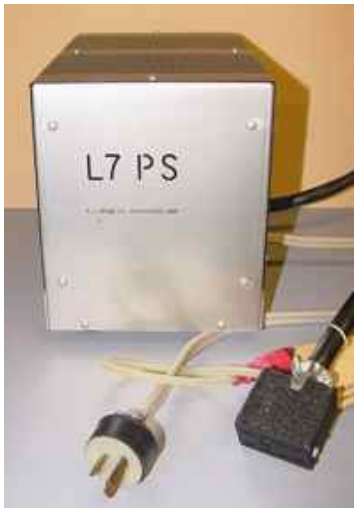
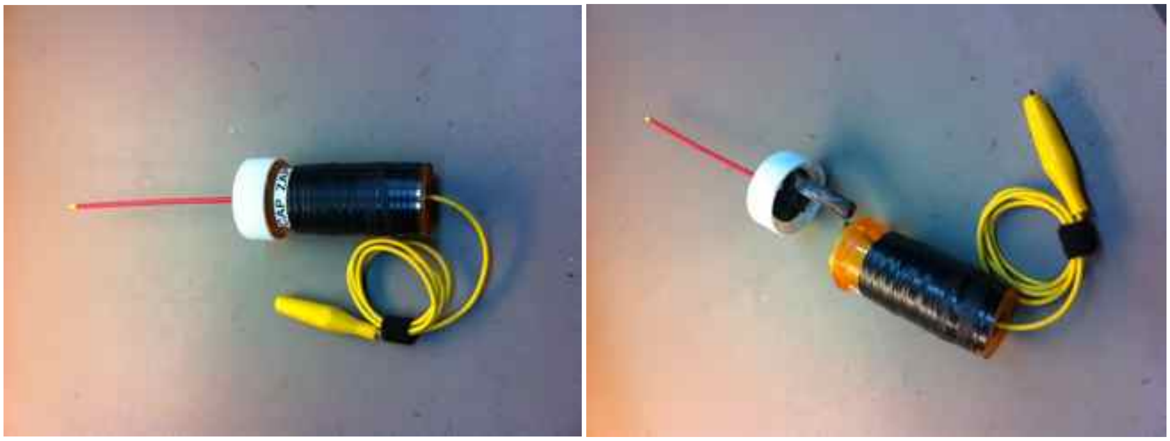
KL0S Shack Note #25
RF Amplifier Power Supply Fix

My good friend Gray W4NGR called recently to report that the R.L. Drake L7PS power supply for his Drake L7 linear amplifier had gone "Bang!" and the system was as dead as a doornail. I had actually rebuilt that supply for Gray a couple of years ago using a great rebuild kit from Harbach Electronics (www.harbachelectronics.com). Gray told me that the failure had occurred when (1) the amplifier was turned on and (2) when he switched between the SSB and CW/Tune power level switch positions. That changeover lowers the high voltage on the plates of the two 3-500Z power tubes from 2500VDC down to about 1900VDC to compensate for the increased duty cycle of the CW and RTTY modes.



WARNING: Do not try to repair an amplifier or its associated power supply if you lack experience working with high voltage as it **will kill you**; the electrolytic capacitors in an amplifier's supply will hold a lot of energy for a long time if the bleeder resistor system fails and that voltage will be present even when the unit is unplugged.

A couple of days later I was in Gray's area and picked up the unit and brought it to my workbench to see if I could repair the failure for him. I hoped that the power supply was the only problem but I brought the RF deck along to check for any damage just in case. After carefully removing the power supply cover I immediately used my homebrew "CAP ZAP" to discharge the electrolytic capacitors in the event any of them were still charged.



Homebrew "CAP ZAP" for discharging electrolytic capacitors

My homebrew "cheater stick" discharge tool is simply a large wattage, somewhat low value resistor (5K or 10K as I recall), which bleeds off any energy that may still be present in the circuit after it is unplugged. Some of you may have seen the power a charged electrolytic capacitor can deliver in an electronics class where the instructor charges one and then discharges it by shorting its terminals with a metal screwdriver – it's certainly exciting and invariably the tool shows significant damage.

The Drake designers back in the day included a 0.82Ω 2W resistor in the high voltage line that would act as a fuse in the event excessive current started to be drawn (normal plate current on SSB peaks runs ~600mA). With the power supply cover off it was immediately apparent that the "resistor fuse" had done its job, well maybe a little too well, as in the process of blowing up it had actually burned the side of the large plate transformer.

Failed resistor and transformer damage

I removed the damaged resistor and cleaned up the charred transformer case material as best I could. My concern was that the damage may have extended down into the transformer's windings but I found no visible evidence of that.

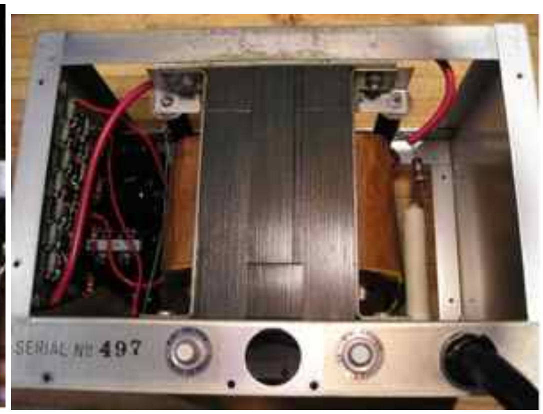
Next, using the power supply's schematic, I checked the continuity of the transformer's primary and secondary windings; both measured less than 1Ω which told me that they were at least still intact and that the protection resistor may very well have done exactly what it was supposed to do (less burning the transformer case that is!). This was good news and I then turned my attention to the charred area. Using a sharp dental-pick style tool I removed as much of the charred material as I could without digging any deeper into the interior of the transformer. But what do you do with the gaping hole in its side? I thought that some kind of potting compound might work but didn't have anything like that available. Then I looked up at the workbench and saw that I did have a couple of bottles of "Liquid Electrical Tape" which is used to insulate wire connections and tool handles and thought maybe that would work. So I took a chance and filled the void with the red colored liquid and it quickly cured to an ugly but nice rubber consistency. I then replaced the resistor from a stock I keep on hand for just such a contingency in my own Drake amplifier power supply.

Transformer case charring

Repaired casing – ugly but it works!

Next came a little electrical testing. The power supply can either be wired for 120VAC (not recommended) or 240VAC as this supply was configured. I simply wanted to see whether the transformer was still functional and I connected my Variac to the primary winding. The Variac will only supply up to about 130VAC but I figured that would be sufficient to verify the transformer's voltage step-up operation. Before I did that though I made sure that the high voltage bleeder system, two series connected 50kΩ 50W resistors, checked out ok and it did.

120/220VAC configuration area



L7PS interior (note rebuild kit at left)

So, while monitoring the voltage on the transformer's secondary winding I slowly increased the primary winding's voltage while keeping a close eye on the Variac's ammeter in the event there was a short between any windings. The secondary voltage came up nicely and topped out at about 430VAC; things were looking good.

After a thorough interior inspection showed no apparent physical damage to the L7 RF deck (including the tube socket pins - see Shack Note #23) I then tested it by connecting it to my L-4BPS power supply since it is identical to the later model L7PS. The L7 worked just fine which confirmed my feeling that the damage was in fact limited to the power supply.

The only thing left to do was to plug in the repaired L7PS power supply and give it a go. With the power switch turned on the amplifier lit up just like it was supposed to. A quick check of the plate voltmeter showed the correct operating voltage levels and after tuning the amplifier up into a dummy load and running key-down for a short period of time without incident I was convinced that repair was successful.

One final comment, let me repeat my caution about working around high voltages…a lot of us old timers grew up around these high voltage levels and you'll often see us putting one hand in our back pocket whenever we're probing those voltages. Why? Because doing so prevents a direct circuit path across you heart between two "poles" – your hands. I even find myself sometimes doing this unconsciously when working around digital level circuits where voltages don't normally exceed 15V! It's just the way I was trained…always better safe than sorry.

Although society is rapidly adopting a "…throw it away, it's cheaper to just buy a new one" philosophy, we hams can still repair a lot of our own equipment with the proper know how and tools…besides that's part of the fun of it all. Sometimes a repair can be easy, sometimes not…this time we were lucky and the amplifier is now safely back at Gray's QTH and operational again.

The Drake L7 Amplifier circa 1981- an old workhorse that just keeps working!

Finally, some of you may be thinking *"Ok, but what caused the resistor to fail?"* and the answer is I really don't know. It may have been a spike in the voltage level as the power level switch was changed; or it may have been a flaw in the 0.82Ω resistor that took many years to emerge; or who knows. Yes, it's always important to treat the cause of a failure, but sometimes you just can't determine it (see Shack Note #4 Letting the Bad Air Out for another good example of this phenomenon).

A special thanks to Evan Rolek K9SQG for his valued advice on repairing this failure and for a number of years all things Drake radio related.

73 – Dino KL0S (kl0s@cox.net)