

Thesis Title	Evaluation of a Photovoltaic to AC Conversion Unit for Grid Connection	
Thesis Credits	12	
Candidate	Mr. Poolsak	Puwavichrenchai
Supervisors	Dr. Krissanapong	Kirtikara
	Dr. Veerapol	Monyakul
	Mr. Tawatchai	Suwannakum
Degree of Study	Master of Engineering	
Department	Energy Technology	
Academic Year	1999	

Abstract

The thesis involved performance evaluation of Solar to AC (STAC) units. STAC is an invention of the Bureau of Technology Development of the Premier Group and is granted a US patent. It can be directly connected between PV panels and mains without use of batteries and inverters, claimed to be of advantage by the inventor. It is necessary that STAC be evaluated technically so that they can be approved for use by electricity utilities.

Testing methods were approved by technical experts from Chulalongkorn University, Kasetsart University, King Mongkut's University of Technology Thonburi, the three Electricity Authorities(MEA, PEA, EGAT), the National Energy Policy Office(NEPO), Premier Group, and NECTEC and KMUTT(the test agencies).

Testing is divided into four parts on, harmonics cancellation, Islanding effect, conducted emission and system overall efficiency.

Harmonic cancellation consists of two methods namely,

1. Direction of flow of current and total current harmonic by applying the Power flow theory and Kirchoff's current law. The testing was carried out with load at a constant current harmonic.

The testing result showed that the deviation of the current harmonic content depended upon the original harmonic and the solar radiation intensity. It caused increasing total current harmonic flow to grid.

2. Total Harmonics Distortion of voltage at connecting point. This is done by series connecting an electrical conductance to the output of transformer for scaling up and clearly display the distortion of voltage harmonic. It was found that the Total Harmonic Distortion of voltage at connecting point was increased and depended on the harmonic distortion of supply and solar radiation intensity.

The harmonic cancellation testing result from the two methods indicated that STAC was not able to cancel the harmonic in the original system as claimed.

For the Islanding effect of STAC, the testing result showed that when the electricity from grid is cut off, while load was storing the energy in the form of magnetic field, the occurrence of the Islanding effect from STAC is highly possible. The voltage at PCC is higher than 50 V. Voltage waveform and Islanding time depend on the type and capacity of load connected and solar radiation intensity.

The conducted emission of STAC, resulted from the switching of electronic switch at high frequency and caused the changing of both capacity and time of voltage and current of load supply. It can generate and cause the disturbance of electromagnetic wave. The testing result showed that at the starting frequency the amplitude of the highest level of noise at the frequency 70.3 kHz is 4.43 mV. At the final frequency, the amplitude of the highest level of noise at the frequency 960 kHz is 10.99 mV. When compared to the limit of the EMC standard, the result showed that it was over those of the CISPR 14.

For the overall efficiency system of STAC, testing result showed that the efficiency of the integrated system is 6.92% when the solar radiation intensity is 600-950 W/m², and the daily short-time average efficiency is 6.6%. The energy extraction capability of the AC conversion unit is 71.8% and the average total efficiency of this unit is 97.59% (at all frequencies combined not only at 50 Hz). The average total power factor is over than 0.9 and the average Total Harmonic Distortion of current (THD_c) is 40%.

From this research, that STAC can be connected to grid. However, it can generate current harmonics to grid connection whose values are over the admitted limit (IEC 1000-3-2, Class A equipment). Moreover, its Islanding effect will be harmful. The STAC should be

technically developed further to decrease its harmonic current generated and the protection of Islanding effect.

Keywords : Solar cells / Photovoltaic to AC Conversion Unit for Grid Connection / Harmonics / Islanding effect / Conducted emission / Performance