

Protecting PoE Equipment from Overvoltage and Overcurrent Damage

The evolution of Power over Ethernet (PoE) continues to expand the functionality of Ethernet technology by supplying reliable DC power over the same cables that currently carry Ethernet data. PoE is modeled after the technology used by the telecommunications industry and enables lifeline quality power for Voice over Internet Protocol (VoIP) telephones as well as many other low power Ethernet network devices, such as wireless access points (WAP) and IP security cameras.

The Institute of Electrical and Electronics Engineers (IEEE) 802.3af standard addresses the requirement for interoperability among a growing number of proprietary methods of distributing DC power to network devices. It has facilitated the development of technology that allows a broad range of devices to supply or draw power over the network without modification to existing infrastructure and provides these advantages:

- eliminates the need to run A/C power wires and permits use of existing IT infrastructure;
- permits the most efficient and convenient installation, regardless of where AC outlets are located;
- allows for use of a centralized UPS to provide power to the appliance even during mains power failure;
- improves safety by eliminating presence of mains voltage; and
- permits remote monitoring and control of devices on the network.

PoE-enabled devices and their electronic components are designed for operation within specified current and voltage ratings. If these ratings are exceeded due to short circuit or voltage transients, components may sustain permanent damage and the equipment may fail. Tyco Electronics' circuit protection devices help protect sensitive electronics from overcurrent and overvoltage damage, and are suitable for both Power Sourcing Equipment (PSE) and Powered Device (PD) equipment.

Power Sourcing Options

The IEEE 802.3af standard defines two types of power source equipment: end-span and mid-span. An end-span PSE integrates the power sourcing functionality with a network switch. End-spans look and function the same as any Ethernet switch, except they can deliver data and power over the same wiring pairs. Since Ethernet data pairs use transformers coupled at each end of the link, DC power can easily be added to the center tap of the transformer without disrupting the data. In this mode of operation, an end-span injects both power and data on pin-pairs 3 and 6 and pin-pairs 1 and 2.

Mid-span PSE devices resemble patch panels and typically have between six and 24 channels. They are placed between older legacy switches and the powered devices. Each of the mid-span ports has an RJ-45 data input and data/power RJ-45 output connector. Mid-span devices tap pin-pairs 4 and 5 and pin-pairs 7 and 8 to carry power, while data runs on the other wire pairs. It is important to note that, although the PSE can only use pin-pairs assigned from an end-span or a mid-span, the PD must be able to accept power from both.

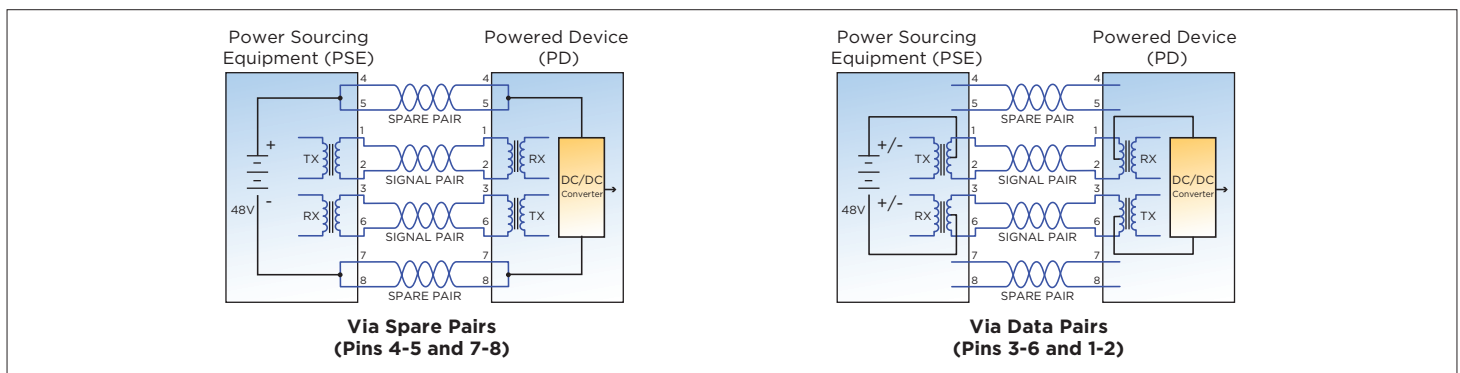


Figure 1. Power sourcing options per IEEE 802.3af standard

Power Requirements

The IEEE 802.3af standard defines power requirements up to 15 watts. Typically defined at ~330mA@48V, Ethernet ports may supply a nominal 48V DC power on the data wire pairs or on the "spare" wire pairs, but not both, and the PSE must never send power to a device that does not expect it.

For higher power requirements, IEEE 802.3af sets the output voltage for PSE devices to 50V to 57V. This voltage range is an increase from the 44V to 57V specified in the IEEE 802.3af standard. The PD voltage will remain the same as the IEEE 802.3af standard at 36V to 57V.

CLASS	USAGE	MINIMUM POWER LEVEL OUTPUT AT THE PSE	MAXIMUM POWER LEVELS AT THE POWER DEVICE
0	Default	15.4W	0.44 to 12.95W
1	Optional	4.0W	0.44 to 3.84W
2	Optional	7.0W	3.84 to 6.49W
3	Optional	15.4W	6.49 to 12.95W
4	Reserved for future use	Treat as Class 0	Reserved for future use: A Class 4 signature cannot be provided by a compliant powered device

Table 1. IEEE 802.3af PSE and PD Power Classifications.

Improving Safety and Reliability of PoE Equipment

A growing number of PoE applications – ranging from smart signs, vending machines, building access control and time and attendance systems to phone and PDA chargers and electronic musical instruments – has created a demand for more reliable and flexible overcurrent and overvoltage protection devices. These devices are required in order to protect:

- the PSE from damage caused by shorts in the Ethernet cable or PD;
- the PD from faults in the PSE; and
- both the PSE and PD from overvoltage shorts/transients.

Single-use fuses are often used to help provide overcurrent protection in PoE applications. Polymeric positive temperature coefficient (PPTC) devices, installed in series with electronic components, also provide a reliable, resettable method of interrupting current flow. Solid-state thyristor overvoltage protection devices may also be installed in parallel with these components to switch rapidly from a high to low impedance state in response to an overvoltage surge.

Overcurrent Protection Options

Tyco Electronics’ PolySwitch devices are commonly used to help provide protection against damage caused by an overcurrent event on both PSE and PD equipment. The resettable functionality of the device allows for placement in inaccessible locations, and a wide range of electrical and physical sizes facilitates precise design solutions.

Although the fuse is generally considered one of the simplest and lowest-cost solutions, many equipment manufacturers find it easy to justify the cost of resettable PPTC device protection if it helps protect against overcurrent damage caused by electrical short, overloaded circuit, or customer misuse. PPTC devices do not generally require replacement after a fault event, and allow the circuit to return to the normal operating condition after the power has been removed and the overcurrent condition is eliminated.

PolySwitch decaSMD devices are compatible with high-volume, automatic insertion electronic assembly processes and meet the overcurrent protection requirements of the IEEE 802.3af standard.

Tyco Electronics also offers a broad range of chip-type surface mount fuses for applications where resettable functionality is not desired. High-current, small size, slow-blow devices provide clean blow characteristics that physically contain the fusing event within the package and can be used to meet the overcurrent protection requirements of the IEEE 802.3af standard. It is important to note that single-use fuses must be tolerant of the current spikes and fluctuations associated with PoE applications.

Figure 2 illustrates how either the PolySwitch decaSMD device, SiBar thyristor, or the Tyco Electronics slow blow chip fuse can be used to help protect PoE equipment from overcurrent damage.

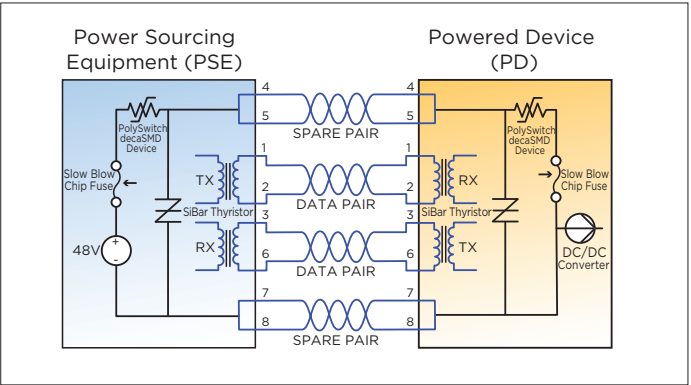


Figure 2. Typical circuit diagram using a SiBar thyristor for overvoltage protection with a PolySwitch device, or optionally, a surface mount Slow Blow fuse for overcurrent protection.

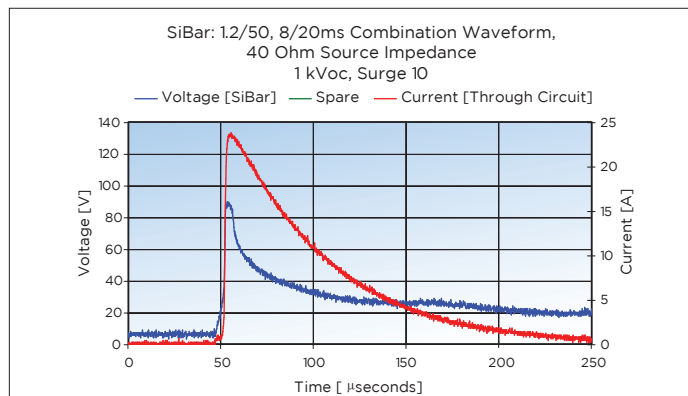
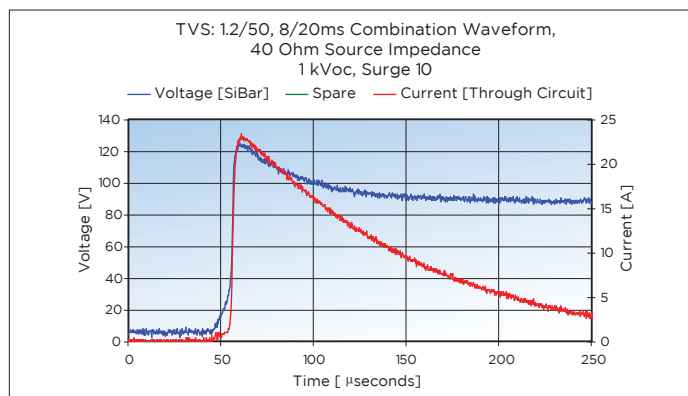
Overvoltage Protection Considerations

A variety of methods can be used to help protect PoE-enabled equipment from damage caused by overvoltages. There are two major categories of overvoltage protection devices – clamping devices and foldback, or “crowbar,” devices. Clamping devices, such as metal oxide varistors (MOVs) and diodes, allow voltages up to a specified clamping level to pass through to the load during operation. Foldback devices, such as gas discharge tubes and thyristor surge suppressors, operate as shunt devices in response to a surge that exceeds the breakover voltage.

Foldback devices have an advantage over clamping devices because in the foldback state very little voltage appears across the load while it conducts harmful surges away from the load; whereas clamping devices remain at the clamping voltage. Therefore, the power dissipated in the foldback device is much lower than in a clamping device.

For many PoE applications, the thyristor surge suppressor is the preferred solution. The results of recent testing by Tyco Electronics, comparing the behavior of a TVS diode with that of a SiBar thyristor, are shown in Figure 3. The SiBar thyristor “folds back” the overvoltage transient to a lower voltage level than the TVS diode and has lower peak and average voltage let-through values than the TVS diode – resulting in less overvoltage and power stresses passed through to the PoE equipment.

Additionally, the SiBar thyristor’s low on-state voltage allows for smaller form factor devices – as compared with a TVS diode of comparable energy handling capability – conserving valuable PC board real estate. The relatively low capacitance of the thyristor also permits its use on high data rate circuits.



Devices	Pk (I)	Pk (V)	Avg (I)	Avg (V)
TVS Diode	23.4	124.8	4.37	74.19
SiBar TVB058SA-L	23.8	89.6	5.41	25.33

Figure 3. Performance comparison of TVS diode and SiBar thyristor.

Summary

The low resistance, fast time-to-trip, low profile, and resettable functionality of PolySwitch overcurrent protection devices helps circuit designers provide a safe and dependable product and comply with regulatory agency requirements. In applications where resettable functionality is not desired, surface mount fuses with slow-blow characteristics can help manufacturers meet the overcurrent protection requirements of the IEEE 802.3af standard.

SiBar thyristor surge suppression devices meet the immunity and test requirements for PoE equipment, provide lower peak and average voltage let-through values during an overvoltage transient, and their low on-state voltage allows for smaller form factor devices – as compared with clamping devices of comparable energy handling capability. The relatively low capacitance of thyristors also makes them useful in high data rate circuits.

Raychem Circuit Protection Products

308 Constitution Drive, Building H
Menlo Park, CA USA 94025-1164

Tel : (800) 227-7040, (650) 361-6900
Fax : (650) 361-4600

www.circuitprotection.com
www.circuitprotection.com.hk (Chinese)
www.tycoelectronics.com/japan/raychem (Japanese)

PolySwitch, Raychem, SiBar, TE Logo and Tyco Electronics are trademarks. All information, including illustrations, is believed to be reliable. Users, however, should independently evaluate the suitability of each product for their application. Tyco Electronics 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.

© 2009 Tyco Electronics Corporation. All rights reserved. Printed in USA. RCP0018E.0108

**Tyco Electronics**
Our commitment. Your advantage.