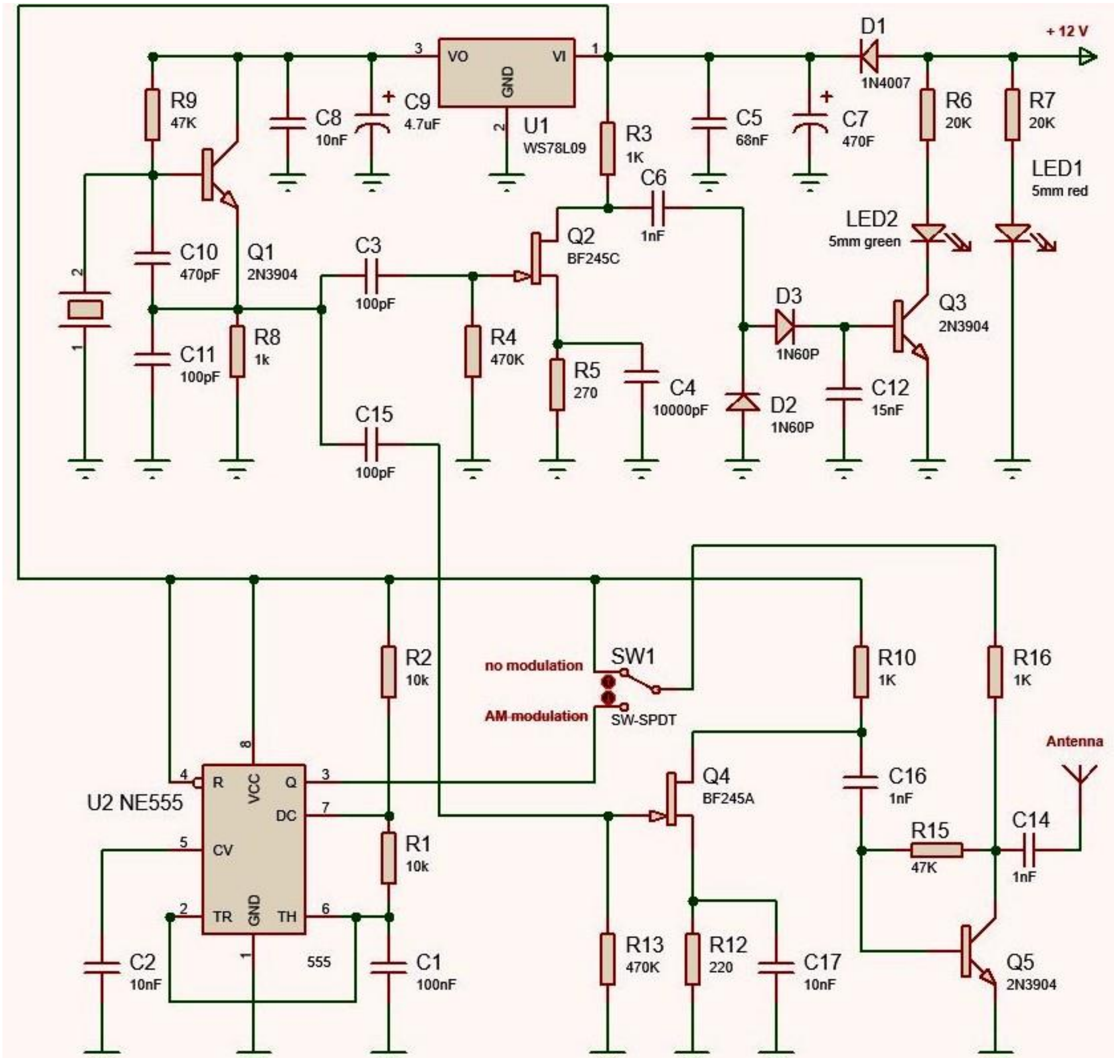
RF AM Generator with Quartz

By VE7LCG Daniel Romila

Note: All pictures from this article can be found in higher resolution at:
https://github.com/danielromila/RF-AM-Generator-with-Quartz

The following schematic generates a signal that can be used for testing shortwave receivers, including 455 KHz and 10.7 MHz intermediate frequencies chains. The signal can be modulated in amplitude with 400 Hz or can be selected not to be modulated. It was tested with ceramic filters and quartz crystals between 455 KHz and 28.6 MHz (this is the highest frequency quartz I have). Every time a RF is generated a LED is switched ON. Since the indicator LED is at the maximum in all frequency interval 0.455 MHz to 28.6 MHz I suspect it can go well beyond those boundaries.

I designed the following schematic, adapting various blocks that can be found in many books. I tested first on the computer. After I made it completely in the air, and only after that, when having all values of the components tested I put it on a PCB and in a case.

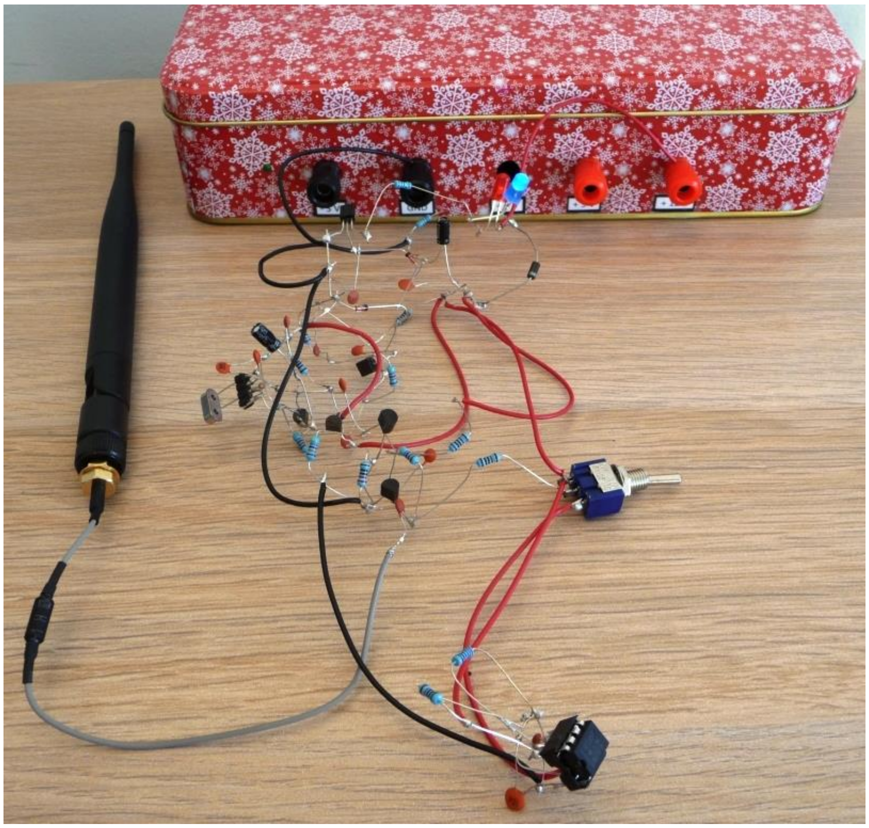


Q1 is a transistor used in a Colpitts oscillator. The capacitor C10 must be 470 pF, C11 100 pF and R9 47 K. This oscillator is found all over the Internet with higher capacitors and declared that it would work up to 30 MHz. It does not. With C10 put as 1000 pF it oscillates with a quartz of 16 MHz, but it no longer oscillates with a 20 MHz crystal. So, the values from my design are the good ones. I used an integrated regulator which has capacitor filters before and after. In this way the oscillator is more stable and also less sensible to catch audio signal from the audio oscillator via the power line.

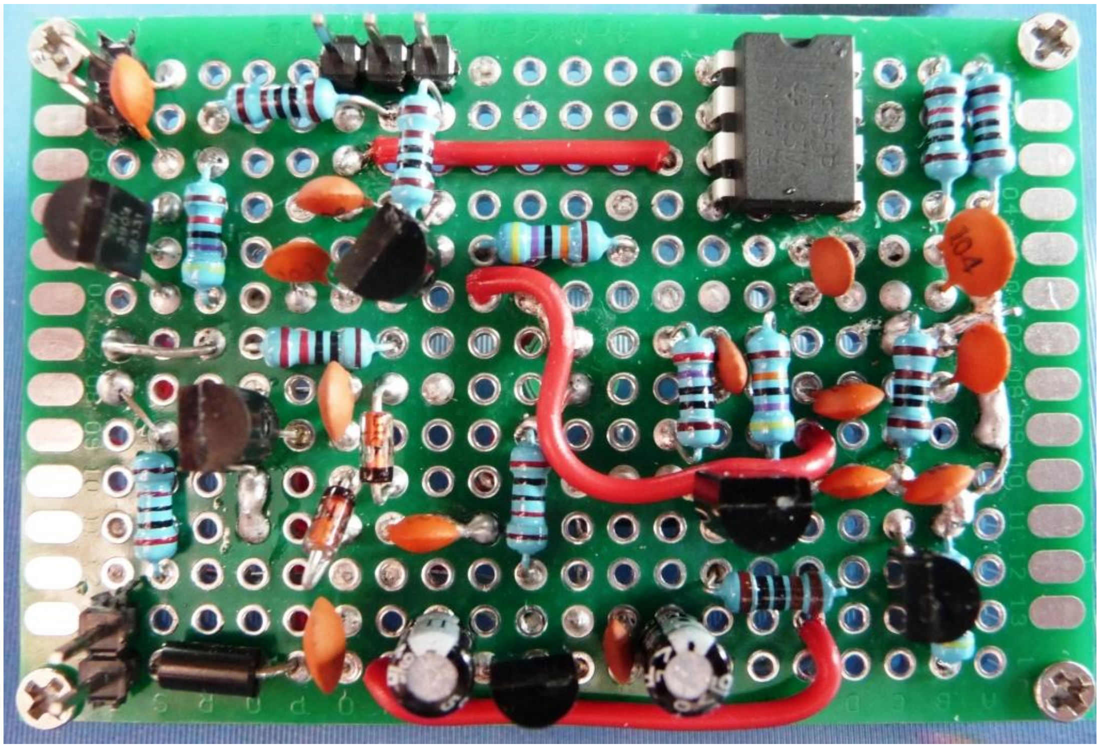
A FET amplifier separates the rectifier part from the oscillator. Q3 drives a 5 mm LED. The LEDs I have give a strong light even at 0.5 mA and | put limitation resistors of 20 K. Q3 is saturated in all the frequency interval. I tested ceramic filters CRB455E, 500 KHz ones and 1 MHz ones. I tried various crystals up to 28.6 MHz and the LED indication was always solid.

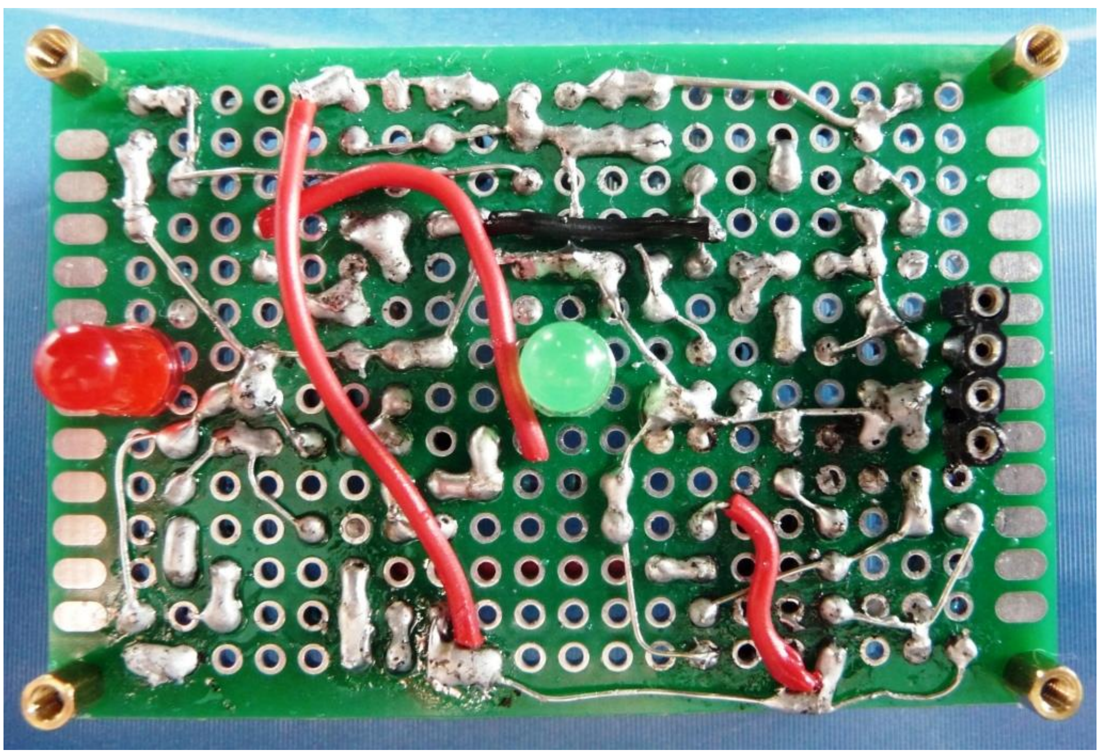
The lower part of the schematics contains a 400 Hz audio oscillator made with the integrated circuit NE555. This IC is capable of directly power supplying Q5 final transistor which was meant to produce around 1 mW RF power. I use a switch to commute the + line of the final transistor to connect either directly to the power supply, via a protection diode 1N4007, or to the modulator made with NE555. A FET BF245A was used to drive the final block. The FET has mainly the purpose of separation from the quartz oscillator and also offers a small amplification.

After several computer iterations, testing and change of components values I built the whole schematic in the air:



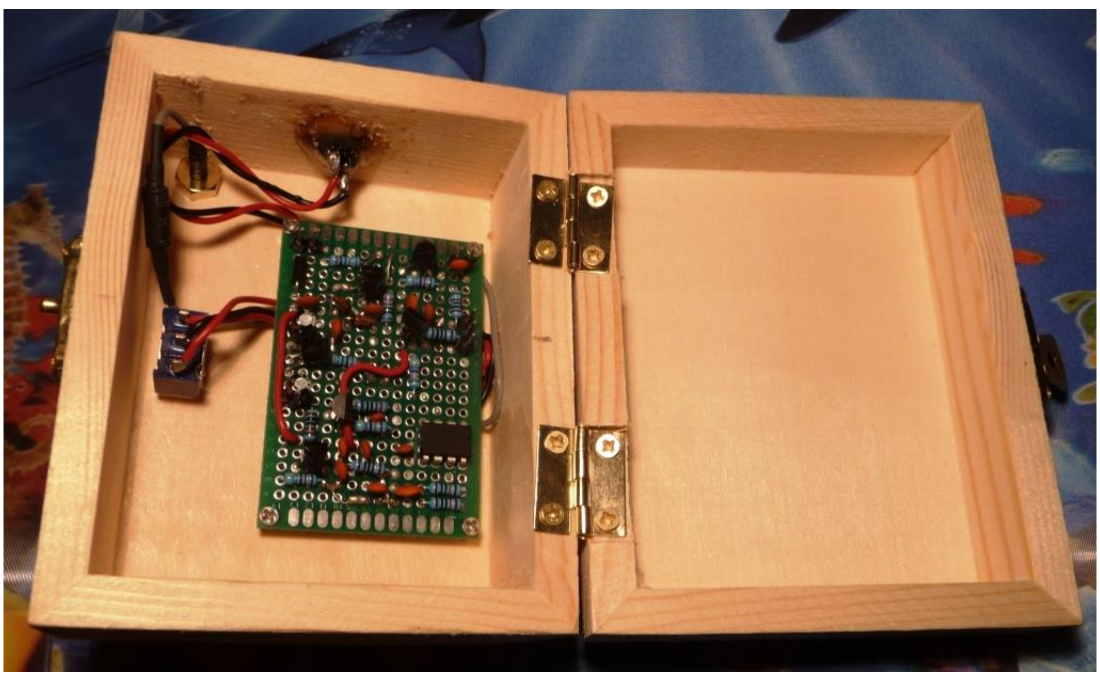
I was happy with the result, so I soldered everything on a double-sided prototyping PCB with the dimensions 4 X 6 centimeters:





I found at Dollar Tree a case that looked perfect for my RF generator and costed only 1.25 CAD plus taxes:

I put my board and connectors inside:



The final product looks like this:


Antenna
CW
AM
Power ON
Quartz OK
Quartz


Antenna
Power ON
CW
AM
Quartz OK
Quartz

The modulated signal of this generator could be heard S9 from 10 meters by a radio Sony ICF7600G, when using a quartz with the frequency 3.686 MHz.

I used a 16 MHz quartz crystal and I could hear the modulated signal in a Kenwood 7950 receiver on 144 MHz (9th harmonic) from one meter distance. The receiver had a small antenna connected in the back. Due to the capacities from the circuit around the quartz the generated frequency can be a little under the value written on the crystal; this is not important for testing purposes, but expect the difference to be multiplied when using harmonics. For example, if the generated frequency is 15.999 instead of 16.000 MHz when using the 9th harmonic expect the signal to be audible at 143.991 MHz instead of 144 MHz. As with all quartz oscillators, such differences can be compensated with a trimmer capacitor, eventually put in series with the quartz instead of inserting the quartz directly into the socket.

As a word of caution, I would like to mention that the only problem I had was the pinouts of the FET transistors. I bought 100 BF245A, from the same supplier, the same manufacturer, at the same moment in time, and I have transistors with different pinouts for BF245A. It was safer to use an instrument for verifying the pinouts of my BF245A transistors: