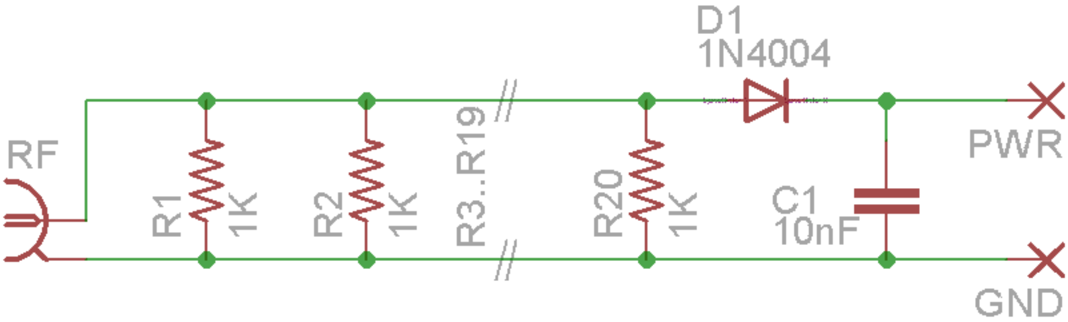
Dummy Load Kit

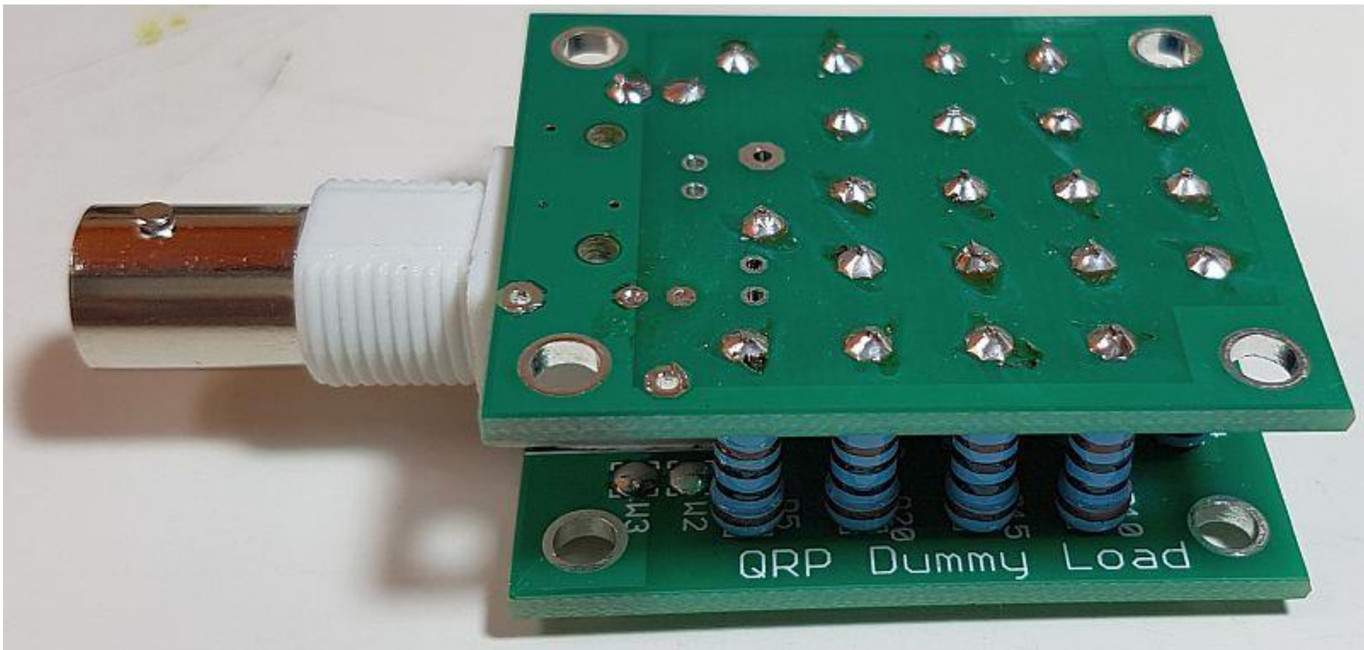
1. Introduction

A dummy load is used at the output of a transmitter for testing purposes. This dummy load consists of 20 1K 1% 1W resistors connected in parallel to make a 50-ohm 20W QRP dummy load.

There is also a simple diode RF detector which rectifies and smooths the peak voltage, which can be read on a Digital Voltmeter (DVM) as a simple indication of power output. This is NOT an accurate power measurement, but it is a good relative indication.

The kit uses two identical PCBs facing each other, and the resistors are sandwiched in the middle.



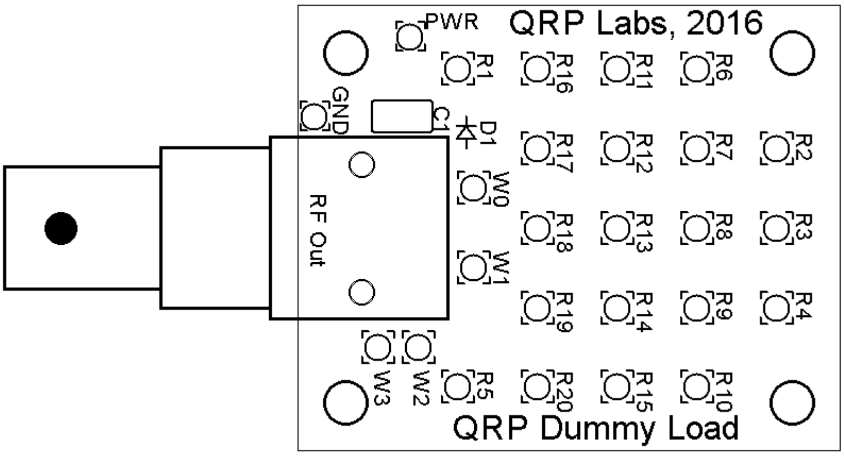


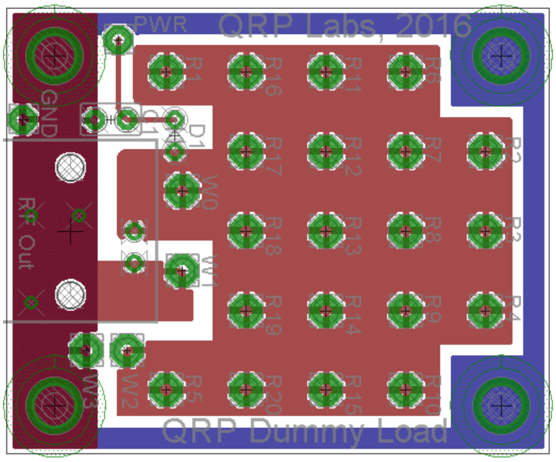
2. Parts List

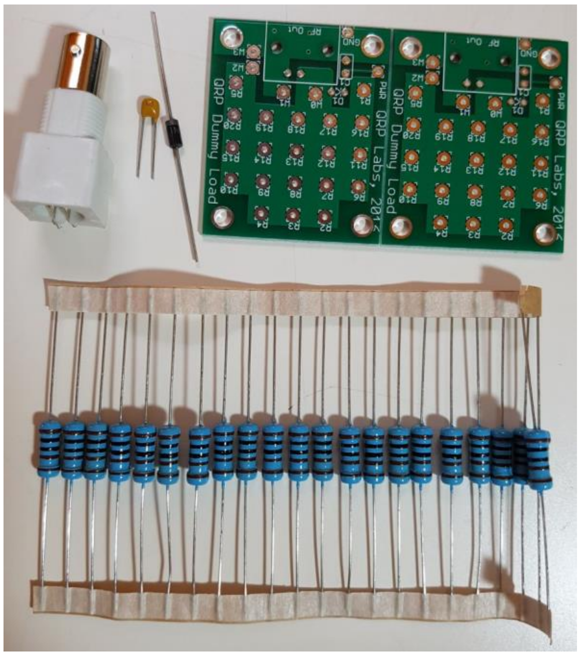
R1-R20	1K 1% 1W resistor
D1	1N4004 diode
C1	10nF capacitor
1x	BNC connector
2x	PCB (two identical PCBs are used in the kit)

3. Assembly instructions

Assembly of this kit is quite straightforward. Please refer to the layout diagram and PCB tracks diagrams below, and follow the steps carefully.







3.1 Inventory kit

First check the components in the kit, and identify each one.

Note that 22 resistors are supplied with the kit, so you will have 2 spare. The spares were just in case the kit packer made an error.

The two PCBs may be supplied joined together. There is a cut along the join. Just snap them apart along the scored join.

3.2 Fit diode D1 and capacitor C1

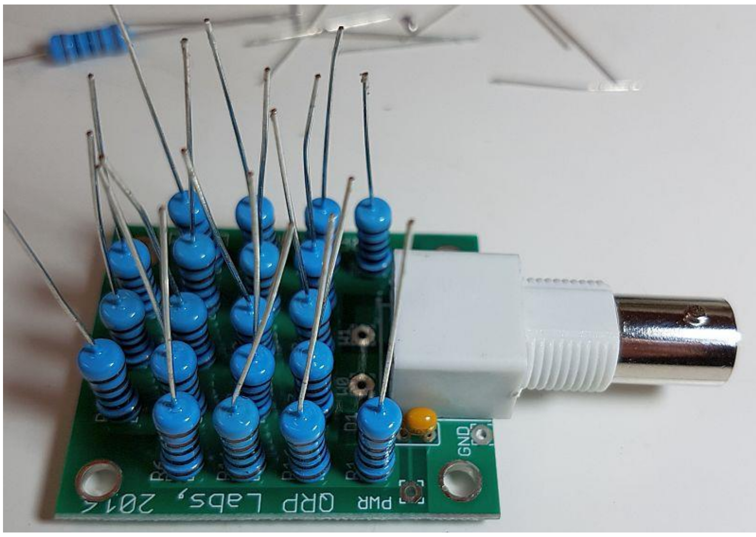
Choose one of the PCBs as the bottom PCB. Install components with the printed silkscreen up, as shown. Bend diode D1 as indicated above, so it will stand vertically when installed on the PCB. Install and solder D1 and C1.

The “RF Out” BNC connector may optionally be installed if needed. Perhaps “RF In” would have been a more appropriate label. You may wish to use this dummy load with a BNC-coax-BNC cable or adapter to your transmitter. Or you may want to install the dummy load in a box etc., in which case you may decide not to install the BNC connector.

3.3 Install R1-R20, 1K resistors

Next install and solder the 20 resistors on the bottom PCB. Push the resistor wire all the way into the hole so that the resistor body is sitting on the PCB. Minimising wire length helps reduce stray inductance which could harm the performance at high frequencies. Cut the surplus wires on the bottom side of the PCB.

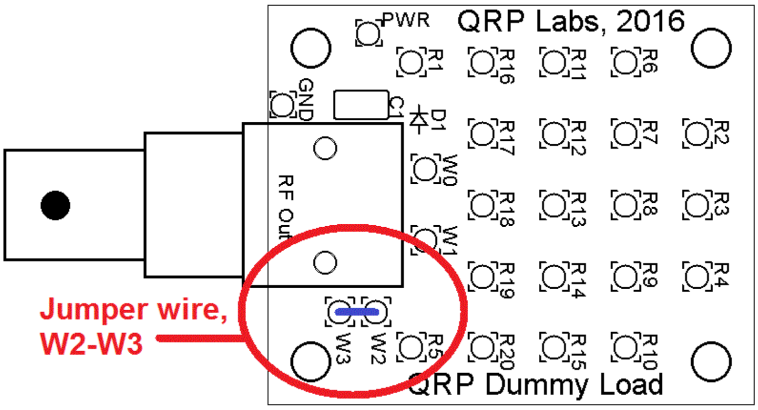
Ensure good solder joints. Remember these resistors are larger than the ones you may normally be used to, so will soak up more heat. It may need a little longer application of the soldering iron to make a good joint.



3.4 Fit jumper W2-W3 on the top PCB

Fit a jumper wire at W2-W3 on the TOP PCB only. **Do NOT fit this jumper PCB on the bottom PCB!**

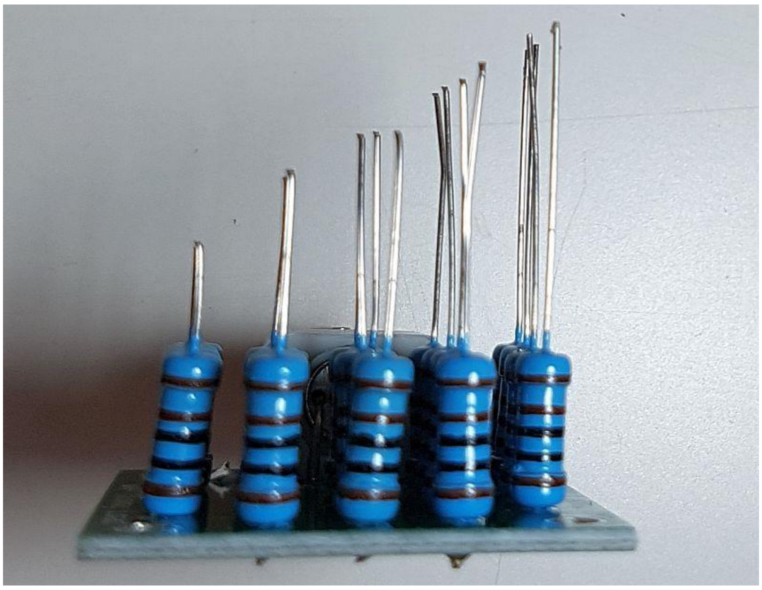
This wire connects the top ends of the parallel resistors to the ground plane around the edge of the top PCB.



3.5 Trim resistor wires to fit to the top PCB.

Now we come to what could easily have become the most difficult part of this assembly: aligning and fitting all these bent resistor wires into the 20 holes in the top PCB! Believe me, it's a very annoying and tedious job.

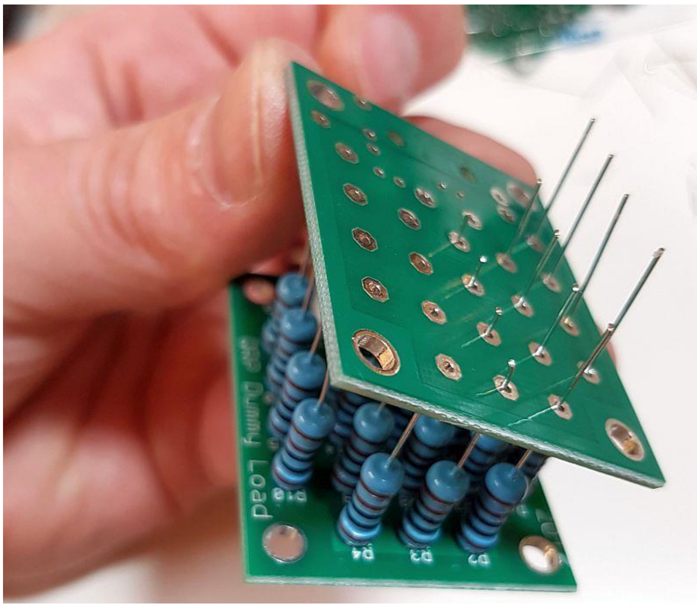
Fortunately, we came up with a life-saving solution that makes it very easy. Hold the lower PCB with the RF connector facing away from you. Cut each of the five columns of wires, at increasing lengths as shown in the photo (right). The left-most column of resistors should be about 1cm, and the right-most column leave un-cut. Interpolate, for the middle columns.

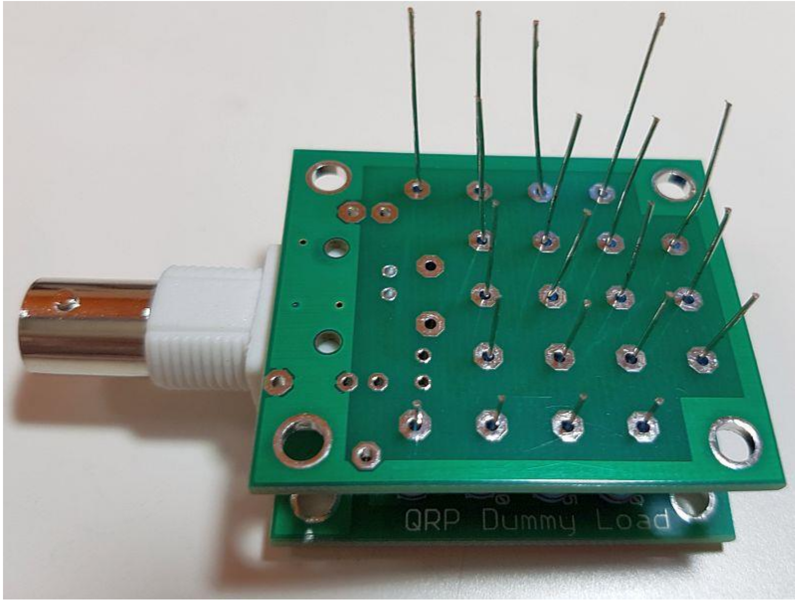


3.6 Fit top PCB to top end of resistors

Now you will see how easy it is to fit those 20 wires into the PCB holes. Make sure you have the top PCB orientated with the silkscreen printing facing DOWN, towards the bottom PCB. Refer to the photographs!

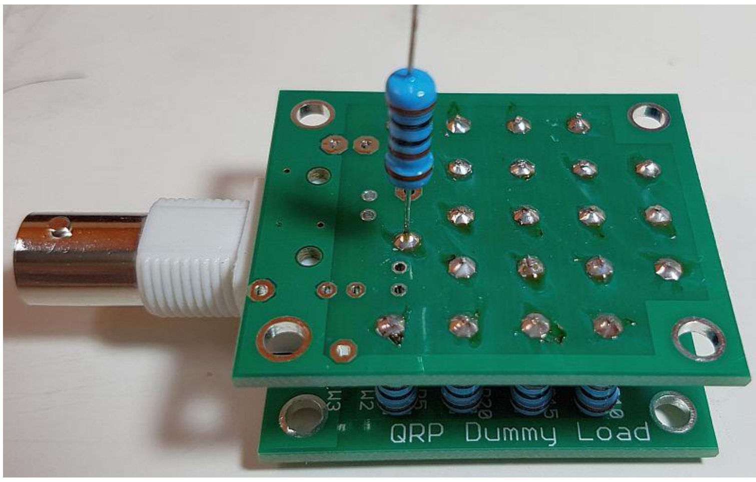
Tilt the PCB and start by fitting the right-most column (longest wires). You only need to align 4 wires! Now push the wires through so that the PCB comes to the next column of 4 wires, align them, and push into the holes. Repeat until all the five columns (meaning all 20 wires) are all in place. The process is shown below left and the end result, below right.





Now with all the wires in place, it is a simple matter to solder each wire, and trim off the excess wire with a wire-cutter. It's a good idea to solder one resistor in each corner first, then make sure that you are happy with the alignment of the two PCBs before soldering the remaining 16 resistors. The PCBs look nicer if they are properly parallel to each other!

3.7 Fit final jumper wire connection



The final and very important step, is to fit a wire connecting the resistor ends on the top PCB, to the groundplane of the bottom PCB! Without this, there is no connection from the resistor end to the ground of the BNC socket!

The easiest way to do this is to use one wire of one of the spare resistors. It seems easiest to fit this jumper wire once ALL the other components are soldered in place, in this PCB sandwich.

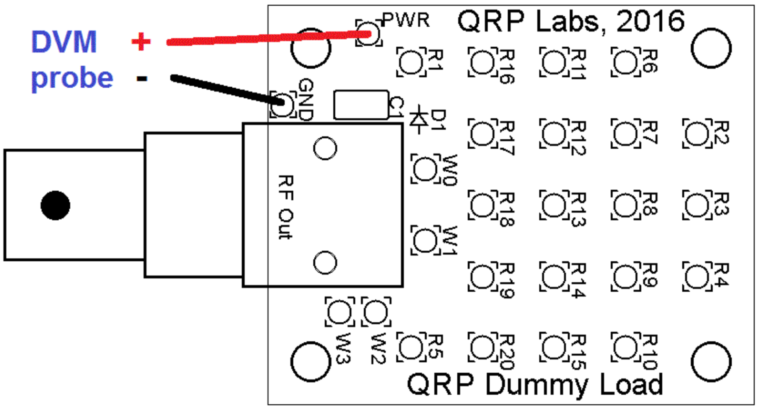
Be sure to insert the resistor straight through vertically, from the correct hole on the top PCB (labelled W0) to the correct hole on the bottom PCB (labelled W1). When the identical PCBs are orientated this way, with their silkscreen printing facing each other, you will see that W0 on the top PCB lines up perfectly above W1 on the bottom PCB! Be careful not to fit anything in W1 on the top PCB, or W0 on the bottom PCB!

Refer to the photograph (above right) for clarification.

4. Dummy load use and power measurement

The power meter is now ready to use!

Note that the resistor ends soldered on the exposed (bottom) side of the lower PCB are connected to the RF centre pin of the RF connector. The resistor ends soldered to the exposed (top) side of the upper PCB are connected to Ground of the RF connector, and the ground-plane surrounding the edge of both PCBs, and the tinned holes in the corners of the PCBs.



To connect a DVM (or moving coil meter) to measure power, connect the DVM probes to the “PWR” and “GND” pads labelled on the bottom PCB (where you fitted D1 and C1).

The voltage measured is the peak voltage. Theoretically you can use this to calculate the power using

Power = peak voltage * peak voltage / 100).

For example, if you measure a peak voltage of 20V, then the power is 4W.

HOWEVER, this is NOT an accurate power measurement circuit! It will give a useful indication of relative power but if you want accuracy, you will need to calibrate it carefully against an accurate power meter. The silicon diode (1N4004) has a nominal voltage drop of 0.6 or 0.7V. But this varies from one device to another. Furthermore it varies depending on the current through the diode, which itself is going to depend on the resistance of your DVM input. There is an RC-filtering action happening too as a result of the capacitor in the circuit, and so there is frequency dependence too.

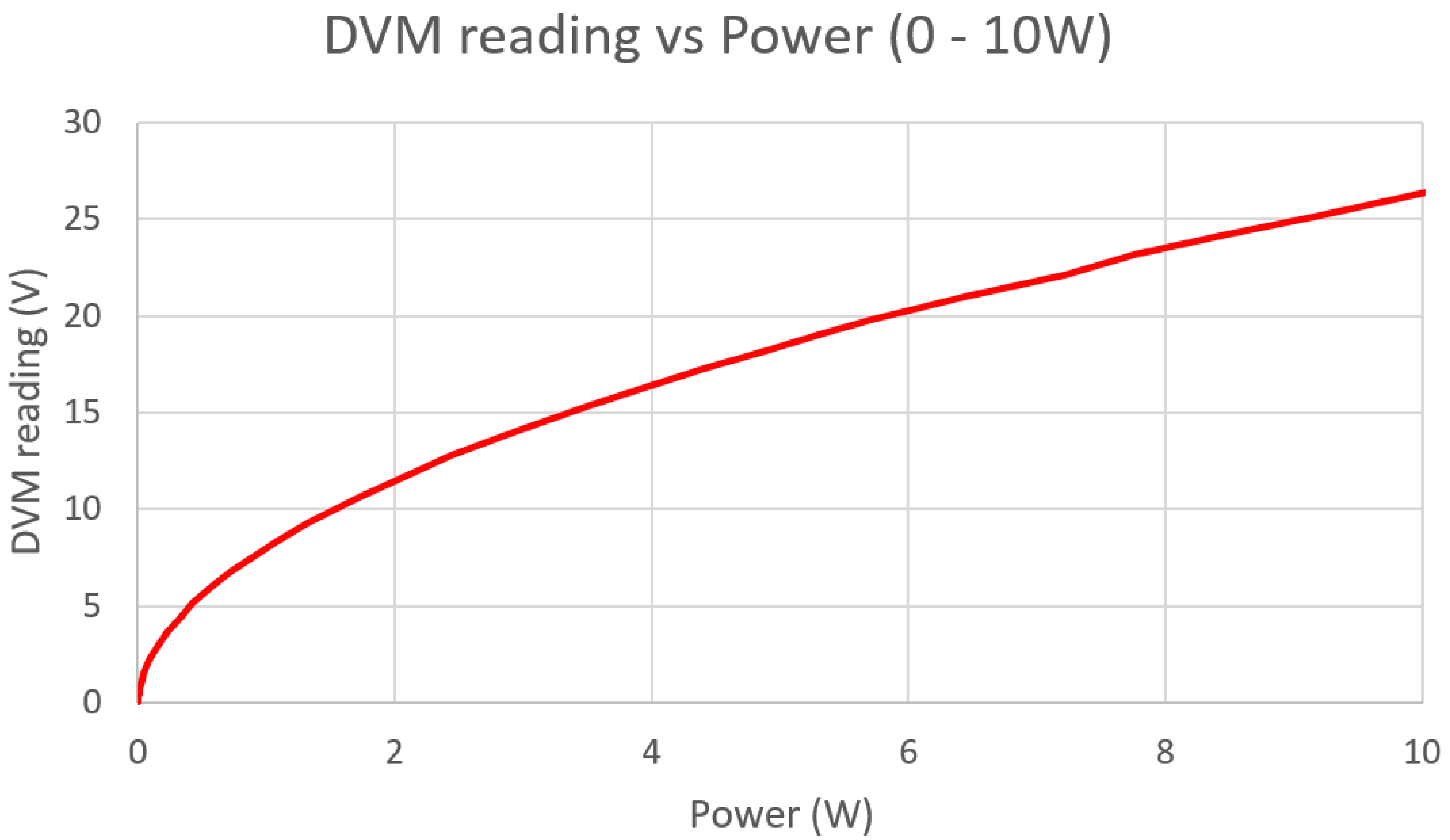
So as I said – do not expect miracles, this power meter can give you an indication of output power but it nowhere near accurate or consistent.

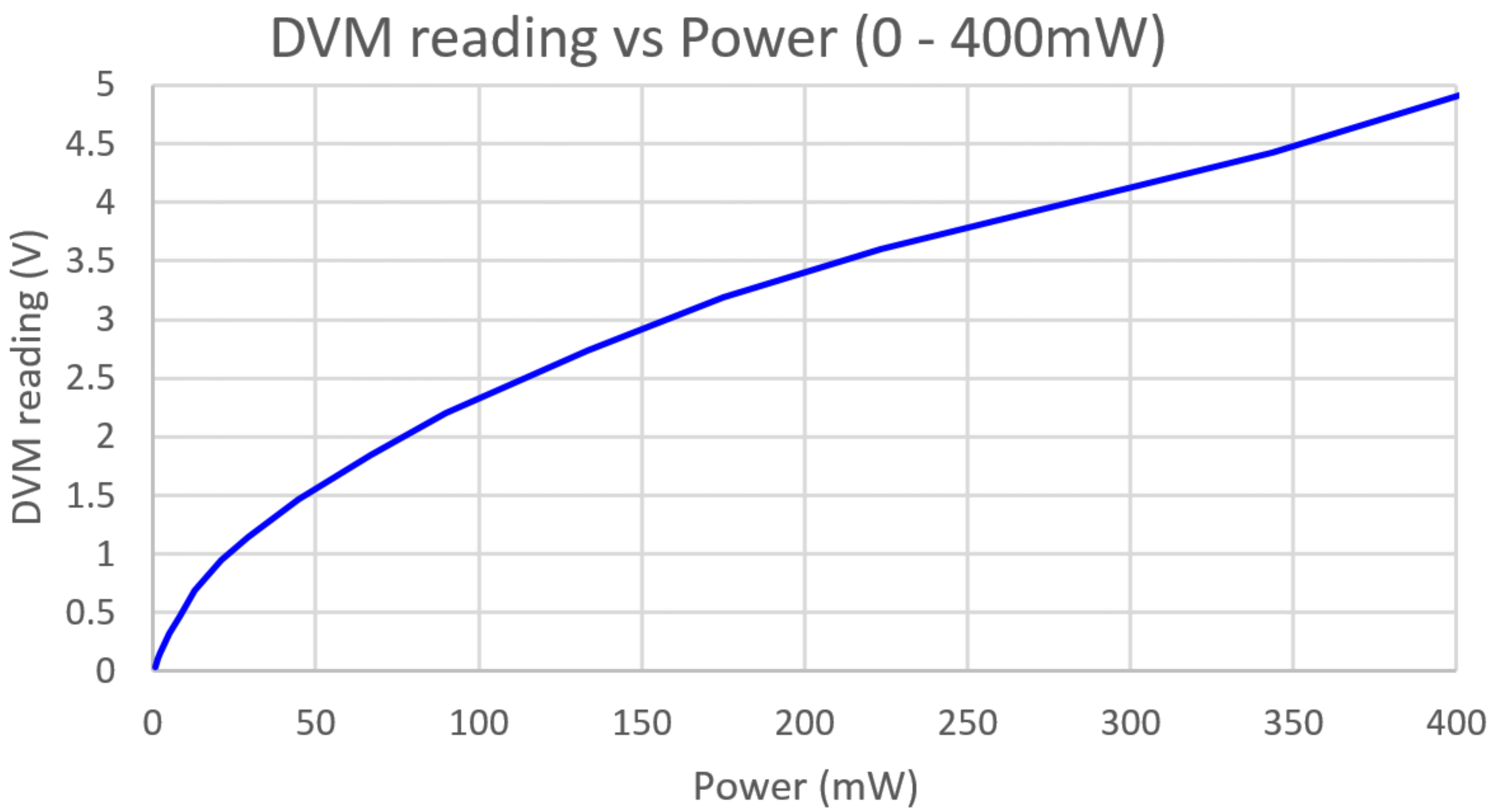
As an example of what to expect, the following graphs show my measurements of one dummy load kit tested here (and photographed during construction, for the illustrations in this assembly manual). The measurements were made at 10MHz, and using RF power varied from 0.8mW to 10W. A QRP Labs 30m LPF was used following the power amplifier, with the dummy load connected at the output of the 30m LPF. The DVM measurement used a very inexpensive DVM (the ubiquitous yellow type, costing a few $), and the “accurate” power measurement was made with the peak-peak measurement function of a 100MHz bandwidth digital oscilloscope.

The first graph (red) shows the full measurement made from 0.8mW to 10W.

The second graph (blue) shows exactly the same measurement data but zooms in on the very low power region 1 to 400mW.

Again a reminder: these measurements are an EXAMPLE only. Results will vary from device to device, and with some frequency dependence too. Do not expect an accurate power measurement with this simple method, unless you calibrate with a known accurate power meter.





5. Resources

Please see the kit page http://qrp-labs.com/dummyload for information and latest updates.