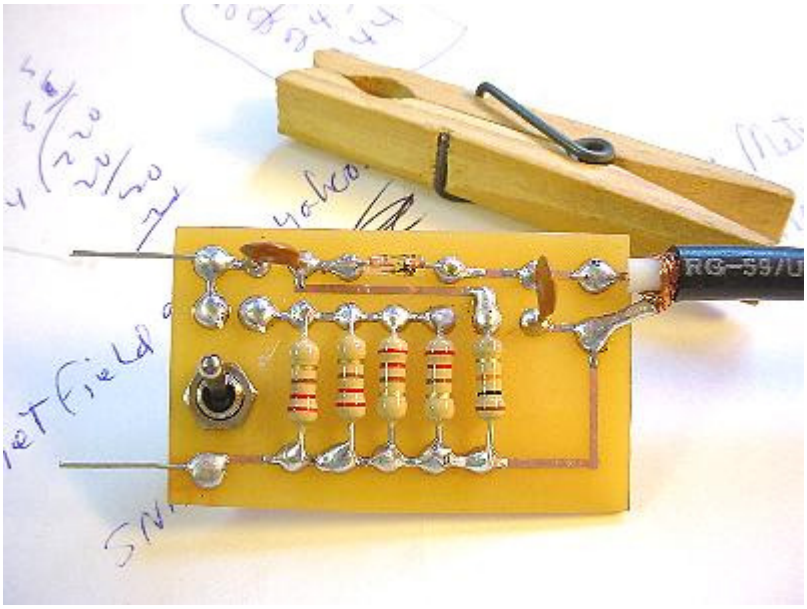
Introducing...

the switchable

RF Probe/Watt Meter Project



For sustained 'loaded output voltages' of up to 2 watts.

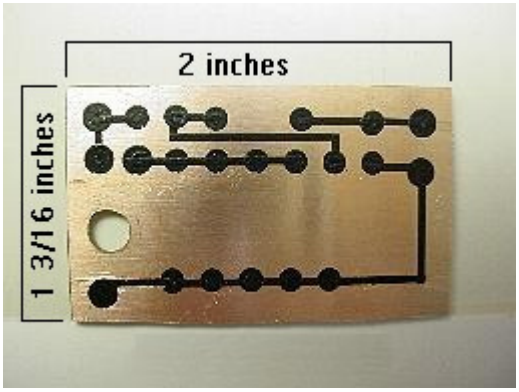
This unique project is one of the most trusted homemade test instruments to have, once you get your FM transmitter up and running ! ! !

This simple little device is capable of finding your FM transmitters'...

Unloaded RMS Output Voltage
Loaded RMS Output Voltage
Output Impedance
Output Wattage

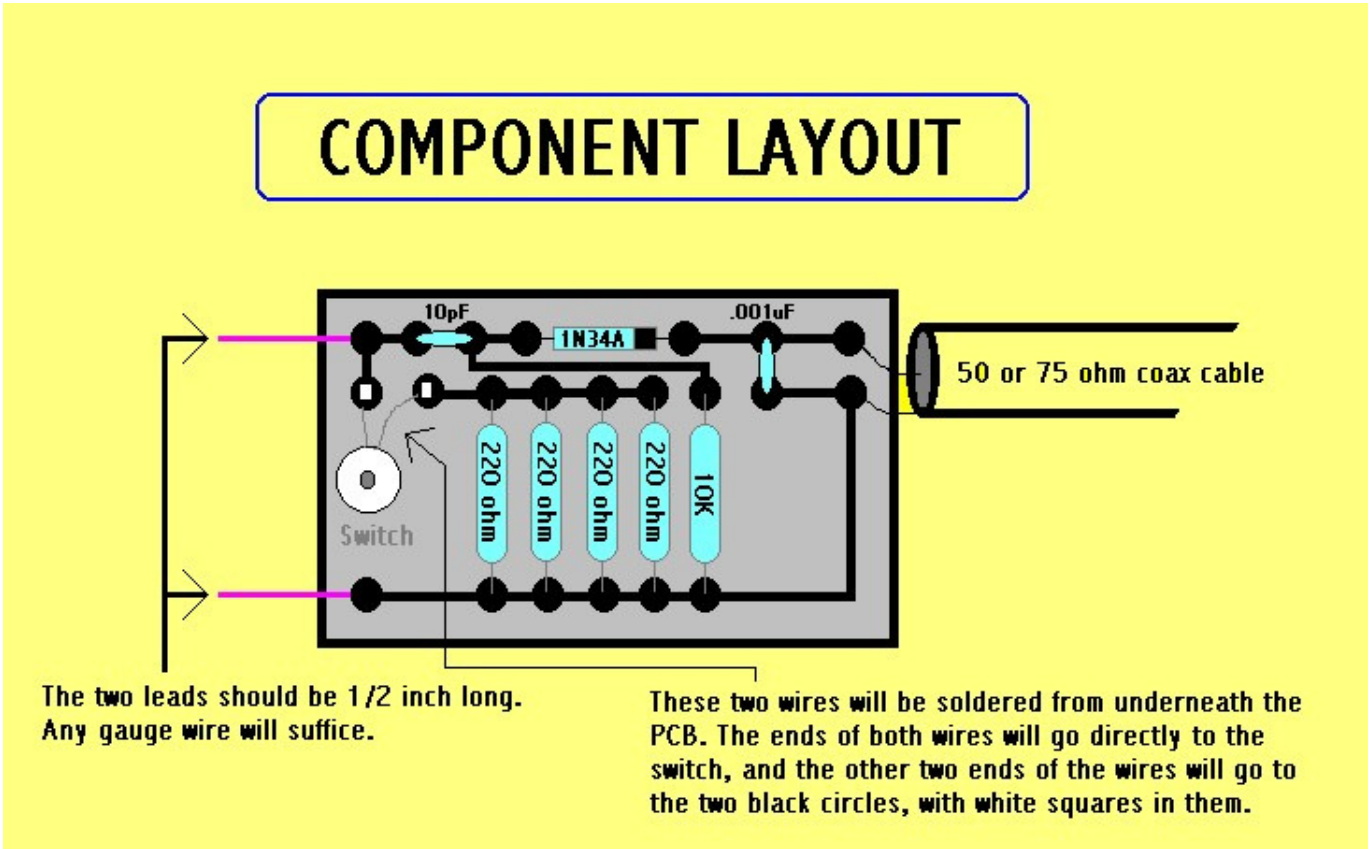
So join with me, once your FM transmitter is functioning, to construct this meter... and then to find out how this little jem can figure out the 4 items mentioned above.

Construction of the Switchable RF Probe/Watt Meter...

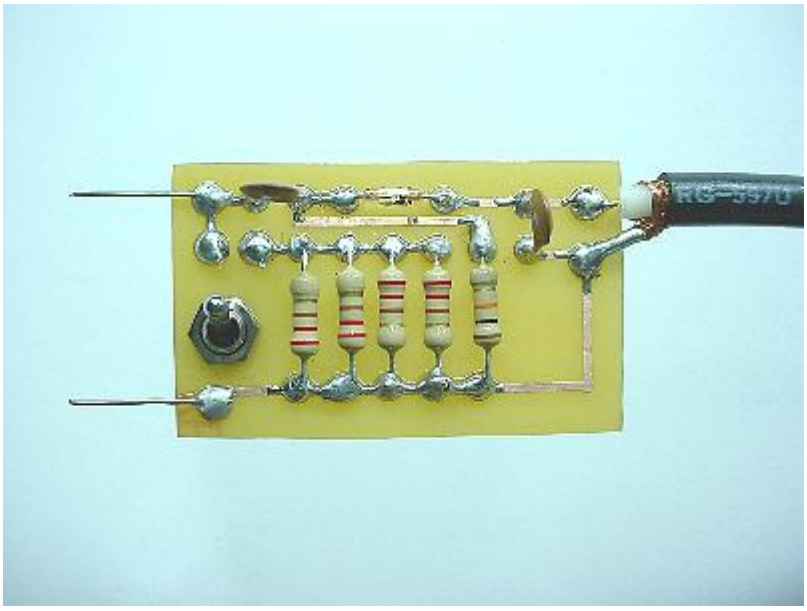


First, print out the PCB template to the left. From the left to the right of the PCB template...it should measure exactly two inches. From the bottom to the top of the PCB template...it should measure exactly 1- 3/16 inches. Send the picture to a graphics program, such as Paint, and squeeze and/or stretch to get a printout of the said dimensions. Once that is done, drill your hole for a SPST Sub-mini switch (Radio Shack part # 275-645A). Then mimmick the same routing as to the template. Use a single sided PCB. If you only have a double-sided PCB, etch away the backside.

Once you have etched your PCB, then go ahead and look at the picture below for soldering and wiring all of the components to the PCB.

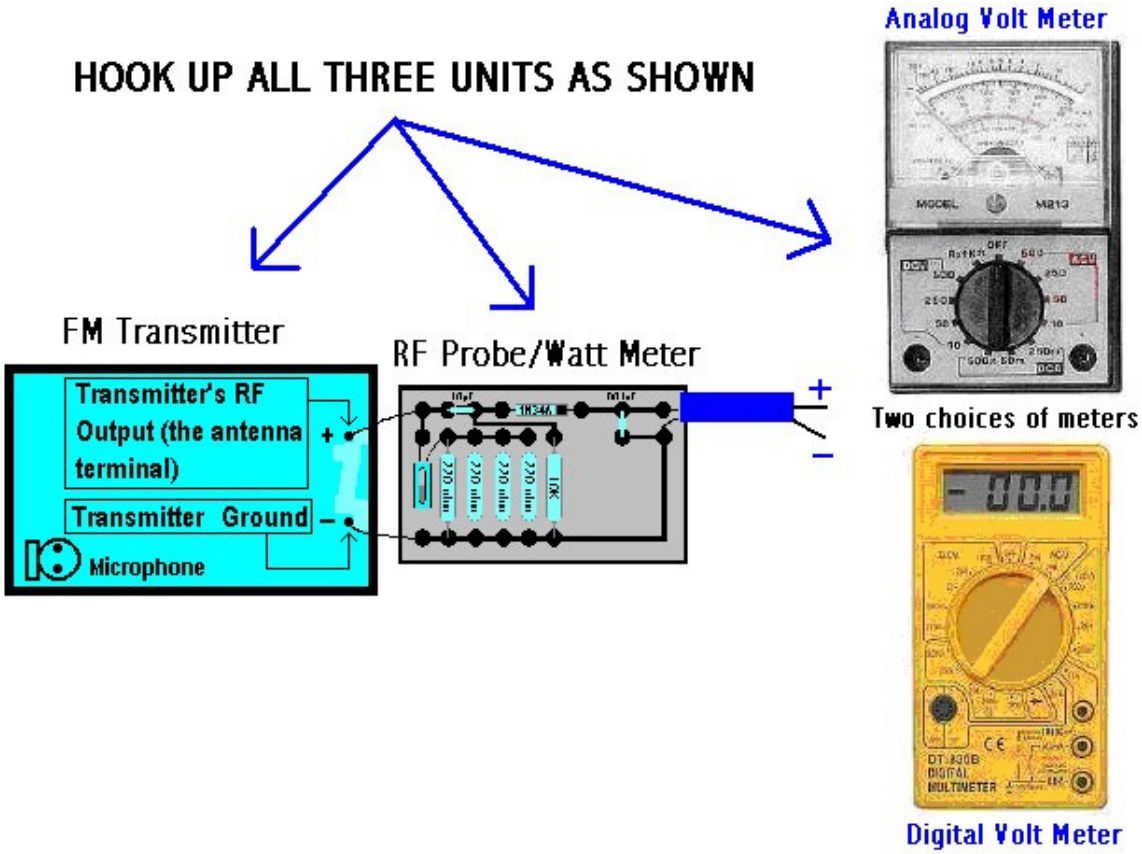


Once you have completed with all the soldering/wiring of the components to the PCB...you are now ready to understand how this little beauty works ! Do take a look at the picture to the right, it shows my completed RF Probe/Watt Meter. Yours should look similar to that. Check to make sure all copper routings show continuity and that all soldering joints are good. Also make sure your germanium diode is oriented correctly into the circuitry.



That is, the cathode (negative) side goes toward the output of the meter.

Begin by hooking up your transmitter, RF Probe/Watt Meter and DVM/Analog Meter as laid out in the picture below.



A DVM will always give detailed readings...to the nearest hundredths, but it usually isn't that reliable in the VHF arena. The analog meter will have a more reliable measurement...although the reading is taken directly upon where the needle rests on the scale...therefore giving a less detailed reading. A DVM seems to always give higher readings then the analog meter, when doing tests with our homemade device. If you have the benefit of having both meters...I would strongly suggest making readings with the analog meter. This type meter can be purchased at your local Wal-Mart for around $10...in the automotive department. That is what I use for my measurements. .

Once your FM transmitter, RF Probe/Watt Meter and DVM/Analoyg Meter is set up, now comes the time to make your tests with your homemade device. Remeber now, there are 4 items that we will investigate...and they are...

I) Finding the transmitters' unloaded RMS output voltage.

II) Finding the transmitters' loaded RMS output voltage.

III) Finding the transmitters' output impedance.

IV) Finding the transmitters' output wattage.

A step-by-step procedure will be used in order to find these 4 items. Let us begin...

I) Finding the FM Transmitters' Unloaded RMS Output Voltage

First, set your DVM/Analog Meter to the low DC scale and then turn it to the ON position. Then turn the RF Probe/Watt Meter switch to the OFF position. This will have the unit work in the RF Probe mode. Next, turn your FM transmitter to the ON position. Read the DC voltage display on your analog meter. Since the reading is a 'peak' voltage reading, and not an RMS reading, a multipliction factor of .707 is needed for the reading that you saw on your analog meters' display. Let's say that the display on the DVM gave you 5.25 dc volts. Then you must multiply that by .707

So the RMS Unloaded Output Voltage reading is...

3.71 volts

...calculate 'your own' number and write it down fur future use.

II) Finding the FM Transmitters' Loaded RMS Output Voltage

Perform the same operations that you did with the Unloaded RMS Ouput Voltage test, but turn your RF Probe/Watt Meter switch to the ON position. This will put the homemade device in the Watt Meter mode. Then whatever the reading your see, multiply that by .707 to get the RMS value. Let us also say that in our example, this second test gave us a value of 2.12 DC volts. Then you must multiply that by .707

So the RMS Loaded Output Voltage reading is...

1.50 volts

...calculate 'your own' number and write it down for future use.

III) Finding the FM Transmitters' Output Impedance

We come now to using Formula I. This formula is represented as...

Output Impedance = Resistance load times (unloaded voltage minus loaded voltage) dividing by loaded voltage...in other words...

Z = R (Uv - Lv) / Lv

Since we used 4 220 ohm resistors in parallel, as the load resistor (having a rated power value of 2 watts), that comes out to 55 ohms. So now we know the value of R in our equation above. And we also know our unloaded and loaded output voltages. Let's plug in our example values...

Z = 55 (3.71 -1.50) / 1.50

Z = 121.55 / 1.50

Z = 81.03

Output Impedance = 81 ohms (load)

...write 'your own' value down for future use.

This answer is a very important step. The formula uses 'transmitter efficiency' as its' main objective. That is, since we have found out that Z = 81 ohms, this means the formula is telling you..."if you can match up your antenna system (that is, the coax cable and antenna itself) to exactly what my output impedance is, which is 81 ohms, then I will become as efiicient as possible...therefore, giving you all of my output wattage available". Best efficiency is governed by a loaded output voltage that is exactly 1/2 from the unloaded output voltage. Since the unloaded output voltage in our example, was 3.71 volts. The 'new' output loaded voltage, using an 81 ohm load, is now 1.855 volts.

...write your own 'new' loaded output voltage down for future use.

IV) Finding the FM Transmitters' Output Wattage

Now we come to Formula II. This formula states that...

Output Wattage = (the new RMS loaded output voltage) times (the new RMS loaded output voltage), then divided by your output impedance. In other words, as our example would show...

Output Wattage = (1.855) (1.855) / 81

Output Wattage = 3.44 / 81

Output Wattage = .0424

Output Wattage = 42 milli-watts

Again, use 'your own' values to come up with your Output Wattage.

So there you have it, my friend. I know there is a lot of mathmatics going on with this little jem, but once you understand these formulas...you will be on your way to understanding what those electro-magnetic waves are doing...as they are leaving your FM transmitter. If you pay attention and read and re-read, it will all become second nature to you. Should you need help on any area concerned, please do not hesitate to write me. I will help the best I can.