Bourns® Advanced Component Solutions for Solar Panel Microinverters

BOURNS®

Introduction

Solar panels are one of the fundamental elements in the arsenal to produce renewable energy to support green and sustainable energy goals. The key advantage they provide is that solar panels can generate a sustainable Direct Current (DC) voltage on otherwise wasted energy. One important consideration, however, is that due to the efficiency and standardization of transmitting electricity via AC waveforms, the solar panel output needs to be inverted into Alternating Current (AC) voltage. There are many widespread methods to accomplish this task.

Microinverters are a popular and effective solution for this conversion, transforming DC voltage into grid-compatible AC directly at the panel level. In addition to the primary DC-AC conversion, microinverter systems require several other essential functions, including:

- Input and output protection to ensure safe delivery of power from solar panel to grid
- Power conversion to maximize energy extraction and maintain system efficiency
- Auxiliary power conversion to supply internal control and monitoring circuitry
- Interface protection for Human-Machine Interfaces (HMIs) and critical communication and data line protection

To meet these demanding requirements, Bourns offers a comprehensive portfolio of solutions, including circuit protection components and power conversion products. These solutions help enable robust, efficient, and long-lasting microinverter designs that meet the challenges of modern solar energy systems.

Bourns® Product Offerings

- Gas Discharge Tubes (GDTs)
- Insulated Gate Bipolar Transistors (IGBTs)
- Silicon Carbide (SiC) Schottky Diodes
- Power TVS Diodes
- TVS Diodes and Arrays
- Rectifier Diodes
- ChipGuard® ESD Suppressors
- Thick Film and Wirewound Resistors
- Current Sense Resistors
- Multifuse® Polymer PTC Resettable Fuses
- SinglFuse™ SMD Fuses
- PowerTherm™ Negative Temperature Coefficient (NTC) Thermistors
- IsoMOV® Hybrid Protectors
- Trimpot® Trimming Potentiometers
- TBU® High-Speed Protectors (HSPs)
- Multilayer Varistors (MLVs)
- Varistors

Application Example

Effective Input and Output Protection

Protecting both the input and output stages of a microinverter is essential to ensure system durability, safety, and uninterrupted energy production. As microinverters operate at the critical interface between solar panels and the power grid, they are exposed to a wide range of electrical hazards from both directions. Without robust input and output protection, these systems are vulnerable to damage that can lead to costly downtime, reduced performance, or even total failure. Bourns provides proven protection solutions designed to defend against these risks and support reliable operation under real-world conditions.

In a microinverter system, input protection from the solar panel is crucial to ensuring the reliability and longevity of the inverter and associated electronics. This protection helps to safeguard the microinverter against electrical faults such as overvoltage, reverse polarity, surges from lightning strikes, and other transient events that may occur at the PV Panel input stage. Key components used for input protection include fuses, Power Transient Voltage Suppression (PTVS) diodes, varistors, and Gas Discharge Tubes (GDTs). By implementing these protections, the system ensures safe operation, reduces the risk of inverter failure, and maintains consistent energy conversion even in harsh environmental conditions.

The microinverter output is connected to the main AC grid where it would be subject to various overvoltage and overcurrent events. These events hold enough power to irreparably damage microinverter systems. Bourns offers a comprehensive range of overvoltage and overcurrent protection products demonstrated to protect microinverters from these events, up to rated limits.

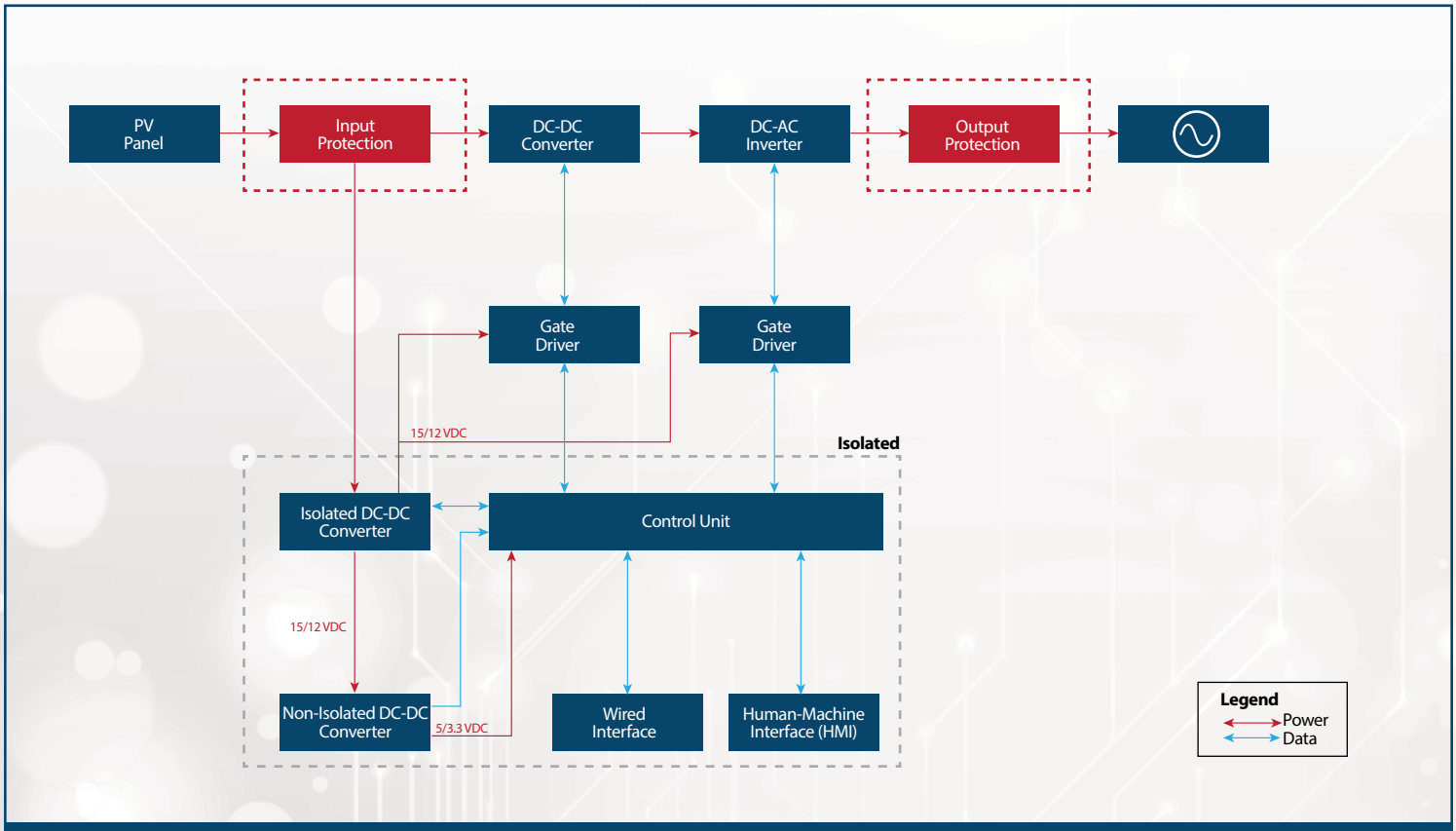
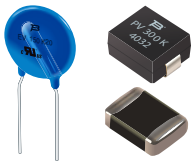
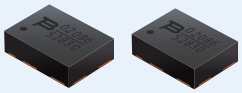
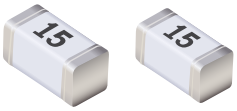
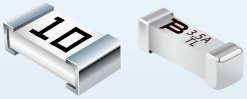


Figure 1 | *Block diagram of a typical microinverter system architecture, highlighting input and output protection to ensure safe delivery of power from solar panel to grid*

Bourns® Product Recommendations

Product Image	Recommended Products	Description	Specifications and Features
	Varistors Through-hole: EV Series SMD: PV Series, ZV HT Series	Varistors are conventional overvoltage protection components that offer an industry-standard form. These components "clamp" excess voltage conditions.	• Max. Voltage: 14-1465 VDC • Max. Peak Current: 100-15000 A, 8/20 µs • Operating Temperature: -55 to +125 °C • Up to 23 mm disc sizes • Through-hole and SMD packages available • UL 1449 Listed
	TVS Diodes PTVS2-xxxC-H Series	Power TVS diodes provide outstanding protection for Direct Current (DC) bus applications. TVS diodes provide tighter clamping with superior speed over traditional varistor technology.	• Standoff Voltage: 15-470 V • Max. Peak Current: 1-20 kA, 8/20 µs • Through-hole and SMD packages available • Bidirectional
	Gas Discharge Tubes (GDTs) GDT21 Series	Gas Discharge Tubes (GDTs) are a conventional overvoltage protection component with high surge current capacities. These components "crowbar" when excess voltage is present.	• Breakdown Voltage: 75-800 V • Up to 25 kA peak current, 8/20 µs waveform • Operating Temperature: -55 to +125 °C • Through-hole and SMD packages available
	SinglFuse™ SMD Fuses SF-1206HH-R Series SF-3812TL-TS Series	SinglFuse™ SMD Fuses are rated at high interrupting currents, providing reliable overcurrent and short-circuit protection.	• Rated Voltage up to 1000 VDC/800 VAC • Rated Current: 62 mA - 60 A • Interrupt Rating up to 160 kA • Designed to UL 248 & IEC 60269 standards • Multiple mounting types available • Automotive grade fuses offered (ISO 8820-8)
	IsoMOV® Hybrid Protectors IsoM5	Combination of MOV and GDT technology in one package. These components have extremely low leakage current and extended reliability.	• Max. Voltage: 56-745 VDC • Max. Peak Current: 6-15 kA, 8/20 µs • Operating Temperature: -40 to +125 °C • Disc Size: 10-20 mm • Through-hole components
	PowerTherm™ Negative Temperature Coefficient (NTC) Thermistors BN-LG15Y Series	PowerTherm™ Negative Temperature Coefficient (NTC) Thermistors are used as inrush current limiters (ICLs) for systems with DC-bus capacitors or inductive loads such as motor drivers that can draw high current levels on startup. ICLs prevent this event from occurring.	• Resistance Range: 0.7-220 Ω • Max. Current: 0.3-15 A • Max. Power: 1.6-7 W • Through-hole components with disc diameters up to 25 mm • Operating Temperature: -40 to +200 °C

Application Example

Valuable Power Conversion

In a microinverter system, the main power conversion process involves transforming the DC electricity generated by a single solar panel into AC electricity suitable for use in homes and the electric grid. A single microinverter is connected to an individual solar panel, allowing it to perform this DC-to-AC conversion at the panel level. This localized conversion improves overall system efficiency and performance, especially in scenarios where shading, debris, or panel mismatch occurs, as each panel operates independently. The output from each microinverter is synchronized with the grid's AC frequency and voltage, enabling safe and efficient integration with household electrical systems or direct export to the utility grid.

To support this conversion process and enhance energy conditioning within solar systems, additional power electronics such as DC-DC converters are often employed. A push-pull converter is a good solution here as it provides consistent switching and a transformer to step up the DC voltage. This system depends on precise switching and voltage transformation, which is why diodes and resistors are also needed to support reliable performance. For example, Bourns® SiC diodes and resistors provide robust switching capabilities and effective power dissipation, making them well-suited for use in these converters.

Building upon this foundation, further power conversion is often required for grid compatibility and energy efficiency. The totem-pole inverter is an example topology for a DC-AC inverter that includes built-in Power Factor Correction (PFC), making it ideal for modern energy systems. It operates by using high-power transistors to switch the input DC voltage into an AC waveform. To help ensure the protection and longevity of these transistors, components such as TVS diodes and resistors are integrated into the circuit. Bourns® IGBT devices, TVS diodes, and resistors all contribute to the safe and efficient operation of the totem-pole inverter, enabling more stable output for demanding applications.

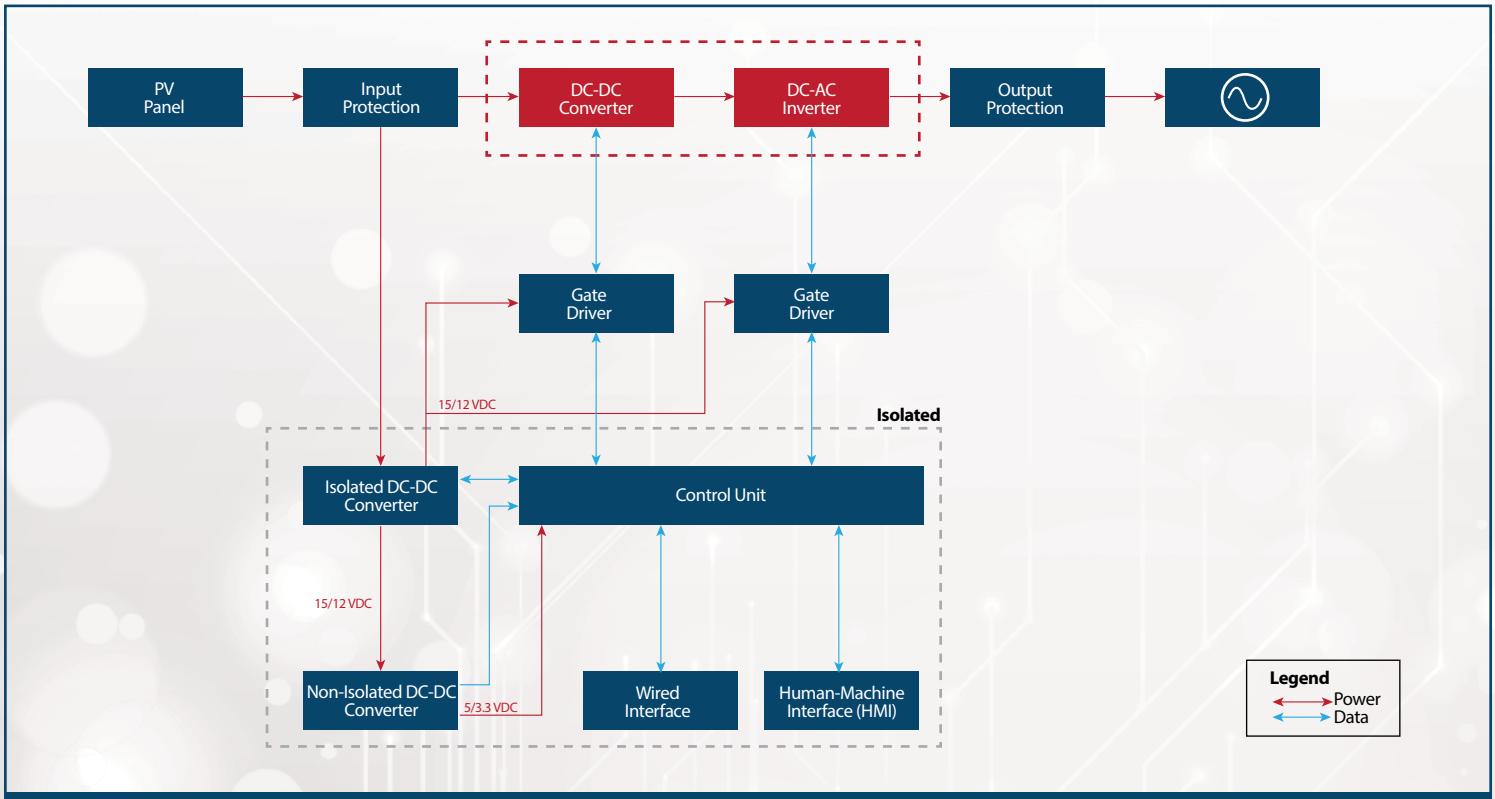
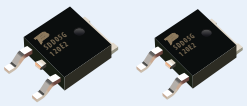
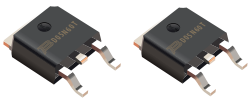
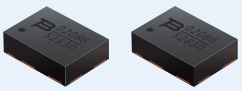
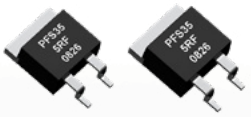


Figure 2 | *Block diagram with highlights for the power conversion circuits for maximizing energy extraction and maintaining system efficiency*

Bourns® Product Recommendations

Product Image	Recommended Products	Description	Specifications and Features
	Silicon Carbide (SiC) Schottky Barrier Diodes BSDD05G120E2 Series	High efficiency diodes that allow the best performance for high voltage and high power applications with practically no switching losses. Best used for PFC and other switch-mode topologies. Also used in high-efficiency snubber and free-wheeling designs.	• Max. Reverse Voltage: 650-1200 V • Max. Forward Current: 5-10 A • Junction Temperature: -55 to +175 °C • Through-hole and surface mount packages available • Low Q_{rr}
	Insulated Gate Bipolar Transistors (IGBT) BIDD05N60T Series	This device uses advanced Trench-Gate Field-Stop technology providing greater control of the dynamic characteristics while resulting in fewer switching losses. Great for use in active rectifier, PFC, or motor drive circuits. High and medium speed grades are available.	• Max. V_{CE}: 600-650 V • Max Current: 12-75 A • Junction Temperature: -55 to +175 °C • Through-hole and surface mount packages available • Trench-Gate Field-Stop technology
	Power TVS Diodes PTVS1-240C-M Series	Power TVS diodes provide outstanding protection for Direct Current (DC) bus applications. TVS diodes provide tighter clamping with superior speed over traditional varistor technology.	• Standoff Voltage: 15-470 V • Max. Peak Current: 1-20 kA, 8/20 µs • Offered in through-hole and SMD packages • Bidirectional
	Thick Film Resistors PFS35 Series	Bourns offers a broad range of resistors for use in precision monitoring, braking, surge protection, and snubbing circuits.	• Resistance Range: 0.01 Ω–130 kΩ • Power Rating: 20-300 W • Tolerance: 1–5 % • Standard packages available
	Wirewound Resistors PWR6927 Series	Bourns offers a broad range of resistors for use in precision monitoring, braking, surge protection, and snubbing circuits.	• Resistance Range: 0.005 Ω–320 kΩ • Power Rating: 0.1-500 W • Tolerance: 0.01–10 % • Standard packages available • Low inductance
	Current Sense Resistors CSI2H-2512 Series	Bare metal SMD shunts for precision monitoring of current. All blocks will incorporate some form of current monitoring for accurate switching characteristics.	• Resistance Range: 0.2-5 mΩ • Power Rating: 1.5-15 W • Tolerance: 1 %, 2 %, 5 % • Temperature Coefficient: 50 PPM/°C • Surface mount • Low thermal EMF
	Rectifier Diodes CD-DF4xxSLSeries	DC-DC converters incorporate diodes to rectify output power. Diodes are crucial to the operation of converters. Bourns offers both Schottky and PN variants to suit a wide range of applications.	• Peak Reverse Voltage: 20-1600 V • Forward Current: 0.2-4 A • Peak Surge Current: 2-150 A • Single/Bridge configurations • Schottky and PN technologies

Application Example

Vital Auxiliary Power Conversion

Auxiliary power converters in a microinverter design play a vital role in supplying isolated and regulated low-voltage power to the control, monitoring, and communication circuits within the system. While the primary function of a microinverter is to convert DC power from a solar panel to AC for grid connection, its internal electronics — such as microcontrollers, gate drivers, sensors, and communication modules — require stable DC power at much lower voltages (e.g., 3.3 V, 5 V, 12 V). Auxiliary power converters, typically implemented as isolated DC-DC converters or flyback converters, step down and isolate power from either the DC input or AC output of the inverter.

This isolation is essential not only for functional integrity but also for meeting safety and regulatory requirements, particularly in systems interfacing with a high-voltage grid. The implementation of an efficient and reliable auxiliary power design contributes directly to maximizing the overall performance and durability of the system while also complying with safety standards required in microinverter systems.

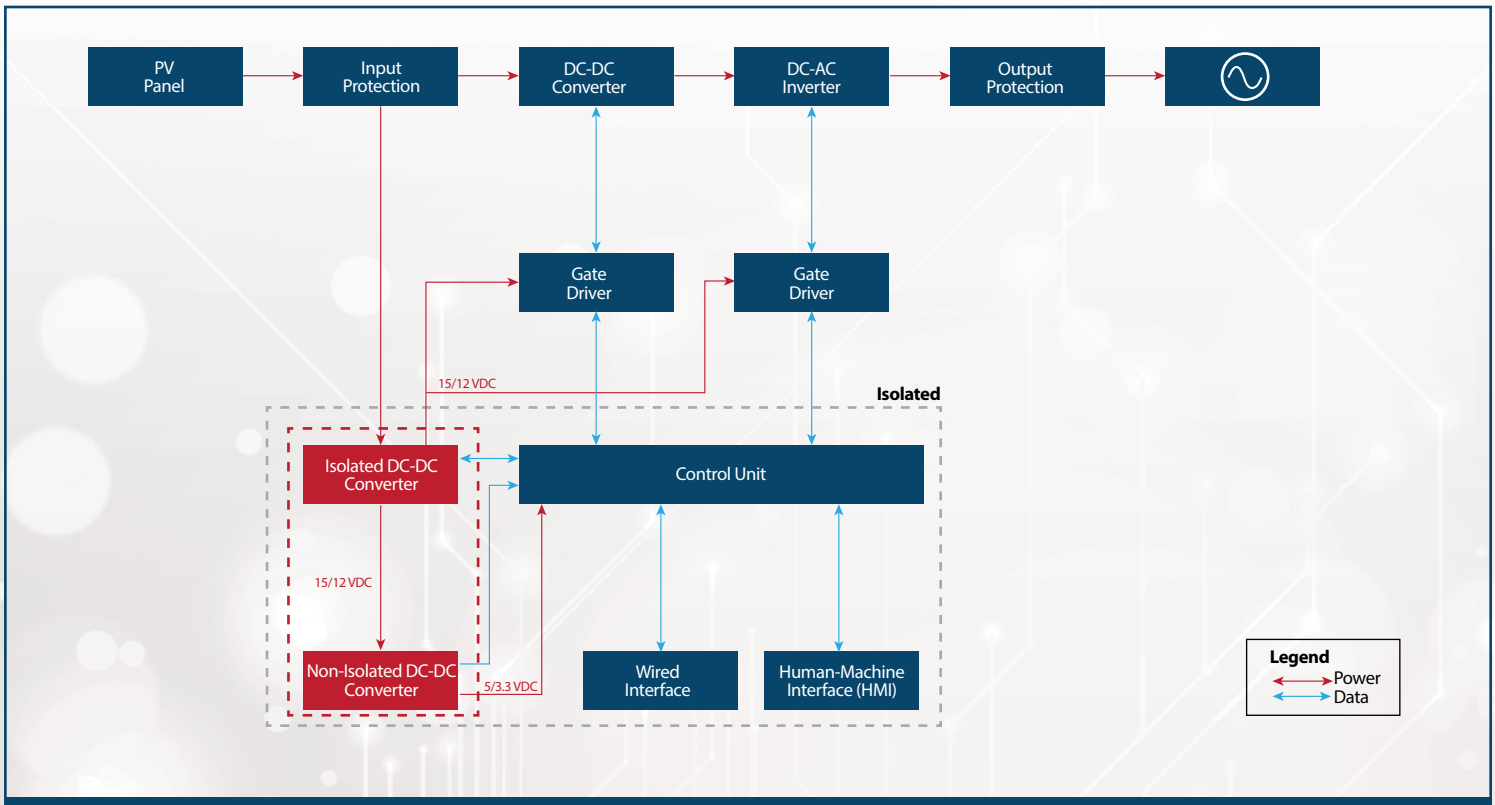
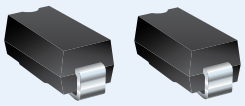
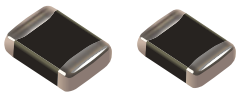
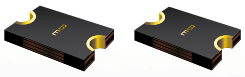
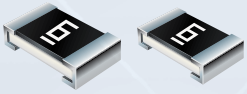
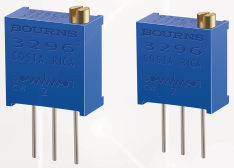


Figure 3 | *Highlighted blocks responsible for auxiliary power conversion to supply internal control and monitoring circuitry*

Bourns® Product Recommendations

Product Image	Recommended Products	Description	Specifications and Features
	TVS Diodes SMF4C Series	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.	• Working Peak Reverse Voltage: 2-495 V • Power Rating: 400-15000 W • Industry standard SMD packages • Tight clamping action
	Multilayer Varistors (MLVs) BVRA1812 Series	For overvoltage protection in lower voltage ranges.	• Working Voltage: 14–385 VDC • Peak Surge Current: 30–1200 A • Standard SMD packages available • Plastic encapsulated PV varistors as direct cross to through-hole MOVs
	Current Sense Chip Resistors CRM Series	Precision SMD current sense resistors ideally suited for Pulse Width Modulation (PWM) circuits. SMD shunts provide tight tolerances with low temperature drift in a small footprint.	• Resistance Range: 1 mΩ – 1 MΩ • Power Rating: 0.1-3 W • Tolerance: 0.5-5 % • Metal and film technologies • Low thermal EMF
	Multifuse® Polymer PTC Resettable Fuses MF-MSMF Series	Resettable overcurrent protection. Good for low voltage and low current DC busses and inputs. SMD packages available.	• Maximum Voltage: 6-72 VDC • Hold Current: 0.05-13 A • Operating Temperature: -40 to 125 °C • SMD and through-hole packages • Fast Time-to-Trip (TTT)
	SinglFuse™ SMD Fuses SF-0603SP-R Series	SinglFuse™ SMD Fuses act as overcurrent protection devices for critical components. Faster than PTCs, but not resettable. SMD packages and various technologies available.	• Rated Voltage: 24-250 VDC; AC rated available • Rated Current: 62 mA to 50 A • Film and metal technologies • Various fusing characteristics
	Trimpot® Trimming Potentiometers 3296 Series	Bourns® Trimpot® Trimming Potentiometers perform a variety of precision circuit adjustments, allowing the converter to be precisely adjusted as needed. Offered in single or multiturn models, SMD or through-hole.	• Power Rating: 0.1-1 W • Resistance Range: 10 Ω to 2 MΩ • Number of turns: 1-25 • Surface mount and through-hole packages offered • Precise adjustability

Application Example

High-Reliability Interface Protection

Interface protection in a microinverter design is necessary to help ensure system reliability, safety, and longevity, especially given the harsh electrical environments in which these devices operate. Because microinverters are connected directly to solar panels and the AC grid, this exposes them to a range of electrical threats such as lightning-induced surges, Electrostatic Discharge (ESD), and switching transients.

These disturbances can enter through communication ports or control interfaces, potentially damaging sensitive components within such as microcontrollers, communication ICs, and sensors. Effective interface protection mitigates these risks by blocking or diverting harmful transients before they can reach critical circuitry.

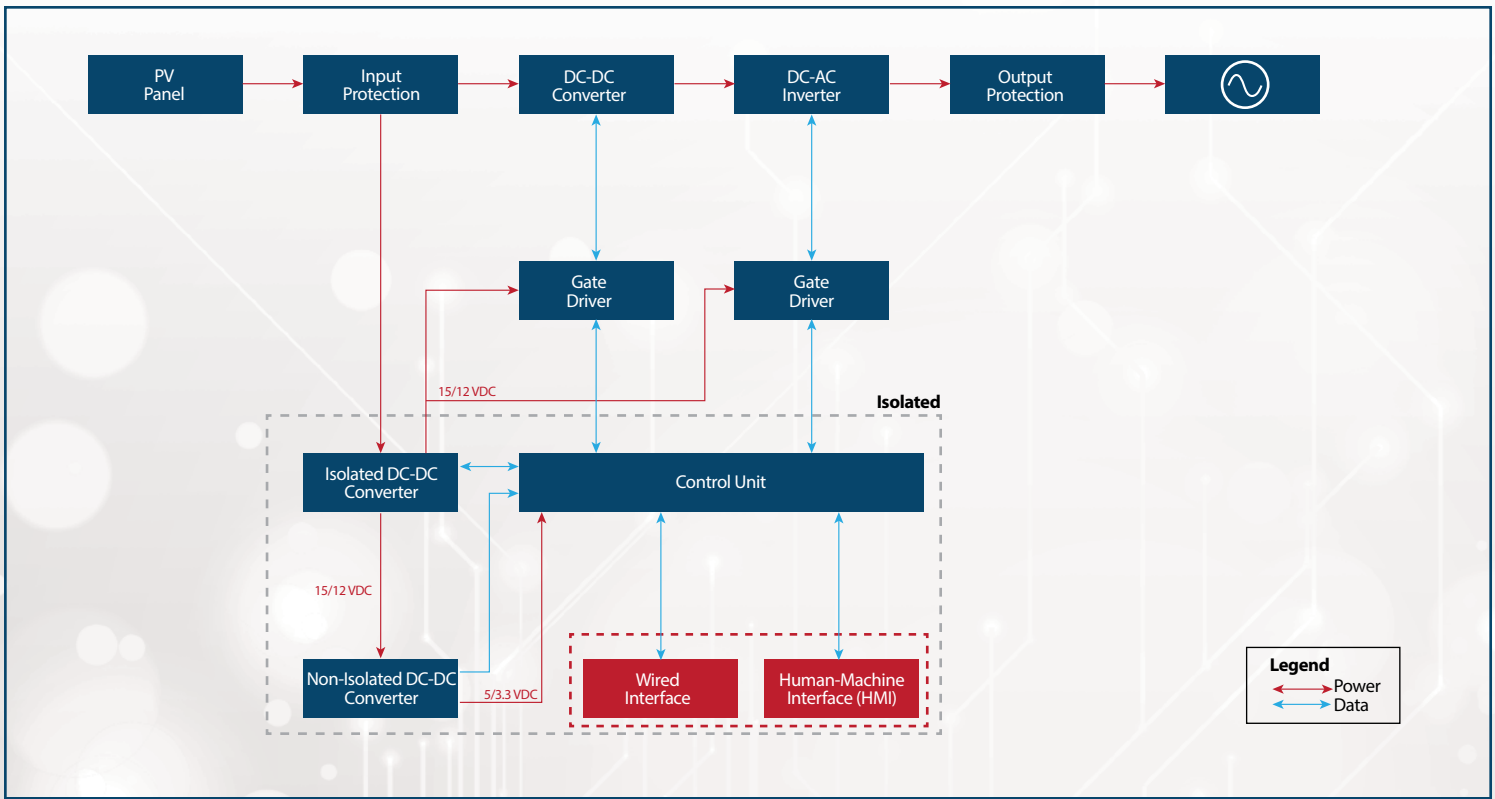
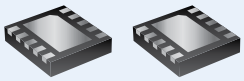
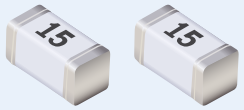
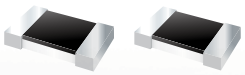


Figure 4 | *Block diagram displaying the blocks responsible for Human-Machine Interfaces (HMIs) and critical communication and data lines*

Bourns® Product Recommendations

Product Image	Recommended Products	Description	Specifications and Features
	TVS Diode Arrays CDDFN10-3304NA Series	Ultra-low capacitance overvoltage protection of several data lines. Bourns offers an extensive line of diode arrays for all types of communication protocols.	• Working Peak Reverse Voltage: 2.2-70 V • Typical Capacitance: 0.02-500 pF • Protection for up to eight lines in a single package • Surface mount with DFN packages
	TBU® High-Speed Protectors (HSPs) TBU-DF Series	TBU® HSPs are resettable, ultra-fast overcurrent protection devices. Offered in dual and single DFN packages, the TBU® HSP guards against power cross, lightning, and other energy surges on communication lines, up to rated limits.	• Max. Impulse Voltage: 40-850 V • Max. RMS Voltage: 28-425 V • Trigger Current: 50-500 mA • Protects up to two data lines in a single package • Uni- and bidirectional options
	Gas Discharge Tubes (GDTs) GDT21 Series	GDTs are conventional overvoltage protection components with high surge current capacities. These components "crowbar" when excess voltage is present. They offer extremely low capacitance making them suitable for low insertion loss devices for communication lines.	• Breakdown Voltage: 90-500 VDC • Temperature Range: -55 to +105 °C • Low capacitance <2.9 pF • Compact, surface mount package
	ChipGuard® ESD Protectors CG0201MLU Series	Varistor-based ESD protection in a small, SMD form factor boasting low capacitance.	• Working voltage: 3.3-56 V • Low capacitance • Response time: <0.5 ns • Standards: IEC 61000-4-2 & 61000-4-3 • ESD protection in a small footprint

Worldwide Sales & Representative Offices

Country/Region	Phone	Email
Americas:	+1-951-781-5500	americus@bourns.com
Brazil:	+55 11 5505 0601	americus@bourns.com
China:	+86 21 64821250	asiacus@bourns.com
Europe, Middle East, Africa:	+36 88 885 877	eurocus@bourns.com
Japan:	+81 49 269 3204	asiacus@bourns.com
Korea:	+82 70 4036 7730	asiacus@bourns.com
Singapore:	+65 6348 7227	asiacus@bourns.com
Taiwan:	+886 2 25624117	asiacus@bourns.com
Other Asia-Pacific Countries:	+886 2 25624117	asiacus@bourns.com

Technical Assistance Region	Phone	Email
Asia-Pacific:	+886 2 25624117	techweb@bourns.com
Europe, Middle East, Africa:	+36 88 885 877	eurotech@bourns.com
Americas:	+1-951-781-5500	techweb@bourns.com

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Specifications subject to change without notice. Actual performance in specific customer applications may differ due to the influence of other variables. Customers should verify actual device performance in their specific applications.

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