

Progress on Standards for PV Performance Measurement

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Introduction

The IEC 60904 series of standards is fundamentally important in ensuring measurements of solar PV device output are accurate, repeatable and reasonably representative of the performance of the device in the field. The series covers everything relating to the characteristic current-voltage curve, including extraction of key performance parameters such as the power conversion efficiency. Applications range from researchers looking for new cell performance milestones, to module manufacturers, importers, solar farms and even courts, seeking to confirm the quality of commercial scale PV modules.

The presentation will discuss recent developments relating to the 60904 series, with particular emphasis on the following:

Update to IEC 60904-1 (2006)

The hub of the 60904 series is 60904-1, which describes the I-V measurement, with links to ten sub-components that describe aspects such as spectral correction, measurement traceability, reference devices, linearity checks, multi-junction and bifacial devices, and solar simulator requirements. A testament to the early robustness of 60904-1 is that we are still using a version published in 2006.

However, after 13 years of technology development it is time for an update, and a new Edition 3 is presently in draft. The new edition is based on the same fundamental methodology, but includes updated language for better consistency and clarity, updated normative references, informative figures and annexes describing how to deal with non-uniformity of the light-field, device capacitance and dark I-V measurements. Importantly, the document now requires the measurement to attempt to capture the “steady-state” behaviour of the device.

IEC Technical Report on “Emerging PV” technologies

In the mid 2000s, the global PV research field saw an explosion in the number of projects to develop new solution-processable PV technologies such as organic, dye-sensitised and more recently perovskite-based PV. From the outset it was recognised that the IEC 60904-1 standard lacked both detail and guidance for measurement of these devices, which are typically subject to special challenges such as: instability in performance over time; unusual spectral responsivity; small device size; difficulty in measuring temperature; a transient response to external stimulus; optical interference effects; and a non-linear current response to irradiance.

In an attempt to address these issues, the IEC in 2016 commenced a process that should eventually provide rules and guidance to allow repeatable and representative measurements on these devices. Stage one of the process was to compile a Technical Report describing the state of the art. That document was prepared with the assistance of more than thirty researchers around the world and in June was published as IEC TR 63228.

IEC TS 60904-1-2 for bi-facial modules

Perhaps the most significant development in PV technology in the past decade is the advent of bi-facial PV modules, which can collect light from both the front and the rear sides. Although this technology hasn't taken off in Australia yet, the overseas experience suggests bi-facial modules will soon become the 'standard' product for use in solar farms.

Bi-facial modules are more complicated to measure than mono-facial modules, due to (i) the need to restrict light from hitting the non-measured side, and (ii) the need to perform low-light measurements on the rear side. The IEC has recently published a Technical Specification document TS 60904-1-2, to help maintain consistency between measurement laboratories around the world. Before that TS can become an International Standard, it is being trialled through a two-year round robin experiment incorporating the top 30 PV measurement laboratories around the world.

The presentation will discuss the process for testing bi-facial modules and CSIRO's participation in the round-robin experiment. Results will be presented if available.

Toward IEC 17025 accreditation for module testing in Australia

CSIRO's PV Performance Laboratory remains the only PV lab accredited to the IEC 17025 technical competency standard in the southern hemisphere. At present however, the scope of CSIRO's accreditation is limited to measurements on encapsulated PV cells. This leaves the Australian utility-scale solar industry without an accredited domestic testing laboratory. Many solar farm construction contracts require that module measurements are only acceptable from an accredited laboratory, meaning Australian test labs lose significant business to overseas.

CSIRO is close to completing the requirements for IEC 17025 accreditation for testing of PV modules, which it is hoped will pave the way for other Australian labs to follow. The presentation will discuss CSIRO's experience with this process, including the requirements for accurate PV module testing.