

PCS Bi-directional Grid Interfacing Reference Document: Smart inverter grid interactive certification

PCS BI-DIRECTIONAL GRID INTERFACING REFERENCE DOCUMENT: SMART INVERTER GRID INTERACTIVE CERTIFICATION

EXECUTIVE SUMMARY

This document serves as the definitive technical reference for the Smart Inverter Grid Interactive Certification framework, as implemented within our flagship commercial and industrial (C&I) energy storage systems. As global grid codes evolve to accommodate higher penetrations of distributed energy resources (DERs), the bi-directional power conversion system (PCS) must transcend basic energy conversion to become an active grid participant. This certification validates our inverter's ability to provide advanced grid support functions, including reactive power control, frequency-watt response, volt-var regulation, and low-voltage ride-through (LVRT), ensuring seamless integration with utility infrastructure from North America to Europe and Asia-Pacific. Designed for system integrators, utility engineers, and asset owners, this document details the hardware architecture, control logic, and verified performance parameters that underpin our industry-leading grid compliance.



SYSTEM ARCHITECTURE & SAFETY

The smart inverter platform is engineered around a modular, three-level neutral-point-clamped (3L-NPC) topology, utilizing silicon carbide (SiC) MOSFETs for high-switching-frequency operation with minimal losses. This architecture enables bi-directional power flow with a peak efficiency of 98.8%, while maintaining total harmonic distortion (THD) below 3% at nominal load. The control system is built on a dual-core ARM Cortex-R5F real-time microcontroller, executing grid synchronization and anti-islanding detection algorithms in under 20ms. Integrated safety mechanisms include redundant overcurrent protection, DC-side ground fault detection, and automatic isolation in response to grid anomalies, ensuring compliance with UL 1741 SA and IEEE 1547. The system's IP66-rated enclosure (ventilated, with optional NEMA 4X) guarantees reliable operation in extreme ambient temperatures ranging from

-30°C to +55°C, with an inbuilt heater option for cold-start scenarios.

KEY FEATURES

- Advanced Grid Support Functions: In-built volt-var, frequency-watt, and reactive power control modes enable active participation in grid stabilization and voltage regulation, reducing utility demand charges and enabling participation in ancillary service markets.
- Seamless Grid Synchronization: Advanced phase-locked loop (PLL) and harmonic rejection algorithms ensure ultra-fast (under 100ms) and smooth reconnection to the grid, preventing nuisance tripping and maximizing system availability.
- Comprehensive Compliance Suite: Pre-certified to key international grid codes, including IEEE 1547-2018, UL 1741 SA (with SB), VDE-AR-N 4110 (Germany), CEI 0-21 (Italy), G98/G99 (UK), and AS/NZS 4777.2 (Australia), ensuring rapid market entry and utility approval.
- Secure Remote Firmware Update: Robust, encrypted over-the-air (OTA) update capability allows for seamless adaptation to evolving grid codes and the deployment of new grid support features without physical intervention.
- Real-time Communication: Supports standard industrial protocols (MODBUS TCP/IP, IEC 61850, DNP3) for seamless integration with site energy management systems (EMS) and grid operator control centers.

COMPLIANCE & STANDARDS

The Smart Inverter Grid Interactive Certification package is backed by exhaustive type-testing and performance verification, conducted at ISO 17025-accredited laboratories. Certified functionalities include low-voltage ride-through (LVRT), high-voltage ride-through (HVRT), and anti-islanding detection. The inverter's response to grid disturbances is characterized by a fixed power factor range of ± 0.8 and a configurable reactive power injection capability of up to 43% of nominal power. Moreover, the system's power quality assurance, with a THD of $<3\%$ and flicker mitigation, ensures it complies with IEC 61000-3-12 and IEC 61000-3-11. The unit also meets the strict environmental standards of IEC 60068-2 for damp heat, vibration, and salt mist, confirming its readiness for both desert coastal and industrial applications.

TECHNICAL SPECIFICATIONS

Parameter	Specification
Nominal AC Power	100 kW / 250 kW / 500 kW
Max. AC Apparent Power	110 kVA / 275 kVA / 550 kVA
AC Grid Connection	3W/N/PE, 400 V (or 480V), 50/60 Hz
Efficiency (Max.)	98.8% (including transformer)

THD	<3% (at nominal power)
Reactive Power Control	±0.8 PF (leading/lagging)
DC Input Voltage Range	600 V – 1500 V
Max. DC Input Current	200 A / 500 A per MPPT
Response Time (LVRT)	< 20 ms
Protection Class	IP66 (indoor/outdoor)
Operating Temperature	-30°C to +55°C (derating >45°C)
Communication Interfaces	Ethernet, RS-485, CAN bus
Protocols	MODBUS TCP/IP, IEC 61850, DNP3
Dimensions (W x H x D)	1200 x 2200 x 800 mm (100kW model)
Weight	~1200 kg (100kW model)

INDUSTRIAL DEPLOYMENT

Deployment of the certified smart inverter is optimized for a wide range of C&I applications, including peak shaving, demand charge reduction, and backup power. The PCS is designed for easy integration with both new and existing PV systems, allowing for direct DC-coupling to solar arrays or AC-coupling to a step-up transformer. Its grid-interactive capabilities are critical for microgrids requiring automatic islanding and resynchronization. When paired with our modular LFP battery cabinets, the system provides turnkey storage solutions

from 30kW to several megawatts. The robust communication architecture and intuitive user interface — accessible via a local HMI or cloud-based EMS — simplify commissioning and ongoing operations. All units come standard with a 5-year warranty, with extended coverage available, underlining the engineering team's commitment to reliability. For detailed project-specific integration and layout planning, please consult our application engineering team.

