Future developments in International Standards for electrical installations

LVDC Distribution and energy efficiency.

By Geoff Cronshaw

The IEE Wiring Regulations (BS 7671:2008) are based on European Standards, which in turn are usually based on international standards.

The UK participates in both European and international standards work. Two new areas of possible development within international standards are requirements for Low Voltage DC distribution and to integrate requirements for energy efficiency into IEC 60364.

The rationale for LVDC distribution

More and more electronic equipment is being introduced in buildings which use dc. There is also a wide range of micro generation technologies – including solar photovoltaic (PV) and wind turbines – being installed which generate dc. One of the main reasons for the proposal to introduce LVDC distribution in a building is to improve energy efficiency by reducing losses in the conversion of ac to dc for electronic loads and conversion of the dc output from micro generation to ac for mains distribution.

The challenges

There are a number of challenges when designing a LVDC installation. Persons involved in dc installations need to have the necessary expertise. Electrical equipment used on a dc installation must be suitable for direct voltage and direct current.

More and more homes are expected to be using micro-generation technology that generates dc in the future

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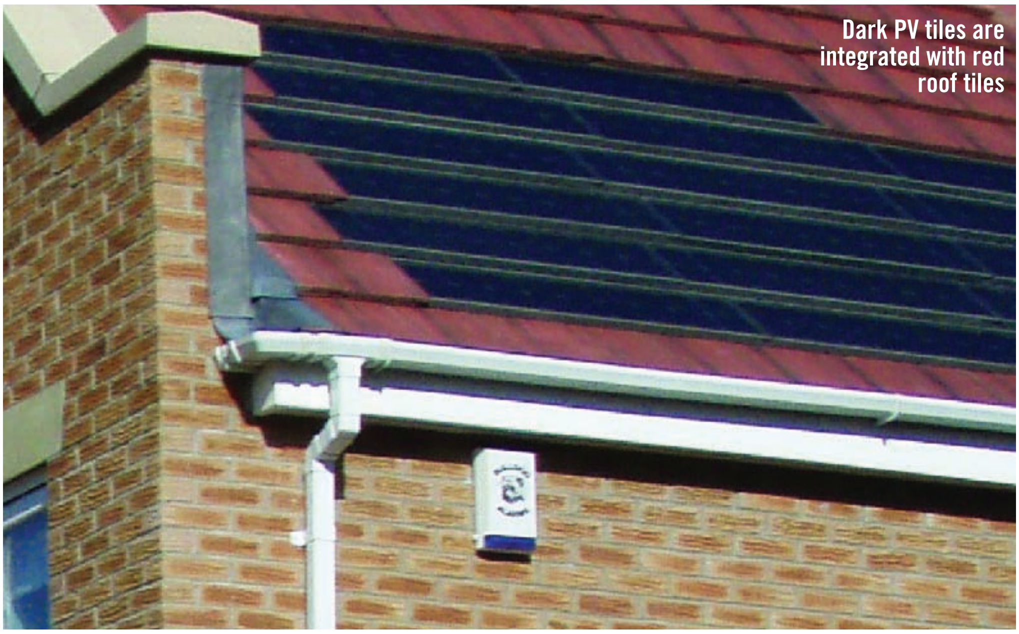


Dark PV tiles are integrated with red roof tiles

Equipment approved to normal ac standards may not be suitable, especially switchgear. For example, the use of plugs and socket outlets for use on dc need careful selection depending on the current rating.

Given the nature of dc, additional requirements need to be taken into account when disconnecting a dc load by withdrawing a plug from a socket outlet. This is because an arc can occur when disconnecting a load, which is more difficult to extinguish compared with an ac load because there is no natural zero point on dc compared to ac. It is understood that one possibility being considered is to use a switched socket outlet with a plug that is interlocked with the socket outlet. The plug and socket outlet is then designed in such a way that the plug cannot be withdrawn from the socket outlet while the plug contacts carry current.

Arc quenching

Circuit breakers for overcurrent protection is another area that needs special consideration. The arc produced when disconnecting a fault on a dc installation is more difficult to extinguish. Designers of dc installations will need to liaise with manufacturers of equipment and exercise careful consideration when selecting a circuit breaker for use on dc to ensure that the circuit breaker has suitable arc-quenching capabilities and are suitable for the operating voltage.

Cables for use on dc again need special consideration. A cable is given a voltage rating which indicates the maximum circuit voltage for which it is designed, not necessarily the voltage at which it will be used. For example, a cable designated 600/1000V is suitable for a circuit operating at 600Vac phase to earth and 1000Vac phase to phase. This cable is traditionally used in areas where mechanical strength is required such as industrial installations. For light industrial circuits operating at 230/400Vac it would be normal to use cables at 450/750Vac, and for domestic circuits operating at 230/400Vac, cable rated at 300/500Vac would often be used. The traditional rating of the cable 300/500V is the ac rating of the cable. The dc rating of this cable for core to earth is 300×1.5 (450V dc max) and the core to core voltage is 500×1.5 (750V dc max). Therefore, designers of dc installations need to give careful consideration when selecting a cable for use on dc to ensure it is suitable for the operating voltage and are recommended to seek advice from the manufacturer.

Renewable sources of electricity

There are a wide range of microgeneration technologies including: solar photovoltaic (PV), wind turbines, small scale hydro and micro CHP (Combined heat and power). For example, in the UK, the 17th edition of the IEE Wiring Regulations (BS 7671:2008) introduced many new requirements to ensure the safe connection of low-voltage generating sets including small

Inverter unit installation

Roof mounted PV installation

scale embedded generators and solar photovoltaic (PV) power supply systems.

Section 712 of BS 7671:2008 is concerned with the safe installation of solar photovoltaic (PV) power-supply systems. The section does not apply to PV power supply systems which are intended for stand-alone operation. Section 712 contains requirements for protective measures comprising automatic disconnection of supply, double or reinforced insulation, or extra-low voltage provided by SELV or PELV. Also Protection against overcurrent and electromagnetic interference is catered for. Detailed requirements for the selection and erection of equipment are included covering compliance with standards, operational conditions, external influences, and accessibility. As you would expect, wiring systems, isolation, switching and control, earthing arrangements and labelling are also covered.

In addition, solar photovoltaic (PV) power supply systems are required to meet the (ESQCR) Electricity Safety, Quality and Continuity Regulations 2002 (as amended) as they are embedded generators. These are mandatory requirements. However, where the output does not exceed 16 A per line they are small scale embedded generators (SSEG) and are exempted from certain of the requirements provided that: (i) the equipment should be type tested and approved by a recognised body, (ii) the consumer's installation should comply with the requirements of BS 7671, (iii) the equipment

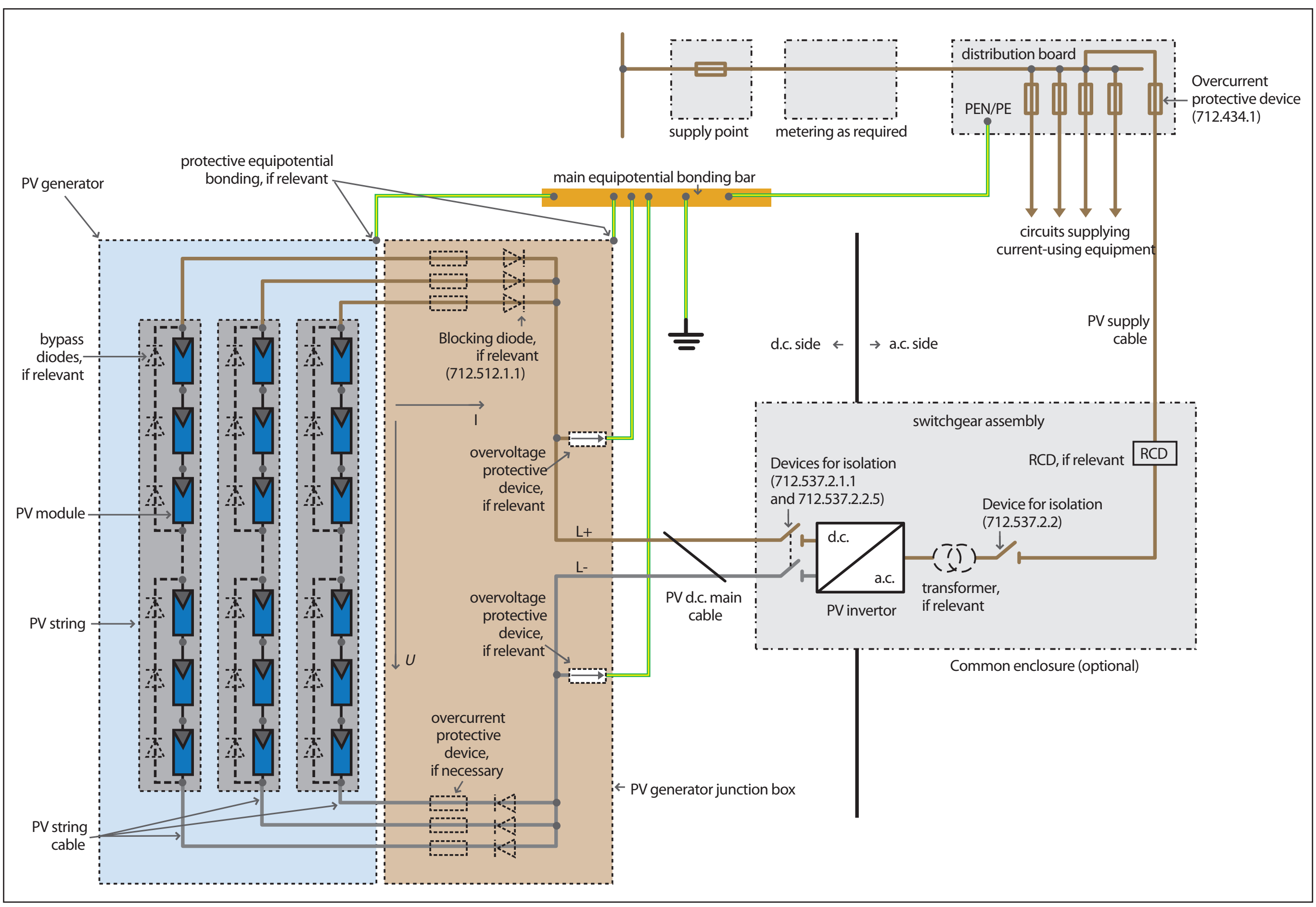


Diagram of a PV Generator, showing the inverter unit converting DC to AC. From IEE Wiring Regulations (BS 7671 2008) must disconnect itself from the distributor's network in the event of a network fault, and (iv) the distributor must be advised of the installation before or at the time of commissioning.

Diagram of PV generator

As can be seen from the diagram taken from the IEE Wiring Regulations (BS 7671:2008), a PV system is a collection of PV cells known as a PV string, which form a PV array and in turn forms the PV generator that turn sunlight directly into electrical energy. The diagram shows the dc output from one array to the PV inverter which converts the dc output of the PV cells to ac for mains distribution. As mentioned previously, one of the main reasons for the proposal to introduce LVDC distribution in a building is to improve energy efficiency by reducing losses in the conversion of the dc output from micro generation to ac for mains distribution.

Low-voltage electrical installations and electrical energy efficiency

Background

It is hoped that the proposal to integrate energy efficency requirements into IEC 60364 will help accelerate the deployment of suitable energy-saving technology, and therefore help to reduce $C0_2$ emissions.

Electrical energy efficiency

IEC 60364 is an international safety standard for electrical installations, therefore any proposals regarding energy efficiency must not jeopardise safety.

It is expected that any proposals to integrate requirements for energy efficiency in IEC 60364 will cover all kinds of electrical installations (residential, small, Medium and large buildings and industrial sites).

Basic concepts

Electrical energy efficiency is intended to obtain the highest possible service from an electrical installation from the lowest energy consumption. In order to make improvements we need to be able to measure the amount of electrical energy consumed and monitor and control energy effectively.

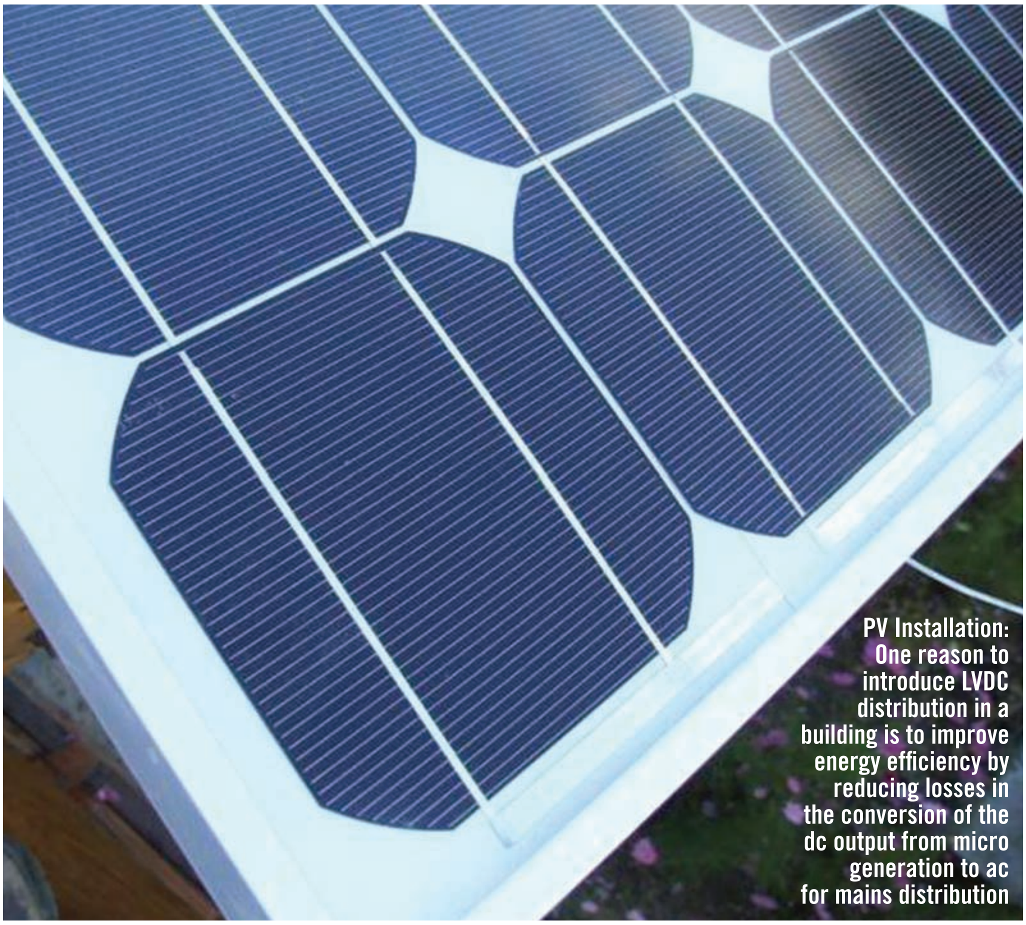
For example in the UK the department of energy and climate change are planning to start a roll-out programme to introduce smart electricity meters into consumers' homes starting in 2012, which is expected to run through until 2020 with the aim of helping customers to reduce their energy bills.

The smart meter will give customers information on energy consumed via a visual display and be capable of sending metering information to the energy supplier regarding the electricity consumed by the customer without the need for a meter reader. This should put an end to estimated bills. It will also allow the consumer to sell energy back to the energy

Lighting control sensors provding occupancy and light level detection supplier where the customer has a microgenerator installed such as a wind turbine or solar panels.

A smart meter is an electricity energy meter that incorporates a communications unit. The meter will measure the energy consumed and also measure any energy exported to the electricity network (where the consumer has micogeneration, such as a wind turbine or solar panels). The big difference is that the smart meter does not require a meter reader to visit the premises to read the meter.

It is understood that smart meters could use a number of communication options such as wireless, or data wire, or power line transmission (PLT), or mobile phone technology to transmit the meter-reading data to the energy supplier. It is not clear at this stage which option will be used. A smart meter may also be capable of controlling the consumers' load in the future by sending signals to consumer appliances to switch off at peak times, etc. It is also expected that the smart meter will be capable of providing flexible tariffs. It is expected that energy suppliers will be responsible for the installation of the smart meters.



PV Installation: One reason to introduce LVDC distribution in a building is to improve energy efficiency by reducing losses in the conversion of the dc output from micro generation to ac for mains distribution

Development of concepts

In the UK, BEAMA have identified technologies that can contribute to the UK carbon reduction targets. For example, lighting controls for residential buildings, lighting controls for commercial, public and industrial buildings, power factor correction, heating control upgrades in existing housing, pump and fan control with variable speed drives etc.

Lighting controls for residential buildings are easy-to-install devices which are able to detect the presence of people and only switch on lights when required.

Lighting controls eliminate wasted energy and save energy simply by switching lights off when not required. Lighting controls for commercial, public and industrial buildings are again easy-to-install devices that are able to automatically switch off lights when no occupants are detected or there are suitable levels of natural light.

Power-factor correction technology is used mainly on commercial and industrial installations to restore the power factor to as close to unity as is economically viable. Low power factors are caused by reactive power demand of inductive loads such as induction motors and fluorescent lights.

A poor power factor reduces the effective capacity of the electrical supply, since the more reactive power that is carried the less useful power can be carried, also causes losses at transformers, and can cause excessive voltage drops in the supply network and may reduce the life expectancy of electrical equipment.
For this reason electricity tariffs encourage the user to maintain a high power factor (nearly unity) in their electrical installation
by penalising a low power factor.

There are a number of ways in which power factor correction can be provided. The most common way that this can be achieved is by the installation of power factor correction capacitors. These can be installed in bulk at the supply position or at the point of usage on motors for example.

Persons involved in this type of work are recommended to seek advice from specialists on the most economic system for a given installation.

Note

It is important to point out that this article is only intended as a brief overview of issues that are being considered at a very early stage and therefore may not become international standards.