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Solar inverter destruction and module degradation - reasons, effects and solutions!

Background:

Since the last three years the internet is full of reports of solar inverter disturbances, fails, destruction, replacement activities, as well as of callback activities of different well-known manufacturers. In Spring 2013, like in the years before, new SWR explosions with fire occurred and they had their cause in capacitor problems.

German example of one numerous internet reports on that problem:
http://www.photovoltaikforum.com/wechselrichter-f3/sma-5000-tl-abgebrannt--t7159.html

Extincting those fires is a very dangerous work for the fire workers.
http://www.feuerwehrverband.de/fileadmin/dfv/Dateien/Fachwissen/DFV-Positionspapier%20PV-Anlagen.pdf.
For the owner of the device a failure always means loss of money and much effort to correct it. Often the PV / solar inverter devices have been financed via loan of money, which have been adapted to the potential SWR value. Additional, costs for device failure are not included and insurances often do not pay them either.

Reasons of SWR failure and destruction.

Solar inverters are affected by high temperature and wetness differences.
It is no surprise that mainly the used capacitors are destroyed.
The test norms for X2 and Y2 capacitors go back to the 1970s and 1980s.At this time mostly linear consumers (trafos) are used. The different norms had been based on those disturbance values.
By introduction and usage of performance transistors, GBT´s, thyristor controls, etc. also the disturbance values in the supply grid have changed.
The norms for components (mainly for capacitors) have not been adjusted. Please read this report:
http://www.bajog.de/en/technical-report/reason-for-x2-and-y2-demolition.html

and:
http://www.bajog.de/en/technical-report/required-adjustment-to-the-standard.html

These both reports explain the reasons of capacitor failure.

Reasons and results of PV modular fails.

A safe working solar inverter needs a special supply grid filter and a DC filter. Both must be able to keep away the described disturbance values from the smart grid and from the solar inverter. (bi - directional). Furthermore the used filters have to be safe in terms of coupling capacitance disturbing

influences! Because of cost considerations mostly none or low quality DC filters are used and the necessary AC filter installed on circuit board.

With insufficient DC – filtering the disturbance voltage of the solar converter has influence on the DC wire and results in a high frequency which streams away over the PV modules. Therefore the PV modules act like antenna and degrade after short usage because of the asymmetric current load.
In terms of OV modular radiation the university Albstadt-Sigmaringen has released a study:
http://www.telemeter.info/documents/content/literatur/emv_fachartikel_entwurf.pdf
So it is explainable why PV modules lose performance already after short usage.

Summary of reasons and their effects:

- Supply grid disturbance factors, dU/dt pressure from up to 10kV/ µs have influence on the used parts in solar converter and destroy them (depending on kind of usage). In towns and industrial areas the supply grid disturbances by harmonics, dU/dt pressure, spikes and transients is usually higher than in a rural area.
- Circuit board filter with standard X2 and Y2 capacitors and DC filters are affected by a strong degradation and cause solar inverter failures and fast aging processes of PV modules.
- Recent norms for parts (like capacitors) do not come up to the recent supply grid disturbances.

Solution:

- Obligatory is an adequate and capsuled AC and DC filter in every solar converter.
- AC – Filter must have the following characteristics:
  - High attenuation in the range of 1kHz – 500 kHz.
  - No saturation even with high asymmetric currents.
  - Constant filter performance even after 15 years of usage with minus and plus degrees outside.
  - dU/dt – compatibility
- For DC – Filter similar specifications are valid.
- AC – Filter (generally), as also DC – Filter for solar converter and frequency converter have to be a tested in a way according to our modern times. EN 133200 is not enough for that.
- The basic testing parameter of future norms for capacitors should be made equal to the Bajog testing parameter and defined with different temperatures up to 85°C and 85% relative air humidity (plus and minus), under nominal current with at least 2KV/µS (10 times within 500 testing hours).
- The EN 55011 .. 22 has to be reformed in the same way, and the disturbance voltage measurement has to be expanded from recent 150kHz – 30 MHz to 1kHz – 30 MHz. The disturbance voltage limit in the range from 1kHz – 10 kHz should be defined to maximum 80dBµV and in the range from 10 KHz – 150 KHz to a maximum of 60dBµV
- This ensures:

- ► all different devices at the supply grid can be used without problems and without having influence on each other,
- ► Power Line Communication (PLC with smart meter) works without disturbances in the range of the CENELEC band
- ► Smart Grid has a safe future!