CHARACTERISTICS OF THE ELECTROMAGNETIC ENVIRONMENTS OF POWER CONDITIONERS FOR PV GENERATING SYSTEMS

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ABSTRACT: In recent years, public awareness of global environmental issues including the prevention of global warming has been increasing. This trend has encouraged wide acceptance of photovoltaic power generation systems in the home market. The power conditioner is an indispensable component of a photovoltaic power generation system. Power conditioners however have a serious problem; they generate electromagnetic noise. To provide basic data for the establishment of the new standard, we conducted measurement and analysis on EMC for a photovoltaic power generation system based on the IEC61000 Series, the conventional EMC standard for electrical appliances.This study proved that lead batteries can be used as a substitute power supply for solar cells to measure the terminal interference wave voltage of a power conditioner. Moreover, we recommend performing measurements not only at high-output conditions, but also at low-output conditions of the power conditioner operation output when measuring the terminal interference wave voltage of the power conditioner.

Keywords: Grid-Connected, PV System, EMC

1 INTRODUCTION

In recent years, public awareness of global environmental issues including the prevention of global warming has been increasing.

This trend has encouraged wide acceptance of photovoltaic power generation systems in the home market. The power conditioner is an indispensable component of a photovoltaic power generation system. Power conditioners however have a serious problem; they generate electromagnetic noise.

To make matters worse, the electromagnetic noise that is generated at power conversion is transmitted to the solar cells through the DC electric wires, and the solar cells act as an antenna to radiate the electromagnetic noise. In addition, the solar cells radiate the electromagnetic noise to the system wires through the AC wires. The radiated electromagnetic noise may cause operation and communication failures in other electronic equipment(1).

Amid this, there has as of yet been no standardization of electromagnetic compatibility either by the International Electrotechnical Commission (IEC), or any other organization. We are hoping that a new EMC standard will be established, and believe it should cover photovoltaic power generation systems.

To provide basic data for the establishment of the new standard, we conducted measurement and analysis on EMC for a photovoltaic power generation system based on the IEC61000 Series, the conventional EMC standard for electrical appliances.

This study reviewed the method used to measure the terminal interference wave voltage generated from a power conditioner to clarify the electromagnetic ambience of power conditioners as the primary unit in photovoltaic power generation systems.

This study is part of the “Research and Development on Electromagnetic Ambience in Photovoltaic Power Generation Systems in Photovoltaic Power Generation Technology Research Development – Research Development and Investigation on Common Infrastructure Technology for Extensive Deployment,” project we conducted under contract to the New Energy and Industrial Technology Development Organization (NEDO).

2 Discussion on Power Conditioner Electromagnetic Ambience

2.1 The Basic Concept of Power Conditioner Electromagnetic Ambience

If we look at photovoltaic power generation systems based on the concept of ports, the basic concept employed in electromagnetic ambience, we can divide the system into four ports: the power conditioner as the frame, DC, AC, and ground.

By using this classification, we can observe a remarkable phenomenon: that actual physical point terminated at solar cells in the DC port exhibits features that make it different to general electrical appliances.

2.2 Power Conditioner Electromagnetic Ambience

When discussing power conditioner electromagnetic noise, we must consider two cases. One is the case where the electromagnetic noise from the power conditioner impacts on other electrical appliances through the AC and DC ports.

The other is the case where the electromagnetic noise from electrical appliances impacts on the power conditioner through the AC and DC ports.

For this reason, tests and measurements should be conducted by port, whose electromagnetic ambience must be focused.

When tests and measurements are conducted, attention must be paid to the terminal interference wave

voltage generated from the AC port, because it impacts directly on electrical appliances in the home and may cause malfunctions.

3 Power Conditioner Terminal Interference Wave Voltage Measurement

To measure the power conditioner terminal interference wave voltage, measurements using an actual system are ideal.
It is, however, difficult to measure the power conditioner terminal interference wave voltage using an actual system, because actual photovoltaic power generation systems do not generate constant power, due to the effects of the amount of solar radiation, temperature, and other meteorological factors. For this reason, we used lead batteries as the power supply device for this experiment in accordance with "How to Measure Terminal Interference Wave Voltage" in CISPR14. The block diagram of the test design is illustrated in Figure 1.

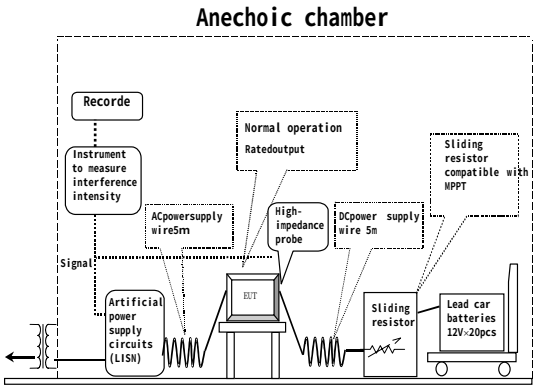


Figure 1: The block diagram of the test design

3.1 Verifying Adequacy of Substitute Power Supply

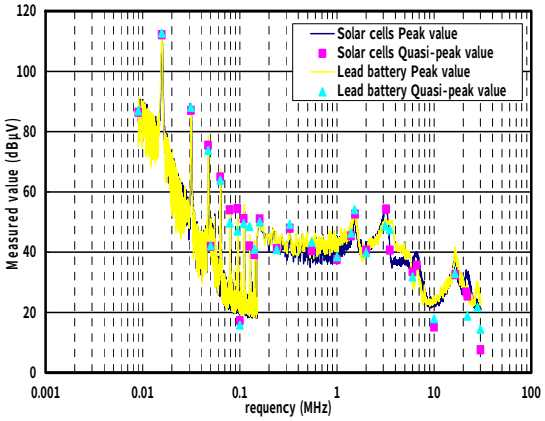
When using lead batteries for the power supply instead of solar cells, the measurement results may be different from those obtained from solar cells, due to the difference in DC input impedance and incompatibility as a result of the maximum power point tracking method (MPPT).

Before performing the experiment, we carried out preliminary measurements of the terminal interference wave voltage at rated output for both solar cells and lead batteries.

The advantages of these preliminary measurements are :

- Measurement is not affected by weather conditions.
- Reproducibility in measurement can easily be maintained.

These measurements were conducted at the EMC test center situated at our Yokohama office. Figure 2 shows the results.



3.2 Verification of Influence of Power Conditioner Operation Output Changes on Terminal Interference Wave Voltage

Since the power conditioner follows the output changes of the solar cells, the MPPT is controlled to always maintain the maximum output.

This MPPT control is suspected to impact on the terminal interference wave voltage.

To ascertain the impact of MPPT control, we compared the terminal interference wave voltages measured in the power conditioner when their operation voltage is changed. For the first step of the measurement, we connected the lead batteries to the DC input of the power conditioner. Next, we set the AC output to 100%, 75%, 50%, and 25% of the rated output, and then measured each voltage.
This measuring method has the following advantages:

- Measurement is not affected by weather conditions.
- Measurement is easily performed.
- Adjustment to constant stable output can be made.
- Reproducibility in measurement can easily be maintained.

. The experiment was conducted at the EMC Test Center at the Yokohama Office of Japan Electrical Safety and Environment Technology Laboratories. Figure 3 shows the results of the experiment.

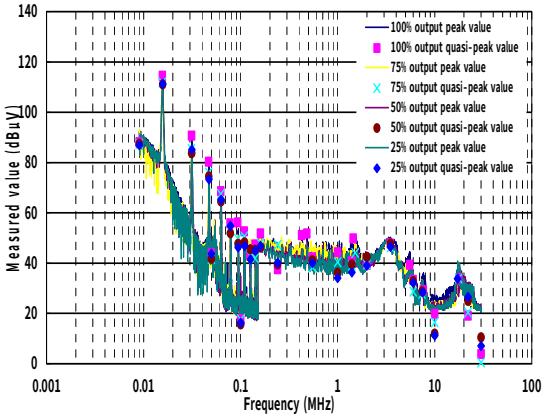


Fig. 3 Results of comparative measurement of the solar battery and battery

As shown in Figure 3, no significant peak value

differences were found in the terminal interference wave voltages even where there were differences in power conditioner operation output. No significant quasi-peak value differences were found either at 100%, 75% or 25%, however the lowest measurement value was obtained at 50%.

General electrical appliances usually show the highest terminal interference wave voltage under stable operating conditions. In this experiment however, the power conditioner exhibits the highest terminal interference wave voltage under low-output conditions. We may attribute this to differences in the switching circuit that controls the power conditioner's power conversion and operation control characteristics.

4 Summary

This study proved that lead batteries can be used as a substitute power supply for solar cells to measure the terminal interference wave voltage of a power conditioner. Moreover, we recommend performing measurements not only at high-output conditions, but also at low-output conditions of the power conditioner operation output when measuring the terminal interference wave voltage of the power conditioner.

Literature

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