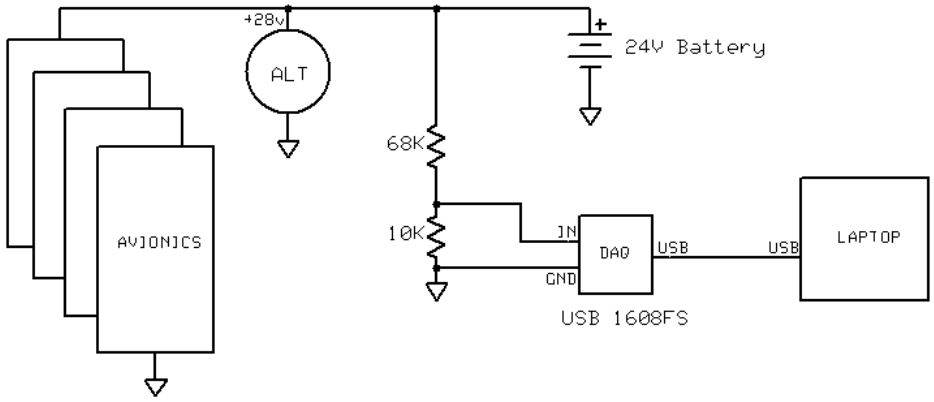
Electrical System Examination

I recently completed construction of a pressurized Lancair ES-P that is in Phase I flight testing. My plane has a 28-volt electrical system energized by a Continental 100A alternator. I used a B&C Specialties LR3C-28 regulator and a series pair of Panasonic LC-X1220P sealed lead acid batteries. The aircraft is composite; the aft-mounted batteries are connected to the business end with 2 AWG cable.

The avionics represent a significant investment; I was interested to see if anything "interesting" was happening on the 28V bus during various phases of operation. The best way I could think to do this was to sample and log the bus voltage during a representative flight and analyze the results later, so I purchased a Measurement Computing Devices USB-1608FS data acquisition module and wrote some simple data logging software. The resulting system allows me to measure from 0 to 78 volts with a few mV precision, sampled every ½ millisecond, for many hours. Here is an idealized diagram of the setup:



I hooked the unit up to my plane's electrical system, connected it to my laptop and went flying. Figure 1 shows a difficult engine start; the vertical axis is the system voltage and the horizontal axis is elapsed time in seconds. The graph begins at the left with master switch engagement; the first engine crank is approximately 1 ½ minutes later. I had lots of trouble starting the engine; you can see twelve attempts! There is significant voltage sag as the starter is engaged; it goes as low as 8.6 volts, and remains below 12 volts for 15mS. The system voltage finds its way back near 24 volts as the engine cranks and there is a small overshoot to about 29.6 volts as the engine sputters. I ran the boost pump several times and hit the electric primer button now and again; there is no apparent effect of this in the voltage trace.

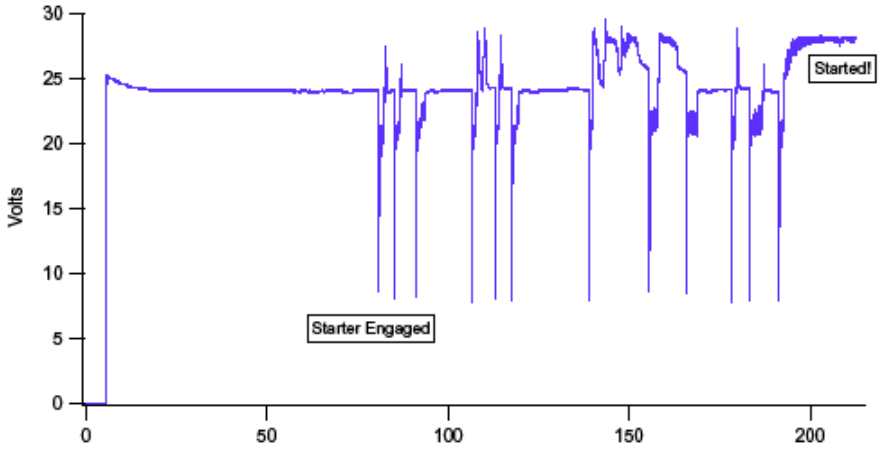


Figure 1 - Multiple Start Attempts

Figure 2 is a closer examination of the first failed engine start from above:

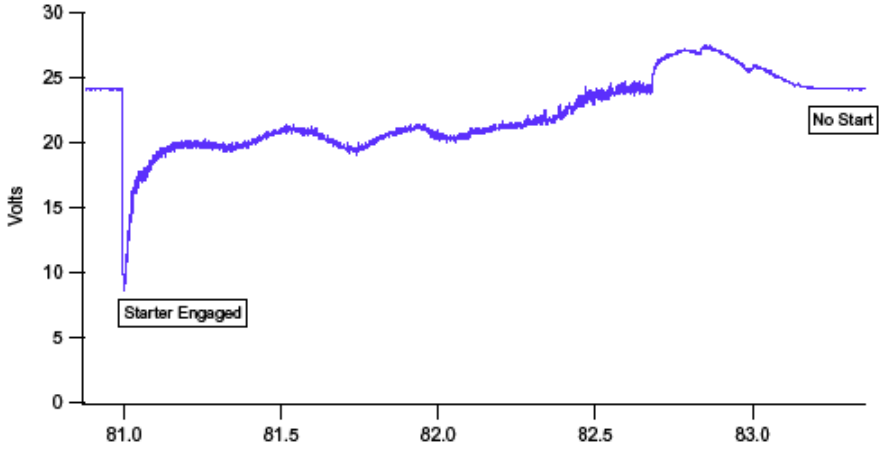


Figure 2 - Failed Start Attempt

I finally got the engine started; Figure 3 covers the runup and departure.

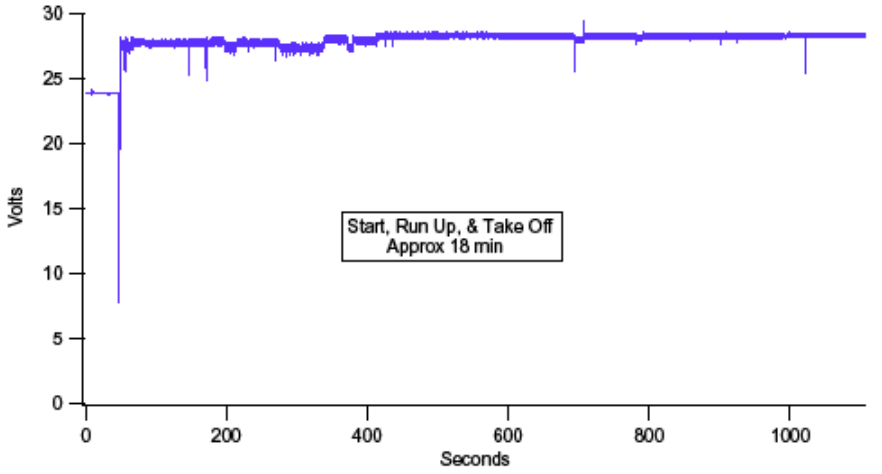


Figure 3 - Start, RunUp, and Departure

The highest current draw on my aircraft is an engine-driven air conditioner. The 17 amp steady state load consists of two blowers and a compressor clutch solenoid. Figure 4 shows when the air conditioner is turned on; Figure 5 is the A/C being turned off.

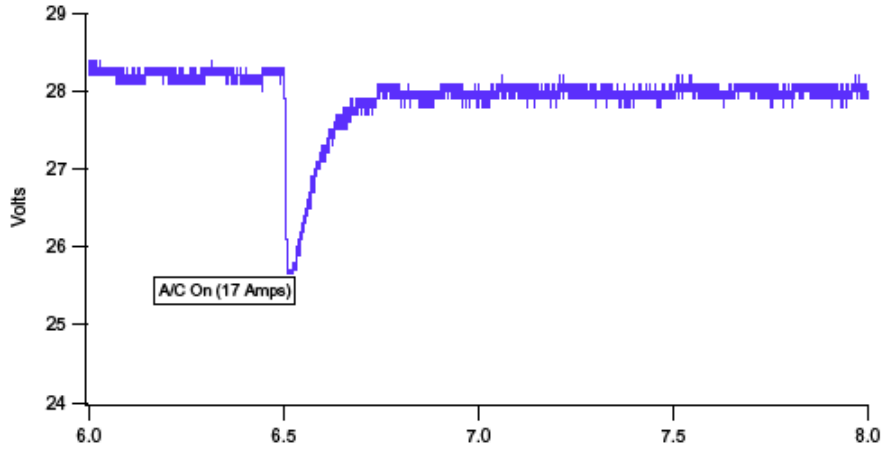


Figure 4 - A/C Turned On

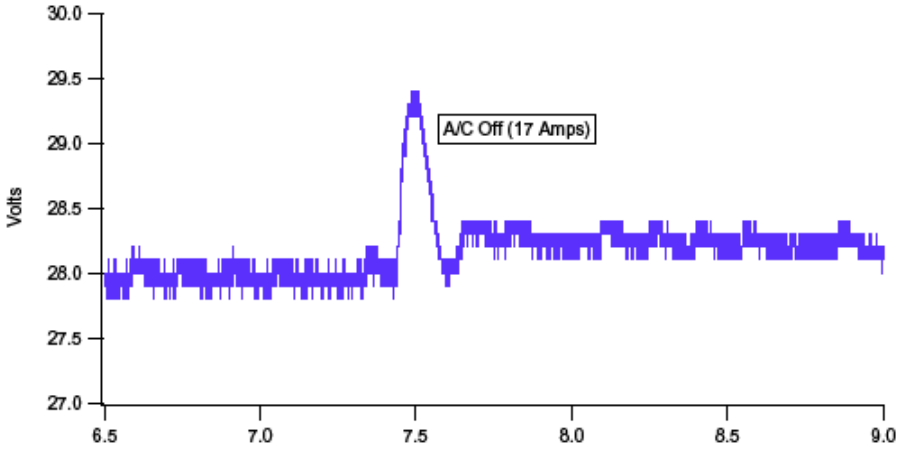


Figure 5 - A/C Turned Off

I have two XeVision HID lamps; the next figures show them turned on and then turned off.

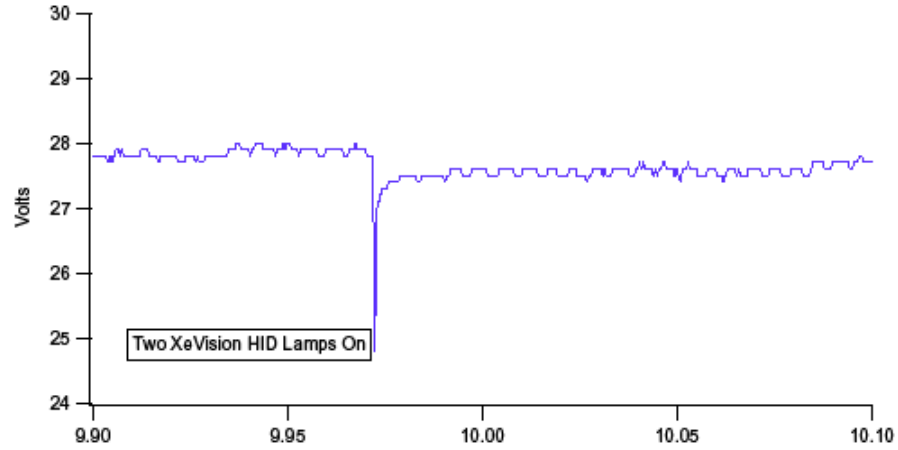


Figure 6 - Lights On

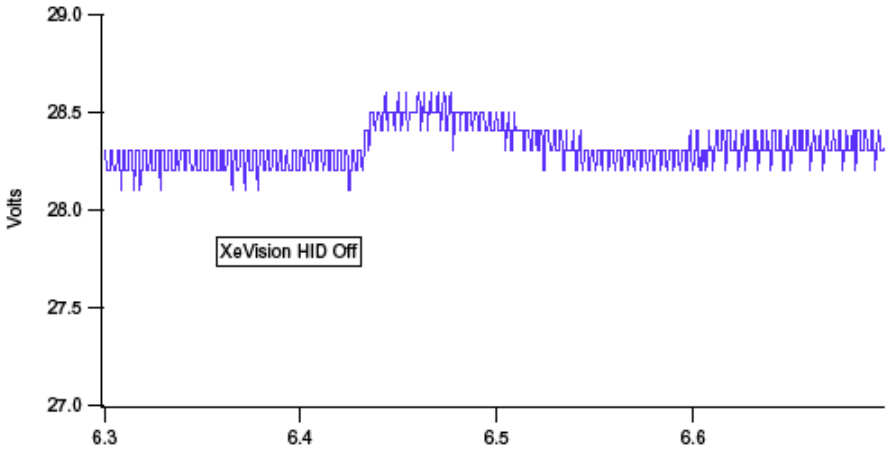


Figure 7 - Lights Off

Finally, Figure 8 shows extreme detail for steady state cruise flight. There is about 0.2 volt ripple in the supply.

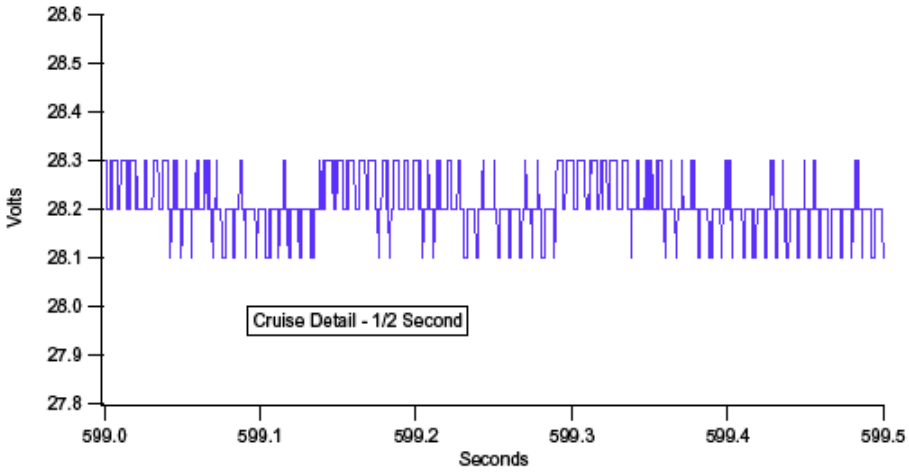


Figure 8 - Cruise Detail