

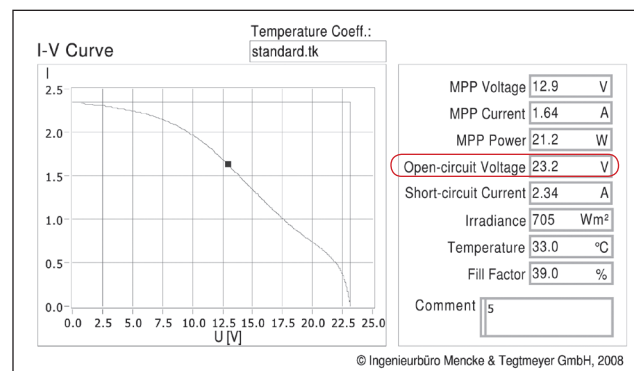
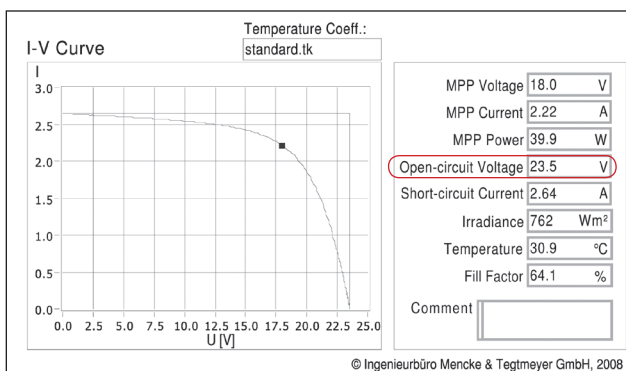
The Importance of Photovoltaic(PV) I-V Curve Analysis On-site Prior to Module Installation

A photovoltaic panel is made up of numerous PV cells and hundreds of electrical connections to bring the output of each of those cells together to provide the overall power output of the module or panel. As little as one defective cell or electrical interconnection can cause serious degradation of the performance of the overall panel within as little as 6 to 12 months after installation. Once installed, one underperforming panel can cause degradation of an entire PV string. A defect in the panel can happen during the manufacturing process and be missed or overlooked in final quality control at the point of manufacture. A defect in the panel can also happen during transportation to the site causing the same overall degradation in the string performance. Once all the panels are mounted in the array, troubleshooting and replacement of a bad module becomes a much more difficult and expensive task. Many installers will simply put a voltmeter on the leads from a module to test open-circuit voltage. If that Voc is within the manufacturers specifications, the installer will feel confident the entire module is fine. A single or even multiple bad cells in that module however might not cause a decrease in Voc. By doing an I-V curve analysis with a field I-V curve analyzer, you will be able to see the entire curve with voltage and current measurements at numerous points, the degradation of the panel performance will be readily visible, and that panel can be deemed defective by the installer and set aside rather than installed.

The overall benefits to the customer if the installer performs 100% I-V curve analysis prior to installation are:

- Initial knowledge that all panels are 100% operational at time of installation
- Stronger position for future warranty claims against the panel manufacturer if necessary due to panel failure or degradation of performance (i.e. customer can show explicitly that the panels were tested properly and all passed prior to installation... "They weren't damaged in shipment.")
- Enormous cost savings of not having to troubleshoot individual strings or the entire array one to five years ahead because a poor panel has now failed or caused an entire string to fail

Below are two I-V curves taken from the same panel. The first curve was taken in full sunlight with no shading on the panel. You can see a nice smooth curve with an open circuit voltage of 23.5V. Simply applying a voltmeter to the leads would have read approximately this same Voc value. The second curve was taken with two cells blocked, simulating bad cells or bad electrical connections between a couple of cells. You can see how badly the I-V curve has deteriorated, indicating problems with the panel. However the Voc still measures 23.2V. If a voltmeter was used to field test this panel rather than an I-V curve analyzer, this problem would have been missed.



All I-V curves above taken using the Mini-KLA Portable I-V Curve Analyzer from IMT Solar.

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