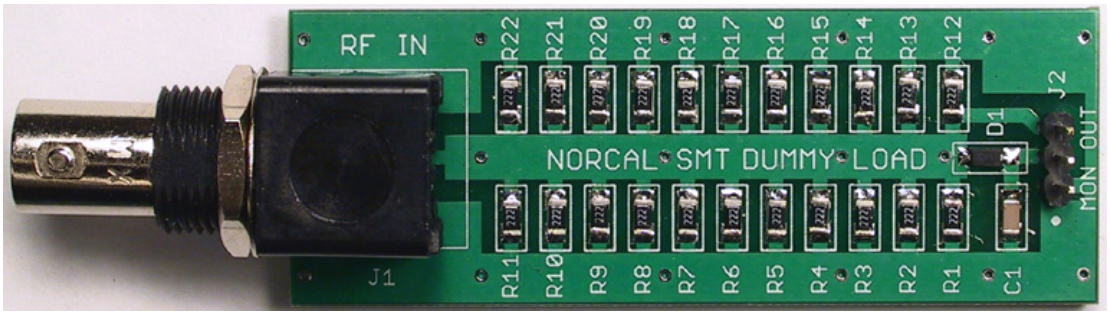
The NorCal
SMT Dummy Load
Assembly and Operating Manual

Rev. 1.0

January 4, 2005



1. Introduction

The NorCal SMT Dummy Load is a practice kit for anyone wishing to gain some experience working with Surface Mount Technology (SMT). The kit uses 44 2.2K resistors in parallel to result in a 50 Ohm load. You can put it together in an hour or less. When you're finished, you'll have a compact QRP dummy load that you can also use to measure output power. An on-board Schottky diode rectifies the RF voltage and provides a peak detected output. It will provide an accurate power measurement from about 0.5W and up. You can also connect the NorTex Accuprobe for accurate low power measurements down to 50 microwatts. The kit includes all of the necessary components, and the manual will guide you through SMT assembly.

A special thanks goes to Tony Parks, KB9YIG, who graciously permitted NorCal to duplicate his design.

2. Specifications

Board Dimensions	2.75" x 1"
Weight	0.7 oz.
Power Handling	10 Watts for 1 minute 5 Watts for 3 minutes
Input Impedance	50 Ohms +/- 5%
Usable Frequency Range	DC to >150 MHz
Outputs:	1. Peak detector DC output: 1 – 10 Watts 2. RF monitor output for precision low power measurements with external detector

3. Assembly Notes

The NorCal Dummy Load uses mostly SMT (Surface Mount Technology) components and can build it in about an hour or less. After you gain some experience soldering the first few surface mount components, you'll be able to finish the kit with confidence. Here's a list of the basic tools and equipment you'll need:

1. .015" diameter rosin core solder
2. A temperature-controlled soldering iron
3. Small diameter soldering iron tip
4. Solder wick
5. Tweezers
6. A cookie sheet with ¾" raised sides to avoid losing parts
7. Headband or illuminated magnifier
8. Adequate lighting, the brighter, the better
9. Masking tape to hold the board during assembly
10. Mutlimeter

Lead-based solder is being phased out, but 60/40 or 63/37 tin/lead rosin-core, 0.015" diameter solder is suitable for installing the surface-mount components in this kit. You can use .025" diameter solder for the thru-hole components. Silver-bearing solder is also acceptable, but not necessary. ***Under no circumstances should you use solder with an acid-core flux***.

A 700^{o}F tip temperature works very well for soldering SMT components. It allows a minimum contact time before the solder flows into the joint. A cooler tip temperature requires a longer contact time which can damage a component.

The parts on the board are spaced wide enough apart to make solder bridges unlikely. But, if a mistake happens, you can always remove the excess solder with solder wick.

Tweezers come in many sizes and tip shapes. Mouser sells Erem EROP2ASA round point tweezers for $3.35, and they're a worthwhile investment if you plan to assemble more SMT kits in the future. They're comfortable to hold and have a flat face that really holds the components.

The need for good lighting and magnification can't be overemphasized. A pair of 100 Watt incandescent lamps on either side of the work surface is a good choice for most people. For magnification, I use inexpensive headband magnifiers because they provide 3D viewing and have a basic magnification of 2.2x. Extra flip down lenses increase it up to 10x. The highest power is necessary for inspecting IC soldering. A good quality jeweler's loupe can be purchased for less than $15.00. A popular online auction lists these and the headband magnifiers.

The concept of a solder side and component side doesn't readily apply to the NorCal SMT Dummy Load because parts are mounted on both sides of the board. Instead, we'll refer to Top and Bottom sides. The Top side has "NORCAL SMT DUMMY LOAD" silkscreened in the center of the board. Outlines for the BNC connector and the 3 pin output connector are also silkscreened on this side.

The assembly instructions below are organized to permit ease of component installation. You should follow the steps in order. The silkscreen component outlines indicate the component locations and orientation. Appendices B and C contain magnified component layouts of the Top and Bottom sides, respectively.

It's strongly suggested you build the kit inside a cookie sheet to avoid losing parts. Extra resistors are supplied, but there's only one diode and capacitor. We'll be installing the resistors first, so losing one isn't a problem. Assembly will start on the Top Side. Orient the board with J1 at the top, as shown in Figure 1. Tape the board to your work surface.

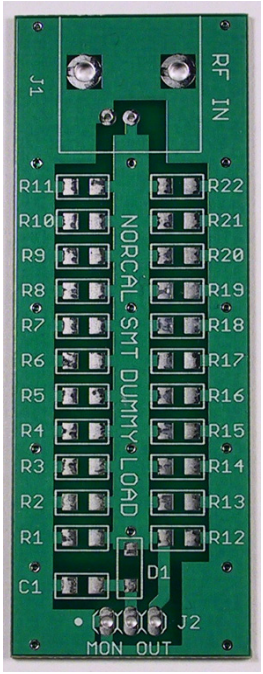


Figure 1. Top Side Orientation

4. Assembly

- ❑ Apply a small amount of solder to the right pad of R1, as shown in Figure 2.

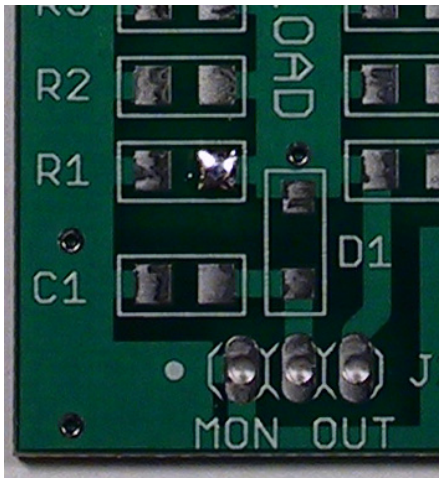


Figure 2.The Right Amount of Solder at R1

- ❑ Remove one 2.2K resistor from the strip. Peel back the plastic strip just enough to let one resistor fall out.

- ❑ Place the resistor on top of the right solder pad at R1 with the numbered side facing up, as shown in Figure 3.

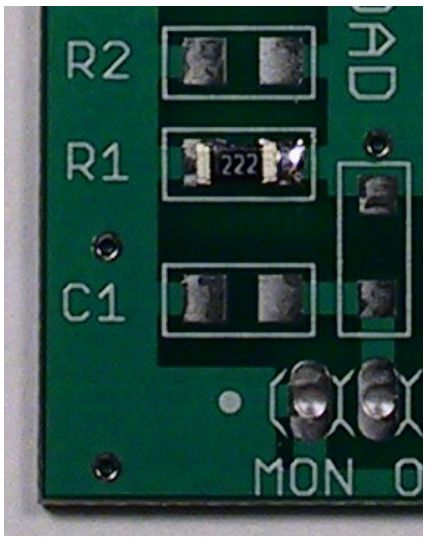


Figure 3. Correct R1 orientation

- ❑ Using tweezers, press down on the part and heat the right pad until the solder melts and the resistor sinks down. If the part shifts, reheat the joint and reposition R1 until it resembles Figure 3.

- ❑ Now heat the other pad and apply just enough solder so that it wets both the pad and the resistor body. This joint should resemble the first one.

- ❑ Set your multimeter to the Ohms function and measure the resistance across pins 1 and 3 of J2, the outer pads. You should read close to 2.2K. If it's greater than 2.5K, reheat each joint, one at a time, and recheck.

- ❑ Now repeat the previous 5 steps for R2 – R22.

- ❑ Check the resistance across the output pins of J2. It should be within 5% of 100 Ohms.

- ❑ Install the 0.01uF capacitor at C1.

- ❑ Install the 1N5711W at D1. The striped end faces J2.

- ❑ Turn the board over and tape it down. Install the 2.2K resistors at R23 through R44. Extras are provided in the kit in case you lose one.

- ❑ Remove the board from the cookie sheet. And install the BNC connector at J1.

- ❑ Check the resistance at the BNC connector. It should be 50 Ohms, +/- 5%. Two prototypes measured 50.4 and 50.5 Ohms, well within this tolerance.

- ❑ You can install your favorite 3-pin header at J2, or attach wires to pins 1 and 2 for monitoring the detector output with your voltmeter.

5. Power Measurements

The built-in detector provides useful power measurements from less than 1 watt to greater than 10 watts. The DC output appears between J2 pins 1 and 2. Pin 1 is ground and identified with a white dot in the silkscreen. Figure 4 graphs the prototype unit's DC output level at various power levels. A digital voltmeter with an 11 Megohm input resistance was used to make the measurements. You can use this graph directly to determine output power, or make up your own calibration chart. The diode is rated for 70 volts. This means that you shouldn't put more than 12 watts into the dummy load to prevent damaging D1.

The detector nonlinearity is obvious below 1 watt. To make accurate low power measurements, you'll need to use a compensated detector, such as the North Texas QRP Club Accuprobe. Connect the probe tip to J2 pin 3. You can find more Accuprobe information at:

http://www.kk5na.com/kk5na_files/accuprobe.htm

The Dummy Load was swept up to 30 MHz and the SWR was immeasurable. Tests at 6m and 2m also showed no reflected power.

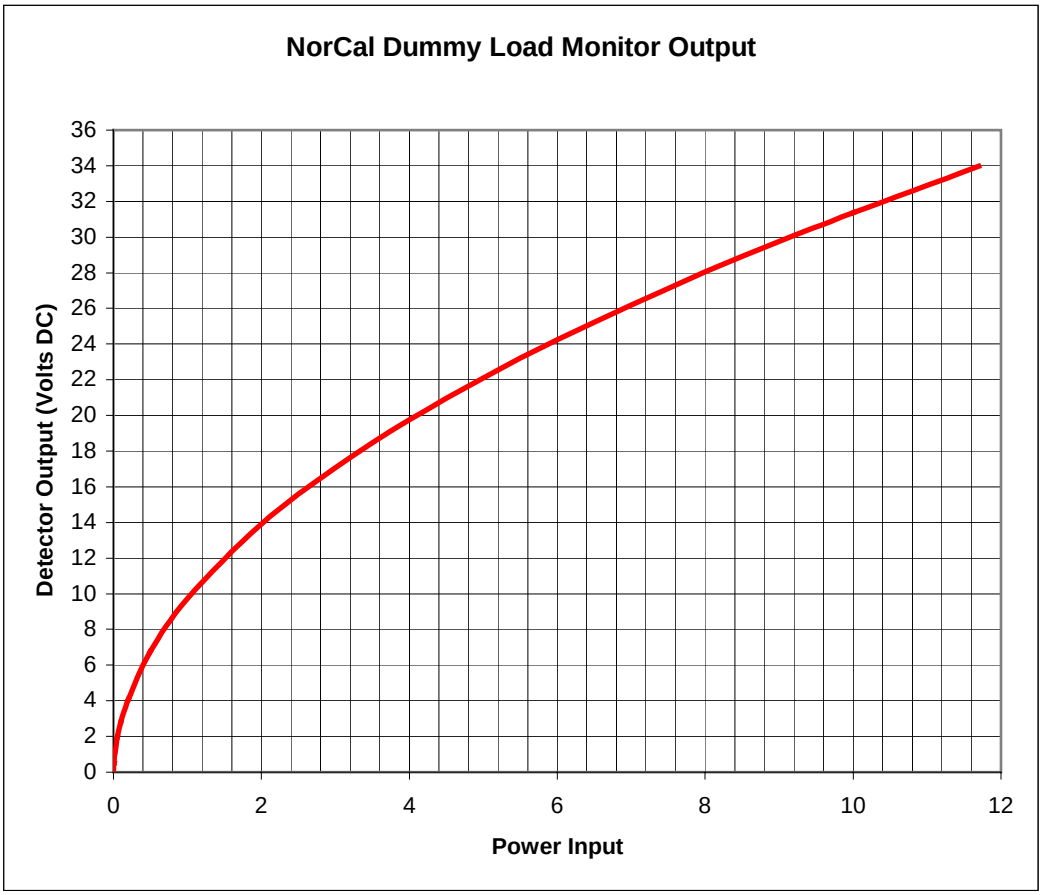
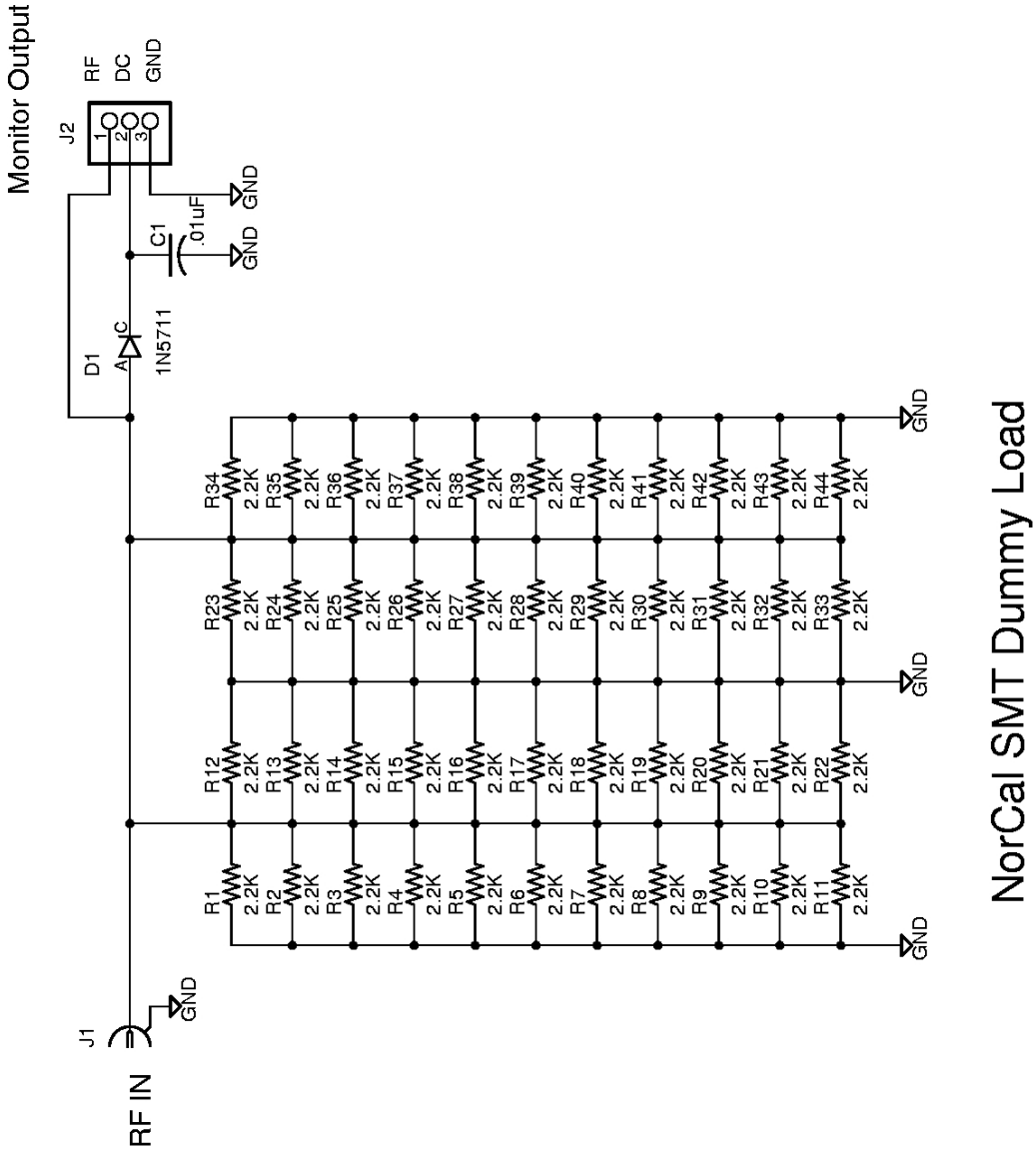
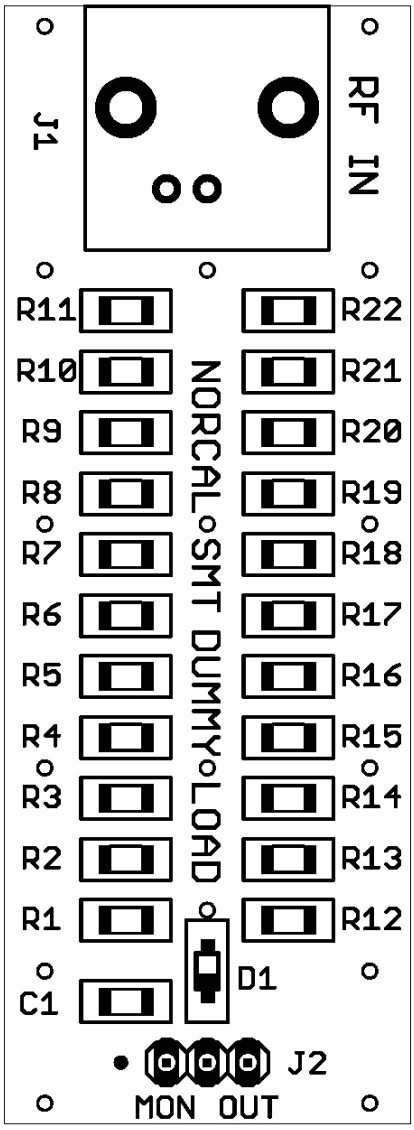


Figure 4. Typical Detector Voltage vs. Input Power

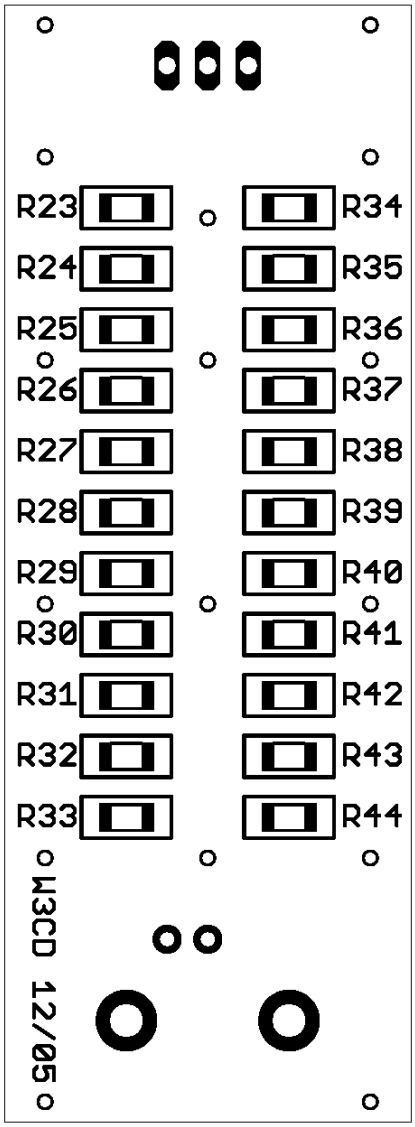
APPENDIX A. Schematic



APPENDIX B. Top Side Component Layout



APPENDIX C. Bottom Side Component Layout



APPENDIX D. Parts List

Item	Qty	Ref. Des.	Value	Description
1	44	R1 – R44	2.2K	1206 2.2K 1/4W
2	1	D1	1N5711W	SOD123 Diode
3	1	C1	0.01uF	1206 ceramic cap
4	1	J1	N/A	BNC connector
5	1	J2	N/A	3 pin header – User supplied
6	1	Board	N/A	NorCal SMT Dummy Load