lead spacing AGRF400 to AGRF1100, AHRF450 to AHRF750*	F	5.08	$\pm 0.75/-0.5$
Lead spacing AGRF1200 to AGRF1400, AHRF1000 to AHRF1300*	F	10.2	$\pm 0.75/-0.5$
Reel width AGRF400 to AGRF600 & AHRF450	w_2	56.0	Maximum
Reel width AGRF700 to AGRF1400, AHRF600 to AHRF1300*	w_2	63.5	Maximum
Reel diameter	a	370.0	Maximum
Space between flanges less device*	w_1	4.75	± 3.25
Arbor hold diameter	c	26.0	± 12.0
Core diameter*	n	91.0	Maximum
Box	—	64/372/362	Maximum
Consecutive missing places	—	None	—
Empty places per reel	—	0.1%	Maximum

*Differs from EIA specification.

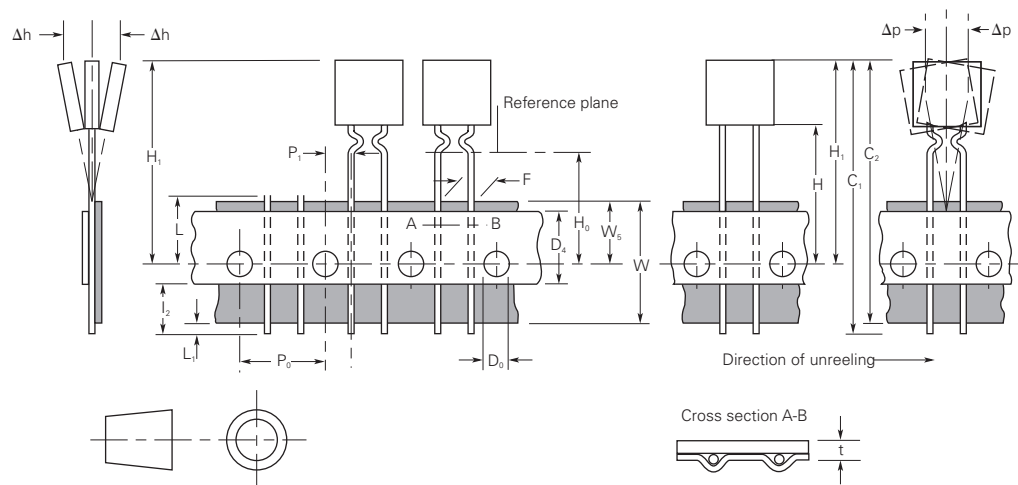
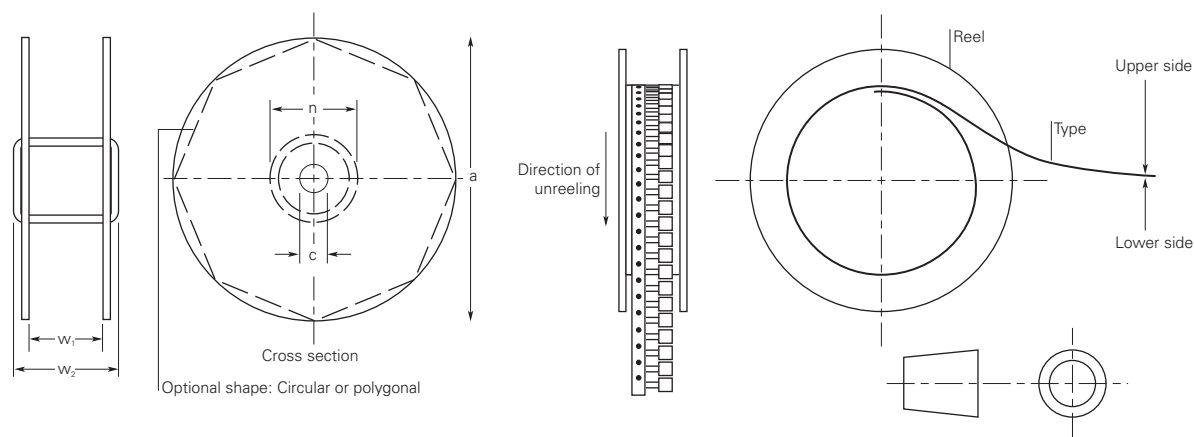
Figure A14 EIA Referenced Taped Component Dimensions for AGRF and AHRF Devices

Figure A15 EIA Referenced Reel Dimensions for AGRF and AHRF Devices

Table A8 Tape and Reel Specifications for AHS/ASMD Automotive Devices

AHS and ASMD devices are available in tape and reel packaging per EIA 468-2 standards. See Figures A16 and A17 for details.

Description	EIA Mark	Dimension (mm)	Tolerance
Carrier tape width	W	16.0	± 0.3
Sprocket hole pitch	P ₀	4.0	± 0.10
Embossed cavity pitch (ASMD030F to ASMD125F & AHS080)	P ₁	8.0	± 0.10
Embossed cavity pitch (ASMD150F to ASMD250F & AHS160)	P ₁	12.0	± 0.10
Ordinate to embossed cavity center	P ₂	2.0	± 0.10
Embossed cavity length (inside) (AHS080)	A ₀	5.11	± 0.15
Embossed cavity length (inside) (ASMD030F to ASMD125F & AHS160)	A ₀	5.6	± 0.23
Embossed cavity length (inside) (ASMD150F to ASMD250F)	A ₀	6.9	± 0.23
Embossed cavity width (inside) (AHS080)	B ₀	5.6	± 0.23
Embossed cavity width (inside) (ASMD030F to ASMD125F)	B ₀	8.1	± 0.15
Embossed cavity width (inside) (ASMD150F to ASMD250F)	B ₀	9.6	± 0.15
Embossed cavity length (outside)	B ₁ max.	12.1	—
Sprocket hole diameter	D ₀	1.5	+ 0.1, -0
Abscissa to embossed cavity center	F	7.5	± 0.10
Sprocket hole location	E ₁	1.75	± 0.10
Sprocket hole location (across embossed cavity)	E ₂ min.	14.25	—
Carrier tape thickness	T max.	0.6	—
Cover tape thickness	T ₁ max.	0.1	—
AHS080	K ₀	1.8	± 0.15
ASMD100F, ASMD125F	K ₀	3.2	± 0.15
ASMD150F to 250F	K ₀	3.4	± 0.15
Embossed cavity depth (inside)	K ₀	—	± 0.15
Leader min.	—	400	—
Trailer min.	—	160	—
Reel diameter	A max.	330	—
Core diameter	N min.	50	—
Reel width measured at inside hub	W ₁	16.4	+ 2.0, -0
Reel width measured at outside hub	W ₂ max.	22.4	—

Figure A16 EIA Referenced Taped Component Dimensions for AHS and ASMD Devices

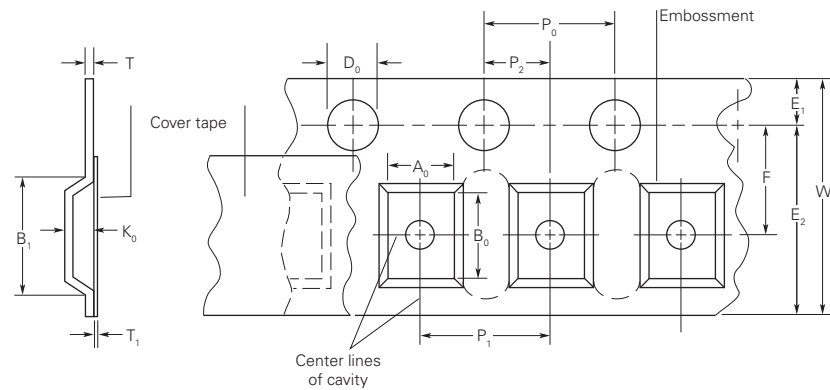
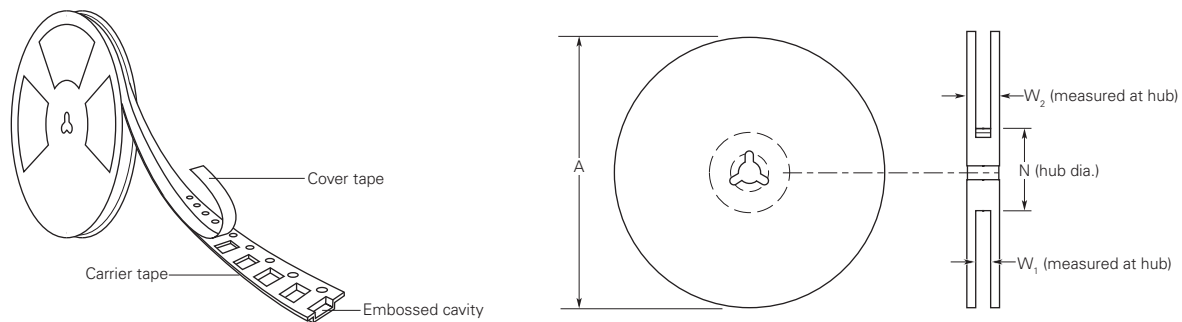
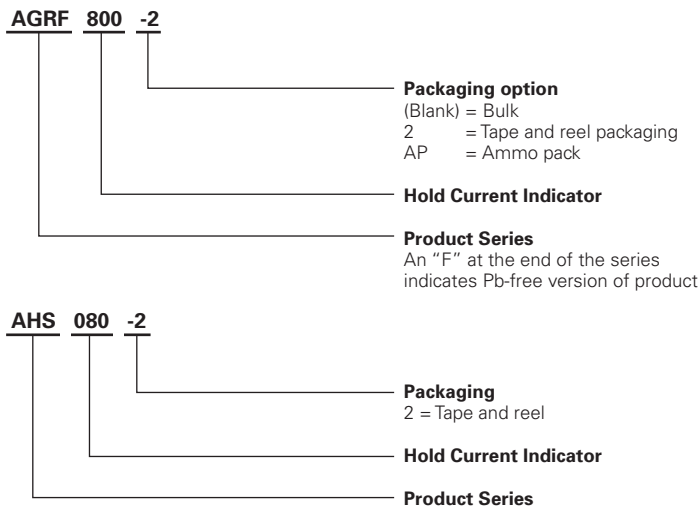


Figure A17 EIA Referenced Reel Dimensions for AHS and ASMD Devices

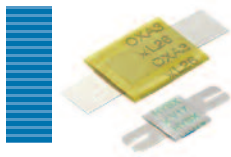


Part Numbering System for Automotive Devices



Warning :

- Operation beyond the maximum ratings or improper use may result in device damage and possible electrical arcing and flame.
- The devices are intended for protection against occasional overcurrent or overtemperature fault conditions and should not be used when repeated fault conditions or prolonged trip events are anticipated.
- Contamination of the PPTC material with certain silicon based oils or some aggressive solvents can adversely impact the performance of the devices.
- Device performance can be impacted negatively if devices are handled in a manner inconsistent with recommended electronic, thermal, and mechanical procedures for electronic components.
- Operation in circuit with a large inductance can generate a circuit voltage ($L di/dt$) above the rated voltage of the PolySwitch resettable device.



PolySwitch Resettable Devices Strap Battery Devices

Tyco Electronics, a pioneer of polymeric positive temperature coefficient resettable devices, has developed several material platforms specifically tailored to help protect battery applications. Each of these material platforms offers different performance characteristics, allowing the engineer greater design flexibility. PolySwitch, Raychem Circuit Protection Products, for battery protection includes SRP, LTP, LR4, VTP, VLP, VLR and MXP series, disc, and special application strap devices.



Benefits

- Many material platforms and device form factors give engineers more design flexibility
- Compatible with high-volume electronics assembly
- Assists in meeting regulatory requirements
- Low resistance devices increase battery operating time

Features

- RoHS compliant
- Lead free versions of all devices are available
- Broad range of resettable devices available
- Current ratings from 0.7A to 13A
- Voltage ratings from 6V to 30V
- Agency recognition, UL, CSA, TÜV
- Fast time-to-trip
- Low resistance

Applications

- Mobile phone battery packs
- Cordless phone battery packs
- Mobile radio battery packs
- Computer battery packs
- Camcorder battery packs
- Portable music player battery packs
- Power tools (charge line)

Protection Application Selection Guide for Strap Battery Devices

The guide below lists PolySwitch devices which are typically used in these applications.

The following pages contain the specifications for the part numbers recommended below.

Once a device is selected, the user should evaluate and test each product for its intended application.

Protection Application	Additional Comments	PolySwitch Resettable Devices — Key Device Selection Criteria		
		Installation Method	Lowest Resistance	Lowest Thermal Cut-off
Mobile phone battery packs	Li-ion	Flexprint	miniSMDE190F	—
		Surface Mount	refer to Surface-mount section of this catalog	
		Prismatic	MXP190BB	VLR175F
Cordless phone battery packs	NiMH	Cylindrical	VLP210F	VTP170F
			SRP175F	
Mobile radio battery packs	NiMH	Cylindrical	LR4-380F	LTP340F
			SRP350F	
Computer battery packs	NiMH	Cylindrical	LR4-900F	—
	Li-ion	Cylindrical	LR4-1300SSF	—
		Prismatic	Consult local Rep	Consult local Rep
Camcorder battery packs	NiMH or Li-ion	Prismatic	VLP270F	VTP210GF
			LR4-380F	—
PDA battery packs	Li-ion	Prismatic	VLP220F	VLR175F
			VTP175F	—
Power tools (charge line)	NiCd, NiMH or Li-ion	Cylindrical	custom LR4	custom VTP

Table B1 Product Series - Current Rating, Voltage Rating / Typical Resistance for Strap Battery Devices

Hold Current (A)	VLR	VLP	VTP	LTP	MXP	SRP	LR4	miniSMDE
	Typical Activation Temperature							
	85°C	90°C	90°C	110°C	120°C	125°C	125°C	110°C
0.70	—	—	—	15V/0.150Ω	—	—	—	—
1.00	—	—	—	24V/0.100Ω	—	—	—	—
1.10	—	—	16V/0.054Ω	—	—	—	—	—
1.20	—	—	—	—	—	15V/0.123Ω	—	—
1.70	12V/0.025Ω	—	16V/0.041Ω	—	—	—	15V/0.061Ω	—
1.75	12V/0.024Ω	—	16V/0.040Ω	—	—	15V/0.070Ω	—	—
1.80	—	—	—	24V/0.054Ω	—	—	—	—
1.90	—	—	—	24V/0.044Ω	6V/0.010Ω	—	15V/0.056Ω	16V/0.032Ω
2.00	—	—	16V/0.031Ω	—	—	30V/0.045Ω	—	—
2.10	—	16V/0.024Ω	16V/0.024Ω	—	—	—	—	—
2.20	—	16V/0.023Ω	—	—	—	—	—	—
2.30	12V/0.015Ω	—	—	—	—	—	—	—
2.40	—	—	16V/0.020Ω	—	—	—	—	—
2.60	—	—	—	24V/0.034Ω	—	—	15V/0.031Ω	—
2.70	—	16V/0.015Ω	—	—	—	—	—	—
3.00	—	—	—	24V/0.023Ω	—	—	—	—
3.40	—	—	—	24V/0.022Ω	—	—	—	—
3.50	—	—	—	—	—	30V/0.024Ω	—	—
3.80	—	—	—	—	—	—	15V/0.020Ω	—
4.20	—	—	—	—	—	30V/0.018Ω	—	—
4.50	—	—	—	—	—	—	20V/0.016Ω	—
5.50	—	—	—	—	—	—	20V/0.013Ω	—
6.00	—	—	—	—	—	—	20V/0.011Ω	—
7.30	—	—	—	—	—	—	20V/0.009Ω	—
8.80	—	—	—	—	—	—	20V/0.085Ω	—
9.00	—	—	—	—	—	—	20V/0.008Ω	—
13.00	—	—	—	—	—	—	20V/0.006Ω	—

Table B2 Thermal Derating for Strap Battery Devices
[Hold Current (A) at Ambient Temperature (°C)]

Part Number	Maximum Ambient Temperature										
	-40°C	-20°C	0°C	20°C	25°C	40°C	50°C	60°C	70°C	80°C	85°C
85°C Typical Activation											
VLR*											
VLR170F	3.5	2.9	2.4	1.84	1.70	1.2	1.0	0.7	0.3	—	—
VLR170LF	3.5	2.9	2.4	1.84	1.70	1.2	1.0	0.7	0.3	—	—
VLR170UF	3.5	2.9	2.4	1.84	1.70	1.2	1.0	0.7	0.3	—	—
VLR175F	3.5	2.9	2.4	1.87	1.75	1.3	1.0	0.8	0.3	—	—
VLR175LF	3.5	2.9	2.4	1.87	1.75	1.3	1.0	0.8	0.3	—	—
VLR175UF	3.5	2.9	2.4	1.87	1.75	1.3	1.0	0.8	0.3	—	—
VLR230F	5.0	4.2	3.4	2.52	2.30	1.7	1.3	0.9	0.4	—	—
VLR230F-C36	5.0	4.2	3.4	2.52	2.30	1.7	1.3	0.9	0.4	—	—
VLR230UF	5.0	4.2	3.4	2.52	2.30	1.7	1.3	0.9	0.4	—	—
90°C Typical Activation											
VLP*											
VLP210F	4.3	3.6	2.9	2.31	2.10	1.6	1.3	1.0	0.6	0.3	0.1
VLP220F	4.5	3.8	3.0	2.45	2.20	1.7	1.4	1.1	0.7	0.3	0.1
VLP270F	5.6	4.7	4.0	3.05	2.70	2.2	1.7	1.4	0.9	0.4	0.1
VTP*											
VTP110F	2.0	1.7	1.4	1.02	1.10	0.8	0.6	0.5	0.3	0.2	0.1
VTP170F	3.2	2.7	2.2	1.80	1.70	1.3	1.0	0.8	0.5	0.3	0.1
VTP170SSF	3.2	2.7	2.2	1.80	1.70	1.3	1.0	0.8	0.5	0.3	0.1
VTP170XF	3.2	2.7	2.2	1.80	1.70	1.3	1.0	0.8	0.5	0.3	0.1
VTP170XSF	3.2	2.7	2.2	1.80	1.70	1.3	1.0	0.8	0.5	0.3	0.1
VTP175F	3.2	2.7	2.2	1.84	1.75	1.3	1.0	0.8	0.5	0.3	0.1
VTP175LF	3.2	2.7	2.2	1.84	1.75	1.3	1.0	0.8	0.5	0.3	0.1
VTP175UF	3.2	2.7	2.2	1.84	1.75	1.3	1.0	0.8	0.5	0.3	0.1
VTP200GF	3.7	3.2	2.6	2.12	2.00	1.5	1.2	0.9	0.5	0.3	0.1
VTP200UF	3.7	3.2	2.6	2.12	2.00	1.5	1.2	0.9	0.5	0.3	0.1
VTP210GF	4.1	3.5	2.9	2.26	2.10	1.6	1.3	1.0	0.7	0.4	0.1
VTP210SF	4.1	3.5	2.9	2.26	2.10	1.6	1.3	1.0	0.7	0.4	0.1
VTP210SLF	4.1	3.5	2.9	2.26	2.10	1.6	1.3	1.0	0.7	0.4	0.1
VTP210SSF	4.1	3.5	2.9	2.26	2.10	1.6	1.3	1.0	0.7	0.4	0.1
VTP240F	4.4	3.7	3.1	2.54	2.40	1.8	1.5	1.2	0.9	0.5	0.1
110°C Typical Activation											
LTP											
LTP070F	1.1	1.0	0.8	0.7	0.65	0.5	0.4	0.3	0.2	0.2	0.1
LTP070SF	1.1	1.0	0.8	0.7	0.65	0.5	0.4	0.3	0.2	0.2	0.1
LTP100F	1.8	1.6	1.4	1.0	0.99	0.8	0.7	0.6	0.4	0.3	0.2
LTP100SF	1.8	1.6	1.4	1.0	0.99	0.8	0.7	0.6	0.4	0.3	0.2
LTP100SLF	1.8	1.6	1.4	1.0	0.99	0.8	0.7	0.6	0.4	0.3	0.2
LTP100SSF	1.8	1.6	1.4	1.0	0.99	0.8	0.7	0.6	0.4	0.3	0.2
LTP180F	3.1	2.6	2.2	1.8	1.67	1.3	1.1	0.9	0.6	0.4	0.3
LTP180LF	3.1	2.6	2.2	1.8	1.67	1.3	1.1	0.9	0.6	0.4	0.3
LTP180SF	3.1	2.6	2.2	1.8	1.67	1.3	1.1	0.9	0.6	0.4	0.3
LTP190F	3.3	2.8	2.4	1.9	1.79	1.4	1.2	1.1	0.7	0.5	0.4
LTP260F	4.3	3.7	3.1	2.6	2.42	1.9	1.6	1.4	1.1	0.8	0.6
LTP300F	5.1	4.4	3.7	3.0	2.82	2.3	1.9	1.6	1.2	0.9	0.7
LTP340F	5.5	4.7	4.0	3.4	3.17	2.6	2.2	1.9	1.5	1.1	0.9
miniSMDE											
miniSMDE190F	3.16	2.74	2.2	1.9	1.74	1.48	1.27	1.10	0.80	0.50	0.35
120°C Typical Activation											
MXP*											
MXP190BB	—	—	2.6	—	1.90	—	—	0.85	—	—	—

* Product electrical characteristics determined at 25°C

Table B2

Thermal Derating for Strap Battery Devices
[Hold Current (A) at Ambient Temperature (°C)]

... Cont'd

Part Number	Maximum Ambient Temperature										
	-40°C	-20°C	0°C	20°C	25°C	40°C	50°C	60°C	70°C	80°C	85°C
Amps											
125°C Typical Activation											
LR4											
LR4-170UF	2.5	2.2	2.0	1.7	1.64	1.4	1.3	1.2	1.0	0.9	0.8
LR4-190F	2.8	2.5	2.3	1.9	1.86	1.6	1.5	1.4	1.2	1.1	1.0
LR4-190SF	2.8	2.5	2.3	1.9	1.86	1.6	1.5	1.4	1.2	1.1	1.0
LR4-260F	3.8	3.4	3.1	2.6	2.54	2.2	2.0	1.9	1.7	1.4	1.3
LR4-260SF	3.8	3.4	3.1	2.6	2.54	2.2	2.0	1.9	1.7	1.4	1.3
LR4-380F	5.4	4.9	4.4	3.8	3.64	3.3	3.0	2.8	2.5	2.3	2.1
LR4-380XF	5.4	4.9	4.4	3.8	3.64	3.3	3.0	2.8	2.5	2.3	2.1
LR4-450F	6.5	5.8	5.3	4.5	4.38	3.9	3.6	3.3	2.9	2.6	2.4
LR4-550F	7.6	6.9	6.2	5.5	5.32	4.7	4.3	4.0	3.6	3.2	3.0
LR4-600F	8.7	7.8	7.1	6.0	5.86	5.2	4.7	4.4	3.9	3.4	3.2
LR4-600XF	8.7	7.8	7.1	6.0	5.86	5.2	4.7	4.4	3.9	3.4	3.2
LR4-730F	10.5	9.5	8.6	7.3	7.13	6.3	5.7	5.4	4.7	4.2	4.0
LR4-880SSF	12.3	11.0	9.8	8.8	8.30	7.4	6.8	6.2	5.5	4.8	4.5
LR4-900F	12.7	11.4	10.0	9.0	8.50	7.5	6.8	6.2	5.5	4.9	4.5
LR4-1300SSF	17.9	16.2	14.5	13.0	12.40	11.1	10.3	9.5	8.6	7.7	7.2
SRP											
SRP120F	1.9	1.7	1.5	1.20	1.17	1.0	0.9	0.8	0.6	0.5	0.4
SRP120LF	1.9	1.7	1.5	1.20	1.17	1.0	0.9	0.8	0.6	0.5	0.4
SRP120SF	1.9	1.7	1.5	1.20	1.17	1.0	0.9	0.8	0.6	0.5	0.4
SRP175F	2.5	2.2	2.0	1.75	1.68	1.4	1.3	1.2	1.0	0.9	0.8
SRP175LF	2.5	2.2	2.0	1.75	1.68	1.4	1.3	1.2	1.0	0.9	0.8
SRP175SF	2.5	2.2	2.0	1.75	1.68	1.4	1.3	1.2	1.0	0.9	0.8
SRP175SSF	2.5	2.2	2.0	1.75	1.68	1.4	1.3	1.2	1.0	0.9	0.8
SRP200F	3.1	2.8	2.5	2.00	1.97	1.7	1.5	1.4	1.2	1.0	0.9
SRP350F	5.3	4.8	4.3	3.50	3.44	3.0	2.7	2.5	2.1	1.8	1.7
SRP420F	6.3	5.7	5.1	4.20	4.11	3.6	3.3	3.0	2.6	2.2	2.1

Figure B1

Thermal Derating Curve for Strap Battery Devices

- A = LR4

B = SRP

C = LTP

D = VTP, VLP, MXP

E = VLR

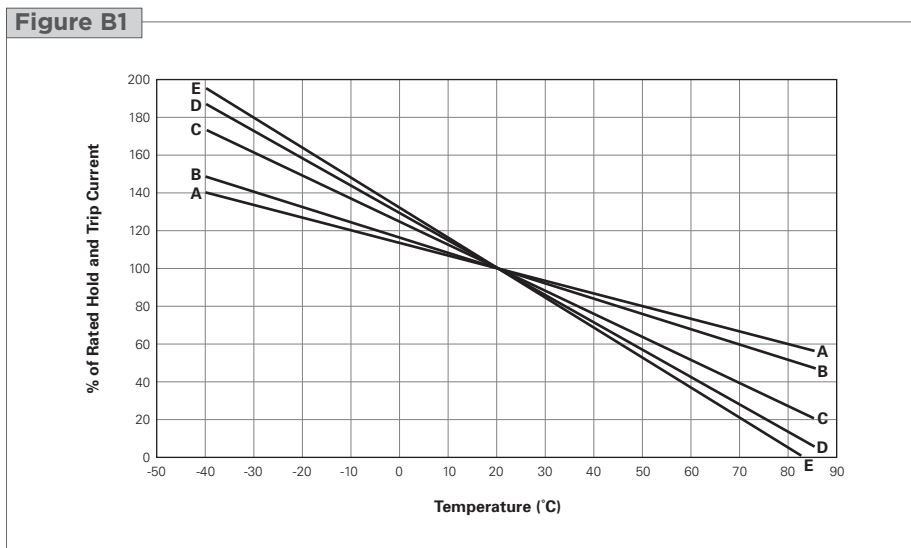


Table B3 Electrical Characteristics for Strap Battery Devices

Part Number	I _H (A)	I _T (A)	V _{DC} ^{Max} (V)	I _{Max} (A)	P _{D TYP} (W)	Max. Time-to-trip (A) (s)		R _{Min} (Ω)	R _{TYP} (Ω)	R _{Max} (Ω)	R _{Tripped TYP} (Ω)	R _{1 Max} (Ω)	Figure for Dimensions
85°C Typical Activation													
VLR*													
VLR170F	1.70	4.1	12	100	1.4	8.50	5.0	0.018	0.025	0.032	0.050	0.064	B3
VLR170LF	1.70	4.1	12	100	1.4	8.50	5.0	0.018	0.025	0.032	0.050	0.064	B3
VLR170UF	1.70	4.1	12	100	1.4	8.50	5.0	0.018	0.025	0.032	0.050	0.064	B6
VLR175F	1.75	4.2	12	100	1.4	8.75	5.0	0.017	0.024	0.031	0.048	0.062	B3
VLR175LF	1.75	4.2	12	100	1.4	8.75	5.0	0.017	0.024	0.031	0.048	0.062	B3
VLR175UF	1.75	4.2	12	100	1.4	8.75	5.0	0.017	0.024	0.031	0.048	0.062	B6
VLR230F	2.30	5.0	12	100	1.4	10.00	5.0	0.012	0.015	0.018	0.030	0.036	B3
VLR230F-C36	2.30	5.0	12	100	2.5	10.00	5.0	0.012	0.015	0.018	0.030	0.036	B10
VLR230UF	2.30	5.0	12	100	1.4	10.00	5.0	0.012	0.015	0.018	0.030	0.036	B6
90°C Typical Activation													
VLP*													
VLP210F	2.10	5.0	16	60	0.8	10.50	5.0	0.018	0.024	0.030	0.048	0.060	B2
VLP220F	2.20	5.3	16	60	0.8	11.00	5.0	0.017	0.023	0.029	0.046	0.058	B3
VLP270F	2.70	6.5	16	60	1.2	13.50	5.0	0.012	0.015	0.018	0.030	0.036	B3
VTP*													
VTP110F	1.10	2.7	16	100	0.7	5.50	5.0	0.038	0.054	0.070	0.108	0.140	B6
VTP170F	1.70	3.4	16	100	1.0	8.50	5.0	0.030	0.041	0.052	0.082	0.105	B2
VTP170SSF	1.70	3.4	16	100	1.0	8.50	5.0	0.030	0.041	0.052	0.082	0.105	B9
VTP170XF	1.70	3.4	16	100	0.7	8.50	5.0	0.030	0.041	0.052	0.082	0.105	B3
VTP170XSF	1.70	3.4	16	100	0.7	8.50	5.0	0.030	0.041	0.052	0.082	0.105	B4
VTP175F	1.75	3.6	16	100	0.8	8.75	5.0	0.029	0.040	0.051	0.080	0.102	B3
VTP175LF	1.75	3.6	16	100	0.8	8.75	5.0	0.029	0.040	0.051	0.080	0.102	B3
VTP175UF	1.75	3.6	16	100	0.8	8.75	5.0	0.029	0.040	0.051	0.080	0.102	B6
VTP200GF	2.00	4.7	16	100	0.9	10.00	5.0	0.022	0.031	0.039	0.062	0.078	B3
VTP200UF	2.00	4.7	16	100	0.9	10.00	5.0	0.022	0.031	0.039	0.062	0.078	B6
VTP210GF	2.10	4.7	16	100	1.2	10.00	5.0	0.018	0.024	0.030	0.048	0.060	B3
VTP210SF	2.10	4.7	16	100	1.2	10.00	5.0	0.018	0.024	0.030	0.048	0.060	B4
VTP210SLF	2.10	4.7	16	100	1.2	10.00	5.0	0.018	0.024	0.030	0.048	0.060	B4
VTP210SSF	2.10	4.7	16	100	1.2	10.00	5.0	0.018	0.024	0.030	0.048	0.060	B5
VTP240F	2.40	5.9	16	100	1.2	12.00	5.0	0.014	0.020	0.026	0.040	0.052	B3
110°C Typical Activation													
LTP													
LTP070F	0.70	1.45	15	100	0.7	3.50	5.0	0.100	0.150	0.200	0.300	0.340	B7
LTP070SF	0.70	1.45	15	100	0.7	3.50	5.0	0.100	0.150	0.200	0.300	0.340	B8
LTP100F	1.00	2.50	24	100	0.9	5.00	7.0	0.070	0.100	0.130	0.200	0.260	B7
LTP100SF	1.00	2.50	24	100	0.9	5.00	7.0	0.070	0.100	0.130	0.200	0.260	B8
LTP100SLF	1.00	2.50	24	100	0.9	5.00	7.0	0.070	0.100	0.130	0.200	0.260	B8
LTP100SSF	1.00	2.50	24	100	0.9	5.00	7.0	0.070	0.100	0.130	0.200	0.260	B9
LTP180F	1.80	3.80	24	100	1.0	9.00	2.9	0.040	0.054	0.068	0.108	0.120	B7
LTP180LF	1.80	3.80	24	100	1.0	9.00	2.9	0.040	0.054	0.068	0.108	0.120	B7
LTP180SF	1.80	3.80	24	100	1.0	9.00	2.9	0.040	0.054	0.068	0.108	0.120	B8
LTP190F	1.90	4.20	24	100	1.5	10.00	3.0	0.030	0.044	0.057	0.088	0.100	B7
LTP260F	2.60	5.20	24	100	1.3	13.00	5.0	0.025	0.034	0.042	0.068	0.076	B7
LTP300F	3.00	6.30	24	100	1.7	15.00	4.0	0.015	0.023	0.031	0.046	0.055	B7
LTP340F	3.40	6.80	24	100	1.6	17.00	5.0	0.016	0.022	0.027	0.044	0.050	B7
miniSMDE													
miniSMDE190F	1.90	3.8	16	100	1.5	10.00	2.0	0.024	0.032	0.040	0.060	0.080†	B15
120°C Typical Activation													
MXP*													
MXP190BB	1.90	4.9	6	50	0.4	9.50	2.0	0.009	0.010	0.014	0.015	0.024	B16

* Product electrical characteristics determined at 25°C

† R_{1max} value for this device is the maximum resistance of the device at 20°C one hour after reflow.

Table B3 Electrical Characteristics for Strap Battery Devices

... Cont'd

Part Number	I _H (A)	I _T (A)	V _{Max} (V _{DC})	I _{Max} (A)	P _{D TYP} (W)	Max. Time-to-trip (A) (s)		R _{Min} (Ω)	R _{TYP} (Ω)	R _{Max} (Ω)	R _{Tripped TYP} (Ω)	R _{1 Max} (Ω)	Figure for Dimensions
125°C Typical Activation													
LR4													
LR4-170UF	1.70	3.4	15	100	0.8	8.50	5.0	0.0440	0.0610	0.0780	0.089	0.1140	B12
LR4-190F	1.90	3.9	15	100	0.8	9.50	5.0	0.0390	0.0560	0.0720	0.079	0.1020	B10
LR4-190SF	1.90	3.9	15	100	0.8	9.50	5.0	0.0390	0.0560	0.0720	0.079	0.1020	B11
LR4-260F	2.60	5.8	15	100	1.0	13.00	5.0	0.0200	0.0310	0.0420	0.046	0.0630	B10
LR4-260SF	2.60	5.8	15	100	1.0	13.00	5.0	0.0200	0.0310	0.0420	0.046	0.0630	B11
LR4-380F	3.80	8.3	15	100	1.2	19.00	5.0	0.0130	0.0200	0.0260	0.028	0.0370	B10
LR4-380XF	3.80	8.3	15	100	1.2	19.00	5.0	0.0130	0.0200	0.0260	0.028	0.0370	B10
LR4-450F	4.50	8.9	20	100	1.4	22.50	5.0	0.0110	0.0160	0.0200	0.022	0.0280	B10
LR4-550F	5.50	10.5	20	100	2.0	27.50	5.0	0.0090	0.0130	0.0160	0.018	0.0220	B10
LR4-600F	6.00	11.7	20	100	1.7	30.00	5.0	0.0070	0.0110	0.0140	0.015	0.0190	B10
LR4-600XF	6.00	11.7	20	100	1.7	30.00	5.0	0.0075	0.0120	0.0140	0.015	0.0190	B10
LR4-730F	7.30	14.1	20	100	1.9	30.00	5.0	0.0060	0.0090	0.0120	0.011	0.0150	B10
LR4-880SSF	8.80	16.0	20	100	2.0	44.00	5.0	0.0065	0.0085	0.0105	0.012	0.0145	B14
LR4-900F	9.00	16.7	20	100	3.0	45.00	5.0	0.0060	0.0080	0.0100	0.011	0.0140	B10
LR4-1300SSF	13.00	21.2	20	100	2.2	65.00	5.0	0.0035	0.0060	0.0065	0.008	0.0090	B14

SRP

SRP120F	1.20	2.7	15	100	0.8	6.00	5.0	0.085	0.123	0.160	0.170	0.220	B7
SRP120LF	1.20	2.7	15	100	0.8	6.00	5.0	0.085	0.123	0.160	0.170	0.220	B7
SRP120SF	1.20	2.7	15	100	0.8	6.00	5.0	0.085	0.123	0.160	0.170	0.220	B13
SRP175F	1.75	3.8	15	100	0.9	8.75	5.0	0.050	0.070	0.090	0.093	0.120	B7
SRP175LF	1.75	3.8	15	100	0.9	8.75	5.0	0.050	0.070	0.090	0.093	0.120	B7
SRP175SF	1.75	3.8	15	100	0.9	8.75	5.0	0.050	0.070	0.090	0.093	0.120	B13
SRP175SSF	1.75	3.8	15	100	0.9	8.75	5.0	0.050	0.070	0.090	0.093	0.120	B14
SRP200F	2.00	4.4	30	100	1.6	10.00	4.0	0.030	0.045	0.060	0.075	0.100	B7
SRP350F	3.50	6.3	30	100	1.9	20.00	3.0	0.017	0.024	0.031	0.040	0.050	B7
SRP420F	4.20	7.6	30	100	2.2	20.00	6.0	0.012	0.018	0.024	0.030	0.040	B7

Notes:

- I_H : Hold current: maximum current device will pass without interruption in 20°C still air unless otherwise specified.
- I_T : Trip current: minimum current that will switch the device from low resistance to high resistance in 20°C still air unless otherwise specified.
- V_{Max} : Maximum voltage device can withstand without damage at rated current.
- I_{Max} : Maximum fault current device can withstand without damage at rated voltage.
- P_D : Power dissipated from device when in the tripped state in 20°C still air unless otherwise specified.
- R_{Min} : Minimum resistance of device as supplied at 20°C unless otherwise specified.
- R_{TYP} : Typical resistance of device as supplied at 20°C unless otherwise specified.
- $R_{TrippedTYP}$: Typical resistance, measured at 20°C unless otherwise specified, of device one hour after being tripped the first time.
- R_{Max} : Maximum resistance of device as supplied at 20°C unless otherwise specified.

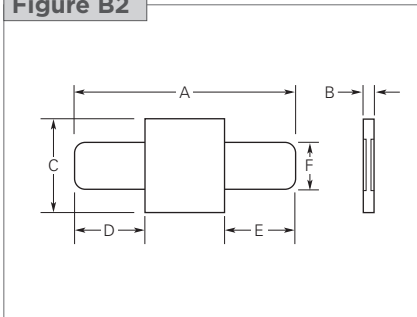
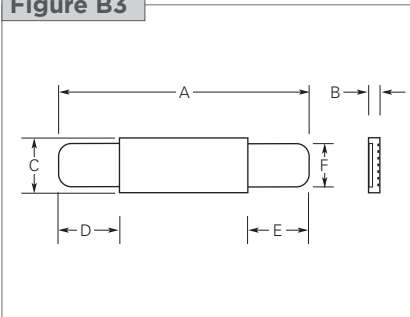
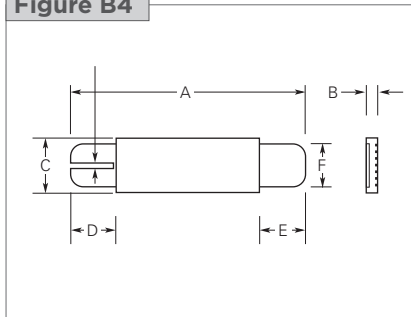
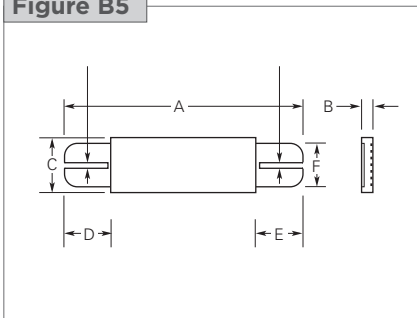
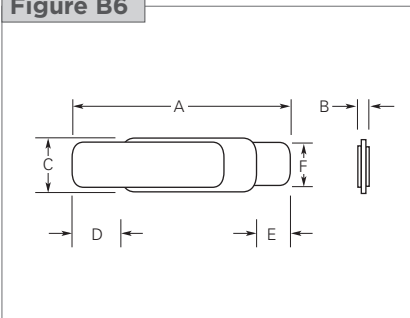
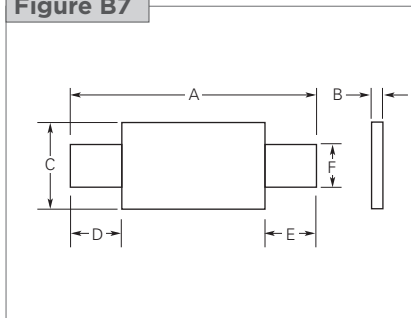
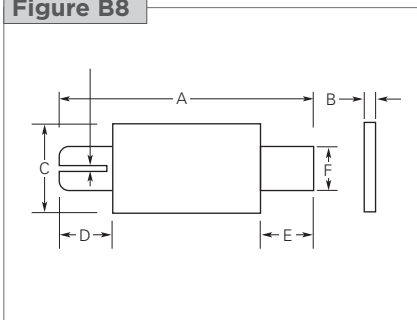
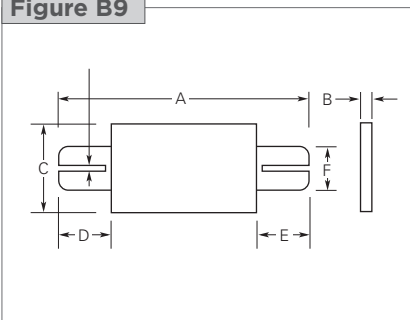
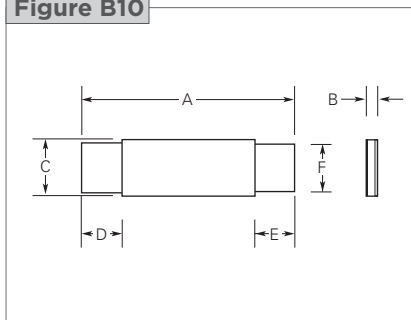
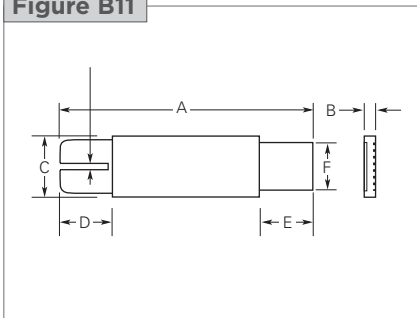
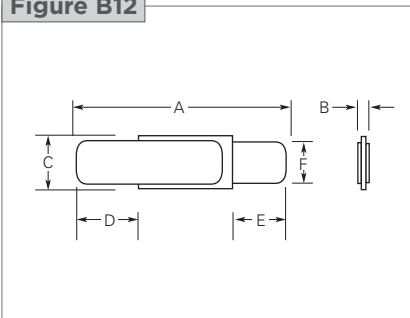
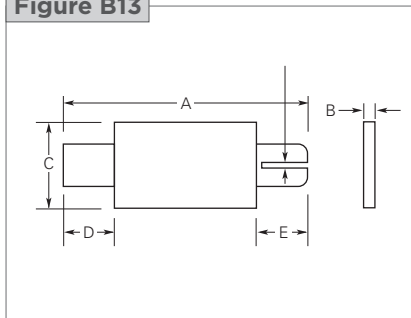
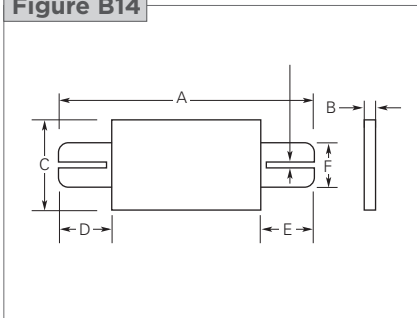
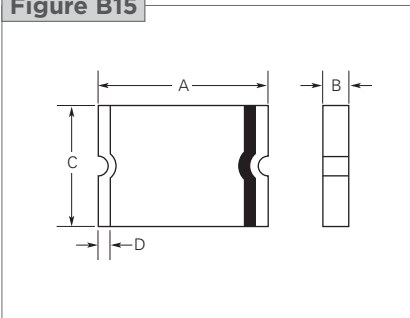
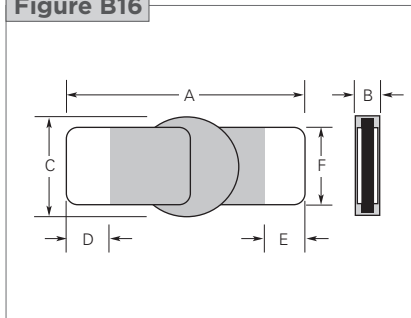
Figure B2-B16 Dimension Figures for Strap Battery Devices
Figure B2

Figure B3

Figure B4

Figure B5

Figure B6

Figure B7

Figure B8

Figure B9

Figure B10

Figure B11

Figure B12

Figure B13

Figure B14

Figure B15

Figure B16


Table B4 Dimensions for Strap Battery Devices in Millimeters (Inches)

Part Number	A		B		C		D		E		F		Figure
	min	max	min	max	min	max	min	max	min	max	min	max	
85°C Typical Activation													
VLR													
VLR170F	20.8 (0.82)	23.2 (0.91)	—	0.8 (0.03)	3.5 (0.14)	3.9 (0.15)	4.5 (0.18)	6.5 (0.26)	4.5 (0.18)	6.5 (0.26)	2.4 (0.09)	2.6 (0.10)	B3 —
VLR170LF	38.8 (1.53)	41.2 (1.62)	—	0.8 (0.03)	3.5 (0.14)	3.9 (0.15)	8.7 (0.34)	10.3 (0.41)	18.7 (0.74)	20.3 (0.80)	2.4 (0.09)	2.6 (0.10)	B3 —
VLR170UF	20.8 (0.81)	23.2 (0.91)	—	0.07 (0.03)	3.5 (0.14)	3.7 (0.15)	5.3 (0.21)	6.7 (0.26)	5.3 (0.21)	6.7 (0.26)	2.4 (0.09)	2.6 (0.10)	B6 —
VLR175F	23.0 (0.91)	24.5 (0.96)	0.5 (0.02)	0.8 (0.03)	2.9 (0.11)	3.3 (0.13)	4.7 (0.19)	7.2 (0.28)	3.8 (0.15)	5.4 (0.21)	2.4 (0.09)	2.6 (0.10)	B3 —
VLR175LF	29.3 (1.15)	31.7 (1.25)	—	0.8 (0.03)	2.9 (0.11)	3.3 (0.13)	5.2 (0.21)	6.8 (0.27)	10 (0.39)	12.5 (0.49)	2.4 (0.09)	2.6 (0.10)	B3 —
VLR175UF	23.0 (0.91)	24.5 (0.96)	—	0.7 (0.03)	2.9 (0.11)	3.1 (0.12)	5.2 (0.20)	7.5 (0.30)	4.3 (0.17)	5.7 (0.22)	2.4 (0.09)	2.6 (0.10)	B6 —
VLR230F	20.9 (0.82)	23.1 (0.91)	—	0.8 (0.03)	4.9 (0.19)	5.3 (0.21)	4.1 (0.16)	5.8 (0.23)	4.1 (0.16)	5.8 (0.23)	3.9 (0.15)	4.1 (0.16)	B3 —
VLR230F-C36	25.3 (0.10)	27.7 (1.09)	—	0.8 (0.03)	3.5 (0.14)	3.9 (0.15)	3.5 (0.14)	5.7 (0.22)	3.5 (0.14)	5.7 (0.22)	2.9 (0.11)	3.1 (0.12)	B10 —
VLR230UF	20.9 (0.82)	23.1 (0.91)	—	0.7 (0.03)	4.9 (0.19)	5.1 (0.20)	4.1 (0.16)	6.0 (0.24)	4.1 (0.16)	6.0 (0.24)	3.9 (0.15)	4.1 (0.16)	B6 —
90°C Typical Activation													
VLP													
VLP210F	15.4 (0.61)	17.5 (0.69)	0.6 (0.02)	0.8 (0.03)	6.9 (0.27)	7.3 (0.29)	4.0 (0.16)	6.2 (0.24)	4.0 (0.16)	6.2 (0.24)	3.9 (0.15)	4.1 (0.16)	B2 —
VLP220F	21.1 (0.83)	23.3 (0.92)	0.6 (0.02)	0.8 (0.03)	3.5 (0.13)	3.9 (0.15)	5.1 (0.20)	6.8 (0.27)	5.1 (0.20)	6.8 (0.27)	2.9 (0.11)	3.1 (0.12)	B3 —
VLP270F	20.9 (0.82)	23.1 (0.91)	0.6 (0.02)	0.8 (0.03)	4.9 (0.19)	5.3 (0.21)	4.1 (0.16)	5.8 (0.23)	4.1 (0.16)	5.8 (0.23)	3.9 (0.15)	4.1 (0.16)	B3 —
VTP													
VTP110F	23.6 (0.93)	25.6 (1.01)	—	0.7 (0.03)	2.7 (0.11)	2.9 (0.11)	7.0 (0.28)	8.0 (0.32)	7.0 (0.28)	8.0 (0.32)	2.3 (0.09)	2.5 (0.10)	B6 —
VTP170F	15.4 (0.606)	17.5 (0.689)	0.5 (0.02)	0.8 (0.03)	7.0 (0.275)	7.4 (0.292)	4.0 (0.157)	6.2 (0.244)	4.0 (0.157)	6.2 (0.244)	3.9 (0.15)	4.1 (0.16)	B2 —
VTP170SSF	15.4 (0.606)	17.5 (0.689)	0.5 (0.02)	0.8 (0.03)	7.0 (0.275)	7.4 (0.292)	4.0 (0.157)	6.2 (0.244)	4.0 (0.157)	6.2 (0.244)	3.9 (0.154)	4.1 (0.161)	B9 —
VTP170XF	20.9 (0.82)	22.9 (0.90)	0.5 (0.02)	0.8 (0.03)	4.9 (0.19)	5.3 (0.21)	6.0 (0.23)	8.6 (0.34)	6.0 (0.23)	8.6 (0.34)	3.9 (0.15)	4.1 (0.16)	B3 —
VTP170XSF	20.9 (0.82)	22.9 (0.90)	0.5 (0.02)	0.8 (0.03)	4.9 (0.19)	5.3 (0.21)	6.0 (0.23)	8.6 (0.34)	6.0 (0.23)	8.6 (0.34)	3.9 (0.15)	4.1 (0.16)	B4 —
VTP175F	21.2 (0.83)	23.2 (0.91)	—	0.8 (0.03)	3.5 (0.14)	3.9 (0.15)	4.6 (0.18)	6.6 (0.26)	4.6 (0.18)	6.6 (0.26)	2.9 (0.11)	3.1 (0.12)	B3 —
VTP175LF	25.8 (1.02)	28.2 (1.11)	—	0.8 (0.03)	3.5 (0.13)	3.9 (0.15)	5.7 (0.22)	7.3 (0.29)	8.7 (0.34)	10.3 (0.41)	2.4 (0.09)	2.6 (0.10)	B3 —
VTP175UF	21.2 (0.83)	23.2 (0.91)	—	0.7 (0.03)	3.5 (0.13)	3.7 (0.15)	5.6 (0.22)	6.8 (0.27)	5.6 (0.22)	6.8 (0.27)	2.9 (0.11)	3.1 (0.12)	B6 —
VTP200GF	20.9 (0.82)	23.1 (0.91)	—	0.8 (0.03)	4.1 (0.16)	4.5 (0.18)	3.0 (0.11)	4.8 (0.19)	3.0 (0.11)	4.8 (0.19)	2.9 (0.11)	3.1 (0.12)	B3 —
VTP200UF	20.9 (0.82)	23.1 (0.91)	—	0.7 (0.03)	4.1 (0.16)	4.3 (0.17)	4.0 (0.16)	5.4 (0.21)	4.0 (0.16)	5.4 (0.21)	2.9 (0.11)	3.1 (0.12)	B6 —
VTP210GF	20.9 (0.82)	23.1 (0.91)	0.6 (0.02)	0.8 (0.03)	4.9 (0.19)	5.3 (0.21)	4.1 (0.16)	5.8 (0.23)	4.1 (0.16)	5.8 (0.23)	3.9 (0.15)	4.1 (0.16)	B3 —
VTP210SF	20.9 (0.82)	23.1 (0.91)	0.6 (0.02)	0.8 (0.03)	4.9 (0.19)	5.3 (0.21)	4.1 (0.16)	5.8 (0.23)	4.1 (0.16)	5.8 (0.23)	3.9 (0.15)	4.1 (0.16)	B4 —
VTP210SLF	29.0 (1.14)	32.0 (1.26)	0.6 (0.02)	0.8 (0.03)	4.9 (0.19)	5.3 (0.21)	12.5 (0.49)	14.5 (0.57)	3.5 (0.13)	5.8 (0.23)	3.9 (0.15)	4.1 (0.16)	B4 —
VTP210SSF	20.9 (0.82)	23.1 (0.91)	0.6 (0.02)	0.8 (0.03)	4.9 (0.19)	5.3 (0.21)	4.1 (0.16)	5.8 (0.23)	4.1 (0.16)	5.8 (0.23)	3.9 (0.15)	4.1 (0.16)	B5 —
VTP240F	23.8 (0.93)	26.2 (1.03)	—	0.8 (0.03)	4.9 (0.19)	5.3 (0.21)	3.5 (0.13)	5.7 (0.23)	3.5 (0.13)	5.7 (0.23)	3.9 (0.15)	4.1 (0.16)	B3 —

Table B4 Dimensions for Strap Battery Devices in Millimeters (Inches)

... Cont'd

Part Number	A		B		C		D		E		F		Figure
	min	max	min	max	min	max	min	max	min	max	min	max	
110°C Typical Activation													
LTP													
LTP070F	19.9 (0.783)	22.1 (0.870)	0.7 (0.027)	1.2 (0.048)	4.9 (0.192)	5.2 (0.205)	5.5 (0.216)	7.5 (0.296)	5.5 (0.216)	7.5 (0.296)	3.9 (0.153)	4.1 (0.162)	B7 —
LTP070SF	19.9 (0.783)	22.1 (0.870)	0.7 (0.027)	1.2 (0.048)	4.9 (0.192)	5.2 (0.205)	5.5 (0.216)	7.5 (0.296)	5.5 (0.216)	7.5 (0.296)	3.9 (0.153)	4.1 (0.162)	B8 —
LTP100F	20.9 (0.82)	23.1 (0.91)	0.6 (0.02)	1.0 (0.04)	4.9 (0.19)	5.2 (0.20)	4.1 (0.16)	5.5 (0.22)	4.1 (0.16)	5.5 (0.22)	3.9 (0.15)	4.1 (0.16)	B7 —
LTP100SF	20.9 (0.82)	23.1 (0.91)	0.6 (0.02)	1.0 (0.04)	4.9 (0.19)	5.2 (0.20)	4.1 (0.16)	5.5 (0.22)	4.1 (0.16)	5.5 (0.22)	3.9 (0.15)	4.1 (0.16)	B8 —
LTP100SLF	29.0 (1.14)	32.0 (1.26)	0.6 (0.02)	1.0 (0.04)	4.9 (0.19)	5.2 (0.20)	3.5 (0.13)	5.5 (0.22)	12.5 (0.49)	14.5 (0.57)	3.9 (0.15)	4.1 (0.16)	B8 —
LTP100SSF	20.9 (0.82)	23.1 (0.91)	0.6 (0.02)	1.0 (0.04)	4.9 (0.19)	5.2 (0.20)	4.1 (0.16)	5.5 (0.22)	4.1 (0.16)	5.5 (0.22)	3.9 (0.15)	4.1 (0.16)	B9 —
LTP180F	24.0 (0.94)	26.0 (1.02)	0.6 (0.02)	1.0 (0.04)	4.9 (0.19)	5.2 (0.20)	4.1 (0.16)	5.5 (0.22)	4.1 (0.16)	5.5 (0.22)	3.9 (0.15)	4.1 (0.16)	B7 —
LTP180LF	35.5 (1.40)	37.5 (1.48)	0.6 (0.02)	1.0 (0.04)	4.9 (0.19)	5.2 (0.20)	9.7 (0.38)	11.0 (0.44)	9.7 (0.38)	11.0 (0.44)	3.9 (0.15)	4.1 (0.16)	B7 —
LTP180SF	24.0 (0.94)	26.0 (1.02)	0.6 (0.02)	1.0 (0.04)	4.9 (0.19)	5.2 (0.20)	4.1 (0.16)	5.5 (0.22)	4.1 (0.16)	5.5 (0.22)	3.9 (0.15)	4.1 (0.16)	B8 —
LTP190F	21.3 (0.84)	23.4 (0.92)	0.5 (0.02)	1.1 (0.04)	10.2 (0.40)	11.0 (0.43)	5.0 (0.20)	7.6 (0.30)	5.0 (0.20)	7.6 (0.30)	4.8 (0.19)	5.4 (0.21)	B7 —
LTP260F	24.0 (0.94)	26.0 (1.02)	0.6 (0.02)	1.0 (0.04)	10.8 (0.43)	11.9 (0.47)	5.0 (0.20)	7.0 (0.28)	5.0 (0.20)	7.0 (0.28)	5.9 (0.23)	6.1 (0.24)	B7 —
LTP300F	28.4 (1.12)	31.8 (1.25)	0.5 (0.02)	1.1 (0.04)	13 (0.51)	13.5 (0.53)	6.3 (0.25)	8.9 (0.35)	6.3 (0.25)	8.9 (0.35)	6.0 (0.24)	6.6 (0.26)	B7 —
LTP340F	24.0 (0.94)	26.0 (1.02)	0.6 (0.02)	1.0 (0.04)	14.8 (0.58)	15.9 (0.63)	4.0 (0.16)	5.0 (0.20)	4.0 (0.16)	5.0 (0.20)	5.9 (0.23)	6.1 (0.24)	B7 —
miniSMDE													
miniSMDE190F	11.15 (0.439)	11.51 (0.453)	0.33 (0.013)	0.53 (0.021)	4.83 (0.19)	5.33 (0.21)	0.51 (0.02)	1.02 (0.04)	— —	— —	— —	— —	B15 —
120°C Typical Activation													
MXP													
MXP190BB	9.2 (0.36)	10.8 (0.43)	0.7 (0.03)	1.1 (0.04)	2.96 (0.01)	3.26 (0.13)	1.6 (0.06)	3.1 (0.12)	1.6 (0.06)	3.1 (0.12)	2.2 (0.09)	2.4 (0.09)	B16
125°C Typical Activation													
LR4													
LR4-170UF	19.0 (0.75)	21.0 (0.83)	0.5 (0.02)	0.7 (0.03)	3.8 (0.15)	4.1 (0.16)	5.3 (0.21)	6.5 (0.26)	5.3 (0.21)	6.5 (0.26)	2.9 (0.11)	3.1 (0.12)	B12 —
LR4-190F	19.9 (0.78)	22.1 (0.87)	0.6 (0.02)	1.0 (0.04)	4.9 (0.19)	5.5 (0.22)	5.5 (0.22)	7.5 (0.30)	5.5 (0.22)	7.5 (0.30)	3.9 (0.15)	4.1 (0.16)	B10 —
LR4-190SF	19.9 (0.78)	22.1 (0.87)	0.6 (0.02)	1.0 (0.04)	4.9 (0.19)	5.5 (0.22)	5.5 (0.22)	7.5 (0.30)	5.5 (0.22)	7.5 (0.30)	3.9 (0.15)	4.1 (0.16)	B11 —
LR4-260F	20.9 (0.82)	23.1 (0.91)	0.6 (0.02)	1.0 (0.04)	4.9 (0.19)	5.5 (0.22)	4.1 (0.16)	5.5 (0.22)	4.1 (0.16)	5.5 (0.22)	3.9 (0.15)	4.1 (0.16)	B10 —
LR4-260SF	20.9 (0.82)	23.1 (0.91)	0.6 (0.02)	1.0 (0.04)	4.9 (0.19)	5.5 (0.22)	4.1 (0.16)	5.5 (0.22)	4.1 (0.16)	5.5 (0.22)	3.9 (0.15)	4.1 (0.16)	B11 —
LR4-380F	24.0 (0.94)	26.0 (1.02)	0.6 (0.02)	1.0 (0.04)	6.9 (0.27)	7.5 (0.30)	4.1 (0.16)	5.5 (0.22)	4.1 (0.16)	5.5 (0.22)	4.9 (0.19)	5.1 (0.20)	B10 —
LR4-380XF	32.2 (1.27)	35.8 (1.41)	0.6 (0.02)	1.0 (0.04)	4.9 (0.19)	5.5 (0.22)	5.5 (0.22)	7.5 (0.30)	5.5 (0.22)	7.5 (0.30)	3.9 (0.15)	4.1 (0.16)	B10 —
LR4-450F	24.0 (0.94)	26 (1.02)	0.6 (0.02)	1.0 (0.04)	9.9 (0.41)	10.5 (0.39)	5.3 (0.21)	6.7 (0.26)	5.3 (0.21)	6.7 (0.26)	5.9 (0.23)	6.1 (0.24)	B10 —
LR4-550F	35.0 (1.38)	37.0 (1.46)	0.6 (0.02)	1.0 (0.04)	6.9 (0.27)	7.5 (0.30)	5.3 (0.21)	6.7 (0.26)	5.3 (0.21)	6.7 (0.26)	4.9 (0.19)	5.1 (0.20)	B10 —
LR4-600F	24.0 (0.95)	26.0 (1.02)	0.6 (0.02)	1.0 (0.04)	13.9 (0.55)	14.5 (0.57)	4.1 (0.16)	5.5 (0.22)	4.1 (0.16)	5.5 (0.22)	5.9 (0.23)	6.1 (0.24)	B10 —
LR4-600XF	40.5 (1.59)	42.7 (1.68)	0.6 (0.02)	1.0 (0.04)	6.9 (0.27)	7.5 (0.30)	5.2 (0.20)	6.8 (0.27)	5.2 (0.20)	6.8 (0.27)	4.9 (0.19)	5.1 (0.20)	B10 —

Table B4 Dimensions for Strap Battery Devices in Millimeters (Inches)

... Cont'd

Part Number	A		B		C		D		E		F		Figure
	min	max	min	max	min	max	min	max	min	max	min	max	
125°C Typical Activation													
LR4													
LR4-730F	27.1 (1.06)	29.1 (1.15)	0.6 (0.02)	1.0 (0.04)	13.9 (0.54)	14.5 (0.57)	4.1 (0.16)	5.5 (0.22)	4.1 (0.16)	5.5 (0.22)	5.9 (0.23)	6.1 (0.24)	B10 —
LR4-880SF	62.8 (2.47)	65.2 (2.57)	0.6 (0.02)	1.0 (0.04)	7.9 (0.31)	8.5 (0.33)	10.0 (0.39)	12.0 (0.47)	10.0 (0.39)	12.0 (0.47)	5.9 (0.23)	6.1 (0.24)	B14 —
LR4-900F	45.4 (1.79)	47.6 (1.87)	0.9 (0.04)	1.3 (0.05)	7.9 (0.31)	8.5 (0.33)	4.6 (0.18)	6.2 (0.24)	4.6 (0.18)	6.2 (0.24)	5.9 (0.23)	6.1 (0.24)	B10 —
LR4-1300SSF	61.5 (0.42)	66.5 (2.62)	0.9 (0.04)	1.3 (0.05)	9.4 (0.37)	10.0 (0.39)	5.0 (0.20)	7.5 (0.30)	5.0 (0.20)	7.5 (0.30)	5.9 (0.23)	6.1 (0.24)	B14 —
SRP													
SRP120F	19.9 (0.78)	22.1 (0.87)	0.6 (0.02)	1.0 (0.04)	4.9 (0.19)	5.2 (0.20)	5.5 (0.22)	7.5 (0.30)	5.5 (0.22)	7.5 (0.30)	3.9 (0.15)	4.1 (0.16)	B7 —
SRP120LF	24.9 (0.98)	27.1 (1.07)	0.6 (0.02)	1.0 (0.04)	4.9 (0.19)	5.2 (0.20)	5.5 (0.22)	7.5 (0.30)	10.5 (0.41)	12.5 (0.49)	3.9 (0.15)	4.1 (0.16)	B7 —
SRP120SF	19.9 (0.78)	22.1 (0.87)	0.6 (0.02)	1.0 (0.04)	4.9 (0.19)	5.2 (0.20)	5.5 (0.22)	7.5 (0.30)	5.5 (0.22)	7.5 (0.30)	3.9 (0.15)	4.1 (0.16)	B13 —
SRP175F	20.9 (0.82)	23.1 (0.91)	0.6 (0.02)	1.0 (0.04)	4.9 (0.19)	5.2 (0.20)	4.1 (0.16)	5.5 (0.22)	4.1 (0.16)	5.5 (0.22)	3.9 (0.15)	4.1 (0.16)	B7 —
SRP175LF	29.9 (1.18)	32.1 (1.26)	0.6 (0.02)	1.0 (0.04)	4.9 (0.19)	5.2 (0.20)	10.5 (0.41)	12.5 (0.49)	5.5 (0.22)	7.5 (0.30)	3.9 (0.15)	4.1 (0.16)	B7 —
SRP175SF	20.9 (0.82)	23.1 (0.91)	0.6 (0.02)	1.0 (0.04)	4.9 (0.19)	5.2 (0.20)	4.1 (0.16)	5.5 (0.22)	4.1 (0.16)	5.5 (0.22)	3.9 (0.15)	4.1 (0.16)	B13 —
SRP175SSF	20.9 (0.82)	23.1 (0.91)	0.6 (0.02)	1.0 (0.04)	4.9 (0.19)	5.2 (0.20)	4.1 (0.16)	5.5 (0.22)	4.1 (0.16)	5.5 (0.22)	3.9 (0.15)	4.1 (0.16)	B14 —
SRP200F	21.3 (0.84)	23.4 (0.92)	0.5 (0.02)	1.1 (0.04)	10.2 (0.40)	11.0 (0.43)	5.0 (0.20)	7.6 (0.30)	5.0 (0.20)	7.6 (0.30)	4.8 (0.19)	5.4 (0.21)	B7 —
SRP350F	28.4 (1.12)	31.8 (1.25)	0.5 (0.02)	1.1 (0.04)	13.0 (0.53)	13.5 (0.51)	6.3 (0.25)	8.9 (0.35)	6.3 (0.25)	8.9 (0.35)	6.0 (0.24)	6.6 (0.26)	B7 —
SRP420F	30.6 (1.20)	32.4 (1.28)	0.5 (0.02)	1.1 (0.04)	12.9 (0.51)	13.6 (0.54)	5.0 (0.20)	7.5 (0.30)	5.0 (0.20)	7.5 (0.30)	6.0 (0.24)	6.7 (0.26)	B7 —

Figure B17-B24 Typical Time-to-trip Curves at 20°C for Strap Battery Devices
VLR (data at 25°C)

A = VLR170F

B = VLR175F

C = VLR230F

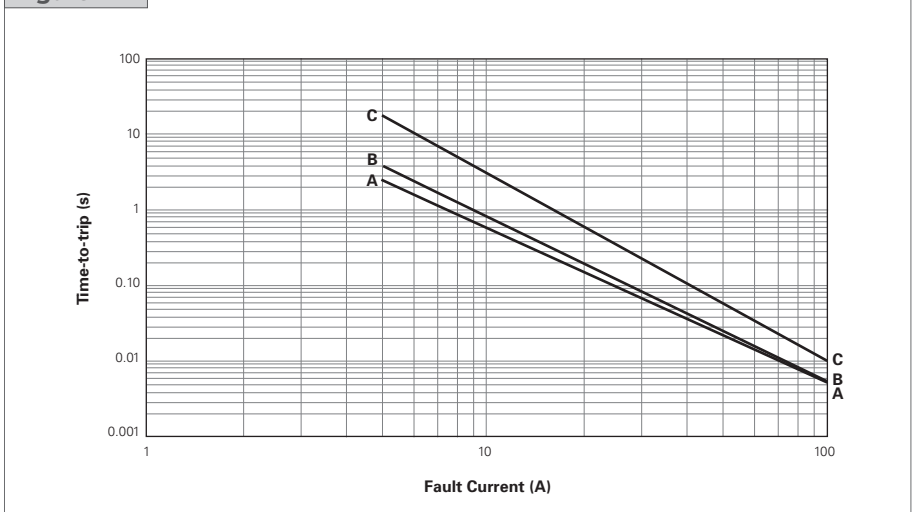
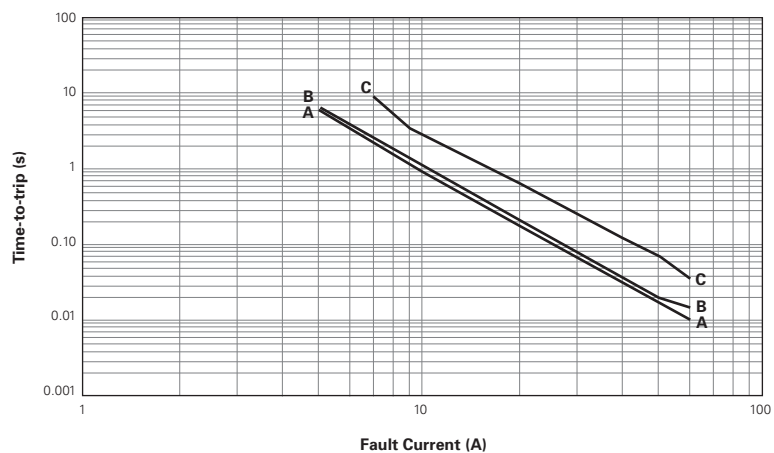
Figure B17


Figure B17-B24 Typical Time-to-trip Curves at 20°C for Strap Battery Devices

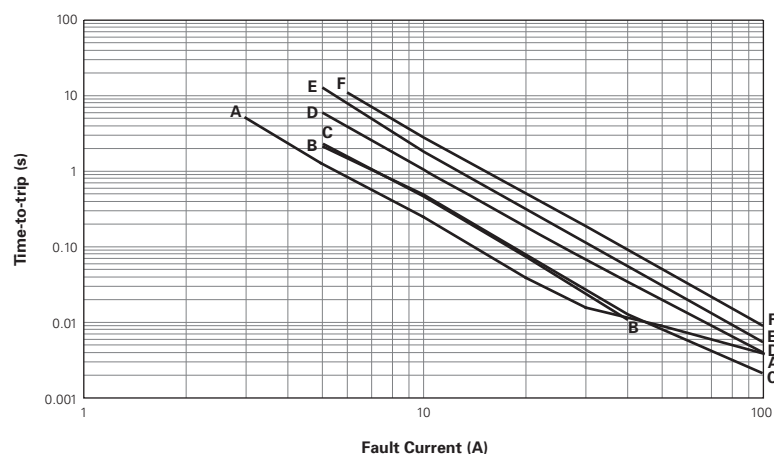
... Cont'd

VLP (data at 25°C)

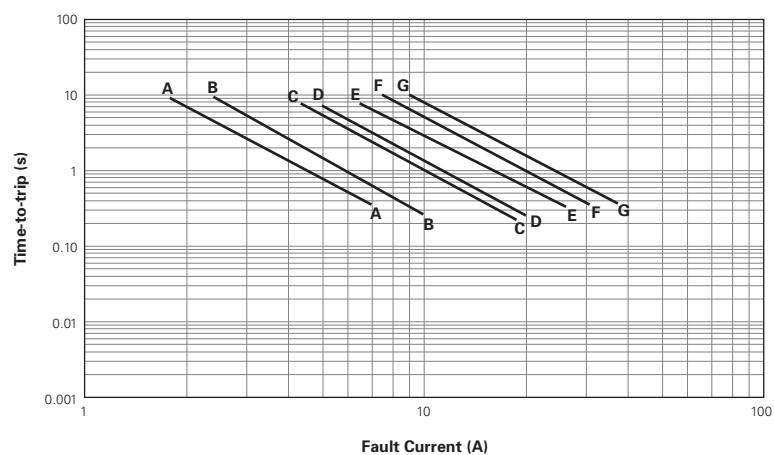
- A = VLP210F
- B = VLP220F
- C = VLP270F

Figure B18

VTP (data at 25°C)

- A = VTP110F
- B = VTP170F
- C = VTP175F
- D = VTP200F
- E = VTP210GF
- F = VTP240F

Figure B19

LTP

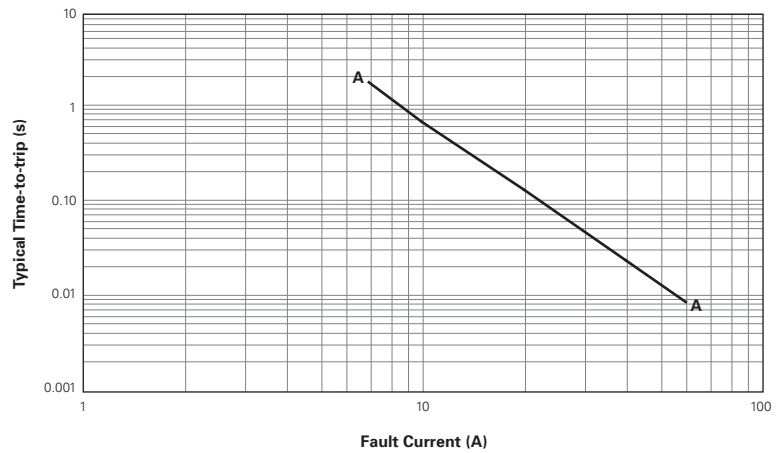
- A = LTP070F
- B = LTP100F
- C = LTP180F
- D = LTP190F
- E = LTP260F
- F = LTP300F
- G = LTP340F

Figure B20


MXP (data at 25°C)

A = MXP190BB

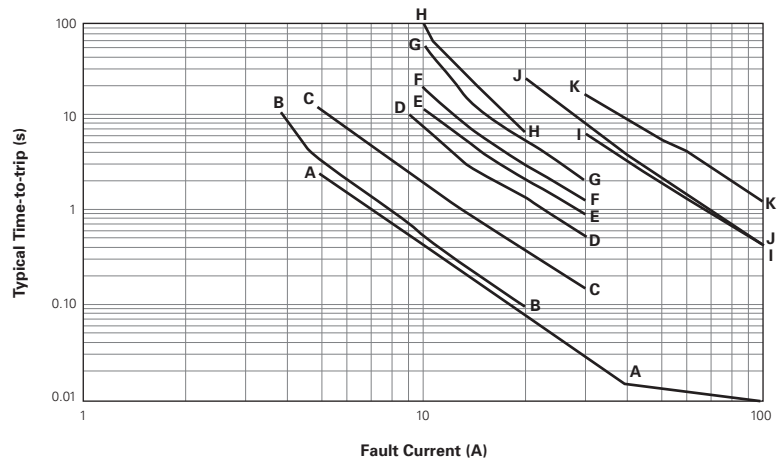
Figure B21



LR4

A = LR4-170UF
 B = LR4-190F
 C = LR4-260F
 D = LR4-380F
 E = LR4-450F
 F = LR4-550F
 G = LR4-600F
 H = LR4-730F
 I = LR4-880F
 J = LR4-900F
 K = LR4-1300F

Figure B22



SRP

A = SRP120F
 B = SRP175F
 C = SRP200F
 D = SRP350F
 E = SRP420F

Figure B23

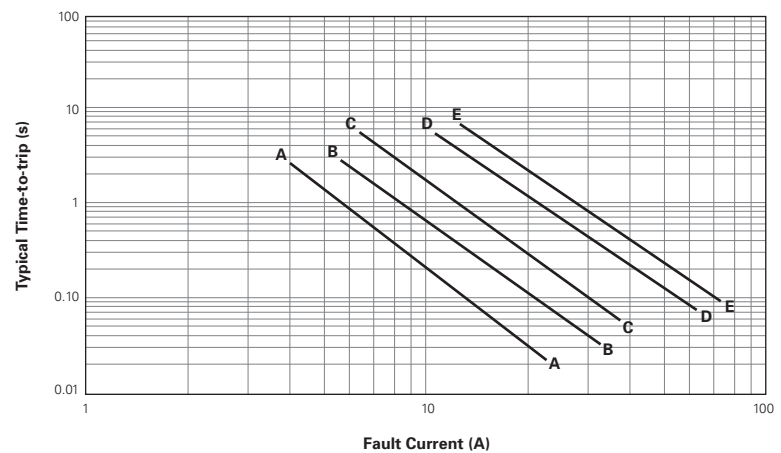
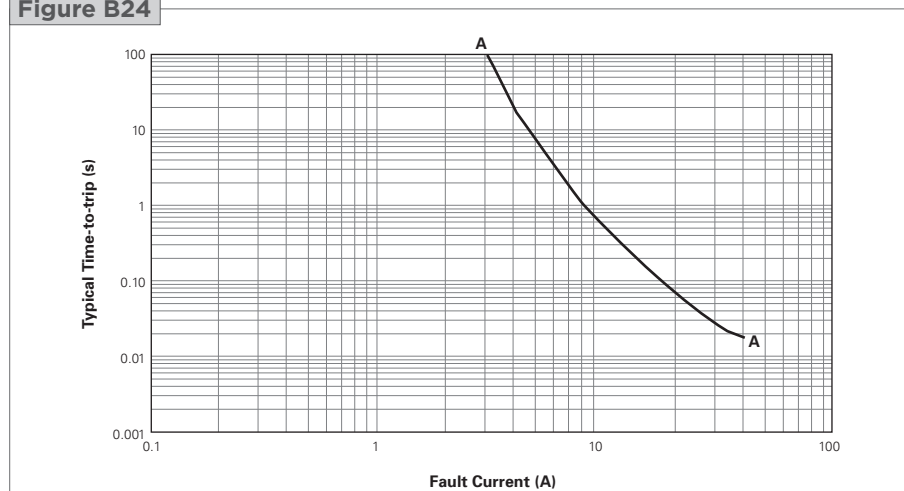


Figure B17-B24 Typical Time-to-trip Curves at 20°C for Strap Battery Devices

... Cont'd

miniSMDE

A = miniSMDE190F

Figure B24**Table B5 Physical Characteristics and Environmental Specifications for Strap Battery Devices****VLR****Physical Characteristics**

Lead material	0.125mm nominal thickness, quarter-hard nickel
Tape material	Polyester

Environmental Specifications

Test	Conditions	Resistance Change
Passive aging	-40°C, 1000 hours	±5%
	60°C, 1000 hours	±20%
Humidity aging	60°C/95% RH, 1000 hours	±30%
Thermal shock	85°C, -40°C (10 times)	±5%
Vibration	MIL-STD-883D, Method 2026	No change

VLP and VTP**Physical Characteristics**

Lead material	0.125mm nominal thickness, quarter-hard nickel
Tape material	Polyester

Environmental Specifications

Test	Conditions	Resistance Change
Passive aging	-40°C, 1000 hours	±5%
	60°C, 1000 hours	±10%
Humidity aging	60°C/95% RH, 1000 hours	±10%
Thermal shock	85°C, -40°C (10 times)	±5%
Vibration	MIL-STD-883D, Method 2026	No change

LTP**Physical Characteristics**

Lead material	0.125mm nominal thickness, quarter-hard nickel
Tape material	Polyester

Environmental Specifications

Test	Conditions	Resistance Change
Passive aging	70°C, 1000 hours	±10%
Humidity aging	85°C/85% RH, 7 days	±15%
Vibration	MIL-STD-883C, Test Condition A	No change

Table B5 Physical Characteristics and Environmental Specifications for Strap Battery Devices ... Cont'd**MXP****Physical Characteristics**

Lead material	0.1mm nominal thickness, half-hard nickel
Coating material	Epoxy

Environmental Specifications

Test	Conditions	Resistance Change
Passive aging	-40°C, 1000 hours	±5%
	60°C, 1000 hours	±20%
Humidity aging	60°C/95% RH, 1000 hours	±30%
Thermal shock	85°C, -40°C (10 times)	±5%
Vibration	MIL-STD-883D, Method 2026	No change

LR4**Physical Characteristics**

Lead material	0.125mm nominal thickness, quarter-hard nickel
Tape material	Polyester

Environmental Specifications

Test	Conditions	Resistance Change
Passive aging	70°C, 1000 hours	±10%
Humidity aging	85°C/85% RH, 7 days	±5%
Vibration	MIL-STD-883D, Method 2026	No change

SRP**Physical Characteristics**

Lead material	0.125mm nominal thickness, quarter-hard nickel
Tape material	Polyester

Environmental Specifications

Test	Conditions	Resistance Change
Passive aging	70°C, 1000 hours	±10%
Humidity aging	85°C/85% RH, 7 days	±5%
Vibration	MIL-STD-883C, Test Condition A	No change

miniSMDE**Physical Characteristics**

Termination pad materials	Solder-plated copper
Termination pad solderability	Meets EIA specification RS186-9E, ANSI/J-STD-002 Category 3

Environmental Specifications

Test	Conditions	Resistance Change
Passive aging	60°C, 1000 hours	±5% typical
	85°C, 1000 hours	±5% typical
Humidity aging	85°C/85% RH, 100 days	±15% typical
Thermal shock	85°C, -40°C (20 times)	-33% typical
	125°C, -55°C (10 times)	-33% typical
Vibration	MIL-STD-883D, Method 2026	No change
Reflow conditions	260°C for 10-20 seconds	Less than R
Tape and reel specifications	Per EIA 481-1	N/A

Note: Storage conditions: 40°C max., 70% RH max.; devices should remain in original sealed bags prior to use. Devices may not meet specified values if these storage conditions are exceeded.

Table B6 Packaging and Marking Information/Agency Recognition for Strap Battery Devices

Part Number	Bag Quantity	Tape & Reel Quantity	Standard Package Quantity	Part Marking	Agency Recognition
85°C Typical Activation					
VLR					
VLR170F	1,000	—	10,000	R17	UL, CSA, TÜV
VLR170LF	1,000	—	10,000	R17	UL, CSA, TÜV
VLR170UF	1,000	—	10,000	—	UL, CSA, TÜV
VLR175F	1,000	—	10,000	R1X	UL, CSA, TÜV
VLR175LF	1,000	—	10,000	R1X	UL, CSA, TÜV
VLR175UF	1,000	—	10,000	—	UL, CSA, TÜV
VLR230F	1,000	—	10,000	R23	UL, CSA, TÜV
VLR230F-C36	1,000	—	10,000	R23	UL, CSA, TÜV
VLR230UF	1,000	—	10,000	—	UL, CSA, TÜV
90°C Typical Activation					
VLP					
VLP210F	1,000	—	10,000	W21	UL, CSA, TÜV
VLP220F	1,000	—	10,000	W22	UL, CSA, TÜV
VLP270F	1,000	—	10,000	W27	UL, CSA, TÜV
VTP					
VTP110F	1,000	—	10,000	—	UL, CSA, TÜV
VTP170F	1,000	—	10,000	V17	UL, CSA, TÜV
VTP170SSF	1,000	—	10,000	V17	UL, CSA, TÜV
VTP170XF	1,000	—	10,000	V17	UL, CSA, TÜV
VTP170XSF	1,000	—	10,000	V17	UL, CSA, TÜV
VTP175F	1,000	—	10,000	V1X	UL, CSA, TÜV
VTP175LF	1,000	—	10,000	V1X	UL, CSA, TÜV
VTP175UF	1,000	—	10,000	—	UL, CSA, TÜV
VTP200GF	1,000	—	10,000	V20	UL, CSA, TÜV
VTP200UF	1,000	—	10,000	—	UL, CSA, TÜV
VTP210GF	1,000	—	10,000	V21	UL, CSA, TÜV
VTP210GUF	1,000	—	10,000	—	UL, CSA, TÜV
VTP210SF	1,000	—	10,000	V21	UL, CSA, TÜV
VTP210SLF	1,000	—	10,000	V21	UL, CSA, TÜV
VTP210SSF	1,000	—	10,000	V21	UL, CSA, TÜV
VTP240F	1,000	—	10,000	V24	UL, CSA, TÜV
110°C Typical Activation					
LTP					
LTP070F	2,000	—	10,000	L07	UL, CSA, TÜV
LTP070SF	2,000	—	10,000	L07	UL, CSA, TÜV
LTP100F	2,000	—	10,000	L10	UL, CSA, TÜV
LTP100SF	2,000	—	10,000	L10	UL, CSA, TÜV
LTP100SLF	2,000	—	40,000	L10	UL, CSA, TÜV
LTP100SSF	2,000	—	10,000	L10	UL, CSA, TÜV
LTP180F	2,000	—	10,000	L18	UL, CSA, TÜV
LTP180LF	500	—	10,000	L18	UL, CSA, TÜV
LTP180SF	2,000	—	10,000	L18	UL, CSA, TÜV
LTP190F	500	—	10,000	L19	UL, CSA, TÜV
LTP260F	1,000	—	10,000	L26	UL, CSA, TÜV
LTP300F	500	—	10,000	L30	UL, CSA, TÜV
LTP340F	500	—	10,000	L34	UL, CSA, TÜV
miniSMDE					
miniSMDE190F-2	—	5,000	5,000	19	UL, CSA, TÜV
120°C Typical Activation					
MXP					
MXP190BB	4,000	—	8,000	—	UL, CSA, TÜV

Table B6 Packaging and Marking Information/Agency Recognition for Strap Battery Devices

... Cont'd

Part Number	Bag Quantity	Tape & Reel Quantity	Standard Package Quantity	Part Marking	Agency Recognition
125°C Typical Activation					
LR4					
LR4-170UF	2,000	—	10,000	NA	UL, CSA, TÜV
LR4-190F	2,000	—	10,000	E19	UL, CSA, TÜV
LR4-190SF	2,000	—	10,000	E19	UL, CSA, TÜV
LR4-260F	1,000	—	10,000	E26	UL, CSA, TÜV
LR4-260SF	1,000	—	10,000	E26	UL, CSA, TÜV
LR4-380F	1,000	—	10,000	E38	UL, CSA, TÜV
LR4-380XF	1,000	—	10,000	E3X	UL, CSA, TÜV
LR4-450F	1,000	—	10,000	E45	UL, CSA, TÜV
LR4-550F	1,000	—	10,000	E55	UL, CSA, TÜV
LR4-600F	1,000	—	10,000	E60	UL, CSA, TÜV
LR4-600XF	1,000	—	10,000	E60	UL, CSA, TÜV
LR4-730F	1,000	—	10,000	E73	UL, CSA, TÜV
LR4-73XF	500	—	10,000	E7X	UL, CSA, TÜV
LR4-880SSF	250	—	8,000	E88	(UL, CSA, TÜV pending)
LR4-900F	500	—	10,000	E90	UL, CSA, TÜV
LR4-1300SSF	250	—	10,000	EX3	UL, CSA, TÜV
SRP					
SRP120F	2,000	—	10,000	120	UL, CSA, TÜV
SRP120LF	1,000	—	10,000	120	UL, CSA, TÜV
SRP120SF	2,000	—	10,000	120	UL, CSA, TÜV
SRP175F	2,000	—	10,000	175	UL, CSA, TÜV
SRP175LF	1,000	—	10,000	175	UL, CSA, TÜV
SRP175SF	2,000	—	10,000	175	UL, CSA, TÜV
SRP175SSF	2,000	—	10,000	175	UL, CSA, TÜV
SRP200F	500	—	10,000	200	UL, CSA, TÜV
SRP350F	500	—	10,000	350	UL, CSA, TÜV
SRP420F	500	—	10,000	420	UL, CSA, TÜV

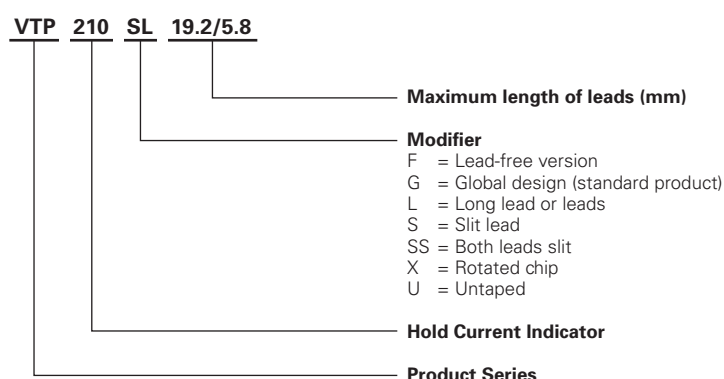
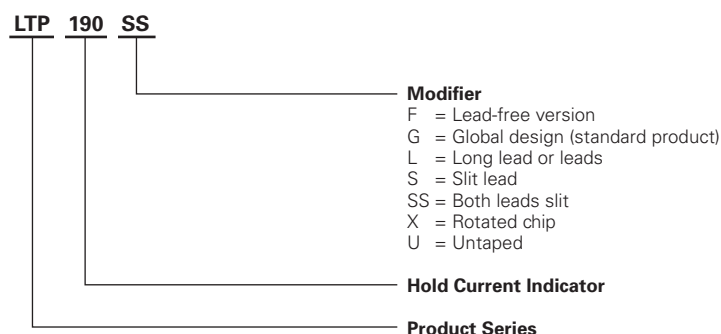
Agency Recognition for Strap Battery Devices

UL	File # E74889
CSA	File # 78165C
TÜV	Certificate number available on request

Installation Guidelines for the Strap Family

- Polymeric PTC devices operate by thermal expansion of the conductive polymer. If devices are placed under pressure or installed in spaces that would prevent thermal expansion, they may not properly protect against fault conditions. Designs must be selected in such a manner that adequate space is maintained over the life of the product.
- Twisting, bending, or placing the Polymeric PTC device in tension will decrease the ability of the device to protect against electrical faults. No residual force should remain on device after installation. Mechanical damage to Polymeric PTC chip may affect device performance and should be avoided.
- Chemical contamination of Polymeric PTC devices should be avoided. Certain greases, solvents, hydraulic fluids, fuels, industrial cleaning agents, volatile components of adhesives, silicones, and electrolytes can have an adverse effect on device performance.
- Polymeric PTC strap devices are designed to be resistance welded to battery cells or to pack interconnect straps, yet some precautions must be taken when doing so. In order for the Polymeric PTC device to exhibit its specified performance, weld placement should be a minimum of 2mm from the edge of the Polymeric PTC chip, weld splatter must not touch the Polymeric PTC chip, and welding conditions must not heat the Polymeric PTC device above its maximum operating temperature.
- Polymeric PTC strap devices are not designed for applications where reflow onto flex circuits or rigid circuit boards is required.
- The polyester tape on PolySwitch strap devices is intended for marking and identification purposes only, not for electrical insulation.
- The coating on MXP devices is intended to prevent oxidization/aging of the devices. Damaging the coating or causing the coating to delaminate can have negative effects on device performance and should be avoided.
- MXP devices have small Polymeric PTC chip size and therefore have weaker peel strength between polymer and Ni-foil of the chip. Excessive mechanical force to the device may cause delamination of Ni-foil from polymer.

Part Numbering System for Strap Battery Devices



Warning :

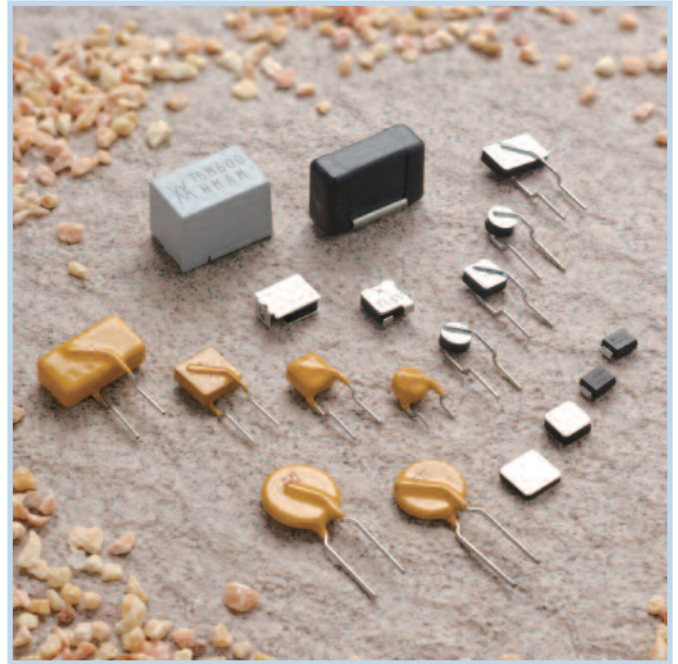
- Operation beyond the maximum ratings or improper use may result in device damage and possible electrical arcing and flame.
- The devices are intended for protection against occasional overcurrent or overtemperature fault conditions and should not be used when repeated fault conditions or prolonged trip events are anticipated.
- Contamination of the PPTC material with certain silicon based oils or some aggressive solvents can adversely impact the performance of the devices.
- Device performance can be impacted negatively if devices are handled in a manner inconsistent with recommended electronic, thermal, and mechanical procedures for electronic components.
- Operation in circuit with a large inductance can generate a circuit voltage ($L di/dt$) above the rated voltage of the PolySwitch resettable device.



PolySwitch Resettable Devices

Telecommunications & Networking Devices

PolySwitch devices for telecommunication and networking applications were initially designed over ten years ago to meet the growing demand for resettable overcurrent protection. These product families help provide protection against power cross and power induction surge as defined in ITU, Telcordia, and UL. Available in chip, surface-mount, and radial-leaded configurations, PolySwitch devices help improve the reliability of customer premise and network equipment world wide.



Benefits

- Many product choices give engineers more design flexibility
- Compatible with high volume electronics assembly
- Assist in meeting regulatory requirements
- Improved line balance
- Applicable for legacy POTS and modern digital communications equipment

Features

- RoHS compliant
- Resettable overcurrent protection
- Surface-mount, radial-leaded, and chip form factors
- Fast time-to-trip
- Agency recognition: UL, CSA, TÜV
- Resistance sorted and matched devices available
- Low parasitic capacitance/flat impedance with frequency

Applications

- | | | |
|----------------------|---------------------------------|----------------------------------|
| • Modems | • PBX systems | • Powered ethernet systems |
| • Phone sets | • MDF modules | • VoIP (Voice over IP equipment) |
| • Fax machines | • Analog and digital line cards | • LAN, WAN equipment |
| • Phone wall outlets | • T1/E1 equipment | • Customer premise equipment |
| • Alarm systems | • xDSL modems and splitters | • Access network hardware |

Protection Application Guide for Telecommunications and Networking Devices*

To use this guide, follow the steps below:

1. Select your equipment type from the guide below.
2. Select the type of protection depending on the agency and regional specifications in the second column.
3. Select the form factor for your application.
4. Use the Agency Specification/ PolySwitch Device Selection Guide on the next page to select a specific part number for each application based on the agency requirements.
5. Parts with fast time-to-trip or low resistance are available. Please consult a Raychem Circuit Protection product representative.

Application	Region/ Specification	Overcurrent Protection			Overvoltage Protection
		Form Factor			SiBar Thyristor Surge Protectors†
		Radial-leaded	Surface-mount	Chip	
Customer Premises equipment	North America	TRF600-150	TS600-170F		TVBxxx(N/R)SA-L,
IT equipment	TIA-968-A (formerly FCC Part 68), UL 60950		TS600-200F		TVBxxx(N/M)SB-L, or TVAxxx(N/R)SA-L
Analog modems, V.90 modems, ISDN modems, xDSL modems, ADSL splitters, phone sets, fax machines, answering machines, caller ID, internet appliances, PBX systems, POS terminals, wall plugs	Europe/Asia/ South America	TRF250-120 TRF250-120T TRF250-145 TRF250-180 TRF250-183	TS250-130F TSV250-130F		TVBxxx(N/R)SA-L TVAxxx(N/R)SA-L
Access network equipment (†)	North America	TRF600-160	TS600-170F TS600-200F TSM600-250F TSM600-400F†† FT600-1250**		TVBxxx(N/M/R)SC-L
Remote terminals, line repeaters, multiplexers, cross-connects, WAN equipment	Europe/Asia/ South America	TRF250-120 TRF250-145 TRF250-120T TRF250-180 TRF250-183	TS250-130F TSV250-130F		TVBxxx(N/R)SA-L TVAxxx(N/R)SA-L
Central office switching equipment (†)	North America	TRF600-160	TSM600-250F TSM600-170F TSM600-200F FT600-1250** TSM600-400F††		TVBxxx(N/M/R)SC-L
Analog/POTS linecards, ISDN linecards, xDSL modems, ADSL/VDSL splitters, T1/E1 linecards, multiplexers, CSU/DSU, servers	Europe/Asia/ South America	TRF250-120 TRF250-145 TRF250-120T TRF250-180 TRF250-183	TS250-130F TSV250-130F		TVBxxx(N/R)SA-L TVAxxx(N/R)SA-L
Primary protection modules (†)	North America	TRF250-180		TCF250-180	N/A
MDF modules, Network Interface Devices (NID)	Europe/Asia/ South America	TRF250-120T TRF250-145T TRF250-145	TS250-130F TSV250-130F	TCF250-120T TCF250-145T TCF250-180	TVBxxx(N/M/R)Sx-L
Short-haul/intrabuilding communications equipment (†)	North America	TRF250-120 Telcordia GR-1089 intrabuilding	TS250-130F TSL250-080F TSV250-130F		TVBxxx(N/R)SA-L TVAxxx(N/R)SA-L
LAN equipment, VoIP cards, cable telephony NIUs, wireless local loop handsets	Europe/Asia/ South America	TRF250-120 TRF250-145 TRF250-180 TRF250-183	TS250-130F TSV250-130F		TVBxxx(N/R)SA-L TVAxxx(N/R)SA-L
LAN intrabuilding power cross protection			TSL250-080F		TVBxxx(N/R)SA-L TVAxxx(N/R)SA-L
LAN equipment, VoIP cards, IP phones	IEEE 802.3 Power over LAN protection		decaSMD050F/60-2‡‡		N/A
Powered ethernet switches and terminals, IP phones, wireless LAN base stations, microcellular base stations, VoIP cards	Cable telephony powering system	BBRF550*** BBRF750***			N/A
Power passing taps					

* This list is not exhaustive. Tyco Electronics welcomes our customers' input for additional application ideas for PolySwitch resettable devices.

† For improved line balance in these applications, resistance-matched parts are recommended.

‡ For more information on Raychem Circuit Protection SiBar thyristor surge protectors, refer to the SiBar product section on page 37.

** FT600-1250 are surface mount telecom fuse devices. FT600-0500 and FT600-2000 reference also available. See FT600 section on page 100.

†† Helps meet GR-1089 issue 3. Consult Raychem Circuit Protection for meeting GR-1089 issue 4.

‡‡ For details on decaSMD050F/60-2, see surface-mount devices section on page 109.

*** For details on BBRF series, see radial-leaded devices section on page 125.

Agency Specification/Selection Guide for Telecommunications and Networking Devices

Use the guide below to select the PolySwitch devices which are typically used in your application. The following pages contain the specifications for the part numbers recommended below. PolySwitch devices assist telecommunication equipment in meeting the applicable protection requirements of these industry specifications. Refer to individual agency specifications for test procedures and circuit schematics. Users should independently evaluate the suitability of, and test each product for their application.

Family	Product*	Lightning	Power Cross
TCF250	TCF250-145T	ITU K.20/21/45 – 4.0kV 10/700µs†	ITU K.20/21/45 – 230V _{AC} , 10Ω
	TCF250-180		ITU K.20/21/45 – 600V _{AC} , 600Ω
	TCF250-120T		
TRF250	TRF250-080U	ITU K.20 – 1.0kV 10/700µs	ITU K.20 – 230V _{AC} , 10Ω ITU K.20 – 600V _{AC} , 600Ω
	TRF250-110U	ITU K.20/21/45 – 1.5kV 10/700µs	ITU K.20/21/45 – 230V _{AC} , 10Ω
	TRF250-120	ITU K.20/21/45 – 4.0kV 10/700µs†	ITU K.20/21/45 – 600V _{AC} , 600Ω
	TRF250-120T		
	TRF250-120U		
	TRF250-120UT		
	TRF250-145		
	TRF250-145U		
	TRF250-180		
	TRF250-180US		
	TRF250-183		
TS250/TSV250	TSV250-130F	ITU K.20/21/45 – 1.5kV 10/700µs	ITU K.20/21/45 – 230V _{AC} , 10Ω
	TS250-130F	ITU K.20/21/45 – 4.0kV 10/700µs†	ITU K.20/21/45 – 600V _{AC} , 600Ω
TSL250	TSL250-080F	Telcordia GR-1089 Intrabuilding – Surge 1 & 2	Telcordia GR-1089 Intrabuilding – 120V _{AC} , 25A ITU K.20/21/45 – 230V _{AC} , 10Ω
TRF600	TRF600-150	TIA-968-A (formerly FCC Part 68)	UL60950, 3rd Ed. – 600V _{AC} , 40A
	TRF600-160	Telcordia GR-1089 – Level 1 and 2, issue 2‡	Telcordia GR-1089 – 600V _{AC} , 60A
TS600	TS600-170F	TIA-968-A (formerly FCC Part 68)	UL60950, 3rd Ed. – 600V _{AC} , 40A
	TS600-200F-RA	Telcordia GR-1089 – Level 1 and 2, issue 2‡	Telcordia GR-1089 – 600V _{AC} , 60A
TSM600	TSM600-250F	TIA-968-A (formerly FCC Part 68)	UL60950, 3rd Ed. – 600V _{AC} , 40A
	TSM600-250F-RA	Telcordia GR-1089 – Level 1 and 2, issue 2‡	Telcordia GR-1089 – 600V _{AC} , 60A
	TSM600-400F	TIA-968-A (formerly FCC Part 68)	UL60950, 3rd Ed. – 600V _{AC} , 40A
		Telcordia GR-1089, issue 3	Telcordia GR-1089 – 600V _{AC} , 60A
FT600**	FT600-0500	TIA-968-A - Type A & B	UL60950, 600V _{AC} , 40A
	FT600-1250	TIA-968-A - Type A & B	UL60950, 3rd Ed. – 600V _{AC} , 40A
	FT600-2000		Telcordia GR-1089 – 600 V _{AC} , 60A

* Applies to all products which share the same prefix.

† Tested with 230V gas discharge tube primary protector.

‡ May require additional series resistor to help telecommunication equipment pass Surge 3 (1kV, 10/1000µs).

** See FT600 section on page 100.

Table T1 Product Series: Size, Current Rating, Voltage Rating, Typical Resistance for Telecommunications and Networking Devices

	TCF250	TRF250	TS250	TSV250	TSL250	TS600 TSM600	TRF600
Voltage Rating (V)† (Operating/Interrupt)	60/250	60/250	60/250	60/250	80/250	60/600	60/600
Specification	ITU	ITU	ITU	ITU	Telcordia GR-1089 Intrabuilding	UL60950 Telcordia GR-1089	UL60950 Telcordia GR-1089
Hold Current (A)							
0.080	—	17.0Ω	—	—	8.0Ω	—	—
0.100	—	—	—	—	—	—	—
0.110	—	7.0Ω	—	—	—	—	—
0.120	10.5Ω	6.0-9.5Ω	—	—	—	—	—
0.130	—	—	8.0-10.5Ω	5.5Ω	—	—	—
0.140	—	—	—	—	—	—	—
0.145	7.0Ω	4.3-5.0Ω	—	—	—	—	—
0.150	—	—	—	—	—	—	8.0Ω
0.160	—	—	—	—	—	—	5.5-7.0Ω*
0.170	—	—	—	—	—	11.0Ω	—
0.180	1.4Ω	1.5Ω‡	—	—	—	—	—
0.183	—	0.8-2.0Ω‡	—	—	—	—	—
0.200	—	—	—	—	—	8.5Ω	—
0.250	—	—	—	—	—	3.0-3.5Ω*	—
0.300	—	—	—	—	—	—	—
0.400	—	—	—	—	—	1.1Ω	—
0.550	—	—	—	—	—	—	—
0.750	—	—	—	—	—	—	—

* These devices have a maximum operating voltage of 250V

† Voltage Rating for telecommunications and networking devices is dependent upon the nature of the fault conditions. See telecom fuses section on page 100.

‡ These devices have a maximum operating voltage of 100V

Voltage Ratings for Telecommunications and Networking Devices

For Raychem Circuit Protection telecommunications devices (TCF, TRF, TSx series) there are two applicable voltage ratings. These are **V_{Max} Operating** and **V_{Max} Interrupt**. To help understand the nature of these two different voltage ratings, the following definitions are provided:

V_{Max} Operating : For telecommunications devices this is the voltage we have used to obtain component recognition under UL1434. Most Raychem Circuit Protection devices (TCF, TRF, TSx) are certified at 60V but can withstand higher V_{max}. TRF600-160 and TSM600 product families are certified at 250V but can withstand higher V_{Max}. Interrupt conditions as noted above.

V_{Max} Interrupt : Under specified conditions this is the highest voltage that can be applied to the device at the maximum current. Devices have been designed to trip safely under higher power level cross conditions, as listed above, to assist equipment in meeting the appropriate industry conditions.

Table T2 Thermal Derating for Telecommunications and Networking Devices
[Hold Current (A) at Ambient Temperature (°C)]

Part Number	Maximum Ambient Temperature								
	-40°C	-20°C	0°C	20°C	40°C	50°C	60°C	70°C	85°C
Chip* — 60/250V									
TCF250									
TCF250-120T	0.186	0.165	0.143	0.120	0.099	0.088	0.077	0.066	0.050
TCF250-145T	0.225	0.199	0.172	0.145	0.119	0.106	0.093	0.080	0.060
TCF250-180**	0.269	0.240	0.211	0.180	0.153	0.138	0.123	0.109	0.087
Radial-leaded* — 60/250V									
TRF250									
TRF250-080U	0.124	0.110	0.095	0.080	0.066	0.059	0.051	0.044	0.033
TRF250-110U	0.171	0.151	0.131	0.110	0.091	0.081	0.071	0.061	0.046
TRF250-120	0.186	0.165	0.143	0.120	0.099	0.088	0.077	0.066	0.050
TRF250-145	0.225	0.199	0.172	0.145	0.119	0.106	0.093	0.080	0.060
TRF250-180**	0.279	0.247	0.213	0.180	0.147	0.131	0.115	0.099	0.074
TRF250-180US**	0.279	0.247	0.213	0.180	0.147	0.131	0.115	0.099	0.074
NEW TRF250-183**	0.284	0.251	0.217	0.183	0.149	0.133	0.117	0.101	0.075
Surface† — 80/250V									
TSL250									
TSL250-080F	0.124	0.110	0.095	0.080	0.066	0.059	0.051	0.044	0.033
Surface* — 60/250V									
TS250/TSV250									
TS250-130F	0.208	0.182	0.156	0.130	0.104	0.091	0.078	0.065	0.045
TSV250-130F	0.208	0.182	0.156	0.130	0.104	0.091	0.078	0.065	0.045
Radial-leaded‡ — 60/600V									
TRF600									
TRF600-150	0.233	0.206	0.178	0.150	0.124	0.110	0.096	0.083	0.062
TRF600-160	0.249	0.219	0.190	0.160	0.132	0.117	0.103	0.088	0.066
Surface‡ — 60/600V									
TSM600/TSM600									
TSM600-170F	0.264	0.230	0.200	0.170	0.140	0.125	0.109	0.094	0.070
TSM600-200F-RA-B-0.5	0.310	0.275	0.238	0.200	0.165	0.147	0.128	0.110	0.083
TSM600-250F	0.400	0.350	0.300	0.250	0.198	0.170	0.140	0.117	0.083
TSM600-250F-RA	0.400	0.350	0.300	0.250	0.198	0.170	0.140	0.117	0.083
TSM600-400F	0.640	0.560	0.480	0.400	0.320	0.270	0.230	0.190	0.130

* 60/250V products are designed to help equipment pass ITU recommendations (K.20, K.21, etc) and Telcordia GR-1089 Intrabuilding power cross.

† 80/250V products are designed to help equipment pass Telcordia GR-1089 Intrabuilding power cross (120V_{AC}/25A).

‡ 60/600V products are designed to help equipment pass UL60950, TIA-968-A (formerly FCC Part 68) and GR1089 specifications.

** Product is not currently available in a resistance matched or sorted option.

Figure T1 Thermal Derating [Hold Current (A) at Ambient Temperature (°C)]

- A = TCF250-180
B = All other TCF, TRF,
TSx, TSM series devices

Figure T1

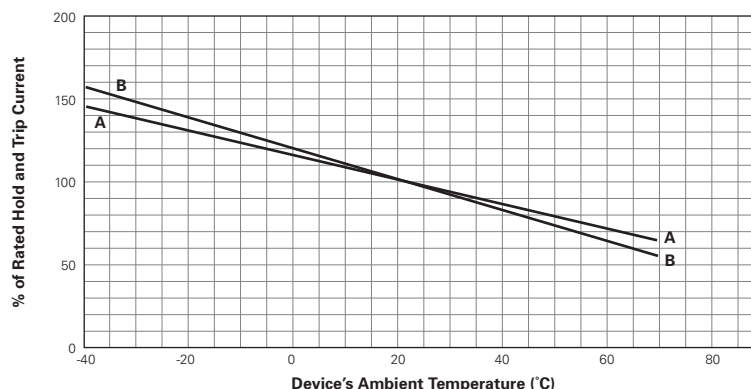


Table T3 Electrical Characteristics for Telecommunications and Networking Devices

Part Number	I _H (A)	I _T (A)	V _{Max} Operating (V _{DC})	V _{Max} Interrupt (V _{RMS})	I _{Max} (A)	P _D TYP (W)	Time-to-trip		R _{Min} (Ω)	R _{Max} (Ω)	R ₁ Max (Ω)
								(A)	(s)		
Chip* — 60/250V											
TCF250											
TCF250-120T	0.120	0.240	60	250	3.0	1.0	1.0	1.20 max	6.3	12.0	18.0
TCF250-145T	0.145	0.290	60	250	3.0	1.0	1.0	1.50 nom	5.0	9.0	14.0
TCF250-180**	0.180	0.650	60	250	3.0	0.8	1.0	15.50 nom	1.0	2.2	4.0
Radial-leaded* — 60/250V											
TRF250											
TRF250-080T	0.080	0.160	60	250	3.0	0.6	0.35	4.00 max	15.0	22.0	33.0
TRF250-080U	0.080	0.160	60	250	3.0	0.6	0.35	4.00 max	14.0	20.0	33.0
TRF250-110U	0.110	0.220	60	250	3.0	1.0	1.00	0.75 nom	5.0	9.0	16.0
TRF250-120	0.120	0.240	60	250	3.0	1.0	1.00	1.50 nom	4.0	8.0	16.0
TRF250-120T	0.120	0.240	60	250	3.0	1.0	0.35	0.70 nom	7.0	12.0	16.0
TRF250-120T-RA	0.120	0.240	60	250	3.0	1.0	1.00	1.20 nom	7.0	9.0	16.0
TRF250-120T-RC	0.130	0.260	60	250	3.0	1.0	1.00	3.00 nom	5.4	7.5	14.0
TRF250-120T-RF	0.120	0.240	60	250	3.0	1.0	1.00	0.90 nom	6.0	10.5	16.0
TRF250-120T-R1	0.120	0.240	60	250	3.0	1.0	1.00	1.00 nom	6.0	9.0	16.0
TRF250-120T-R2	0.120	0.240	60	250	3.0	1.0	1.00	0.75 nom	8.0	10.5	16.0
TRF250-120U	0.120	0.240	60	250	3.0	1.0	1.00	1.00 nom	6.0	10.0	16.0
TRF250-120UT	0.120	0.240	60	250	3.0	1.0	1.00	0.70 nom	7.0	12.0	16.0
TRF250-145	0.145	0.290	60	250	3.0	1.0	1.00	2.50 nom	3.0	6.0	14.0
TRF250-145-RA	0.145	0.290	60	250	3.0	1.0	1.00	2.50 nom	3.0	5.5	12.0
TRF250-145-RB	0.145	0.290	60	250	3.0	1.0	1.00	2.00 nom	4.5	6.0	14.0
TRF250-145T	0.145	0.290	60	250	3.0	1.0	1.00	1.50 nom	5.4	7.5	14.0
TRF250-145U	0.145	0.290	60	250	3.0	1.0	1.00	2.00 nom	3.5	6.5	14.0
TRF250-180**	0.180	0.650	100	250	10.0	1.5	3.00	0.50 nom	0.8	2.2	4.0
TRF250-180US**	0.180	0.650	100	250	10.0	1.4	3.00	0.50 nom/2.0 max	0.8	2.2	4.0
TRF250-183**	0.183	0.685	100	250	10.0	0.9	3.00	0.55 nom/1.8 max	0.8	2.2	3.4
Surface† — 80/250V											
TSL250											
TSL250-080F	0.080	0.160	80	250	3.0	1.2	1.0	0.80 nom	5.0	11.0	20.0
Surface* — 60/250V											
TS250/TSV250											
TS250-130F	0.130	0.260	60	250	3.0	1.1	1.0	0.90 nom	6.5	12.0	20.0
	—	—	60	600	1.0	—	—	—	—	—	—
TS250-130F-RA	0.130	0.260	60	250	3.0	1.1	1.0	1.40 nom	6.5	9.0	15.0
	—	—	60	600	1.0	—	—	—	—	—	—
TS250-130F-RB	0.130	0.260	60	250	3.0	1.1	1.0	0.70 nom	9.0	12.0	20.0
	—	—	60	600	1.0	—	—	—	—	—	—
TS250-130F-RC	0.130	0.260	60	250	3.0	1.1	1.0	1.10 nom	7.0	10.0	17.0
	—	—	60	600	1.0	—	—	—	—	—	—
TSV250-130F	0.130	0.260	60	250	3.0	1.5	1.0	2.00 nom	4.0	7.0	12.0††
Radial-leaded‡ — 60/600V											
TRF600											
TRF600-150	0.150	0.300	250	600	3.0	1.0	1.0	1.40 nom	6.0	10.0	17.0
TRF600-150-RB	0.130	0.260	250	600	3.0	1.0	1.0	1.00 nom	9.0	12.0	22.0
TRF600-160	0.160	0.320	250	600	3.0	1.0	1.0	7.50 nom	4.0	10.0	18.0
TRF600-160-RA	0.160	0.320	250	600	3.0	1.0	1.0	9.50 nom	4.0	7.0	16.0
TRF600-160-R1	0.160	0.320	250	600	3.0	1.0	1.0	9.00 nom	4.0	8.0	17.0
Surface‡ — 60/600V											
TS600/TSM600											
TS600-170F	0.170	0.400	60	600	3.0	2.5	1.0	10.00 nom	4.0	9.0	18.0
TS600-200F-RA-B-0.5	0.200	0.400	60	600	3.0	2.5	1.0	12.00 nom	4.0	7.5	13.5
TSM600-250F	0.250	0.860	250	600	3.0	2.0	3.0	0.80 nom	1.0	3.5	7.0
TSM600-250F-RA	0.250	0.860	250	600	3.0	2.0	3.0	1.00 nom	1.0	3.0	5.0
TSM600-400F	0.400	1.000	250	600	3.0	2.0	3.0	5.0 nom/14.0 max	0.5	1.5	2.0

Notes:

- I_H : Hold current: maximum current device will pass without interruption in 20°C still air.
- I_T : Trip current: minimum current that will switch the device from low resistance to high resistance in 20°C still air.
- V_{Max} Interrupt : Maximum voltage that can be safely placed across a device in its tripped state under specified fault conditions.
- I_{Max} : Maximum fault current device can withstand without damage at rated voltage.
- P_D : Power dissipated from device when in the tripped state in 20°C still air.
- R_{Min} : Maximum resistance of device as supplied at 20°C unless otherwise specified.
- $R_{1\ Max}$: Measured one hour post-trip or post-reflow at 20°C.

* 60/250V products are designed to help equipment pass ITU recommendations (K.20, K.21, etc) and Telcordia GR-1089 Intrabuilding power cross.

† 80/250V products are designed to help equipment pass Telcordia GR-1089 Intrabuilding power cross (120V_{AC}/25A).

‡ 60/600V products are designed to help equipment pass UL60950, TIA-968-A (formerly FCC Part 68) and GR1089 specifications.

** Product is not currently available in a resistance matched or sorted option.

†† $R_{1\ Max}$ measured 1 hour post-trip, or 24 hours post-reflow at 20°C.

Figure T2

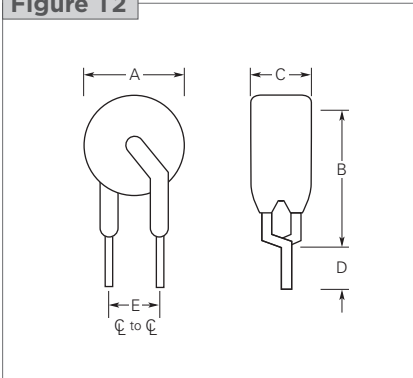


Figure T3

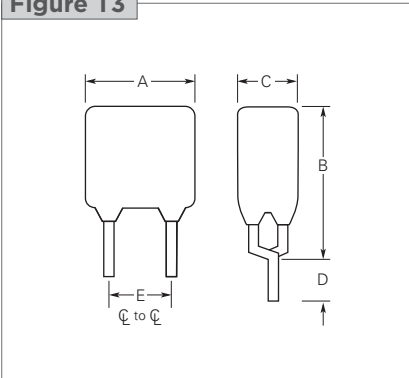


Figure T4

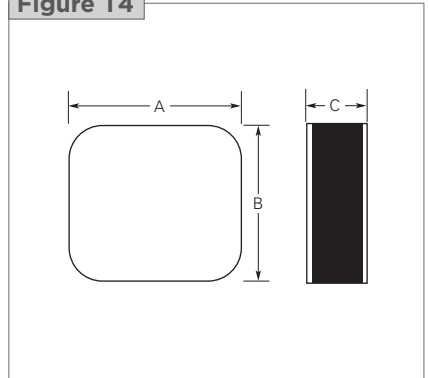


Figure T5

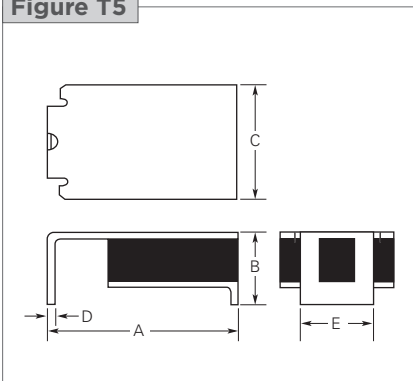


Figure T6

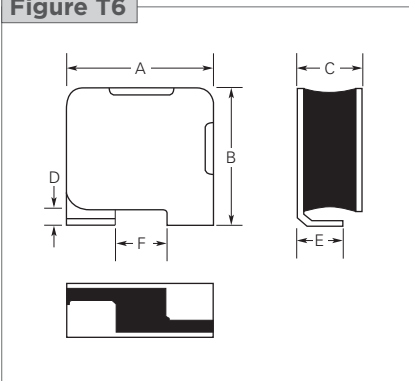


Figure T7

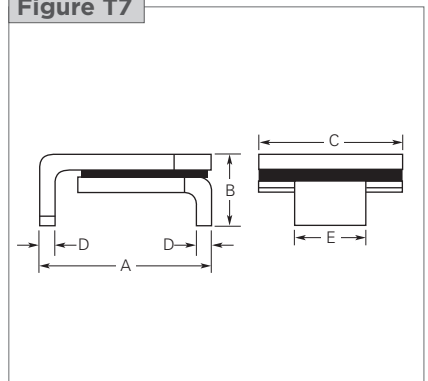


Figure T8

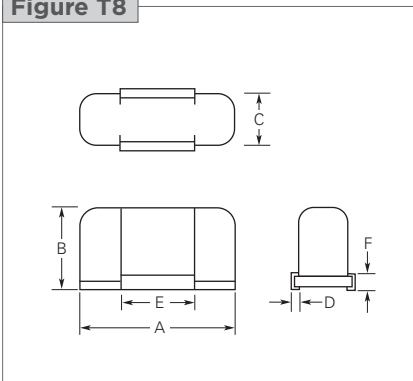


Figure T9

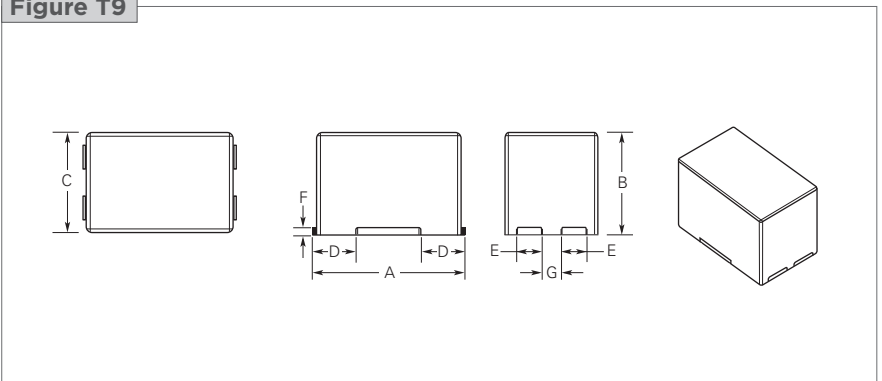


Figure T10

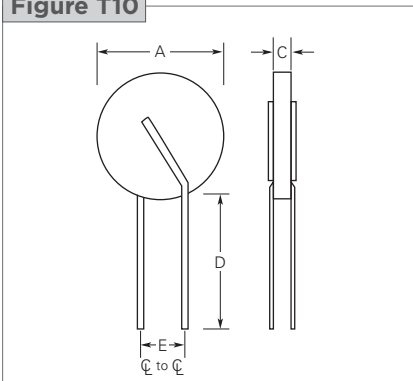


Figure T11

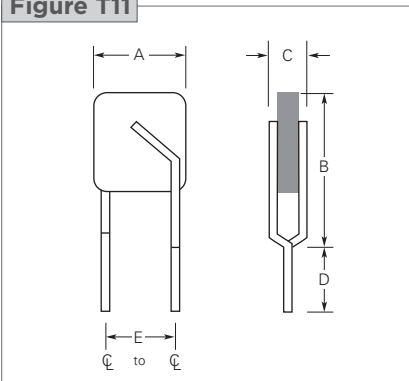


Figure T12

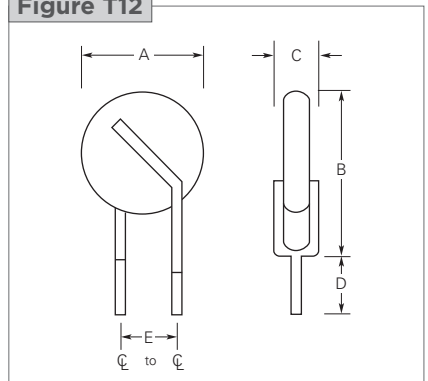


Table T4 Dimensions for Telecommunications and Networking Devices in Millimeters (Inches)

Part Number	A		B		C		D		E		F		G		Figure
	min	max	min	max	min	max	min	max	min	max	min	max	min	max	
 TCF															
60/250V*															
TCF250-120T	5.4 (0.213)	5.6 (0.221)	5.4 (0.213)	5.6 (0.221)	2.0 (0.079)	2.3 (0.091)	—	—	—	—	—	—	—	—	T4
TCF250-145T	5.4 (0.213)	5.6 (0.221)	5.4 (0.213)	5.6 (0.221)	2.0 (0.080)	2.5 (0.100)	—	—	—	—	—	—	—	—	T4
TCF250-180	6.9 (0.270)	7.1 (0.280)	6.9 (0.270)	7.1 (0.280)	1.3 (0.050)	1.6 (0.060)	—	—	—	—	—	—	—	—	T4
 TRF250															
60/250V*															
TRF250-080T	—	5.8 (0.228)	—	9.9 (0.390)	—	4.6 (0.181)	4.7 (0.185)	—	5.0** (0.197)	—	—	—	—	—	T2
TRF250-080U	—	4.8 (0.189)	—	9.3 (0.366)	—	3.8 (0.150)	4.7 (0.185)	—	5.0** (0.197)	—	—	—	—	—	T12
TRF250-110U	—	5.33 (0.210)	—	9.4 (0.370)	—	3.8 (0.150)	4.7 (0.185)	—	5.0** (0.197)	—	—	—	—	—	T12
TRF250-120	—	6.5 (0.256)	—	11.0 (0.433)	—	4.6 (0.181)	4.7 (0.185)	—	5.0** (0.197)	—	—	—	—	—	T3
TRF250-120U	—	6.0 (0.236)	—	10.0 (0.394)	—	3.8 (0.150)	4.7 (0.185)	—	5.0** (0.197)	—	—	—	—	—	T11
TRF250-145	—	6.5 (0.256)	—	11.0 (0.433)	—	4.6 (0.181)	4.7 (0.185)	—	5.0** (0.197)	—	—	—	—	—	T3
TRF250-145U	—	6.0 (0.236)	—	10.0 (0.394)	—	3.8 (0.150)	4.7 (0.185)	—	5.0** (0.197)	—	—	—	—	—	T11
TRF250-180	—	9.0 (0.354)	—	12.0 (0.412)	—	3.8 (0.150)	4.7 (0.185)	—	5.0** (0.197)	—	—	—	—	—	T2
TRF250-180US	—	8.1 (0.319)	—	—	—	3.0 (0.118)	4.7 (0.185)	—	5.0** (0.197)	—	—	—	—	—	T10
 TRF250-183	—	7.5 (0.290)	—	10.5 (0.410)	—	4.1 (0.160)	4.7 (0.185)	—	5.0** (0.197)	—	—	—	—	—	T2
 TSL250															
80/250V†															
TSL250-080F	6.7 (0.265)	7.9 (0.310)	2.7 (0.110)	3.7 (0.145)	4.8 (0.190)	5.3 (0.210)	0.2 (0.008)	0.4 (0.015)	2.5 (0.100)	3.1 (0.120)	—	—	—	—	T7
 TS250/TSV250															
60/250V*															
TS250-130F	8.5 (0.335)	9.4 (0.370)	—	3.4 (0.135)	—	7.4 (0.290)	0.3** (0.011)	—	3.8** (0.150)	—	—	—	—	—	T5
TSV250-130F	—	6.1 (0.240)	—	6.9 (0.270)	—	3.2 (0.126)	0.56 (0.022)	—	—	1.9 (0.075)	1.6 (0.065)	2.3 (0.091)	—	—	T6
 TRF600															
60/600V‡															
TRF600-150	—	9.0 (0.354)	—	12.5 (0.492)	—	4.6 (0.180)	4.7 (0.185)	—	5.0 (0.197)	—	—	9.0 (0.354)	—	—	T3
TRF600-160	—	16.0 (0.630)	—	12.6 (0.496)	—	6.0 (0.236)	4.7 (0.185)	—	5.0** (0.197)	—	—	10.0 (0.394)	—	—	T3
 TS600/TSM600															
60/600V‡															
TS600-170F	18.29 (0.720)	19.43 (0.765)	11.56 (0.455)	12.32 (0.485)	7.24 (0.285)	8.26 (0.325)	1.65 (0.065)	2.41 (0.095)	9.91 (0.390)	10.41 (0.410)	1.52 (0.060)	2.29 (0.090)	—	—	T8
TS600-200F-RA	18.29 (0.720)	19.43 (0.765)	11.56 (0.455)	12.32 (0.485)	7.24 (0.285)	8.26 (0.325)	1.65 (0.065)	2.41 (0.095)	9.91 (0.390)	10.41 (0.410)	1.52 (0.060)	2.29 (0.090)	—	—	T8
TSM600-250F	17.00 (0.671)	17.60 (0.690)	11.20 (0.440)	11.70 (0.460)	10.40 (0.410)	11.20 (0.440)	4.80 (0.187)	5.20 (0.203)	2.50 (0.099)	2.80 (0.111)	0.60 (0.022)	1.0 (0.038)	2.2 (0.087)	3.1 0.122	T9
TSM600-250F-RA	17.00 (0.671)	17.60 (0.690)	11.20 (0.440)	11.70 (0.460)	10.40 (0.410)	11.20 (0.440)	4.80 (0.187)	5.20 (0.203)	2.50 (0.099)	2.80 (0.111)	0.60 (0.022)	1.0 (0.038)	2.2 (0.087)	3.1 0.122	T9

* 60/250V products are designed to help equipment pass ITU specifications (K.20, K.21, etc) and Telcordia GR-1089 Intrabuilding power cross.

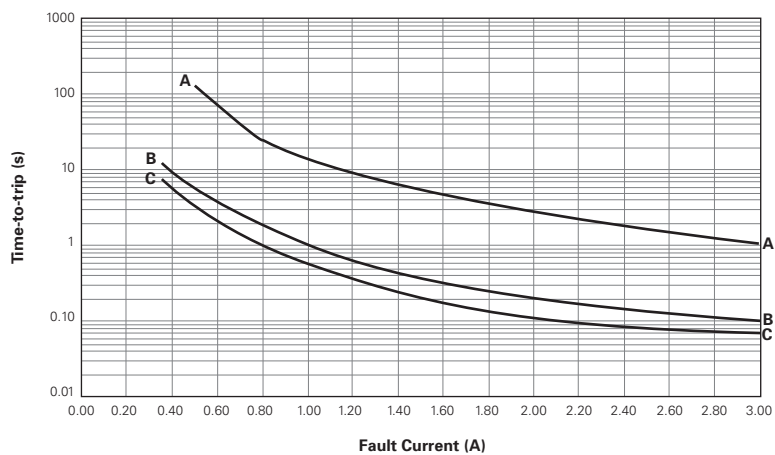
† 80/250V product designed to help equipment pass Telcordia GR-1089 Intrabuilding power cross (120V_{AC}/25A).

‡ 60/600V products are designed to help equipment pass UL 60950, TIA-968-A (formerly FCC Part 68) and Telcordia GR-1089 specification.

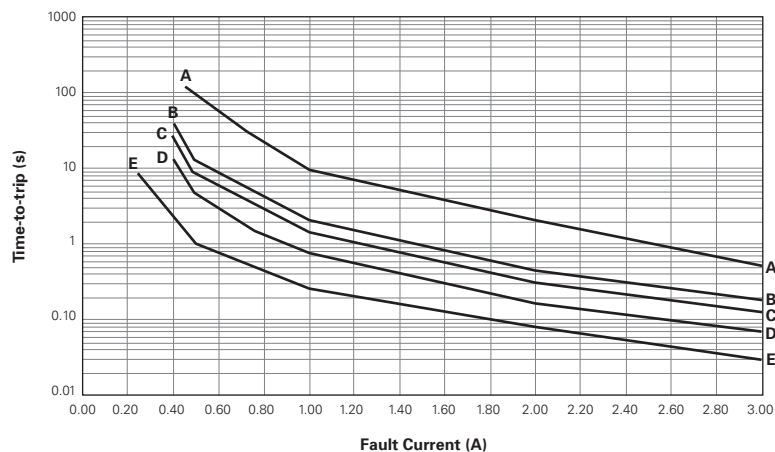
** Indicates dimension is typical, not minimum.

Figure T13-T16**Typical Time-to-trip Curves at 20°C for
Telecommunications and Networking Devices****TCF250**

- A = TCF250-180
 B = TCF250-145T
 C = TCF250-120T

Figure T13**TRF250**

- A = TRF250-180/183
 B = TRF250-145/145U
 C = TRF250-120/120U
 D = TRF250-110U/120UT/120T
 E = TRF250-080T/080U/080US

Figure T14**TS250/TSV250/TSL250**

- A = TSV250-130F
 B = TS250-130F
 C = TSL250-080F

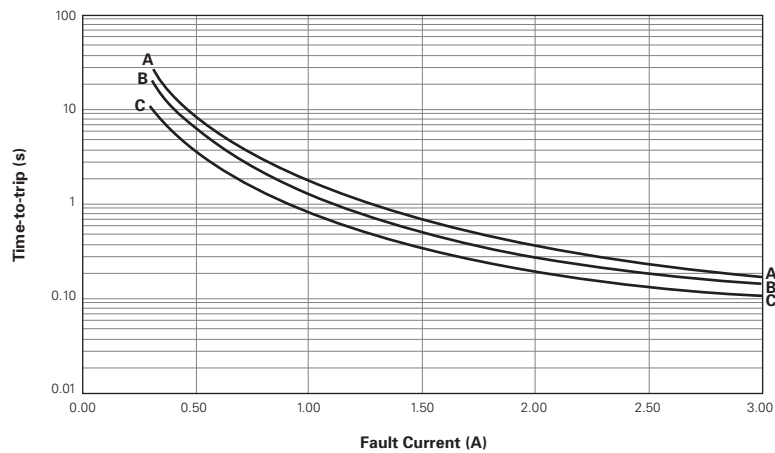
Figure T15

Figure T13-T16

Typical Time-to-trip Curves at 20°C for Telecommunications and Networking Devices

... Cont'd

TRF600/TS600/TSM600

- A = TSM600-250F
- B = TS600-170F/200F
- C = TRF600-160
- D = TRF600-150
- E = TSM600-400F

Figure T16

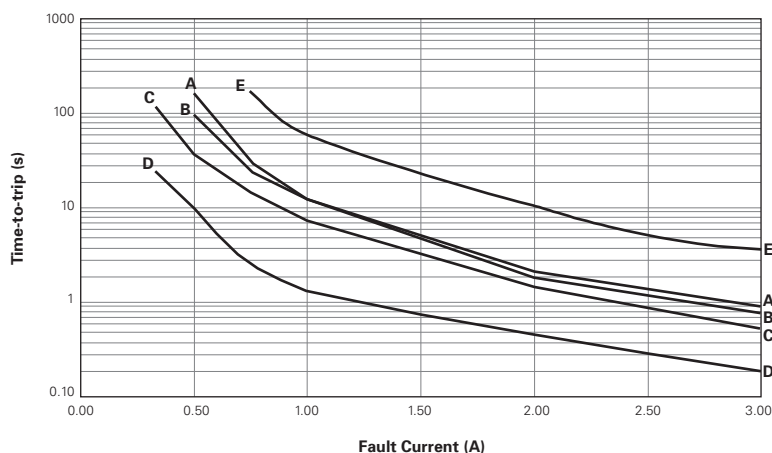


Table T5

Physical Characteristics and Environmental Specifications for Telecommunications and Networking Devices

(Operating temperature range for all listed products is -40°C to 85°C)

TCF250*

Physical Characteristics

Terminal material Nickel foil

Environmental Specifications

Test	Conditions
Passive aging	60°C, 1000 hours 85°C, 1000 hours
Humidity aging	85°C, 85% RH, 1000 hours
Thermal shock	125°C, -55°C (10 times)
Solvent resistance	MIL-STD-202, Method 215F

Note: Storage conditions: 40°C max., 70% RH max., devices should remain in original sealed bag prior to use. Devices may not meet specified values if these storage conditions are exceeded.

TRF250*

Physical Characteristics

Lead material	Tin plated copper, 22AWG
Insulating material	Cured epoxy polymer
Flammability	per IEC 695-2-2 Needle Flame Test for 20s
Soldering characteristics	ANSI/J-STD-002, Category 3
Solder heat withstand	IEC-STD 68-2-20, Test Tb, Section 5 Method 1A, Condition B: can withstand 10 seconds at 260°C±5°C

Note: Devices are not designed to be placed through a reflow process.

Environmental Specifications

Test	Conditions
Passive aging	60°C, 1000 hours 85°C, 1000 hours
Humidity aging	85°C, 85% RH, 1000 hours
Thermal shock	125°C, -55°C (10 times)
Solvent resistance	MIL-STD-202, Method 215F

Note: Storage conditions: 40°C max., 70% RH max., devices should remain in original sealed bag prior to use. Devices may not meet specified values if these storage conditions are exceeded.

Table T5

Physical Characteristics and Environmental Specifications for
Telecommunications and Networking Devices

... Cont'd

(Operating temperature range for all listed products is -40°C to 85°C)

TS250*/TSV250*/TSL250†

Physical Characteristics

Terminal material	Tin plated brass, Nickel under plating
Soldering characteristics	EIC 60008-2-58

Environmental Specifications

Test Conditions

Passive aging	60°C, 1000 hours 85°C, 1000 hours
Humidity aging	85°C, 85% RH, 500 hours
Thermal shock	125°C, -55°C (10 times)
Solvent resistance	MIL-STD-202, Method 215F

Note: Storage conditions: 40°C max., 70% RH max., devices should remain in original sealed bag prior to use. Devices may not meet specified values if these storage conditions are exceeded.

TRF600‡

Physical Characteristics

Lead material	Tin plated copper, 22AWG
Insulating material	Cured epoxy polymer**
Flammability	per IEC 695-2-2 Needle flame test for 20s
Soldering characteristics	ANSI/J-STD-002, Category 3
Solder heat withstand	IEC-STD 68-2-20, Test Tb, Section 5 Method 1A, Condition B: can withstand 10 seconds at 260°C±5°C

Note: Devices are not designed to be placed through a reflow process. Contact Raychem Circuit Protection product representative for TR600 series devices that are compatible with this process.

Environmental Specifications

Test Conditions

Passive aging	60°C, 1000 hours 85°C, 1000 hours
Humidity aging	85°C, 85% RH, 1000 hours
Thermal shock	125°C, -55°C (10 times)
Solvent resistance	MIL-STD-202, Method 215F

Note: Storage conditions: 40°C max., 70% RH max., devices should remain in original sealed bag prior to use. Devices may not meet specified values if these storage conditions are exceeded.

TS600‡

Physical Characteristics

Terminal material	Tin-plated brass
Insulating material	Nylon resin (UL94V-0), 1000V dielectric rating
Flammability	IEC 695-2-2 Needle Flame Test for 20s
Soldering characteristics	ANSI/J-STD-002, Category 3
Solder heat withstand	IEC-STD 68-2-20, Test Tb, Section 5 Method 1A

Environmental Specifications

Test Conditions

Passive aging	60°C, 1000 hours 85°C, 1000 hours
Humidity aging	85°C, 85% RH, 1000 hours
Thermal shock	125°C, -55°C (10 times)
Solvent resistance	MIL-STD-202, Method 215F

Note: Storage conditions: 40°C max., 70% RH max., devices should remain in original sealed bag prior to use. Devices may not meet specified values if these storage conditions are exceeded.

Table T5 Physical Characteristics and Environmental Specifications for Telecommunications and Networking Devices

... Cont'd

(Operating temperature range for all listed products is -40°C to 85°C)

TSM600†**Physical Characteristics**

Terminal material	Tin-plated brass
Insulating material	Nylon resin (UL94V-0), 1000V dielectric rating
Flammability	IEC 695-2-2 Needle Flame Test for 20s
Soldering characteristics	ANSI/J-STD-002, Category 3
Solder heat withstand	IEC-STD 68-2-20, Test Tb, Section 5 Method 1A

Environmental Specifications

Test	Conditions
Lead material	Tin-plated brass
Case material	Nylon resin (UL94 V-0), 1000 V dielectric rating
Lead solderability	IEC 60068-2-58, Method 7
Solder heat withstand	IEC-STD 68-2-20, Test Tb, Section 5, Method 1A
Solvent resistance	MIL-STD-202, Method 215J
Flammability rating	IEC 695-2-2 Needle Flame Test for 20s
Storage humidity	Per IPC/JEDEC J-STD-020A Level 2a

Note: Storage conditions: 40°C max., 70% RH max., devices should remain in original sealed bag prior to use. Devices may not meet specified values if these storage conditions are exceeded.

* 60/250V products are designed to help equipment pass ITU recommendations (K.20, K.21, etc) and Telcordia GR-1089 Intrabuilding power cross.

† 80/250V product designed to help equipment pass Telcordia GR-1089 Intrabuilding power cross (120V_{AC}/25A).

‡ 60/600V products are designed to help equipment pass UL 60950, TIA-968-A (formerly FCC Part 68) and Telcordia GR-1089 specification.

** Excluding TRF600-150

Table T6 Packaging and Marking Information for Telecommunications and Networking Devices

Part Number	Bag Quantity	Tape & Reel Quantity	Standard Package Quantity	Part Marking	Agency Recognition
Chip* — 60/250V					
 TCF250					
TCF250-120T	2,500	—	10,000	—	—
TCF250-145T	2,500	—	10,000	—	—
TCF250-180	2,500	—	10,000	—	UL
Radial-leaded* — 60/250V					
 TRF250					
TRF250-080U	500	—	10,000	—	UL, CSA, TÜV
TRF250-080U-2	—	1,500	7,500	—	UL, CSA, TÜV
TRF250-080T	500	—	10,000	08F	UL, CSA, TÜV
TRF250-110U	500	—	10,000	—	UL, CSA, TÜV
TRF250-110U-2	—	1,500	7,500	—	UL, CSA, TÜV
TRF250-120	500	—	10,000	20F	UL, CSA, TÜV
TRF250-120-2	—	1,500	7,500	20F	UL, CSA, TÜV
TRF250-120T	500	—	10,000	20F	UL, CSA, TÜV
TRF250-120T-2	—	1,500	7,500	20F	UL, CSA, TÜV
TRF250-120U	500	—	10,000	20F	UL, CSA, TÜV
TRF250-120U-2	—	1,500	7,500	20F	UL, CSA, TÜV
TRF250-120UT	500	—	10,000	20F	UL, CSA, TÜV
TRF250-145	500	—	10,000	45F	UL, CSA, TÜV
TRF250-145-2	—	1,500	7,500	45F	UL, CSA, TÜV
TRF250-145-RA	500	—	10,000	45F	UL, CSA, TÜV
TRF250-145U	500	—	10,000	45F	UL, CSA, TÜV
TRF250-145U-2	—	1,500	7,500	45F	UL, CSA, TÜV
TRF250-180	500	—	10,000	80F	UL, CSA, TÜV
TRF250-180-2	—	1,500	7,500	80F	UL, CSA, TÜV
TRF250-180US	500	—	10,000	—	UL, CSA, TÜV
NEW TRF250-183	500	—	10,000	83F	UL, CSA, TÜV
NEW TRF250-183-2	—	1,500	7,500	83F	UL, CSA, TÜV

Table T6 Packaging and Marking Information for Telecommunications and Networking Devices ... Cont'd

Part Number	Bag Quantity	Tape & Reel Quantity	Standard Pack Quantity	Part Marking	Agency Recognition
Surface† — 80/250V					
 TSL250					
TSL250-080F-2	—	1,500	7,500	T08	UL, CSA, TÜV
Surface* — 60/250V					
 TS250/TSV250					
TS250-130F-2	—	1,500	7,500	T13	UL, CSA, TÜV
TSV250-130F-2	—	1,200	6,000	T13V	UL, CSA, TÜV
Radial-leaded‡ — 60/600V					
 TRF600					
TRF600-150	500	—	10,000	150F	UL, CSA, TÜV
TRF600-150-2	—	1,500	7,500	150F	UL, CSA, TÜV
TRF600-160	500	—	10,000	160F	UL, CSA, TÜV
TRF600-160-2	—	600	3,000	160F	UL, CSA, TÜV
Surface‡ — 60/600V					
 TS600/TSM600					
TS600-170F-2	—	300	900	T20	UL, CSA
TS600-200F-RA-2	—	300	900	T20	UL, CSA
TSM600-250F-2	—	200	1,000	TSM600	UL, CSA
TSM600-250F-RA-2	—	200	1,000	TSM600	UL, CSA
TSM600-400F-2	—	200	1,000	TSM600	UL

* 60/250V products are designed to help equipment pass ITU recommendations (K.20, K.21, etc) and Telcordia GR-1089 Intrabuilding power cross.

† 80/250V product designed to help equipment pass Telcordia GR-1089 Intrabuilding power cross (120V_{AC}/25A).

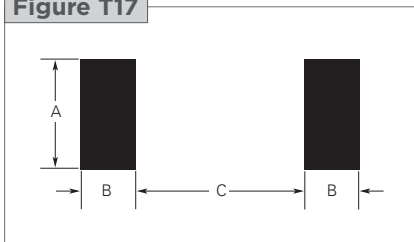
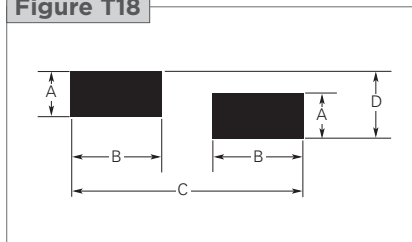
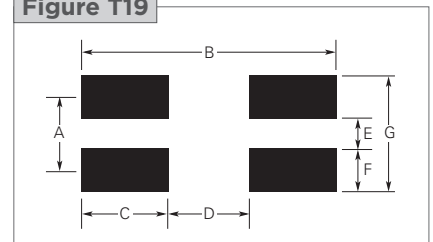
‡ 60/600V products are designed to help equipment pass UL 60950, TIA-968-A (formerly FCC Part 68) and Telcordia GR-1089 specifications.

Agency Recognition for Telecommunications and Networking Devices

UL	File # E74889	
CSA	File #78165C	
TÜV	Per IEC60730-1	Certificate # for individual products available upon request.

Table T7 Recommended Pad Layouts for Surface-mount Telecommunications and Networking Devices in millimeters (inches) Nominal

Device	A	B	C	D	E	F	G	Figure
TS250 (All)	4.60 (0.180)	1.80 (0.070)	6.10 (0.240)	—	—	—	—	T17
TSV250-130F	2.29 (0.090)	2.41 (0.095)	6.35 (0.250)	3.43 (0.135)	—	—	—	T18
TSL250-080F	3.60 (0.140)	1.80 (0.070)	5.50 (0.220)	—	—	—	—	T17
TS600 (All)	10.42 (0.410)	3.30 (0.130)	3.35 (0.132)	—	—	—	—	T17
TSM600	5.20 (0.205)	17.80 (0.701)	5.54 (0.218)	6.75 (0.266)	2.08 (0.082)	3.12 (0.123)	8.39 (0.331)	T19

Figure T17**Figure T18****Figure T19**

Solder Reflow and Rework Recommendations for Telecommunications Surface-mount Devices

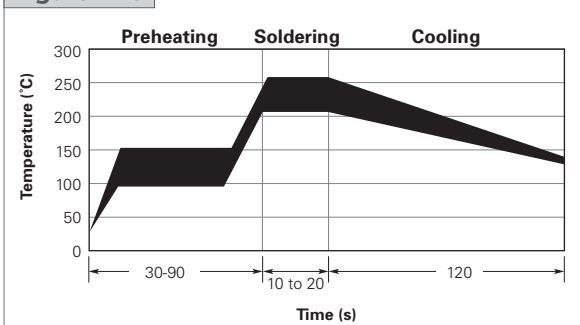
Solder Reflow

- Recommended reflow methods: IR, vapor phase oven, hot air oven.
- Surface-mount devices are not designed to be wave soldered to the bottom side of the board.
- Recommended maximum paste thickness of 0.25mm (0.010 in).
- Devices can be cleaned using standard industry methods and solvents.

Rework

- If a device is removed from the board, it should be discarded and replaced with a new device.

Figure T20



Wave Soldering and Rework Recommendations for Telecommunications Radial-leaded Devices

Recommended Wave Soldering

- Soldering temperature profile
Temperature characteristic at component terminal with dual wave soldering

Rework

- If a device is removed from the board, it should be discarded and replaced with a new device.

Figure T21

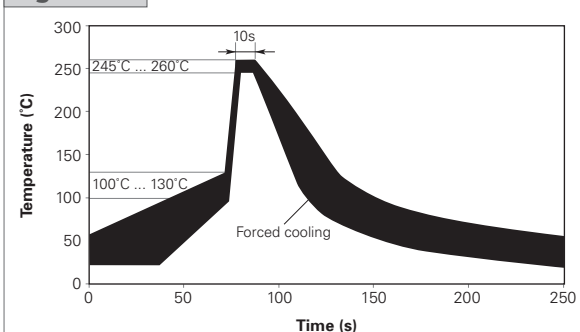


Table T8 TRF250/TRF600 Tape and Reel Specifications for Telecommunications and Networking Device

TRF250/TRF600 devices are available in tape and reel packaging per EIA 468-B standard. See Figures T22 and T23 for details.

Dimension Description	EIA Mark	IEC Mark	Dimension (mm)	Tolerance
Carrier tape width	W	W	18	-0.5/+1.0
Hold down tape width	W ₄	W ₀	5	Minimum
Top distance between tape edges	W ₆	W ₂	3	Maximum
Sprocket hole position	W ₅	W ₁	9	-0.5/+0.75
Sprocket hole diameter	D ₀	D ₀	4	±0.2
Abcissa to plane (straight lead)	H	H	18.5	±3.0
Abcissa to plane (kinked lead)*	H ₀	H ₀	16	-0.5/+0.6
Abcissa to top	H ₁	H ₁	32.2	Maximum
Overall width w/lead protrusion	—	C ₁	43.2	Maximum
Overall width w/o lead protrusion	—	C ₂	42.5	Maximum
Lead protrusion	L ₁	L ₁	1.0	Maximum
Protrusion of cut-out	L	L	11	Maximum
Protrusion beyond hold down tape	I ₂	I ₂	Not specified	—
Sprocket hole pitch	P ₀	P ₀	12.7	±0.3
Device pitch: TRF250	—	—	12.7	—
Device pitch: TRF600	—	—	25.4	—
Pitch tolerance	—	—	20 consecutive	±1
Tape thickness	t	t	0.9	Maximum
Tape thickness with splice*	t ₁	—	2.0	Maximum
Splice sprocket hole alignment	—	—	0	±0.3
Body lateral deviation	Δh	Δh	0	±1.0
Body tape plane deviation	Δp	Δp	0	±1.3
Lead spacing plane deviation	ΔP ₁	P ₁	0	±0.7
Lead spacing*	F	F	5.08	±0.6

Table T8

TRF250/TRF600 Tape and Reel Specifications for Telecommunications and Networking Device

... Cont'd

TRF250/TRF600 devices are available in tape and reel packaging per EIA 468-B standard. See Figures T22 and T23 for details.

Dimension Description	EIA Mark	IEC Mark	Dimension (mm)	Tolerance
Reel width	w ₂	w	56	Maximum
Reel diameter	a	d	370	Maximum
Space between flanges less device	w ₁	—	4.75	±3.25
Arbor hole diameter	c	f	26	±12.0
Core diameter	n	h	80	Maximum
Box	—	—	56/372/372	Maximum
Consecutive missing pieces*	—	—	3 maximum	—
Empty places per reel*	—	—	Not specified	—

* Differs from EIA specification.

Figure T22

EIA Referenced Taped Component Dimensions for TRF Devices

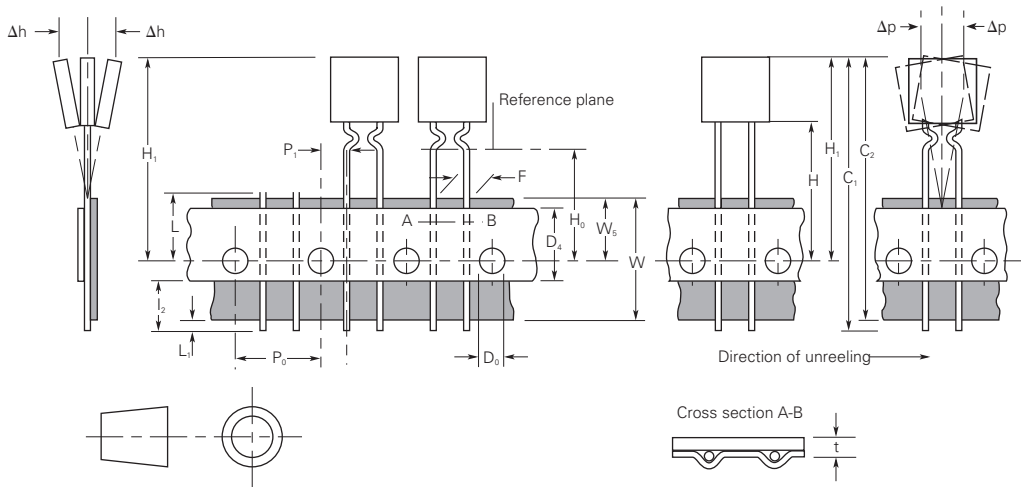


Figure T23

Reel Dimensions for TRF Devices

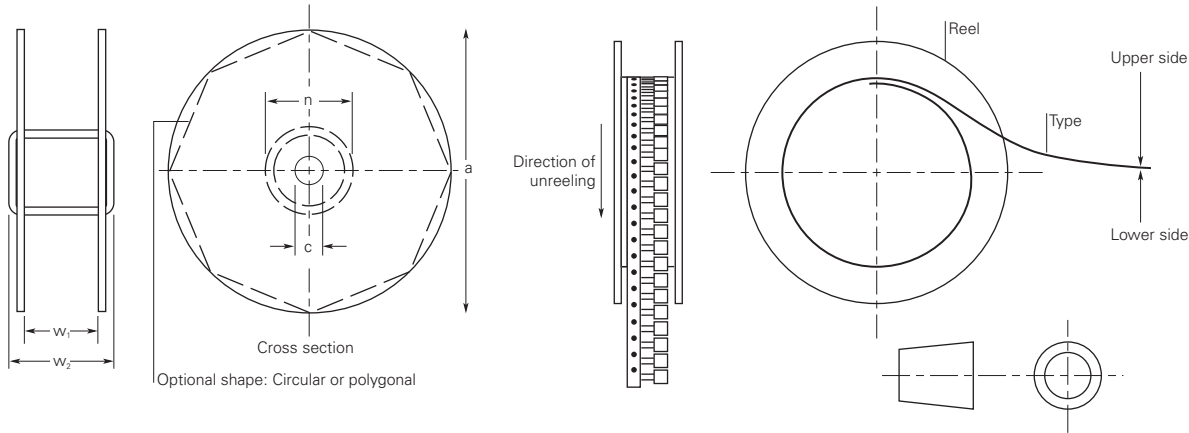


Table T9 TS Tape and Reel Specifications for Telecommunications and Networking Devices

TS devices are packaged per EIA 481 and EIA 481-2 standards. See Figures T24 and T25 for details.

TS250/TSV250/TSV250

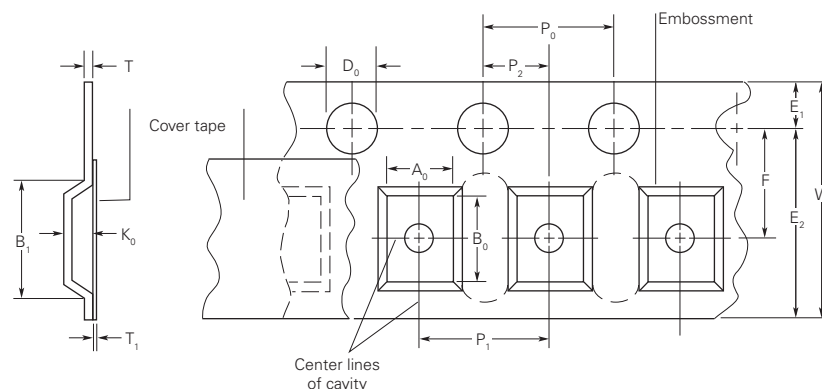
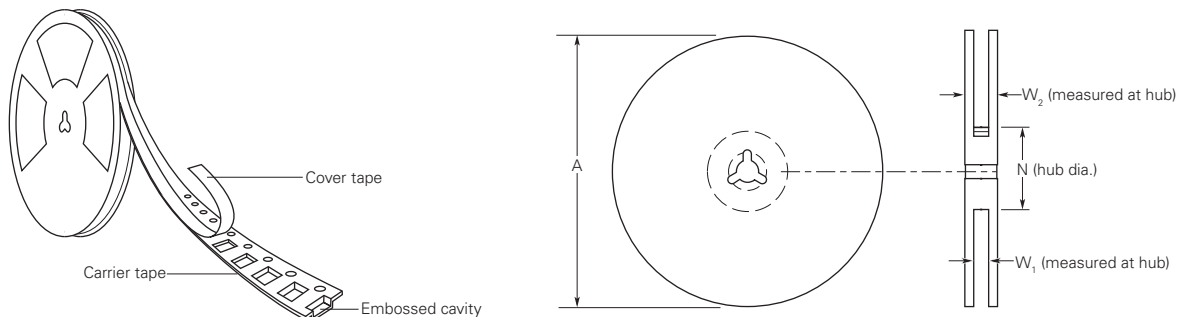
Dimension Description	EIA Mark	TS250		TSV250		TSL250	
		Dimension(mm)	Tolerance(mm)	Dimension(mm)	Tolerance(mm)	Dimension(mm)	Tolerance(mm)
Carrier tape width	W	16	±0.30	16.0	±0.3	16	±0.3
Sprocket hole pitch	P ₀	4.0	±0.10	4.0	±0.1	4.0	±0.10
	P ₁	12.0	±0.10	8.0	±0.1	8.0	±0.10
	P ₂	2.0	±0.10	2.0	±0.1	2.0	±0.10
	A ₀	6.9	±0.23	5.5	±0.1	5.5	±0.10
	B ₀	9.6	±0.15	6.2	±0.1	7.9	±0.10
	B ₁ MAX.	12.1	—	8.0	—	9.2	—
Sprocket hole diameter	D ₀	1.5	-0/+0.1	1.55	±0.05	1.55	±0.05
	F	7.5	±0.10	7.5	±0.10	7.5	±0.10
	E ₁	1.75	±0.10	1.75	±0.10	1.75	±0.10
	E ₂ MIN.	14.25	—	—	—	—	—
Tape thickness	T _{MAX.}	0.4	—	0.45	—	0.35	—
Tape thickness with splice cover tape thickness	T ₁ MAX.	0.1	—	0.1	—	0.1	—
Reel dimensions	K ₀	3.4	±0.15	7.0	±0.1	3.70	±0.10
	Leader min.	300	—	390	—	390	—
	Trailer min.	300	—	160	—	160	—
Reel diameter	A max.	340	—	340	—	340	—
Core diameter	N min.	50	—	50	—	50	—
Space between flanges less device	W ₁	16.4	-0/+2.0	16.4	-0/+2.0	16.4	-0/+2.0
Reel width	W ₂ MAX.	22.4	—	22.4	—	22.4	—

TS600

Dimension Description	EIA Mark	Dimension (mm)	Tolerance
Carrier tape width	W	32	±0.3
Sprocket hole pitch	P ₀	4.0	±0.1
	P ₁	16	±0.1
	P ₂	2.0	±0.1
	A ₀	10	±0.1
	B ₀	19.2	±0.1
	B ₁ max.	21.6	—
Sprocket hole diameter	D ₀	1.5	-0/+1.0
	F	14.2	±0.1
	E ₁	1.75	±0.1
	E ₂ min.	28.4	±0.1
Tape thickness	T _{max.}	0.50	±0.5
Tape thickness with splice	T ₁ max.	0.1	—
Reel Dimensions	K ₀	13.2	±0.1
	Leader min.	390	—
	Trailer min.	160	—
Reel diameter	A max.	360	—
Core diameter	N min.	50	—
Space between flanges less device	W ₁	32.4	-0/+2.0
Reel width	W ₂ max.	40	—

Table T9 TS Tape and Reel Specifications for Telecommunications and Networking Devices ... Cont'd**TSM600**

Dimension Description	EIA Mark	Dimension (mm)	Tolerance
Carrier tape width	W	32	±0.3
Sprocket hole pitch	P ₀	4.0	±0.1
	P ₁	24	±0.1
	P ₂	2.0	±0.1
	A ₀	11.2	±0.1
	B ₀	17.8	±0.1
	B _{1 max.}	23.45	
Sprocket hole diameter	D	1.5	-0/+1.0
	F	14.2	±0.1
	E ₁	1.74	±0.1
	E _{2 min.}	28.4	±0.1
Tape thickness	T max.	0.5	±0.5
Tape thickness with splice	T _{1 max.}	0.1	
	K ₀	11.9	±0.1
	Leader min.	390	
	Trailer min.	160	
Reel Dimensions			
Reel diameter	A max.	360	
Core diameter	N min.	50	
Space between flanges less device	W ₁	32.4	-0/+2.0
Reel width	W _{2 max.}	40	

Figure T24 EIA Referenced Taped Component Dimensions for TS Devices**Figure T25 EIA Referenced Reel Dimensions for TS Devices**

Resistance-sorted and Resistance-matched Devices

Most TCF, TRF and TS devices are available in resistance-sorted and/or resistance-matched versions.

Resistance-sorted Devices

Resistance-sorted devices (part number suffix “Rx”, where x = 1, 2, A, B, C, F etc.) are supplied with resistance values that are within specified segments of the device’s full range of resistance.

Feature

- Narrow resistance range.

Benefits

- Greater flexibility for design engineers.
- Lower resistance devices can allow for increased loop length on line card designs.
- Higher resistance devices may provide greater protection by offering faster time-to-trip.

Resistance-matched Devices

Resistance-matched devices are supplied such that all parts in one particular package (or reel) are within 0.5Ω of each other (1.0Ω for TRF250-080T devices). Individual matched packages are supplied from the full resistance range of the specified device.

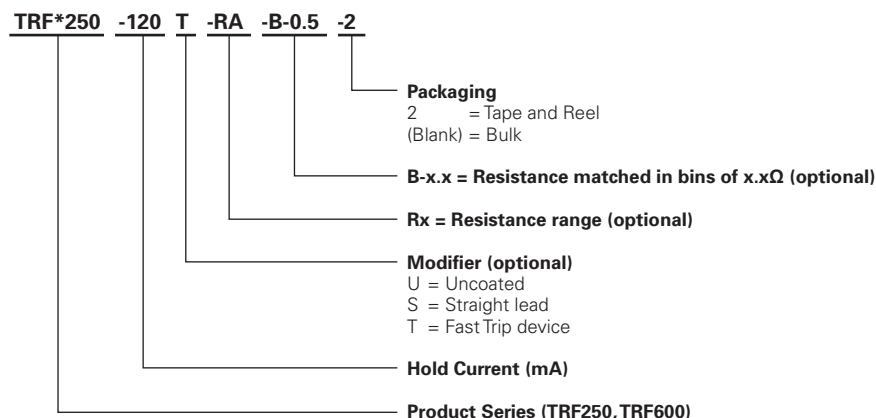
Feature

- Tighter resistance balance between any two parts in a package.

Benefits

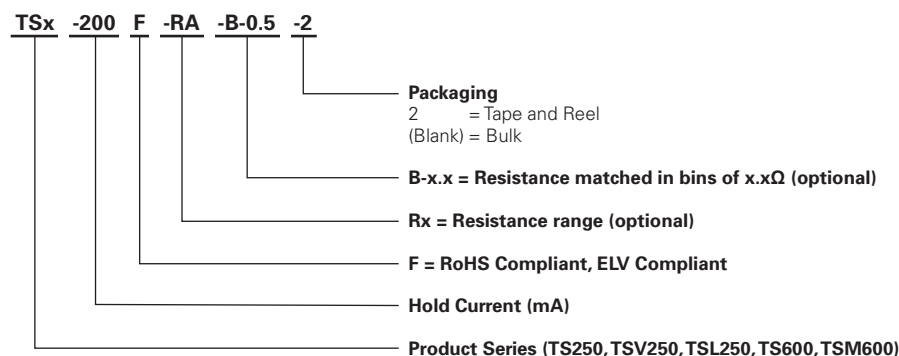
- Resistance-matched devices may reduce the tip-ring resistance differential, reducing the possibility of line imbalance.

Part Numbering System for Radial-leaded Telecommunications and Networking Devices

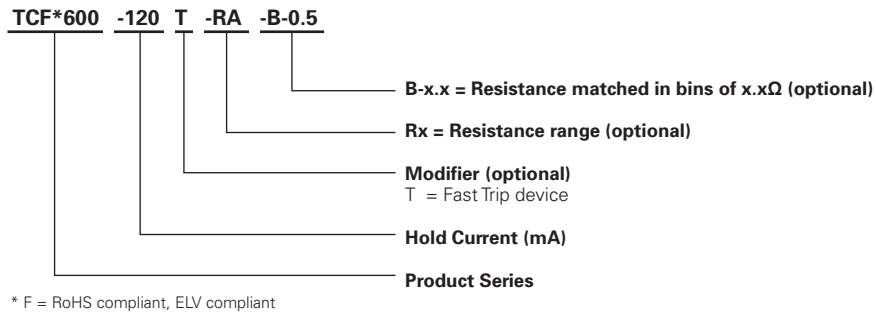


* F = RoHS compliant, ELV compliant

Part Numbering System for Surface-mount Telecommunications and Networking Devices



Part Numbering System for Chip Telecommunications and Networking Devices



Warning :

- Operation beyond the maximum ratings or improper use may result in device damage and possible electrical arcing and flame.
- The devices are intended for protection against occasional overcurrent or overtemperature fault conditions and should not be used when repeated fault conditions or prolonged trip events are anticipated.
- Contamination of the PPTC material with certain silicon based oils or some aggressive solvents can adversely impact the performance of the devices.
- Device performance can be impacted negatively if devices are handled in a manner inconsistent with recommended electronic, thermal, and mechanical procedures for electronic components.
- Operation in circuit with a large inductance can generate a circuit voltage ($L \, di/dt$) above the rated voltage of the PolySwitch resettable device.



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