

APPLICATION BRIEF

Situation

A residential smart energy meter operating on a 120 V/240 V service must accurately measure real-time power consumption while maintaining reliable operation in a harsh electrical environment. The meter's metrology IC and communication modules depend on precise current sensing inputs through shunt resistors to calculate energy usage and support utility billing accuracy.

Because the meter is directly connected to the utility mains, it is routinely exposed to voltage transients, lightning-induced surges, switching events, and potential overcurrent conditions. These disturbances can damage the front-end, disrupt measurement accuracy, or cause premature failure of sensitive semiconductor components.

To ensure long-term field reliability, the smart meter requires robust overcurrent and surge protection at both the 120 V and 240 V inputs, as well as stable, low-resistance current sensing elements capable of handling continuous load currents and high fault energy. Integrating properly rated shunts, fuses, and surge protection devices helps safeguard the metrology circuitry, maintain safety compliance, and support accurate energy monitoring throughout the meter's service life.

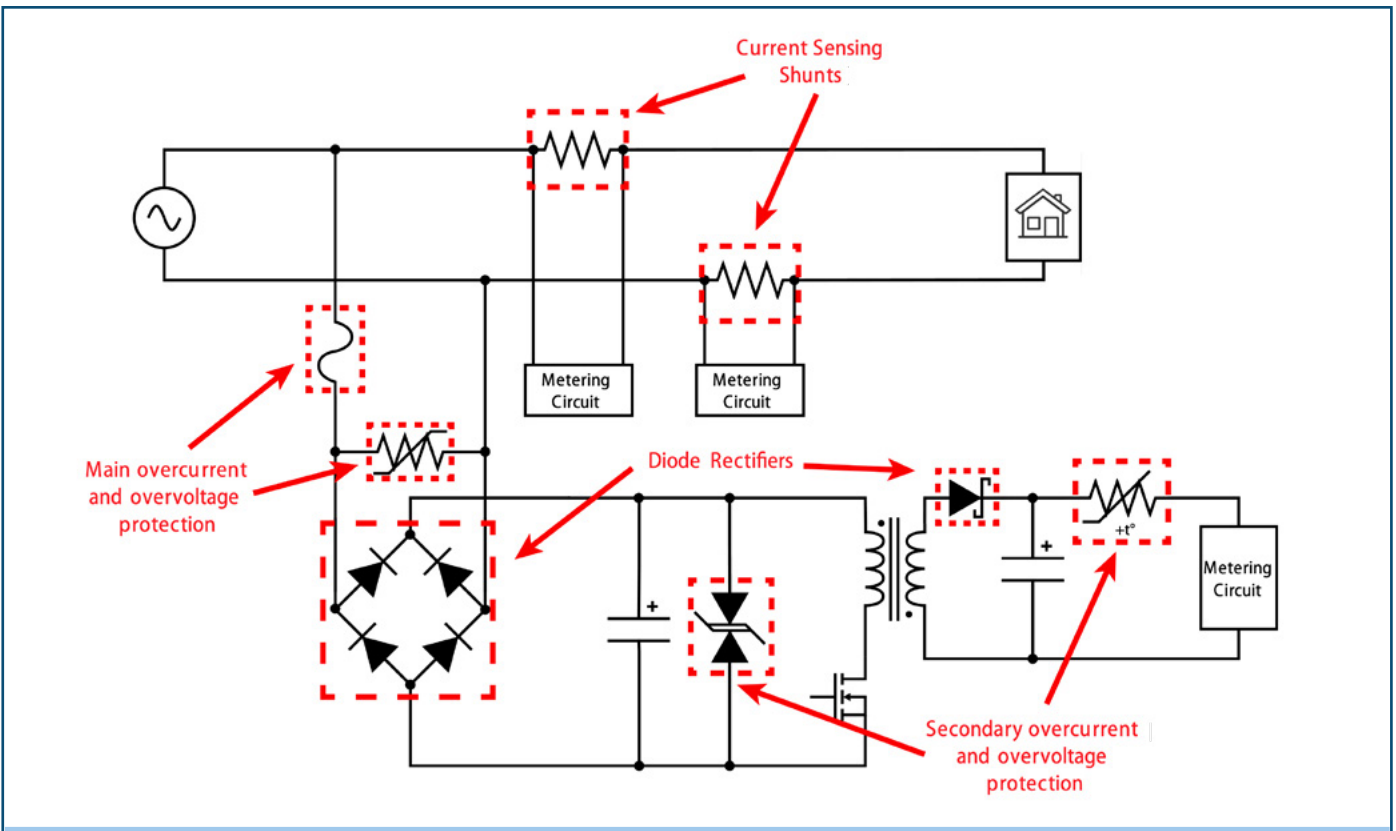


Figure 1. | Simplified circuit diagram showcasing circuit protection, current sensing, rectification, and DC-DC conversion components

APPLICATION BRIEF

Solution

A reliable smart energy meter design for 120 V/240 V service requires a combined approach that ensures accurate current measurement while protecting sensitive metrology electronics from the harsh conditions present on utility mains. The solution integrates a properly rated current-sensing element such as a low-ohm metal shunt with a coordinated set of surge and overcurrent protection devices positioned to shield the front-end power supply from high-energy events.









For current sensing, a low-resistance, low-TCR metal strip shunt provides a cost-effective, high-accuracy method of measuring load current, especially when paired with Kelvin sense connections and a stable, isolated differential amplifier. Proper thermal management is essential as shunt resistors must be rated for the continuous load current and fault energy.

In addition to measurement accuracy, the smart meter must safely derive its own operating power from the 120 V/240 V mains. This requires a rectification and protection stage capable of withstanding grid disturbances while delivering clean, isolated low-voltage power to the metrology IC, microcontroller, and communication modules.

The AC input typically passes through a fuse and coordinated surge protection stack before entering the rectifier and primary-side filtering network. Because smart meters must remain operational during voltage fluctuations, brownouts, and transient dips, the power front end must incorporate high-reliability components such as MOVs, GDTs, and TVS devices to manage overvoltage events, as well as robust rectifier diodes and capacitors that can tolerate continuous thermal and electrical stress. Ensuring stable DC power is essential not only for functional operation, but also for maintaining measurement accuracy, communication uptime, and long-term field reliability.

Additional protection after the meter's front-end further enhances system robustness. Series resistors, small PTCs, and low-capacitance TVS devices can be used to limit fault currents and clamp differential surges entering the sense amplifier or ADC inputs as well as residual energy leftover from the protection circuit front-end. Proper PCB design and mechanical layout are equally critical. High-current traces should be kept short and wide, while Kelvin connections ensure accurate sensing. Creepage and clearance distances must meet UL and IEC safety requirements, and thermal spacing helps prevent measurement drift caused by hot components. In outdoor or harsh environments, potting or conformal coating can improve long-term durability.

Benefits

Product Image	Recommended Products	Key Benefits
	Current Sense Resistors & Shunts CSI2H-2512 Series	High measurement accuracy, low TCR stability, and reliable high-current performance for precise energy metering.
	Gas Discharge Tubes (GDTs) GDT21 Series , GDT25 Series	Robust primary surge defense against lightning and grid disturbances for long-term meter durability.
	Varistors (MOVs & MLVs) EV, PV, BVRA1812 Series	Cost-effective transient suppression that safeguards the rectifier and power front end. MLVs applied for lower voltage circuits
	Hybrid Protectors IsoMOV® Hybrid Protectors	Combination of MOV and GDT technology into one package while offering extremely low leakage current and extended reliability.
	TVS Diodes & Arrays PTVS1-240C-M Series , SMF4C Series CDDFN10-3304NA Series	Fast, low-capacitance protection for high- and low-voltage buses, metrology ICs and communications, preventing surge, ESD, and fast transient damage.
	SinglFuse™ SMD Fuses & Multifuse® Resettable PTCs SF-3812TL-T Series , MF-MSMF Series	Reliable overcurrent protection that enhances safety and reduces field maintenance.
	Bridge Rectifier Diodes CD-DF4xxSL Series , CD214B-B3xR Series	Supports efficient, reliable AC-DC & DC-DC power conversion inside the meter.
	Power Resistors PWR6927 , PWR2635-35 , UT Series	Delivers stable, high-energy dissipation for inrush limiting and power conditioning, improving overall meter reliability and protection.

COPYRIGHT © 2026 • BOURNS, INC. • 2/26 • e/K2622

"Bourns", "Multifuse", and "IsoMOV" are registered trademarks of Bourns, Inc. in the U.S. and other countries. "SinglFuse" is a trademark of Bourns, Inc. in the U.S. and other countries.