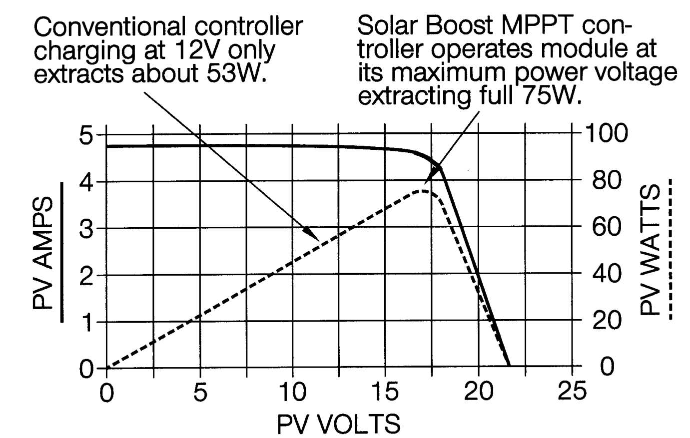
# *What is Maximum Power Point Tracking (MPPT) and How Does it Work?*

Maximum Power Point Tracking, frequently referred to as MPPT, is an electronic system that operates the Photovoltaic (PV) modules in a manner that allows the modules to produce all the power they are capable of. MPPT is not a mechanical tracking system that “physically moves” the modules to make them point more directly at the sun. MPPT is a fully electronic system that varies the electrical operating point of the modules so that the modules are able to deliver maximum available power. Additional power harvested from the modules is then made available as increased battery charge current. MPPT can be used in conjunction with a mechanical tracking system, but the two systems are completely different.

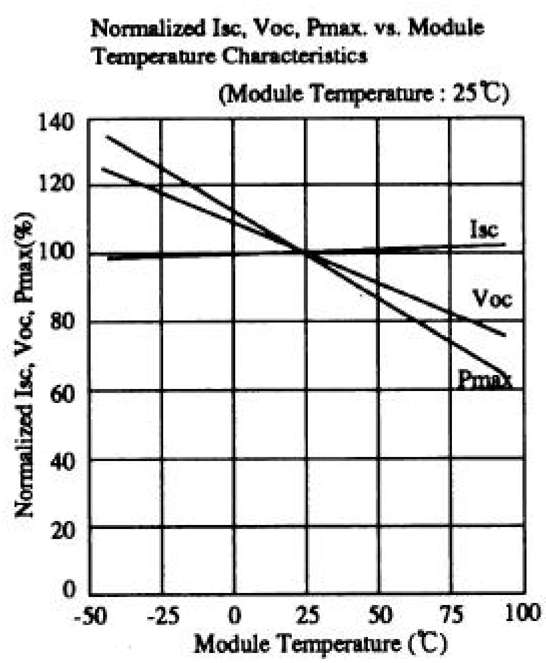
To understand how MPPT works, let’s first consider the operation of a conventional (non-MPPT) charge controller. When a conventional controller is charging a discharged battery, it simply connects the modules directly to the battery. This forces the modules to operate at battery voltage, typically not the ideal operating voltage at which the modules are able to produce their maximum available power. The PV Module Power/Voltage/Current graph shows the traditional Current/Voltage curve for a typical 75W module at standard test conditions of 25°C cell temperature and 1000W/m$^2$ of insolation. This graph also shows PV module power delivered vs module voltage. For the example shown, the conventional controller simply connects the module to the battery and therefore forces the module to operate at 12V. By forcing the 75W module to operate at 12V the conventional controller artificially limits power production to ≈53W.




Typical 75W PV Module Power/Voltage/Current At Standard Test Conditions

Rather than simply connecting the module to the battery, the patented MPPT system in a Solar Boost™ charge controller calculates the voltage at which the module is able to produce maximum power. In this example the maximum power voltage of the module ($V_{MP}$) is 17V. The MPPT system then operates the modules at 17V to extract the full 75W, regardless of present battery voltage. A high efficiency DC-to-DC power converter converts the 17V module voltage at the controller input to battery voltage at the output. If the whole system wiring and all was 100% efficient, battery charge current in this example would be $V_{MODULE} \div V_{BATTERY} \times I_{MODULE}$, or 17V ÷ 12V x 4.45A = 6.30A. A charge current increase of 1.85A or 42% would be achieved by harvesting module power that would have been left behind by a conventional controller and turning it into useable charge current. But, nothing is 100% efficient and actual charge current increase will be somewhat lower as some power is lost in wiring, fuses, circuit breakers, and in the Solar Boost charge controller.

Actual charge current increase varies with operating conditions. As shown above, the greater the difference between PV module maximum power voltage $V_{MP}$ and battery voltage, the greater the charge current increase will be. Cooler PV module cell temperatures tend to produce higher $V_{MP}$ and therefore greater charge current increase. This is because $V_{MP}$ and available power increase as module cell temperature decreases as shown in the PV Module Temperature Performance graph. Modules with a 25°C $V_{MP}$ rating higher than 17V will also tend to produce more charge current increase because the difference between actual $V_{MP}$ and battery voltage will be greater. A highly discharged battery will also increase charge current since battery voltage is lower, and output to the battery during MPPT could be thought of as being "constant power".




Typical PV Module Temperature Performance

What most people see in cool comfortable temperatures with typical battery conditions is a charge current increase of between 10 – 25%. Cooler temperatures and highly discharged batteries can produce increases in excess of 30%. Customers in cold climates have reported charge current increases in excess of 40%. What this means is that current increase tends to be greatest when it is needed most; in cooler conditions when days are short, sun is low on the horizon, and batteries may be more highly discharged. In conditions where extra power is not available (highly charged battery and hot PV modules) a Solar Boost charge controller will perform as a conventional PWM type controller. Home Power Magazine has presented RV Power Products (now Blue Sky Energy, Inc.) with two Things-That-Work articles; Solar Boost 2000 in HP#73 Oct./Nov. 1999, and Solar Boost 50 in HP#77 June/July 2000, Links to these articles can be found on the Blue Sky Energy, Inc. web site at www.blueskyenergyinc.com.

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