FACTORS FOR IMPROVING THE PRECISION OF OUTDOOR PHOTOVOLTAIC PERFORMANCE MEASUREMENT

Yoshihiro HISHIKAWA, Takuya DOI, Michiya HIGA, Takakazu TAKEUCHI, Hironori OHSHIMA, and Kengo YAMAGOE

National Institute of Advanced Industrial Science and Technology (AIST), Japan

There is growing demand for precise on-site performance measurement of PV modules and systems. Conventional outdoor PV performance measurements have problems such as limitation of measurement opportunity to clear sunny days and inferior repeatability than indoor measurements. The authors have recently demonstrated [1] that precise outdoor performance measurements can be realized by reducing the measurement time to 0.2 s while simultaneously monitoring solar irradiance by PV module irradiance sensors. The present study investigates various factors that affect the outdoor performance measurements, in order to establish the measurement procedure, and to further improve the measurement precision.

(1) Excellent agreement within about ±0.5% of precise indoor measurement is observed on a clear sunny day (Fig. 1(a)), for very wide ranges of irradiance, temperature, and solar elevation conditions nearly throughout the daytime. This shows the basic usefulness of the outdoor measurement procedure of the present study.

(2) Similar level of precision is observed even on a cloudy day when the irradiance is unstable (Fig. 1(b)). The error in the outdoor measurement possibly increases in rare cases when the variation of irradiance is extremely high, such as those seen as spikes in the lower graph of Fig. 1(b). Those errors are small, and can be removed by filtering out the data if the variation of irradiance is extremely high.

(3) Some types of modules show slight deviation of the measured performances from the indoor results such as the $I_{sc}$, $V_{oc}$, FF, and $P_{max}$, as shown in Fig. 1(c). Although the detailed source of deviation is not completely defined yet and is under investigation, factors such as the dependence of the module’s performance on the angle of incident light, and the error related to the module temperature measurement are probably affecting the small difference of around ±1%.

Detailed investigation on the factors and further improvement in precision will be discussed at the conference.

Fig. 1 Upper graphs show the irradiance (red lines) and module temperature (blue lines). Lower graphs show the outdoor measurement results of this study for $I_{sc}$ (green lines), $V_{oc}$ (blue lines), FF (black lines), and $P_{max}$ (red lines) of (a) module N16D03 on a clear sunny day, (b) module N16D03 on a cloudy day, and (c) module N15A01 on a clear sunny day.

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