MOORABBIN & DISTRICT RADIO CLUB
KIT 2009-2
HF 100 W DUMMY LOAD AND POWER METER

Skill level required: ~~Beginner~~, Novice, Experienced, ~~Expert~~.

DESCRIPTION

This is a simple but useful adjunct to any shack. A large number of resistors are connected in parallel to give a nominal 50.0 ohm resistive load capable of dissipating over 100 watts continuously.

It can be built into a case of the builder's choosing but there are a number of ex mobile phone base station cases that are ideally suited. They are cheap and provide ventilation via a large number of slots in the sides and top. A simple resistive divider is used to limit the voltage applied to the diode rectifier.

The divider resistors are chosen to give close to 2,200 ohms and also have very good frequency response over the HF region. An analog meter gives a reading of the applied power.

Photo 1. The completed instrument in its recycled case

SPECIFICATION

Frequency range: DC to 60 MHz
SWR: less than 1.3:1 to 60 MHz, less than 3:1 to 150 MHz.
Rated power: 100 watts
Duty cycle: 100%
Power accuracy: 10% from 10 to 100 watts for dc to 60 MHz.

PARTS LIST

43 off 3 watt 2,200 ohm resistors
1 off meter scale to suit MU45 microammeter
4 off 560 ohm 1 watt film resistors.
400 mm RG58 coax.
1 SO239 (or connector type of choice) panel mount coaxial connector
4 off mounting screws with nuts and washers for connector and solder lug if required.
2 off pieces of single sided copper PCB material 50 mm by 300 mm.
1 off signal diode (HP hot carrier diode preferred). 1N4148, etc. is also suitable.
1 off RF filter capacitor, 1000 pF 50 v ceramic. .
1 off 47kΩ 0.1 watt resistor.
1 off 1 K linear tab potentiometer.
1 off MU45 0-50 µA analog meter. (Builder may substitute other type but will have to produce own power scale.
2 off 3 mm brass metal threads with nuts.
300 mm insulated hook-up wire.
Small quantity of paper glue.
Four adhesive backed feet

The first two items are available from the M&DRC Kits Manager, Ian Morris VK3IFM as the minimal short form kit. All other items are available from the usual suppliers if they are not in your "junk box". A complete short form kit (all bits but no case) can be supplied on request.

CONSTRUCTION

Using a lead pencil mark two parallel lines 10 mm in from the edge on each piece of PCB material. Make 23 marks on each of these lines spaced 13 mm apart. This is where the resistors will go. Use a prick punch to make a drill starting indent at each of the 46 marks on one board. Drill a 1 mm diameter hole at each point and deburr.

On the other board mark a centre line and prick punch two places 50 mm in from each end. Drill two 4 mm holes here.

Solder the two brass nuts onto the copper centred on these holes. Place this board in the required position on the bottom of the box and mark the centre of the nuts on the box. Prick punch and drill these with a 4 mm drill.

Clean the leads of the 2,200 ohm resistors with an ink eraser or steel wool.

For each resistor:
Bend one lead at right angles 10 mm from the resistor body. (This can be reduced to 5 mm if your general dexterity with the soldering is good). Clip the excess lead to leave 5 mm after the bend.

Take the PCB board with the 45 holes and hold it with the copper up. Starting at one end push a 2,200 ohm resistor straight lead through a hole. Turn the resistor so the bent lead is parallel with the board length. Now bend the protruding wire over leaving 5 mm of lead between the body of the resistor and the board. See photo 2. Solder it in place. Fit a second resistor next to this one and proceed as above.

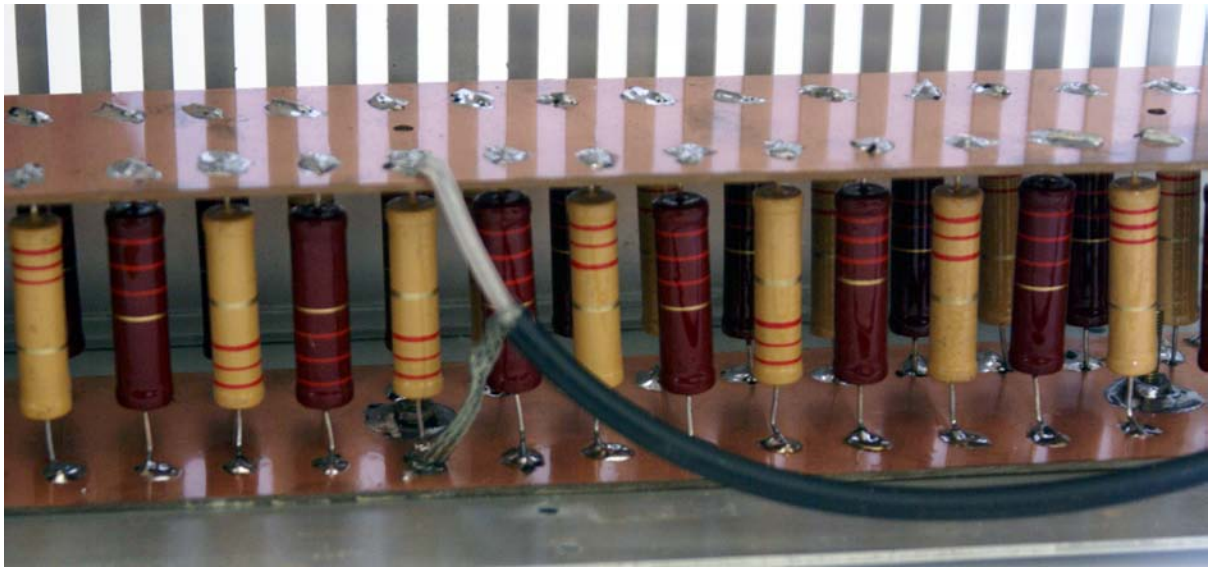


Photo 2. View of resistors and coax mounting in wattmeter element. **Soldering details can be seen.**

Once all the 2,200 resistors are in place the four 560 ohm resistors can be fitted. Twist their leads together so that they have only about 5 mm lead length. Bend as per photo and circuit diagram. Solder the leads and fit one end as the larger resistors.

Turn the second board so the copper is facing up. You should be able to sit the resistors on this board so all the bent leads touch the copper close to the marks you made earlier.

Start at one end and solder the bent leads to the PCB.

The main element of the dummy load is complete.

Solder in the diode, filter capacitor, 47 kΩ resistor dead bug style. Lead length is not critical. Solder in the tab pot taking care that the adjustment slot faces out to the

side. A short piece of hook-up wire is needed to connect one side of the pot to the ground (copper foil on the lower PCB).

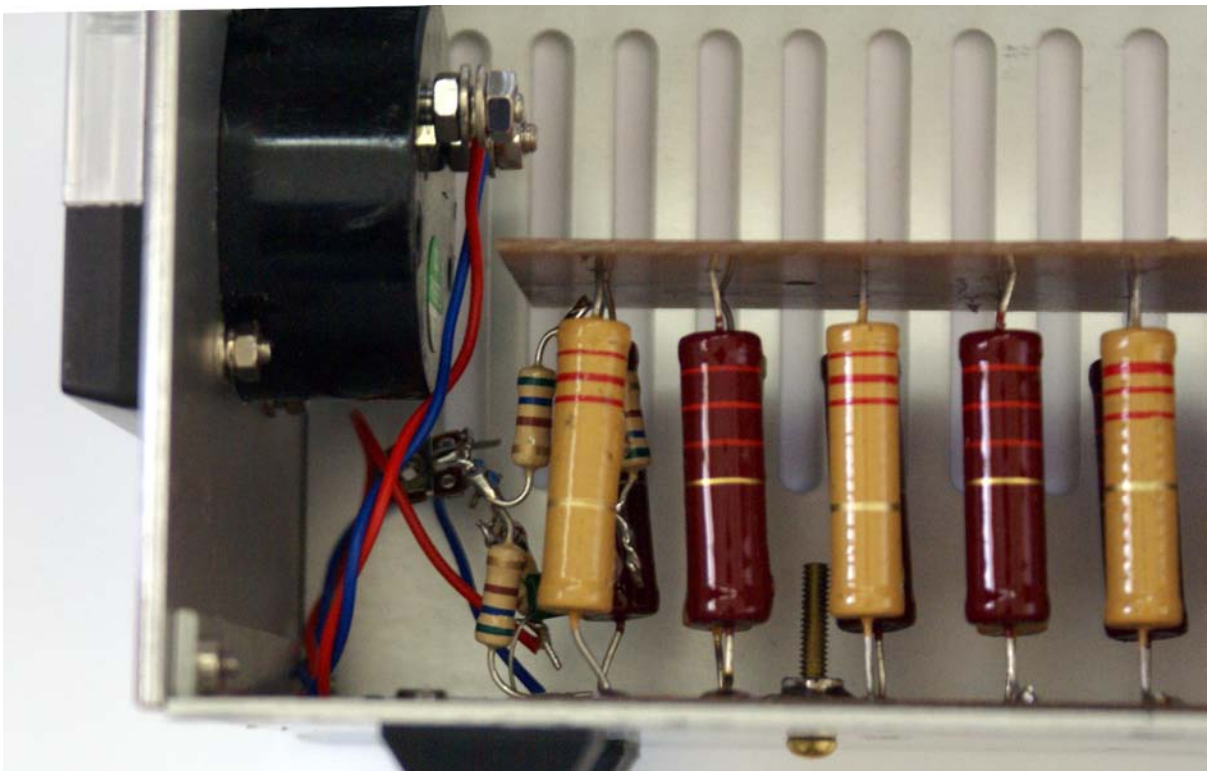
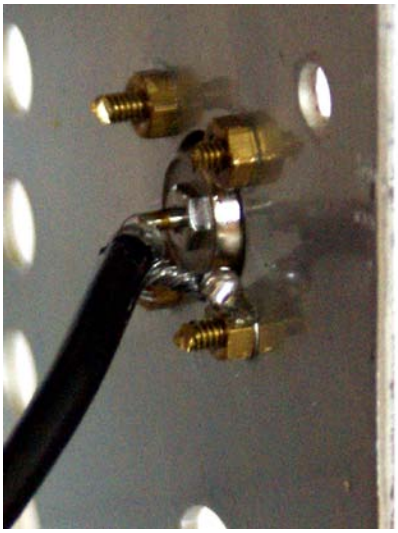


Photo 3. View of resistive divider, diode detector capacitor and calibration pot. Mounting brass bolt and soldered nut can also be clearly seen.

Remove the meter face cover carefully. Trim and trial fit the new meter scale in place. Be careful and try not to touch the pointer. You must not damage the pointer or its bearings. Trim a bit more off the new scale if required. Make sure you can position it exactly over the original meter zero and full scale marks. Glue it in place. Replace the meter cover.



Make mounting holes in the case for the meter and the coaxial connector. Mount the connector.

Strip some insulation off one end of the RG58 coax and solder it to the connector as per photo 4.

Photo 4. Coax connections to connector. Note short leads and use of a solder lug under one nut.

Mount the Meter in the case.

Mount the load element in the case. Use the two brass metal threads. The reason for soldering the nuts is now clear. It is too hard to hold them in place with fingers etc while screwing the thread in place.

Use some hook-up wire to connect the meter.

Check your construction.

Strip back about 40 mm of braid from the free end of the coax. Solder the centre conductor to the upper copper foil at the mid point and the braid to the lower foil immediately below.

Check the wiring.

Close up the case.

Fit the rubber feet.

The instrument is now ready for calibration.

CALIBRATION.

Apply a known 100 watts to the load and adjust Rv for a reading of exactly 100 watts.

Note that at this frequency the meter accuracy is going to be 2% + accuracy of your 100 w power level.

If you do not have a means of measuring your power you could just assume that your modern rig is set to give 100 w out on say 7 MHz and use this as the reference.

Or you could apply a low frequency AC signal of 70.71 volts rms and adjust Rv for a reading of 100 w. A variac would be useful in setting the voltage but be careful to keep the case earthed.

A DC voltage of 100 volts could be briefly applied to get the adjustment. The wattmeter is a peak reading device so it needs the peak voltage (1.414 x rms volts). However the applied power will now be 200 W and must not be applied for more than 5 seconds every 30 seconds.

IN SERVICE

Only use good quality and carefully checked coax to connect to the dummy load.

The load and power meter will be very useful up to 60 MHz for off-air testing of transmitters, checking and adjusting of SWR meters and bridges.

You can check the power output from your transmitter and if it is of an older design you can find the optimum setting of the tune and load controls.

If the transmitter is suspected of giving a problem but it is uncertain if it is the set or the antenna installation then this instrument will help identify the culprit.

Although it could be connected to a 2 m transmitter the SWR is likely to exceed 2:1 and the power level will be in error. It would of course be better than nothing.

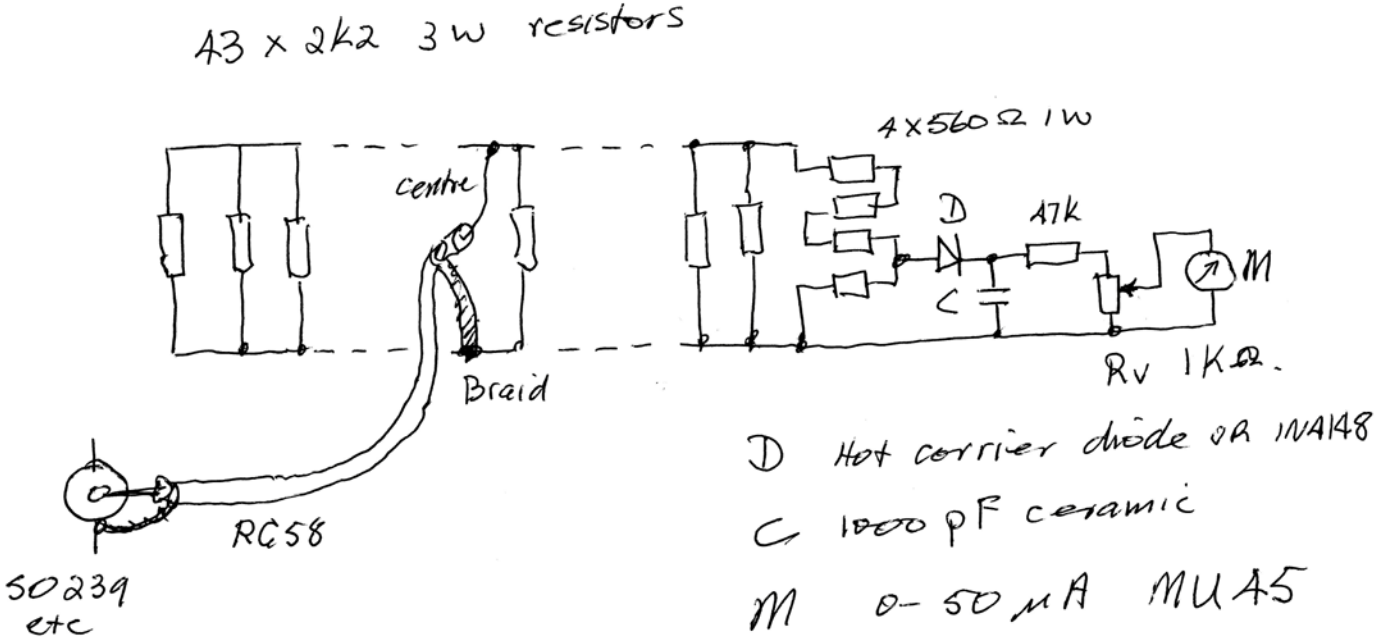
The power sensor is a peak reading device calibrated for RMS. It has a short time constant in its present configuration so it tends to show average SSB power not PEP. While it has not been tried, shunting the 1,000 pf capacitor with a capacitor of up to 47 nF may provide this facility.

Note that the meter scale is used for other projects, hence the VSWR scale which is redundant in this instrument.

This instrument will give decades of service and repay handsomely the time expended in building it.

Parameter	Marker 1	Marker 2	Marker 3	Marker 4	Marker 5	Marker 6
Frequency (MHz)	0.050000	6.944250	20.972550	27.986700	49.988350	60.000000
|Zs|	49.769079	49.600777	47.507760	46.023452	42.190472	42.237457

Table of measured impedance of prototype load.
Measured by Roderick Wall VK3YC



100 W DUMMY LOAD.