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Photovoltaic Inverters Come of Age

Demand for Alternative Energy Sources Power New Opportunities and Challenges

Currently, issues about alternate energy sources dominate what we see and hear in the media today. As the demand for energy increases, so does the need to find alternative, yet inexpensive, green energy sources such as wind energy and solar energy. Additionally, wave energy, tidal energy, geothermal, and many others are also being further developed and utilized.

In 2002, there were approximately 100MW of solar power generation worldwide, which grew to 1,700MW by 2006. In 2007, there were approximately 120GW of wind power generation. The electrical power from these alternate power sources are often produced as a DC voltage, which must then be converted to AC for domestic or industrial usage. Once converted to AC, electrical power can be used by a dedicated load or instead exported to the power grid. When exported to the power grid, this is often referred to as micro generation, and more commonly referred to as a grid tied inverter.

Conversion from DC to AC voltage is achieved by a DC to AC Inverter. The size of the inverter can range from a few watts to many kilowatts, depending upon the application. The inverter may also have a charge controller to charge batteries for use when the energy source is unavailable (i.e., nighttime or a day without wind).

In Figure 1, the inverter converts the DC input voltage into AC voltage, thereby powering the dedicated load. Excess power from the DC Source charges the batteries. When the DC source is unavailable, the batteries can provide the DC voltage for the DC to AC inverter. The charge controller, which is often part of the inverter, manages the charging and discharging of the battery.

In Figure 2, the DC Source is converted to AC and fed directly to the utility power grid. Connection to the grid must meet the country's national and local codes.

Traditionally, electrical power has been produced in large power stations, with the power flowing generally from the point of power generation to the point of utilization (or the customer). When grid tied inverters are used, we now have the situation of power flow from the customer towards the power generators. This can create unique problems on the power grid. With power being generated in many local areas, the overall voltage regulation on the power grid might be affected. At present, grid tied inverters usually do not provide any means of active voltage regulation, but, rather, follow the voltage at the point of connection.

Following are some are the more common questions often asked about inverter technology used to power the grid, for which relatively short answers are offered.

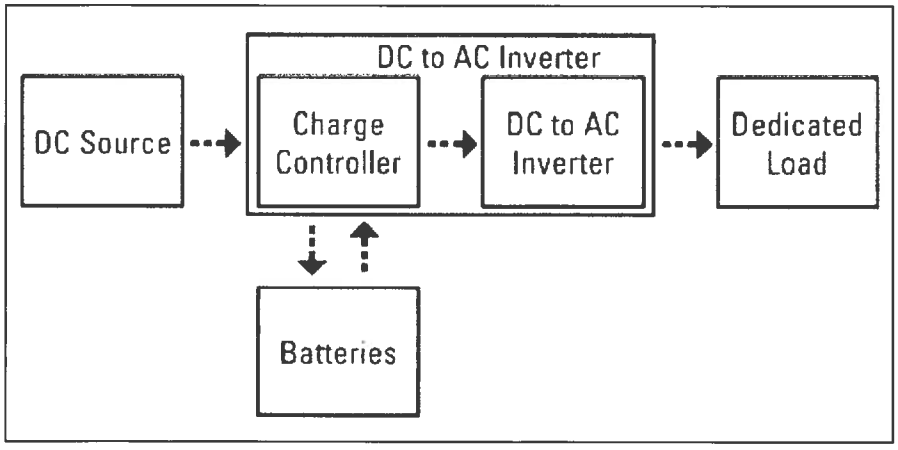

Figure 1

ISLAND OF POWER

If a fault occurs on the power grid, it is possible to have a situation of a local island of power caused by the grid tied inverter. Because this island is not being powered by the grid, the power quality may no longer be within specifications. This can cause damage to equipment that is now being powered by the inverter alone. In addition, this situation can be dangerous for people working on the power grid, since power can now be flowing from the other direction.

AUTOMATIC GRID DISCONNECTION

Consequently, there is a requirement that inverters stop exporting power to the grid when the grid voltage or frequency go out of specification or if it detects that there is a fault on the grid (i.e., blackout). This is often referred to as automatic grid disconnection.

MAXIMUM POINT TRACKING

Inverters are usually optimized for the type of DC source to maximize the efficiency of the overall system. This is often referred to as Maximum Power Point Tracking System (MPPTS). For example, the amount of power available from a photovoltaic system is a

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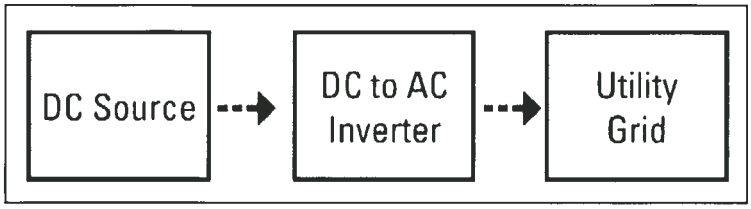

Figure 2

function of sunlight and temperature, and the output power is elevated with increased sunlight or in lower temperatures. The MPPTS will automatically adjust the inverter operating point to ensure maximum power transfer from the photovoltaic cells.

REGULATORY STANDARDS FOR NORTH AMERICA

From country to country, the standards by which inverters are tested vary. On the same token, the conditions to stop exporting power also vary from country to country. In North America, there are two different standards to consider. In the United States, companies must follow UL1741 "Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources." The latest edition of UL1741 now uses IEEE1547 "IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems." In Canada, CSA 107.1 "General Use Power Supplies" is the appropriate standard.

EUROPEAN INVERTER STANDARDS

In Europe, the standard EN 50178:1997 "Electronic Equipment for use in Power Installations" covers the basic safety of the inverter. At present, a new standard IEC 62109 "Safety of Power Converters for Use in Photovoltaic Installations" is being used alongside EN50178.

Each European country has different requirements for the grid interface. For example, in Germany, it is VDE 0126-1 "Automatic Disconnection Device Between The Generator and The Public Low Voltage Grid." In Italy, compliance to the Enel (Italy's largest power company) standard, DK 5940 "Criteria for plant connections to the grid" (translation) is required. The change provides clarification for the Document DK5940. Although similar in intent, each of these standards will have different limits of voltage and frequency variation under which the inverter must disconnect from the grid.

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