BOURNS®

Protection Solutions for Building Automation Systems

WHITE PAPER

Introduction

Building Automation Systems (BAS) are transforming industries such as HVAC, lighting, and security through smart technologies. With the integration of data communication and AI-driven predictive scheduling, BAS meets the demand for convenient, energy-efficient homes. By incorporating sensors and predictive models, BAS can control various systems within a building. In residential, as well as commercial buildings, BAS enhances both comfort and efficiency.

The introduction of new technologies such as the Internet of Things (IoT), artificial intelligence (AI), wireless sensor networks, and Power over Ethernet (PoE), has made BAS a key driver in modern building design. Each new development enables BAS to further reduce energy consumption and cost while enhancing system flexibility.

This white paper explores the integration of PoE with BAS and outlines how Bourns® protection devices safeguard PoE infrastructure against overvoltage and overcurrent events.

Power over Ethernet (PoE) vs. Wireless

In BAS systems, a key consideration is whether to connect Powered Devices (PDs) via wireless communication or wired PoE. This is especially relevant in smart buildings with dozens of interconnected devices.

Wired PoE and wireless communication each offer distinct advantages and trade-offs. PoE is best suited for robust networks that prioritize security, reliability, and centralized control while wireless communication is ideal where flexibility and convenience are critical. Both methods are essential considerations in BAS design and play a vital role in enabling IoT infrastructure.

Type	Ethernet/ PoE	Wireless communication
Reliability	Stable; direct connection to central system	Less reliable; susceptible to interference and signal loss
Security	Wired connection; isolated from external networks	Each unit is a potential failure point and vulnerable to intrusion
Power usage	Powered devices can receive up to 90 W via Type 4 PoE protocol	Powered by AC mains or internal Battery Management System (BMS)
Wire usage	Single Cat5e - Cat8 Ethernet cable	Data transmitted through wireless communication; includes wired interface for powering
Speed	Consistent 1 Gbps with 1000BASE-T Gigabit Ethernet protocol; higher or lower speeds can be transmitted based on data protocol	Variable; typically less than 1 Gbps
Implementation size	Requires an Ethernet PHY, and an RJ-45 socket; typically larger footprint	Utilizes antenna and transmitter; smaller footprint
Installation	More complex, requires centralized Ethernet infrastructure	Simpler; only requiring power
Flexibility	Must accommodate Ethernet cabling; not limited by material obstructions	Usable anywhere; signal degrades with environmental interference
Organization	Centralized system	Commonly a decentralized system

Applications of PoE in BAS

PoE is increasingly deployed in real-world building automation scenarios due to its ability to simplify infrastructure while delivering high performance. In modern office buildings, PoE powers and connects smart LED lighting systems that adjust brightness and color temperature based on occupancy and natural light, significantly reducing energy consumption. In commercial security systems, PoE enables centralized control of IP cameras, access control panels, and motion sensors-all through a single Ethernet cable.

Educational institutions use PoE to support digital signage, classroom AV systems, and environmental sensors that monitor air quality and temperature. In smart homes, PoE integrates voice assistants, thermostats, and surveillance devices into a unified, energy-efficient network. These applications demonstrate how PoE enhances flexibility, reduces installation costs, and supports scalable, intelligent environments across diverse building types.

Power over Ethernet (PoE)

PoE acts as a bridge between two traditionally separate domains in electrical systems: data communication and electrical power. Most devices require distinct connections for each device. PoE combines DC power and data signals over one Ethernet cable, maintaining the integrity of both signals. 4PPoE or Type 4 PoE, as defined by IEEE 802.3bt, can deliver up to 90 W, sufficient to power small control units and sensors within a smart home environment.

PoE begins at a central computer and power sourcing equipment (PSE), where they are combined using a center-tapped transformer. This combined signal is sent across the ethernet cable to a PD. At the PD, another center-tapped transformer separates the data and power as illustrated in Figure 1.

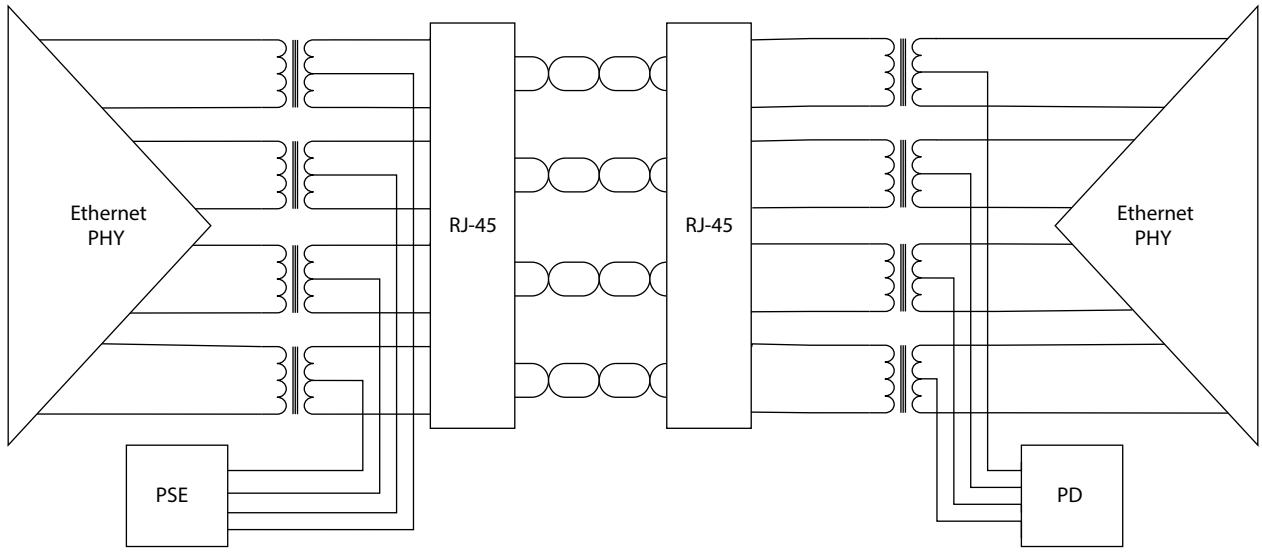


Figure 1. PoE layout with center-tapped transformers

PoE is a flexible system applicable to a wide range of BAS devices distributed throughout a building. Installing and servicing separate power and data lines can be expensive. However, PoE faces the unique challenge of handling high-speed data while operating with high-voltage AC lines.

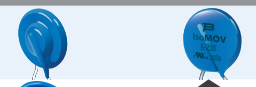
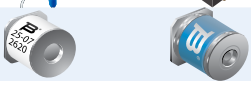
Therefore, protection must account for both 120 VAC input for the PSE and gigabit-speed data transmission. Several design practices address this dual requirement.

Protecting PSE from Overvoltage and Overcurrent Threats

PSE powered via traditional AC mains must convert high-voltage AC mains into usable power. In the U.S., incoming AC power is single-phase 120 V. Environmental hazards expose buildings to overvoltage and overcurrent events such as lightning strikes, arcing, ground faults, and power surges. These surges must be either absorbed or safely diverted away from the PSE. The standard protection approach involves using various high-power devices, each serving a specific role in a sequence of protection as seen in Figure 2.

Figure 2 depicts the typical front-end of the PSE where protection for overvoltage and overcurrent reside. As an example, the Bourns® SinglFuse™ device protects the system from overcurrent situations that could be caused by events such as internal shorts or ground faults. For overvoltage protection against surges caused by indirect coupling of lightning or other events, Bourns® hybrid protection components are recommended. Hybrid overvoltage components like the IsoMOV® and GMOV™ series combine the conventional GDT with MOV in a symbiotic connection, improving reliability and performance. These components, along with additional safety capacitors and chokes, ensure the safe and reliable operation of the PSE while also helping to mitigate harmonic distortion.

Overcurrent Protection		
Product Image	Series	Description
	SinglFuse™ SMD Fuses	Bourns® SinglFuse™ SMD fuses provide effective overcurrent protection in standard SMD sizes ranging from 0402 to 3812. They are innovated by eight technologies and feature various voltage and current ratings, operating temperature coverage as well as fusing characteristics.

Overvoltage Protection		
Product Image	Series	Description
	GMOV™ Hybrid Protector, IsoMOV® Hybrid Protector	Combination of MOV and GDT technology in one package. These components have extremely low leakage current and extended reliability.
	Through-hole MOV: EV, CV, CVQ, MOV-xxD, SV SMD MOV: PV	Through-hole MOVs are conventional overvoltage protection components that offer an industry-standard form. These components "clamp" excess voltage conditions.
	GDT25-xx-S1 Gas Discharge Tube 2035-xx-XX Gas Discharge Tube	GDTs are a conventional overvoltage protection component with high surge current capacities. These components "crowbar" when excess voltage is present.

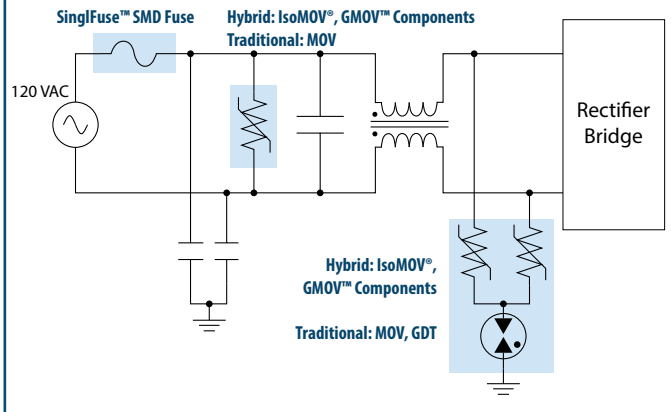


Figure 2. Bourns® Devices used in an AC Power Protection System

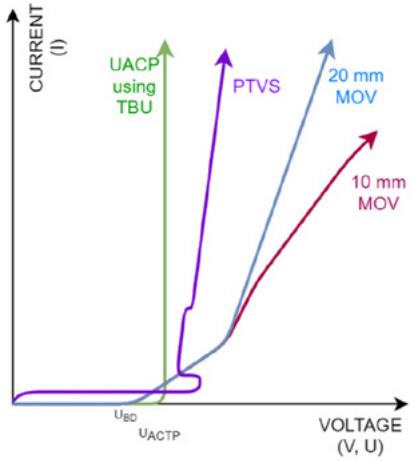


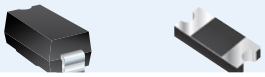
Figure 3. Universal AC Power Protection Residual Voltage Compared to Varistors

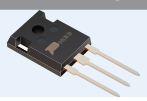
Protecting PSE from Overvoltage and Overcurrent Threats (Continued)

The purpose of the PSE is to ensure AC mains are converted to a usable DC voltage supply that complies with PoE standard protocols. PSEs utilize Switch-Mode Power Supplies (SMPS) to perform this conversion, as illustrated in Figure 3. The SMPS converts AC to DC using a standard bridge rectifier, an array of diodes that allows only positive voltages. Next, a Power Factor Correction (PFC) stage improves energy efficiency and reduces signal noise and distortion. Once stabilized, the voltage is converted from a high voltage to 44-57 VDC using an isolated DC-DC converter. At each stage, circuit protection is essential, as overvoltage and overcurrent risks persist, and modern devices operate within narrow maximum voltage ratings.

Bourns also offers a range of components that play a crucial role in the AC-to-DC conversion process. A broad portfolio including IGBTs, rectifier diodes, thick film resistors, and current sensing shunts enables PSE designs to achieve enhanced efficiency while addressing space constraints.

Once the SMPS converts the incoming AC power to a stable DC voltage, this output can then be applied to the PoE system, as illustrated in Figure 4.

Diodes		
Product Image	Series	Description
	CD214A-B1XR Schottky Diode CD214B-S2X Schottky Diode	DC-DC converters incorporate diodes to rectify output power. Diodes are crucial to the operation of converters. Bourns offers Schottky variants to suit a wide range of applications.

IGBTs		
Product Image	Series	Description
	BID Insulated Gate Bipolar Transistor	This device uses advanced Trench-Gate Field-Stop technology providing greater control of the dynamic characteristics while resulting in fewer switching losses.. High speed and low speed grades are available.

Resistors and Shunts		
Product Image	Series	Description
	PWR Power Resistors	Bourns offers a broad range of PWR series high power thick film resistors with standard packages. Great for use in snubbing circuits.
	CSS Current Sense Resistor CSI Current Sense Resistor	Bare metal SMD shunts for precision monitoring of current. Current monitoring is crucial for accurate switching characteristics.

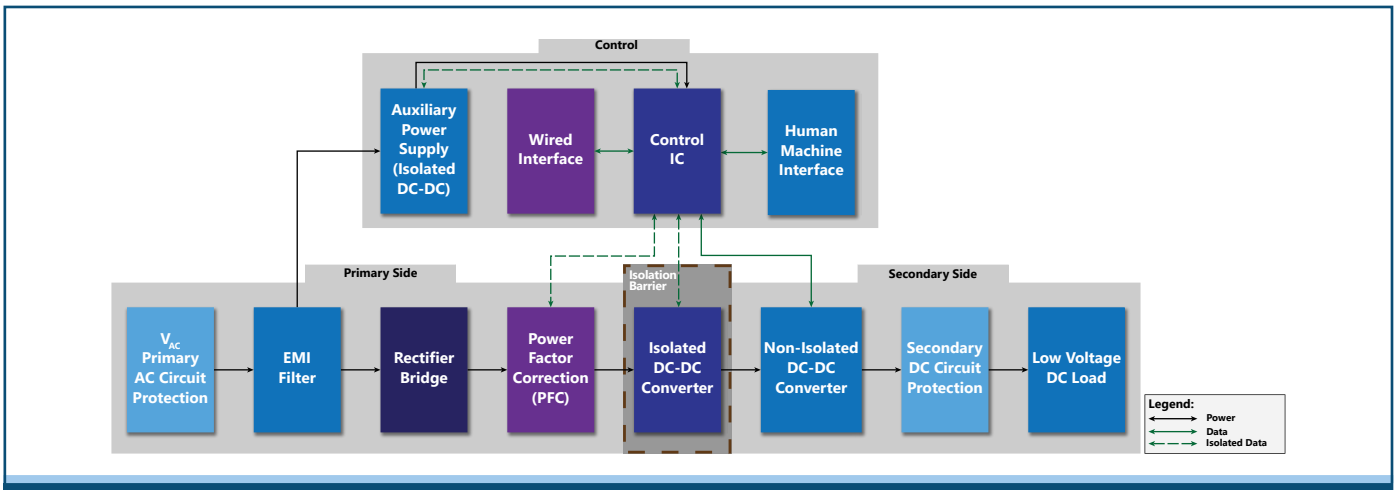


Figure 4. Block Diagram of a Switch-Mode Power Supply (SMPS) Found in PSE

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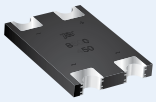
PoE Protection

When selecting protection strategies for PoE signals, two critical considerations are high-speed response times and a narrow working voltage window. Bourns addresses this challenge with a combination of diode arrays, isolation transformers, and Transient Current Suppressors (TCS), as illustrated in Figure 4. While Figure 4 shows only the PD side, protecting the PSE side is similarly constructed.

The first component in the protection chain is the center-tapped isolation transformer, which serves two key roles: it separates the DC power signal from the high-speed Ethernet data and physically breaks the wire connection. This separation helps reduce electrical noise and contain any transient surges. High-speed precision protection devices, such as the TCS and diode arrays, are needed once only the data signal remains. Following the isolation stage, PoE employs diode arrays and TVS diodes. These semiconductor devices clamp high voltages by diverting excess energy safely to ground. The final layer of this protection scheme is the Bourns® TCS™ HSP, which responds within nanoseconds to block transient energy. This device safeguards against overcurrent conditions caused by random electrical noise. This intricate and sensitive protection architecture is essential for maintaining secure and reliable communication between the central computer and distributed devices throughout the building.

Ethernet & PoE Protection		
Product Image	Model or Series	Description
	CDDFN10-3304NA Diode Array CDS0T23-SM712 Diode Array	Ultra-low capacitance overvoltage protection of several data lines. Bourns offers an extensive line of diode arrays for communication protocols.
	TCS™ High-Speed Protectors (HSPs)	Overcurrent protection devices, such as Bourns® TCS™ High-Speed Protectors (HSPs), are used to guard against overcurrent. This kind of circuit protection is frequently used in conjunction with low capacitance TVS devices to provide fault protection.
	CD-MBL1xxS Bridge Rectifier Diode	Bourns offers bridge rectifier diodes for rectification applications in compact chip packages.
	SMAJ TVS Diode SMLJ TVS Diode	For precision overvoltage protection of low voltage DC busses. Can protect against residual surge energy and electrostatic discharge (ESD). Quick clamping action with several power options and voltages available.

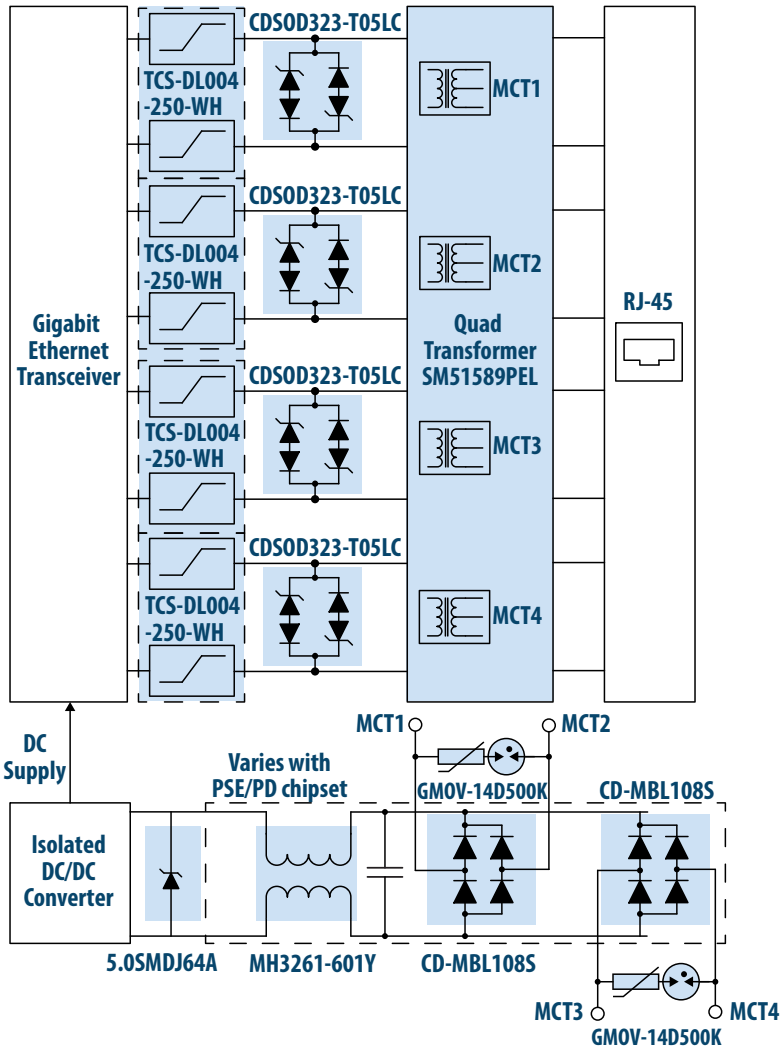


Figure 5. A Protected POE PD Layout with Bourns® TCS™ and Diode Arrays

PoE Protection in a BAS System

Power and data protection within a BAS-enabled building are vital for ensuring longevity and reliability throughout the entire building. PoE technology gives architects and engineers more design flexibility, allowing them to streamline the wiring and connectivity of smart devices. BAS technologies enhance building intelligence by reducing energy consumption and operational costs, while enabling dynamic adaptation to changing environmental conditions.

Bourns' circuit protection and switching solutions are critical to ensuring that BAS systems remain efficient and operational even during overvoltage and overcurrent events. Manufacturers such as Bourns play a key role in safeguarding these systems.