Lightning Protection for Solar Systems according to new Regulations

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1. Topic

Often enough, large PV systems are mounted on roofs, with an already existing lightning protection system. Many solar technicians/electricians do not know that in this case, certain rules must be respected; others only have partial knowledge concerning this topic. Free roof space for example, cannot be allocated randomly. The present example will illustrate some crucial points concerning the subject-matter.

2. Implementation

2.1. Roof structure

2.1.1. The Task

After a planning phase during the summer of 2009, the TEC institute began installing a PV system on a flat roof, visible on picture 1. The aim was to utilize the available roof space (around 1243 m^2) in an optimal way, i.e. to install as many modules as possible. Thereby, a few things had to be taken into consideration.

Fig. 1: Available space on the flat roof (marked by white line)

2.1.2. The roof

The present example concerns a flat roof with roof lights and an existing lightning protection system. Due to this installation, the new PV system needs to be integrated into the protection system according to the effective lightning protection

regulations. Picture 2 shows a section of the roof with roof lights and parts of the lightning protection equipment.

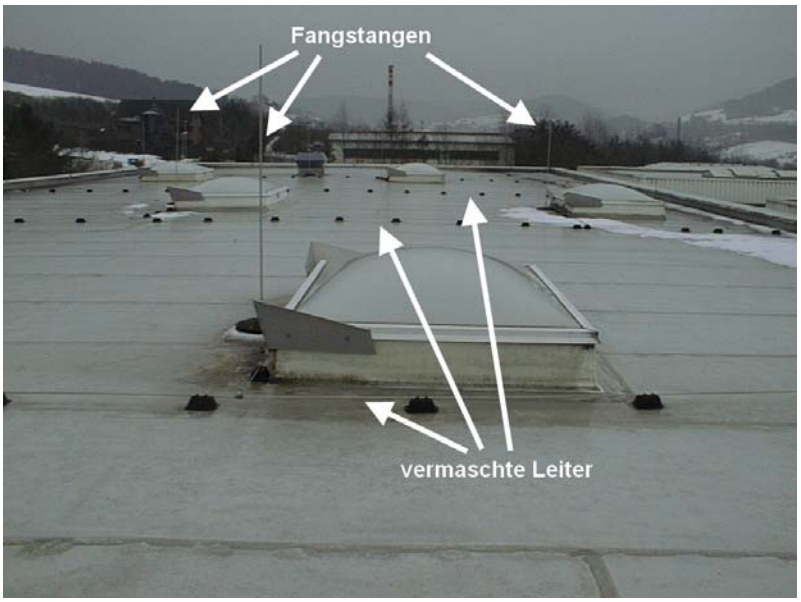


Fig. 2: roof lights, air termination rods, air-termination system (meshed conductors)

2.1.3. Module support-frame

To begin with, the static weight limit of the flat roof (lightweight construction) was examined. In this case, a maximum static weight of 7 kg/ m^2 (as mean value for the whole roof) must not be exceeded. Accordingly, we chose a low ballast mounting system for flat roofs, which was easy to install.

2.1.4. Modules used

When choosing from the modules in question, we decided in favour of those, which had succeeded in our testing series during the past two years. In this case, the monocrystalline module-type ANTARIS ASM 175.

The modules were installed with a 20° angle and - due to the orientation of the building – mounted with an azimuth angle of +28° (southwest).

Fig. 3: Low ballast flat roof mounting system during installation.

2.2 Lightning Protection

2.2.1 Laying of DC wiring

Metal cable troughs were laid for the DC-wiring as well as for the equipotential bonding wires. These run centric on the roof, and from there lead to the inverters, visible on picture 4.

Fig. 4: Wiring inside the module frame and the cable trough.

2.2.2 Lightning protection equipment

As the PV system had to be integrated into the existing lightning protection equipment, a calculated separation distance of 1m had to be maintained from the parapet as well as the roof lights with their metal frame and the air-termination system (meshed conductors).

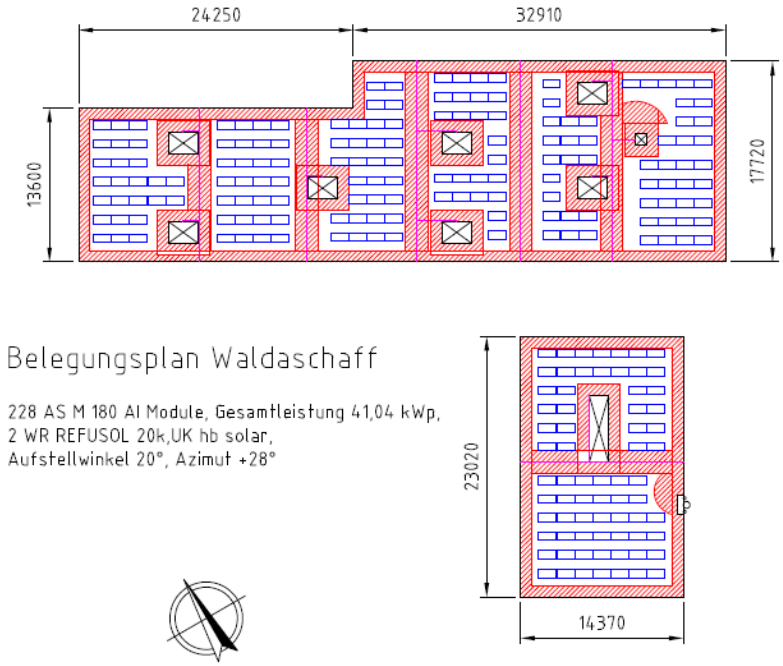


Fig. 5: Module array with the calculated, mandatory separation distance of 1 m.

In picture 5, areas which are marked in red represent the required separation distances to the lightning protection equipment. Due to this mandatory distance, the number of modules which had originally been planned had to be reduced drastically (total output ca. 40 kWp). Picture 6 shows the number of modules which could have been installed without keeping the required distance (considering the shading by the roof lights and the ventilation shaft).

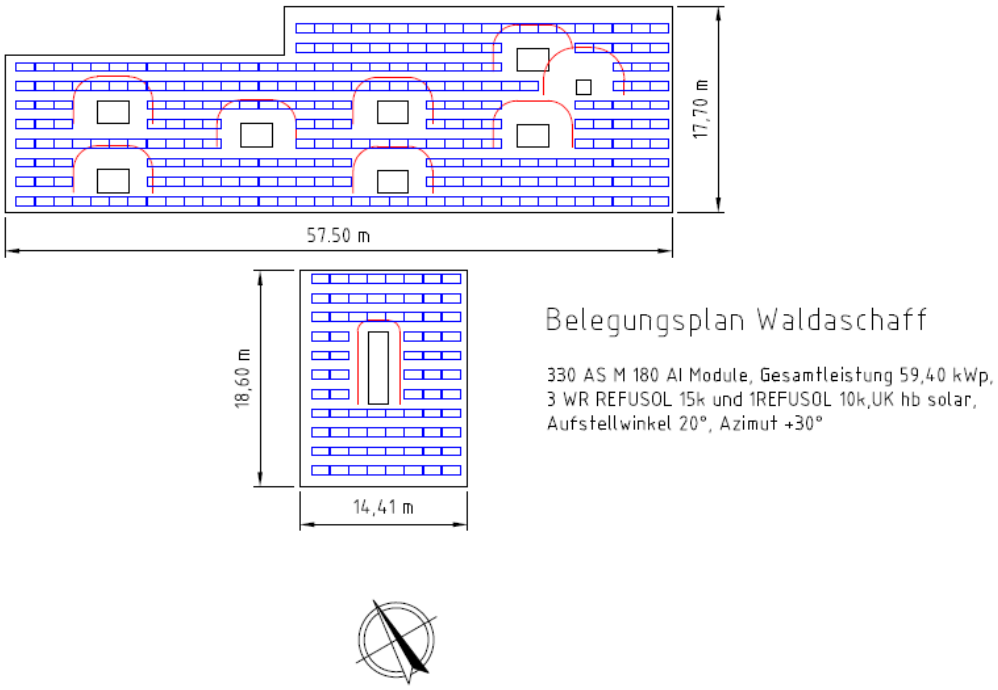


Fig. 6: Module array, disregarding the required distance of 1m (total output ca. 60 kWp)

In one special case, complete removal of one mesh from the lightning protection system, while adhering to the maximum mesh width of 15m (protection class III) allowed us to increase the number of modules slightly.

2.2.3 Bridging with elevated cable troughs

In places where the cable trough intersected with the parapet, the parapet was crossed via a special mount.
In places where the cable trough intersected with the metallically conducting parapet, the same distance had to be kept. By elevating the cable trough with a mount, the parapets could be crossed, while the required distance of 1m was adhered to. An alternative to bridging the parapet in this way, would be to remove 2m of metal from the parapet and replace it with synthetic material.

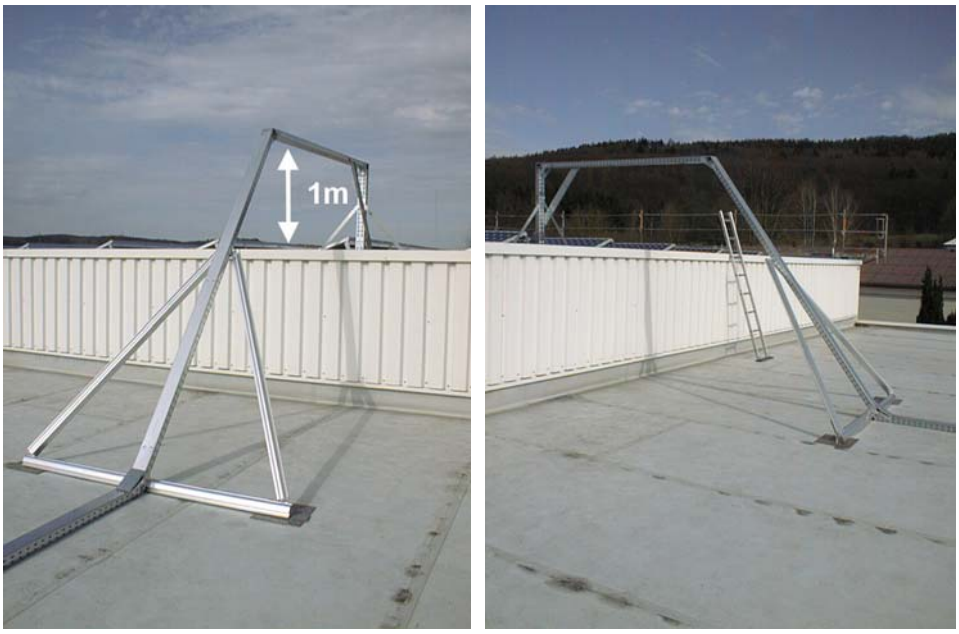
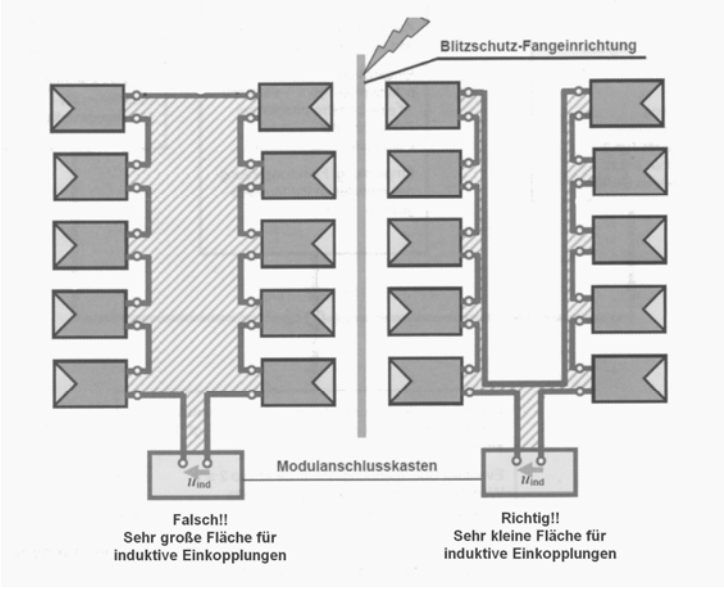


Fig. 7a, 7b: Bridging of the parapet while keeping the required distance.

2.2.4 Decrease of inductive effect

Decrease of an inductive effect from direct and nearby lightning strikes is achieved by a non-planar wire arrangement of the strings.

The magnetic effect is decreased by means of shielding with a metal cable trough or a cable duct.



incorrect **correct**

Fig. 8: Inductive coupling, DIN and VDE (2009), S. 16

2.2.5 Further information on the required separation distance

In order to keep the mandatory separation distance between the PV system and a meshed conductor, a horizontal crossover was built from air-termination rods at the height of 1m above the down conductors and the cable troughs.

If the down conductor was lying on the roof, the mandatory distance to the PV system could not be maintained. As a consequence, the arrester rods throw a very slim shadow on certain modules, depending on the position of the sun. This results in a power loss - albeit a very small one - for the modules in question. In this case, it seems to make sense to wire up the modules in a separate string.

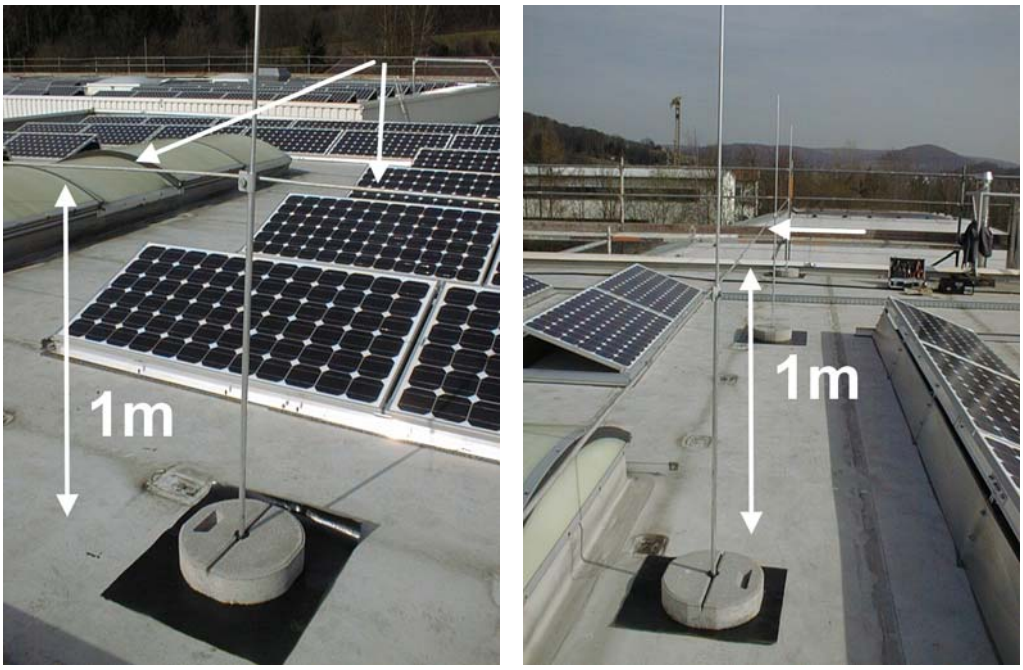


Fig. 9, 9a: Elevating a meshed conductor belonging to the air-termination system 1m above the roof

Apart from that, sufficient air-termination rods have to be installed considering the protective angle, see also fig. 9a and 9b.
Here, it should be noted, that the air-termination rods in picture 9a and 9b have two functions.

a) compliance with the separation distance (elevation of the lightning conductor to 1m)
b) implementation of the protective angle

2.2.6 Inverter

The inverters were mounted under a porch at the north side of the building. On the left side, there is a sub distribution to feed back energy into the utility company's grid. The DC side is secured by an overvoltage protection (type 2), the AC side by type 1 and 2.

> Overvoltage caused by direct atmospheric discharge is limited by surge protectors (SPD) type 1, according to DIN EN 61643-11 (VDE 0675-6-11).
> Overvoltage caused by distant lightning strikes or switching operations are limited by surge protectors (SPD) type 2 and type 3, according to DIN EN 61643-11 (VDE 0675-6-11).
> Dehn und Söhne (2009), 5.2 Innerer Blitzschutz

Sub distribution, two inverters, suge protection

The PV system with the (rounded) nominal power of ca. 40 kWp was finished in March 2010, approved by the utility company E.ON Bavaria, and after that came on-line.

Fig. 11: completed PV system, nominal power 40kWp

2.2.7 Information sign according to DIN/VDE

A special concern on behalf of the fire department

"This information sign (in order to label PV systems) was decided on by the working team 221.1.4 of the *German Commission Electrotechnology, Electronic, Information Techniques at DIN and VDE*, which deals with the topic of PV systems.

Recommended to be placed on electric circuit junctions and/or switching or meter cabinets.

In Bavaria, this is already being realized with the friendly support of the Versicherungskammer Bayern and a utility company.”

3. Conclusion

The “net” roof space available cannot always be utilized completely, as was the case in the present situation. In order to protect the PV system - respectively the connected electronic equipment of a building - from inductive effects caused from lightning strikes, the mandatory separation distances between PV system and lightning protection installation need to be maintained.

Additionally, actuarial aspects should not be disregarded. Building and protective regulations, which are not adhered to, lead to benefit cut-backs, in the worst case the insurance will not pay for the lightning damage at all.

4. Sources

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5. Acknowledgements

I would like to thank Mr. Jürgen Hessler, of Architekturbüro Franz for his competent counsel. Mr. Markus Scholand, sworn appraiser and VDS-accredited expert for the appraisal of electronic installations according to clause 3602, as well as graduate engineer Jens Ehrler of Dehn & Söhne. Also, I would like to thank Eberhard Zentgraf of TEC Institute for his technical support and Julia Kunze.

Waldaschaff, 31/03/2010
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