Voltage on Module Frame

Technical Information Release

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Summary

It was brought to the attention of Meyer Burger that when a PV module is in use, connected to an inverter and generating AC power through the use of a transformerless inverter, voltage can be measured between the module frame and earth, if the system is isolated (panels and mounting system not earthed). This voltage is related to the capacitance that is inherent to all standard PV modules and results in a leakage current caused by the internal circuitry of the transformerless inverter. Common procedures are available to avoid the this leakage current, such as bonding the mounting system to the building earth. Additionally, the safety of an installation is ensured by using equipment that conforms to the standards such as IEC 62109 for PV inverters and IEC 61215 and 61730 for PV modules.

Testing and Confirmation:

To investigate the measured values, Meyer Burger tested five different inverters from five different manufacturers and connected three different module types, Meyer Burger White, Meyer Burger Glass and standard multiwire glass-backsheet module (without aluminum in the backsheet). All test configurations exhibited similar leakage voltages between the module frame and the earth connection. The leakage current varied, with the aluminum backsheet modules showing the highest values and glass-glass modules showing the lowest.

Question:
Why is there aluminum in the backsheet, anyway?

Answer:
The aluminum in the backsheet completely blocks the transmission of oxygen and moisture, while plastics do not. This allows Meyer Burger glass-backsheet modules to achieve some of the longest lifetimes in the PV module industry.

Source:

The voltage measured indicated the presense of what is known as “Leakage Current”. It ocurrs in transformerless inverters regardless of manufacturer. This leakage current is a transfer of energy from one circuit to another, in this case it is the AC wave form that leaks through the switching circuity of the inverter and ends up on the DC voltage of the cell strings. This voltage transfers across the capacitor which is built by the two closely spaced conductive sufaces that are the cell strings and the conductive layer formed by either a sheet of moisture or the aluminum in the backsheet. The amount of leakage current is directly dependant on the capacitance of the module, which is in turn determined by the amount of moisture surrounding the PV module as well as the makeup of the module.

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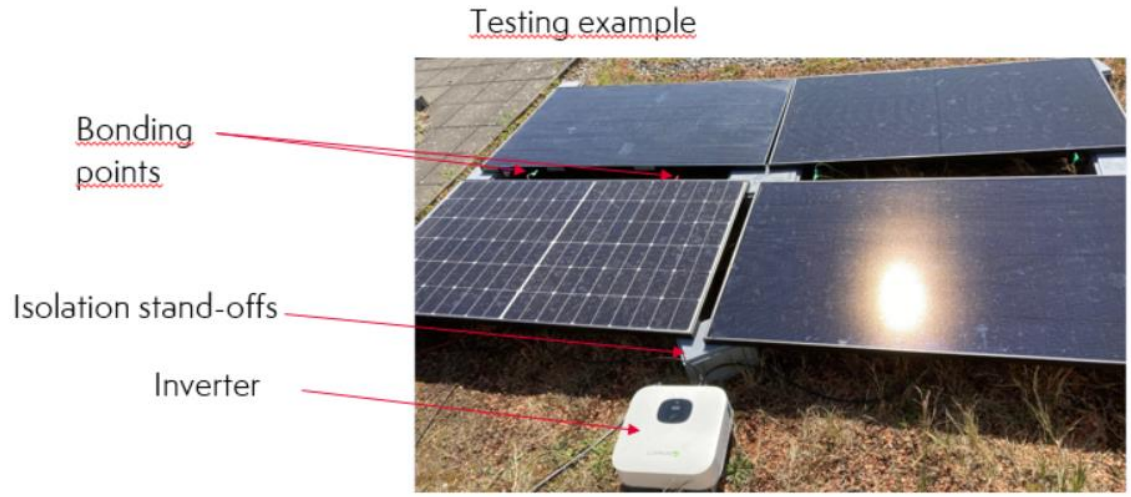
Inverters tested:

- Test inverter 1 – Brand A
- Test inverter 2 – Brand B
- Test inverter 3 – Brand C
- Test inverter 4 – Brand D
- Test inverter 5 – Brand E



Picture 1 - Test setup example

Module Type	Voltage from frame to ground	Leakage current	Total Leakage Current, module front and back wet, flat mounted 2x MPPT 600vdc strings (extrapolated from test data)	Danger level for humans: Leakage current
Meyer Burger White	115 vac	0.98 mA /module	19.6 mA	30 mA
Meyer Burger Glass	103 vac	0.27 mA / module	5.3 mA	30 mA
Standard multiwire glass backsheet module without aluminum in backsheet	105vac	Data not available	Data not available	30 mA

Table 1 – Leakage current and voltages

Safety: Testing and research indicates that safety is not compromised

By giving the leakage current a path to earth, the voltage on the frame and the mounting system can be reduced to zero. This is one way to minimize the risk. The second is built into the inverter itself. According the IEC standard 62109-1 and -2, all inverter manufacturers must provide a Residual Current Detector (RCD) either built into the inverter, or directly specified in the manual to be installed on the AC side. All five of the inverters tested here had built-in RCD's. These integrated RCD's must trigger at either a 300mA constant load or at a 30mA sudden load. This sudden load has the same trigger level as the ubiquitous RCD for kitchens and bathrooms. This covers the protection during such ocurrances as an animal biting through insulation causing a current to flow to the mounting system. The 300mA constant load covers, for example, the leakage current which builds up slowly as the module becomes damp as the inverter ramps up to power, such as after a short rain burst followed by sunshine.
Additionally, in comparison with the standard household RCD which require a manual reset, the inverter integrated RCD's are allowed to automatically re-energize to avoid nuisance trip situations which could lead to many days of lost power due to unnoticed inverter shut-downs.

Recommend Solutions: Common procedures can be used to avoid this issue

By bonding the modules and mounting system to earth, the leakage current is delivered to earth and the voltage drops to zero. This directly limits the possibility of rooftop shocks, which although not deadly, could lead to other accidents. Standard practice in Germany, Switzerland and the US are to bond the mounting systems and panels to earth. Another way to reduce hazards is to switch off the inverter whenever work is being performed on the installation. When the inverter is off, the leakage current drops to zero, regardless if the system is bonded to earth or not. Additionally, remember to always follow the inverter manufacturer's instructions as well as local and national installation standards.