**Replacing R61 for Improved Microphone Amplifier Performance**

## Purpose & Discussion

The stock vs.4 µBITX has many opportunities for improvement, two of which are to make the unit compliant with Federal regulations regarding harmonic and spurious emissions and to improve the power output on sideband. These are related in that as power in the transmitter chain increases, harmonics and spurs are created as the active stages approach gain compression. While these are not the only sources of harmonics and spurs, and they may actually be minor in the unit, they are related to the issue of low power output on sideband.

Data taken on my unit indicate that the radio's RF output becomes nonlinear at about 90 mV peak into the microphone amplifier. Also, power out with either the stock electret microphone or a (probably) better quality microphone in a gamer's headset is very low and barely moves the needle on an MFJ power meter. The meter has been crudely calibrated and from prior work, its measurements are commensurate with the measured RF voltages. Measurements indicated that the microphones mentioned above, with normal speaking, generate about 20 mV pk on average.

PSpice modelling of the first amplifier stage allowed calculation of its gain and nonlinearities. The gain was calculated as 26 dB, with a low frequency 3 dB cut-off of about 100 Hz. Gain was flat to beyond 5 KHz.

Simulations indicated that the stock bias resistors biased the 2N3904 transistor at approximately 11 volts, leaving less than a volt of headroom. This limits the non-distorted dynamic range of the amplifier. Increasing the resistance of R61, the bias resistor for Q6, lowers the bias voltage at the collector of the transistor, increasing headroom and lowering distortion. It also changes the input impedance and the modeling accounted for that effect.

## Parts

5.6K Ohm surface mount resistor, size 1206[1]
Soldering iron, needle-nose pliers, and sadly, a magnifying glass

## Procedure

1. Remove the board from the case.
2. Gently, and with minimum heat so as not to jeopardize the traces, remove R61.
3. When the area is cool – a few seconds – apply solder flux[2] to the area. While a film of solder remains on the pads, none is on the new resistor and putting flux there will encourage good solder connections.
4. Place the new resistor on the pads and gently holding it in place using pressure from the needle nose pliers, briefly touch the soldering iron tip to one side until the solder melts. Immediately remove the iron. You no longer need to secure the resistor.
5. Briefly touch the soldering iron to the other side of the resistor until the solder melts.
6. Reinstall the board and test for sideband output power similar to before the part change.

[1] Size 0805 resistors will fit, but are not preferred. I have extras for those who want to make this modification.
[2] I have liquid flux for surface mount soldering and will bring it to kit build sessions.

## Result

Though the predicted results should not be noticeable in daily use, they should allow cleaner transmitted signals and improve quality of digital mode signals. The predicted marginal gain improvement of 1 dB will not overcome the lack of gain in the audio stage.

Simulated results indicate a 31 dB reduction in the second harmonic at 0.08 mV pk input to the amplifier, however, at approximately -37 dBC before modification, this change cannot be considered a major improvement.

| | 2.2K Ω | | 5.6K Ω | |
|---|---|---|---|---|
| | Stock value | | Modified value | |
| Input (Vpk mV) | 2nd Harmonic (dB) | 3rd Harmonic (dB) | 2nd Harmonic (dB) | 3rd Harmonic (dB) |
| .01 | -55.35 | - | - | - |
| .02 | -49.32 | -85.28 | -71.50 | - |
| .03 | -45.75 | -85.23 | -68.98 | -83.44 |
| .04 | -43.06 | -77.46 | -65.04 | -88.04 |
| .05 | -41.21 | -70.27 | -65.14 | -86.72 |
| .06 | -39.55 | -66.23 | -64.02 | - |
| .07 | -38.18 | -62.98 | -66.07 | -68.19 |
| .08 | -36.99 | -60.21 | -67.16 | -57.38 |
| | | | | |

Installation was easy and as predicted, there is no noticeable change in power output on sideband under normal speaking conditions. However, given the very low cost of the resistor, low installation risk, and ease of installation, it made me feel good.

Comments, questions, and suggestions welcome.

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