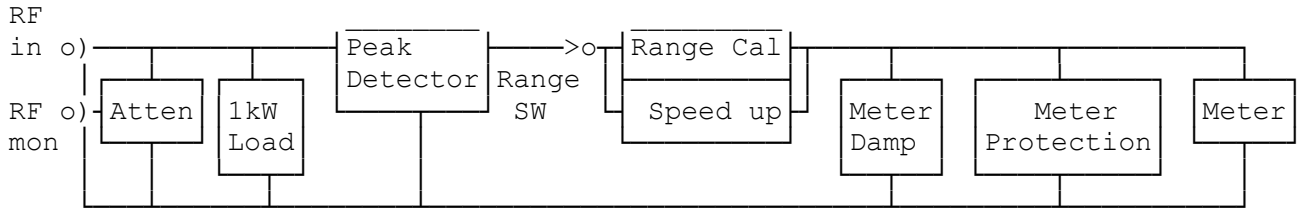
QRO 1kW HF Metered Dummy Load

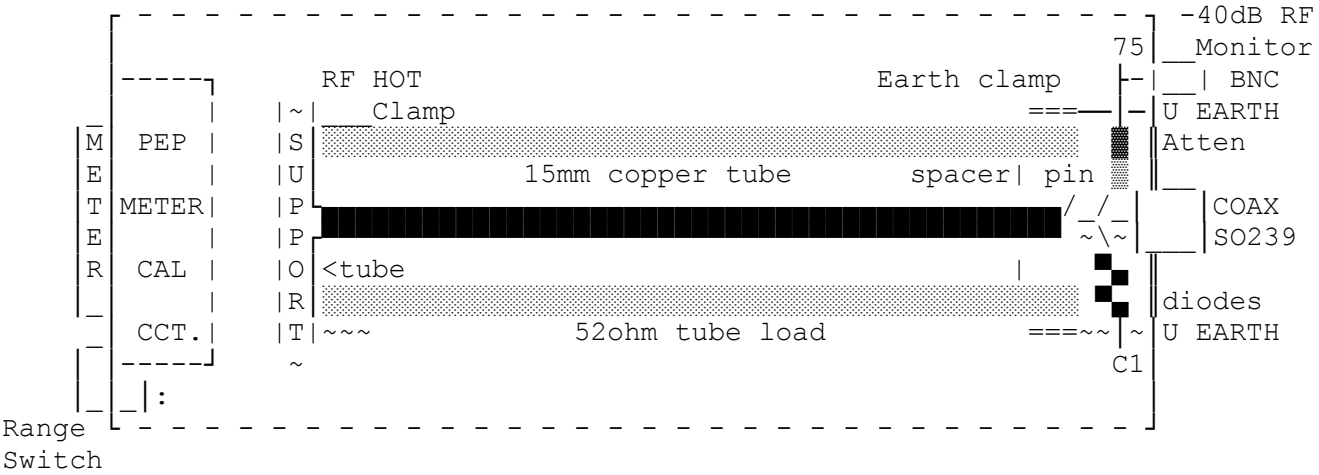
By G8MNY (Updated Dec 12)
(8 Bit ASCII graphics use code page 437 or 850, Terminal Font)

This is a peak reading metered, QRO dummy load, & with a low level RF monitor.

SCHEMATIC



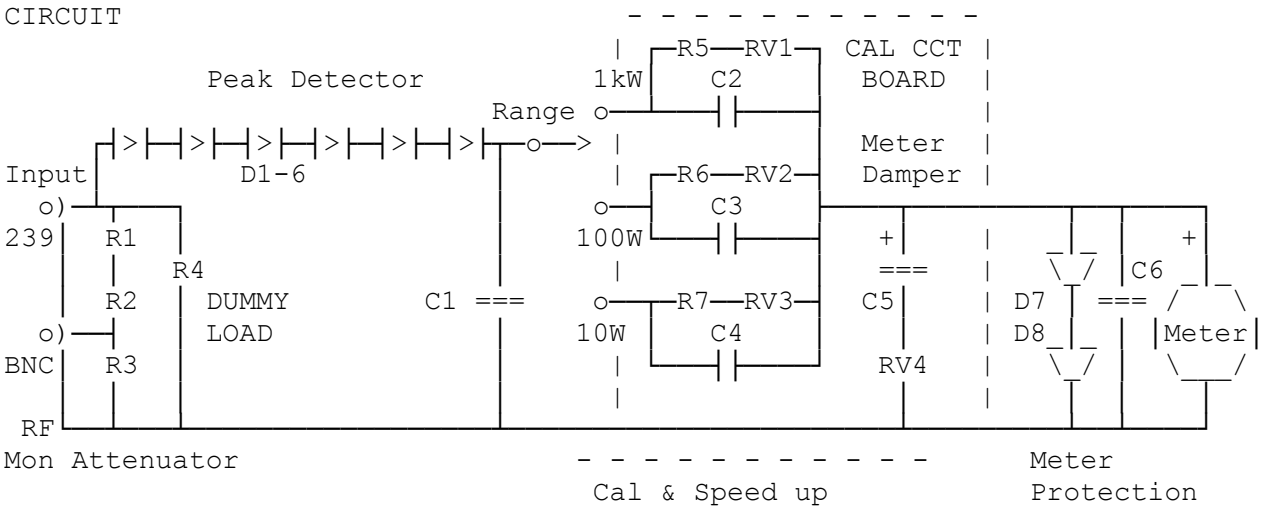
LAYOUT
It uses a commercial 1kW 52ohm coaxial long load 5cm dia x 30cm, mounted in a perforated steel panelled screwed together metal box 43 x 13 x 13cm.



The input socket is bolted through a 2cm wide U shaped copper earth strip, that is clamped on to the outer of the dummy load with a capacitor type clamp. The socket centre is soldered to the monitor attenuator R, diode probe stack, & also a 4mm banana plug pin that engages into a banana socket soldered to the 15mm dia copper centre tube. This tube forms the centre of 5cm dia coax to make the low radiating load. It is supported inside the load at the pin end with a card spacer to hold it central for assembly.

The copper tube's far end is split & flatted out to make 2 long tags that are bolted to the "RF hot clamp". This clamp has an insulated paxalin (copper less PCB) sheet support from the case bottom with a metal right angle strip.

CIRCUIT



COMPONENTS

No	Resistors	Capacitors	Diodes	Preset RV	Misc
1	* 3k9 3W	0u33 400V	BYW29 200V 35nS	1M	Meter 100uA 1kΩ
2	* 3k3 2W	@ 23n 1kV	"	330k	BNC chassis mount
3	* 75R	@ 68n 400V	"	100k	SO239 chassis mount
4	* 52R 1kW	@ 150n 400V	"	10k	Switch 1 pole 3 way
5	2M2 0.25W	@ 10u 10V	"		Perf Boxing panels
6	820k 0.25W	$ 1nF 25V	"		Nuts & bolts
7	220k		$ 1N4001		4mm Plug & Socket
8			$ 1N4001		

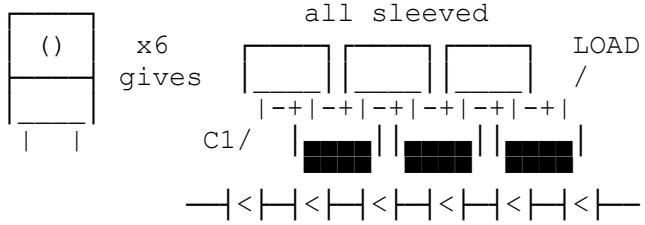
* = non inductive type, @ = for my meter ballistics, $ = mounted on meter

RF MONITOR

This give about -40dB output (-46dB terminated) for scopes or analysers, & uses just 3 Rs that are laid down close to the metal panel to reduce extra RF pickup. The output impedance is 75Ω. It should be noted that the peak reading diodes will cause some even harmonics to appear on suddenly increasing signal levels as the peak dummy load RF actually gets slightly clipped.

PEAK READING

The 6 fast recovery tab type diodes, give a 1200V PIV 8A RMS 35nS detector. They all have their tabs sawn off (tin snips cuts I found damaged them!) Other slower diode types easily blow up in this peak reading application! The diodes are soldered in series (1/2 about face & upside down) & have individual heat shrink over the tab remains so there in no chance of shorting out.



C1 is mounted on a tag around the input socket so there is next to no lead inductance to give false readings. There is very high pulse current into C1 on applying sudden RF, as the source Z is actually 25Ω & there could be >300V peak, that is 12A peak current on a 1kW sudden RF pulse! The meter load is only 100uA max, so there is no real loss due to that loading. C1 has to store the peak value until the next speech peak not just the RF peak, hence it is very large value for an RF detector.

The long DC lead away from C1 to the meter switch is glued to the metal base plate to kept it away from the dummy load R4, so there is little RF pick up & no chance of it getting burnt too.

The resultant DC + diode losses is then exactly the AC peak value.

$$POWER = \frac{Vrms^2}{R}$$

But sine wave crest power is 2x RMS so...

$$POWER = \frac{Vpk^2}{100 \text{ (for 50ohm)}}$$

Leads to & from the calibration circuit matrix board are also kept close to the front metal case as possible to reduce RF pick up from the load.

CALIBRATION
From above, the 3 meter scales can be accurately calibrated from 1st principles. The meter scale 0-100% needs to be drawn in Watts. e.g. a square law scale...

%SCALE	VOLTS	WATTS	VOLTS	WATTS	VOLTS	WATTS	CORRECTED
0	0	0	0	0	0	0	0
5	17	3	5	0.3	1.7	0.03	0.1
7	22	5	7	0.5	2.2	0.05	0.2
10	32	10	10	1	3.2	0.1	0.3
14	45	20	14	2	4.5	0.2	0.5
17	55	30	17	3	5.5	0.3	0.5
23	71	50	23	5	7.1	0.5	1
32	100	100	32	10	10	1	2
39	123	150	39	15	12.2	1.5	2.5
45	141	200	45	20	14.1	2	3
50	158	250	50	25	15.8	2.5	3.5
54	173	300	54	30	17.3	3	4
63	200	400	63	40	20	4	5
71	224	500	71	50	22.4	5	6
78	245	600	78	60	24.5	6	7
84	265	700	84	70	26.6	7	8
89	281	800	98	80	28	8	8.7
94	300	900	94	90	30	9	9.5
100	316	1000	100	100	32	10	10
	CAL RV1		CAL RV2		CAL RV3		

The diode loss of about 3V is almost insignificant except on the 10W scale & the correction can be added in if you wanted to make that scale a special one.

A 1kW variac on mains with a DVM meter will confirm the calibration to 1000W, as the RF power meter is quite flat from about 20Hz to 30MHz.

METER BALLISTICS for PEP measurement.
An attempt has been made in this circuit to use both meter damping to stop overshoots with C5 & RV4 (terminate the meter movement) & also proved meter speed up capacitors C2,C3 & C4 across the series calibration ratio Rs. My bul on "Meter Damping & Speed Up" explains the principles in detail.

The capacitor values used are ONLY correct for my meter movement. Using a slow RF step pulse of known square envelope (scope it), you can determine best values for both of these, so there is no overshoot, but still a very fast rise time.

CONCLUSION
The result here is a very accurate peak reading meter up to 30MHz. Above that the coax line load & diode detectors all start to go wrong & can't be trusted!

If the RF has a high harmonic content (e.g. worse than -20dB) then there will be quite an error in the power reading as the peak voltage will be wrong.

I have used the load for testing Ham HF amps up to 1kW & soak testing 531kHz AM Tx at up to 800W PEP when it did get very hot!

See my tech buls "Meter Damping & Speed Up", "AF 2 Tone Test Osc Design". "PA instability in ICOM IC735". "QRO Dummy Loads" & "QRP Power Meter & Dummy Load"

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73 De John, G8MNY @ GB7CIP