Build a simple HF/VHF 100W dummy load

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Every radio amateur should own a dummy load. The one described here is capable of dissipating 100 Watts for short periods of time and provides a low power 50Ω port suitable for connecting a receiver or spectrum analyser for station monitoring.

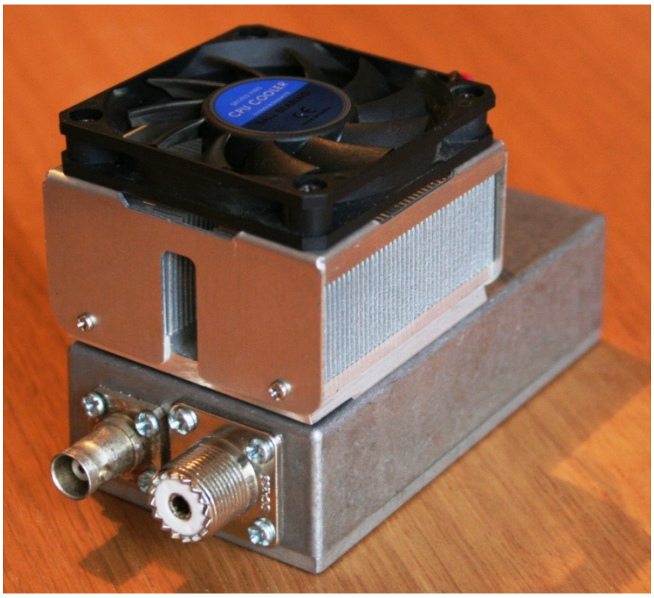

Figure 1 - Compact Dummy Load

A common approach is to connect multiple resistors parallel; for example twenty 1kΩ 2 Watt resistors in parallel can provide a 40Watt 50Ω load. This approach works well but can be physically large and requires a lot of wiring.

Some amateurs increase the thermal capacity by immersing resistors in cooking oil or similar. Another approach is to pour saltwater into a jar and adjust the salinity and metallic contact area until 50 Ohm is achieved. These methods are potentially messy and dangerous if care is not taken - pushing hundred of watts into a small container full of fluid could result in high temperatures.

Figure 2 - Thick Film Resistor

The approach described here extracts and dissipates heat using air cooling. Suitable heat sink mountable devices are widely available. I used two 100Ω 'Thick Film' power resistors rated at 30 Watts each and connected in parallel. These devices are available from Farnell Electronics and cost approximately £2.96 each (Order Code: 1357077). But be aware, the power rating is only valid if the devices are properly fitted to an adequate heat sink. Without the heat sink, the resistors will only dissipate a few watts. The data sheet suggests a heat sink with thermal resistance of 4.2 °C/W or lower should be sufficient. I used an old heat sink from a CPU with built in fan costing £2 second hand from a junk shop. I am not sure of the thermal resistance rating but it seemed adequate. Take the usual precautions to de-bur the mounting holes and use heat-sink compound to mount the resistor to the aluminium.

The circuit diagram is unremarkable. The 4.7 kΩ resistor provides a theoretic 39.55 dB insertion loss assuming a 50 Ohm system. The tap off point provides a means to connect a spectrum analyser or second receiver to monitor and set up the transmitter and also the means to measure power.

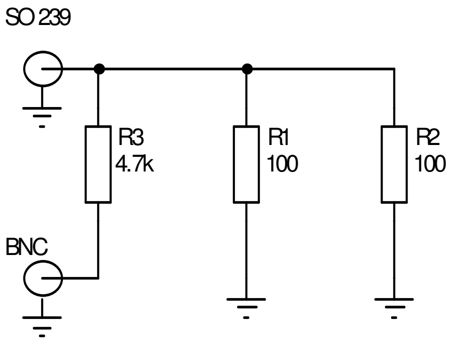

Figure 3 - Circuit diagram

How well does it work?

The project was originally designed for HF use but with careful construction, performance can easily be extended to VHF. Without special care and using SO239 sockets, the frequency response of the load extended beyond 144 MHz. Above 160 MHz, stray inductance and capacitance in the wiring causes resonances. For really good frequency response, a better approach is to use a coax-terminated 'N' type bulkhead mounted connector and extend 50 Ω coax all the way to the resistors. If the leads are kept very short, performance up to 1 GHz may be possible. The following plot details the frequency response and was made by measuring the return loss using a directional coupler.

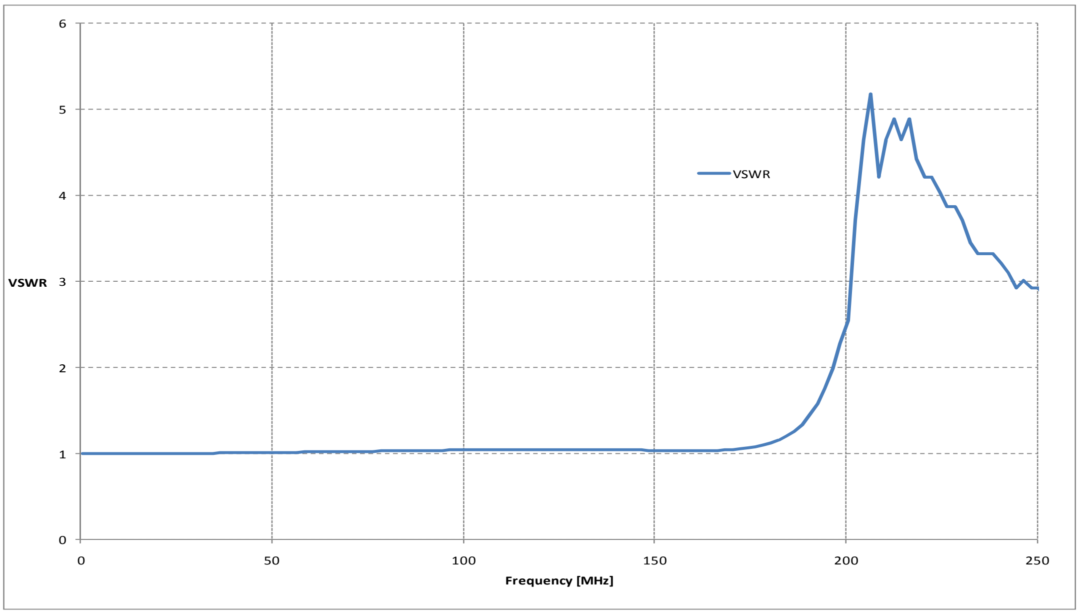

Figure 4 - VSWR plotted against frequency

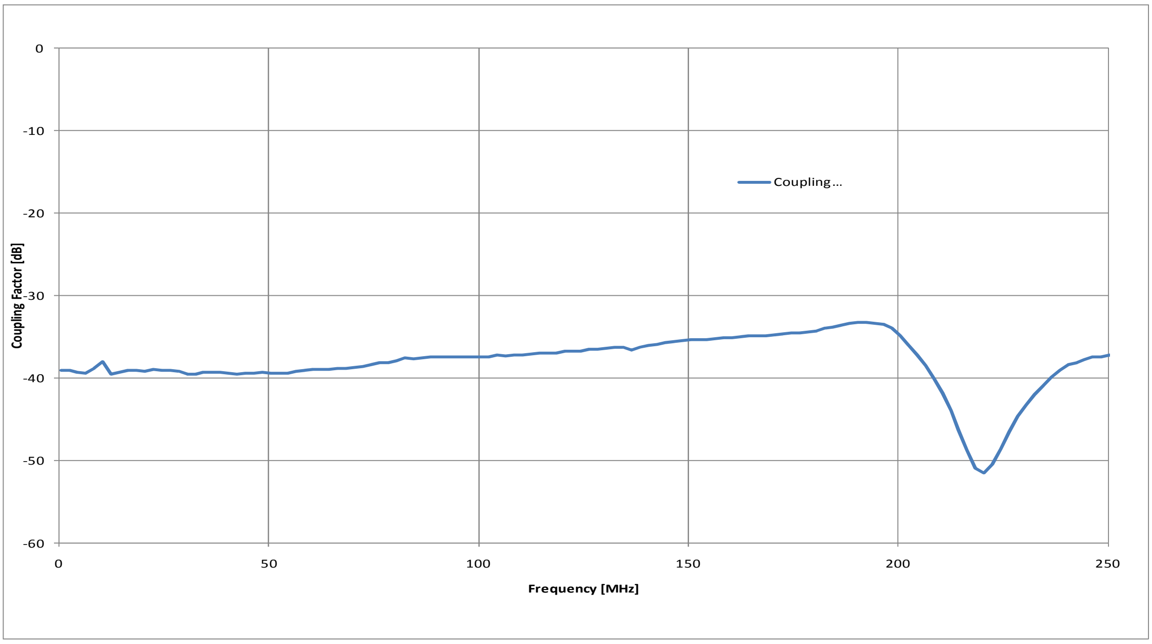

Figure 5 - Coupling function {dB}

The insertion loss function (Figure 4) behaves as expected with approximately 39.7 dB at low frequencies. Interestingly, the insertion loss decreases steadily with frequency which is presumably due to very small capacitive coupling between the input and output sockets which, in this case, are only about 2 cm apart.

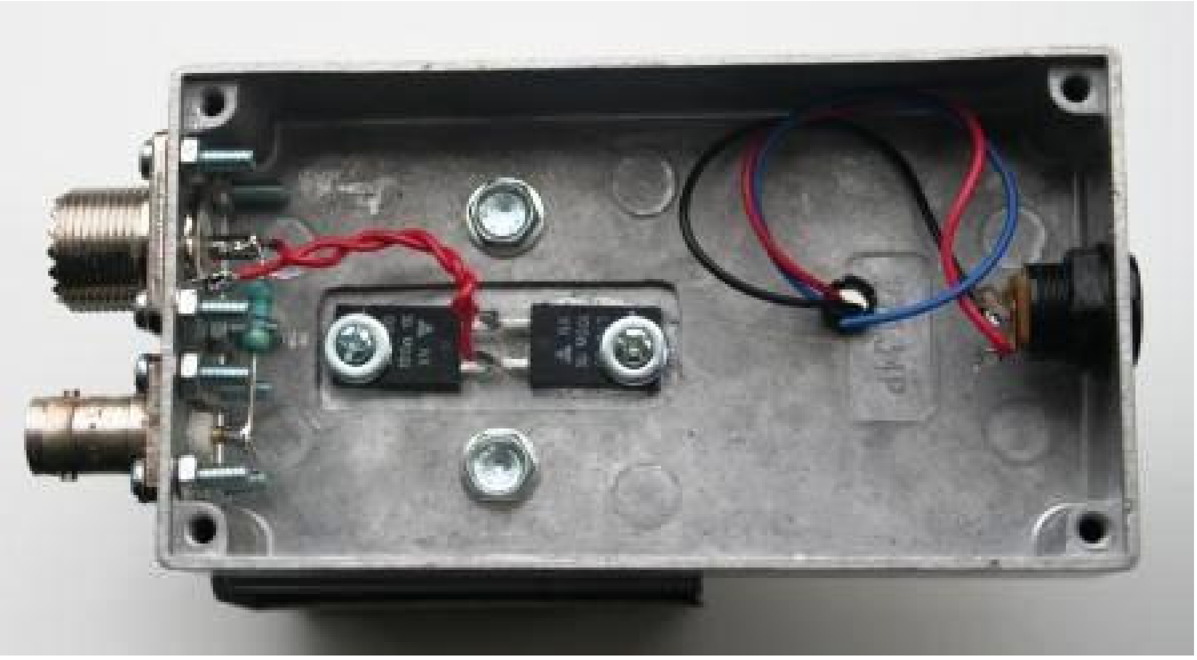

Figure 6 - Underside wiring

Care needs to be taken to keep the wiring short; extend the coax socket using a twisted pair. Better still; maintain a coaxial connection all the way through to the load resistors.

Higher power loads can be fabricated by using more resistors in parallel or alternatively by using a combination of series and parallel connections. It may be more difficult controlling stray reactance at VHF/UHF in these cases.

The resistors need to be mounted directly onto the heat sink using thermal grease. I attached the base of the heat-sink to the die cast box using self tapping screws that holds firm and also helps transfers heat to the box surface.

The fan is a standard 12V three wire device that normally plugs into a CPU fan power plug on the motherboard. The third wire is a tachometer output derived from a coil in the fan that enables the CPU to monitor speed. It is not required and is left disconnected. The fan wiring is: RED = +12 V; BLACK = -12V.

Thermal Considerations

The question is: how hot does it get? The specification states that the absolute maximum temperature for the resistors is 150°C, which is very hot! I decided to investigate the heat rating of the load by injecting power and measuring the resulting increase in temperature of the resistor body. I did this twice: once with the fan running and again with the fan switched off. I used a garden thermometer with the bulb touching the resistor body via thermal grease, which is all a bit crude and cheerful.

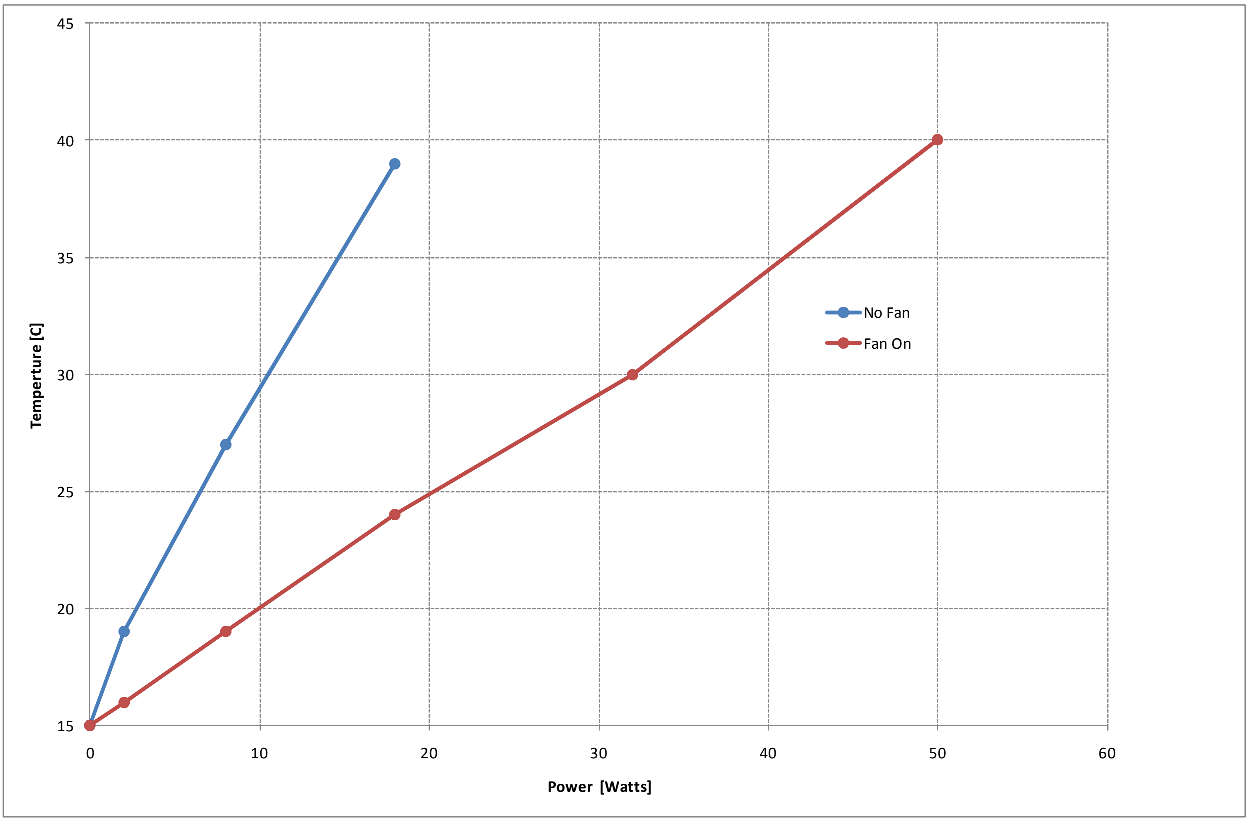

Figure 7 - Thermal Capacity

I had to stop at 40°C because my thermometer only went that high. Accepting the crudeness of the method, the thermal resistance of the load in 15°C ambient is approximately 1.3°C/W without the fan running and 0.5°C/W with the fan spinning at full speed. Clearly the fan makes a big difference and is worth including. This implies that 120 Watts RF output will drive the resistors to approximately 75°C if maintained over several minutes. In practice SSB at 100Watts in short bursts warms the resistors but not significantly - you can still touch them without discomfort.

This has proved to be a very useful and 'cool' project in more than one sense. I plan to try a very high performance CPU heat sink with heat pipes and large diameter fans just to see how much power can be pumped into a single resistor. Clearly another project in the making!

73's

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