ESTIMATING POWER FROM A SOLAR PANEL

INTRODUCTION

The usable power generated by the Davis Solar Power Kit may vary depending on latitude, time of year, weather condition and the storage battery capacity. This Application note discusses estimating the usable power generated and delivered by the combination of the solar panel and storage battery.

FACTORS AFFECTING SOLAR PANEL OUTPUT

- Output rating of the solar panel. Larger panels produce more power than smaller panels. The Davis solar panel is rated at 10 Watts. It provides about 600 mA of current in bright sunshine (1000 W/m^2).
- Intensity of solar radiation. Bright sunshine produces more power than cloud cover. In cloudy conditions, output from the Davis solar panel drops to about 20 to 30% of the current generated in bright sunshine. Time of year may also affect output: solar intensity is reduced in winter. Finally, snow or other materials covering the panel may reduce or cut off power output.
- Hours of available light. Time of year also affects the duration of light available to the panel. In middle latitudes, summer days may have 14 hours of daylight, while winter days may have as few as ten hours. In higher latitudes, daylight hours may be even further reduced.

FACTORS AFFECTING CHOICE OF STORAGE BATTERY

- A battery stores excess power produced by the solar panel. This power runs the weather station at night and during prolonged daytime cloudy periods when there is not enough light to power the station from the panel.
- Storage capacity of the battery. Larger batteries can store more power than smaller batteries. The Davis battery (#7711) is rated at 6.5 Amp-Hours. This means that when fully charged, the battery can supply about .325 Amps (325 mA) of current to a load for 20 hours. A typical Davis weather station uses about 15 mA, so this battery would operate it for about 650 hours or 18 days.

ESTIMATING SOLAR PANEL OUTPUT

As a rule of thumb, in the middle latitudes, a solar panel will generate as much as 50% of its rated capacity per day. This means the Davis panel will produce an average of about 300 mA per hour or about 2.4 Amp-Hours per day. This is more than adequate for an installation that will only be powering a weather station. If other devices need power, such as a radio modem, you will need to refine your estimate. The most accurate way to calculate solar power potential is to obtain historical data for the site showing the typical solar radiation over the course of a year. Look at the time of year when the solar radiation produced per day over a 2-week period is the least. This is the worst case period and will produce the least amount of power from the solar panel. If you estimate the average solar radiation per hour during this period, you can then estimate how much power the solar panel will generate. Assume that the sun averages about 400 W/m^2 for about 8 hours per day. The current generated by the solar panel is roughly proportional to the ratio of the actual solar radiation to 1000 W/m^2 multiplied by 600 mA. Therefore, the average current would be

$$(400/1000)*600 = 240 \text{ mA}.$$

Amp-Hours is equal to the average current multiplied by the number of hours at this current. For this example the worst case would be (240 mA) * (8 hours) = 1920 mAmp-Hours = 1.92 Amp-Hours.

Rather than searching historical records, you can create your own historical solar radiation database using a Davis weather station equipped with a solar radiation sensor. You can then estimate panel output as outlined above.

SIZING THE SOLAR PANEL AND BATTERY

The solar panel will only generate power during daylight hours. Supplying power to the station at night and during periods of significant cloud cover or fog requires using a storage battery. During daylight the solar panel must power the weather station as well as recharge the battery. Note the following three points for a conservative design approach.

- Estimate the average current consumption for the weather station and any auxiliary loads. For this example, assume about 15 mA for a simple weather station installation.
- Factor in a continuous backup period during which the solar panel generates no charging current due to cloud or snow cover. Assume an 18 day duration.
- Factor in the number of days that the solar panel will take to completely recharge the battery. Assume a period of 7 days.

Using these assumptions, we can calculate the following:

- Battery capacity in Amp-Hours. This depends on a backup period assumption of 21 days.

Capacity = (21 days) * (15 mA) * (24 hours)
= about 6.5 Amp-Hours
Note: Davis 6.5 Amp-Hour battery meets this requirement.

- Average daily power output of the solar panel. This depends on the weather station load of 10 mA and the need to recharge a dead battery in 7 days.

Output = ((24 hours) * (15 mA) + 6.5 Amp-Hours) / (7 days)
= about 1.3 Amp-Hours / day
Note: Davis solar panel easily generates this power in most locations.

This example demonstrates how solar panel and bettery capacity are related for a typical installation. If your system needs more electrical power or more backup time, you should revise the assumptions and recalculate new solar panel and battery capacity values. Newly calculated values may exceed the rating of the Davis 10 Watt solar panel and/or 6.5 Amp-Hour battery. If this happens, recheck each assumption and make sure that your estimates and safety margins are reasonable. If the calculated capacities still exceed the standard Davis products you will need to purchase a larger solar panel or battery from another vendor.

Larger solar panels are available from many alternate energy suppliers. A larger solar panel will require a suitably sized regulator. West Marine Products sells a complete line of rugged solar panels and regulators for the recreational boating market. Contact 1-800-538-0775 for further information.

Larger capacity storage batteries can battery cases are available from many RV and boating suppliers. Also, most Sears Battery and Tire Centers carry deep cycle batteries and cases. Die Hard Model 96494, a deep cycle 24M battery cost $59.99 in July 1997.

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