Three-Phase String Inverter Systems Overview

Solutions

Three-phase string inverter systems convert the DC power generated by the photovoltaic (PV) panel arrays into the AC power fed into a 380 V or higher three-phase grid connection. The power rating of these inverters ranges from 10kW up to more than 250kW (realized through stacking multi-modules), covering different markets and applications, ranging from residential to commercial or industrial up to utility-scale.

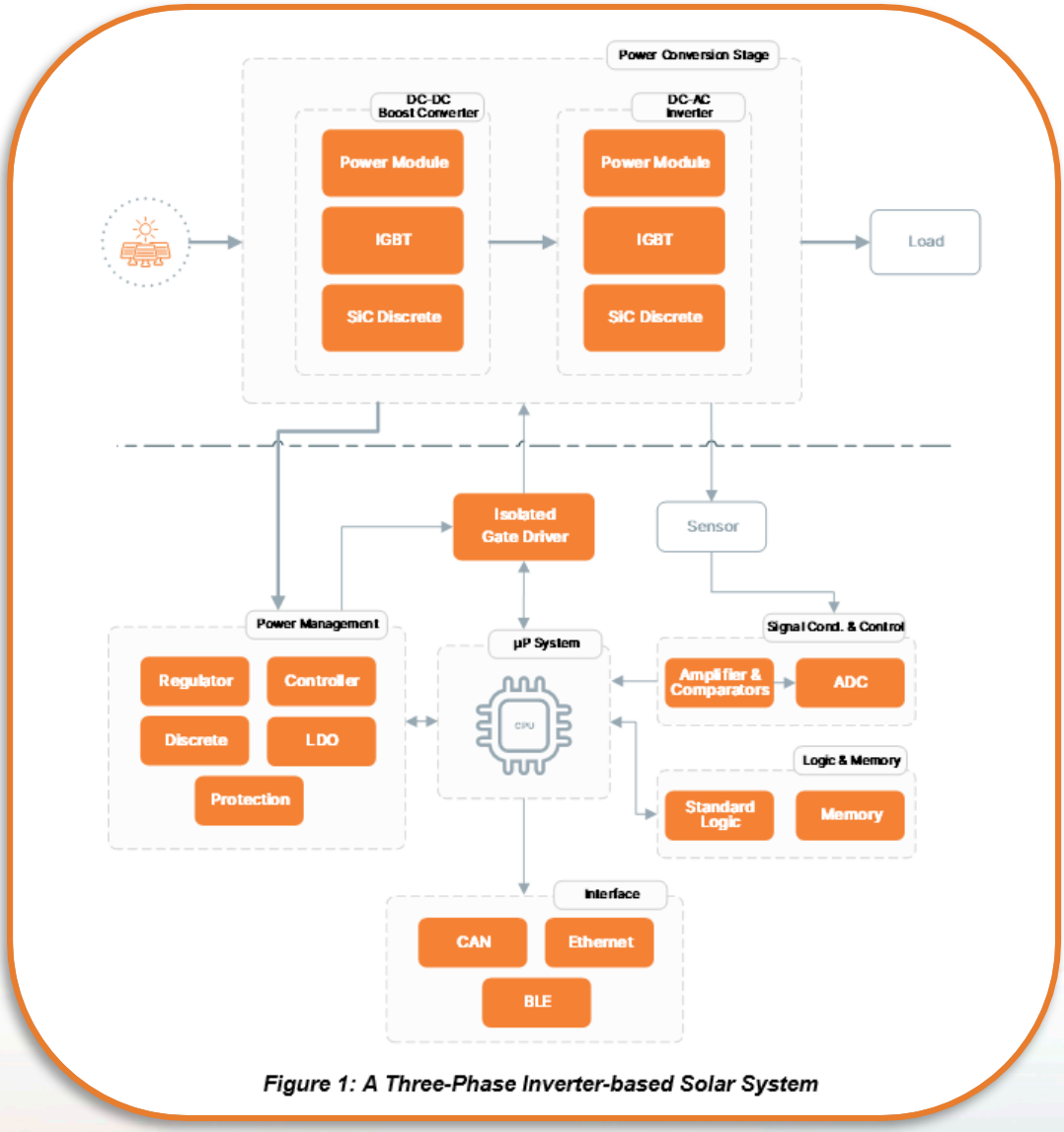

Figure 1: A Three-Phase Inverter-based Solar System

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System Overview

The system's main components are the PV panels, the DC link capacitors, cables, the DC-DC boost module and the inverter module, which handles the DC-AC conversion. Often the DC-DC boost stages are used between the PV strings and the DC link. These systems elevate the output voltage of the PV string to the DC link operating level and run the MPPT (Maximum Power Point Tracking) function, which maximizes the power generated by the PV strings in different environmental and sun irradiance conditions. When the PV string can reach the DC link operating voltage level, the DC - DC converter is bypassed (via a low VF diode) to maximize efficiency.

A three-phase inverter system is operating at an output power level ranging from 10kW to above 300kW, used in commercial and decentralized utility-scale applications. High output power can be realized through stacking multiple medium-power blocks. The low and medium-power systems of around 100kW are typically implemented at 1100 V DC link voltage while higher bus voltage which is 1500 V is preferred in utility-scale system. Higher bus voltage means lower operating current when output power could remain the same. As a result, cost of cables, inductors and heat sinks, together with total system dimension can be significantly reduced.

Architecture and Technologies

Three-level topology is considered as the best configuration in high-power solar inverter systems. In addition to lower switching losses and drain-source voltage requirements, EMI can also be reduced as the conducted EMI is mainly linked to the current ripple. Moreover, a three-level system can provide better sinusoidal voltage waveform. High-quality output can reduce the stress on cables and failure risks of high-sensitive electrical devices.

In the DC-DC stage, symmetric boost and flying-cap boost are highly recommended to double the inductor frequencies to save the space. I-NPC, T-NPC and A-NPC are the most common configurations of the DC-AC inverters, each with different characteristics in terms of performance, cost and control complexity.

onsemi offers a wide variety of power integrated modules including SiC hybrid modules, IGBT modules and full SiC modules to ensure the high-power density.

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