Spectrian 2304 MHz SSPA

Garry C. Hess, K3SIW
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A *solid-state power amplifier* (SSPA) manufactured by Spectrian can produce on the order of 200 W linear output[1] at 2304 MHz with little modification. Units are often available through eBay at reasonable cost. The web page of NR6CA (http://www.nr6ca.org/spectrian.html) has a nice description of one way to convert these amplifiers for 13 cm amateur use. Joe Ruggieri (pyrojoe@prodigy.net), an eBay seller of the amplifiers, has some different suggestions. This article details the route followed at K3SIW.

Begin by removing the top and bottom covers. They are attached by a large number of beveled Phillips-type screws. Next, four small fans should be mounted on the rear of the chassis. My fans run off an external 12 VDC supply and are oriented to push air into the rear of the unit, over the internal heat sinking fins, and out the front cover openings. Figure 1 shows the end result.

Figure 1 View of 4 small 12 VDC fans mounted on rear of chassis to push air through the unit for cooling purposes.

[1] The "official" rating of just 63 W is for meeting stringent digital modulation linearity specifications. The six 60-W Motorola MRF-286 devices that are combined for the output can produce substantially more output power for amateur radio purposes.

Our conversion philosophy was to avoid do things that would make it difficult to return the amplifier to its original state. To that end, we did not tamper with the quick-release connector that originally provided RF input, RF output, -48 VDC power, and monitoring. The original 0.141" semi-rigid output cable male-sma connector is unscrewed and the cable is pulled through to the bottom, "below decks" so to speak, where it is stowed. In its place, a short run of 0.141" semi-rigid cable with sma-male connectors on both ends is routed into place. The underneath end mates with an sma-female to N-female bulkhead connector[2]. Clearance is at a premium so four-hole bulkhead connectors do not fit. Instead, the style that holds the connector with a single large nut must be used. Figures 2 and 3 show "top" and "bottom" views of the new semi-rigid cable, respectively. The smaller 0.085" semi-rigid cable visible in Figure 2 carries a forward power sample to the front panel. A simple diode detector driven by this sample will allow relative power to be displayed by a DC micro ammeter. The black RF absorber material sits atop a Nova drop-in circulator rated at 125 W. The original semi-rigid output cable that is no longer used can be seen in the middle right of Figure 3.

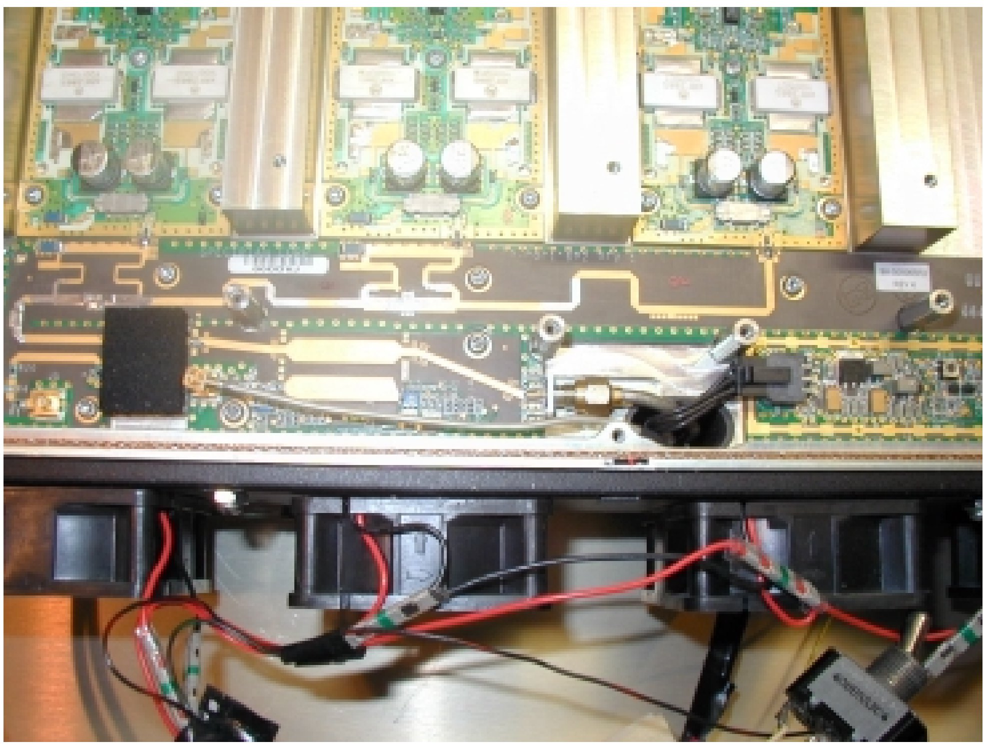

Figure 2 View of amplifier output to 0.141" semi-rigid cable, sma-male end.

[2] Because high power is involved, it is advisable to convert to N-connector size as soon as possible. If only an sma-sma bulkhead bullet is available, an adapter external to the amplifier can be used to do this.

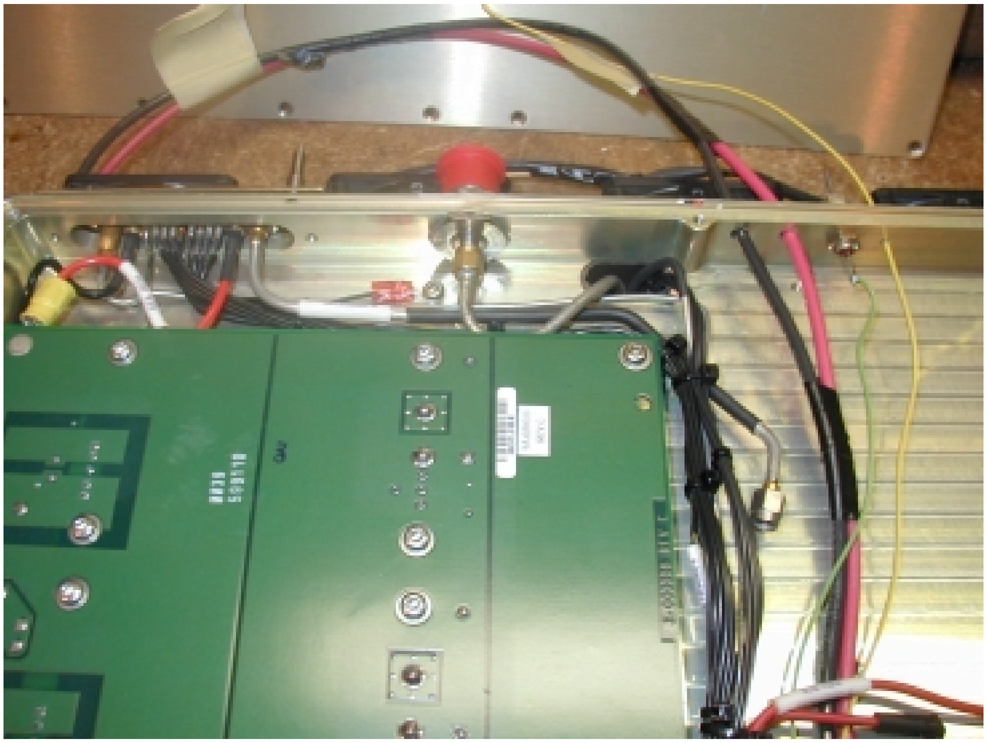

Figure 3 View of other end of 0.141” semi-rigid cable (an sma-male connector mates with an sma-female to N-female bulkhead adaptor.

Next, the left-hand side of Figure 4 indicates how RF drive is input to the amplifier. A hole is drilled through the front panel for an sma-female to sma-female bulkhead connector. Because of the extra width of the front panel, the front portion of the hole must be recessed somewhat by a larger drill bit. Then the bulkhead connector can be secured with enough threads exposed to attach the right angle sma-male end of the red cable. Originally, a 0.085” semi-rigid cable with MCX-male connectors on both ends connected RF drive from an attenuator printed circuit board (LHS of Figure 4) to the RF driver printed circuit board (RHS of Figure 4, inside a shielded enclosure). Lift the LHS connector from its MCX-female printed circuit board connector and connect it to the SMC-female connector on the other end of the red cable. If such a cable cannot be obtained, a destructive alternative is to cut the 0.085” semi-rigid cable and attach an sma-male connector. Another alternative is to obtain a printed circuit board MCX-female jack and solder a length of miniature coax to it[3].

[3] Unfortunately, straight MCX cable jacks do not appear to exist and tack soldering a cable onto the printed circuit board at an appropriate point would be difficult.

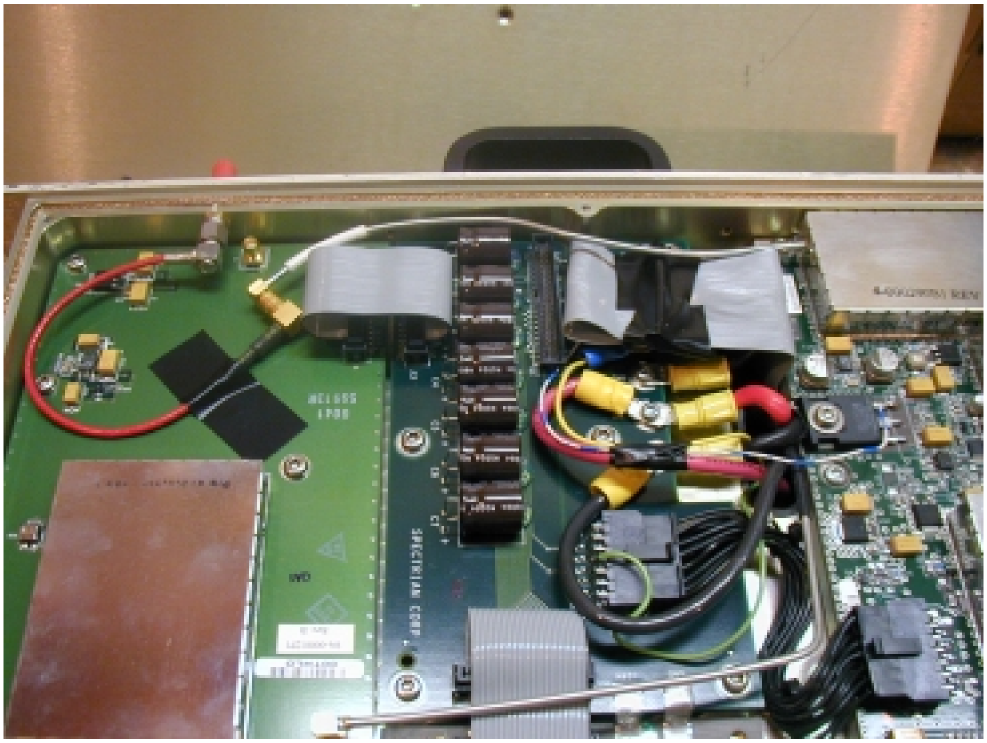

Figure 4 View of RF input connections (a female-to-female sma bulkhead connector mates with a right-angle sma-male connector on a red jumper cable; the smc-female connector on the other end of that cable mates with the MCX-male connector on the original jumper cable to the RF driver board).

Figure 5 better indicates where the large #10 wires for 26 VDC power connect. Their lugs are simply piggybacked with the original wires from the –48 VDC DC-DC converter. It is not necessary to remove that converter because the output floats. In fact, it is advantageous to keep the DC distribution circuit board in place because it also contains a 26-to13 VDC regulator. 13 VDC is needed to bias the transistors on and thus enable the transmitter. To confirm that this regulator is functioning, a wire is passed out of the enclosure to a voltmeter. Grounding the green wire soldered to pin 11 of the distribution board does this. It is passed out of the enclosure via a 1000 pf feedthrough capacitor where an external PTT line from the 2304 MHz transverter controls it. The IXFH75N10 power FET turns on and its source terminal (rightmost and top pin in Figure 5) supplies 13 VDC to pin 4 on connector J4 (blue/white wire in Figure 5). This pin is connected to pin 2, the enable pin, of each PA board connector.

Figure 5 View of 26 VDC (red) and return (black) cables, blue/white jumper to route 13 VDC to amplifier modules, green wire for PTT control (ground enables the transmitter), and yellow wire for monitoring 13 VDC.

Because of the high RF output power generated by this amplifier, a substantial transmit/receive relay is a must. SMA-type relays are not advisable above the 100 W level. Instead, a type-N relay should be used. Figure 6 shows the N adaptor "plumbing" used to attach a Tohtsu CZX3500 relay, available from Down East Microwave, Inc. at http://downeastmicrowave.com/cat-frame.htm. This relay is rated 250 W at 2 GHz with a minimum isolation of 65 dB. Transmitting 100 W at 2304 MHz, ours produced no measurable signal on an HP435A power meter set to the –15 dBm scale. Thus, the low-noise amplifier on the relay receive port is safely protected. Also shown in Figure 6 are the 12 VDC open-frame linear power supply used to drive all the cooling fans (4 for the amplifier enclosure and 2 for the 27 VDC power supply) and the Ericsson 1200 W switcher power supply used to supply 26 VDC[4]

[4] While labeled as a 24 VDC source, this supply actually defaults to about 27 VDC after turn on. When 50 amps are being drawn (i.e., full transmit power), resistance in the power cables lowers this somewhat.

(picture right). This power supply runs off 240 VAC rather than 120 VAC. Thus, it draws only about 5 amps when the amplifier is operating at full power. Nonetheless, a large #10 yellow power cord is used. To spread the DC current draw over the output connector lugs, three #12 wires are run to both the hot (white) and return (black) sides. They are in turn connected to #10 wires that pass into the amplifier cabinet. The 50 amp metering shunt can be seen above the 12 VDC fan supply, along with small wires that go to the meter itself.

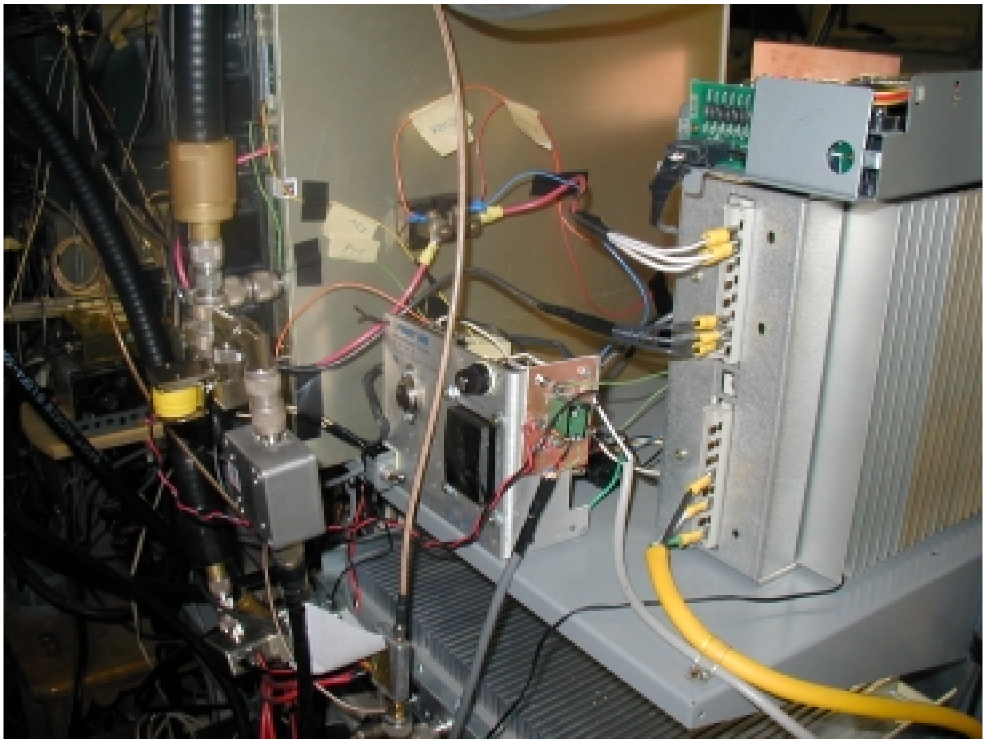

Figure 6 Rear view of Spectrian amplifier tray, showing transmit/receive relay connection to 7/8" Heliax antenna feed line and low-noise preamp; also shown are the 12 VDC fan power supply and the 26 VDC switcher power supply with 50 amp meter shunt..

Figure 7 shows the front of the Spectrian amplifier tray under full output conditions (5 dBm input, 175 W output, 50 amp draw at 27 VDC). Fine control of the input drive power is obtained by using a Merrimac AUM-15A variable attenuator (picture, bottom right). Front-panel sampled power is applied to a microwave detector to drive a micro ammeter in proportion to the output power[5]. The bottom meter is a 0-40 VDC scale device. It is switch-selectable between 26 VDC and 13 VDC lines. The top meter reads 0-50 amps with the 0.001-ohm shunt shown in Figure 6 (50 mv full scale).

[5] The coupling factor on our unit is about 50 dB. Thus, when 100 W is being output the sampled port supplies about 0 dBm to a 50 ohm load. This is more than adequate for a microwave diode detector to deflect a 50 micro ammeter full scale.

Figure 7 Front view of Spectrian amplifier tray, shown keyed at full power out.