


# Grounding of photovoltaic modules

## Reliable grounding over mounting systems (Tests with prototypes)

Weitergabe und Vervielfältigung dieser Unterlage  
 Verwertung und Mittelung ihres Inhaltes nicht  
 gestattet, soweit nicht ausdrücklich zugestanden.  
 Zuwiderhandlungen verpflichten zu Schadenersatz.  
 Alle Rechte für den Fall der Patenterteilung oder  
 Gebrauchsmuster-Eintragung vorbehalten.  
 (Schutzvermerk DIN54 - 1 - 0)

© Schletter Solar Montagesysteme, 2005

					Datum	Name	
				Bearb.	01/05	Urban	
				Gepr.	01/05	Urban	
				Norm.			
Zust.	Änderung	Datum	Name				

# 1 Preliminary notes

The shock-hazard protection of electrical plants is especially important on roofs, because here primary damages by electric strokes are very dangerous since they can easily lead to heavy secondary damages (falling off the roof...). Potential equalisation for all metal parts of a plant is compulsory according to DIN VDE 0100, part 712.

Especially if you use inverters without transformer a capacitive charging to high voltages at the module cannot be excluded. For this reason the manufacturers of inverters without transformers specify that the module frames have to be grounded (example instruction manual SMA):



In diesem Zusammenhang achten Sie bitte unbedingt darauf, daß berührbare leitende Teile des PV-Generators (z.B. Metallrahmen, aluminiumhaltige Folien der Module, Tragkonstruktion etc.) geerdet sein müssen, damit im Betrieb auftretende Verschiebungsladungen abgeleitet werden können.

*Translation: „In this context please see that all touchable conductive parts of the photovoltaic generator (e.g. metal frames, foils of the modules containing aluminium, mounting frames...) have to be grounded, so that occurring shifting charges can be discharged.”*

When building a photovoltaic plant the compulsory grounding of the modules is often neglected in practice. The modules with their anodised frames are only clamped to the mounting rack. Our measurements shown in this report demonstrate that a reliable grounding is not reached with this method. With the new grounding middle clamps a reliable grounding can be proven according to our measurements.

## Hint:

In any case please also note further regulations for the lightning protection of photovoltaic plants!

## 2 Module grounding over the mounting system Measurements made with prototypes

### Test items

Test items 1 to 3:  
Module clamps with grounding inserts  
(prototypes) made of VA 1.4301

Test items 4 to 6:  
Standard module clamps



### Comparing measurement

To exclude measuring errors because of the testing conductors and the contact points, a short-circuit measurement was made over the grippers (picture) and also over the contacts to the module frame. The frame was blank at the contact points.

Result:  
Measurement over the grippers (picture):  
less than 0,1 Ohm

Measurement over the contact points at  
the frame:  
less than 0,1 Ohm



The low resistance measurements were made with a measure bridge conforming to all standards.

All resistance measurements outside of the measuring range of the measure bridge were made with a multimeter.

## Measurement with normal middle clamps

Result:

Test item 4:  
Transition resistance app. 2,1 M $\Omega$ !

Test item 5:  
Transition resistance app. 2,1 M $\Omega$ !

Test item 6:  
Transition resistance app. 2,1 M $\Omega$ !



## Summary:

**There is practically no conductive connection between module frame and mounting system. The high transition resistances are very accurately reproducible.**

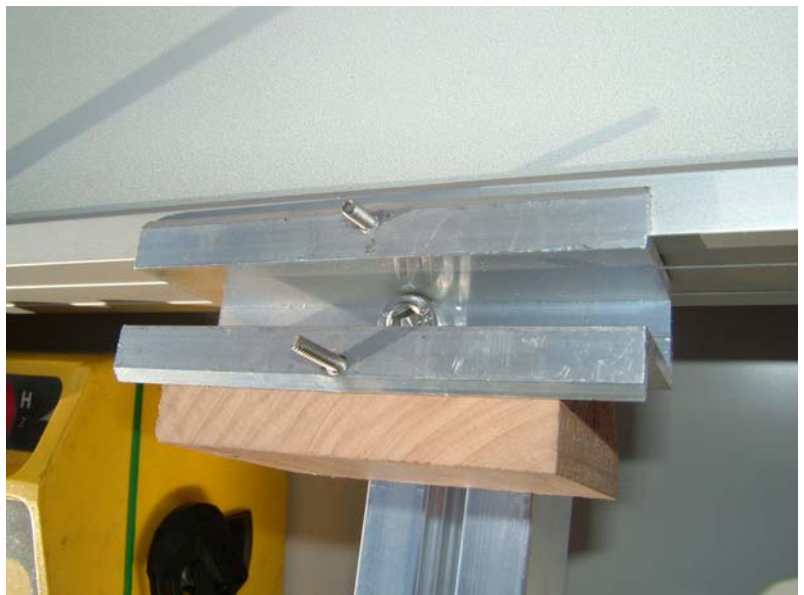
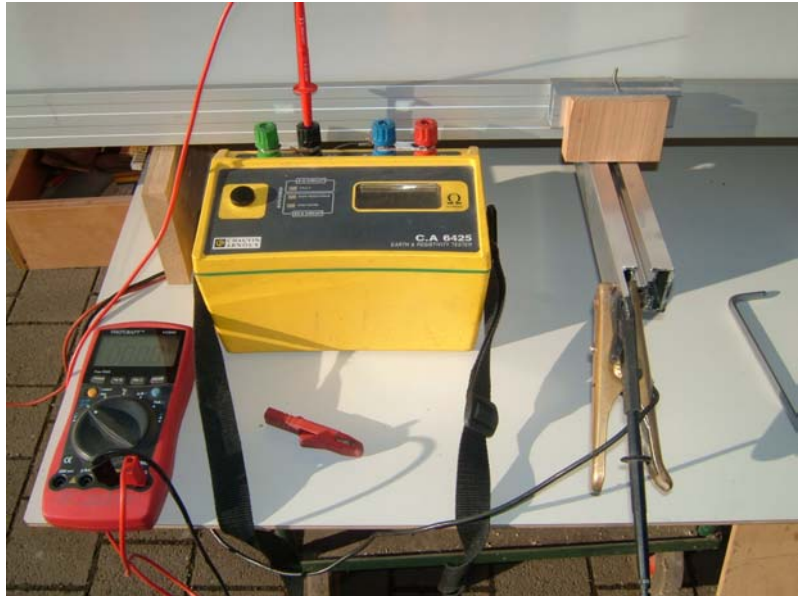
## Measurements with grounding middle clamps

Result:

Test item 1:  
Transition resistance less than 0,1  $\Omega$ !

Test item 2:  
Transition resistance less than 0,1  $\Omega$ !

Test item 3:  
Transition resistance less than 0,1  $\Omega$ !



## Summary:

**The grounding middle clamps create a very well reproducible connection between module frame and mounting system. With only one clamp a transition resistance below the accuracy of measurement of the measure bridge respectively measurement set-up. If the grounding middle clamps are used regularly each module is grounded over four, at the end of a row over two contacts. Like this a special grounding end clamp is not necessary.**

**Note: All transition resistances were measured from the module frame (blank) to the crossbeam.**

## Pictures:

After the test with three test items there were three identical indentations in the module frame.

The connection to the frame (where the inserts of the grounding clamp foraminates the anodised coating) was made at very low torques a lot under the recommended tightening torques for M8 screws.



### 3 Summary

- **The usage of grounding middle clamps is a reliable possibility of grounding anodised module frames over the mounting frame.**
- **The low transition resistance guarantees for shock-hazard protection at the module frame.**
- **The transition resistances without grounding middle clamps are very high; the module is practically isolated from the mounting frame.**
- **The high transition resistances do not provide for shock-hazard protection. Especially if you use an inverter without transformer grounding middle clamps or something similar have to be used or each module has to be grounded with a wire connection. Then the usage of suitable tools has to guarantee for the penetration of the anodised coating.**

### 4 Confirmation

The test has been made in proper form. The results are duly written down in the test report.

Haag, 20.01.05

Dipl.Ing. Johannes Urban

A handwritten signature in black ink, appearing to read "J. Urban".