SOLAR PANEL WIRING – in Series and/or Parallel

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SECTION 1: INTRODUCTION

DESCRIPTION

SERIES AND PARALLEL

As Scorpio have a number of two piece solar panels, it is common (and preferable) to wire the solar panel (or even 2 panels) to allow either series or parallel connections. This allows you to make the most of the changing sunlight conditions by flicking a switch.

This allows an effective reduction in drive ratio of 2:1 at the flick of a switch because the motor RPM varies directly with voltage so parallel connection with half the voltage of series connection halves the motor RPM.



At the same time current (amps) in parallel is twice that in series and motor torque varies directly with current, consequently we have twice the torque.

WHAT DOES THAT MEAN?

- At full sunlight, when the solar panel's two sections are connected in series a solar car or boat will run fast. As the sunlight diminishes, the speed will also gradually diminish until finally the solar car or boat will stop. It stops because the current is too low.
- When the current gets too low (with the sections in series), reconnect the two sections in parallel. This provides double the current, and the motor will start running again – although slower, due to the voltage being reduced.

INFORMATION PROVIDED

The information provided is based on the SOLAR26 panel. However the same principle applies to any 2 piece panel, or any 2 solar panels being connected together (only the values change).

POSSIBLE ITEMS FOR INVESTIGATION

This project provides a number of different aspects of solar power for both cars and boats for investigation. Some ideas are listed below.

- The Solar panel is a purpose-designed unit, consisting of 2 sections, and these may be connected in series or parallel. The use of 2 sections is useful for experimentation, as it means that you could experiment with the output of the panel in 3 different configurations:
 - $\circ~$ Only one section to see how much power is output, what speed is attained this can easily be done by covering one section with a piece of cardboard.
 - Both sections connected in Series.



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- Both sections connected in Parallel.
- $\circ~$ Establish conditions for using the solar panel sections in series or parallel. Set up a test schedule for these experiments.



Typical output in full Sun:

+ve

7.0 Volts

-ve

SECTION 4: SWITCHED SERIES OR PARALLEL



SECTION 1: TEST RESULTS

Static thrust tests with a Scorpio Solar panel 26, boat motor and 2 bladed propeller gave the following results. Examination of the graphs show indicate the changeover point from parallel to series should be at around 60% Sun.

Below 60% Sun parallel is indicated and above 60% Sun series is indicated. As Sun levels usually do not change significantly in the short term a reasonable approach to avoid the complex wiring (for primary students) to achieve a switched series / parallel set up would be to use alligator clip leads to configure the panel.



SECTION 5: THEORY

HOW THE SOLAR PANEL WORKS

Silicon solar cells generate electricity when exposed to sunlight, but a halogen lamp can also be used.

- > Each cell produces 0.5 Volts.
- The current (amps) produced is proportional to the cell's surface area. The cell's power is rated at "full sunlight".
- When the sky is overcast, the sun's power is lower, and the amount of amps produced is less, while the voltage remains at 0.5 volts.

NOTE: The power output also decreases as the temperature of the panel increases.

Each of the sections in our panel has 7 cells connected in series, to give a voltage of 3.5 Volt. Each section is designed to be 0.8 Amps at full sunlight.