5W Amplifier Construction Hints – V1.0
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.

The idea was to provide a **good low cost** Amplifier for the HF bands (160m to 6m) which can be driven by a UHFSDR or any other low power driver. Low power being defined as 50-100mW. This Amp uses well received RD06HHF1 RF MOSFETs which are rated at 9+W 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 RD06HHF1 is that the mounting tab is attached to the "Source" pin which is at ground potential …so no mica insulator is required. The Amplifier has a Signal Operated Switch (SOX) for CW QSK

GENERAL

The design and components which have been selected require that the operational criteria of 1) an Input of 250mW max (500mW with a 3dB attenuator) – AND -- 2) an Output of 6W max ……whichever comes first, NOT be exceeded. The more power the hotter the device will run. 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, RD06HHF1 MOSFET with bias levels set to provide 300-450mA quiescent current, and it has a 3dB attenuator on the input. The result is a linear power profile (to within 0.1dBm) from 2MHz to 60MHz with 5.8W output. You can push it to 5-6W but it's not linear.there. You can also run the 5W Amp in Class C mode (CW) by reducing the MOSFET bias to ~20mA. At this lower quiescent power level, mounting the MOSFET to your enclosure may be all the heatsink that is required. In A/B mode you WILL require a heatsink.

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.

After assembly **with the MOSFET screwed to the heatsink** and the Bias switch closed (Class A/B), turn the bias potentiometers previously turned fully **counterclockwise**, connect a 50ohm load to the input connector and output connector, turn the PTT 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 the bias pot clockwise until the current increases 300-350mA. Now the bias levels are set for Class A/B operation for your Amplifier. Lower bias levels will result in lower output where the signal is linear …..maybe linear up to 2.5W.

The design also provides Class C operation (CW only). This allows much lower power consumption when you really don't need linear operation. Reduce the Gate Bias current on the MOSFET to around 20mA.

Many MOSFET Amplifier circuits do not use a feedback circuit because this design does not need one but a little FB is provided with the 910 ohm resistor and 3nF capacitor (both mounted on the bottom of the board. The compensation capacitor is made up of one 249pF Mica 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.

ASSEMBLY HINTS

All the SMT components should be soldered in place **FIRST** and the solder joints carefully inspected. **98% 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 5T to 3T ratio. Since the secondary has both windings in series, the impedance ratio should be 25 to 64 or 2.56. For a 50 ohm input, it has a 128 ohm output which is what I'm looking for. 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". Any wire repositioning can be done with a wooden toothpick (prevents scratching the enamel wire coating). 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 check with an ohmmeter to make sure it's connected as shown on the schematic. The 5 turn primary winding should be towards the 3dB attenuator resistors.

The Ferrite Output Transformer, T2 should have the 1T of large braid wire routed first, then the 3 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) and will not go through the hole on the board, but the #24 bare wire sure will and it makes for a nice looking assembly, The ends of the Teflon wire are soldered directly to the board. Use a toothpick to make room for the Teflon wire as needed on T2.

L2,and L3 all use the BN43-2402 core and 2 turns of #26 wire and will act as RF chokes.

There are 3 very small 1N4148 diodes in the SOX area. There is a Cathode mark on the diodes and on the board silkscreen. The 4th 1N4148 diode is across the relay coil on the bottom of 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. 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.

The series Feedback components "RF" and "CF" mount on the bottom of the board where indicated and dress the parts against the board. You can also change values of the resistor if you want more or less feedback. The value picked seems to work well.

R3 can be mounted on top of the board or on the bottom, I put the artwork on the bottom since I ran out of room on top and this part was added later in the design process to allow 5V relay use.

As a last step before final assembly and testing apply a thin coat of the white heat conducting paste (if you have some) to the back of the MOSFET surface and bolt it down.

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. If you are running the Amp in Class C (much lower power consumption) you may be able to use your metal enclosure for the heatsink. The heatsink has 3 tapped holes, 1 for the MOSFET and 2 for mounting the board. My first prototype board shown in the picture did not have mounting holes, your board will have mounting holes. Make sure any mounting hardware does not short out board wiring…..flathead machine screws work great.

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 (better solution). RG-174 is spec'd good for 40W.

C2 affects the SOX hold delay. Use whichever value works best for you ….1uF (fast) and 10uF (slow) are provided (…maybe 3.3uF works best for you ;o)

5W HF Amplifier
(13.8VDC, 0.1W input)

Kees K5BCQ windy10605@ju
Reflects V1.0 Board

Qty	Part ID	Part number	Description	Identification	Notes
1			PC board		1-3/8" x 2-3/8"
1	Q3	RD06HHF!	MOSFET		
1			RF Relay		Straighten pins and insert in bo
1		KA78L06A	6V Regulator		
1	L6	FB43-101	Ferrite Bead		
3	L2,3,T1	BN43-2402	Binocular Ferrite Core	small one	
1	T2	BN43-202	Binocular Ferrite Core	large one	
1	Q1	2N3904	NPN Transistor		
1	Q4	2N3906	PNP Transistor		
4	D1,2,3,4	1N4148	Signal Diode	smt	Anode band on one end, yes…
1	C19		249pF Mica Capacitor	radial lead	
2	C25,26		33uF Electrolytic Capacitor	SMT	Black mark is "-"
1	C30		10uF Ceramic Capacitor		
1	C2		1uF or 10uF Capacitor	radial lead	Selects SOX delay time: 1uF fa
6	C4,5,9,16,22,27		100nF Ceramic Capacitor		8 in one strip
4	C12,23,28,29		10nF Ceramic Capacitor		strip marked "10nF"
1	C1		1nF 1KV Ceramic Capacitor	radial lead	
4	C3,10,14,21		1nF Ceramic Capacitor		strip marked "1nF"
1	R6		130 ohm Resistor	axial lead	
1	R10		4.7K ohm Resistor		
2	R9,12		3.3K ohm Resistor		
1	R		270 ohm Resistor	axial lead	Relay voltage dropping resistor **bottom**
1	R1		0 ohm Resistor		
1	R7		1 ohm Resistor		
1	R11		1K ohm Resistor		
1	FB Resistor		910 ohm FeedBack Resistor	axial lead	mount on bottom of board betw Source
1	FB Capacitor		3nF 1KV FeedBack Capacitor	1206 SMT	mount on bottom of board betw Source
1	R4		10K Potentiometer		**Set pots FULLY counter-cloc**
1	Rx	Vishay 5%	1W, 18 ohm	axial lead	For 3dB attenuator
2	Ry	Vishay 5%	1W, 300 ohm	axial lead	For 3dB attenuator
1	6 inches		50 ohm coax		
1	6 inches		#24 AWG enameled wire		
1	2 inches		braid wire		
1	12 inches		#26 AWG Teflon Wire	white	

1	12 inches	#28 AWG enameled wire	
1	**OPTIONAL**	Heatsink without Fan	**$5 Optional** Drilled for MOSFE