$\boxed{\text{Patrick Harrington}}$
ECEN 2420
On-Site Homework 9
April 2, 2013

1 Driver Amplifier

First, the Driver Amplifier was built. The associated schematic can be seen in Figure 1.

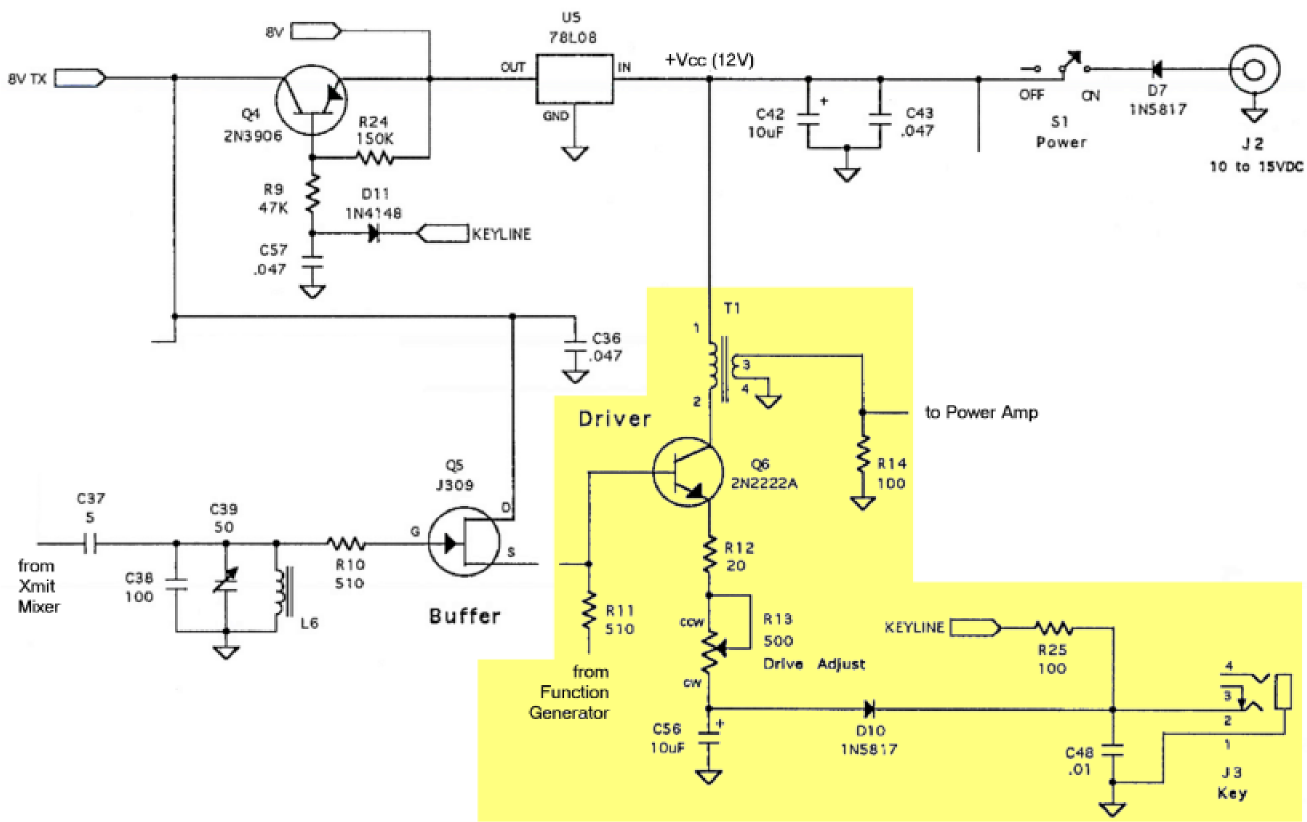

Figure 1: Circuit Schematic for the Driver Amplifier

1.1 Measured Output Voltage: V_{out}

With the function generator set to 7.04MHz, and with an offset of $0.5V$. The output voltage across R_{14} was m easured to be $\boxed{2.16V_{RMS}}$. The voltage observed was high, which threw off the following calculated values.

1.2 Calculated Output Power: P

P is calculated using the following:

$$P = \frac{V_{RMS}^2}{R_{14}} \implies \frac{2.16^2}{100\Omega} = \boxed{47mW}$$

1.3 Calculated Supply Power: P_0

1.3.1 $V_{R_{12}}$

The DC voltage across R_{12}, $V_{R_{12}}$ was recorded to be $\boxed{594mV}$.

1.3.2 i_E

The emitter current, i_E, was found by:

$$i_E = \frac{V_{R_{12}}}{R_{12}} \implies \frac{595mV}{20\Omega} = \boxed{29.8mA}$$

1.3.3 Supply Power: P_0

V_{cc} was measured at the small resistor across S_1, and found to be $\boxed{9.72V}$ Therefore, the DC supply power $P_0 = (V_{cc} \cdot i_E) = \boxed{289mW}$

1.4 System Efficiency: η

The efficiency η was calculated to be:

$$\eta = \frac{P}{P_0} \implies \frac{47mW}{289mW} \approx \boxed{16\%}$$

1.5 Amplifier Gain: G

The gain G was found to be:

$$G = 10log\left(\frac{P}{P_0}\right) \implies 10log\left(\frac{47mW}{289mW}\right) = \boxed{-7.9\text{dB}}$$

Since the resistor R_{13} was fully clockwise, this meant that $G = G_{v\,(Max)}$. When R_{13} is fully counter-clockwise (min), the voltage gain was found to be:

$$G_{v\,(Min)} = 10log\left(\frac{15.6\mu W}{132\mu W}\right) = \boxed{-9.3\text{dB}}$$

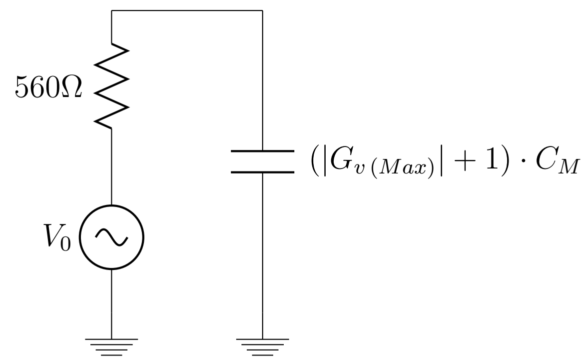

Figure 2: Equivalent circuit for extracting Miller Capacitance, C_M

1.6 Miller Capacitance, C_M

Using $G_{v\,(Max)}$ found in the previous section, the Miller Capacitance C_M was found analyzing the equivalent circuit in Figure 2.

$$
\begin{aligned}
Z_C &= \frac{1}{\omega C} \implies C = \frac{1}{\omega Z_C} \\
\text{Where } \omega &= (2\pi \cdot 7.04MHz) \approx 44.2\left[M\tfrac{rad}{s}\right] \\
V_R &= V_0\left(\frac{560\Omega}{(560\Omega + Z_C)}\right) \ \textit{(Voltage divider rule)} \\
\text{Since } V_0 &= 1V \text{ ; } V_R = 400mV \\
Z_C &= 560\Omega\left(\frac{V_0}{V_R} - 1\right) \implies 560\Omega\left(\frac{1}{400 \cdot 10^{-3}} - 1\right) \\
Z_C &= 840\Omega \\
\text{Since } C &= \frac{1}{(\omega Z_C)} \implies \frac{1}{(44.2 \cdot 10^6) \cdot 840} = 26.9pF \\
C_M &= \frac{C}{|G_{v\,(Max)}| + 1} \implies \frac{26.9pF}{8.9\text{dB}} \\
\therefore C_M &= \boxed{3.02pF}
\end{aligned}
$$

(*Note:* At the end of this step, the other end of R_{11} was soldered).

2 Buffer Amplifier

Figure 3 shows the schematic of the Buffer amplifier.

Such a circuit is a source-follower, and therefore has no impedance gain and a high input impedance. The function generator was connected to C_{37} with the $1.5k\Omega$ resistor. The frequency used was $7.04V$ and the amplitude was $1V_{pp}$.

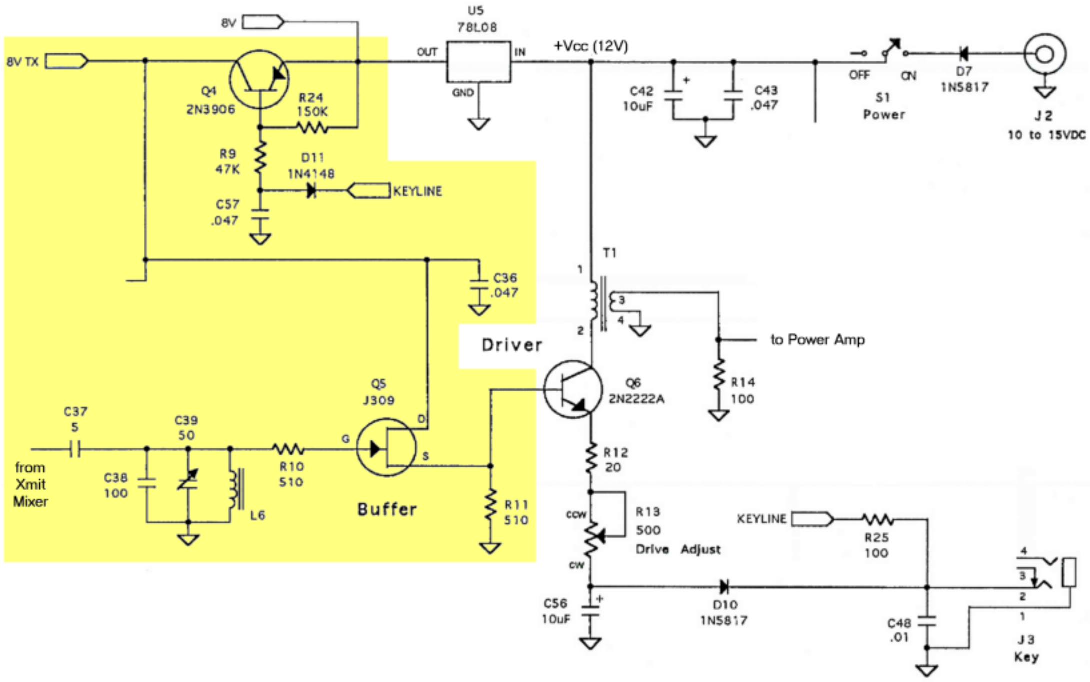

Figure 3: Circuit Schematic for the Buffer Amplifier

2.1 Max Voltage Across R_{10}

C_{39} was adjusted for maximum voltage. The measured maximum value was $\boxed{65.1V_{RMS}}$.

2.2 Voltage Gain G_v across R_{11}

The voltage gain across R_{11} was calculated to be:

$$G_v = 20log\left(\frac{v}{v_i}\right) \implies 20log\left(\frac{1.09V}{65.1mV}\right) = \boxed{24.5\text{dB}}$$

2.3 Power Gain, G_P

Given that a $1.5k\Omega$ resistor is at the input and a 510Ω is at the load, the power gain was calculated to be:

$$G_P = 10log\left(\frac{P}{P_0}\right) \implies 10log\left(\frac{2.33mW}{2.83\mu W}\right) = \boxed{29.2\text{dB}}$$