Laboratory No. 04:
FM Transmitter

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I. INTRODUCTION

A. Purpose

The objectives in this laboratory are to

1. Build and test an FM transmitter
2. Learn about FM modulation
3. Understand the operation of the FM transmitter including transistor operation and resonance
4. Learn about building high frequency circuits and the behavior of components at radio frequencies
5. Become acquainted with a spectrum analyzer and learn to use the oscilloscope FFT function

B. Equipment

- Pre-printed circuit board
- Soldering iron and solder
- Safety glasses
- Tektronix TDS 2022 oscilloscope
- Spectrum analyzer
- Resistors: 120Ω 180Ω 4.7kΩ, (2) 13kΩ, 68kΩ, 100kΩ
- Transistors: (2) 2N3904
- Capacitors: 5 pF, 25 pF, (2) 470 pF, (2) 0.01 μF
- Inductor: 5 turns of #24 wire around a 1/8" inch shaft (open air).

C. Procedure

1. Characterize the operation of the circuit.
    - What is the expected carrier (resonant) frequency with the values in the schematic? *By using the formula* $\omega = \frac{1}{\sqrt{LC}}$ *I get* $\omega = \frac{1}{\sqrt{(.1\mu H)(25pF)}} = 632.5$MHz
    - What values of capacitance will take the carrier frequency out of the FM band? $25uF$
    - What is the expected carrier frequency given the particular parts you are using? 10kHz
2. Wire the circuit.
    - A microphone is typically used with this circuit but for this lab a signal generator producing an audio tone will be used.
3. Use an FM receiver, a Tektronix TDS 2022 oscilloscope, and a spectrum analyzer to test out your FM transmitter.
    - Use the FFT function of the Tektronix TDS 2022 oscilloscope to use it as a spectrum analyzer.
    - What happens as you expand or compress L1? *Simply put, the FM frequency changes.*
4. Write up a lab report for this lab.

II. SCHEMATICS

Below, are the schematics that were used to build the FM transmitter.

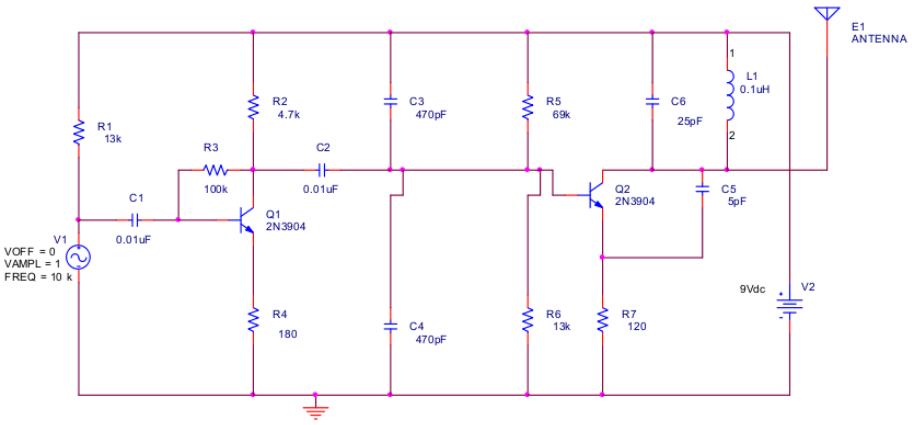

FIG. 1: The schematic used to build the overall FM transmitter.

PINNING

PIN	DESCRIPTION
1	collector
2	base
3	emitter

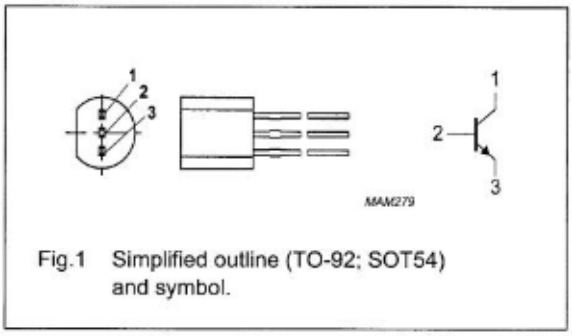

FIG. 2: The schematic used to assist in the placement of the transistors on the board 1-Emitter, 2-Base, 3-Collector.

III. CONCLUSION

This laboratory introduced students to FM, or frequency modulation, signals, what goes into building an FM transmitter, and how to pick up that signal by using a spectrum analyzer. At the beginning of this exercise, the instructor let the students try and start piecing together the FM transmitter on the breadboard. After instructing the students on how the connections on the breadboard act like a tiny capacitor, and how the connections were too complicated for such a small board, he then handed out pre-printed circuit boards that they could use to piece it together and solder it. In the end, the students got the chance to bring home their finished product.

There were some problems that I ran into during this laboratory exercise. One being that my pre-printed circuit board actually had missing contact points, so I had to bridge the gaps with the leads on some of the components. It worked well in the end. After testing my transmitter at the test bench by using the spectrum analyzer I saw that it was transmitting on about the 101.4kHz station. The neat thing was, I could tune an FM radio to that station and hear the frequencies that the frequency generator was giving out. It would have been more beneficial to hook up a microphone to the circuit to really get a feel for how it works, but due to the time we had, it wasn't going to happen. When I took my board off of the test bench and brought it back to my own station to hook it up, nothing worked anymore. In fact, the power supply that I had it hooked to was overloading. I didn't take the time to troubleshoot it, so I couldn't get a screengrab from the oscilloscope. I suspect it may have been a short where I had to bridge some of the gaps. Also, I used the schematic in Figure 2 to help me figure out how to connect the transistors to the board. Another problem that I had personally was matching up the results to the questions in the procedure section to the final product of this lab. I may need to try and get a better understanding for why we needed those values.

Overall, this lab was enjoyable. I liked that I got to put the things that I've been learning in the classroom to good use by building something practical. In fact, I thought about making a baby monitor out of it! This was a great exercise to go through for myself and I would like to learn more about FM transmitters.