Turn in: Monday, February 22nd, in Homework Session 6:15-9:30pm

Homework Policy:  You are allowed to work with others on homework, BUT under 2 rules:
  o Rule 1: You write your own solutions.
  o Rule 2: You list all the other students with whom you collaborated on the assignment at the top of your homework.

Odd-numbered teams are doing L5.1 and L5.2 first, and even-numbered teams are doing L5.3 and L5.4 first. This means that teams 1,3,5, etc. will solder components for the transmit switch and test it, while teams 2,4,6, etc. will solder components for the receive switch and test it. Then you will swap circuits and only test the one that your complementary team built.

ODD GROUPS DO THIS PART FIRST

L5.1: Transmitter switch

The NorCal40A transmitter switch serves to connect the supply voltage to the amplifiers and enable transmission. The switch is implemented with a pnp transistor (U5). Solder all the parts as indicated on the board. From J2 (supply jack), follow the block diagram through diode D7, which is connected through the switch to a voltage regulator (78L08) that supplies voltage to the emitter of the switch. The switch connects the supply jack to the output (labeled 8V TX). When you are testing this circuit, the power amplifier is not drawing any current, so you should see approximately the same voltages at input and output.

Look up the specifications for all the parts in the back of the book and get familiar with the parts. Make sure you understand the transistor, diode and electrolytic capacitor (C42) polarities. Call a TA to check before you solder any of these parts in

First explain how the transmit switch operates in both ON and OFF states.

ON-state:
Next, test the functionality by connecting 10-15V from the DC power supply to the power supply jack J2 and toggling the (red) switch manually. Measure the output voltage at G1. To activate the switch, you need to short/open the end of the diode D11.

Voltage at J2: ____________________
Voltage output G1: ____________________

**L5.2: Tuned transformer T3**

You now move to the receiver circuit to transformer T3, which you will test on a breadboard first. For this part of the lab, you will first wind the transformer on a core:
- The core is a FT37-61 (unpainted)
- The inductance constant is $A_L = 66\text{nH/turn}^2$
- Use a 40-cm long section of #26 insulated wire for the primary, and carefully wind 23 turns (figure below). Remove insulation from the ends of the leads.
- Use a 15-cm long thin colored wire for the secondary.
When you have wound the transformer, answer the following questions:

What are the current, voltage and impedance transformation ratios?

\[ N_I = \frac{I_p}{I_s} = \quad N_V = \frac{V_p}{V_s} = \quad N_Z = \frac{Z_p}{Z_s} = \]

From class, what is the relationship between the magnetic flux in the core, current and voltage on the secondary if the current is at a frequency \( f \)? (Pages 119-120 in the book)

\[ \Phi_m (I) = \quad V(\Phi_m) = \quad V (I) = \]

How do you find the inductance of the primary? \( L = \)

Set the function generator to a 4.9-MHz sine wave with 0.5Vpp. Connect the tuned transformer to the function generator on the primary with a 47-pF capacitor in parallel and a 200-ohm resistor load on the secondary.

Check the functionality of the transformer – what is the voltage ratio?

\[ V_p = \quad \quad V_s = \]

What is the function of the capacitor and is the value correct?

_____________________________________________________________________________

_____________________________________________________________________________

_____________________________________________________________________________
EVEN GROUPS DO THIS PART FIRST

L5.3: Receiver switch and tuned transformer

The receiver switch board is shown in the figure below. G5 is the connection from antenna and goes to C1 (refer to block diagram on the inside book cover). G4 is connected to the 8-V supply voltage of the transmit side.

First we will just look at the npn-transistor switch and investigate its turn-on and turn-off times. DO NOT SOLDER THE POTENTIOMETER R2 INTO THE BOARD UNTIL AFTER TESTING THE TUNED TRANSFORMER.

In the first test, connect a function generator to the base of the transistor, with a 1-kHz square wave, and use an offset that makes the square wave have 8V and 0V levels. Nothing is connected to the antenna input (G5) and the output of the transistor (collector) is connected directly to the scope. Measure the rise and fall times of the switch:

Rise time = _____________________

Fall-time = _____________________

Next, connect a power supply to the base of the switch transistor and the function generator to the antenna connector G5, with a 7-MHz sine wave. Measure the output with an oscilloscope and adjust C1 to get the maximum output voltage at 7MHz.

What is the theoretical value of the capacitor? C1 = _________________
Measure the OFF and ON voltages at the output by changing the supply voltage, and calculate the rejection defined as $R = 20 \log \left( \frac{V_{\text{off}}}{V_{\text{on}}} \right)$. For this, you will have to adjust the amplitude on the function generator between the two cases because when the switch is ON it will be harder to see the signal (close to ground level). You can try with 1Vpp for the OFF state and 10Vpp for the ON state.

$V_{\text{off}} =$ ____________

$V_{\text{on}} =$ ____________

**L.5.4: Tuned transformer T2**

Next we separately test the tuned transformer T2. For this part of the lab, you will first wind the transformer on a core:

- The core is a FT37-61 (unpainted)
- The inductance constant is $A_L = 66 \text{nH/turn}^2$
- Use a 35-cm long section of #26 insulated wire for the secondary, and carefully wind 20 turns (figure below). Remove insulation from the ends of the leads.
- Use a 5-cm long thin colored wire for the single-turn primary.

When you have wound the transformer, answer the following questions:

What are the current, voltage and impedance transformation ratios?

\[ N_I = I_p/I_s = \] ____________ \[ N_V = V_p/V_s = \] ____________ \[ N_Z = Z_p/Z_s = \] ____________

The transformer windings (left) and circuit for the tuned transformer tests (right).

From class, what is the relationship between the magnetic flux in the core, current and voltage on the secondary if the current is at a frequency $f$? (Pages 119-120 in the book).
\[ \Phi_m (I) = \quad V(\Phi_m) = \quad V (I) = \]

How do you find the inductance of the primary? \[ L = \] ______________

Set the function generator to a 7-MHz sine wave with 0.5Vpp. Connect the tuned transformer to the function generator on one end (ask a TA if you do not know how to do that) and a scope on the other end. You can also use a 1.5k resistor as a dummy load that represents the mixer. Use the shortest cables possible when you do this.

Check the functionality of the transformer – what is the voltage ratio?

\[ V_p = \] __________
\[ V_s = \] __________

Find the ratio of the power absorbed by the load to the available power. Express the loss in dB.

\[ P(\text{available}) = \] __________
\[ P(\text{load}) = \] ________________

\[ \text{Loss (dB)} = \] ________________

Explain the function of C2: ______________________________________________________
__________________________________________________________________________
__________________________________________________________________________

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