

Article Overview

A photovoltaic power station transformer communication module enables data exchange between inverters, transformers, and central coordinators using power line communication (PLC) for monitoring, control, and grid integration.

Overview of Communication in PV Transformer Stations

In modern photovoltaic (PV) power stations, transformers are integrated with communication modules to facilitate real-time monitoring and control of inverters and the overall system. Each inverter converts DC from PV modules or energy storage devices into AC, which is then transmitted to a transformer. The transformer boosts the AC voltage for grid connection while the communication module collects operational data such as voltage, current, power, and internal status of each inverter .

Power Line Communication (PLC) in PV Systems

PLC technology is commonly used to transmit data over existing power lines, eliminating the need for additional communication cabling. In a PV station, PLC modules allow:

- o Central Coordinator (CCO): Acts as the root node, controlling and collecting information from proxy coordinators and inverters (stations) over long distances, often exceeding 1000 meters .
- o Proxy Coordinator (PCO): Intermediate node that forwards data between the CCO and inverters.
- o Station (STA): Leaf node that reports inverter status to the CCO. This setup ensures low-latency communication, typically at millisecond levels, which is critical for grid scheduling and rapid response to operational changes .

Transformer Station Integration

Transformer stations, such as the JUPITER series, are designed for PV applications with features including:

- o High-efficiency oil-immersed or dry-type transformers
 - o Real-time detection of LV panel and transformer parameters
 - o Remote control of ACB and MV circuit breakers
 - o Robust design for harsh environments and high availability
- These stations integrate PLC modules to communicate with multiple inverters, often grouped into subarrays. Each subarray connects to a dedicated PLC interface on the central coordinator, which aggregates data and transmits it to a data collector via Ethernet for monitoring and analysis .

Advantages of Using Communication Modules

- o Efficient monitoring: Collects detailed inverter and transformer data for performance optimization.
- o Low-latency control: Enables rapid response to grid instructions and fault conditions.
- o Simplified installation: Reduces the need for additional cabling by using existing power lines for communication .
- o Scalability: Supports large PV stations with multiple inverters and long-distance communication requirements.

Applications

- o Grid integration: Synchronizes inverters and transformers with grid requirements.
- o Remote monitoring: Provides operators with real-time data for predictive maintenance and fault detection.
- o Safety compliance: Supports rapid shutdown and protection functions in accordance with standards like SunSpec(R) RSD and UL1741 . In summary, photovoltaic power station transformer communication modules are essential for efficient, low-latency, and scalable monitoring and control of PV systems, enabling seamless integration with the grid and ensuring safe, reliable operation of large-scale solar installations .

A photovoltaic system employs solar modules, each comprising a number of solar cells, which generate electrical power. PV

PLC module for PV system enables reliable communication between solar panels, inverters,

Explore the various communication solutions for photovoltaic inverters, including GPRS,

In large-scale photovoltaic (PV) power plants, a PV Power Plant Communication Gateway is the core device for

In this paper, a digital twin (DT) model based on a domain-matched transformer is proposed using convolutional neural

The custom-designed communication board (a) is depicted in blue, the Uplink receiver backend (b) is yellow, the Downlink

As the brain of a photovoltaic (PV) power station, inverters play a crucial role in collecting

In this paper, two communication systems were developed using only open-source software, in which the first was

This work contributes to the design of reliable monitoring and communication of large-scale PV power plants.

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Another option to distinguish is communication from solar panels towards the inverters and the communication towards the grid.

I. INTRODUCTION Utility scale photovoltaic (PV) systems are connected to the network at medium or high voltage levels. To step up

The categories of the various data transmission modules for wireless communication in solar PV monitoring systems

For example, PLC is normally used in big commercial or utility scale projects because of its cost-saving characters like

The main communication and regulation instruments in a photovoltaic system are the gateway and Power Plant

The electric power generated by PV modules goes through a series of transformations before it reaches the grid. Those

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