LowCost-Outdoor-Electroluminescence: Significant Improvements of the Method

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Introduction

Electroluminescence pictures (EL pictures) of solar modules are a powerful tool for quality analysis. Recently, it was shown that with modified inexpensive DSLR cameras and suitable blocking filters even onsite-outdoor measurements can be realized. This LowCost-Outdoor-Electroluminescence method facilitates a detailed error analysis of whole strings with respect to micro cracks, potential induced degradation (PID), defective bypass diodes etc. [1-5]. A disadvantage of the hitherto existing method lies in the relatively long exposure time which enforces the use of a tripod. At least for a quick first inventory of the PV plant it would be desirable to find the string set under current on the roof with the video mode of the camera and to already roughly examine it for peculiarities.

Deployment of Consumer Cameras

The frame rate of typical consumer cameras (e.g. Canon EOS-700D) is in the order of 25 or 50 fps (frames per second). However with the alternative camera operation system Magic Lantern also smaller frame rates can be adjusted (Fig. 1 and 2). This leads to a sufficient EL-brightness even in video mode (Fig. 3). In practice to make a first quick inventory of the plant a frame rate of 7 fps has been well-tryed.

Deployment of semi-professional Cameras

Only shortly compact system cameras (< 2000 €) are on the market which show excellent detector sensitivities (e.g. ISO values up to 400,000). This is combined with a relatively high sensitivity also in the IR spectrum relevant for EL measurements. Therefore this camera is suitable (after modification) to take EL videos at high frame rates with meaningful results of PV plants. As an example, Fig. 4 shows a single frame of a video which was taken with 25 fps. Obviously the brightness is sufficient to see details and to detect errors.

With this type of camera the whole inspection of the PV plant can be done in video mode without taking single pictures. This extremely speeds up the inspection of a plant. The EL video technique even facilitates the deployment cameras with attached EL camera (Fig. 5). As a copter has only restricted battery time it is desirable to subsequently energize the separate strings of a plant. Figure 6 shows the developed string-switching-box. This box can subsequently switch the current of a high voltage power supply to 8 different strings. Control can be done by a wireless remote control device.

Suppression of extraneous light

With the blocking filters mentioned above already a large amount of the extraneous light can be suppressed. However in the IR range around 1100 nm sunlight still has large spectral contributions [3]. Therefore EL measurements are typically done in the night. In order to make high-contrast EL exposures also at dawn first a picture with EL current and then one without EL current is taken. By forming the difference of both pictures already large contrast improvements can be attained.

In case of EL videos the reverse feeding current must be modulated. In the simplest case it is simply switched on and off. Afterwards the frames of the “dark cycle” can be subtracted from the “bright cycle”. An example of such an extraneous light suppression is shown in Figures 7-9. In Fig. 7 (with current) the EL characteristics are only poorly to be seen. Fig. 8 shows the exposure without feeding current (only diffuse light from the Sun). After subtraction of Fig. 8 from Fig. 7 a much better EL contrast is achieved (Fig. 9).

Conclusion

With suitable measures the Low-Cost-Outdoor-EL method can be extended to the possibility to take EL videos of whole PV plants. With this extension the capabilities of the method are significantly improved and expanded. Besides facilitating a quick overview of the PV plant to whole detailed plant inspections the video mode offers a lot of possibilities that were not possible up to now. As a result the Low-Cost-Outdoor-EL method will continue its way to become a standard inspection method besides thermography to analyze PV plants onsite.

Literature