

# EA-467 Electrical Power System (EPS) Battery Charge/discharge (day 1) (rev a) Fall 2008

**Elements:** PV cells, IV curves, NiCd Cells, Charging/discharging, Series/Shunt Regulators

**Covered in EA204:** IV curve, cell efficiency, incidence angle,  $1/r^2$  distance, and RTG's

**Introduction:** The EPS consists of a power source (usually PV cells), energy storage (usually batteries), a means of power distribution, and a means of power regulation and control. Rechargeable batteries are charged when PV panels are in the Sun and provide power (discharge) when the panels are in eclipse.

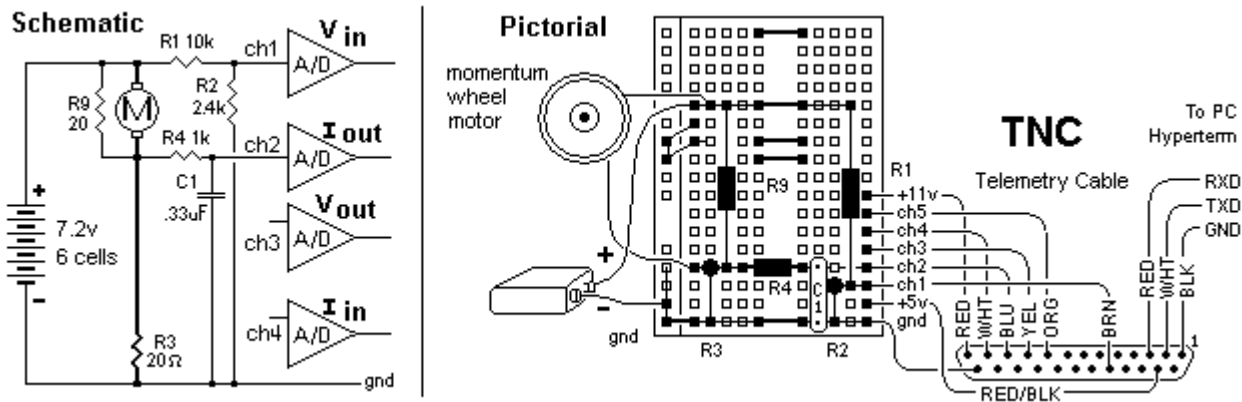
**LABsat Configuration:** Your LABsat EPS includes a solar panel, and a circuit prototyping area for connecting loads (a resistor box) and regulators to its telemetry system. As in the telemetry labs, your LABsat will output its telemetry via its serial port to your PC running Hyperterm. You will use this configuration to observe the following experiments:

1. Battery charge and discharge characteristics
2. Solar panel I-V and power-voltage (P-V) characteristic curves.
3. Temperature effects on solar panel voltage and shadow effects.
4. Voltage regulators for Series, Shunt and Switching regulators.



Form groups of two for each LABsat. Although you will use the LABsat telemetry for most plots, you should also sketch some of your data during the lab to ensure its validity while you still have time to fix it. Show sketches to the instructor for confirmation before leaving class.

**Part A. Nickel Cadmium Battery Discharge :** The battery discharge will be performed on an auxiliary “9 volt” NiCd battery using your momentum wheel motor as the load with data collected by the LABsat telemetry system. The purpose of this experiment is to observe the discharge characteristics of the battery composed of multiple NiCd cells in series.

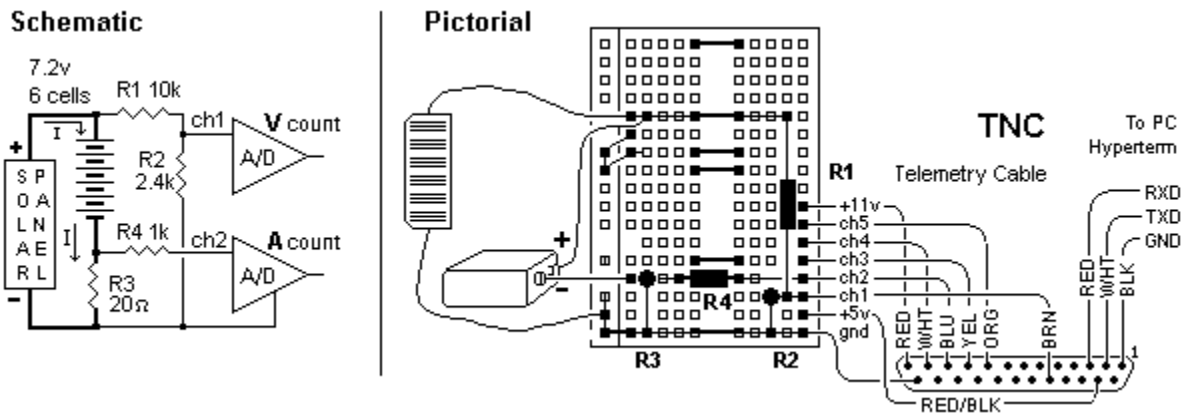


1. Start a Hyperterm capture file. Use the TE 1 command to set your telemetry rate to 10 seconds. You will use channel 1 to read Voltage and channel 2 to read current as the battery discharges.
2. Connect the momentum wheel motor to the 6 cell NiCd “9v” battery as shown below so that channel 1 reads the voltage from the battery via the R1/R2 voltage divider and channel 2 reads the current as the voltage drop across R3. The 20 Ohm R9 parallels the motor to significantly increase the load so that the battery should run down in about 15 minutes (we hope).
3. Use a 1k resistor R4 and .33 uF capacitor on the channel 2 A/D input to act as a low pass filter to smooth out the current transients from the motor that we observed in the telemetry lab.

- The LABsat will sample the telemetry data every 10 seconds. Watch the voltage and current as the battery discharges. When the motor stops, save your Capture file.

**Post-Lab:** Load your capture file into Excel. Import only the Channel 1 and Channel 2 columns. Plot the voltage, current and power versus time of the battery discharge. As you learned in the Telemetry Lab, the 10k/2.4k resistors R1/R2 give a voltage equation of about 1 count = 0.1 volt and R3 of 20 ohms gives a current equation of about 1 count = 1 mA. Discuss the curves. Annotate any stair-step drops you observe in the battery voltage as individual cells are depleted first? Estimate the area under the current curve (I) to give you the total milliamp-hours (mA-h) extracted from the battery.

**Part B. Battery Charging:** This experiment examines the solar array's ability to charge the 120 mA-h, "9 V" battery consisting of 6 NiCd cells. Cells will charge up to 1.4 V per cell and typically discharge at 1.2 V per cell. For typical consumer applications NiCd's are trickle charged at the 0.1C current rating (for 14 hours) to allow for 40% inefficiency in the charging process. This yields an effective capacity of 10 hours at 0.1C capacity or 1C. Charging at higher rates can overheat, and/or ruin the battery.



- Start a new capture file and reconfigure your LABsat for charging instead of discharging.
- Unplug and replace the battery pins with the solar panel pins. Remove the R9 resistor and plug the battery into where the R9 resistor was to implement the schematic above.
- Move the negative terminal of the battery from the ground line to the R3/R4 junction point as shown so that the charge current will pass through R3 for measuring with channel 2. Channel 1 still reads the battery voltage with the R1/R2 voltage divider.
- Place your LABsat in the Sun spot and confirm that the telemetry you are receiving is reasonable for the voltage and current expected. Watch it for a while to see any trends or see if you see when any cells that may have been at zero, begin to charge.
- Since you will be charging at a less than 1C rate, this charge will take some time before it is complete. You will observe the telemetry to the end of the 1<sup>st</sup> day's class. Inform your instructor of the filename so that after you have left class and the charge is complete, the file may be emailed to you.
- Note the battery capacity printed on the battery. All NiCd's will have the capacity noted on the cell so you know how to safely charge the cell.

**Post-Lab:** Load the data file into Excel, capturing only the channel 1 and channel 2 telemetry. Plot the battery voltage and charge current with time. See if your data detected the peak voltage rise at the point where the cells reached full charge. Since each cell will peak on its own, look for indications of cells that peak early or late. Your report will cover this part A and B and remaining parts in the next lab period.