Lightning and surge protection for PV systems on solar plants

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In recent years, photovoltaic (PV) systems have become a significant sector within the energy market, with the International Energy Agency in 2011 saying that: 'The development of affordable, inexhaustible and clean solar energy technologies will have huge longer-term benefits.

'It will increase countries’ energy security through reliance on an indigenous, inexhaustible and mostly import-independent resource, enhance sustainability, reduce pollution, lower the costs of mitigating climate change and keep fossil fuel prices lower than otherwise. These advantages are global'.

Given that these costly plants are frequently subject to climatic influence, measures to protect the sensitive electronic system components from failure due to lightning flashes and surges are essential.

Lightning surges in the PV system can damage PV modules and inverters, leading to both high repair costs and considerable profit cuts for the operator of the plant related to system failure.

For a complex PV installation, such as a solar power plant, the aim is to protect both the operation building and the PV array against damage by fire (direct lightning strike) and the electrical and electronic systems (inverter, remote diagnostics system, generator main line) against the effects of lightning electromagnetic impulses (LEMP).

Air-termination system and down conductor system

For the protection of the PV array against direct lightning strikes, it is necessary to arrange the solar modules in the protection zone of an isolated air-termination system. According to the class of lightning protection system, the height and the quality of the air-termination rods required is determined by means of the rolling sphere method. Furthermore, it has to be ensured that the separation distance is kept between the PV supporting frames and the air-termination rods. Also, the operation building must be equipped with external lightning protection. Down conductors must be connected with the earth-termination system by using terminal lugs. Due to the corrosion risk at the point where the terminal lugs come out of the soil or concrete, they have to be made out of corrosion-resistant material or be protected by corresponding measures (applying sealing tape or heat-shrinkable sleeve, for example).

Earth-termination system

The earth-termination system of the PV system is designed as a ring earth electrode (surface earth electrode); whilst the earth-termination system of the operation building should be designed as a foundation earth electrode. The metal supporting frames, onto which the PV modules are fixed, must be connected to the earth-termination system.
The interconnection of the individual earth-termination systems reduces considerably the total earthing resistance; whilst the intermeshing of the earth-termination system creates an equipotential surface that considerably reduces the voltage load of lightning effects on the electric connecting cables between the PV array and operation building.

Lightning equipotential bonding

In principle, all conductive systems entering the operation building from outside have to be generally included into the lightning equipotential bonding.

The requirements of lightning equipotential bonding are fulfilled by the direct connection of all metal systems and by the indirect connection of all live systems via lightning current arresters. Lightning equipotential bonding should be performed preferably near the entrance of the structure in order to prevent partial lightning currents from penetrating the building.

Surge protection measures in the PV array

In order to reduce the load on the isolation inside the solar modules at a lightning strike into the isolated air-termination system, thermally monitored surge protective devices are installed in a generator junction box as loosely as possible to the PV generator.

On the dc side, a surge protective device is installed in each generator junction box. The surge protective devices in the generator junction boxes assume the protection for the PV modules locally and ensure that no spark overs caused by conducted or field-related interferences come up at the PV modules.

Surge protection measures for IT systems

The operation building provides a remote diagnostics system, which is used for the quick and easy function check of the PV systems, permitting the operator to recognise and remedy any malfunctions at an early stage.

The remote supervisory control system provides the performance data of the PV generator constantly in order to optimise the output of the PV system. Measurements of wind velocity, module temperature and ambient temperature are performed via external sensors at the PV system and can be read directly from the acquisition unit. The data acquisition unit provides an Ethernet interface, which a PC or modems are connected to for remote enquiry and maintenance. Thus, the service engineers can determine the cause of a malfunction by tele-diagnosis and then directly eliminate it.

Conclusion

In order to provide a reliable trouble-free and continuous transmission of the measured data to the measuring unit, it is necessary to lead the sensor cables entering the building via surge protective devices. When choosing the protective devices, it has to be ensured that the measurements cannot be impaired.

Safety in the forwarding of the measured data via the telecommunication network per ISDN modem must be given as well in order to provide a continuous monitoring and optimisation of the performance of the installation.

About the author

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