AMATEUR RADIO STATION

AI4JI

OIL FILLED, POWER MEASURING, DUMMY LOAD

This project will demonstrate how to build a dummy load, and measure power correctly.
(you can also calibrate your meters for accuracy with this project)

Description

This dummy load uses twenty non-inductive resistors in parallel to achieve fifty ohms over a very wide frequency range. The internal components are specially arranged and submerged in oil to dissipate heat and allow extended operation for transmitter tuning, testing and alignments.

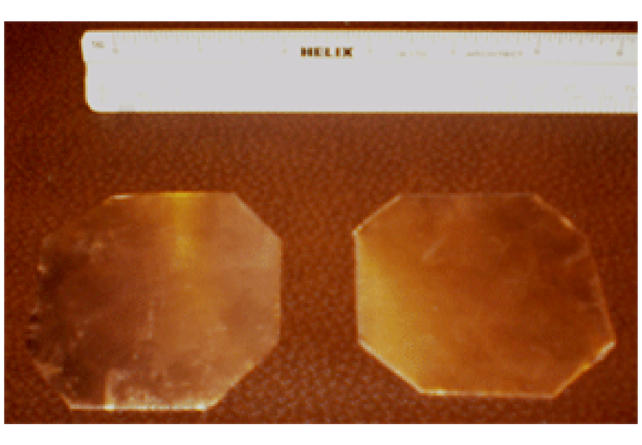
The advantages of this project are that is is fairly inexpensive to build; it provides a very pure fifty ohm load through a wide range of frequencies, LF, HF, VHF and UHF; it allows for accurate power measuring and transmitter testing.

Parts

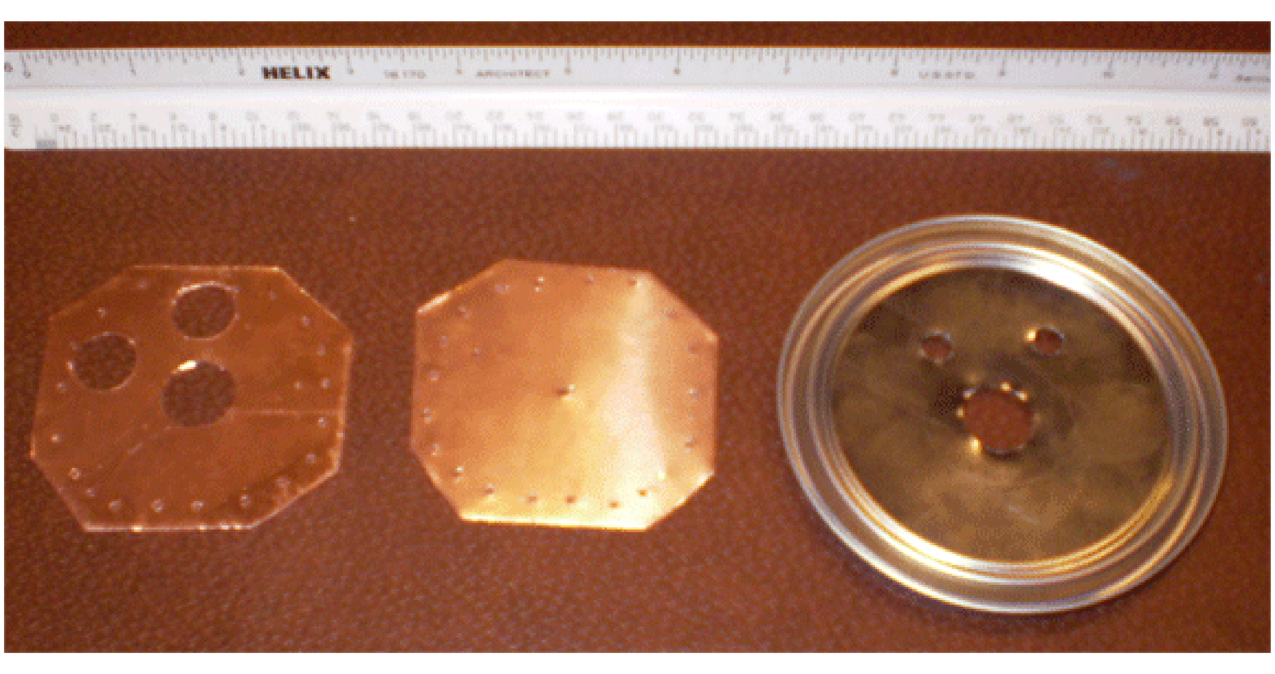
A one quart paint can, a small copper sheet and one quart of mineral oil, all found at Ace Hardware. Twenty 1K ohm, 3 watt metal film resistors, one SO-239 panel connector, one BAV21 250 volt signal diode, one 0.01uf 250v ceramic disc capacitor, one pair of binding posts, and about 4" of 12AWG solid copper wire. I was able to obtain all the parts listed from Mouser Electronics, very cheaply. (I had the 12AWG wire laying around)

Construction

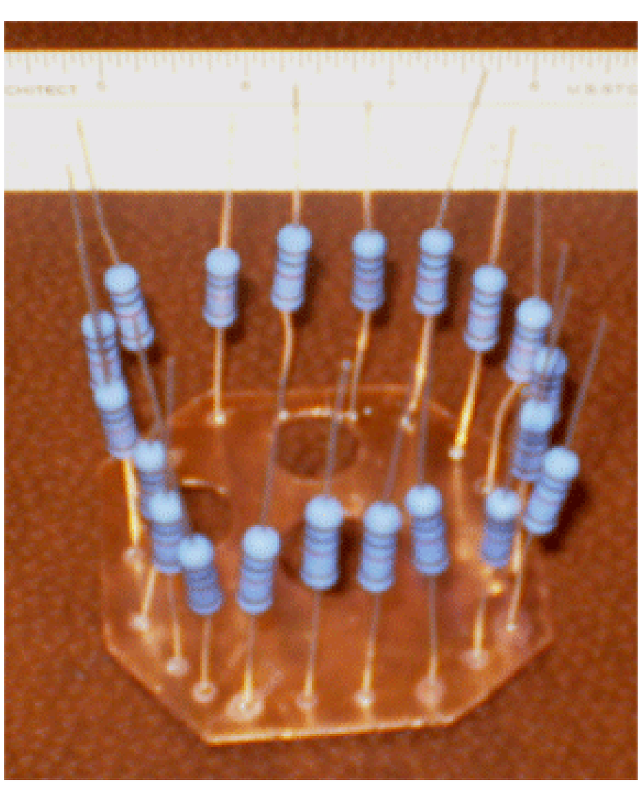
I used the can lid to measure the copper plates and cut them to size. I cut them square, then nipped the corners off to fit into the can. (You want as much copper as you can get, as this helps to dissipate heat.)



I then punched twenty holes around the outside edge of the copper plates and drilled them to accommodate the resistor leads. I also drilled the center of the top plate to fit the bottom of the SO-239, and two more holes to allow the binding posts to pass through without contacting the plate. On the bottom plate I drilled a hole in the center to fit the 12AWG wire and lastly one hole to allow attachment of the signal diode. I drilled the can lid to accept the SO-239 and the binding posts.

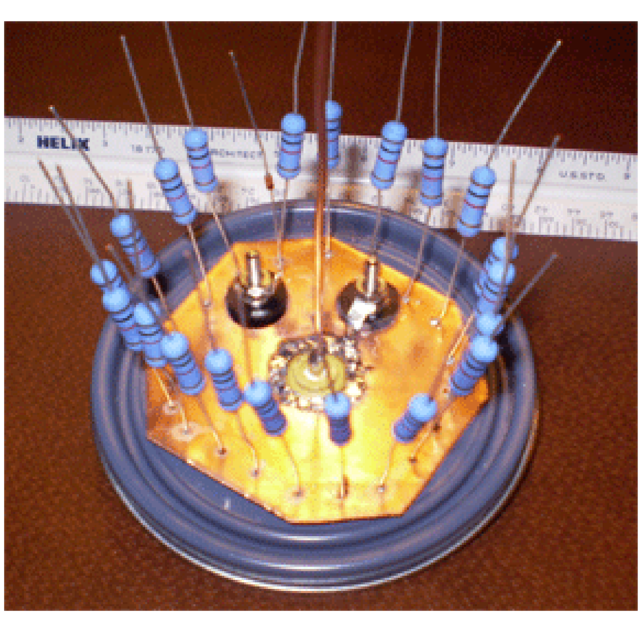


I inserted the twenty resistors into the top plate and soldered them with high temp silver solder.



I fitted the SO-239 connector to the top of the can lid and soldered it all the way around to provide a good ground and a leak-proof seal.

I then soldered the resistor top plate to the bottom of the SO-239. I soldered the length of 12AWG wire into the center of the SO-239 bottom. I installed the two binding posts and soldered the diode to the positive post and soldered the negative post to ground on the copper plate.



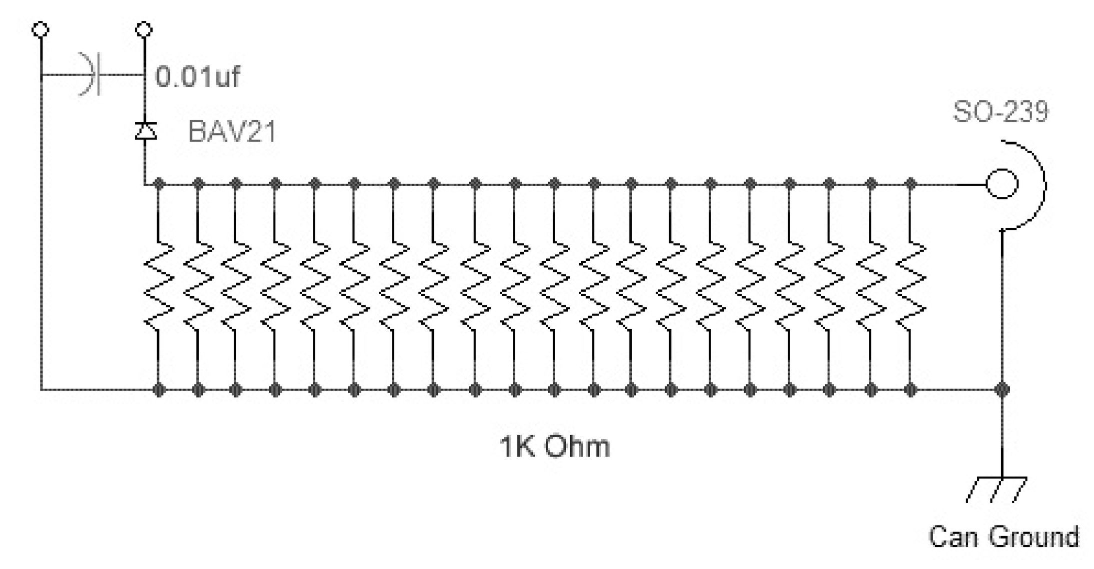
I added the bottom copper plate, using high temp silver solder. We are done and ready to fill with the mineral oil.
(I did not trim the leads protruding through the bottom plate; again the more metal, the more heat will dissipate)

Once filled, I carefully put the lid firmly on the can. I added the capacitor between the binding posts to allow for proper power measurements. The dummy load is now complete and ready for many years of service.

(This project took less than 2 hours to assemble)

Note: If you feel you have burned up your dummy load, the resistance will go UP in value. If you measure the resistance at the SO-239 and find it has climbed way above 50 ohms, you probably cooked it!

I added that nifty power chart to my dummy load. It already takes into account the diode drop. If you would like a copy of the chart, click HERE.



Measuring Power Accurately with your new Dummy Load

When you measure the peak voltage from the detector (the BAV21 signal diode), you are measuring within one percent of the true peak value of the carrier, not including the diode drop. (you will add that back in later)

For power measurements, you should use a 0.01uf disk ceramic capacitor of at least 250V rating, connected between the binding posts. This will charge to the peak voltage applied to the 50-Ohm load, less the diode drop. You can then measure this voltage with your Digital Volt Meter.

If you measure 70.3V with your DVM. Add 0.4V for the forward drop across the BAV21, for a total peak voltage reading of 70.7V. (The diode drop is a constant, always add 0.4V to your reading!) (*These readings assume you are using a standard DVM or with an input impedance of 10 Megohms. For 100V DC, the forward current will be 10ua, for a forward diode drop of 0.4V*)

Since this is a peak voltage, you need to divide by the square root of 2 to get RMS voltage. Take your calculator and divide by 1.414.

70.7 divided by 1.414 equals 50 Vrms.

To calculate power, you take the RMS voltage, square it, and divide by the load impedance, which in this case is ALWAYS 50 Ohms!

(70.7)^2 / 50 = 50W

So the output power, dependant on the accuracy of your DVM, is nearly 50W. If your DVM is accurate, to within 1% on DC voltage measurements (most are), you have calculated your rig's output power to within 2%, or 2W!

When power is measured by looking at the peak voltage, accuracy is the sum of your DVM's accuracy, plus the distortion in your output signal; the total of which may be on the order of 2% - - That's a 98W to 102W measurement! This dummy load method is substantially more accurate than several hundred dollars worth of Bird Wattmeter and slugs!

One More Time for Practice

You measure 99.6V from the binding posts on top of the dummy load. Add 0.4V to make up for the diode drop, for a total of 100V peak. Divide by 1.414 and you get 70.72Vrms. Square and divide by 50 Ohms, and you get 100W.

Calibrate Your Meters

If you place your power meter inline while you are taking this measurement, you can then calibrate it to your calculated power output measurement. You will then know the power measurements into the dummy load, or any 50 Ohm resistive load, are quite accurate. Your meters will no longer read 85 watts when your rig is really putting out 105 watts!

I hope you like the project, I sure do! AI4JI

AI4JI Oil-Cooled Dummy Load

Power Chart

Volts	Watts	Volts	Watts
9.6	1	89.1	80
22.0	5	91.8	85
31.3	10	94.5	90
38.4	15	97.1	95
44.3	20	99.6	100
49.6	25	102.1	105
54.4	30	104.5	110
58.8	35	106.9	115
62.9	40	109.2	120
70.3	50	111.4	125
73.8	55	113.7	130
77.1	60	115.8	135
80.2	65	117.9	140
83.3	70	120.0	145
86.2	75	122.1	150

Power Formula: Voltage +.4 (diode drop) = RMS
$RMS^2 \div 50$ (Ω load) = Power in Watts