St Leonards Amateur Radio Society

POWER METER

Construction notes

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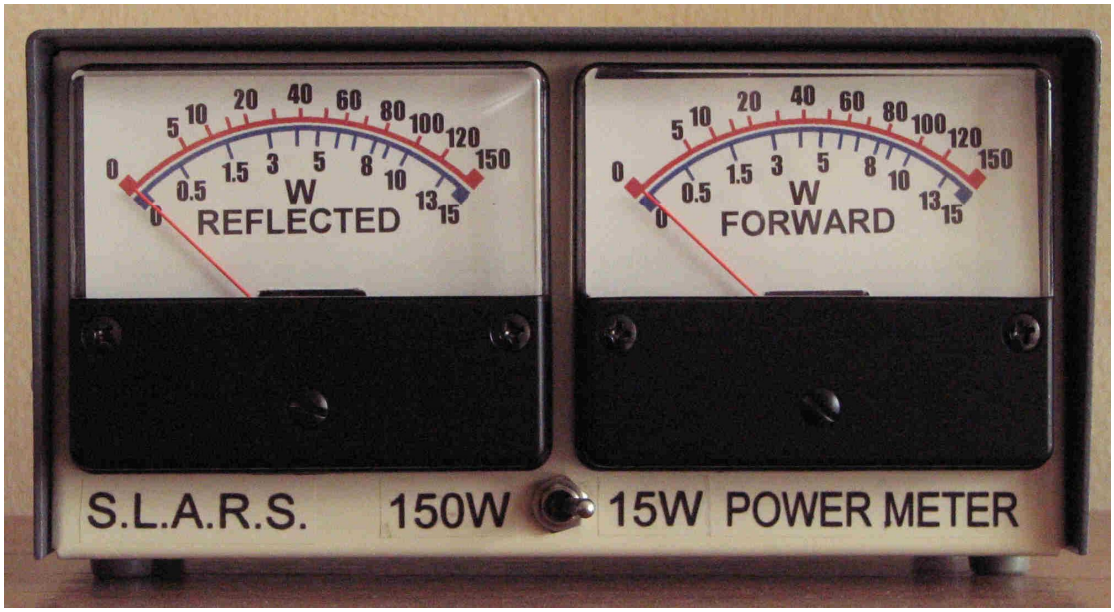


By G4NVH

1. Circuit Description

This bi-directional wattmeter is built around a hybrid coupler consisting of two transformers with four ports (connections). Figure 1 shows the coupler connected to two 50 ohm terminations (which determine the working impedance of the coupler), a transmitter and a load (the antenna). Forward power from the transmitter enters port A and leaves port B to be delivered to the load. A small proportional sample of that power is diverted to port D where it is dissipated in the termination resistor. If the load is not correctly matched, some of the transmitter power is reflected and enters the coupler at port B, and the same small proportional sample of that reflected power is diverted to port C to be dissipated in the other termination resistor. The proportion of the power appearing in the terminations is determined by the square of the turns ratio of the transformers. In this case, only $1/144^{th}$ of the transmitter power is delivered to the termination at port D and the remainder, ignoring losses, appears at the load. The wattmeter can be left permanently in circuit without significantly reducing the power delivered to the antenna. Because the hybrid is symmetrical, reversing the connections to the transmitter and load merely sends the forward sample to port C and the reflected sample to port D.

Simple termination wattmeters (Figure 2) are used to measure the forward and reflected power samples. The voltage developed across the 50 ohm load is proportional to the square root of the power dissipated, since $P=V^2 R$ and $V=(PxR)^{0.5}$. For example, 1 watt dissipated in a 50 ohm load produces a voltage of $50^{0.5} = 7.071V$ RMS. For a sine wave this gives a peak voltage of 7.071 x 1.4142 = 10V. D1 and C1 form a peak-detecting rectifier to apply DC to the meter movement M1. D1 is a Schottky diode with a forward voltage drop of around 0.25V. The current-limiting resistors R1 and VR1 are chosen to give the required full-scale meter reading. The capacitor C2 bypasses the meter movement for AC. In this wattmeter the meters are actually calibrated to read the powers entering ports A and B, not the powers dissipated in the termination resistors. The terminations are rated at 2 watts, so the maximum input power is 2 x 144 = 288 watts.

Figure 1.

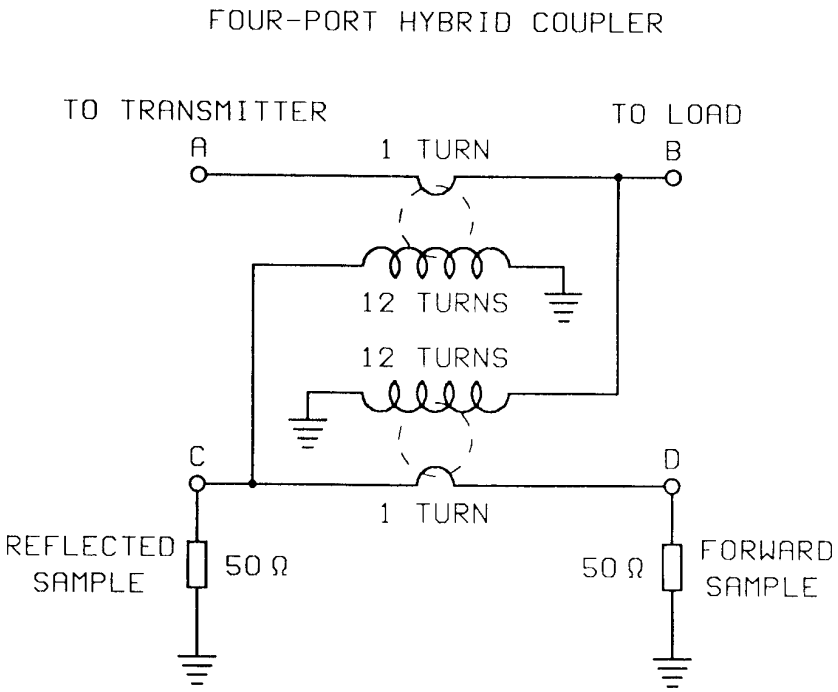
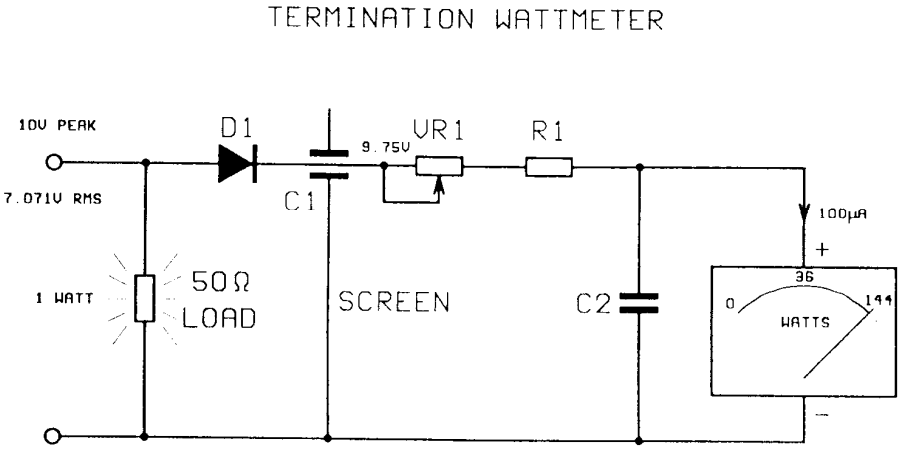
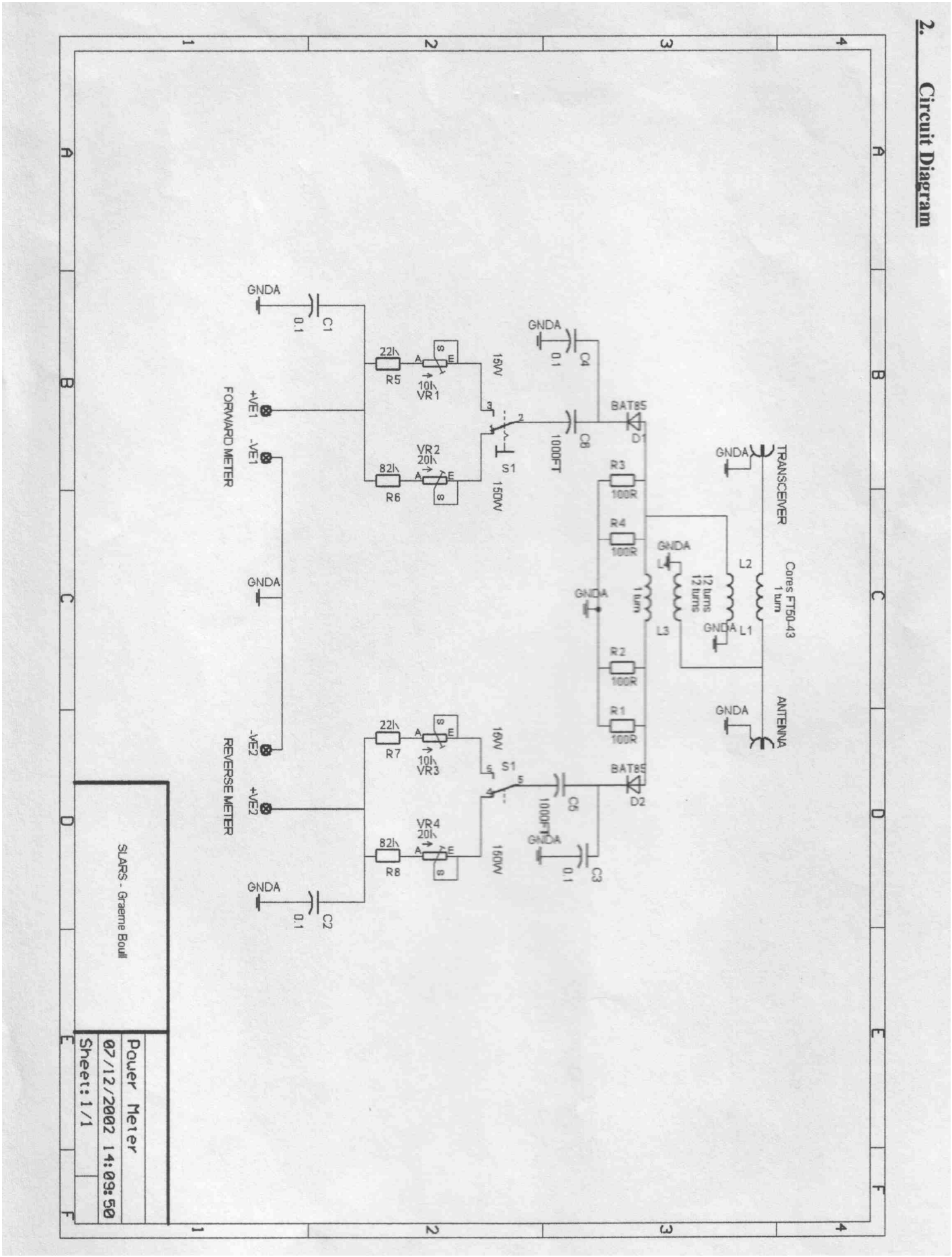


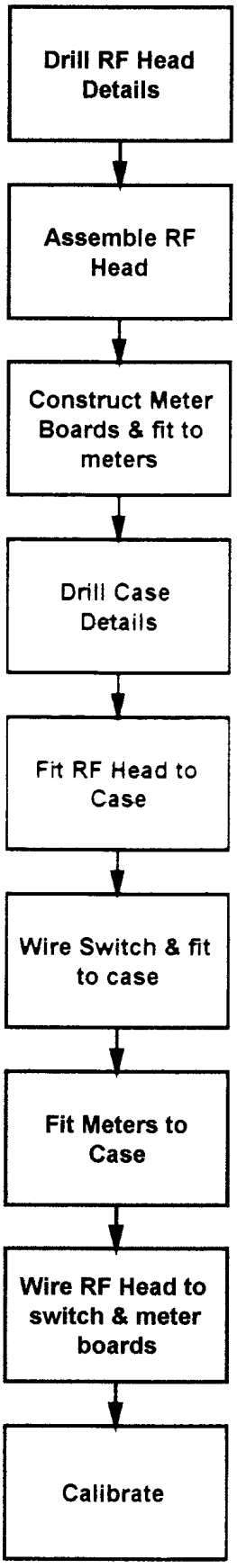
Figure 2



2. Circuit Diagram



3. Construction Sequence

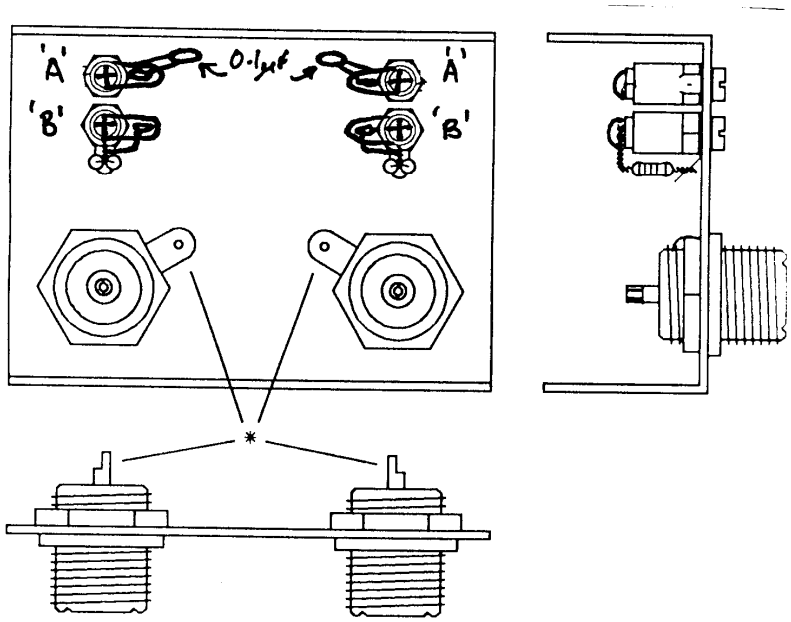


4. RF Head Assembly

NOTE: The RF Head forms the heart of the Power Meter. For correct operation it is essential that symmetry is maintained throughout its construction.

- After drilling all of the holes and removing the plastic film, fit the four Pillars as in Figure 3. Each pillar has an M3 solder tag fitted between the pillar and RF Head base and one fitted on the top. On the two pillars marked 'A' the top and bottom solder tags face in towards each other. On the two pillars marked 'B' the bottom solder tags are at right angles and point towards the SO239 connectors. All of the bottom solder tags should bend up slightly to aid soldering.

  Figure 3.

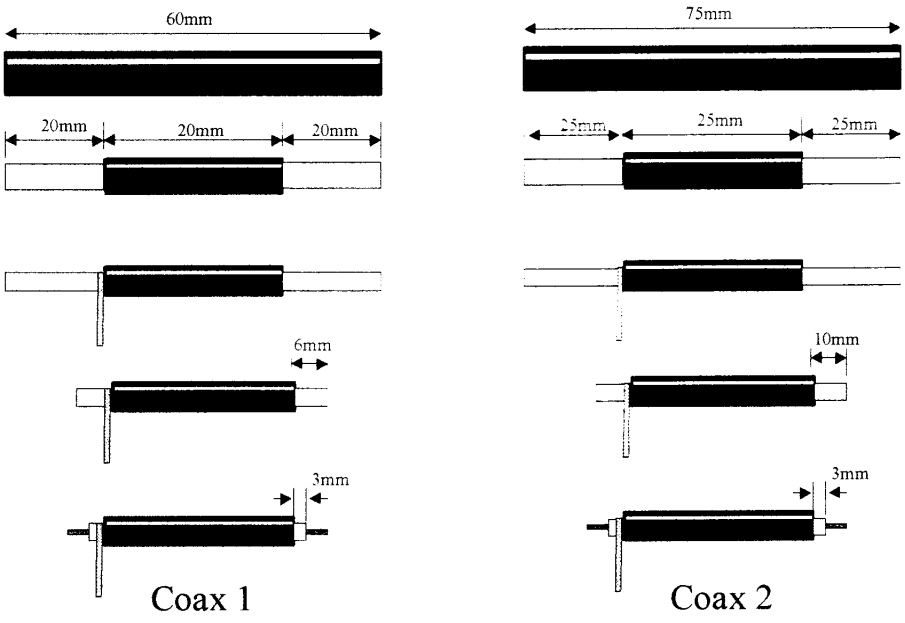


* ADJUST THE POSITIONS OF THE SOLDER TAGS AND CONNECTOR SOLDER TERMINALS AS ABOVE, THEN TIGHTEN THE NUTS FIRMLY

- Fit the SO239 connectors, ensuring that the ends of the solder rings are bent up slightly
- Solder a 0.1uF capacitor between the top and bottom solder tags of the 'A' pillars

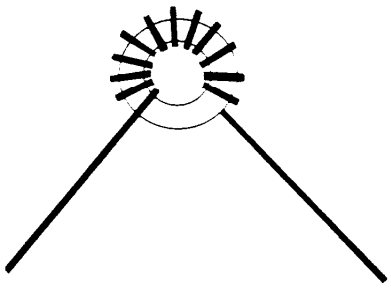
- Twist the ends of two of the 100Ohm resistors together to form a 50 Ohm resistor. Do the same to the other pair. Form the legs of the resistors so that they fit between the upper and lower solder tags of the 'B' pillars and solder in place, cutting off any excess in the process.
- Fit and solder the two diodes and the feed through capacitors as shown in figure 4. (note: the diodes and 0.1u F caps are shown on the wrong side of the pillars for clarity)
- Prepare 2 pieces of RG58 coax as shown in Figure 5 below.

Figure 5.



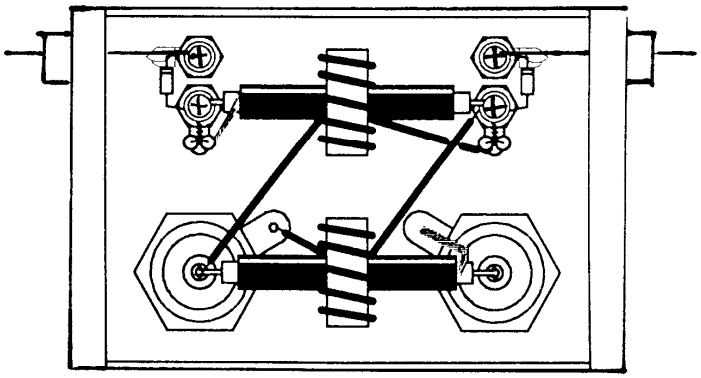
- Wind twelve turns of the enamelled copper wire onto each ferrite core and leave about 50mm pigtails. Ensure that the turns are fairly tight and evenly spaced allowing a gap of 60 degrees or so at the end of the windings. See figure 6.

Figure 6.



- Slide the ferrite cores over Coax 1 and 2
- Fit and solder the core assemblies to the RF Head in accordance with Figure 7. Coax 1 is fitted to the upper stand off spacers. Coax 2 is fitted between the SO239 Connectors.

Figure 7.

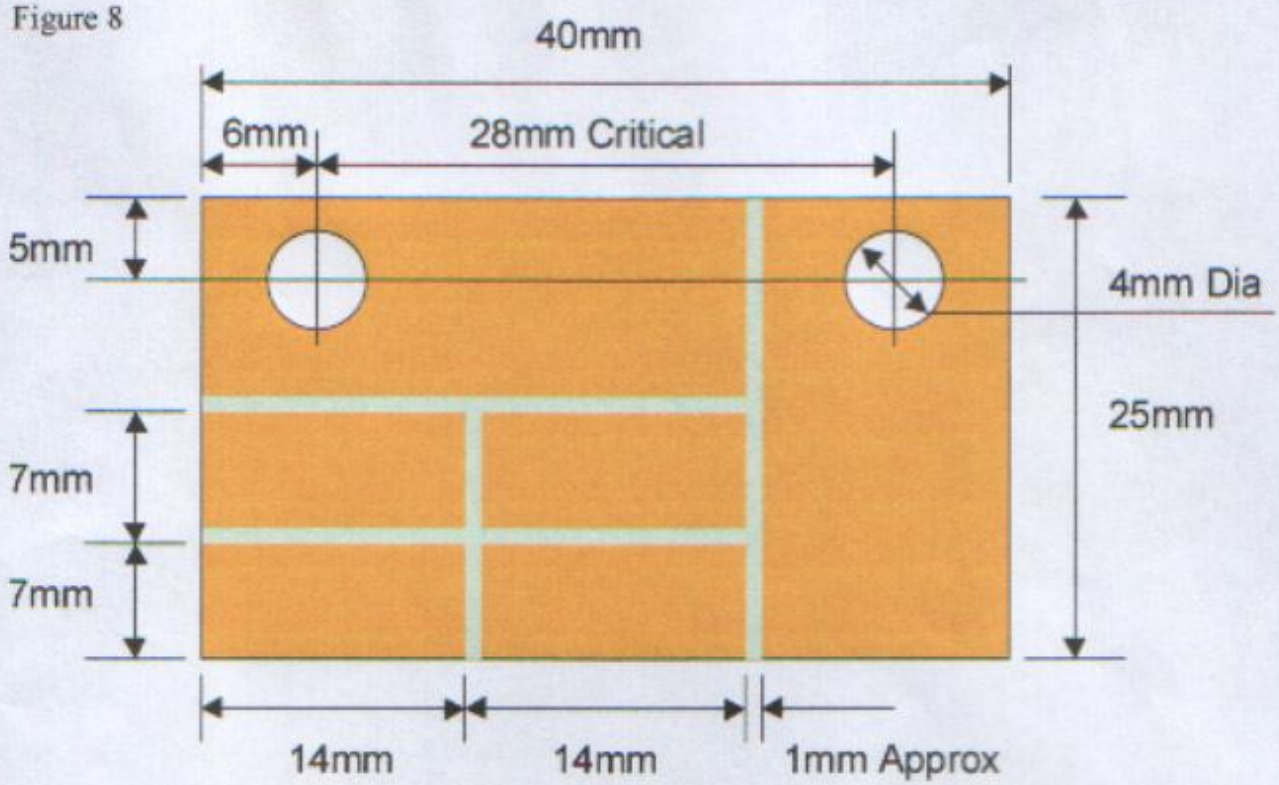


This concludes the building of the RF Head.

5. Meter Boards

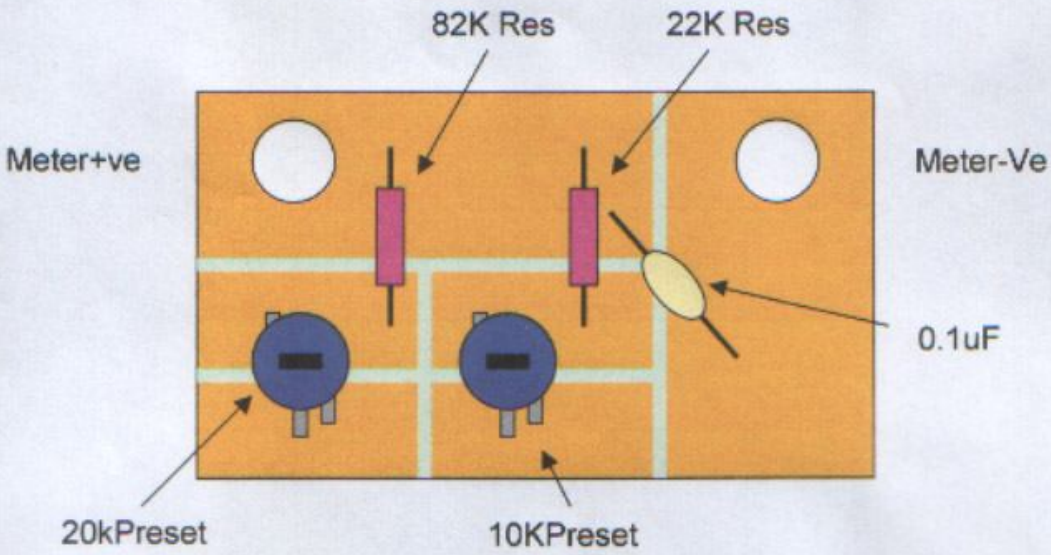
- There are two identical meter boards constructed on single sided PCB material.
- After cutting the boards out and carefully de-burring all edges, drill the two holes as in figure 8.
- The boards are constructed using isolated pads. The pads are created by removing copper using a small rose bit cutter and a dremmel type drill. Alternatively, a scriber can be used to score through the copper and a hot soldering iron used to peel off the copper strips. (I will demonstrate both methods if anyone is not sure of how to do this).

Figure 8



- Form the legs of the preset resistors so that the centre and one outside leg point one way and the other leg points 180 deg away. See figure 9.
- Surface mount the rest of the components onto the board.
- Be careful when forming components, otherwise damage will ensue.

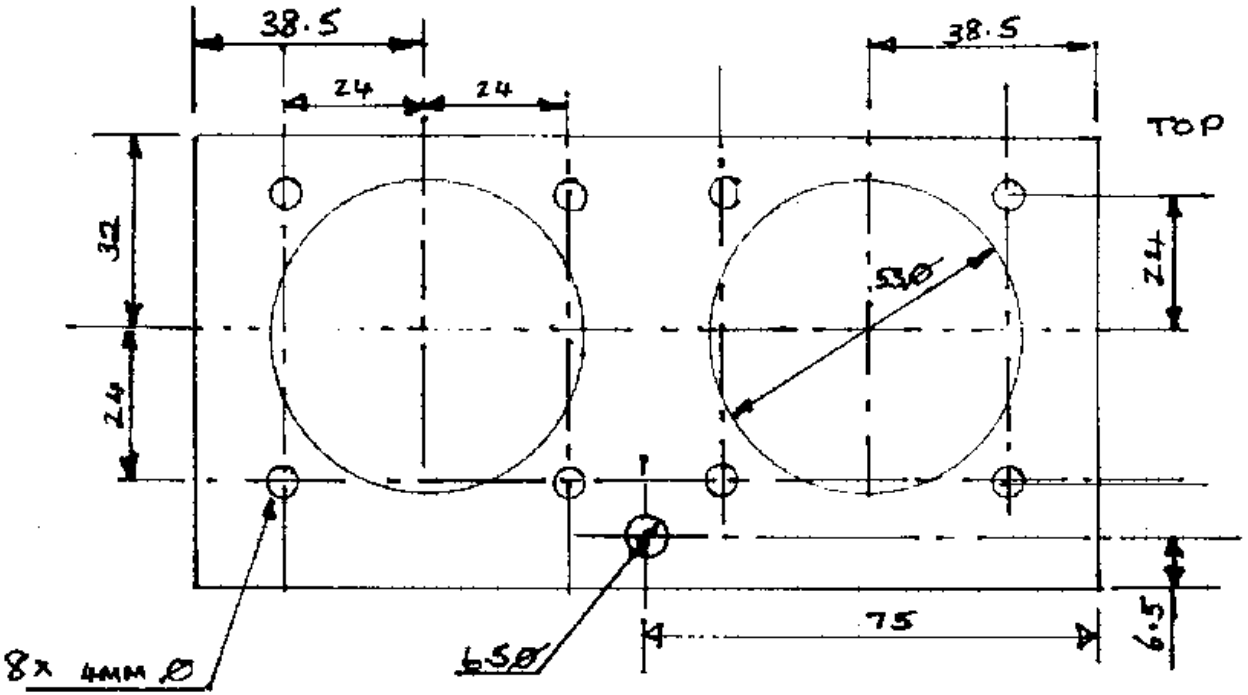
Figure 9



Note: Components are surface Mount

- This concludes the meter boards

POWER METER

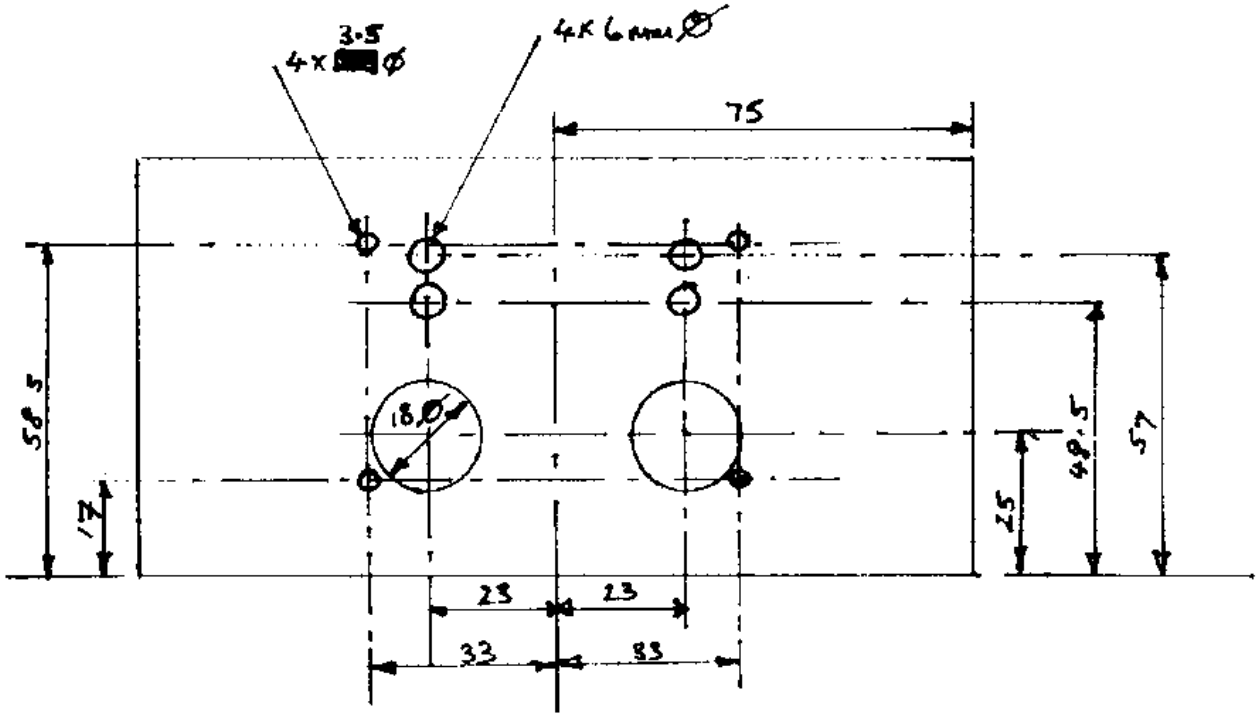


FRONT PANEL DRILLING DETAILS

NOT TO SCALE

Boull. 5/12/02.

Power Meter.



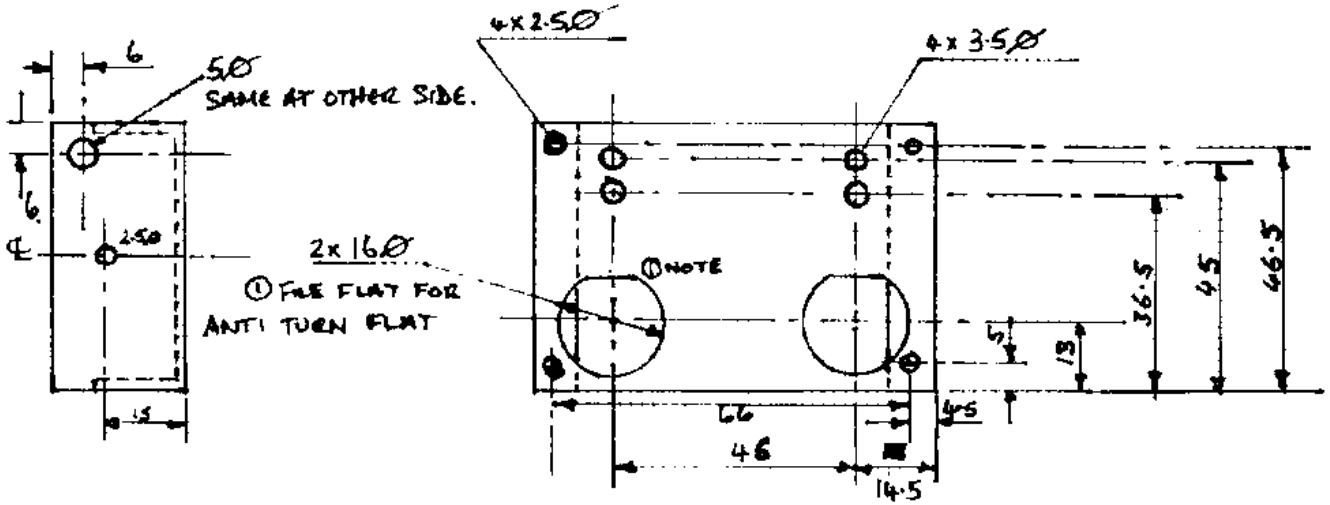
NOT TO SCALE

REAR PANEL DRILLING DETAILS

2 of 3

BBoull 4/12/02.

POWER METER



SIDE VIEW.

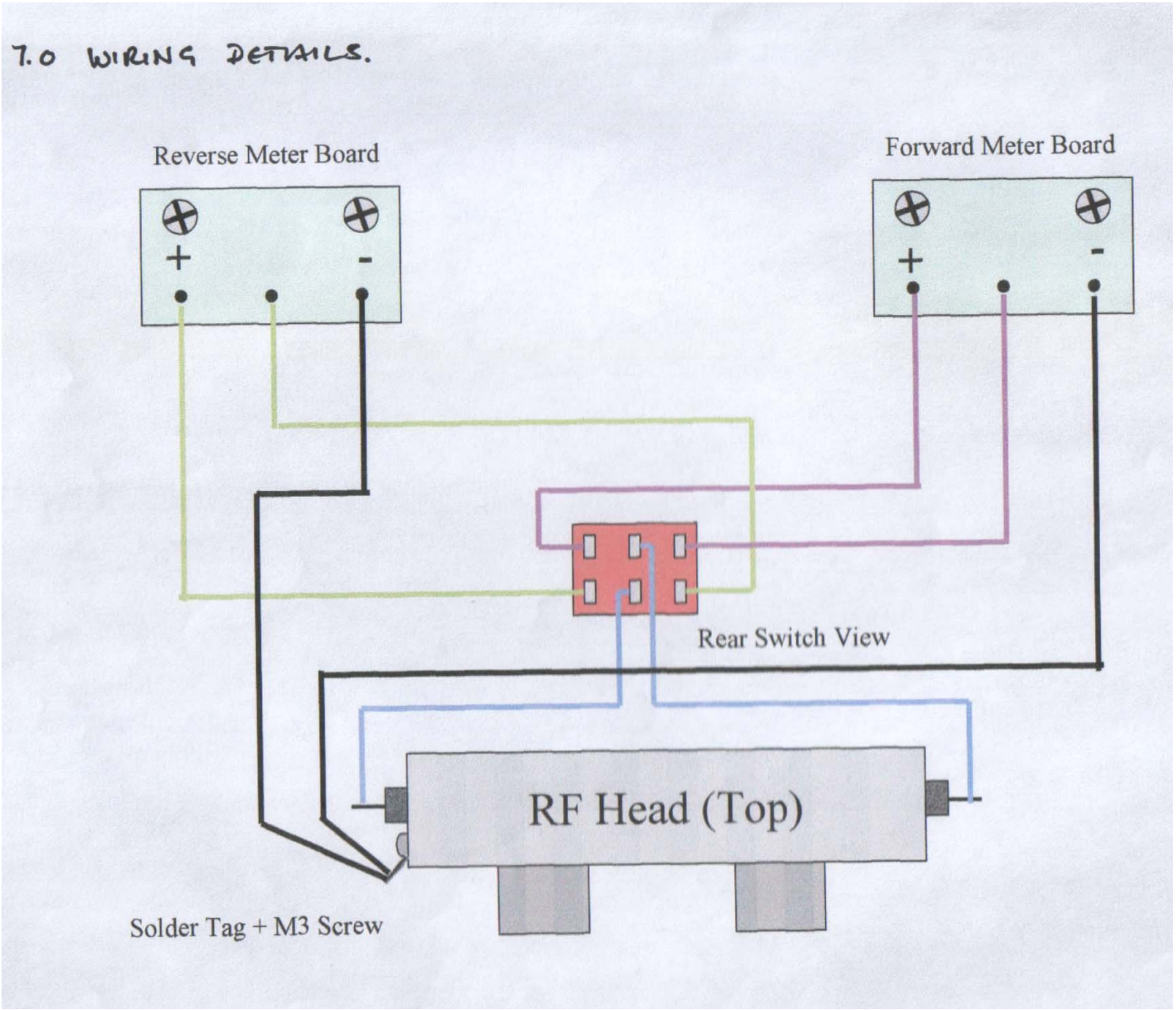
RF SENSE HEAD DRILLING DETAILS.

NOT TO SCALE

S Bull 4/12/02.

3 of 3.

7.0 WIRING DETAILS.



St Leonards Amateur Radio Society - Power Meter Project - 150/15 Watts

No	Description	Qty		Supplier	Code	Cost Ea	Tot Cost
1	Ferrite Cores (FT50-43)	2	22	JAB	61001101	£0.50	£1.00
2	UHF SO239 Sockets	2	22	Rapid	16-0155	£0.40	£0.80
3	BAT85 Schottky Diodes	2	22	Rapid	47-3108	£0.12	£0.24
4	100 ohm 1 watt carbon resistors	4	44	JAB	CR100100R	£0.06	£0.24
5	1nF Feedthrough caps	2	22	JAB	SFX-1000	£1.20	£2.40
6	100nF Disc Caps	4	44	Club Stock			£0.00
7	Preset resistor 20k	2	22	JAB	406P-20K	£0.30	£0.60
8	Preset resistor 10k	2	22	JAB	406P-10K	£0.30	£0.60
9	22k 0.25w carbon resistor	2	22	JAB	CR2522K	£0.02	£0.04
10	820k 0,25w carbon resistor	2	22	JAB	CR25820K	£0.02	£0.04
11	100uA meter	2	22	Rapid	48-0305	£5.20	£10.40
12	Stand of insulators	4	44	Maplin	FS36P	£0.27	£1.08
13	M3 Solder tags	9	99	Rapid	33-1810	£0.02	£0.18
14	Case feet	4	44			£0.00	£0.00
15	RG58 Coax	2	22				£0.00
16	24swg insulated wire	2	22				£0.00
17	Large Case	1	11	Maplin	XY43W	£6.50	£6.50
18	Small Case	1	11	Maplin	LF13	£1.26	£1.26
19	Self Tapping Screws	5	55	Maplin	LJ93B	£0.02	£0.10
20	Toggle Switch	1	11	Rapid	75-0040	£0.85	£0.85
21	Post & Packing	1	11				£0.50