Please be advised that it might be illegal to use this transmitter. This project is presented here only for educational purposes.demysteryboy.yolasite.com shall not not be responsible for any future legal issues if u wish to continue with this project.Thank you

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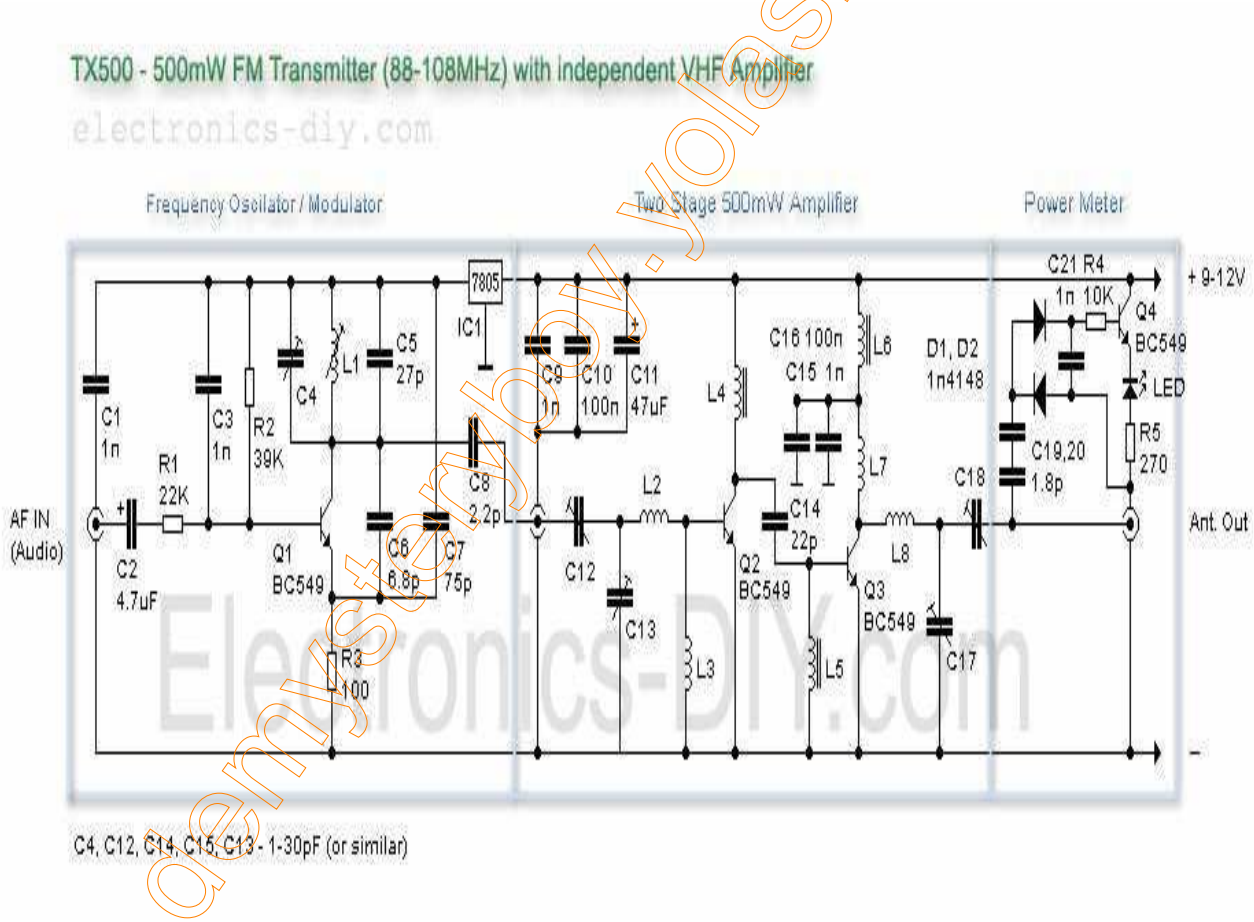
Mysterious 500mW FM Transmitter

The TX500 is a simple to build 500mW FM Transmitter. It consists of three blocks; modulator / oscillator, two stage 500mW VHF amplifier and LED based power meter. The TX500 allows to transmit audio signals to FM band at frequencies from 88 MHz to 108 MHz. Due to the very low power consumption of less than 100mA the circuit may be perfectly powered by using 9-12V battery or power supply if you prefer. The circuit has been divided into separate stages so that it is be better for everyone to understand how every part works independently.



Transistors

Notice that all of the transmitter blocks have been built using four low noise general purpose NPN transistors. These transistors should be easy to find. Most of the regular NPN transistors should work fine and these are just some of the examples: BC549 (low noise), 2n2222, BC109 (low noise), BC107, etc. Please be aware that audio power transistors like BD140, 2n3055, TIP3055, 2SC5200 and such will not work because they can not handle higher frequencies. Thanks to the fact that the regular NPN can work at 100MHz and above we can use them in all of the lower power blocks of FM transmitters. If you prefer you may also use RF transistors like BF199, MPSH10, BF240, etc.

How FM Transmitter Works

Stability

The first block of TX500 based around transistor Q1 - BC549 acts as a simple modulator / oscillator. Many of the low cost FM transmitters use very similar circuit to generate radio signals but this oscillator has been carefully improved to provide much better stability. First thing that does make a great difference is the use of a tunable coil for L1 as opposed to a regular air coil. The use of this kind of coil allows for precise tuning of a desired frequency which is especially important on crowded FM bands. An issue with an air based coils is that it is much more difficult to tune-in to a specific frequency and usually more time is needed to set such oscillator to a desired frequency. Another advantage of tunable coil is that its coil is very firm and thus much more resistive to frequency drifts caused by an temperature changes. These type of oscillators are also prone to frequency drifts caused by unstable supply voltages. This refers both to a batteries and DC power supplies as well. To help solve this problem an IC1 - 5V regulator is used to power an oscillator.

Oscillator

The carrier frequency of an oscillator is determined by the capacity of C4, C5 in conjunction with the inductance of the coil L1. 3.5 turns are needed and 27pF for C5 to tune to a lower part of FM band (88-100MHz). To be able to tune to a higher part (100-108MHz) you can use a 10pF capacitor. C6 is necessary for Q1 to keep oscillating and C7 helps in frequency tuning. R1 - 100 Ohm has been selected to provide a clear oscillation of a frequency. Do not get tempted to use much lower resistance or to remove it completely because that would bring instability and generation of unwanted frequencies around the main carrier frequency. C8 is the final and very important element. Its job is to both separate an oscillator from the rest of the blocks to prevent a frequency drifts and 2.2pF is just enough to pass an oscillator's signal to an amplifier. Again, do not get tempted to use a larger capacitance because that will not increase an output power of the transmitter, it would in fact do the opposite and cause undesired behavior.

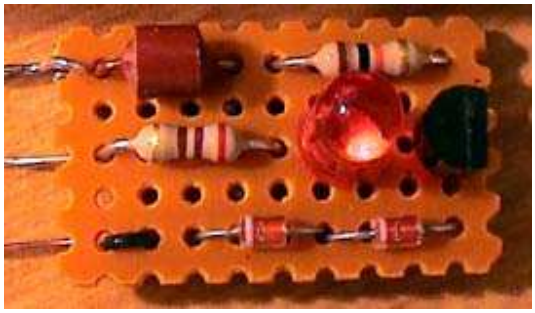
VHF Amplifier

This is the block that will give you a lot of fun and teach you the basic concept of VHF amplifiers, especially if you have never built one. Please do not get discouraged if the schematic looks like it has so many coils because they are very easy to make. From the above picture of an early prototype you can see one of the possible ways to build the VHF amplifier. By doing it this way you will greatly minimize the external noise that could otherwise have been amplified along with the incoming signal from the oscillator. What you will need is copper PC board as the main board and small pieces of PC bard that serve as interconnections between the components. As you can notice the driver is also separated by a metal plate that is soldered to the ground. All these additions will increase

the overall amplifier's quality because the amplified signal from the output stage will not be bounced back to the driver's stage. Another very crucial thing that you should always keep in mind while designing a good amplifier is that the coils should not be placed too close to each other, always provide some minimal air separation.

Power Meter

With just a few components you may also build a LED based RF meter that is extremely handy to check for a presence and strength of a RF signal. The power meter can be built on a tiny board 0.5"x1" as shown below. It only needs three connectors; RF input, voltage supply and a ground.



This meter will only detect high frequencies and the strength of their signal. If there is no RF activity the LED will not illuminate. You can even connect its RF input to 12V and see that nothing will happen because an input of the meter is separated by two 1.8pF capacitors that will only pass RF signals. To test and see if the meter works, simply connect the first block (oscillator) to the power supply, then connect the input of the meter to an output of an oscillator and LED should illuminate at around 20% out its full brightness.

For the sake of efficiency two stage amplifier have been used here. Transistor Q2 works as a driver and Q3 as an output stage of an amplifier. One could build an amplifier using just one single transistor but in that case the transistor would not be able to provide its maximum 500mW output power. That's why most amplifiers use both a driver and an output transistors.

The driver's job here is to take the fragile signal coming out from an oscillator (Q1) and amplify it to a required level before passing it to an output transistor. Driver may be built with just one transistor and it may use two, three or as many it is necessary. The reason for this is that every transistor that is used in an output stage needs a certain amount of input power to achieve its peak output power. You can't just plug-in an oscillator to one 1W, 10W or 100W transistor and expect to give its full RF power. Every data sheet of a given transistor should state what is a minimum power that is needed to drive that given transistor. For example 1W transistor like 2n4427 may need 150-300mW input signal, 2n3866 5W transistor at least 500mW, 10W transistor al least 1W and 100W transistor at least 10W. You should always keep that in mind while building a VHF amplifier.

If you take a look at amplifier's schematic you may notice that driver and output transistor was set to provide the maximum gain because there is no resistor between the emitter of Q2, Q3 and the ground. This was done to maximize an output power of NPN transistors and because of that these transistors may get a little warm but not hot). If in place of Q2 and Q3 you decide to use some more powerful transistors than you will definitely need to use a small resistance resistor to protect them and to minimize the heat dissipation. Driver

should have a resistor of larger resistance like 100 Ohms depending on the voltage supply and the type of transistor being used. Output transistor should have a resistor with a lower resistance.

When amplifier is used and there is no incoming RF signal it is simply in the "resting stage" and power meter's LED should not illuminate. As soon as the oscillator or small power transmitter is connected power meter's LED will illuminate indicating the presence of RF signal and giving you feedback that amplifier is working properly.

Before using a RF amplifier small tuning needs to be performed so that amplifier can provide the maximum output power. Adjust trimmers C12 and C13 so that LED illuminates at its highest peak. Do the same for C17 and C18 trimmers. If you connect input of the power meter to the capacitor C14 from an antenna output side LED should illuminate at 50 - 60% of its full peak. Now check an oscillator's output and notice how RF signal is amplified. It is very easy to see that RF signal is amplified gradually and this is the way it should always be done. In stronger transmitters when driver needs to provide more RF power, for instance 1W, the signal is first amplified by small signal transistors and passed on to the stronger RF transistors.

You should also understand that RF amplifier will amplify certain range of frequencies. Through using specified amount of turns in the coils, amplifier will amplify the desired frequencies (in our case frequencies around 80-120MHz). With a small modifications the same amplifier may be also used to amplify an antenna's signal of your FM radio.

Coils

Required Materials

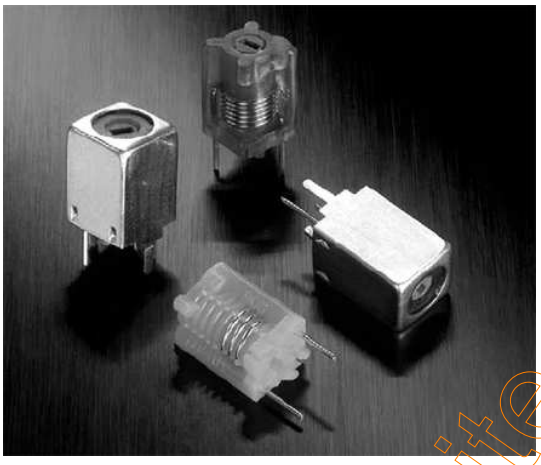
These are materials that have been used to make coils for TX500 transmitter. If you don't have any spare magnet wires check Radio Shack. They sell three spools of magnet wire for around $5. The coil pack purchased from Radio Shack includes 14 meters of 22AWG (.065mm) wire, 25 meters of 26AWG (0.4mm) wire and 65 meters of 30AWG (0.25mm)

Miniature ferrite beads are used for amplifier coils.If you have difficulties finding ferrite beads you may replace L4, L5, L7 coils with regular air coils but keep in mind that ferrite based coils provide higher output gain.

Here are the replacements:
L4, L5 - 4 turns / 5mm diameter / 0.5-1mm magnet wire (exactly the same as L2, L8)
L5 - is the same as L4, L5 but should have 5 turns instead of 4.

L1 Coil
Use 3.5 turns high precision variable coil (0.5mm / 24AWG magnet wire on 5mm diameter). Tunable RF coils are ideal for precise frequency tuning of FM transmitter throughout the entire FM band (88 - 108MHz). The magnet wire is halfway embedded

within the plastic providing excellent frequency stability.



If you have no access to variable coils you could try to use a regular air coil. The wire thickness should be around 1 mm and make sure to use resin it to make it firm. Keep in mind air coils are not recommended for oscillator coils because temperature changes will cause frequency drifts.

L2, L8 Coils
4 turns of 0.65mm / 22AWG magnet wire on 5mm diameter.

1. Cut 9cm (3.5") of wire (1mm - 0.2m / 18 - 30AWG wire is fine as well).
2. Make 4 complete turns a shown on the pictures.

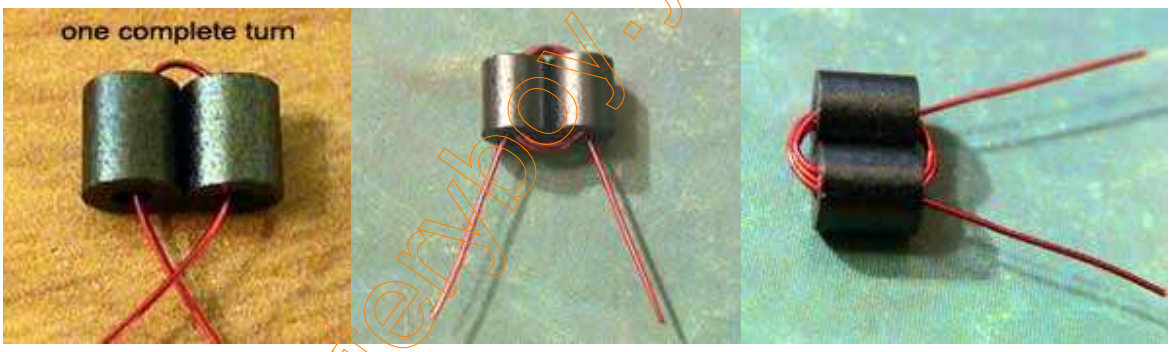
L3 Coil
4 turns of 0.65mm / 22AWG magnet wire on 9mm diameter.

1. Cut 13cm (5") of magnet wire (1mm - 0.2m / 18 - 30AWG wire is fine as well).
2. Make 4 complete turns (as in L2, L8) on a 9mm diameter or a pencil.
3. Spread it to approximately 0.6mm

L4, L7 Coils
Wind 4 turns of 0.25mm / 30AWG magnet wire on two small ferrite beads.

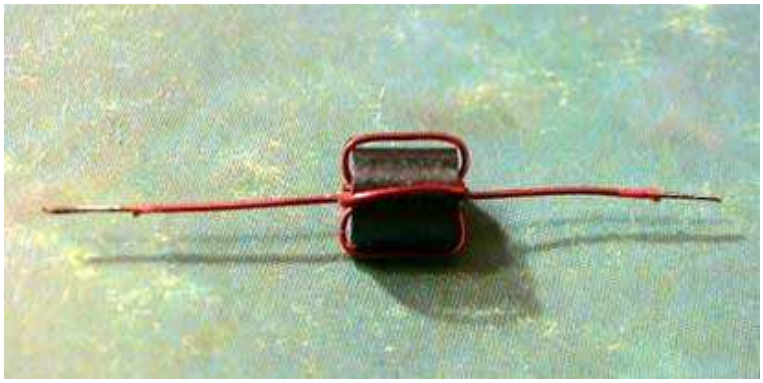
1. Cut 9cm (3.5") of magnet wire
2. Make 4 turns. The first picture shows one complete turn, four turns will be complete when you will see four wires in the upper part.

These small beads are perfect to use in the transmitters up to 1W. Larger ferrite beads and a thicker magnet wire should be used for higher output transmitters.



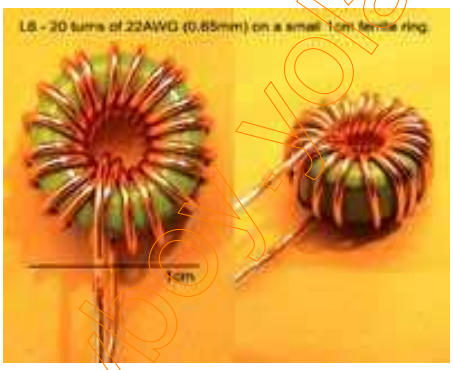
L5 Coil
4 turns on a single ferrite bead.

1. Cut 10cm of 0.25mm / 30AWG magnet wire.
2. Make 4 turns on one small ferrite bead as shown on the pictures.

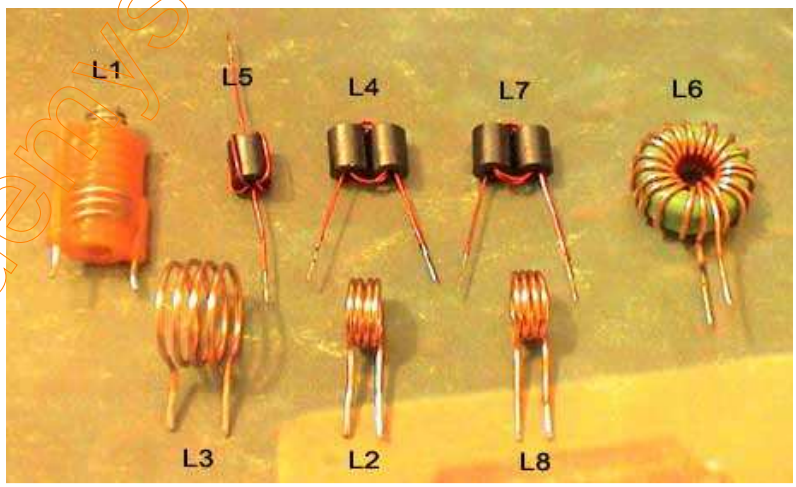


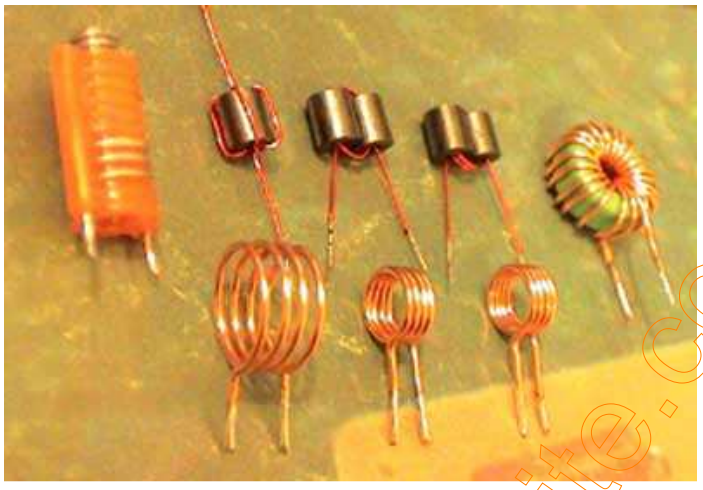
L6 Choke
20 turns of 0.65mm / 22AWG magnet wire on a ferrite ring.

This is a 1.5 cm ferrite ring that can be found in computer power supplies or motherboards. They may come in a different colors but they certainly will do the same job.



Pictures of finished coils that have been used in TX500 transmitter.





Designing the PC Board

It is recommended to use two 1" x 3" PCBs, one for oscillator and the other one for VHF Amplifier. This option will allow you to experiment with the different oscillators / transmitters. While constructing RF amplifier care must be taken to enclose both oscillator and amplifier in the metal cases to minimize external frequency noise.

Glossary of Common Terms:

FM - Frequency Modulation
VFO - Variable Frequency Oscillator
VCO - Voltage Controlled Oscillator
PLL - Phase Locked Loop (digitally controlled oscillator)
Oscillator - device that generates a frequency

Frequency Ranges:
VLF - Very Low Frequency (3KHz - 30KHz) - Surface
LF - Low Frequency (30KHz - 300KHz) - Surface
MF - Middle Frequency (300KHz - 3MHz) - Tropospheric
HF - High Frequency (3MHz - 30MHz) - Ionospheric
VHF - Very High Frequency (30MHz - 300MHz) - Space and line of sight
UHF - Ultra High Frequency (300MHz - 3GHz) - Space and line of sight
SHF - Super High Frequency (3GHz - 30GHz) - Space
EHF - Extremely High Frequency (30GHz - 300GHz) - Space