FM Transmitter Developer Guide

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Introduction

A frequency modulation transmitter, better known as an FM transmitter, takes an input, usually music, and transmits it to a receiver to be broadcasted. Think of a car radio. The music station is playing music miles away from where the subject is, but the car radio is able to play that same music at the same time due to FM frequencies. To break it down further, first, a sine wave is produced that contains music or some kind of sound. It is then transmitted by altering the frequency signals so that it matches a carrier frequency. To do so, the signal goes through an amplification and an oscillator. The carrier frequency is then picked up by a receiver, normally an antenna. Finally, the sound being carried as a sine wave is broadcasted to whatever it is playing it from. Building a simple FM transmitter is quite simple. Everything is documented in this guide to build a simple FM transmitter. This FM transmitter will be able to transmit within the FM range of 88MHz to 108MHz.

Equipment

- Breadboard/prototyping board
- Soldering kit
- A precision Phillip-head screwdriver
    - Non-conductive would be best
    - It would be better to use a plastic item that can fit in the capacitor's bridge.
- Wire stripper
- FM Radio

Parts

Manufacturer Part Number	Manufacturer	Digi-Key Part Number	Quantity	Unit Price	Extended Price	Description
CF14JT100R	Stackpole Electronics Inc	CF14JT100RCT-ND	1	0.04	$0.12	RES 100 OHM 1/4W 5% AXIAL
CF14JT10K0	Stackpole Electronics Inc	CF14JT10K0CT-ND	1	0.04	$0.12	RES 10K OHM 1/4W 5% AXIAL
CF14JT1K00	Stackpole Electronics Inc	CF14JT1K00CT-ND	1	0.04	$0.12	RES 1K OHM 1/4W 5% AXIAL
CF14JT100K	Stackpole Electronics Inc	CF14JT100KCT-ND	1	0.04	$0.12	RES 100K OHM 1/4W 5% AXIAL
CF14JT1M00	Stackpole Electronics Inc	CF14JT1M00CT-ND	1	0.04	$0.12	RES 1M OHM 1/4W 5% AXIAL
CF14JT6K80	Stackpole Electronics Inc	CF14JT6K80CT-ND	1	0.04	$0.10	RES 6.8K OHM 1/4W 5% AXIAL
CF14JT12K0	Stackpole Electronics Inc	CF14JT12K0CT-ND	1	0.04	$0.10	RES 12K OHM 1/4W 5% AXIAL
SR215C104KARTR1	AVX Corporation	478-7336-1-ND	2	0.23	$0.46	CAP CER 0.1UF 50V X7R RADIAL
FG28C0G1H040CNT06	TDK Corporation	445-173466-1-ND	1	0.24	$0.24	CAP CER 4PF 50V C0G RADIAL
SR215C103KAATR1	AVX Corporation	478-11035-1-ND	1	0.25	$0.25	CAP CER 10000PF 50V X7R RADIAL
233	Keystone Electronics	36-233-ND	1	0.49	$0.49	BATTERY CONNECT SNAP 9V 6" LEADS
2N3904TA	ON Semiconductor	2N3904TAFSCT-ND	2	0.21	$0.42	TRANS NPN 40V 0.2A TO-92
C2052A.93.03	General Cable/Carol Brand	C2052R-50-ND	1	4.44	$4.44	HOOK-UP SOLID 18AWG 300V RED 50'
10-02150	Tensility International Corp	839-1404-ND	1	5.09	$5.09	CBL 3.5MM F 28AWG SHLD
6LF22XWA/B	Panasonic -	P687-ND	1	1.9	$1.90	BATTERY

	BSG					ALKALINE 9V
N/A	N/A	N/A	1	1.25	$1.25	CAP TRIMMER 7-60pF

Notes:

- Instead of a 3.5mm audio jack, an electret microphone could be used as a substitute.
- For an antenna, a simple wire can be used.

Block Diagram

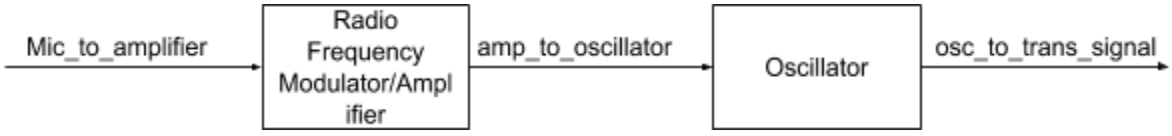

Figure 1. Block Diagram

Name	Type	Specifics
Mic_to_amplifier	Analog signal	- Voltage = 2-10V - A = ~ 7 - 8 mA - Takes an audio signal and outputs radio frequency using the LC components
amp_to_oscillator	Analog signal	- Voltage (AC): 12 - 14V - A = ~ 7- 8 mA - Converts DC to AC
osc_to_trans_signal	Analog signal	Output distance = ~30ft Frequency Min. = 88MHz Frequency Max = 108MHz

Schematic

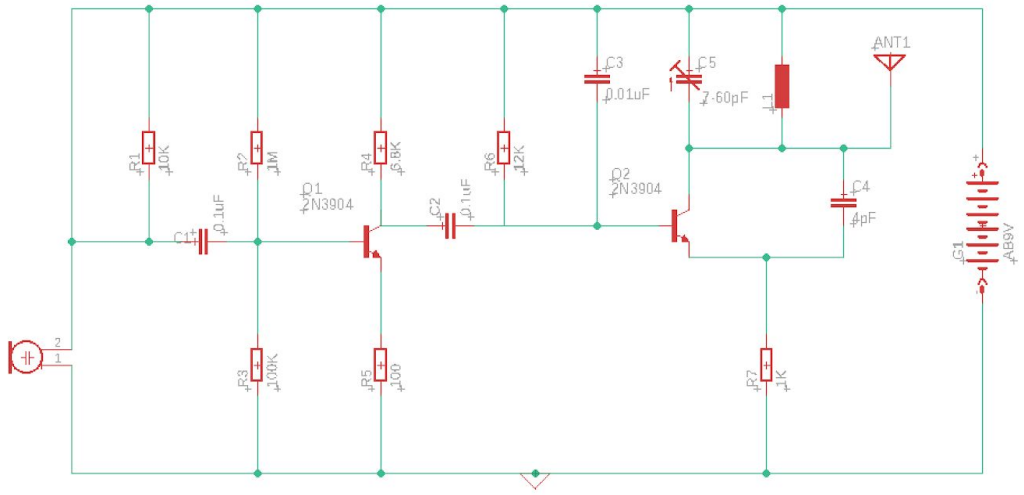

Figure 2. Schematic

Suggestion:

- Building the schematic in an auto CAD program like EAGLE makes it easier to create a PCB board and its files.

PCB

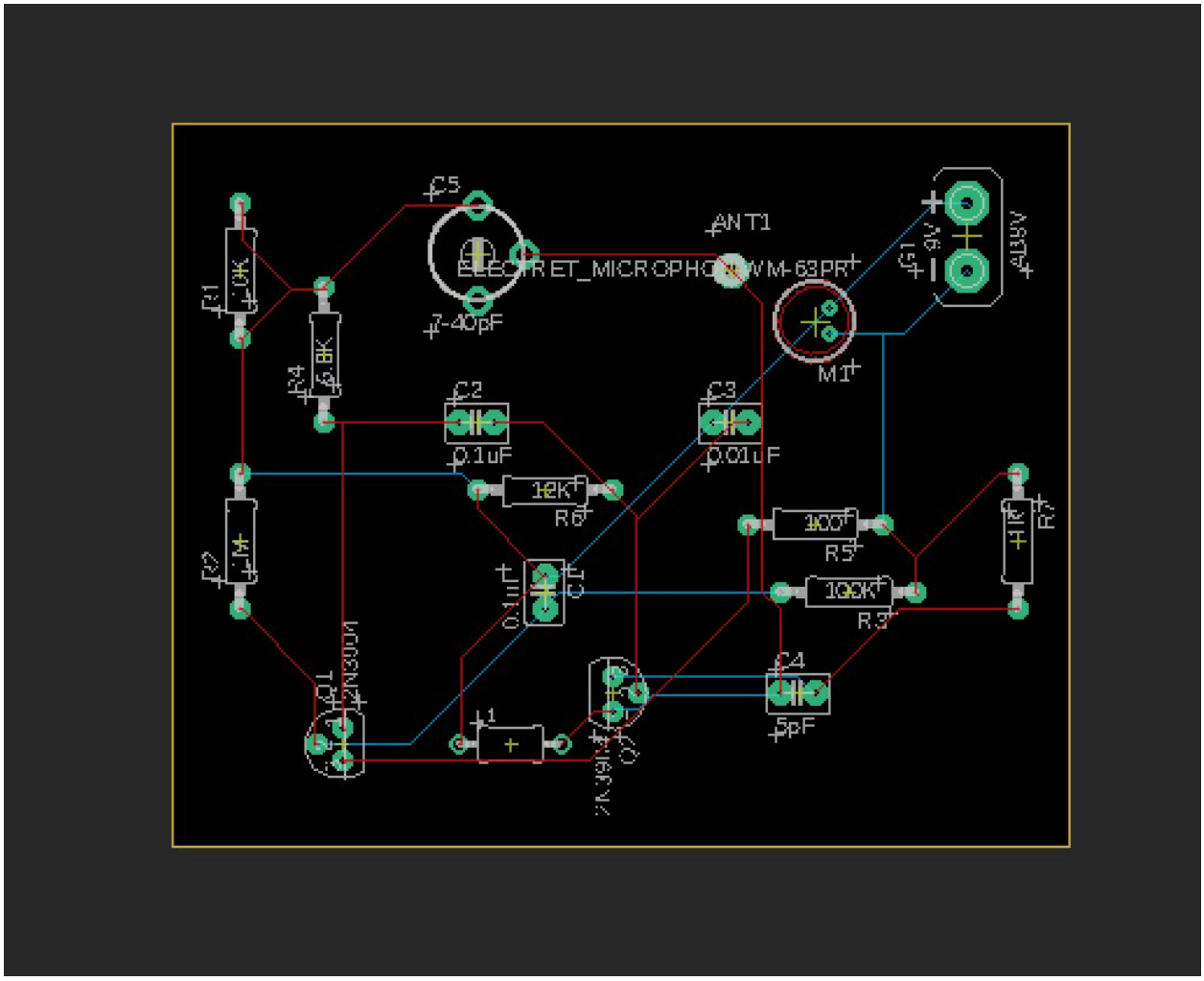

Figure 3. PCB Layout

Description: 2.66 x 2.15 inch (67.6 x 54.6 mm)

This is the layout of the PCB board. Each board can be different depending on how the parts are laid out during design. To make a PCB board, using an auto-CAD program like EAGLE works wonderfully. For instructions to make a PCB using EAGLE, Sparkfun has a great and detailed guide: https://learn.sparkfun.com/tutorials/using-eagle-board-layout/all. To order a PCB, there are many manufacturers like OSHPark, which is located in the USA. Submit the Gerber file and select the fabrication time to complete the order.

Assembly

1. Start with a prototyping board like a breadboard. Making a prototype will allow for adjustments to be made before making a final product. Many of the resistors and capacitors in this project could be replaced with other values if the exact values cannot be found.
2. To create the coil, use a 18AWG wire. Strip about seven to eight inches of the wire. Make a ¼ inch diameter coil with about eight to nine turns. Using a pencil or a pen will suffice in making the coil. To adjust the number of turns or to use a different wire, this website is quite helpful: http://electronics-diy.com/calculators.php
3. Now that all the parts are ready to go, assemble the circuit using the schematic.
4. Test the circuit. The instructions for testing are on the next page.
5. If satisfied with what is being produced, continue onto making a PCB board.

Notes:

- Only two legs of the trimmer capacitor will be used, the stator and the rotor. Essentially, the middle leg and one of the side legs. The capacitor is not polarized, it doesn't matter where each leg is connected.
- If using a female audio jack like the one listed in the parts, the left and right wires will have to be shorted together. Solder resistors to each of the wires and then connect the two of the same valued resistors on the other end to short it. The value of the resistors could range from 1k ohm to 47k ohm. The shorted end will be the part that connects to R1 and C1.
- If using an electret microphone, one of the legs will be grounded. Use a DMM to figure out which leg it is.
- The antenna should be at least seven inches. The longer the antenna, the transmission will be able to reach at a longer distance.

Testing

To test the FM transmitter, connect the audio source to the audio jack or start playing music near the microphone. On the radio, tune to an empty station. Using the precision Phillip head screwdriver, turn the trimmer capacitor slowly until the music can be heard. This may take some time due to having to go through the whole range of frequencies. Another way to test it would be to set the trimmer capacitor and tune the radio until music can be heard. The only problem with this could be that the transmitter could be set on a station that is occupied or could possibly be out of range.

The sound from the radio may not be the clearest, but the music should be heard. There are a lot of factors that go into how clear the sound is coming from the radio. The transmitter may be fighting with another station to get through the radio. The antenna may not be consistent. There could be a lot of interference between the transmitter and the radio. Using a regular precision Phillip head screwdriver can also interfere with the frequencies. It is best to use a non-conductive screwdriver or something plastic to turn the capacitor. Play around with the parts. The sound could come out clearer or the signal could be stronger.

Enclosure

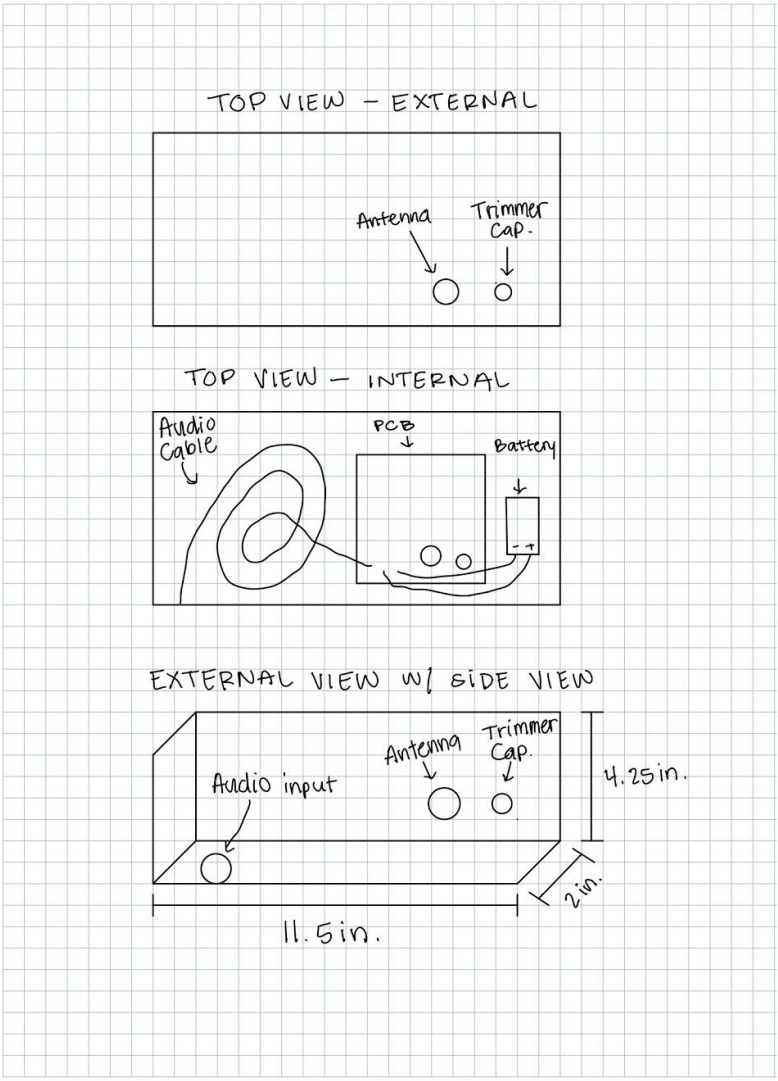

Figure 4. Enclosure Drawing

For an enclosure, a simple box or container could work. It can be a recycled container or handmade. An enclosure allows for the project to look neat and all together. It also allows the outside of the enclosure to be personalized. Designing in Auto-CAD can allow for 3D printing or to get some kind of visual before constructing.

Summary

Overall, this is a great DIY project. It uses simple and basic parts. Many parts could be recycled from other electronics. There could be adjustments to improve the signal. The transmitter could be used in a number of ways. If using an electret microphone, it could be used as a communication device for those who are near each other, like a walkie talkie. Make two of these transmitters, get a radio for each person, and it can be a fun time. The possibilities are endless. Happy tinkering!