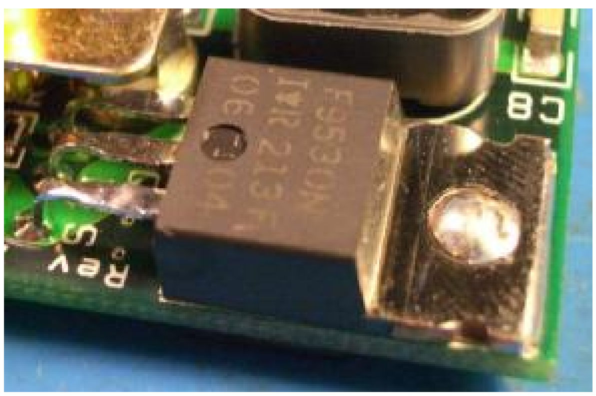
CAN-DO Power Switch Current Capabilities

The question of how much current the CAN-DO widget power switch can safely pass had not been answered so I performed a series of tests in an attempt to resolve this issue. Following is a description of those tests along with their results. I believe the results show that we can safely allow a module to draw up to one amp of current through a widget. If a module needs more than this it will have to obtain that power from another source.

The real issue when considering how much current can safely passed through the widget power switch transistor is how the temperature of that transistor rises as the current is increased. Other specifications of the transistor are such that we will always be safely below their limits. The transistor is an IRF9530N and the pertinent specifications are shown here.

IRF9530N
Vdss = 100 Volts
Rds(on) = 0.20 ohms
Id (continuous) = 14 Amps, de-rated to 12.5 Amps at 55 deg C
T (operating) = -55 to +175 deg C

This is the same transistor used for on/off power switching in AO-40's RUDAK and IHU-2. This transistor is mounted in the corner of the widget PCB near one of the two PCB mounting positions. The transistor tab is soldered to the PCB to maximize thermal conduction into the PCB. And the transistor is placed on the side of the PCB that will be facing the box edge through which the 15 pin sub-D connector is mounted.

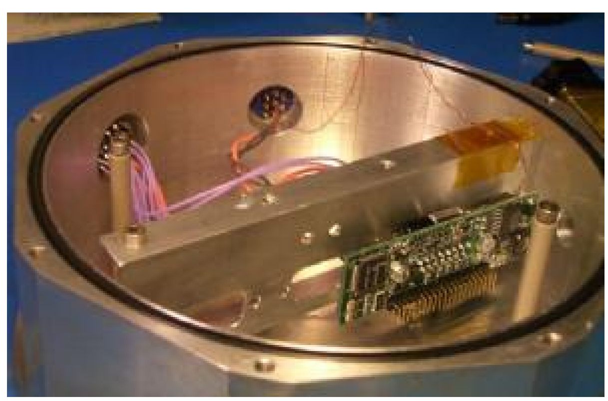


Meaningful testing of the transistor can only be performed in a vacuum. So I borrowed a vacuum chamber from the University of Arizona. A good quality vacuum pump was used for 1.5 hours to pull the vacuum. I do not have a vacuum gauge so I don't know the actual pressure obtained, but I am confident it was sufficiently low to eliminate any significant convection cooling.

A thermistor was placed on the body of the transistor to continuously monitor the transistor temperature. A thermistor was also placed on the outside of the vacuum chamber. Since the vacuum chamber is thick Aluminum this should be a good representation of the ambient temperature inside the chamber. There is also a thermistor as part of the widget which is mounted on the widget PCB about 3 cm away from the power switch transistor. It's readings are influenced mostly by the PCB temperature.

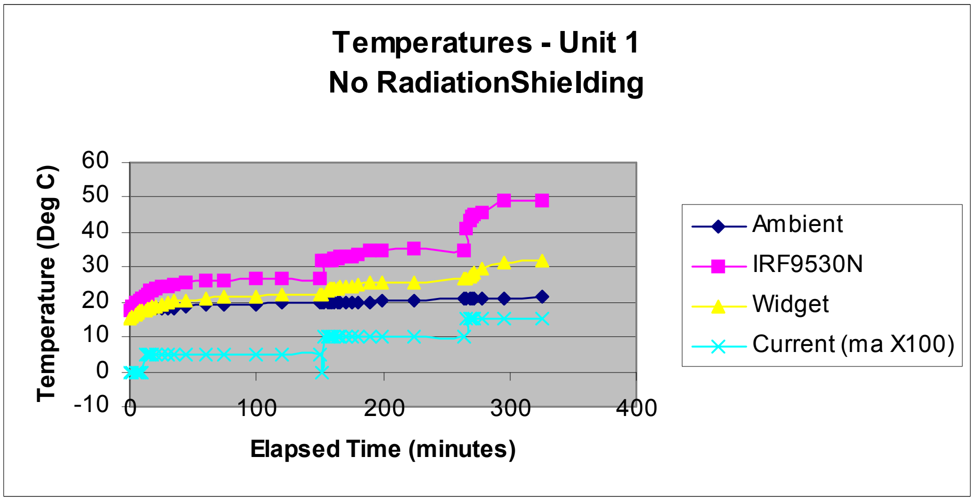
Current was calculated by measuring the voltage drop across a 0.5 ohm, 1% resistance with a 3 1/2 digit Fluke multimeter. The current was also measured by the widget. The measurements taken will be used to adjust the equation converting the widget analog-to-digital converter count to current. Note that the A/D converter is saturated at 0.964 Amps. This can not be easily changed and, given the results of this test, I would suggest that it is just fine the way it is.

The widget was mounted on a P3D box end which was then mounted in the vacuum chamber.

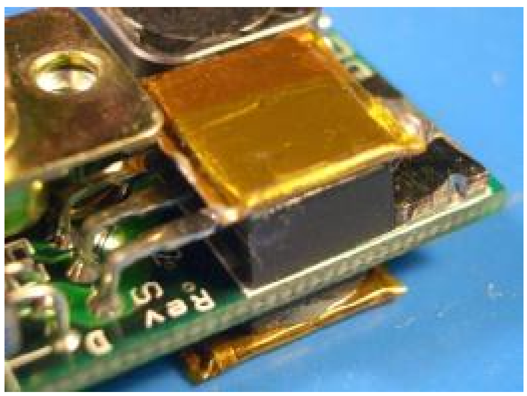


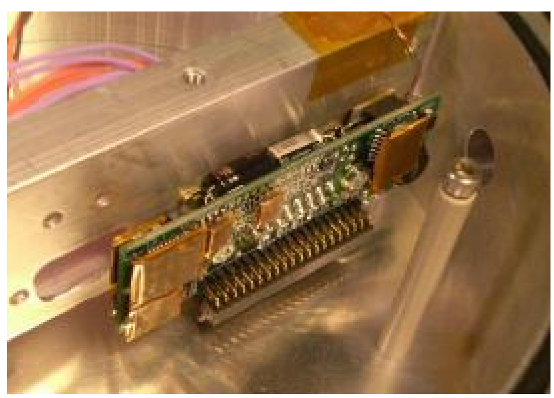
10 Volts were applied to the widget. Current through the transistor was set at 0.5 Amp, 1.0 Amp, and 1.5 Amp. as time progressed. This can be seen on the graphs below.

The first tests were run using a widget which did not have radiation shields installed.

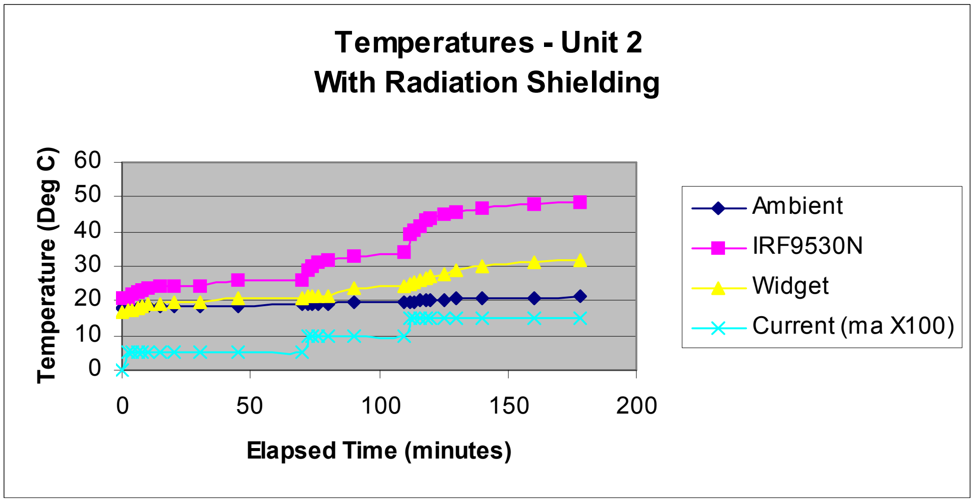


The tests were run a second time with a widget containing radiation shielding.





I was concerned that the radiation shielding would act as a blanket making it harder for the transistor to dissipate heat. It turns out that, if anything, the radiation shields help the transfer of heat out of the transistor.



As can be seen from the graphs above, the temperature of the transistor did not exceed 50 deg C at 1.5 Amps. And it only reached 35 deg C at 1.0 Amp. Considering the maximum rated operating temperature for the transistor of 175 deg C, we are in very good condition.

The widget has a 2 Amp fuse and we should not come too close to this limit with a maximum current specification for the module builder. Also, we don't want the size of the wires in the satellite supplying this current to be any larger than needed by most modules. And with the current measurement limit of 0.964 Amp, I would suggest we state to the users that the maximum current they can take from this source is 0.9 Amp. I suspect only things like transmitters will want more.

While everything was set up, I took multiple current measurements between 0 and 964 ma. This was to compare the stated current from John's widget support software with the actual current. The error function obtained is extremely linear which should make it easy for John to adjust the conversion equation. This will provide current readings accurate to about 1%. Both widgets tested showed exactly the same result.

I also attempted to obtain similar data regarding the temperature readings. Due to various factors, this will be more difficult and final measurements will be made later. But one of the tests I made was interesting. I put the entire vacuum chamber, without a vacuum, in my freezer overnight. I took it out and tested it right away. The temperature was -12 deg C and it started and ran without difficulty.