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Group 4
ECEN 2420
On-Site Homework 11
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Introduction

This lab concludes the Norcal 40A assembly and includes the final radio alignment.

1 Installation of remaining components

The highlighted items in Figure 1 were installed on the Norcal board. All temporary resistors and wires were removed before the parts were installed.

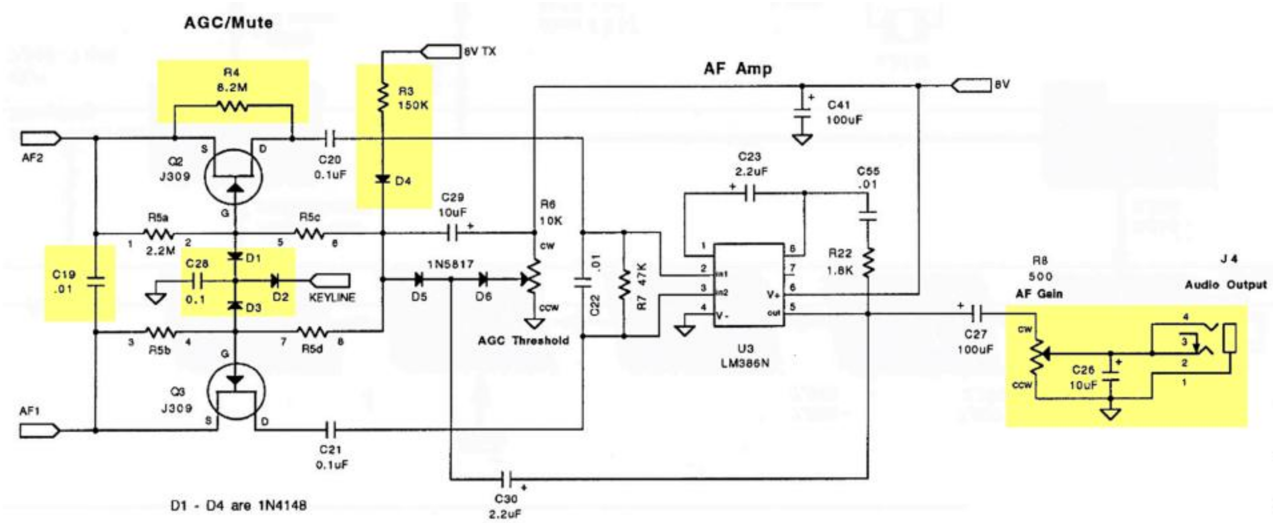

Figure 1: Remaining parts for the Norcal 40A

2 Initial Settings

1. All (4) jacks, (2) switches, (3) trimpots, (6) trimcaps, (3) pots had their locations noted.
2. Key jack J_3 and the antenna jack J_1 were kept disconnected.
3. A 3.5mm stereo jack was plugged into J_4, which is the audio output jack.

4. The trimmer potentiometers were adjusted according to the following specs:
   - R_6 was set to maximum (clockwise) to disable the AGC.
   - R_8 was set to maximum (clockwise) so that the audio was at the highest value.
   - R_{13} was set completely counter-clockwise so the transmitter drive was at the lowest value.
5. The main potentiometers were then set
   - R_2 was set fully clockwise so the RF gain was maxed out.
6. Switch S_1 was set off (down position) so the power would be off
7. Switch S_2 was also set in the down position so the RIT would be disabled.

3 Final Checklist

Before proceeding to the final calibration leg, the following steps were taken to ensure everything went along properly.

1. DC Power Supply set to 12.0V, current limited to 100mA.
2. The power cable was attached to the Norcal 40A and S_1 was turned on (up position). The DC current was measured to be $\boxed{16mA}$ which fell in the expected range between 15mA and 18mA.
3. Using a proper CW keyer, the DC current draw was then measured. The range of values was between 25mA and 55mA, the measured DC current draw with the key active was $\boxed{26mA}$.
4. Ater these measurements were taken, the keyer was detached from the key jack J_3.

3.1 Problems Encountered

Sadly, during this step, a serious issue with the radio was found. Namely, when powered on, there was a continuous 700Hz tone from the audio output, except for when the keyer was pressed. Observing the DC supply showed that the current draw was $25mA$ under all conditions (even when the keyer was pressed). Initially, the ICs U_1 and U_2 were replaced since it was found that the 8V line was oscillating at $\approx$ 2MHz; it was assumed that these ICs may have been defective. This however proved futile! Next, the capacitor C_{48} was replaced as it was possible that it had been leaking. Interestingly, the tone persisted even after the capacitor was removed. The conclusion was that the transistor Q_4 was damaged and leaking. After replacing this part, the tuning procedure finally resumed without issue or further exasperation.

4 Calibration

With the pre-calibration steps carefully completed, we proceeded to follow the following through exactly as directed:

4.1 External Equipment Setup

1. The signal generator was set to output $4mV_{pp}$ into 50Ω at a frequency of $7.040MHz$.
2. The signal generator was connected to a 40dB attenuator and was attached appropriately to the Norcal 40A.
3. The Oscilloscope was then calibrated to measure $200mV$ per division and the time base $200ns$ per division. The channel was set for a X10 probe with AC coupling. The scope was then set to measure frequency and Voltage in V_{pp}.
4. The scope probe was then connected to the test point wire near switch S_2 and the scope ground was grounded on a reliable ground.

4.2 Calibrating the VFO

1. With the scope probe set to 10:1, the signal was measured to be within 600 and 800 mV_{pp}.
2. With R_{17} set at half position, C_{50} was adjusted until the VFO frequency was at 2. 125MHz.
3. R_{17} was then set counterclockwise and the frequency was precisely measured to be $\boxed{2.14457MHz \pm 100Hz}$
4. R_{17} was then set fully clockwise and the frequency was precisely measured to be $\boxed{2.10505MHz \pm 100Hz}$
5. $R_1 7$ was then adjusted until the frequency was as close to possible to 2.125MHz.
6. The freq range of the radio was found to be $\boxed{39.5200kHz}$

4.3 Receiver Alignment

1. The scope was again checked so that it measured 200mV per division, and the time base was set to 2ms per division.
2. C_{17} was adjusted so that the measured frequency was $575 \pm 10Hz$.
3. The measured audio voltage was found to be $\boxed{3.32mV_{pp}}$.
4. The RF signal generator was adjusted such that a 6dB or a $\frac{1}{2}$ change was observed.

5. The 6dB bandwidth was measured to be $\boxed{454Hz}$.
6. The RF signal was then adjusted until it was near $575Hz$.
7. Next, the RIT was set on by turning on S_2, and R_16 was adjusted and the frequencies were noted. The range of frequencies was found to be between $\boxed{227Hz \rightarrow 1.02kHz}$, or simply a range of $\boxed{793Hz}$.
8. The RIT switch S_2 was turned off and the audio frequency was returned to $\approx 575Hz$.
9. The AGC potentiometer R_6 was adjusted such that the voltage at the scope dropped by $\frac{1}{3}$.
10. Finally, the function generator was disconnected from the 30dB attenuator with the pad still connected to J_1.

4.4 Transmitter Alignment

1. The scope was set to read 50mV per division and the time base set to 2ms per division.
2. The DC supply was set with a limit at 200mA
3. R_{13} was set to be at half-value.
4. The CW keyer was connected J_3
5. C_{39} (TX filter) was set to yield max voltage at an audio frequency on the scope, where the trimcap C_{39} was not near either extreme value.
6. The DC current draw was measured to be $\boxed{100mA}$
7. C_{34} (TX frequency) was adjusted to be $\approx 575Hz \pm 10Hz$
8. The scope was then set to read 2V per division and the time base was set to 200ns per division. The scope was attached to the TX end of the 30dB attenuator (which was not the open end).
9. The 40dB attenuator was found to reduce the power by a factor of $10\,log_{10}(P_{in}) = \boxed{10,000}$
10. The RF voltage was measured in order to calculate the transmitter power, which was found to be $20V$ (accounting for the attenuator), and therefore the transmitter power was found as:

$$\begin{aligned} P_{TX} &= \frac{V_{pp}^2}{16 \cdot R} \\ &= \frac{20^2}{16 \cdot 50} \\ &= \boxed{500mW} \end{aligned}$$

11. The DC power supply was limited to 600mA
12. The scope was set to read 5V per division
13. R_{13} was set to full clockwise position, and the RF voltage was measured, taking care to keep the transmitter from running for more than a few seconds at max power. The full-power voltage was found to be $\boxed{31V}$.
14. The maximum power the transmitter can provide was found to be $\boxed{1.2W}$. Unfortunately, this is 60% of the ideal transmitting power of $2W$.
15. Finally, R_{13} was set to the lowest value such that transmission would persist. Sadly, this was about $\frac{3}{4}$ the way turned, which means that the radio has little headroom for transmission. It seems worthwhile to try and track down the cause of non-ideal performance in the future.