Spectra UHF Range 3 Modifications for the 440 MHz Amateur Band

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Scope

This document details the steps to modify the UHF Spectra Range 3 (450-482 MHz) Mid and High power radios for use in the 440-450 MHz Amateur band and achieve near stock specifications. Step-by-step modifications for both the receiver and transmitter are covered in detail.

Production Models

The Spectra radios are available in the following four frequency ranges:

Range	Frequency MHz	Low Power 6/25 watt D14 T14 D34 T34	Mid Power 40 watt D44 T44	High Power 110 watt T84	Preamp Option
1	403-433	X	X	X	X
2	438-470	X			X
3	450-483	X	X	X	X
4	482-512	X	X	X (78W)	X

The most common model is the Range 3 and there are a few Range 1 versions on the surplus market. The Range 2 versions are rather rare and were primarily sold as a 25-watt motorcycle version. Tests on the Range 3 model show a drop in receive sensitivity typically starting at ~450 MHz and degrading significantly by 440 MHz. Some front-ends start to roll-off at ~452 and are at 5uV by 445 MHz. The ceramic preselector is the primary cause the sensitivity degradation. The Spectra was available with a preamp option for all models. The stock receive sensitivity without a preamp is <0.5uV and <0.30uV at 20DB quieting with the preamp.

Both the mid and high power transmitters suffer from lower output below 450 MHz. The mid power transmitter is typically 31 watts at 440 MHz and can be restored to about 37 watts by adding 3 chip capacitors. The high power transmitter is down to 71 watts at 440 MHz and can be restored to 110 watts by adding two chip capacitors.

The Spectra was built in two chassis versions, a mid power and a larger high power chassis. The mid chassis can be either dash or trunk mounted. The high power is only available in a trunk mount version. The high power version uses the same RF & command boards except for a larger PA assembly and a chassis with a significantly larger heat sink.

Note: Due to the variability of component values and transistor gains your results will likely be slightly different from those in this document.

High and Mid power Spectra

Modification Summary

- Modify the preselector to improve the lower frequency sensitivity
- Add the optional preamp: Robert Meister, WA1MIK has written an excellent article- http://www.repeater-builder.com/motorola/spectra/spectra-preamp.html
- Modify the PA for improved power output

The preselector modification is easy with moderate assembly and no soldering. The transmitter modification does require some surface mount soldering and minimal assembly. The preamp modification is challenging as it requires moderate assembly and soldering of very small surface mount parts on a thick ceramic circuit board which tends to sink away the head from soldering iron. If you plan to use the Spectra in a marginal coverage area the preamp modification is highly recommended, it really does balance out the radio RX/TX performance.

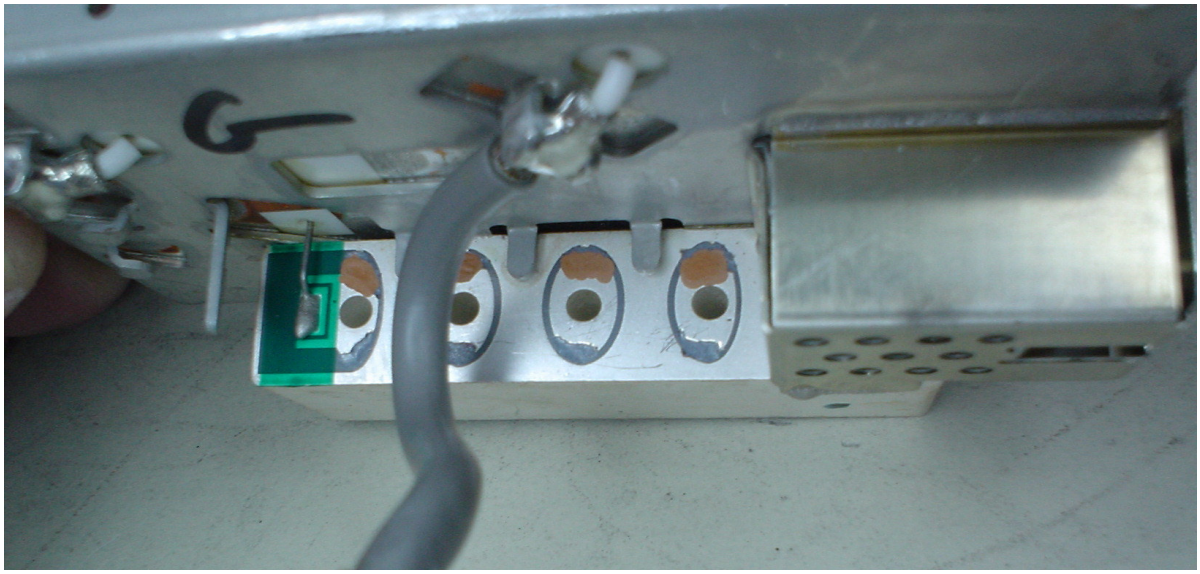
Receiver Modification

This modification can be applied to both the mid and high power versions, as the receiver front-end is identical for both models. The Spectra front end uses a five element ceramic preselector filter to provide the required RF selectivity. A visual inspection shows “tuning pads” at the top of each element that have been factory trimmed to raise the pass-band frequency of the filter. The tuning pad for a Range 3 filter appears as small (3/16”) oval of metallization that has been partially ground or etched away, reducing the area and the effective capacitance and raising the resonant frequency. A Range 1 radio has pads that are complete without any portions removed. Range 2 radios have a small amount of the pad removed and Range 3 radios have a little more of the pad removed. To bring the pass-band down to 440 MHz all that’s needed is to add back some of the metallization using a small dab of conductive paint. Conductive copper paint can be purchased as part of a rear-window defogger repair kit available from most auto supply stores. Silver paint was tested and showed no improvement over the copper paint but cost about 5DB more.

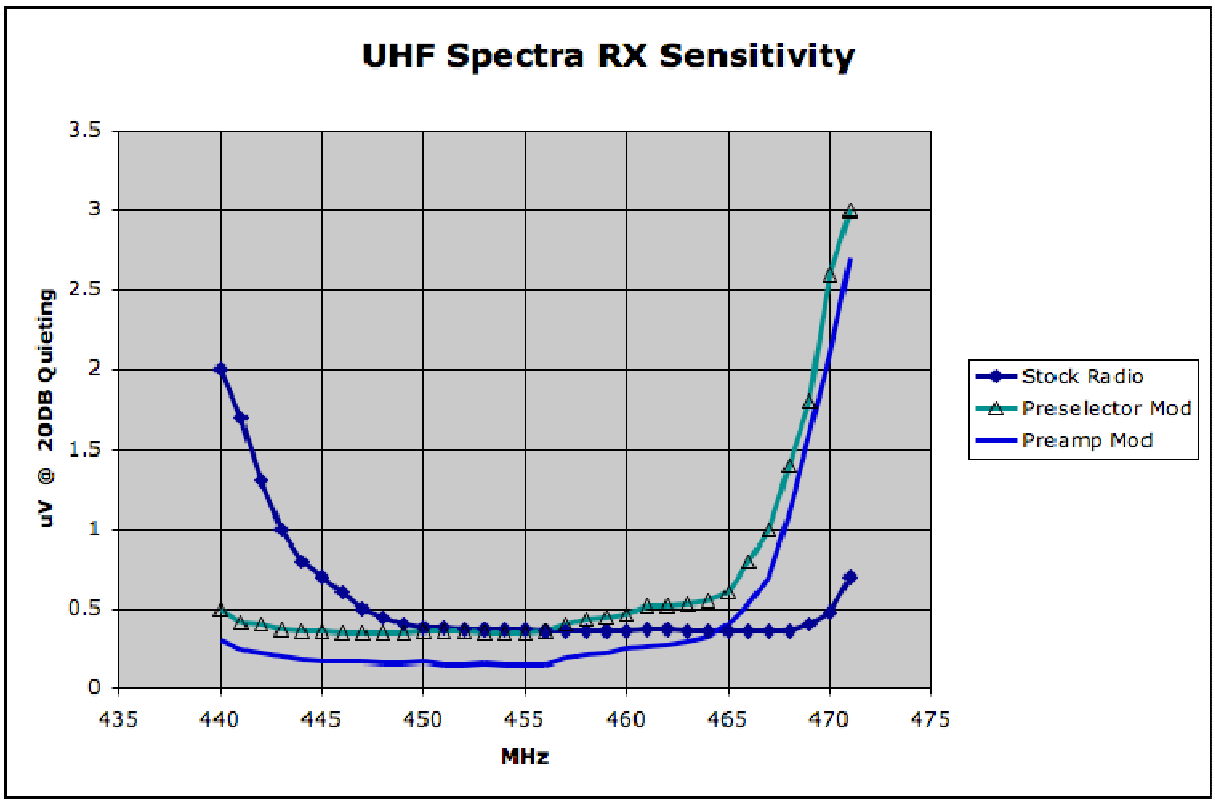
You can still purchase the Range 2 ceramic preselector from Motorola for about $65 plus shipping but you will need two large soldering irons or a torch and some luck to remove the Range 3 filter with out damaging the ceramic substrate. The front-end assembly is made from with thick metal and the filter has significant thermal mass. I replaced my Range 3 with the Range 2 filter and it's not worth the $70+ or the effort to unsolder it. You can easily achieve the same performance using conductive paint and there is no risk of burnt fingers!

1. Remove the top radio cover.
2. Remove the Front-end assembly four screws using a 15mm torx bit and remove the shield.
3. Remove the bottom radio cover and the RF Board shield.
4. Using pliers carefully unplug the shielded cable on the RF Board coming from the Front-end assembly.
5. Carefully lift the Front-end assembly and unplug the shielded cable coming from the PA.
6. Carefully unplug the shielded cable coming from VCO the under the Front-end.

The following picture shows the tuning pads after adding the conductive paint. There are actually five tuning pads with one hidden behind the antenna input shield cage on the right. It is not easy to unsolder the shield (here again you will need a Big soldering iron) and clearly not worth the extra couple of DB of sensitivity that appears below 442 MHz. Unless you just must have that last bit of extra sensitivity I would not bother with it, save the time and go get a Starbucks.



Thoroughly shake the conductive paint bottle to ensure the copper particles are well mixed. Use a toothpick to apply the conductive paint to only one side of the oval pad. Caution- you must be very careful to not short the tuning pad to the surrounding ground metallization by applying too much paint. If you do apply too much conductive paint, DO NOT use a metal tool to scrape away the paint as you will be embedding metal particles into the ceramic surface which will lower the Q and increase the filter loss. You will need to overlap the tuning pad with conductive paint to ensure a good contact. Once the conductive paint dries the radio may be assembled using the reverse order of the above steps. One bottle of conductive paint should be enough to modify several dozen radios.



This chart clearly shows the improved sensitivity at the low end of the 440-450 band and a moderate decrease above 456 MHz compared to the stock radio. The addition of the preamp brings the 20DB quieting sensitivity down to about 0.16uV or better across most of the amateur band.

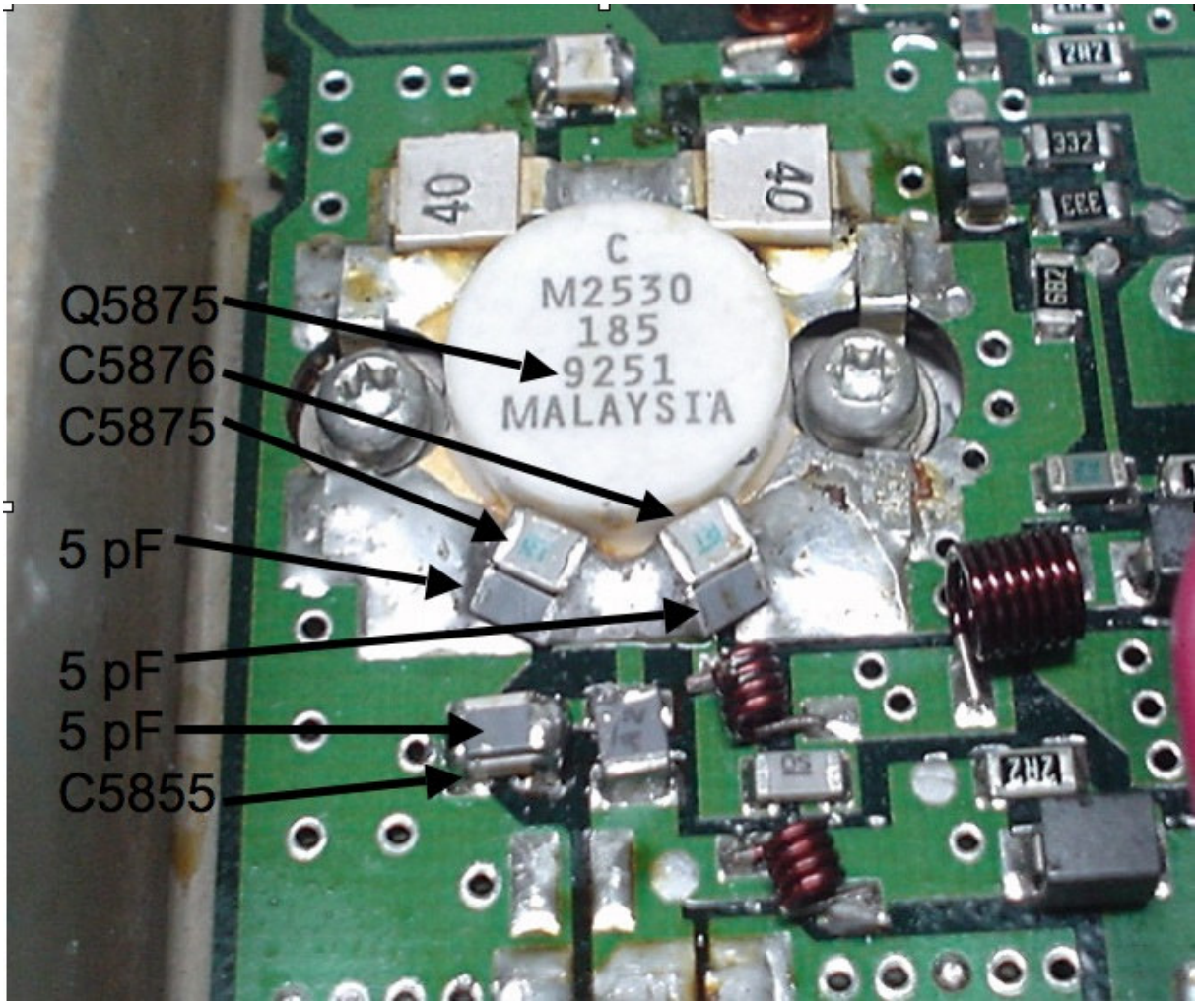
Transmitter Modification

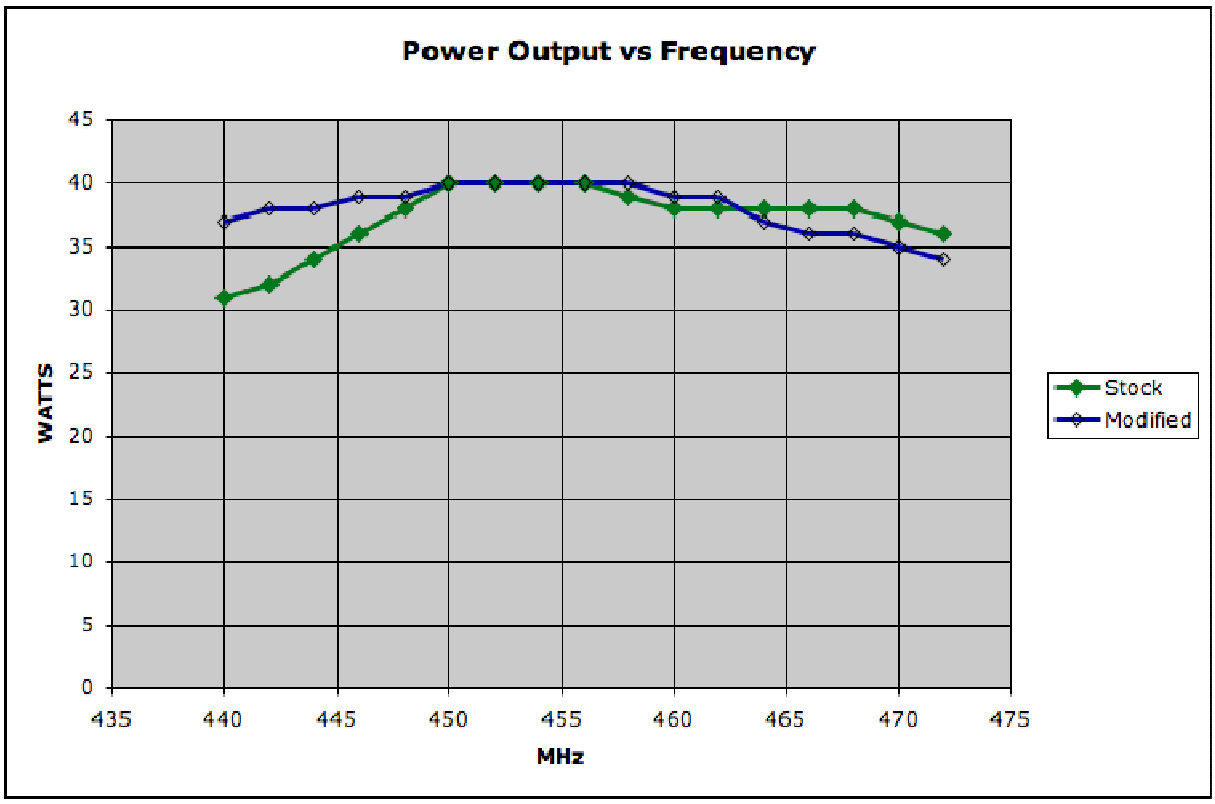
Parts required: 3 each, 5.6 pF chip capacitor, Mouser part number 80-C1206C569J5G

Mid Power PA

The stock Mid power PA is typically 31 watts at 440 MHz, this modification brings the power up to 37 watts with a slight decrease above 463 MHz. Due to the fixed PCB transmission lines the full 40 watt output was not realized.

1. Using a 15mm torx bit, **r**emove the bottom rear cover and PA shield.
2. Using a 40 watt soldering iron with at least a 1/8" wide tip, add a 5 pF ceramic chip capacitor in parallel with C5875 as shown in the picture below. This capacitor connects from the final PA transistor, Q5875, base to emitter.
3. Add a 5 pF ceramic chip capacitor in parallel with C5876, from the opposite emitter lead to the base of Q5875.
4. Add a 5 pF ceramic capacitor in parallel with C5855, place the 5 pF cap on top of C5855.





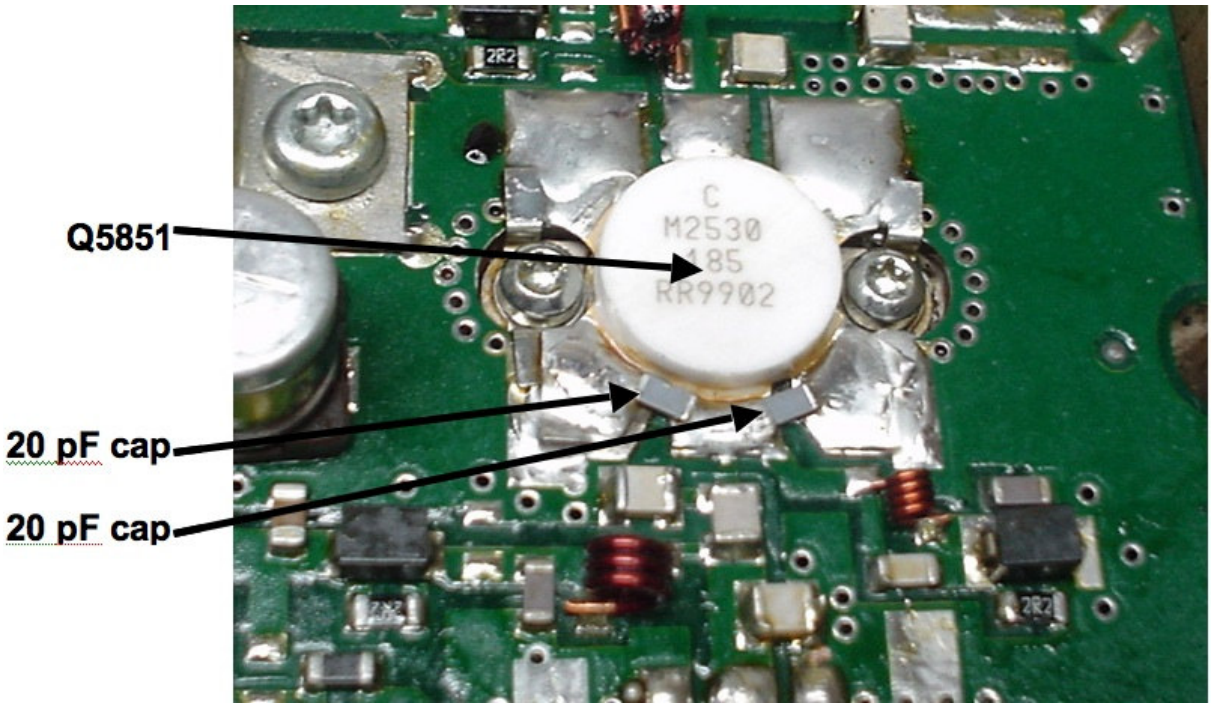
This chart shows the output power improvement compared to the stock Mid power model.

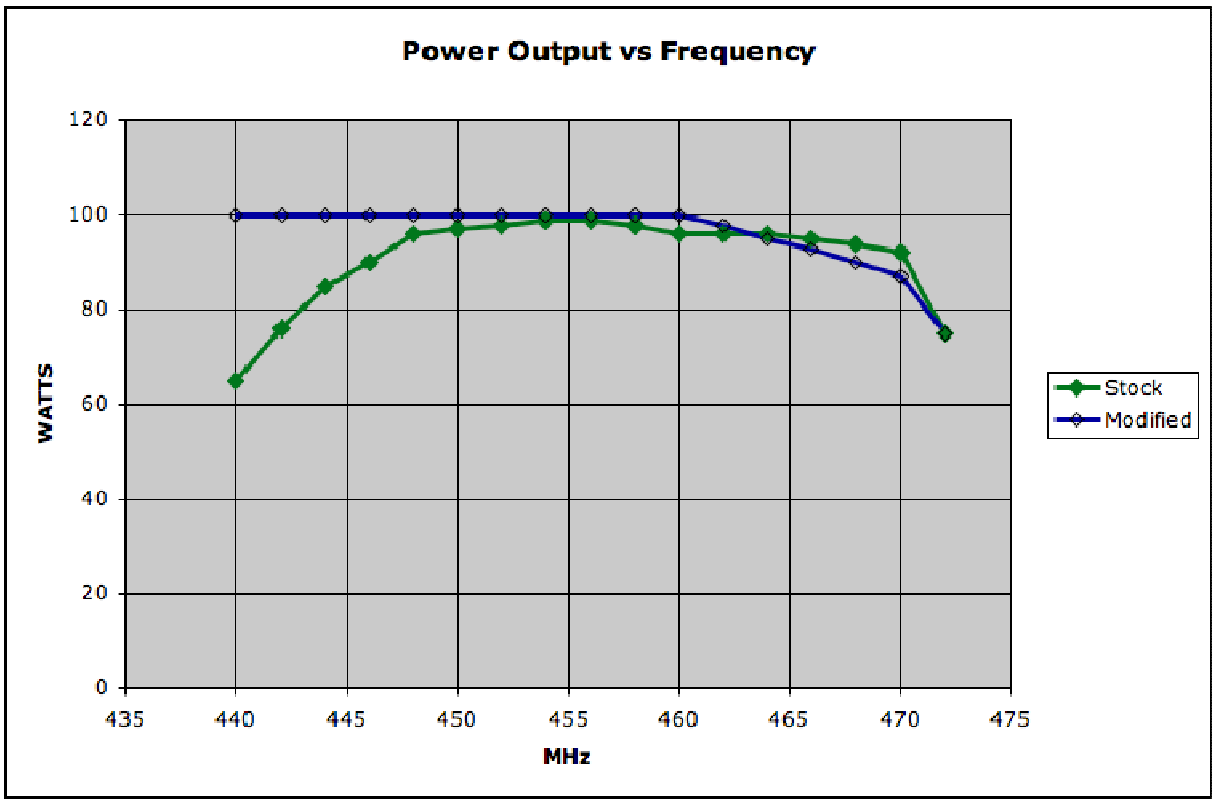
High Power PA

Parts Required: 2 each, 20 pF ceramic chip capacitors, Mouser part number 80-C1206C200J5G

The stock High power model output and efficiency drops significantly below 450 MHz, producing only 65 watts and still drawing 21 amps at 440 MHz. The output power can be easily restored to 110 watts clear down to 440 MHz by adding a pair of 20 pF chip capacitors to the driver transistor.

1. Using a 15mm torx bit, **r**emove the bottom rear cover and PA shield.
2. Using a 40 watt soldering iron with at least a 1/8" wide tip, add a 20 pF ceramic chip capacitor in from base to emitter the driver transistor Q5851.
3. Add a 20 pF ceramic chip capacitor from the opposite emitter lead to the base of Q5851.





The above chart shows the stock verses modified output power for the High Power T84 model. The modified PA current also matches very close to the stock values, averaging at 24 amps. The power was adjusted using the radio "Align" mode for a 100 watt output, this made it much easier to read levels on a Bird watt meter.

Acknowledgements & Credits:

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