20W Amplifier Construction Hints – V1.3B
The modern day Captain Midnight Secret Decoder Ring
(read em' now or after the parts are soldered)

SPLASH WORDS, CREDIT, and RATIONALLE

When it comes to Amplifiers, the Radio Amateur is responsible for making sure his amplifier operates within the guidelines established by the FCC and that it does not cause unwanted interference. This is a Broadband Amplifier and will require some sort of Low Pass Filter (LPF) on the output to attenuate harmonics. Various optional LPFs are discussed in the documentation. You may already have one you intend to use.

Amplifiers have been around a long time and continue to evolve, one design being based on another, etc. I want to give credit to some who "plowed the ground" before me: G6ALU, KE9H, WA2EBY, TF3LJ, K5OOR and above all N5OK who provided all the testing in his extensive lab. The question may come up, "Why ANOTHER Amplifier ?" To that I say, "Looks like fun, why not ?"

My idea was to provide a **good and low cost** Amplifier for the HF bands (160m to 6m) which can be driven by a SoftRock SDR or any other low power driver. Low power being defined as less than 1W. Some of the new SDR units supply less than 50mw and really need a little "boost". This Amp uses well received RD16HHF1 RF MOSFETs which are each rated at 16W output for 12.5VDC at 30+MHz. These parts are quite robust and much better than the IRF510 Switching Power Supply MOSFETs used earlier, largely because of their low cost and availability. The other advantage of the RD16HHF1 is that the mounting tab is attached to the "Drain" pin which is at ground potential …so no mica insulator is required. The Amplifier has a Signal Operated Switch (SOX) for CW QSK. I didn't really put it there for SSB …..but who knows (still better to use PTT). Did I mention **good and low cost** ?

GENERAL

The design and components which have been selected require that the operational criteria of 1) an Input of 1W max –AND-- 2) an Output of 20W max ……whichever comes first, NOT be exceeded. To allow some adjustment, the input to the Amplifier has places for a Pi network Input Attenuator of your selection (Rx, Ry, Ry) ….3dB, 6dB, etc. Parts for a 3dB (50% power reduction) attenuator are provided in the kit. The purpose of the attenuator is to reduce input power and to provide proper 50ohm matching for the driver. This design has been extensively tested and optimized to provide good matching to 50ohms **without** the attenuator. If you elect to not use an attenuator, replace Rx with a jumper and do not install either Ry.

The Amp is designed for 13.6VDC, 50 ohm input and output, both RD16HHF1 MOSFETs with bias levels set to provide 450mA quiescent current on each, and it has a 3dB attenuator on the input. The result for 500mW drive (250mW at the MOSFETs) is a linear power profile (to within 0.5dBm) from 2MHz to 60MHz with 17.4W output. .....that's flat. You can push it to 20W but it's not linear.there.

Some differences that make it a "IB" vs the earlier "I" are: The passive component pads have pin-in-hole locations as well as SMT pads. I elected to supply SMT parts where possible in this kit. This allows flexibility but makes the soldering a little more difficult due to extra heat and solder required, especially on the grounded pads so you will have to hold the iron down longer and use good flux. But this is a more electrically solid RF ground. Some of the chokes were unnecessarily high in value on he first model and have been reduced. Additional bulk electrolytics were added.

The rest of the circuit is the the same and kits will soon be available again. I'll be using SMT parts where appropriate.

After assembly **with the MOSFETs screwed to the heatsink** and the Bias switch closed (Class A/B), turn the bias potentiometers fully counterclockwise, connect a 50ohm load to the input connector and output connector, turn the function switch to “On (Lock)” (this will allow the relay to be picked and turns on the 6V bias regulator). Now measure the current. There should be a small current draw. Turn one bias pot clockwise until the current increases 450mA, then turn the other bias pot until the current increases an additional 450mA. Now the bias levels are balanced and set for Class A/B operation for your Amplifier.

The design also provides Class C operation (CW only). This allows lower power consumption when you really don’t need linear operation. A single resistor reduces the Gate Bias current on the MOSFETs to around 25-35mA each. You can also use the potentiometers to adjust this if you prefer.

Many MOSFET Amplifier circuits do not use a feedback circuit because this design does not need one. The compensation capacitor is made up of two 249pF Mica capacitors in series. This was done for two reasons, the distributed capacitance and lead inductance “seems” to work better than a single capacitor, Mica capacitors are very stable across a broad range of frequency and temperature ……and I happen to now have a lot of 249pF Mica capacitors. The combined 125pF provides a better response at 6m.

ASSEMBLY HINTS

All the SMT components should be soldered in place **first** and the solder joints carefully inspected. **95% of all problems I’ve seen are defective solder joints**. Because the board does not use thermals, more heat is required for a good solder joint …..especially on the grounded pads.

Here are some of the areas where you might have questions.

T1 is made with a BN43-2402 core and 4 turns of bifilar wire. Prepare the core by turning a ¼" drill bit with your fingers in the openings to remove any sharp edges (prevents scratching the enamel wire coating). One hairpin pass of wire through both holes is considered "1 turn". Be sure to unkink and untwist the bifilar wire. Any wire repositioning can be done with a wooden toothpick (prevents scratching the enamel wire coating). Experimentation has shown bifilar wire is much better at the higher frequencies than twisting two wires together. Scrape the insulation off with a single edge razor blade or X-Acto knife and tin with solder. Mounting T1 on the board is easy and the wires can go in either hole.

The Ferrrite Output Transformers, T2 and T4 should have the 1T of large braid wire routed first, then the 4 turns of white Teflon wire. Then loop a small length of excess resistor wire around the braid wire end and solder it. Pull it tight up against the BN43-202 and do the same thing to the other end of the braid. The braid is too large (larger was found to work better) will not go through the hole on the board, but the #20 bare wire sure will and it makes for a nice looking assembly, The ends of the Teflon wire are soldered directly to the board.

L1, L2,and L3 all use the BN43-2402 core and 2 turns of #24 wire and act as RF chokes.

There are 3 very small 1N4148 diodes in the SOX area. There is an Anode mark on the diodes and a silkscreen Anode mark on the board.

Mount the larger pin-in-hole parts last ….it still pretty easy to get to everything.

Once you have decided on the heatsink you will use, bend the leads on the MOSFETs to match the mounting hole in the board and align the leads with their respective holes in the board. No not apply the white heat conducting paste until later. After the MOSFETs are aligned and mounted to the heatsink, solder the MOSFET pins. Be sure the center ground pin on the MOSFET is well soldered on both the top and bottom of the board. As a last step before final assembly and testing apply a thin coat of the white heat conducting paste to the back of the MOSFET surface.

I have decided that I'll provide a drilled and tapped heatsink as an **option** because not all will have access to a used heatsink or the tools to drill and tap the holes. I used a drill press and hand tapped the holes …..but I am, by no definition, a "machinist".You still have to provide the mounting hardware and nylon spacers. It also means the kit has to be shipped in a USPS Priority Mail box to accommodate the heatsink.

For those still wanting to use their own heatsink……..the first step is to drill and tap 6 holes in the heatsink. Using the Amplifier board as a template, locate the centers for the 6 holes and mark them (preferably between the heatsink fins). The 4 board mounting holes should be drilled and tapped for 4-40 machine screws and the 2 MOSFET mounting holes

for 6-32 machine screws. It's a little tricky to miss the fins on the other side with the drill bit….so measure twice and drill once.

The Input/Output attachment points for the coax have one small hole for the center conductor and one large hole for the shield. The coax should be 50ohm (RG174 or other small coax) and attached perpendicular to the board. Twist the braid shield and insert it through the large hole or wrap a wire around it and solder to the braid. RG-174 is spec'd good for 40W.

C2 affects the SOX hold delay. Use whichever value works best for you ….1uF is provided ……maybe 3.3uF works best for you ;o)