

By Jan Skirrow

Curing the HF-2050 Heat Problem

A colleague of mine is the proud owner of a stable of Collins HF-2050 receivers. The HF-2050 was built (apparently only) for the Canadian military in the 1970s and pushed the envelope in the design of high-performance radios. It covers 14kHz to 29.99999 MHz, tunable in 10Hz steps. It features digital signal processing, selectable bandwidth, RS-422 remote control interface and microprocessor control of all displays and functions. Frequency is set by keypad entry, continuous tuning or selectable preset channels.

Despite the design effort lavished on the HF-2050, it suffers from one inexplicable fault. It runs very, very hot. Information from the technicians who maintained this equipment for the military pointed to heat related failure as a common problem, even with forced air cooling. The basic problem is the power supply, which while robust enough to last forever, will destroy the radio and itself given time!



The power supply uses a traditional transformer - pass transistor regulator design. There are separate regulators for each of the three voltages needed by the radio. It is designed to maintain regulation over a wide range of AC line voltages. One consequence is that the normal voltage drop across the regulator transis-



tors is higher than one might expect, and thus the heat dissipated by them under normal or high line voltage conditions is substantial.

High reliability test equipment built during the same period by Tektronix and Hewlett-Packard typically used a similar approach, except that the heat generating pass transistors were mounted on a large heat sink on the outside of the main instrument case, and/or used a large volume fan for cooling.

The HF-2050 power supply is a commercial Deltron unit that uses the power supply case as a heatsink for the pass transistors. The power supply is completely enclosed inside the radio, in a compartment separated from the radio proper by an internal partition. Even though the

top and bottom radio covers are perforated for cooling, little attention seems to have been paid to heat buildup in the radio compartment.

It is obviously wrong to assume that transistors always run cold. Many transistors normally run at quite high temperatures. But there is no doubt that heat is the enemy of all electronic equipment, especially so as the normal aging of components, printed circuit boards and wiring occurs.

Solving the Heat Problem

Several solutions have been proposed by HF-2050 owners. The simplest is to provide forced air cooling. While this improves matters, the physical layout of the supply and the construction of the top and bottom covers makes this a relatively unsatisfactory approach and offends my engineer's notion of technical elegance! The radio here had two fans to cool the pass transistors themselves, as well as one to push cool air into the main radio compartment directly over the heatsinked CPU, and another one inside to spread it around. A problem I hadn't anticipated was that some of these fans were epoxied to the covers, and I could not remove them short of breaking them away. So I left them as an exercise for the owner.

Another approach would be to redesign the power supply. It is possible to reduce the pass transistor dissipation through selection of a different transformer. This sounds simple but isn't, if only because transformers are hard to find and very expensive. Finding a single unit with exactly the right secondaries to run all three regulators seems a remote possibility.

A modern switching design would be worth exploring, although I think the problems of RF interference with the radio could be significant - especially as this is one source of interference the radio designers wouldn't have taken into account. The HF-2050 requires +15VDC at 1.5A,

-15VDC at 1A and +5.2VDC at 3.3A. Presumably any supply that provides these will work.

Using a Variac to reduce the line voltage is also quite useful, as long as it isn't set so low that the regulators stop regulating. It would likely work as long as it was set higher than the minimum the radio was designed for (115VAC \pm 10%). With an aging radio, however, a variety of quirky and unforeseen problems could arise.

The PSEctomy

The Collins design suggests an obvious solution. The "drop-in" Deltron power supply can be "dropped out" and mounted separately. It is also consistent with my "mods and rework" philosophy!



My philosophy in modifying fine old equipment undoubtedly makes life difficult on occasion. It stems from observing how high quality ex-military equipment that was available new for almost free on the surplus market in the 1950s and 1960s has come to be virtually unobtainable in decent condition because of the hatchet jobs done to "update" it. So for something that is rare and likely to be of increasing interest to collectors (like the HF-2050) it is worth making no changes that are not easily reversible, making as few changes as possible to the internal circuitry, and taking care to not introduce new problems.

The power supply is attached to the chassis with four screws. With the radio on its side, power supply down, remove the four screws, lockwashers and spacers. A 5 pin Molex connector provides switched line voltage to the supply and a large multi-conductor cable pro-

vides power to the radio. Disconnect the 5 pin Molex connector. Remove the nylon cable clamp that holds the cable to the PCB board near the 20 pin header. The 20 pin cable connector should be easy to pull out of the header. Then ease the cable between the power supply and the lip of the chassis, pulling it through to the other side so that it looks like the picture above.

The power supply can now be taken more or less straight out of the chassis towards what is normally the top of the radio (the opposite of the side shown in the above picture). Be careful not to snag the smaller white cables in the power supply compartment, or damage the various capacitors.

The External Mount

My basic plan was to mount the power supply on a standard 5.25x19" rack panel using the same hardware that mounted it in the HF-2050. This would work well with the owner's equipment rack, which has mounting positions on the rear as well as the front. It could be mounted anywhere away from thermal contact with the radio, keeping in mind that the interconnecting cables should be kept as short as possible and that the exposed pass transistor cases are at the supply voltages.

The AC line power from the radio connects to the power supply with a standard 5 pin Molex connector. So extending this cable using the same connectors was simple and resulted in no modifications to the radio.

For the DC power connection, there were two options. One was to replace the existing cable

with an identical longer one. One end of this cable connects to a PCB header in the main radio compartment using a small format connector. The cable uses 16 of the 20 pins available, adapting to the small connector by using several wires to carry each of the supply voltages. I didn't have one of this type of connector in my junk box, and didn't want to make up a new 16 wire cable. Anyway, chances are the original cable, which would be useful if the radio were ever restored to its original condition, would soon disappear.

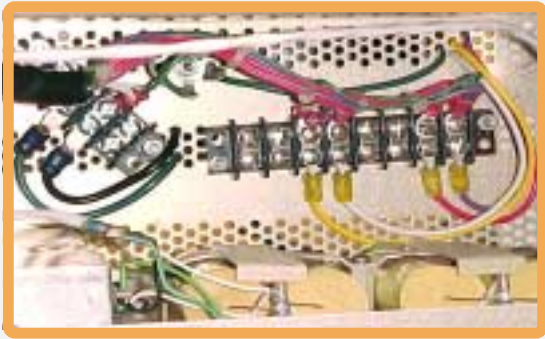
The second option was to use the existing cable, but connect the end that normally goes to the power supply to similar barrier strips mounted in the old power supply compartment. Then all that was needed was an extension with seven wires, and ring tongue terminals on each end. Seven wires would allow for the three voltages, separate ground returns, and a chassis ground.

I had one concern. We had also been told by military technicians that they had experienced problems with RF leakage on the HF-2050 that had led to the addition of the stiffer shielding plates over the power supply compartment. I hoped that this problem resulted from operating the radios in a high RF environment, and was not the result of leakage within the radio itself. In any case it seemed useful to keep the cables as short as possible.

This second approach also had the advantage of making it easier to install RF bypass capacitors on the power lines in the radio, should it turn out that the external power supply leads picked up enough stray RF to interfere with the radio.

The issue of "to drill or not to drill" (new holes) was considered. I was inclined to make a single, fairly large hole to allow my new cables to exit the 2050. I have some grommets that require a 3/4" hole, but don't have a drill able to make such a hole, or a punch. So I took the easy way out and decided to use some of the existing honey-





comb holes. This is good in that the RF shielding of the compartment isn't compromised, but bad in that some care is needed to ensure the wire insulation isn't damaged. I used one of the chassis guide pin holes already on the rear deck to pass the three power leads. I also used existing honeycomb holes for the screws to hold the barrier strips. I used #18 wire for all the connections except for the 5VDC supply, where I used #14. I checked that the voltage at the barrier strips was as per the manual specs.

The Final Result

The power supply is now easily disconnected from the radio, but must be mounted fairly close



to it. So far as I can tell, the radio performs as before, with no obvious problems resulting from the longer power supply leads. Of course the radio itself is much lighter, and operates much cooler. The change is very easily reversed should the owner decide to sell the radio as "unmodified." The only thing I'm not happy with is that the power supply is exposed and will collect dust. The line voltages on the power supply chassis are reasonably protected from probing fingers, but I'd still prefer to have the supply enclosed. The pass transistors continue

to be protected against accidental shorts to ground by being between the power supply chassis and the front panel.

What, you ask, is the extra screw on the left of the panel? The power supply is originally attached to the HF-2050 using four spacers. One spacer is a longer than the other three and can't be used in this rework. Given how hard it can be to find spacers of a specific size, I fastened it to the panel so that it doesn't get lost.



If I Were Doing It Again?

If I were doing this again, and if it were my radio, I would use a 10 pin military box mount connector permanently mounted on the rear panel. If done properly, this would not alter the radio's value. However, I would still use the internal barrier strip approach, if only to make it possible to easily reverse the modification.

Want More?

See the
Next 3 Pages!

Addendum- February 2001

The owner of this radio did some temperature measurements that I thought might be of interest to other owners. In addition, a member of the Premium Radios reflector added some comments that may be useful to those concerned about heat, but not prepared to do major surgery!

Walt said:

The major concern I had was the introduction of noise into the sensitive circuitry of the receiver. I'm happy to report this has not been the case at all. Granted, Jan purposely kept the wiring short to lessen this possibility. I also used a sensitive portable in the vicinity of the power supply and found no noise on the shortwave bands tested. Now for the heat results. I used my trusty 3 channel temperature probe. For simplicity sake, I used the degrees F scale. In the table below, the first column represents internal receiver temperature in the vicinity of the CPU chip. The second temperature is ambient, while the third is on the externally mounted power supply. I tried various methods as shown. A simple small 12v muffin fan, surface mounted over the CPU on the top cover to draw warm air out was added after 2 hours.

Several observations noted:

- No increase in receiver noise was noted
- A major decrease in internal receiver temperature noted. Recall that my initial experiments with this receiver showed internal temperatures easily reaching over 150 to 160 deg F within 30 minutes of start up without cooling.
- Being paranoid, or at least very interested

in cooling, a very simple cooling muffin fan reduced the internal temperature to negligible values. With anything like my "supercooled" units, with multiple fans mounted on top and bottom covers, I'm sure I could attain near ambient temperatures, but this would not really accomplish anything but increase ambient noise.

- The temperature of the power supply, now

Test Conditions	In	Out	Power Supply
<i>No Fan</i>			
Start	66	66	
1 Hour	99	67	
2 Hours	108	69	
<i>Fan added at 12volts</i>			
30 Seconds	100		
1 Minute	98		
3 Minutes	95	70	120
30 Minutes	91	70	122
<i>Fan voltage reduced until fan barely audible</i>			
Initial	93	69	122
1 hour later	91	67	122
Overnight	87	61	116
<i>Fan disconnected for 30 minutes</i>			
	102	61	116

being external did not rise to the extent found when internally mounted. A win-win situation in my opinion.

Paul added:

I haven't played with the 2050 in a while but when I first bought it, I too, did some research into why there was so much heat coming from such a simple supply. I read all of the work being done with thermisters, fans, heatsinks and liquid nitrogen, and as interesting and well researched all of this was, it still didn't address the root cause of the heat. I did some voltage measurements and it looks like the supply was










designed to work on quite a wide range of input AC voltage, maybe 85 - 130. I tried this with a variac and found it would work just fine on about 90VAC, and ran much cooler. I suppose that shipboard generators could fluctuate quite a bit and you wouldn't want your RX to die just because of a low voltage problem.

Anyway, there is way more voltage ahead of the regulators than need be for good regulation. If I remember correctly, somewhere in the order of 27VDC for the 15 volt supplies and maybe 13 volts for the 5 volt supply. Obviously, this is where the heat is generated and I discovered that the power xfmr has multiple primary taps, and that if one moves the tap to the highest voltage position, the overall secondary voltage drops significantly. Less voltage across the regs means less heat to dissipate and thus an easy step to make in the path to overall heat reduction. If the tap change doesn't bring the temp down into a comfortable range then perhaps a different xfmr could be installed with lower secondary voltages.

More Resources

on the
Next Page!

Want Parts, Information, Pictures??

-  [Boatanchor Dreams](#) - information on collecting and resurrecting fine old radios. Military, ham & broadcast.
-  [Classic Technology](#) - military connectors, semiconductors, lamps, manuals etc. Small quantities, no minimum order for the collector, hobbyist & rebuilder.
-  [Tech Talk 1](#) - The R-390A RF deck is the radio's heart. There is a safe and relatively easy way to thoroughly clean it.
-  [Tech Talk 2](#) - The R-390A often comes without meters. Read why! Originals are hard to find and pricey. But there are other meters available that can be adapted!
-  [Tech Talk 3](#) - Turn on your precious tube radio and tubes, transformers and other pricey bits may blow. Learn how to protect from In-Rush Current Surges!
-  [Tech Talk 4](#) - Want to Improve your R-390A Audio? Read this first!
-  [Tech Talk 5](#) - Receiver multicouplers are great! Read about the classic Collins CU-168/FRR.
-  [Tech Talk 6](#) - Another multicoupler - the RCA CU-5069 and the problem with heat.
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