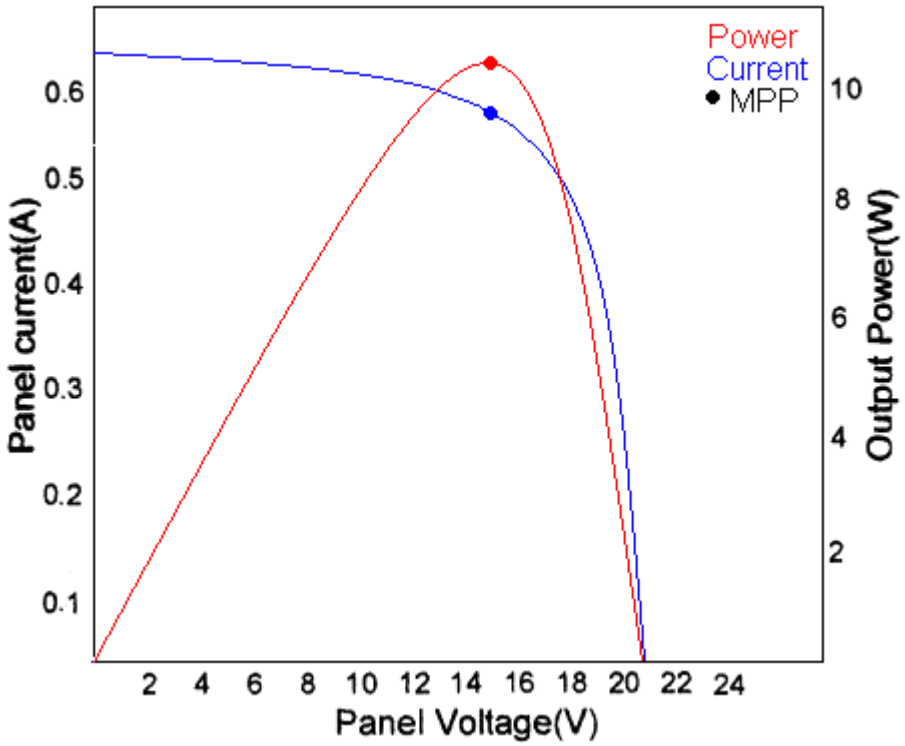
Competition Electronics
EasYMaX Solar Power Enhancer

Introduction

The power output of a solar panel varies significantly with varying load conditions given constant illumination on the panel's surface. Under full sunlight, a 10 watt panel can output 10 watts given ideal load conditions, or it can output less than 1 watt, given non ideal load conditions.

The ideal load for a specific solar panel depends solely on the solar panels MPP (maximum power point). The MPP is a point on the I/V curve where output power is at maximum. Below is a I/V curve with the MPP clearly labelled with a dot. As you can see, the output power varies greatly with varying output voltage.



When I talk of the 'Ideal load', what I mean is; a load that will not pull or push the solar panels voltage below or above the MPP voltage.

Now, the problem is, when we connect the panel directly to a motor to drive, the load is hardly ever ideal. Why?? Ok, when your motor is stalled, or under heavy load (e.g. at the start-up gate), the voltage across the motor terminals is very low (it acts like a low Ω resistor), typically around 0.2-2 volts for a standard solar car motor. As the car speeds up, the voltage will increase (motor voltage is proportional to its speed), and eventually reach the MPP voltage. During a typical solar car race, a well geared car will sit at or around the MPP for only 10 – 20% of the race. So, it's only seeing maximum power for only around 10 – 20% of the time.

Now, how can we solve this problem?? How can we deliver maximum power to the motor, throughout the full lap?? Ok. This is what the enhancer does. It holds the solar

panels output voltage at its MPP voltage regardless of the load conditions. We can have 2 volts across the motor terminals, while having 15 volts across the solar panels terminals. Huh?? What happen to the rest of the voltage?? K. Its smart. It converts all the excess voltage into current. So we can have more amps going to motor, resulting in better acceleration, or increased torque.

I don't get it!! Ok, here's an example:

We have a 10watt solar panel with a MPP at 15.5 volts, and a short circuit current of 0.7 amps. During the beginning of our race our motor voltage will be low (voltage is proportional to speed remember). Let's say our motor voltage will be 3 volts. At 3 volts, the panel will produce around 0.68 amps, so our power going to the motor is 0.68amps x 3volts = 2.04 watts. Damn, we are losing like 8 watts. However, if we use a solar enhancer our panel voltage is always 15.5 volts and panel current is around 0.65 amps (10watts). So when we have 3volts across the motor, our motor current will be 10watts/3volts = 3.33 amps. WOW, we have 5 times the current, which means 5 times more torque at that motor speed (resulting in better acceleration). As our motor voltage increases, the current decreases, maintaining a output power of P_{max} watts (minus the enhancer losses which are very low).

EasyMax vs. Others

Because all solar panels have a different MPP, and because the MPP fluctuates with different light intensities and temperatures, you need to always tune your maximiser to get maximum performance.

With a normal maximiser, to tune your maximiser you'll need to connect a voltmeter to the motor, stall the motor, and trim a potentiometer until you get maximum voltage across the motor. When you see maximum voltage across the motor, it means your solar panel is at its MPP. This method of tuning can be tricky, takes a lot of time, and sometimes, if you stuff up the tuning, it can lead to a huge power loss.

The EasyMax, however, is much easier to tune. It has a built in microcontroller, which is programmed to sweep your solar panels power curve, and find the MPP at a push of a button. The entire process takes less than a second, and it will find your MPP to an accuracy of ±2%, which is excellent, given your MPP can fluctuate up to ±20% throughout a normal day. It can easily be set before every race, to ensure that your panel is always at its MPP (maximum power point).

Specs

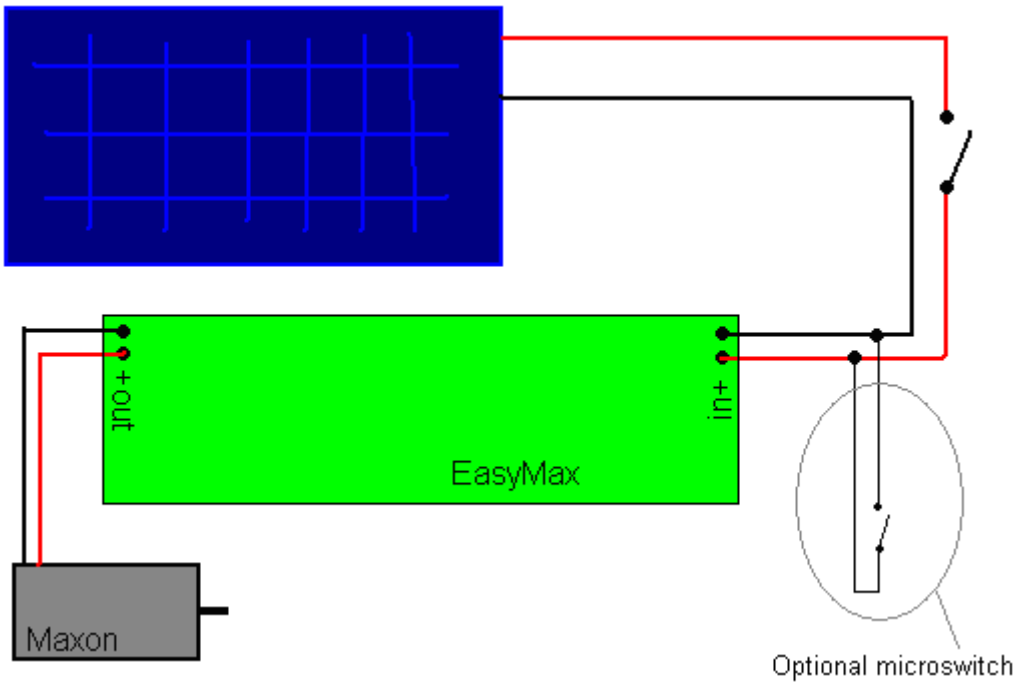
Easy One-Touch setup
Maximum efficiency: 97%
Input voltage: 10 – 25 volts
Output Voltage: 0 – $V_{(OC)}$
Power: 3 – 12 watts.

Setting it up

Connection

The rear of the EasyMax's PCB is labelled with **in** and **out**, with the positive terminal clearly labelled with a **+** sign. The **in** connects to your solar panel, and the **out** connects to your motor. Make sure you have the solar panel and motor polarities the right way.

Below is a connection diagram to make things simpler. (☺ 1337 paint skillz)



>> If you want Back-EMF braking, just connect the switch in parallel with the panel (to short it) instead of in series.

>> Also, to prevent wheel spin at the start gate, you can have a micro-switch, connected to short the panel. Have separate wires connecting it so that way your actual power wires are short as possible. This will ensure minimal voltage drop.

The EasyMax has onboard Dean's Micro Plugs. These make the connections really simple and prevent stuff-ups later on. All you need to do is solder the motor, and solar panel wires onto the plugs and your set. You will get a set of micro plugs to start with, if you need more, just order them from your local hobby shop, or wherever you got the EasyMax from. They are cheap. Not more than $4 a pair.

Setting the MPP

The EasyMax is set in a few easy steps, and there is a status LED to tell you what's going on. During the setup process, your motor needs to be connected, and your panel needs to be in the same lighting conditions that you're going to race in. Usually, you'll place you car on the track, then set it up.

Procedure:

1. Make sure the panel, and the motor are connected, and the power is turned on. (When the power is turned on, the LED will flash once every 3-4 seconds and the motor will be spinning).
2. **Stall the motor or the wheel.** (We need to stall the motor shaft so it doesn't spin, so the motor acts like a resistor).
3. **Press, and let go of the button.** (When you press the button, the controller will search for your solar panels MPP. The LED will be turned on while it's searching, and when the LED turns off, it means that MPP is set). The process will take about 1 second.
4. After the LED turns off, you can release the motor to spin again.

Once the MPP is set, the LED will continue to flash once every 3-4 seconds. This means it's under normal operation.

The microcontroller will store the MPP in its memory. So you can turn the EasyMax on and off, and it will remember your last setting.

If you let go of the motor shaft during the set-up procedure, the LED will flash very fast. This means you need to re-set the maximiser. Make sure the motor shaft isn't slipping, or you're not letting go too early.

LED status:

Blinking slowly:	Normal operation;
Fully on:	Searching for the MPP (will only do this when button is pressed);
Blinking Fast:	Did not set; Turn off, and try again. (Usually happens if the motor shaft slips).
Never on:	No power; or input power is reversed.

EasyMax has reversed input protection, and input-output protection.

Questions or Problems:

Got any problems, questions or suggestions???
Shoot me an email at Dreamtec@dreamtec-rc.com

-Tony Bazouni.