RF and DC Power Considerations for the Baofeng BF-888S

DC Power:

The BRIAN (SM) Allstar node (www.hamprojects.info/brian) uses the PC board from a Baofeng BF-888S HT for the radio portion of the node. This board has gone through numerous revisions since the original BRIAN was conceived 2 years ago. Recently, while building a BRIAN, I found that the Baofeng BF-888S board I was using was drawing more than 1.2 amps of current when in the transmit mode. BRIAN is powered by the USB port of a Raspberry Pi. The PI3 and Pi4 are only capable of supplying 1.2 amps via all USB ports so the current draw of the BRIAN was forcing the Raspberry Pi USB current limiting circuitry to cycle on and off continuously.

An extensive investigation determined that the gate bias on the final power amplifier (PA), a Renesas RQA0009 Silicon N-Channel MOS FET, was set too high for this particular device causing it to have a quiescent drain current (I_{DQ}) of over 1.2 amps. The RQA0009 data sheet recommends about 200 mA for I_{DQ}. In the BF-888S, the gate bias voltage (V_{GS}) for the PA is provided by the RDA Microelectronics RDA1846 Single Chip Transceiver. The PABIAS provided on pin 22 of the IC can be set to 1.5 to 2.8 volts. Since the RDA1846 is managed by a microcontroller on the BF-888S PC board, only the manufacturer can set this voltage, it is not user adjustable.

On the BF-888S board, the bias voltage from the RDA-1846 is reduced by a voltage divider circuit at the PA and applied to the gate of the RQA0009. This voltage divider consists of a 68K and a 33K resistor as shown in the simplified schematic of Figure 1. The output of the voltage divider is connected to the gate of the RQA0009 via a 100 ohm resistor. Note that the bias voltage can be reduced by placing a resistor in parallel with the 33K resistor. Also note that the 68K resistor, the 33K resistor, the 100 ohm resistor and a capacitor are connected together.

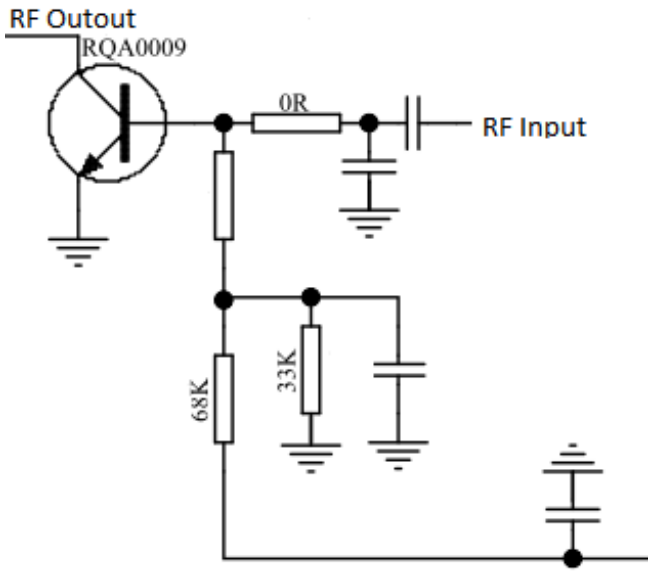

Figure 1 – Simplified BF-888S PA Schematic

Figure 2 shows a method of adding leaded ¼ watt carbon film resistor in parallel with the 33K ohm resistor. In my case, 22K ohm was used. One end of the resistor is soldered to the common junction point of the 4 components discussed above. The other end is soldered to the copper ground plane. The epoxy solder resist is scraped away to expose the copper ground plane.

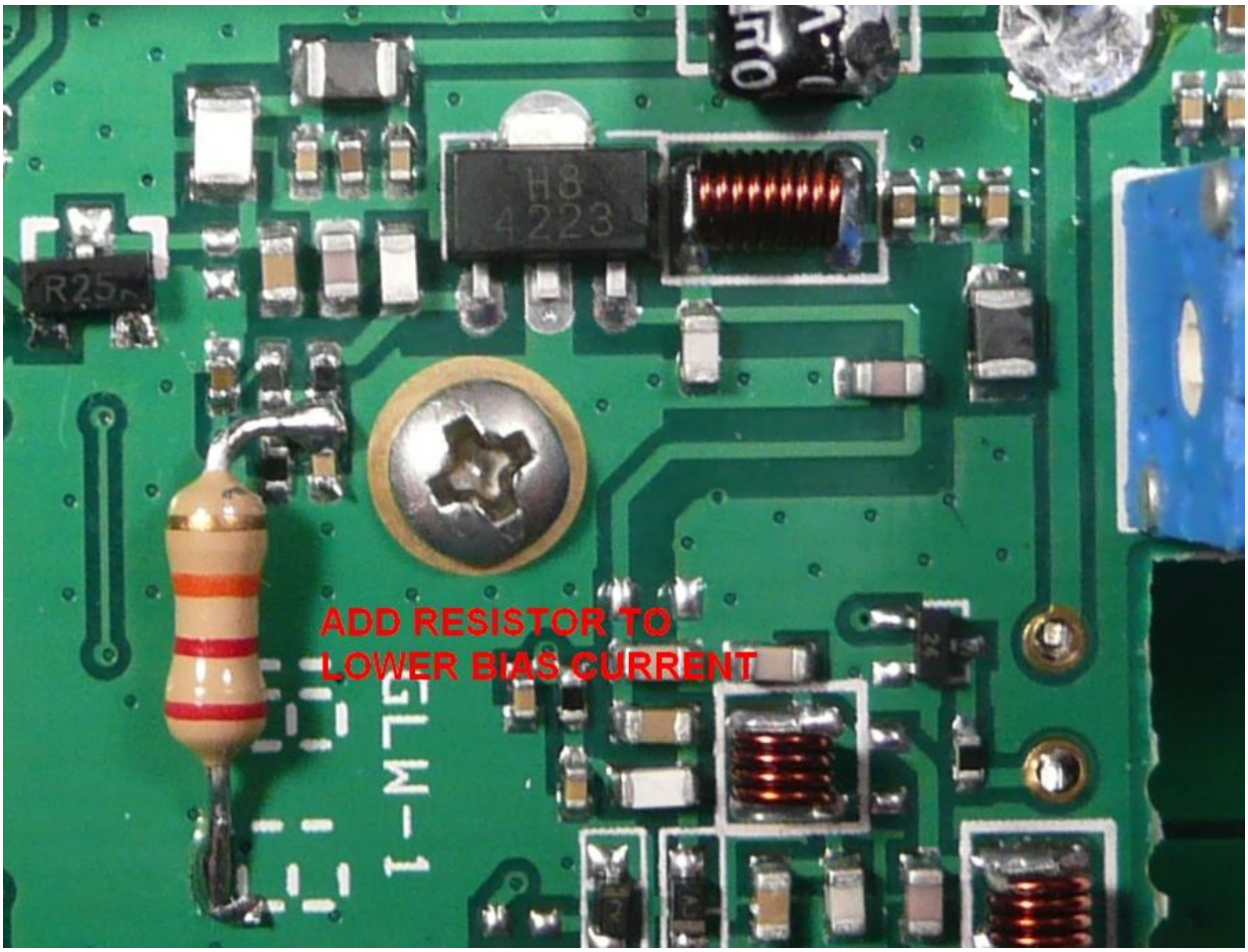

Figure 2 - Adding a Resistor to Lower PA BIAS Current

Using the 22K ohm resistor, the I_{DQ} on the board was lowered from over 1 amp to 200 mA. The V_{GS} was 1.215 VDC. The measured power out at 446.100 MHz was 1 watt with a current to the BF-888S board of 750 mA. The second harmonic was > -60 dBc and the third harmonic was about -55 dBc.

Of course the optimum resistor will vary from board to board.

Reducing RF Output Power

As described in the document titled “BRIAN (SM) Construction Manual Version 1.01” on the BRIAN groups.io site, the output power can be reduced to 20 to 50 milliwatts by removing the PA transistor, several other surrounding parts and adding a wire jumper. During the investigation into the excessive bias current, I discovered a different method to lower the PA RF drive and thus reduce output power.

This is accomplished by soldering a 0805 or 0603 SMT capacitor between the gate and source of the R25 (2SK3078A) driver transistor. A 220 pF capacitor lowered the BF-888S power output by about 12 dB on my board. The location for this capacitor is shown in Figure 3. The power output will decrease as the capacitance is increased.

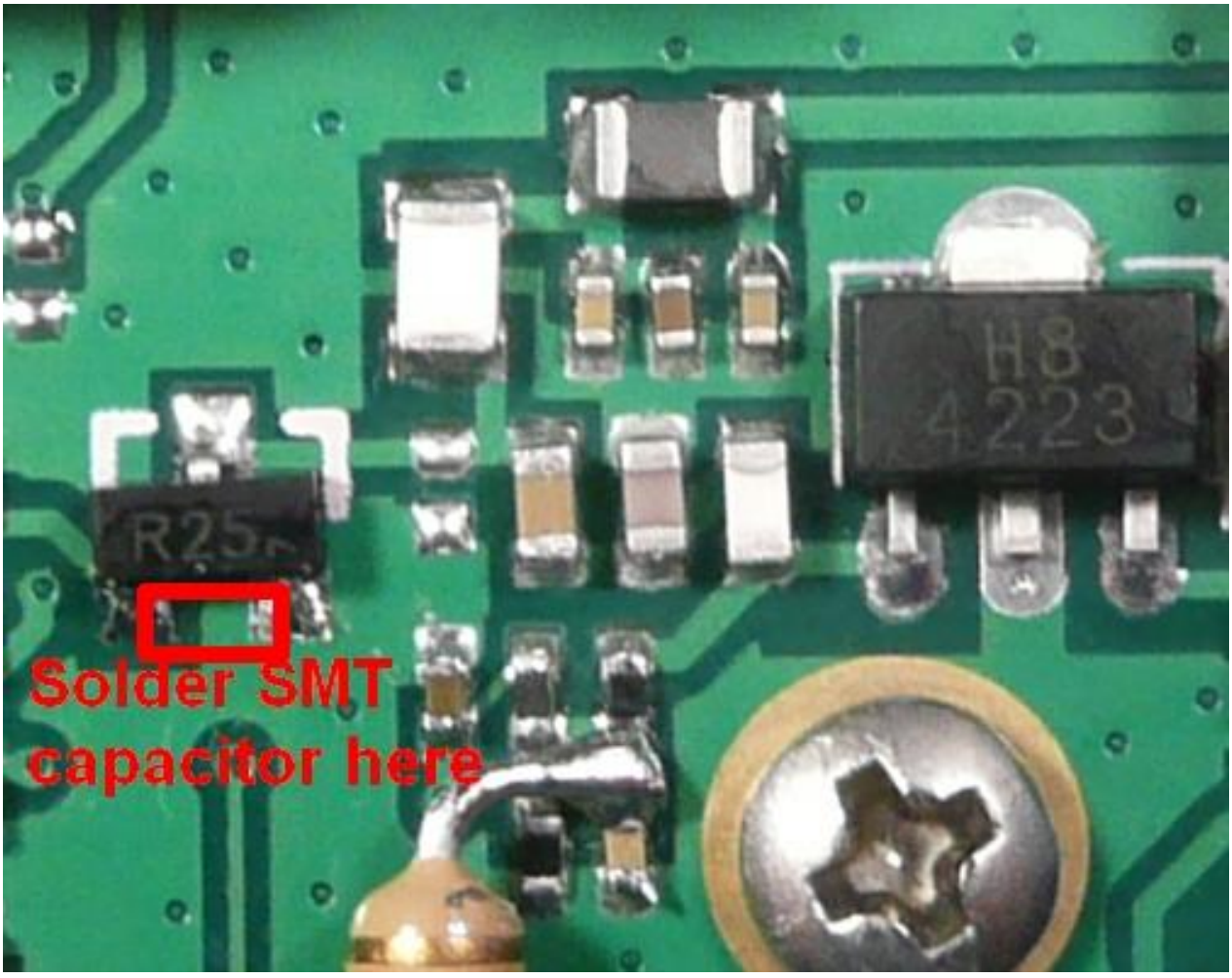

Figure 3 - Capacitor Location to Reduce RF Output Power