# A 250 Watt amplifier for Es'Hail DATV uplink at 2400-2410 MHz


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**Having built an amplifier based on a Spectrian 60W amplifier board from Pyrojosef and realised that limits me to a maximum transmit symbol rate of 500 KS at a pinch, I did some research and found that an Ampleon device designed for microwave ovens at 2400 – 2500 MHz would probably fit the bill.**

**Although ready built modules are available as a single stage from Digi-key** https://www.digikey.co.uk/products/en?keywords=BPC2425M9X250Z **which has 18dB of gain and costs £213 plus postage etc.., and a double stage version with a lot more gain from RMW** https://www.rfmw.com/Products/Detail/BPC2425M9X250Z-Ampleon/612403/?fbclid=IwAR2FPnKZ-yn-I_BTmuoZDtYmy4C0F5EaqGBdupUa0CeFeJJTzRZXQAwExHw **for about £400, I decided to just buy the device and make my own PCB using the test fixture design as shown on the data sheet pdf for the transistor from Ampleon which is a BLC2425M9LS250 which is available from Digi-Key for about £65.**

**I also heard that there were problems with the stability of the ready built modules.**

**I happened to have a little PCB material suitable, some Arlon25FR 0.762mm thick with 38um copper cladding both sides, which is practically the same as the ROGERS 6035HTC (same dimensions) that is recommended by Ampleon.**

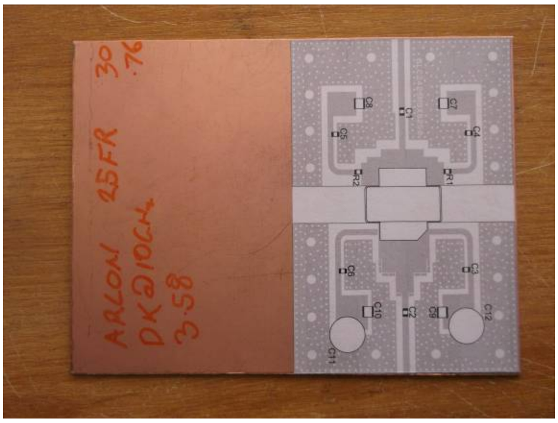


Fig.1. The self adhesive label stuck to the PCB material.

**I printed out the PCB drawing and adjusted the print scaling until the dimensions were correct then printed onto an adhesive paper label. I then stuck the paper label onto the PCB material and carefully cut along the lines with a sharp scalpel. I then peeled off the paper and then, again using the scalpel, peeled off the unwanted copper.**

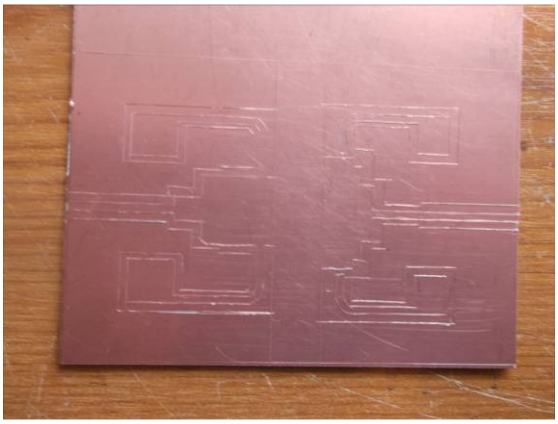

Fig.2. After scoring the lines through through the label with a SHARP scalpel guided by a steel ruler.

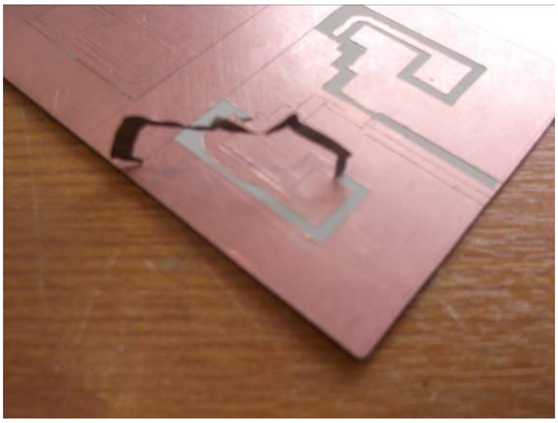

Fig.3. Peeling the copper from the board after lifting the ends with a scalpel

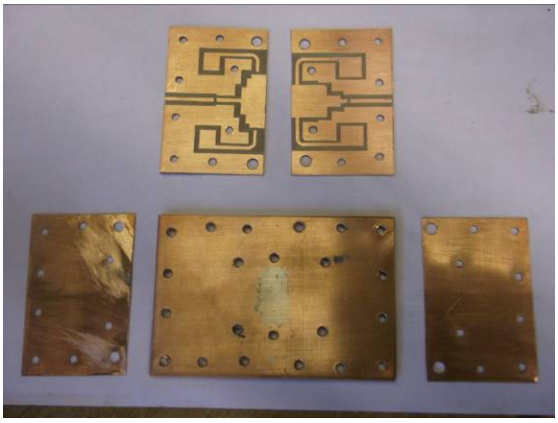

Fig.4. The cut and drilled PCB, heat spreader and 0.5mm copper spacers

**The cut PCB's were then mounted on a piece of 3mm copper plate with another 0.5mm copper plate under each PCB to raise the top track up to the level of the transistor tabs to avoid getting the baseplate/heat spreader**

**milled.**

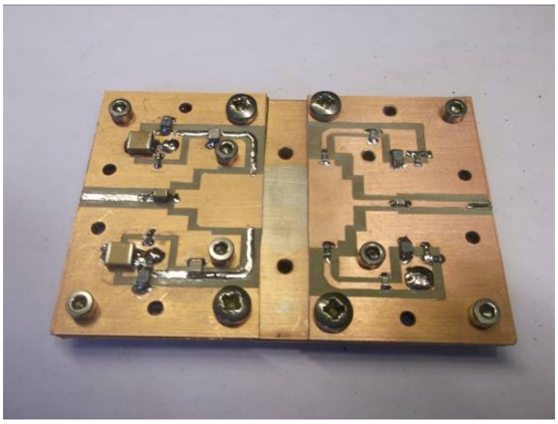

Fig.5. The components soldered to the assembled PCB

**The whole unit was then carefully drilled and four of the holes tapped M4 to hold the PCB's in the correct alignment while the other holes were drilled 3mm right through to allow for mounting bolts to the heatsink. A piece of 2mm aluminium the same size was drilled through at the same time to provide a heatsink drilling jig.**

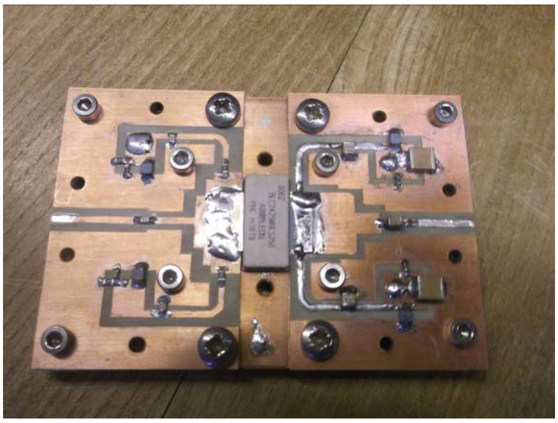

Fig.6 The power transistor soldered to the heat spreader and PCB

**Note that I did not use any through plated vias so drill in about the same positions I used.**

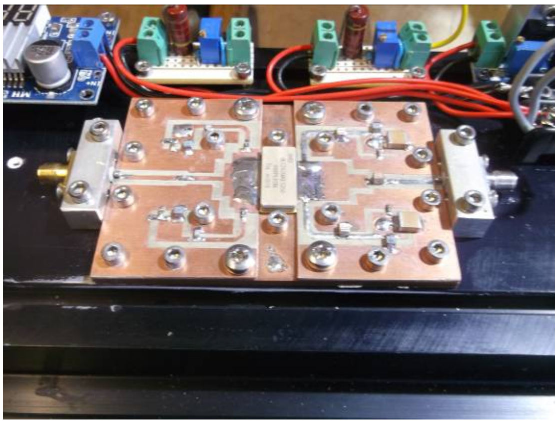

Fig.7. The pallet bolted down to the heatsink with 18 M3 screws and the connector blocks fitted.

**The components were then fitted as shown on the transistor data sheet with the addition of a 100k resistor to earth from both of the gate supply input pads to guard**

against static. The Electrolytics were replaced with 10uf 50v ceramic smd caps as the electrolytics got very hot in use.

I also added some extra decoupling capacitors on the main and gate supply pads to ground. These were 270pf ATC.

The power transistor was the soldered to the heat spreader using a little solder paste by fixing the heat spreader in a vice, then heated FROM UNDERNEATH with a blowlamp until the solder paste became molten and bright then removed the heat and allowed to cool slowly. A small drop of solder paste was put on the heat spreader near the transistor to indicate when it was hot enough.

Once the module is cool enough to touch then solder the transistor tabs to the PCB. Once this has been done check the tabs to earth with a continuity tester to make sure there are no shorts to earth. The 47k resistor will show a reading on the tester but not a short if all is ok. DON'T USE AN OHM METER – TOO MANY VOLTS ON SOME OF THEM! The module will now be safe to handle with little fear of static damage. I have never had a transistor failure using a blowlamp but you could use a hotplate instead if you preferred. I had a tiny blob of solder cause a short to earth on the gate so I unsoldered the Mosfet using the same method, cleaned away the excess and soldered it back on.

Connection blocks were then made from 3/8" square aluminium and drilled carefully so that the SMA centre pin just rested on the PCB track.

A LARGE Heatsink was then selected (mine is 310mm x 120mm x 90mm and the aluminium jig was used to drill and tap it. The heat spreader should be near the centre of the heatsink. Other holes were

**drilled and tapped for the fan supply PCB and the gate bias PCB's.**

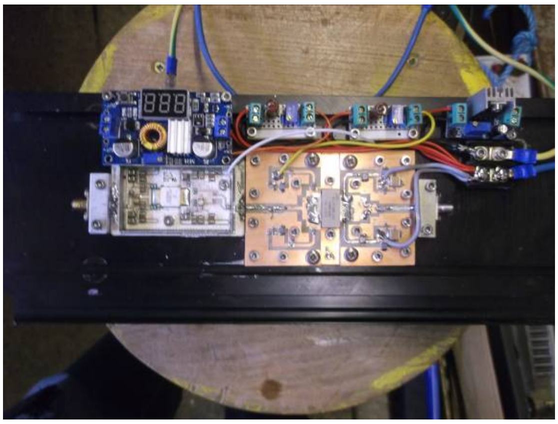

Fig.8. The driver amplifier fitted to the heatsink. The circuit boards across the top of the amplifier are from left to right; The 24 volt fan supply, The driver bias supply, The main amp bias supply and the indicator lamp supply.

**The heatsink needs a large noisy high power fan to keep it cool as it has to dissipate up to 250 watts and makes a nice room heater!**

**I used an old retuned Andrew 2.2GHz module as a driver which gave about 13dB gain and 20W max output although the power amp can be used with an external driver amplifier**

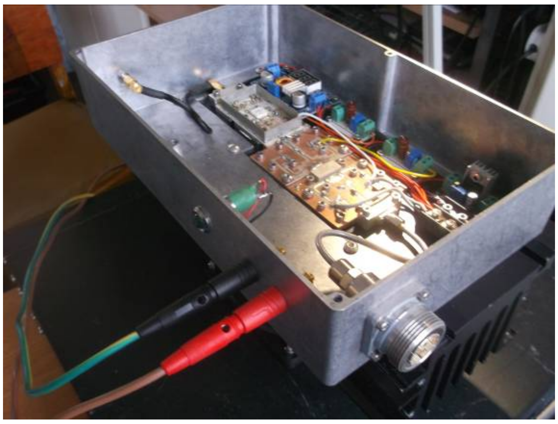

Fig.9. The unit fitted in a box with a 7.16 output socket.

**A power supply was made using three cheap 12volt 30amp units from Ebay , each turned down to 10.67 volts and wired in series with a 20 amp schottky diode connected reverse biased across the output of each power supply to protect them against short circuit.**

Fig.11. The power supply

**Note that the gate bias is external to the pallet so a simple variable voltage from 0 to about 5 volts needs to be supplied. I used an LM317 regulator board as supplied on Ebay but found that hysteresis was a small problem so opted instead for a small veroboard circuit using a dropper resistor, zener and 20 turn preset of about 5k which worked better. I set the idle current Idq to 1 amp.**

**When tested the amplifier was first snowflake tuned at low power which only gave me about an extra 0.5dB but every little helps! At full smoke the amplifier gave me 330 watts saturated and 250 watts in the more linear region for 432 watts input power (58% efficiency).**

**The main power amplifier pallet has a gain of about 17.5dB up to 200 watts and then it starts to roll off as the device nears saturation.**

**The complete unit that I built with a driver has an overall gain of 31dB up to 200 watts.**

**I used RG402 semi-rigid cable and a very good quality (expensive) Radiall SMA soldered connector to link the output to the 7/16 panel socket that I used and this RG402 cable got hot! Even the LDF2-50 Heliax cable to the load got warm so don't use anything smaller – it will fail!**

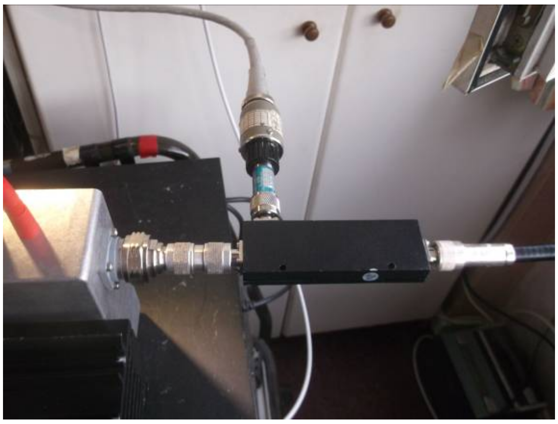

Fig.10. The power measurement setup using a 30dB directional coupler and 20dB attenuator giving 1kW F.S.D on the 10mW range of an HP432A power meter.

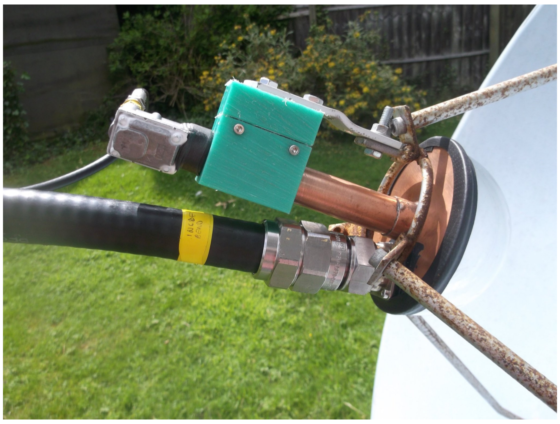

Fig.12. the angled 7.16 connector on the 3mm reflector on my patch antenna to allow very low loss cable to be used (LDF7-50).

For testing I used a Patch antenna hung out of the window and a 30dB directional coupler with a further 20dB attenuator to connect it to my HP432A power meter. I don't have a dummy load of that power rating that will work at 2.4GHz and I don't think many people could afford one!

**In conclusion, the amplifier has performed very well via Es'Hail at symbol rates up to 2000 on DVBS2 QPSK and FEC 2/3. At this symbol rate, it delivers about 210 watts to my 1.2 metre prime focus dish to equal the power level of the beacon.**

**It is difficult to say how much the project cost me as the only significant costs were the transistor and the power supplies. The rest came from rallies, scrapyards, my junk box, donations from friends and items like the copper heat spreader and bolts came from ebay. The PCB material will present the biggest challenge to any prospective builder so good luck!**