Efficiency with usability

ABB's all new string inverter for photo-voltaic systems

JUKKA NURMI – The worries of global warming and soaring oil and gas prices mean the utilization of renewable energy sources looks set to increase to meet growing global energy demands. The planet has always received generous amounts of one source of renewable energy, sun rays. The simplest method of harnessing solar energy is through the use of photovoltaic cells. These cells produce direct current (DC) which needs to be converted into alternating current (AC). This conversion is carried out using an inverter, and ABB string inverters are designed for photovoltaic systems installed primarily on residential and small- to medium-sized commercial buildings. The new inverter series now includes built-in protection functions, which reduce the need for costly and space-consuming external protection devices and larger enclosures.

1 ABB's PVS300 string inverter

Technological developments are continuously improving the efficiency and cost effectiveness of photovoltaic systems. For its part, ABB has long been a leader in inverter and power converter technology and it has been using this knowledge and experience to provide leading-edge and high-quality solutions for photovoltaic power systems. Its portfolio of solar inverters ranges from small single-phase string inverters right up to central inverters with power ranges of hundreds of kilowatts. The latest addition to this portfolio, the PVS300 ➔ 1, has a power range from 3.3 to 8 kW, making it suitable for residential buildings as well as small and medium-sized commercial and industrial buildings. Its all-in-one design makes it reliable, safe and extremely cost effective, especially in installations using multiple inverters.

The heart of the PVS300 string inverter is the intuitive control unit equipped with a user-friendly graphical display that provides three main views: sun meter; solar energy production information; and help/settings menus. The sun-meter symbol indicates the amount of sun shining (10 rays mean full sunshine, one ray means rain) ➔ 2, and at night the inverter goes into sleep mode, consuming less than 1W. The solar energy production information display is designed to provide the necessary data for those interested or involved in the feed-in tariffs [1] provided by many countries for environmentally friendly production such as solar power ➔ 3. The built-in data logger displays and stores the exact daily, weekly, monthly and yearly production for up to 24 years. In addition, the inverter calculates CO_2-emission savings. Detailed technical data are available for those who want more than a general overview of their solar energy production.

A dedicated "help" key and built-in user's manual are provided to explain the different views and setting possibilities. The display platform supports up to 24 languages.

Start-up, guaranteed in just four straightforward steps, is guided by a start-up assistant that is initiated when the inverter is first powered up. Settings can be easily changed thanks to a menu structure with a look and feel similar to that found in everyday devices, such as mobile phones.

The display can be detached from the inverter ➔ 4 and 5 and mounted separately on a wall to monitor inverter performance from outside the installation room. It can also be wirelessly connected to the in-

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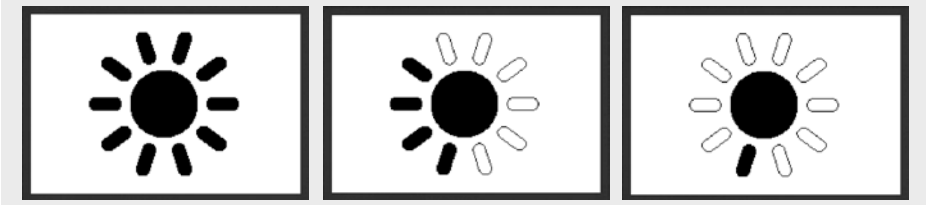
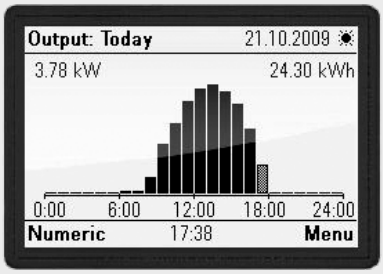
Title Picture
ABB's new string inverter, designed for photovoltaic systems installed on residential and small-to-medium-sized commercial buildings now includes built-in protection functions.

Footnote
1 A feed-in tariff (FiT) is a policy mechanism designed to encourage the adoption of renewable energy sources and to help accelerate the move toward grid parity. Under a feed-in tariff, eligible renewable electricity generators (which can include those in homes and businesses) are paid a premium price for any renewable electricity they produce.

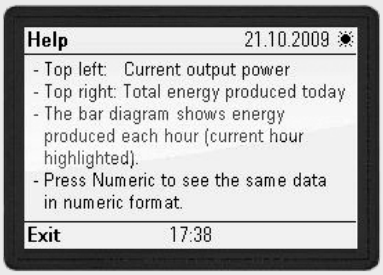
2 Displays even a child can understand



3 Detailed technical information is available for those who want a bigger picture of their solar energy production



3a Solar-energy-production-information



3b A "help" key explains the different views

verter; the wireless transmitter and receiver are already paired in the factory so that the user does not have to play with the complex settings so often needed in wireless connections. The technology and frequency range is similar to that used in wireless weather sensors but it covers longer distances than Bluetooth and consumes significantly less power than Wi-Fi.

Built-in protection

The attention given to the aesthetics, and the internal design and layout of ABB's string inverter were important to fully support system integrators and those installing photovoltaic systems. In particular, the addition of comprehensive built-in protection eliminates the need for the external components used in most traditional photovoltaic systems.

To begin with, fault currents, created in an ungrounded system when two ground faults or a line-to-line fault exist, may damage modules or cause excessive heating in some part of the system. The systems need to be protected against this admittedly rare occurrence by placing string fuses in both the negative and positive legs of the string cabling.

Also solar arrays are subject to atmospheric activity and may be damaged by the overvoltage generated by lightning. To minimize these risks, surge protective devices (SPD) need to be installed on each polarity. The impedance of these devices varies depending on the voltage applied; for example, in normal operation the impedance is extremely high and is only reduced – in the case of over voltage – by discharging the associated current towards ground. Unfortunately,

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standard SPDs do not work properly in photovoltaic systems. Instead specially designed ones are needed for PV systems having high nominal DC voltage

The PVS300 has a power range from 3.3 to 8 kW, and its all-in-one design makes it reliable and safe especially in installations using multiple inverters.

The neutral point clamped (NPC) topology combined with ABB's patent-pending modulation scheme provides an efficient inverter with minimal leakage current and the maximum allowed DC voltage.

4 The PVS300 string inverter is suitable for residential and commercial use

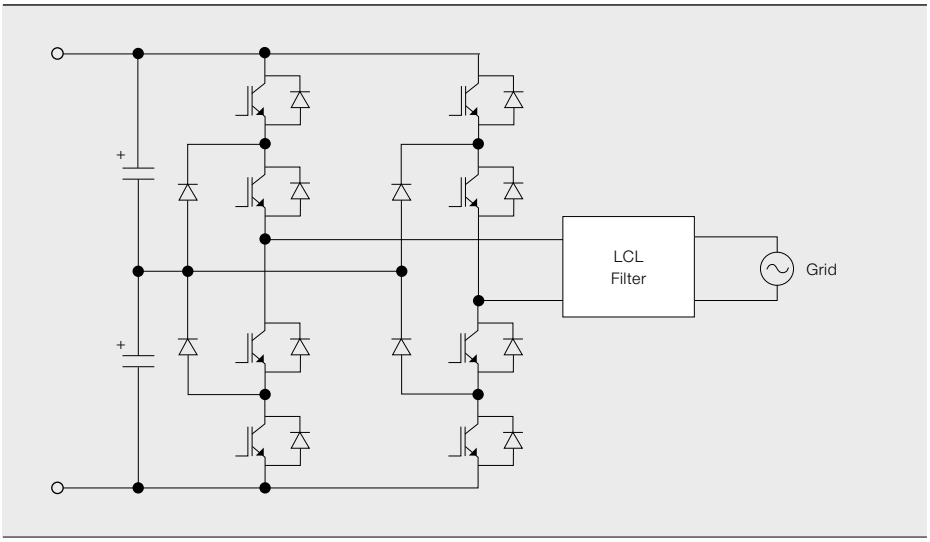
5 PVS300 display can be detached for remote monitoring

6 Integrated DC switch, string fuses and surge protection devices under the main cover

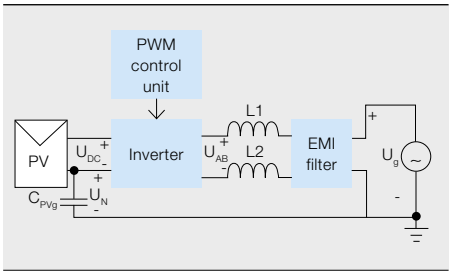
and low short-circuit current capability. Typically, these protection devices are placed in a separate junction box between the solar modules and the inverter.

The built-in protection designed into ABB's PVS300 string inverter avoids the time and cost required to select, design and install external protection devices and enclosures → 6. For system integrators and during installation, a compact integrated solution means space is used much more efficiently, something that is valued especially in installations that use multiple inverters. For end users, the internal design of the inverter significantly reduces troubleshooting and repair time when a problem occurs. For example, an in-built microprocessor monitors internal protection devices (eg, fuses and surge protective devices) and immediately transmits error messages or information to the inverter display and optionally over the Internet as an e-mail in the event of a problem; and components such as pluggable surge-arrester cartridges can be easily and safely replaced. Finally, the reduction in material usage is a major contributor to minimizing CO_2 emissions over the product lifecycle.

7 PVS300 string inverter full bridge neutral point clamped (NPC) topology



8 Photovoltaic system with stray capacitance



Pure performance at the core

The core of ABB's string inverter design is described as a full bridge, neutral point clamped (NPC) topology ➔ 7, which is combined with ABB's patent-pending modulation scheme to provide an inverter that is extremely efficient with minimal leakage current and high maximum allowed DC voltage.

High efficiency comes from simplicity, which is illustrated when certain aspects of a traditional solar inverter design are compared to the PVS300 design. For example, the traditional design uses an additional boost converter in the input or a step-up transformer in the output whereas the ABB string inverter only uses one DC to AC power conversion stage. The elimination of additional power conversion stages not only improves the efficiency but also the reliability of the system. Additional efficiency gains are achieved using intelligent sleep logic and advanced materials, such as amorphous alloy cores in the output LCL filter.

A typical ungrounded photovoltaic system is shown in ➔ 8. Solar modules are always connected to ground through a parasitic capacitance (C_{PVg}). Any AC component present in the voltage U_N will generate a current through this capacitance to ground. If the voltage across the capacitor contains excessively high-frequency components, it can produce equally excessive high-frequency ground currents that can either create electromagnetic compatibility issues, or degrade or damage the solar modules over time. ABB's patent-pending high-frequency elimination modulation scheme eliminates the high-frequency components from U_N that some inverters in the market actually introduce.

The solar-system DC voltage varies depending on the system configuration, temperature and solar irradiation. Due to its wide DC-input range, the ABB string inverter easily accommodates a broad selection of series and parallel configurations and different solar module types. Its high maximum DC voltage allows more modules to be connected in series and this in turn reduces the cost and losses in the DC cabling.

The PVS300 string inverter was introduced to the market for the first time at the 2010 Intersolar fair in Munich, the world's largest exhibition for the solar industry. It follows the successful launch of ABB's central inverter product family for photovoltaic power plants a year earlier.

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