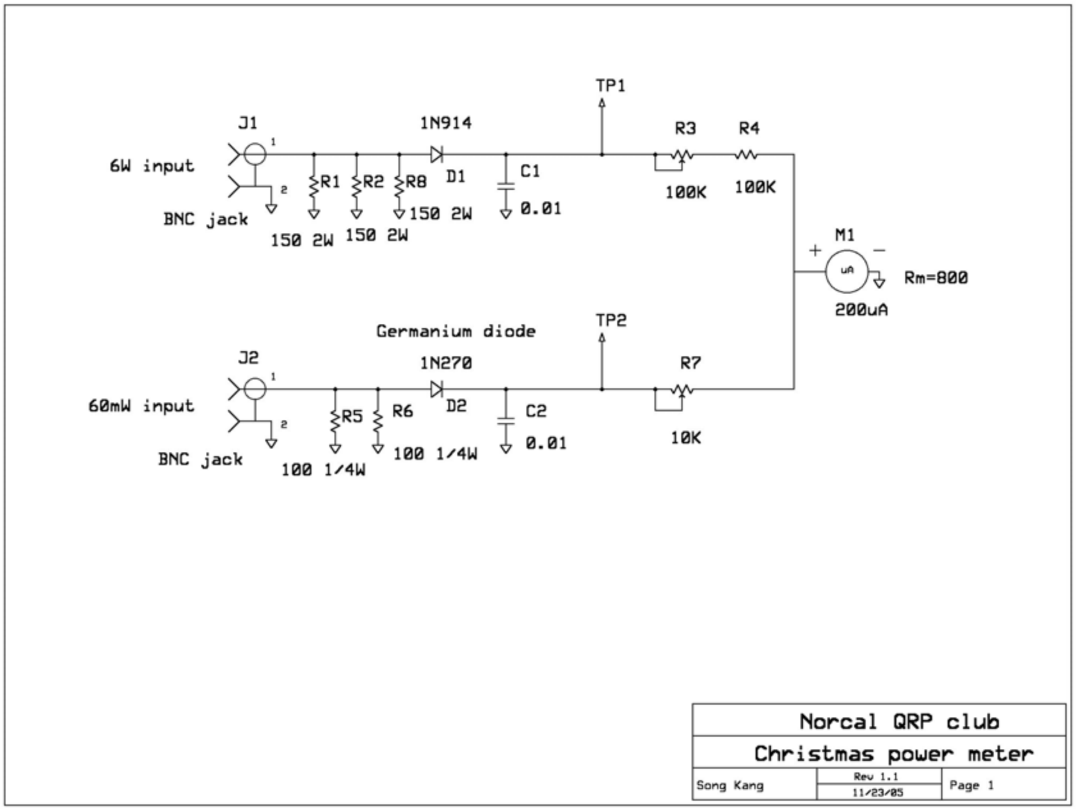
NORCAL CHRISTMAS POWER METER

Here is a simple power meter to measure a QRP transmitter output, up to 6W, and low-level driver circuits, up to 60mW.



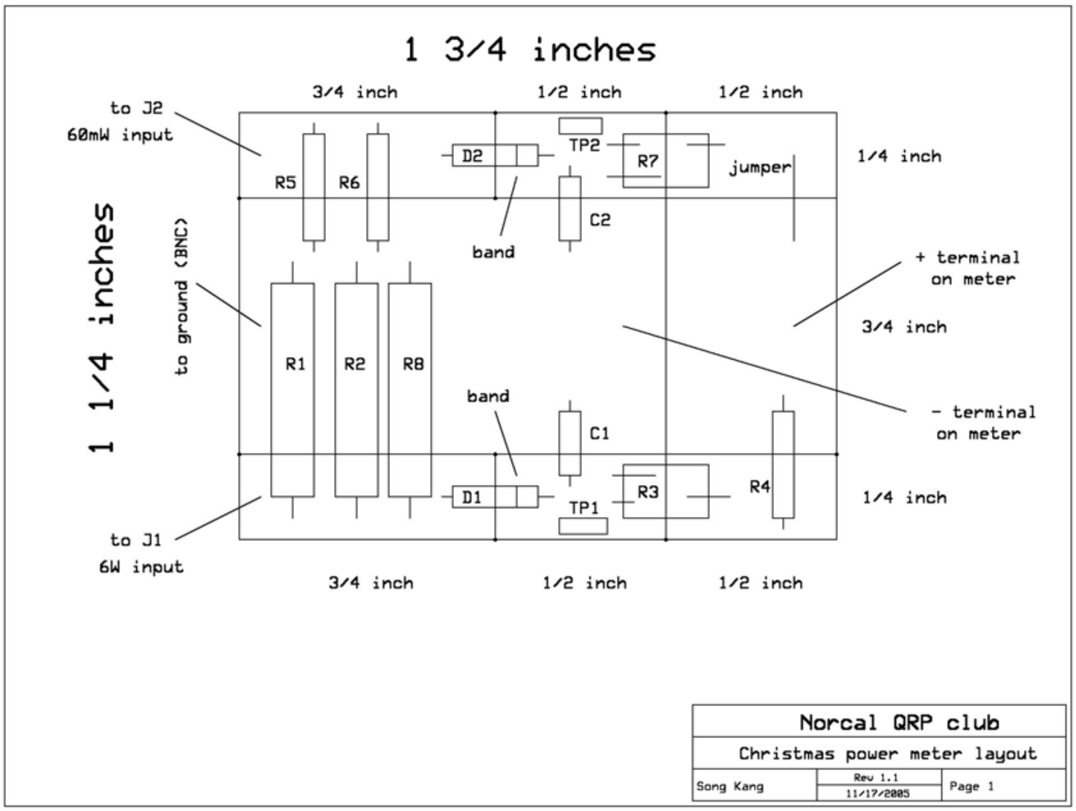
Parts List:
C1,2 - .01uF
D1 – 1N914 or 1N4148
D2 – 1N270 Germanium Diode
J1, J2 input connector of builders choice, not supplied
M1 – 200uA
R1,2,8, - 150 ohm, 2 watt
R3 – 100K Trimpot
R4 – 100K ¼ watt
R5,6 – 100 ohm ¼ watt
R7 – 10K Trimpot

The 6W input is terminated with three 150 ohm resistors to provide a 50 ohm load, and the 60mW is terminated with two 100 ohm resistors.

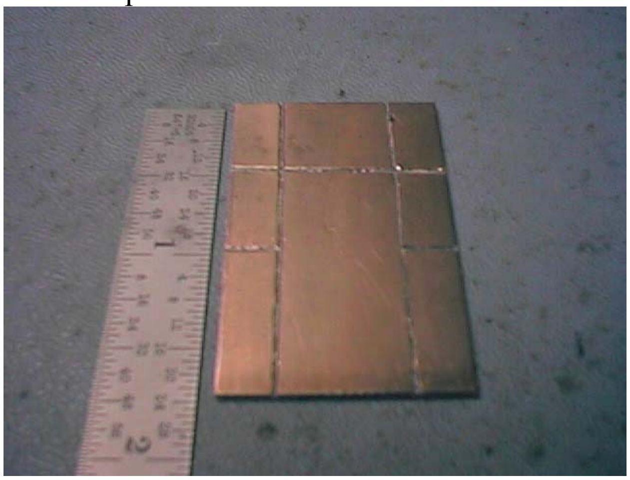
A single diode functions as a peak detector. We us a high-speed silicon diode for 6W and a germanium diode is used for low power. It has less voltage drop across the diode and enables low power measurements.

C1 and C2 smooth out the detected voltage applied to a voltage meter. It is formed by a 200uA meter and resistors R3&R4 for 6W, and R7 for 60mW.

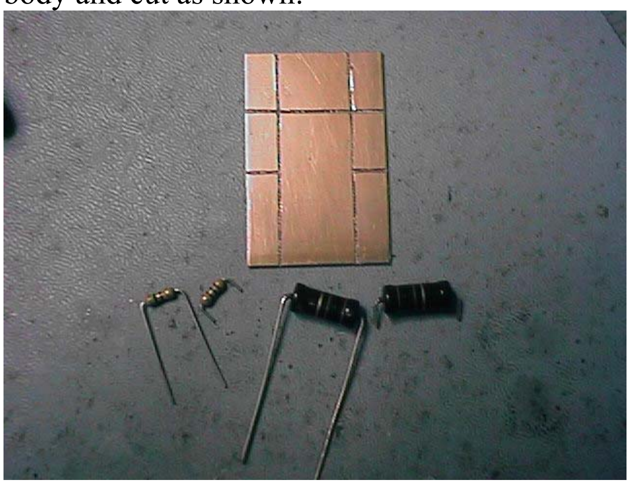
The entire circuit is built on 1 ¾" by 1 ¼" PCB. Here is the layout



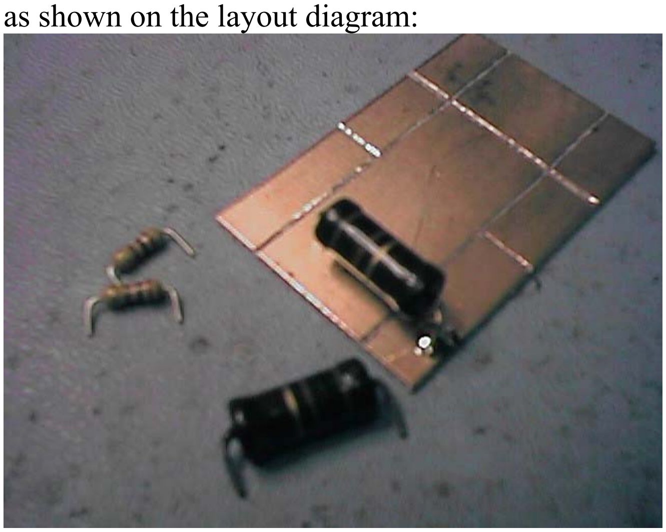
The trace cut is made with a dremel tool or exacto knife. Inspect for copper sliver shorts.
Here is a picture after the trace cuts.

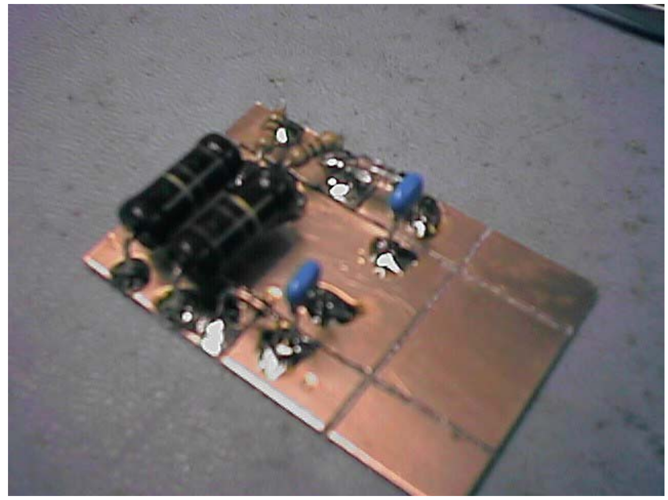


The axial component leads are bent close to the body and cut as shown:

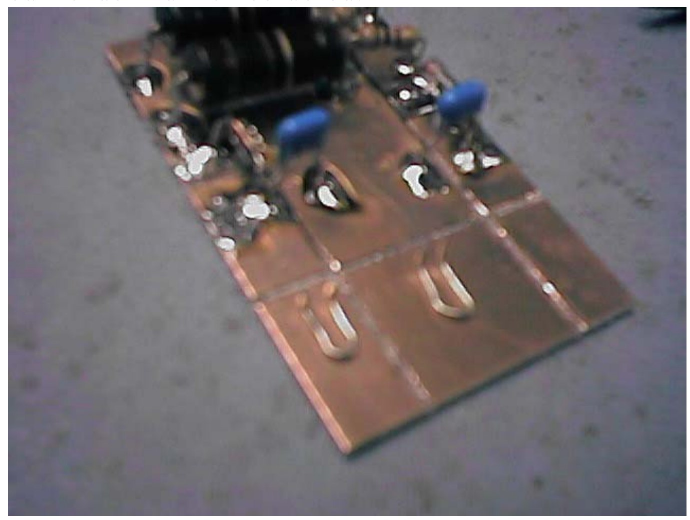


Individual components are tack soldered to the PCB as shown on the layout diagram:

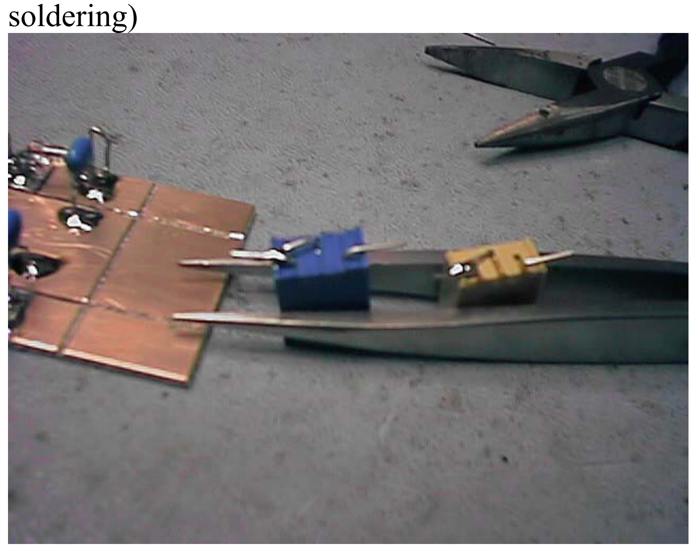


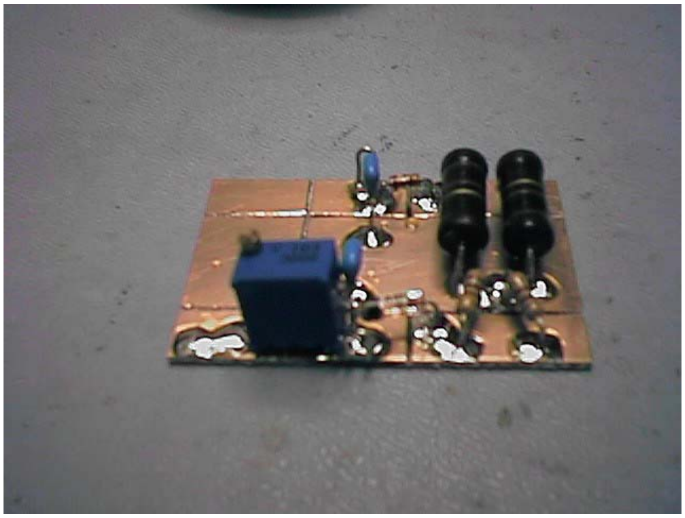


(Note that this prototype has two 2W resistors at 6W input. The kit contains three resistors)
The test points are made by forming a loop with cut-leads and tack soldered.

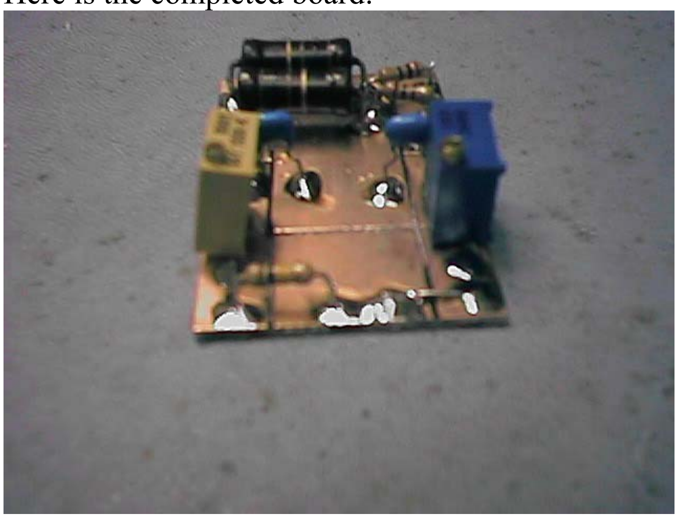


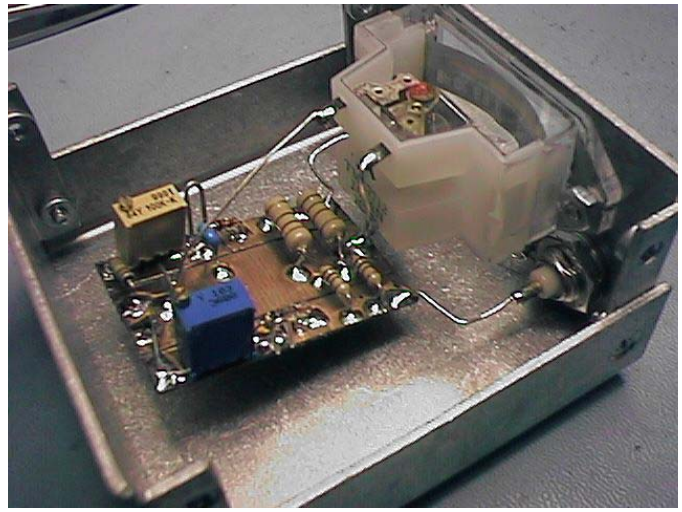
Prep the leads on R3 and R7 as shown and solder two leads on each pot: (Preset R7 to 5.7K before soldering)





Here is the completed board:





The enclosure is up to the builder. The BLT case, available from qrpkits.com, is shown here:

Meter Calibration:
To calibrate the power meter, a little math is required:
Vrms = square root (power * load)
= sqrt (6W * 50) = 17.32 Vrms

The detector is a single diode, or peak detector. The output of the detector can be calculated:
Vpeak = Vrms * square root (2) = 17.32Vrms * 1.414 = 24.5Vpeak
The actual output of the detector is approximately 0.7V less due to the voltage drop across the diode.
Vout at TP1 = 24.5V – 0.7V = 23.8V
The capacitor C1 smooths out the ripple and 23.8V would be applied to the 200uA meter through R3 and R4.

The value for R3 and R4 is:
R3&R4 = 23.8V / 200uA = 119 Kohms
R4 is a fixed 100K and R3 would be adjusted for full deflection on the meter.

The calibration can be performed by substituting the detector with a DC voltage.
Attach positive lead to TP1.
Apply the following DC voltages to TP1 and label where the meter movement stops:

Power level	Power supply
6W	23.8V (adjust R3 for full deflection)
5W	21.7V (label the meter)
4W	19.4V (label the meter)
3W	16.7V
2W	13.5V
1W	9.4V
0.5W	6.4V

If you don't have a power supply, three 9V batteries and a 1K pot can be used to calibrate the meter.

Calibrating 60mW input:
The same calculation is used for the 60mW input, with a couple of differences.
The low level detector is a germanium diode and the voltage drop is 0.2V.
The metering circuit, R7 and resistance of the meter, has relatively low impedance, and loads down the detector circuit. The calculated voltage is reduced by some factor.
It's difficult to calculate the factor and empirical method is used to determine the value.
Preset R7 to 5.67 Kohms.
Apply +1.51V to TP2 and adjust R7 to 5W (not full deflection) on the meter.
The label marking from 6W is used for low level, but it's in tens mW. IE: 5W = 50mW.
The accuracy is good from 10mW to 60mW.

Notes:
Scrape the oxidation off the meter terminal before soldering. Try to solder as quickly as possible. The plastic housing may melt if soldered too long.
The meter casing is removed by taking off the tape. Take care not to damage the meter movement during the labeling. The germanium detector has a poor frequency response and you will notice the power reading drop on higher frequencies.

This project came about during a brain storming session at the November NorCal meeting. Doug, KI6DS mentioned that he had some 200 uA meters that would make neat power meters and that he would be willing to donate them to the club. Song Kang volunteered to design and prototype the project, and James and Paul gave the go ahead. It was decided to give the kits away to members who attended the December meeting (we had enough for about 40 kits), then put the this article on the web page so others could roll their own. Merry Christmas from NorCal.