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Client: Smartvolt AG, Herzogenbuchsee, Switzerland

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Wind loads on the "SmartSolarBox V5.0" solar ballasted roof mount system of Smartvolt AG

Design wind loads for uplift and sliding according to the European standard EN 1991-1-4

The present report consists of 4 pages.

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Smartvolt AG, Herzogenbuchsee, Switzerland, develop and manufacture mounting systems for photovoltaic panels. An analysis of wind tunnel data based on testing of generic solar ballasted roof mount systems was conducted to determine the design wind loads for the “SmartSolarBox V5.0” system. The analysis was performed by I.F.I. Institut für Industrieaerodynamik GmbH (Institute for Industrial Aerodynamics), Institute at the Aachen University of Applied Sciences in accordance with the test procedures described in the German Standards DIN EN 1991-1-4:2010-12, DIN EN 1991-1-4/NA:2010-12 and with the wind tunnel guideline of the German Wind Engineering Association, WtG as well as EN 1991-1-4:2005.

The modules of the “SmartSolarBox V5.0” solar ballasted roof mount system have tilt angles of 10° and are installed on a substructure in landscape orientation. The system consists of solar PV panels which are tilted east-west. The modules may have chord lengths between 1085 mm and up to 1140 mm. The array assembly along with the most important geometric dimensions is shown in Figure 1.

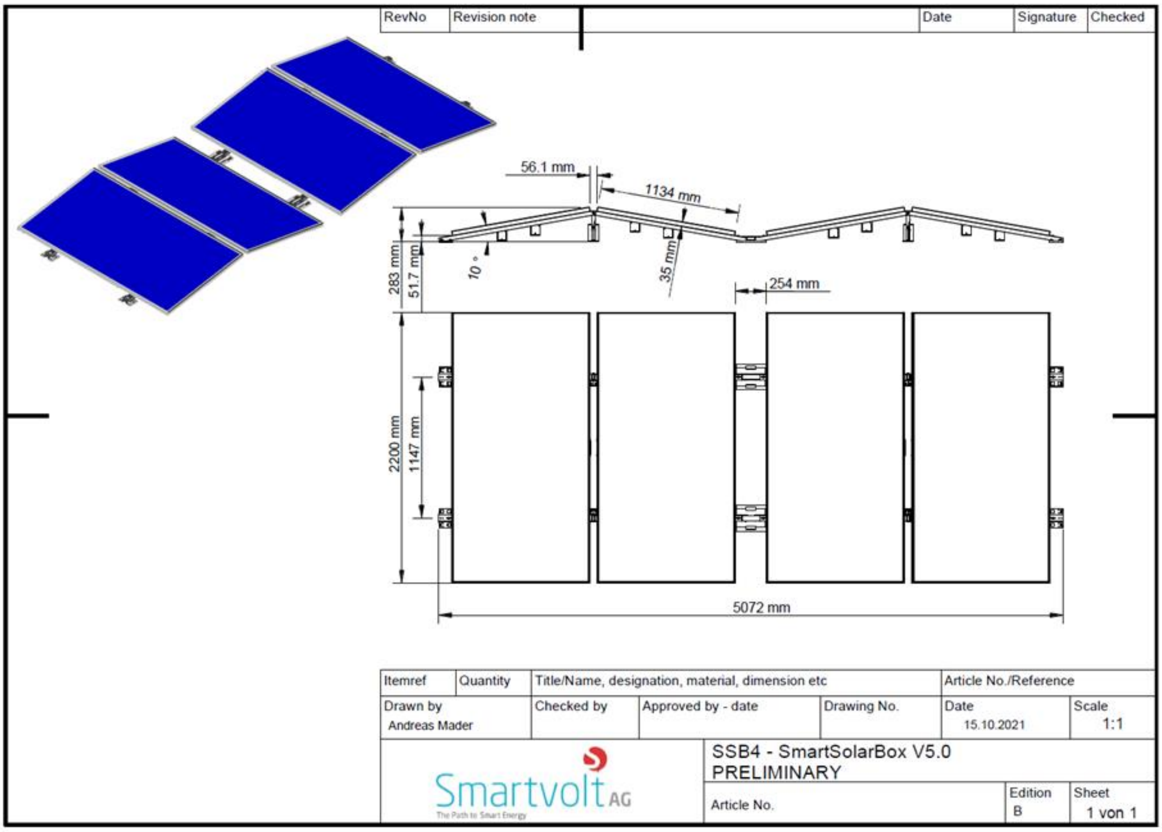

Figure 1: Geometric dimensions of the “SmartSolarBox V5.0” solar ballasted roof mount system of Smartvolt AG; module tilt angles of 10°; chord lengths of 1134 mm

The test results are likely to be appropriate for upwind terrain categories 0 through IV on flat-roofed buildings, assuming use in compliance with EN 1991-1-4:2005 and corresponding National Annexes. Pressure coefficients are given separately for different roof and array zones as well as for different wind sectors. These results are only to be used for arrays with setback from the roof edges of $a \geq 2 \cdot (h_s - h_p)$, where h_s is system height and h_p is parapet height. Smaller offsets require additional safeties to be incorporated into ballast calculation.

In order to determine the wind loads, the net pressure coefficients, c_p, have to be multiplied with the peak velocity pressure, q_p, at roof height z. The corresponding peak velocity pressure, q_p, at roof height z, is calculated by the National Annexes to EN 1991-1-4:2005. For calculation of q_p in Germany, see DIN EN 1991-1-4:2010-12 and DIN EN 1991-1-4/NA:2010-12.

Peak suctions and peak wind loads on solar panels located on flat roofs are usually not caused by winds normal to the building walls, but by vortices originating from the roof corners due to oblique winds, see also Figure 2. The pressure coefficients were determined for a set-up where wind direction 0° corresponded to wind blowing on the north façade of the flat-roofed building. However, the results may also be applied if the main axis of the array is skewed with the building edges. Moreover, the present design loads for wind actions apply without restriction to solar arrays deployed on buildings which are considered rigid. For rooftop obstructions, array interruptions, stepped (multi-level) roofs, L-shaped and other non-rectangular roofs, and for taller neighboring structures provisions for design pertaining to wind effects are given.

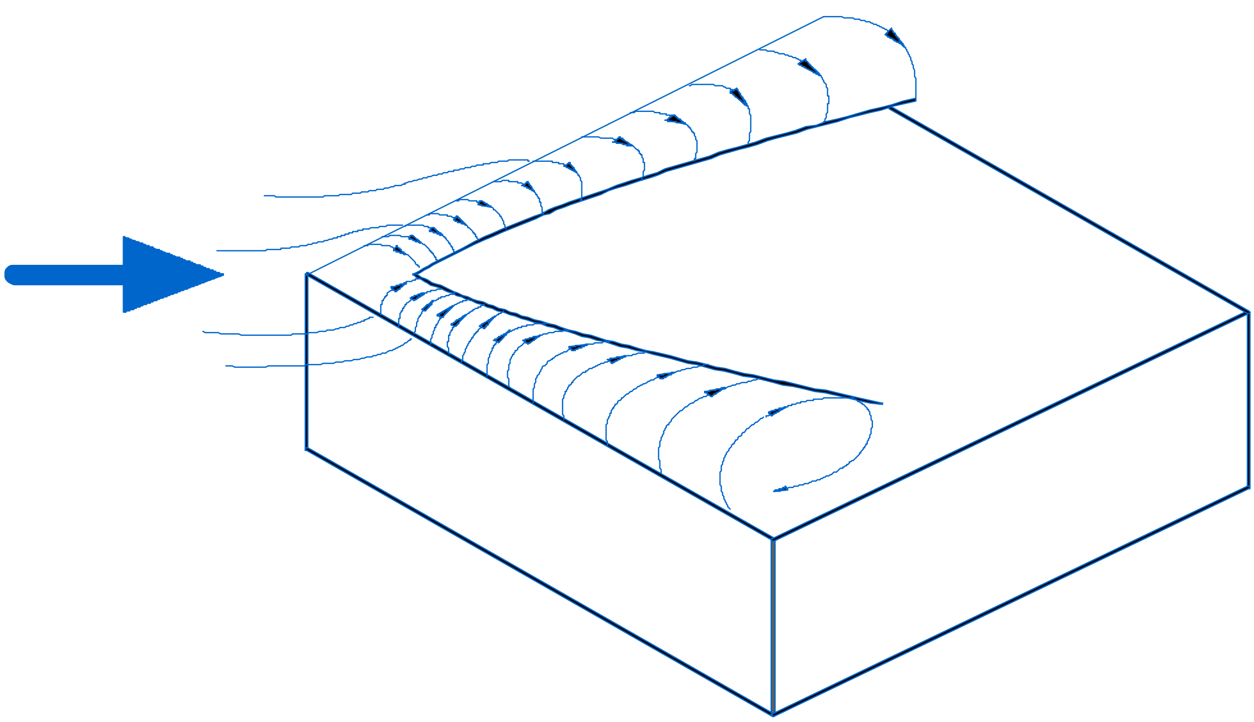

Figure 2: Vortices originating from the windward roof corner causing the peak suctions on flat roofs and on roof mount solar panels

The methodology of the wind tunnel testing and of the analysis is given in more detail in report SVH01-1. This methodology is based on state-of-the-art wind tunnel testing procedures outlined in novel codes such as ASCE 7-22, ASCE 49-21 and SEAOC-PV-2-2017 and has become a global standard in recent years. I.F.I. have significantly contributed to SEAOC-PV-2-2017 "Wind Design For Solar Arrays", the guideline of the Structural Engineering Association of California the contents of which have been widely adopted by ASCE 7-16, the previous version of the US building code, and are still found in the most recent version, ASCE 7-22. In addition, I.F.I. have published numerous scientific papers related to wind design for low-profile solar photovoltaic arrays on flat roofs. These publications are based on wind tunnel studies conducted on numerous different solar roof and ground mount systems, the results of which were applied over the past decade to solar projects in Europe, the U.S. and all over the world.

Recent publications issued by I.F.I. which are related to wind loading on solar arrays are among others

- "Peak net pressure coefficients on roof-parallel photovoltaic arrays mounted on a low-rise, 10° gable roof", International Conference on Wind Engineering (ICWE14), Porto Alegre, Brazil, 2015
- "Peak negative pressure coefficients on low-tilted solar arrays mounted on flat roofs: The effects of building size and model scale", European African Conference on Wind Engineering EACWE, Liège, Belgium, 2017
- "Peak wind loads on single-axis PV tracking systems", International Conference on Wind Engineering (ICWE15), Beijing, China, 2019
- "The effect of a wind deflector on the wind loads of a photovoltaic roof mount system", 8th European and African Conference on Wind Engineering (EACWE8), Bucharest, Romania, 2022