Be sure. testo

Checklist for inspecting photovoltaic systems with a thermal imager

A. When to check:

- **After commissioning:** to rule out any initial defects.
- **In the event of a problem:** if there is a malfunction or a drop in efficiency.
- **Regularly and before the end of the warranty period** (as specified by the manufacturer): In order to make warranty claims.
- **Regularly (every 2 years):** to ensure optimum efficiency.
- **Regularly** (as per insurance conditions): to make claims.

B. Checklist

√ **Visual inspection of the modules:** Dirt, damage and stresses, cracks or other anomalies on modules.

√ **Functional check of modules, inverter and bypass diode:**
Correct installation, "hotspots" (areas indicating problems).

√ **Check the safety devices:**
Overvoltage protection and residual current devices.

√ **Check the assembly system and cabling:**
Correct installation, damage due to weather conditions, animal bites or scorching.

√ **If present:** Check and calibrate the meter, check the electricity storage system.

√ **Power measurement of the system**

√ **Maintenance or cleaning of the system**

√ **Documentation of anomalies and maintenance work in the log**

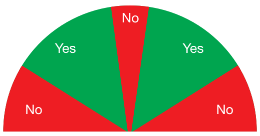
√ **Measuring instruments**
- Thermal imager with high resolution and exchangeable lenses (see below)
- Electrical measuring instrument for current, voltage and resistance
- Instrument for measuring solar radiation (pyranometer)

C. Environmental and measurement conditions:

- **Solar radiation > 500 W/m²** (ideally > 700 W/m²), since existing module faults may be overlooked at lower values.
- **Clear sky** to prevent any interfering reflections from clouds. If the sky is overcast, it is only possible to obtain meaningful images if the infrared camera used is sensitive enough.
- **Avoid reflections** from surrounding buildings or satellite/aerial systems.
- Measurements should be taken in **conditions with as little wind as possible** so as not to affect the thermal gradient.
- **Taking pictures in the morning** may be an option if there is sufficient sunlight, since the air temperature is lower and therefore the thermal contrast is higher.

D. Positioning of the thermal imager:

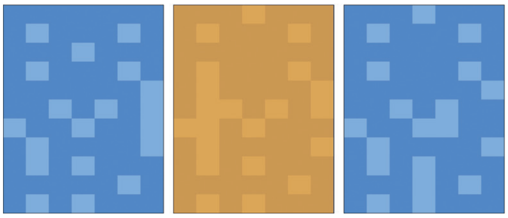
- **Viewing angle** from 5° to 60° (shown in green in the image): to prevent self-reflection, do not position the imager perpendicular to the module.



- A **greater distance** from the target can be advantageous, since a larger area can be captured in one go. For the thermal image to be of sufficient quality, it is advisable to have a resolution of at least 320 × 240, or even better 640 × 480 pixels and an interchangeable telephoto lens.

Be sure. testo

Fault images and causes

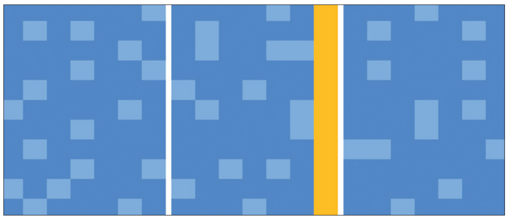


Infrared image 1

Description: Constant heating of module compared with the others.

Possible faults: Module is at open circuit.

Possible cause: Module not connected, cable worn through or broken.

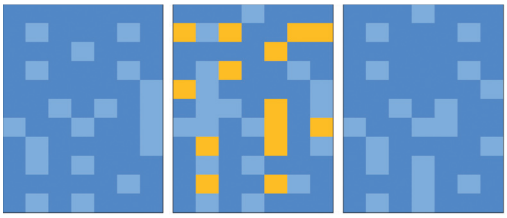


Infrared image 2

Description: The module has line-like heating of a string.

Possible faults: Short circuit in a cell string.

Possible cause: Faulty bypass diode e.g. after a storm.

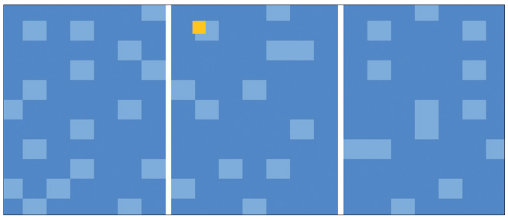


Infrared image 3

Description: "Patchwork pattern" where individual cells are randomly distributed and significantly hotter.

Possible faults: Complete module in short-circuit.

Possible cause: Incorrectly connected or all bypass diodes faulty.

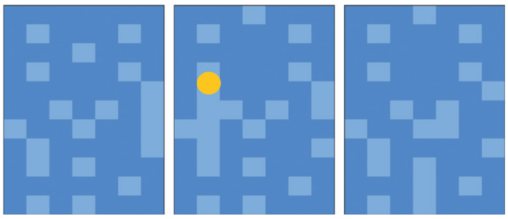


Infrared image 4

Description: Only part of a cell is significantly hotter.

Possible faults: Cell rupture.

Possible cause: Transportation or installation damage or other external mechanical influence.

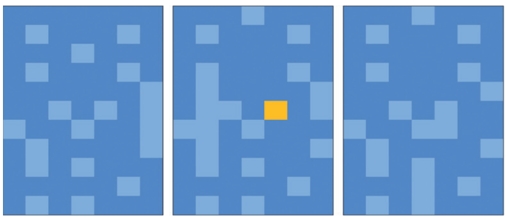


Infrared image 5

Description: Heating at specific points or unevenly.

Possible faults: Crack in a cell or artefact formation.

Possible cause: Manufacturing fault with cell cracking. Shade due, for example, to dirt (bird droppings, etc.).



Infrared image 6

Description: Heating of an individual cell.

Possible faults: Not necessarily a fault.

Possible cause: Shade or faulty cell.

dk/03.2024