Reasons

for decreased Power and Yield of PV Generators

Error	To be detected by:	Possible reason / *workaround*
System configuration chosen inadequately	Measurement of mismatch losses	Design fault / *redesign*
Erroneous match of strings and inverter	Fed power too low for location and in relation to nominal generator power	Design fault / r*edesign, replacement of inverters*
Cast shadow	I-V-curve shows "bulge", **peak power** too low, optical check	Barrier near module (e.g. tree, chimney, birds excrements) / *remove barrier*
Diffuse shading (may be hardly visible for bare eye!)	I-V-curve is "impressed", **peak power** too low	Barrier in some distance to module (high portion of diffuse light) / *remove barrier*
Corrosion at plugs and cables	**Serial internal resistance R_s** too high	Material, planning or mounting fault / *cleaning, replacement*
Delamination of cell embedding	See: **diffuse shading**	Material or production fault / *replacement*
Bubbling in resin	See: **diffuse shading**	Material defect */ replacement by supplier*
Transparent covering material (glass, plastics, resin) becomes blind	Optical check, **peak power** too low (s. a. **diffuse shading**)	Material defect */ replacement by supplier*
Discolouring of the transparent cover or embedding material (plastics, resin)	Optical check, **peak power** too low (s. a. **diffuse shading**)	Material defect */ replacement by supplier*
Intrusion of water into the laminate, leads to other problems (corrosion, discolouring)	Optical check	Material or production fault */ replacement by supplier*
Faults in the crystalline structure of single cells (hot-spot effect)	See: **diffuse shading**	Production fault */ reduction of price, replacement by supplier*
Pollution of the module by dust	Optical check, see: **diffuse shading**	High dust impact / *check modules periodically, cleaning*
Moss / algae on module, birds excrements	See: **cast shadow**	Normal for several regions */ cleaning*
Broken cover glass, leads to other problems (corrosion, discolouring)	Optical check	Hailstorm, mounting or transportation fault */ replacement by supplier*
Break of single cells in module	**Peak power** too low, possibly deformation of I-V-curve	material defective */ replacement by supplier*
Improper electrical connections in module	**Peak power** too low, **internal series resistance R_s** higher than calculated	Fault in soldering, material defective, corrosion */ replacement by supplier*
Bypass diode defective (short circuit)	**Peak power of** strings reduced by module power	Overload, material defective */ repair*
Bypass diode mounted the wrong way	**Peak power** of strings reduced by module power	Mounting fault / r*epair*
No bypass diode mounted or diode defective (high resistance)	Shading of one module reduces power of the string dramatically	Planning or mounting fault / r*epair*
Dimension of cabling too small	**Internal series resistance R_s** too high	Design fault / *replacement of cables*
Cable defective (e.g. break, corrosion)	**Internal series resistance R_s** too high	Mounting fault / r*epair*
Insufficient mounting of connectors	**Internal series resistance R_s** too high	Mounting fault / r*epair*
Corrosion in screwed or plugged connectors	**Internal series resistance R_s** too high	Mounting fault / *cleaning, repair*
Insufficient pre-selection of modules regarding peak power	**Peak power** of plant too low	Mounting fault (match losses) / *New pre-selection after peak power measurement*
Insufficient pre-selection of single cells regarding power during module production	**Peak power** of module too low	Production fault / *reduction of price, replacement by supplier*
Short circuit between cells in the module	**Peak power** of plant too low, open circuit voltage V_{oc} too low, shape of curve	Production fault / r*eplacement by supplier*
Fabrication tolerances in cell production	**Peak power** too low, shape of curve	Production fault / *reduction of price, replacement by supplier*
PID – Potential induced degradation	**Peak power** too low, voltage low, shape of curve	Design or material fault / *redesign, replacement*

Please notice: some faults may appear only under special operating states, e.g. high module temperatures.
This compilation does not claim to be complete or free of failures.

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Measurement Devices Series PVPM -

more than „only“ curves!

Internal Series Resistance R_s

This resistance physically results from the material used in the module production as well as the cable connection and has a fixed value depending on the type of module: we expect about 0.5Ω for crystalline modules and 2...3Ω for thin film modules.

The measurement of the internal series resistance is now possible with the measurement devices series PVPM. Only one measured I-V-curve of the module is necessary. Based on this data the device can automatically calculate the R_s as well as the peak power P_{pk} and the parallel resistance R_p.

The theoretical value of the internal series resistance R_s can be calculated. This is for example possible with the software PVPM*disp:* You enter the STC values V_{oc}, I_{sc}, V_{Mpp} and I_{Mpp} of the module and the software immediately displays the R_s.

The calculated R_s now can be compared to the measured value that a PVPM will display immediately after the measurement. If the measured value is too high the cabling should be checked for breaks, corrosion, connection faults and insufficient dimensioning.

Peak Power P_{pk}

To assure the comparability of power specifications of pv modules a standard was created that defines the conditions for the test of the so called “peak power” of pv modules: cell temperature 25°C, Irradiance 1000W/m^2, light spectrum comparable to AM1.5. These conditions are called Standard Test Conditions (STC).

Unfortunately under natural ambient conditions these STC are quite rare. That is why the measurements were performed in laboratories, where the STC were reproduced with a very high operating effort (and cost).

With the new developed methods of the peak power measuring devices series PVPM now these measurements can be performed easily under natural ambient conditions - the device will convert the results to STC automatically. After the measurement of one single I-V-curve the results peak power P_{pk}, the internal series resistance R_s and the parallel resistance R_p are instantly displayed. These results, compared to the specificated values for the pv generator, are an indication for several errors in the pv generator and even simplify the peak power check and error detection.