H.F. Power Measurement

By VU2BD

It is heartening to see that Home Brewing activity has once again started in a big way in the Eastern Zone of India, after remaining in hybernation for decades. Basically home brewed sets are QRP rigs to start with and the builder wants to know how much power his rig is delivering. A simple and cheap but reliable method of RF power measurement is described here.

A Bit of Basic Theory:

For a pure sine wave form, like the blank carrier, there is a definite relationship between its peak value and its effective value, often called its RMS or its Root Mean Square value. Thus in mathematical terms, the Peak value of its voltage will be higher than its Effective value, by a factor of 1.4 or $\sqrt{2}$ times. In other words: $E_{peak} = \sqrt{2}\,E_{effective}$, or $E_{RMS} = E_{Peak}$ devided by $\sqrt{2}$.
i.e $E_{RMS} = \frac{E_{Peak}}{\sqrt{2}}$.

If a sinusidal carrier wave is rectified to give a d.c Voltage and if a capacitor is shunted across, to smooth out the ripples, then the capacitor will be charged at its peak voltage. A sensitive voltmeter connected across it will read E_{Peak}. This principle is utilised to measure the RMS power of the Tx. When a dummy load of 'R' ohms resistance is connected to the Tx output, a voltage will be developed across this resistance and power will be dissipated in it according to the well known formula $P = E^2/R$, P is in watts, E is the volts, all in RMS value. Since we are measuring the peak value in our voltmeter, our formula for RMS power will now be $P_{RMS} = \left(\frac{E_{peak}}{2}\right)^2 \div R$

With 50 ohms $P_{RMS} = \frac{(E)^2}{\sqrt{2}} \div 50 = \frac{E_p^{\,2}}{100}$ or $\left(\frac{E_p}{10}\right)^2$

When resistance is 50 ohms, it is:

$$P = \frac{\frac{E^2}{2}}{50} = \frac{E_p^{\,2}}{100} \text{ or } \left(\frac{E_p}{10}\right)^2$$

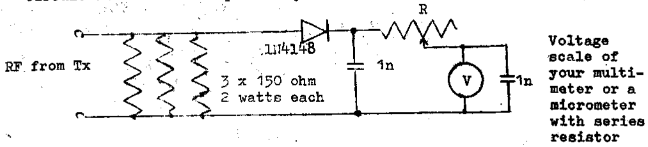
Thus by measuring the peak voltage drop in the load resistance, we get the RMS power of the transmitter output. Theoretically the voltage measured is slightly less than the actual voltage developed, because of the internal drop of the rectifier diode, which is about 0.6 volts. So this value is to be added to the observed voltage for correction. The final formula therefore becomes:

$$P_{RMS} = \left(\frac{E_p + 0.6}{10}\right)^2$$

contd. page 4

A practical setup:

The basic circuit for measuring th R.F. power is drawn below. The circuit will be self explanetory:



For y our ready reference, a few values of power and their corresponding values of measured voltages are tabulated below:

POWER in watts	VOLTs	POWER in watts	VOLTs
0.1	2.56	1.5	11.65
0.5	6.47	2.0	13.50
0.75	8.00	3.0	16.70
1.00	9.40	5.0	21.75

The actual set up in my shack is given in the sketch drawn below. It will be the ingenuity of individual Hams to modify and improve upon it to suit his/her requirement. If you want to measure higher power, then more number of high wattage non-inductive resistances in parallel to provide a 50 ohms dummy load. You may also submerge the resistances in transformer oil or even in mobil oil to avoid hot spot temperatures. A suitable voltage divider network, say one 10 kilo ohms resistance in series with a 1000 ohms resistance, at the input of the diode serving as a tapping point will multiply the voltage reading by a factor of 10, thus saving the diode from high voltage, break down !

S K E T C H