

March 15, 2007

Tonight was the first real use of my new Bench Power Supply & Load Center. Tonight I did an organized test of my PWM DC motor controller. I was testing for main component heating under measured loads.

The bench power supply consists of a 1 amp 14.5 volt Radio Shack power supply, converting house current to DC. I use this section to provide power when I work on control circuits. This gets used a lot.

The second part of my power supply is used to supply heavier currents for real world load testing. This supply consists of two well used automotive batteries connected in parallel. I manually charge them with a 10 amp charger prior to a test. During the test the charger is disconnected.

The load center consists of a bank of wire wound resistors, six different values, two aircraft headlights, a small squirrel-cage fan and an automotive radiator fan that will pull about 10 amps at 12 volts. I have 12 common “wall” switches (like you use on your house circuits to control lights) to turn all of these various loads on and off.

All supply current goes through a 50 amp shunt. I have permanently dedicated two identical digital volt meters to the power supply. One DVM monitors the shunt so I can see at a glance the amp load from 1.0 to 50 amps. The second DVM monitors the actual supply voltage. You will see these “used” automotive batteries while massive do drop voltage over a 10-20 minute testing period.



Bench Power & Load Center



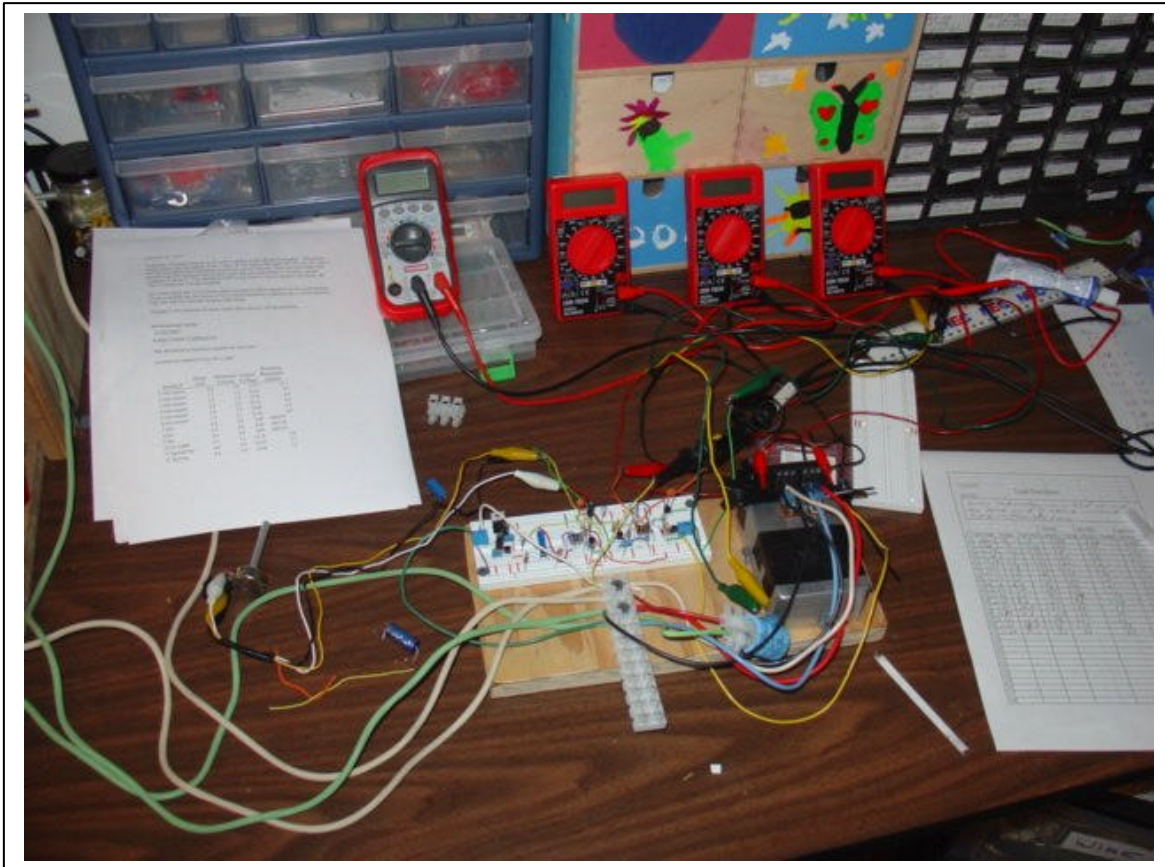
Used Automotive Batteries

In the next series of photos you will see the breadboard sitting just to the right of the load center, my two O-scopes are on the far right. You can see that my “new” Tektronix 466 Storage scope (doesn't work yet) is earning its keep holding up my trusty old 1982 Phillips scope (still works great).

## Test Bench Work Area



You will see a series of volt meters behind the breadboard, the left one is measuring the PWM reference voltage so I can note what PWM% I am at during a reading. The three identical DMV's to the right are measuring the thermister resistance of the flywheel diode, the big mosfet and the load capacitor. I have a thermister epoxied onto each component in order to track the component case temperature.



## Close-up of test circuit and instrumentation

The diecast aluminum case on the right has the TO-220 mosfet and the TO-220 flywheel diode mounted with proper hardware. This mounting simulates how they will be used on the final circuit. The final PCB will get rid of all those long noisy wires.

### ACTUAL LOAD TEST:

Tonight's exercise was intended to start testing what this circuit and its components can withstand thermally. The intended maximum working load is 20 amps in an automotive environment, 12 – 14.7 volt range. The circuit can run anywhere from 0 to 100 % Pulse Width Modulation.

I have pasted in the data collection sheet at the end of this article. My basic procedure was to select a the appropriate load resistors and adjust the PWM% (a simple potentiometer control) until the power supply shunt reading settled on the desired current load. Then I started my stop watch and let it sit for a full minute. By the end of a minute the thermister readings were stable. At that point I recorded the data. Reset and repeat for the next data point.

The three main components being tested; the large mosfet (Fairchild N-channel RFG50N06), the flywheel diode (STPS41H100CG) and the power capacitor (CDE 300681M040JE8\_680uF). Each of these components had a NTE-202 thermister epoxied onto their case in order to have some level of temperature measurement.

The two TO0220 components have a 175 C rating for their internal junction. The capacitor is rated up to 105 C. For tonight's exercise I decided not let the TO-220 case temperatures exceed 100 C. Initially I had calculated the mosfet could survive 20 amps in the conditions it will be used. I need to review the calculations between case temp and internal junction temp. I may or may not have been close to the limit on the mosfet.

I think in a more ideal world I would have the two TO-220 units on separate heat sinks. I think the mosfet was building significant load and the flywheel diode heated up primarily due to conducted heat from the mosfet.

3/15/07

### Load Test Series

#### NOTES:

Various load resistors were switched on and then PWM% was varied to achieve the desired current load. Readings were taken after one minute at each load.

#	Vpwr sup	Amps	Vpwm%	Diode		Mosfet		Capacitor	
				(ohms)	Temp	(ohms)	Temp	(ohms)	Temp
1	0.00	0.00	0.00	2920		2930		2640	
2	12.68	0.20	4.18	2900		2920		2710	
3	12.59	1.10	3.39	2890		2870		2720	
4	12.48	1.90	3.39	2870		2800		2730	

5	12.39	2.90	3.39	2840	2600	2720
6	12.24	3.80	3.39	2510	2010	2650
7	12.24	4.00	3.25	2370	1880	2580
8	12.17	5.00	2.56	2250	1750	2510
9	12.10	6.00	1.92	2160	1630	2470
10	12.03	7.00	1.30	2120	1520	2460
11	11.96	8.00	1.95	1840	1120	2390
12	11.90	9.00	1.60	1760	1000	2350
13	11.84	10.00	2.40	1400	570	2180
14	11.78	11.00	2.07	1260	490	2060
15	11.72	12.00	1.80	1170	420	1970
16	11.68	13.00	1.26	1100	380	1960
17	11.62	14.10	1.88	840	210	1840
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I haven't coded in the thermister temp/resistance function yet but about 200 ohms equals 100 C (I tested with boiling water). 5.6 – 6.2K equals Mt Dew on ice. You can see that the flywheel diode didn't initially build heat nearly as fast as the mosfet. It wasn't until the mosfet actually started getting warm that the diode started gaining heat.

The capacitor didn't seem to get any real heat buildup. I also looked at a very sharp edged 2 volt ripple with a very brief 3-4 volt spike in the waveform. I think this capacitor might have been too large to respond and round off, moderate the supply voltage. Next time I will test with a 220uF capacitor that is rated for 105 C and power supply use. I am trying to avoid adding an inductor if possible (KISS). But that might be the only way to avoid throwing a nasty 2 volt ripple back into the auto's electrical system.

Next time, review case and junction relationship to judge how useful the case temp readings are. Repeat test with smaller capacitor. Consider testing with an inductor to at least see the affect it has on the voltage ripple.