



Surge protection for solar inverters from Danfoss

Location and selection of surge protection devices (SPDs)

Purpose

This note is written in response to questions about lightning protection of solar inverters from Danfoss.

Protection level is established by a risk assessment of the solar power plant. Options in the resultant type, number and location of protection devices required, give rise to the questions addressed by the note.

Installation of surge protection against lightning is not a Danfoss requirement, but simply a matter of preference.

Danfoss retains the right to change the information at any time.

Danfoss provides no guarantee of its accuracy and accepts no liability for losses or injury, resulting from the inaccuracy or incorrectness of the information provided.

Scope

The term 'surge protection' encompasses protection against lightning and overvoltage events. Protection devices used against lightning or overvoltage act to reduce the risk of equipment damage and personal injury respectively.

This note explains

- protection built into inverters from Danfoss
- where to install surge protection devices (SPDs) for lightning protection of solar inverters from Danfoss.
- how to choose the type and quantity of SPDs required
- help available from SPD manufacturers

System requirements and the corresponding standards are discussed.

Contents: Protection classes
 Types of surge protection device (SPD)
 How to select an SPD
 Earthing systems
 Manufacturers
 References

Danfoss Solar Inverters A/S

Ulsnaes 1
DK-6300 Graasten
Denmark
Tel: +45 7488 1300
Fax: +45 7488 1301
E-mail: solar-inverters@danfoss.com
www.danfoss.com/solar



Protection classes

It is important to distinguish between the lightning protection class and the overvoltage protection categories used for planning clearances in the equipment itself.

Lightning protection

Provision of lightning protection is the responsibility of the plant designer and operator.

- Lightning protection for solar inverters must comply with the overall solar power plant design requirements.
- Consider also the lightning risk assessment issues laid out in the standard IEC 62305.
- Lightning protection classification is defined in the standards IEC 61643-1 for power and IEC 61643-21 for telecommunications systems.

Overvoltage protection

Overvoltage protection is a built-in function of the inverter. No further protection against overvoltage is required.

- Overvoltage protection classification falls into the categories OVC I, II, III, and IV as specified in the standard EN 50178 §5.2.16.
- Overvoltage protection of the Danfoss inverters comprises OVC III protection on the AC side and OVC II protection on the DC side.

Types of surge protection device (SPD)

SPD type	Purpose	Test standard
Type 1	Designed to run-off energy caused by an overvoltage event comparable to a direct lightning strike	I _{10/350} wave standard (according to IEC 62304-4) for class I test
Type 2	Designed to run-off energy caused by an overvoltage event comparable to an indirect lightning strike or an operating overvoltage	I _{8/20} wave standard (according to IEC 62304-4) for class II test
Type 3*		I _{CWG} wave standard (according to IEC 62304-4) for class III test

*Type 3 SPD is normally not relevant for inverter lightning protection. However it can be used to provide additional protection.

Danfoss Solar Inverters A/S

Ulsnaes 1
 DK-6300 Graasten
 Denmark
 Tel: +45 7488 1300
 Fax: +45 7488 1301
 E-mail: solar-inverters@danfoss.com
www.danfoss.com/solar



How to select an SPD

The type and quantity of SPDs required depend on system characteristics and location.

System characteristics

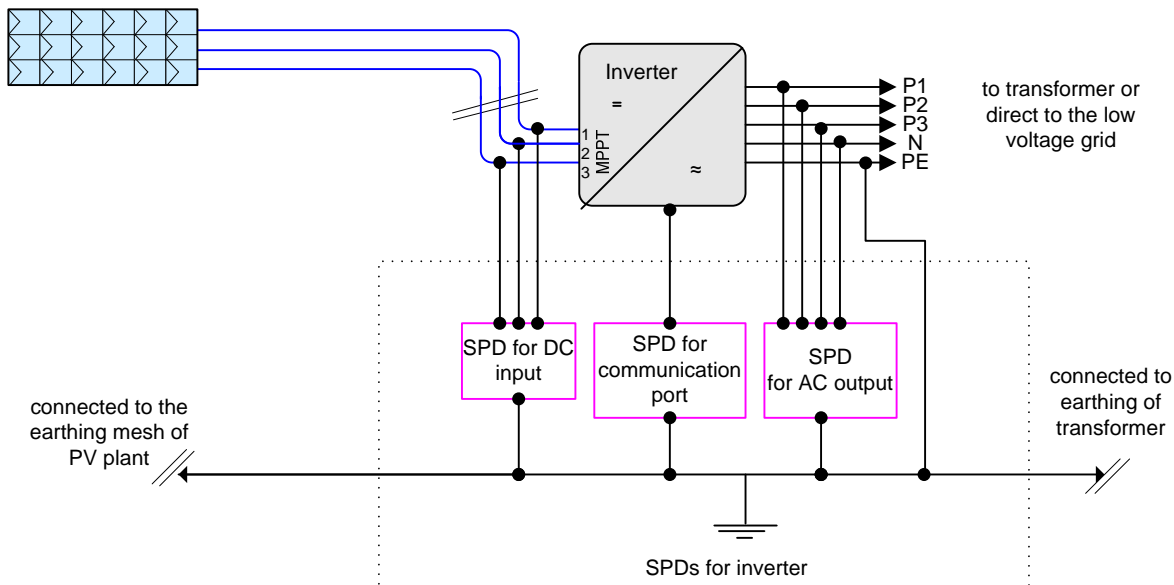
These criteria are used to specify a suitable device:

- Protection level (U_p)
- Maximum discharge capability: I_{imp} or I_{max} (10/350 or 8/20 impulse wave)
- Type of system to be protected, for example AC system, DC system, or communication system
- Network earthing system, for AC side (that is, TT, IT or TN)
- Operating voltages (U_c , U_T)
- Optional functions of the SPD, for example end of life indicator
- The short-circuit current (I_p) of a power supply in the installation

Location

The following solar plant layout diagram shows the locations where SPD are required:

- SPD for DC input
- SPD for AC output
- SPD for communication port



Danfoss Solar Inverters A/S

Ulsnaes 1
 DK-6300 Graasten
 Denmark
 Tel: +45 7488 1300
 Fax: +45 7488 1301
 E-mail: solar-inverters@danfoss.com
 www.danfoss.com/solar



Type 1 or type 2 SPD?

For a solar power plant where a general lightning protection system is installed

- Use type 1 SPDs if the separation distance between lightning rod and inverter is below the value of the separation distance, 's'. The value of 's' for different applications is defined in IEC 62305-3.
- Use type 2 SPDs if the separation distance between lightning rod and inverter is greater than the value 's'. Refer to IEC 62305-3 for the value of 's'.

Number and location of SPDs

SPDs for DC input

SPDs are required when the cable length between the PV panel and the inverter is greater than 10 m.

The number of SPDs required depends upon how the inputs are connected.

- When the spacing between inverters is less than 10m, then inputs connected in parallel can share one SPD unit
- Inputs not connected in parallel always require one SPD per input

SPDs for AC output

No additional SPD is required when

- the inverters are connected to a transformer with proper SPD, and
- the distance between inverter and transformer is less than 10m

In all other cases, install an SPD for AC output.

The SPD can be shared for each phase and neutral when

- the AC outputs of a series of inverters are connected in parallel, and
- the other critical parameters comply with requirements. For example, the distance between inverters sharing an SPD is less than 10m.

When the inverter-transformer distance is greater than 10m, refer to the SPD manufacturer to assess the number of SPDs required.

SPDs for communication port

Install an SPD for the data communication system on at least one inverter in the array.

Select a location in the middle of the inverter array. Then each SPD protects as many inverters as possible within its operating radius of 10m.

Danfoss Solar Inverters A/S

Ulsnaes 1
 DK-6300 Graasten
 Denmark
 Tel: +45 7488 1300
 Fax: +45 7488 1301
 E-mail: solar-inverters@danfoss.com
www.danfoss.com/solar



Earthing systems

Like other SPDs employed in the solar power plant system, the SPDs for inverters can only function with a suitable earthing system and equipotential bonding system. Please refer to IEC 62305 for suitable earthing systems.

Manufacturers

Consult the manufacturer to find the optimal type and number of SPDs for the specific protection application. The criteria are power plant layout, protection level, quality level, and price.

Some suitable manufacturers in alphabetical order:

ABB
CITEL
CUALE
DEHN
FERRAZ SHAWMUT
FUSHAN FATECH
FUSHAN PROSURGE
LEUTRON
OBO BETTERMANN
PHONIX CONTACTS

References

EN 50178 §5.2.16
Electronic equipment for use in power installations

IEC 61643-1
Low-voltage surge protective devices
Part 1: Surge protective devices connected to low-voltage power distribution systems – Requirements and tests

IEC 61643
Low voltage surge protective devices
Part 21: Surge protective devices connected to telecommunications and signalling networks – Performance requirements and testing methods

IEC 62305
Protection against lightning

Danfoss Solar Inverters A/S

Ulsnaes 1
DK-6300 Graasten
Denmark
Tel: +45 7488 1300
Fax: +45 7488 1301
E-mail: solar-inverters@danfoss.com
www.danfoss.com/solar