SWITCHING POWER SUPPLY AUTOMATIC TEST SYSTEM IN TAIWAN PHOTON SOURCE

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Abstract

This paper studies the use of a novel switching power supply automatic test system used in Taiwan photon source, Model 8000 is the ultimate solution for power electronic testing, the system includes a wide range of hardware choice such as AC/DC source, electronic loads, DMM, oscillate scope, noise analyzer and short/OVP tester. The ATS 8000 system uses a unique test command optimization technology to prevent repetitive control commands from being sent to system hardware devices. This improve test speed dramatically and makes ideal choice for both high speed production applications as well as design verification.

INTRODUCTION

Taiwan photon source (TPS) was built in 2012 and commission succeed in 2014. Taiwan photon source synchrotron light source facilities total budget of NT6.88 billion and provide 518 meters perimeter, the energy of 3 GeV of light source facilities to users in 2016. This "Taiwan Photon Source" will be the largest ever research platform in China to provide the world's highest brightness synchrotron light source, can create a new experimental technology and expand the field of scientific research, promote scientific research on the vigorous development. However, synchrotron radiation accelerators must consume a lot of energy to provide accelerator operation. Monthly electricity costs of TPS must as high as NT 1 million. According to statistics, Taiwan's energy self-sufficiency rate of less than 3%, the annual energy expenditure up to NT 2 trillion, a potential national security issues, the development of renewable energy will enhance Taiwan's energy self-sufficiency rate, while achieving low carbon and non-nuclear energy final goal of government [1]. Therefore, the National Center for Synchrotron Radiation invests large amounts of money to build solar power station. This project has three periods to build solar panels, the total generating capacity of 18Mw, the investment amount of up to NT2 billion. First period generating capacity of 450kw and investment NT33 million at Jan in 2016. Second period generating capacity of 435kw and investment NT30 million at Sep in 2016. The last period generating capacity of 250kw and investment NT18 million in 2022.

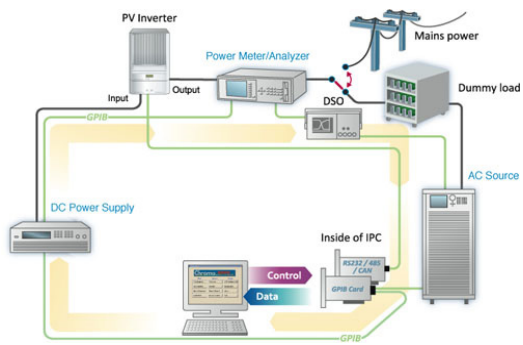
PV SYSTEM

A photovoltaic (PV) system is an energy system that converts solar energy directly into electrical energy. When the sun shines on the solar cell (array) can produce DC power, collected by the PV inverter converted to AC power. Figure 1 has shown two main types of photovoltaic systems: grid and off grid connected system. Grid connected systems are usually installed in residential buildings, providing electricity directly into the grid; off grid inverters directly provide electricity, usually used in the case of the grid unable provide.

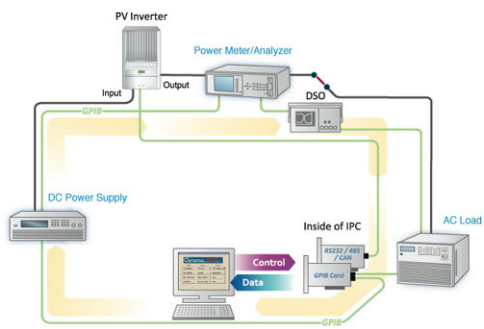
Figure 2 has shown the Chroma 8000 integrates power boards and solar inverter automatic test systems. The software platform has high compatibility and can adapt to the same equipment produced by different manufacturers. Built-in command library to provide users with friendly use of the editing environment, the user can edit the test project according to the measured object, and finally generate the test data report and statistical report [2].

The Chroma 8000 system has the following features:

(1) Integration of programmable equipment, providing integrated control environment to achieve rapid and efficient purposes.
(2) Provide a complete test program.
(3) System architecture modularization and flexibility.
(4) Graphical interface.
(5) Support standard hardware interface: IEEE-488, RS-232C, I2C, USB.
(6) Allow users to develop test items.



(a)



(b)

Figure 1: Grid and Off Grid Connected PV Inverter Test Block Diagram.

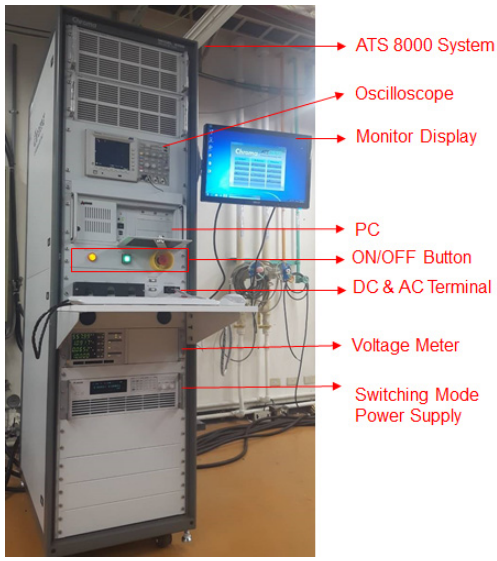


Figure 2: Chroma ATS 8000 system.

SOLAR ARRAY

Conventional c-Si solar cells, normally wired in series, are encapsulated in a solar module to protect them from the weather. The module consists of a tempered glass as cover, a soft and flexible encapsulant, a rear backsheet made of a weathering and fire-resistant material and an aluminium frame around the outer edge. Electrically connected and mounted on a supporting structure, solar modules build a string of modules, often called solar panel. A solar array consists of one or many such panels. A photovoltaic array, or solar array, is a linked collection of solar panels. The power that one module can produce is seldom enough to meet requirements of a home or a business, so the modules are linked together to form an array. Most PV arrays use an inverter to convert the DC power produced by the modules into alternating current that can power lights, motors, and other loads. The modules in a PV array are usually first connected in series to obtain the desired voltage; the individual strings are then connected in parallel to allow the system to produce more current [3]. Typical panel ratings range from less than 100 watts to over 400 watts. For this project is purchase for the Tynsolar corporation product TYNS62610290 solar panel. TYNS62610290 has features such as: bypass diode minimizes the power drop by shade, white tempered glass, EVA resin, weather proof film and anodized aluminium frame to provide efficient protection from the severest environmental conditions. This solar array dimension length is 1640mm*992m and maximum power is 290W and module efficiency is 17.83%. Figure 3 is shown V and I scale of TYNS62610290 solar panel for switching power supply automatic test system. For this figure condition is serial connect 3 module and maximum power is 870-w, the radiation is 800 w/m^2 and solar array temperature by 300k. Illustration: Red dot: Once the voltage is outputted, the measurement is presented by a red dot. Green line: It is the acting I-V curve or the curve presented after altered by I rate or P pate that is generally called active. Gray line: It is the preview line of the next I-V Curve or the previous I-V curve that is usually inactive.

V_{oc}: Open Circuit Voltage
I_{sc}: Short Circuit Current
V_{mp}: Maximum Power Voltage
I_{mp}: Maximum Power Current
P_{mp}: Maximum Power

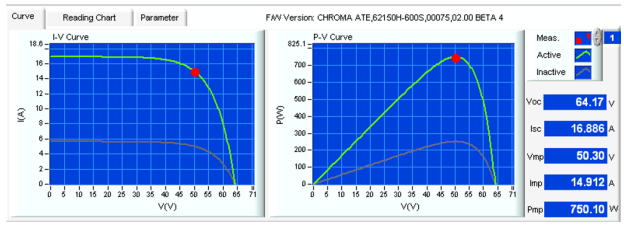


Figure 3: I-V curve simulation curve.

MAXIMUM POWER POINT TRACKING

Maximum power point tracking is a technique used commonly with wind turbines and photovoltaic (PV) solar systems to maximize power extraction under all conditions. PV solar systems exist in many different configurations with regard to their relationship to inverter systems, external grids, battery banks, or other electrical loads.[5] Regardless of the ultimate destination of the solar power, though, the central problem addressed by MPPT is that the efficiency of power transfer from the solar cell depends on both the amount of sunlight falling on the solar panels and the electrical characteristics of the load. As the amount of sunlight varies, the load characteristic that gives the highest power transfer efficiency changes, so that the efficiency of the system is optimized when the load characteristic changes to keep the power transfer at highest efficiency [4], [5]. This load characteristic is called the maximum power point and MPPT is the process of finding this point and keeping the load characteristic there. Electrical circuits can be designed to present arbitrary loads to the photovoltaic cells and then convert the voltage, current, or frequency to suit other devices or systems, and MPPT solves the problem of choosing the best load to be presented to the cells in order to get the most usable power out. The advanced Dynamic MPPT Test function has built in Sandia (Simplified Photovoltaic I-V Curve) and EN50530 (PV generator model) dynamic MPPT test patterns. The user can use the Dynamic MPPT Test function by selecting the Sandia or EN50530 I-V mathematical expressions and test items in the graphical soft panel. It can simulate the luminance and temperature change I-V curve under actual weather to test the PV inverter's dynamic MPPT performance. The user can edit the execution time and temperature change time from low to high luminance by Dynamic I-V curve easily and set its repetition cycle. The GUI will calculate the MPPT performance for analysis after running the test. The software also has test data recording function that can edit the test parameters to be recorded such as voltage, cu rent, power, watt and MPPT performance along with the sampling interval (1 - 10,000s) and total time length to facilitate the

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analysis and validation of PV inverter. Figure 4 is shown dynamic MPPT test panel of ATS 8000 system.

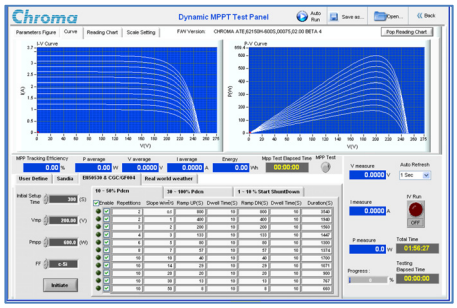

Figure 4: Dynamic MPPT Test Panel.

SHADE-TOLERANT MPPT SIMULATION RESULT

When discussing shaded PV, partial module shade can't be ignored. It's virtually impossible to find a PV array that experiences only even shade on each module. The sun is constantly moving in the sky and shadows are dynamic. Even modules soiled with dirt and debris aren't often soiled in a homogenous way. For these reasons it is necessary to further examine the I-V curve characteristics of a partially shaded module. The effects of partial module shade on the module's I-V curve can be understood by considering individual module sub-sections. The ATS 8000 System has dynamic MPPT test function can fast to find maximum power on the solar array. Figure 5 is shows the relationship between the time, power and solar radiation of the solar module. When the sun is shaded, the amount of solar radiation in three periods suddenly dropped from 780 w/m^2 to250 w/m^2, solar panel power from 50W down to 5W and temperature dropped from 328k to 313k. Solar array power will continue to rise when the sunshine radiation recovery. At this time, the ATS 8000 system built-in dynamic maximum power tracking program will continue to action, in order to pursue the maximum power point and can be observe the maximum power point between about 45W to 55W.

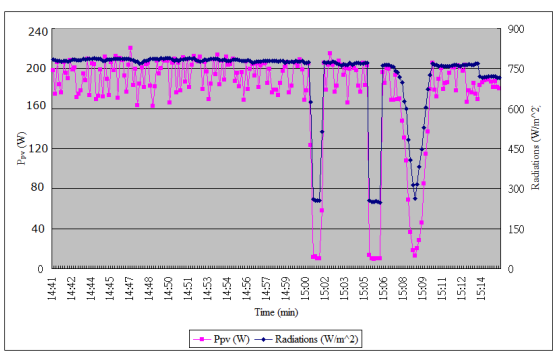

Figure 5: Solar cell module time, power and radiation relation curve.

CONCLUSION

Switching power supply automatic test system integration of programmable equipment, providing integrated control environment to achieve rapid and efficient purposes. It also can be very easy and accurate measurement characteristics of the curve in the solar array. Built-in dynamic MPPT function can solve the problem of shielding effect. Finally, simulation shade-tolerant at 30 minutes, ATS 8000 system dynamic MPPT function to start. Successfully tracked the maximum power of the solar panel array when restoring sunlight.

ACKNOWLEDGEMENT

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