BOURNS®

Microinverter's Crucial Role: Protecting and Powering the Future of Solar Use

APPLICATION BRIEF

Introduction

As solar panels increase in popularity and affordability for residential and commercial buildings, there is a growing demand for systems that can be operated and controlled in a safe and reliable manner. Microinverters are controllers and regulators for individual solar panel units that are seen as the solution to enable this capability.

A microinverter converts the solar panel's photovoltaic (PV) DC output into an AC waveform that is compatible with the electrical grid. This is done with high-speed devices that constantly switch power with a feedback loop. As such, microinverters require high frequency switching components along with a solution that can protect against overvoltage and overcurrent events, such as lightning, load change electrical grid surges, that can cause costly downtimes and repairs.

This application brief presents recommended high-speed switching and circuit protection component solutions for microinverters. Components covered include Insulated Gate Bipolar Transistors (IGBTs) and Silicon Carbide (SiC) diodes for switching, as well as Power Transient Voltage Suppressor (PTVS) diodes, resistors, shunts, fuses, and Metal-Oxide Varistors (MOVs) for circuit protection. The brief will highlight how these solutions help improve system uptime, extend product lifespan, and reduce maintenance costs for residential and commercial solar installations that use microinverters.

Solution

The typical maximum voltage at the solar panel is V_{PV} = 48 VDC and output to the AC grid is V_{AC} out = 120 or 240 VAC. In addition, 400 VDC busses are also needed for high efficiency operation. Given these specifications, Bourns® overvoltage protection components such as varistors, PTVS diodes, and IsoMOV® hybrid protectors offer working voltage levels that meet the requirements of systems like microinverters.

In addition, the output power of a residential solar panel can be up to 400 W, which is why many microinverters are designed around 400 W. Push-pull converters and bridgeless totem pole PFCs deliver efficient DC-DC and DC-AC conversion within the 400W range. For these circuits, Bourns® IGBTs can be used for the switching elements and feature higher current handling capabilities to support a reduction in maximum switching frequency. Designers that are working with switching frequencies that are lower than ~100 kHz will benefit from using IGBTs.

Bourns also offers SiC Schottky diodes that meet higher switching frequency needs as the technology offers virtually zero reverse recovery energy. Also, due to the SiC material, SiC diodes can be used in higher voltage systems such as in 48 VDC to 400 VDC switch mode power supplies.

Microinverters, like all systems, can experience short circuits or overload current conditions. Knowing microinverters typically are built to handle ~400 W, currents of 1-10 A are possible given maximum power and voltages ranging from 48-400 VDC and 120-240 VAC. Bourns offers a host of traditional style fuses in surface mount packages that are rated for both current and voltage needed in a microinverter system.

Resistors are valuable components for a comprehensive range of applications. That is true for microinverters too. Microinverters need resistive components that are built for both precision and power. Designers should look for current sensing shunts that can handle the current whilst providing low Temperature Coefficient Of Resistances (TCRs). Essentially, the lower the TCR value, the less variation in resistance there will be with a change in temperature.
Bourns offers shunts that are both through-hole and surface mount with varying power levels but are entirely focused on keeping TCRs minimal. Bourns also offers precision resistors that are useful for voltage sensing. Furthermore, Bourns® Trimpot® trimming potentiometers and thin film resistors are great for voltage sensing circuits that need high resistance, yet low TCRs. Trimpot® trimming potentiometers are excellent solutions helping designers to tune circuit for precise measurement accuracy.

If a designer is looking for a resistor that can handle pulse energy or generally high currents, Bourns® power thick film and wirewound resistors are a great option. Given the construction of these two technologies, these resistors can absorb energy that could be generated from inductive elements or other excess current situations. These devices are typically used in snubber, braking and other high energy or pulsed circuitry.

Benefits

- High-Speed, High-Power Performance: Bourns® IGBTs and SiC diodes are engineered to operate accurately at switching frequencies in the hundreds of kHz while handling high voltages. Thus, enabling designers to achieve both power density and speed without compromise.
- Enhanced System Reliability: Bourns® protection components such as, PTVS diodes, IsoMOV® hybrid protectors, resistors, and fuses, safeguard sensitive electronics from overvoltage and overcurrent events. With a wide range of operating thresholds, designers can implement precise, application-specific protection schemes that reduce downtime and maintenance.
- Compact, Flexible Design Integration: Many Bourns components are available in surface-mount packages and miniaturized footprints giving engineers greater PCB layout flexibility and enable smaller, more efficient microinverter designs.
- Global Experience and Support: Bourns' strong global presence and decades of experience in circuit protection and power conversion, the Company understands the diverse needs of solar and power electronics markets. Customers benefit from component solutions backed by worldwide application support, ongoing innovation, and a commitment to meeting international standards.

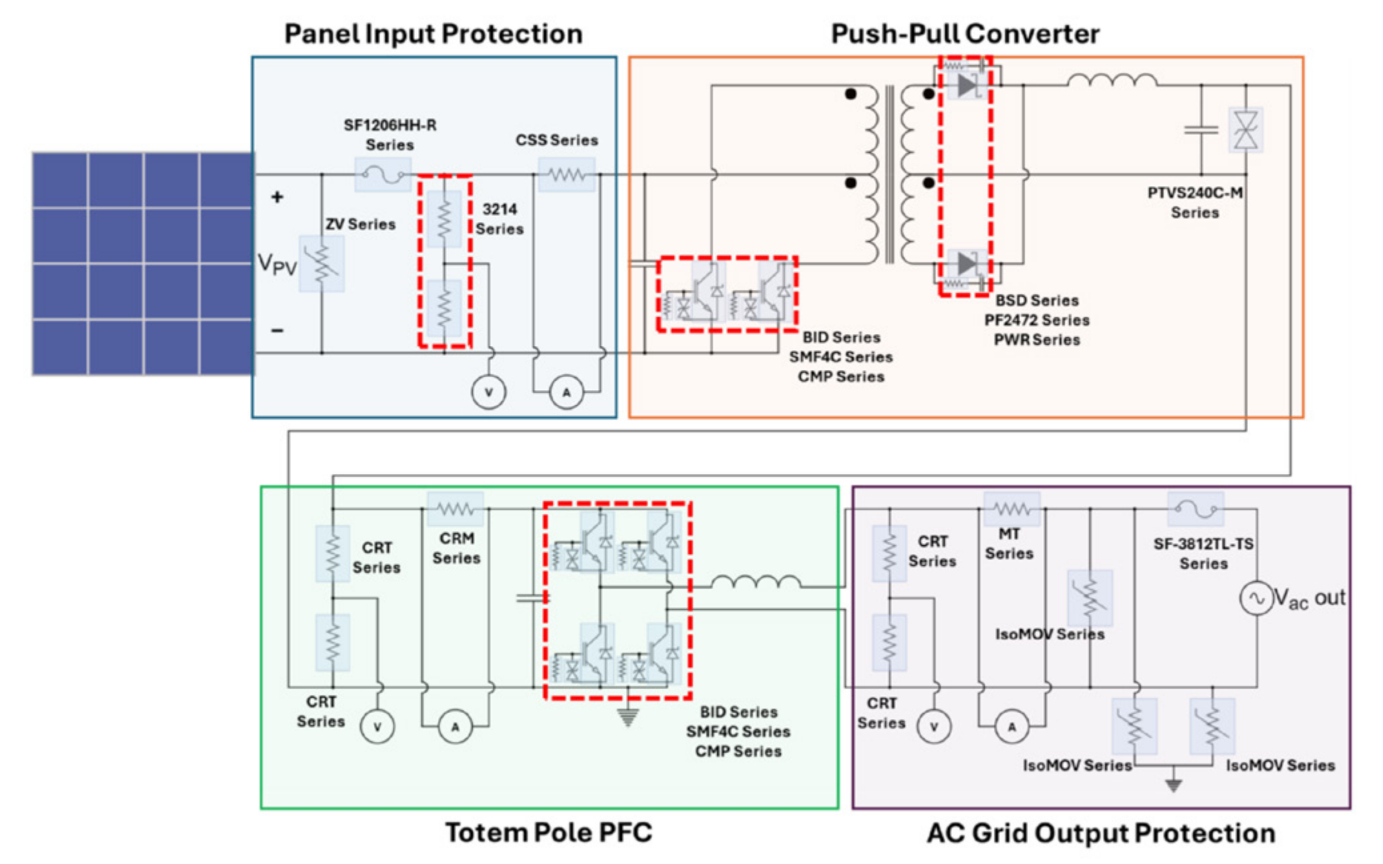
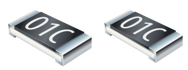


Figure 1. Circuit Protection Diagram of the Role of a Microinverter

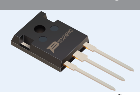
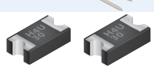
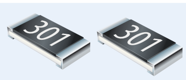
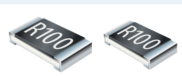
Microinverter's Crucial Role: Protecting and Powering the Future of Solar Use

APPLICATION BRIEF

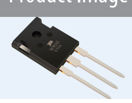
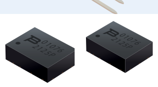
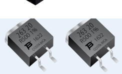
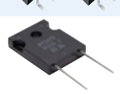
AC Grid Output Protection

Product Image	Recommended Products	Specifications & Features
	IsoMOV® Hybrid Protectors	• Max. Voltage: 175-555 VAC • Max. Peak Current: 6-15 kA, 8/20 µs • Operating Temperature: -40 to +125 °C
	CRT Thin Film Precision Resistors	• Resistance Range: 4.7-1 MΩ • Temp Coefficient: +/- 2-50 ppm • Max. Power: 63 - 250 mW
	SF-3812TL-TS SinglFuse™ SMD Fuses	• Rated Voltage up to 600 VAC • Rated Current: 0.062-60 A
	MT Series Wirwound Shunt Resistors	• Resistance Range: 3-100 mΩ • Power Rating: 1-10 W • Tolerance: 0.1 - 5 %

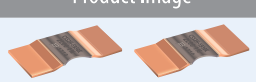
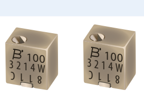
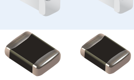
Totem Pole PFC Protection

Product Image	Recommended Products	Specifications & Features
	BID Series IGBTs	• Max. V_{CE}: 600-650 V • Max Current: 12-75 A • Junction Temp.: -55 to +175 °C
	SMF4C TVS Diodes	• Working Peak Reverse Voltage: 2-495 V • Power Rating: 400-15000 W
	CMP Thick Film Resistors	• Resistance Range: 0.047 Ω–100 MΩ • Power Rating: 0.03-3 W • Tolerance: 0.5–5 %
	CRM Thick Film Shunt Resistors	• Resistance Range: 3-100 mΩ • Power Rating: 1-10 W • Tolerance: 0.1 - 5 %

Push-Pull Converter Protection

Product Image	Recommended Products	Specifications & Features
	BSD SiC Schottky Diodes	• Max. Reverse Voltage: 650-1200 V • Max. Forward Current: 5-10 A • Junction Temperature: -55 to +175 °C
	PTVS1-240C-M Power TVS Diodes	• DC Bus Protection • Standoff Voltage: 15-470 V • Max. Peak Current: 1-20 kA, 8/20 µs
	PWR Wirewound Power Resistors	• Resistance Range: 0.005 Ω–320 kΩ
	PF2472 Thick Film Power Resistors	• Resistance Range: 0.02-130 kΩ • Power Rating: 20-300 W • Tolerance: 1 - 5 %

Panel Input Protection

Product Image	Recommended Products	Specifications & Features
	CSS Series Current Sense Resistors	• Resistance Range: 0.2-5 mΩ • Power Rating: 1.5-15 W • Tolerance: 1 %, 2 %, 5 %
	3214 Series Trimpot® Trimming Potentiometers	• Power Rating: 0.1-1 W • Resistance Range: 10 Ω to 2 MΩ • Number of turns: 1-25
	SF-3812TL-TS SinglFuse™ SMD Fuses	• Rated Voltage up to 600 VAC • Rated Current: 0.062-60 A
	ZV Varistors	• Working Voltage: 14-385 VDC • Peak Surge Current: 30-1200 A