Abstract

Electromagnetic compatibility (EMC) is a major technical challenge for solar photovoltaic (PV) systems. As the use of PV systems has increased in recent years, the problems of electromagnetic interference (EMI) of PV systems are becoming more evident. The main source of EMI in these systems are the power converters, such as DC-DC converter and DC-AC inverters, which uses high frequency switching power electronic devices. These power converters transmit conducted noise emission between, at both input side, where PV panels are connected, and output side, where loads and AC grid are connected. At the output side the conducted emissions must comply with the relevant EMI regulation to prevent interference to loads or the AC gird. Although similar regulation does not apply on the DC input of a PV system, the high frequency switching converters with its DC input connected to the PV panel causes conducted emissions to propagate along the DC cables. These emissions can then radiate through the DC cable and the PV panel, which serve as unintentional antennas.

Since the PV systems are becoming widely accepted in both residential and industrial applications, it is necessary to evaluate the EMI of the system systematically so that it does not interfere with other electronic devices. In order to evaluate the EMI of a system, a proper EMI model of the system should be developed. This research therefore proposes to develop a measurement-based EMI model of PV systems. This approach provides simple yet accurate model for analyzing EMI of a system. Using the method, separate noise equivalent models for common-mode (CM) and differential-mode (DM) emissions of a PV system are developed. The model can then be used to study the conducted emissions and radiated emission from the system. Additionally, the model will be useful for designing optimized EMI filters for the system.

In order to develop accurate EMI model of a PV system, the noise source model of the power converters and PV panels should be extracted at operating conditions. For this purpose, an in-circuit measurement approach is used to extract the noise source model at the DC input of a PV system under its actual operating conditions, which provides adequate information for EMI modeling and mitigation purposes without the full knowledge of the internal circuit of the PV system. The noise source model allows us to estimate noise emissions and evaluate the effectiveness of the filter for EMI mitigation without a trial-and error process.

Author’s Publications

Journal Paper

- **M. Prajapati** and K. Y. See, "Extraction of Equivalent Noise Source Model from Photovoltaic Systems," in *IEEE Transactions on Electromagnetic Compatibility*, 2018.

Conference Papers

- **M. Prajapati** and K. Y. See, "Extraction of equivalent impedance of photovoltaic panel under its actual operating conditions," *2018 IEEE International Symposium on Electromagnetic Compatibility and 2018 IEEE Asia-Pacific Symposium on Electromagnetic Compatibility (EMC/APEMC)*, Suntec City, Singapore, 2018, pp. 1145-1149.
- S. B. Rathnayaka, K. Y. See, **M. Prajapati**, K. Li, N. B. Narampanawe and F. Fan, "Inductive coupling method for on-line frequency response analysis (FRA) for transformer winding diagnostic," *TENCON 2017 - 2017 IEEE Region 10 Conference*, Penang, 2017, pp. 88-92.
- S. B. Rathnayaka, K. Y. See, **M. Prajapati**, K. Li, N. B. Narampanawe and F. Fan, "Influence of temperature on transformer's winding defect analysis using inductive probes," *2017 Progress in Electromagnetics Research Symposium - Fall (PIERS - FALL)*, Singapore, 2017, pp. 2285-2289.