Simple dummy loads for rig testing at HF and higher frequencies

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Some 10 years back, the design and manufacture of a good high-power dummy load typically involved a detailed study of how to incorporate a large, nichrome film, tubular pyrex glass resistor into a 50 ohm transmission line, and get rid of a lot of heat at the same time.

Today, it is much easier. A search of eBay or AliExpress using the search term *50-ohm dummy load* will reveal a number of resistors with very low stray inductance specifically made for use in radiofrequency (RF) loads. These are typically available in 50, 100, and 200 ohm values, with power ratings of 100 or 250 watts, and are mounted on flat metal plates with mounting centres that match the mounting screw spacing on SO239 and N-type RF panel-mount connectors. Even better, their price is typically AU$6.00 or less!

These are thin-film resistors that are enclosed between two insulating plates of aluminium nitride which, in turn, are thermally bonded to a metal mounting plate. Aluminium nitride is both an excellent electrical insulator and a great heat conductor, which is second only to beryllium oxide (BeO) in its thermal properties. However, unlike BeO, which is horribly toxic, aluminium nitride is intrinsically safe when properly handled.

Properly mounted, with heatsink paste and very short leads, such a "250 watt" resistor will provide an excellent dummy load with a rating of least 100 watts, with a frequency response flat to around 2 GHz. Of course, the 250 watt rating is only valid at 25° C and must be significantly de-rated for operation at higher temperatures.

These resistors are typically sold on AliExpress under the brand name

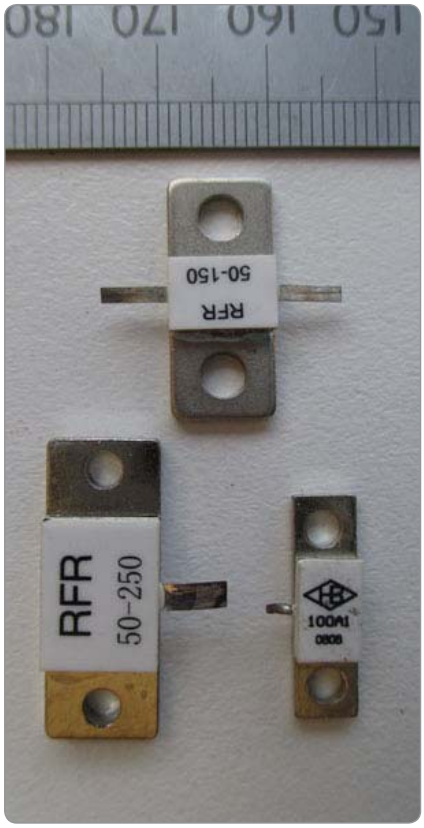

Photo 1: Thin-film, high-power rated resistors suited for making simple dummy loads for rig testing.

RFR and have two basic styles. In one type, the resistor element is earthed at one end via the metal mounting plate and so only has one connecting tag. The second type features a completely floating thin film resistor and has two connecting tags.

Although RFR provides no data for the breakdown voltage between the thin-film resistor and its mounting plate, the maximum on any one resistor is about 223 Vp. A check with a1500 V megger reveals that the breakdown voltage is above that. So, these two-tag resistors are ideal for use in a series chain of resistors where part of the chain is at a RF voltage well above

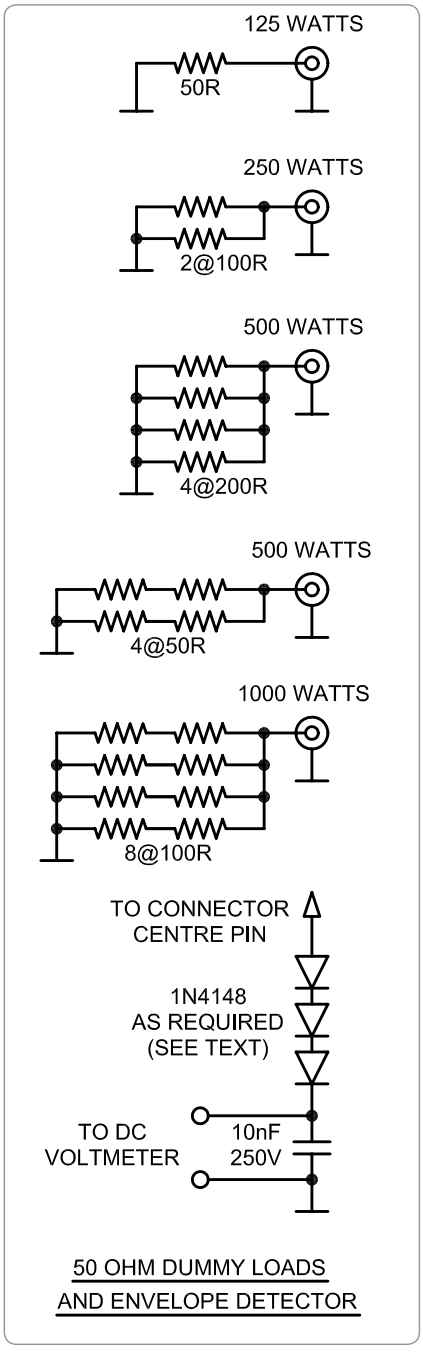

Figure 1: Ways to achieve wanted load ratings.

ground. As the peak voltage existing at a power level of 1000 watts in a 50 ohm system is 316 volts, there

Photo 2: A heatsink, a coax socket and a thin-film resistor – it's simple, alright.

Photo 3: Multiple resistors in series/parallel arrangements enable high power rated dummy loads. The addition of a diode envelope detector, as per Figure 1, enables voltage measurement related to power, as per Table 1.

is a BIG safety margin. Figure 1 shows how various combinations of these "250 watt" resistors can be connected to form 50 ohm loads with different power ratings.

Adding a useful feature

A very useful feature to add to such a load is a peak-responding envelope detector. This allows load power to be easily measured using a standard high impedance analog multimeter and can thus be used to check SWR/power meters. Some digital multimeters may not withstand the high RF environment, may give erroneous readings, or fail permanently. The load with detector can also be turned into a cheap and very accurate power meter by permanently adding a series resistor and appropriately calibrated analog meter. For powers up to 100 watts, use three 1N4148 diodes in the detector; powers up to 500 watts need at least five 1N4148 diodes. The ceramic capacitor should have a rating of at least 500 Vdc. Power in 50 ohm systems can be read from Table 1, or can be calculated accurately from the following relationship:

Power (watts) = $(V_{peak}$ + diode drop$)^2$ /100

Where: V_{peak} = peak dc meter reading
diode drop = no. of diodes x 0.7 V

- diode drop of 0.7 Vdc is approximate, it may be lower. Note that this formula is only correct for symmetrical waveforms (e.g. carrier without modulation).

DC VOLTMETER READING	WATTS OUT
29.5	10
42.6	20
52.6	30
61.1	40
68.6	50
75.4	60
81.6	70
87.3	80
92.9	90
97.9	100
109.7	125
120.4	150
130.2	175
139.3	200
156.0	250
171.1	300
185.0	350
197.9	400

Table 1: Use this table to read off power into the load.

Heatsinks

Heatsinks have two important properties: these being their thermal resistance to the ambient environment, and their thermal mass. The first is specified in degrees Celcius per watt (°C/W) and is determined by the surface area of the heatsink and the conductor cross-section used to get the heat away from the place it is generated and out to the place where it will be dissipated to atmosphere. A good heatsink will thus have many fins, each being fed by metal of heavy cross-section. The thermal resistance of such a heatsink can be massively reduced by a small fan blowing air through the fins.

The thermal rating in °C/W becomes most important when a load dissipates continuous power. Note that very few sinks have thermal resistances in free air of less than 0.5° C per watt (check out Jaycar and Altronics). Four hundred watts of continuous power will therefore raise the temperature of such a heatsink by 200 Centigrade!! Fans and other techniques of conducting heat away hence become mandatory under these conditions.

The second property is the thermal mass (almost never specified). Simply put – the larger and more conductive the lump of metal is, the smaller the temperature rise will be for a short-term blast of power, independent of whether fins are present or not. Thermal mass is most important in low duty cycle applications.

For most amateur work, the heatsinks shown in the photos are excellent for short-term, very intermittent tuning up (under 20 seconds) at powers up to 400 watts. Typical dimensions are 150 x 105 x 40 mm, with a weight of 500 grams. For continuous power, either use a larger heatsink, add a fan, or a bucket of water.

AMSAT-VK

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About AMSAT-VK

AMSAT-VK is a group of Australian amateur radio operators who share a common interest in building, launching and communicating with each other through non-commercial amateur radio satellites. Many of our members also have an interest in other space based communications, including listening to and communicating with the International Space Station, Earth-Moon-Earth (EME), monitoring weather (WX) satellites and other spacecraft.
AMSAT-VK is the primary point of contact for those interested in becoming involved in amateur radio satellite operations. If you are interested in learning more about satellite operations or just wish to become a member of AMSAT-Australia, please see our website.

AMSAT-VK monthly net
Australian National Satellite net

The Australian National Satellite Net is held on the second Tuesday of the month (except January) at 8.30 pm eastern, that's either 9.30 or 10.30Z depending on daylight saving. Please note we will be taking check-ins from 8.20pm-ish. Check-in starts 10 minutes prior to the start time. The AMSAT-VK net has been running for many years with the aim of allowing amateur radio operators who are operating or have an interest in working in the satellite mode, to make contact with others in order to share their experiences and to catch up on pertinent news. The format also facilitates other aspects like making 'skeds' and for a general 'off-bird' chat. Operators may join the net via EchoLink by connecting to either the *AMSAT* or *VK3JED* conferences. Past experience has shown that the VK3JED server offers clearer audio. The net is also available via IRLP reflector number 9558. In addition to the EchoLink conference, the net will also be available via RF on the following repeaters and links.

In New South Wales
VK2RBM Blue Mountains repeater on 147.050 MHz

In Queensland
VK4RRC Redcliffe 146.925 MHz -ve offset IRLP node 6404 EchoLink 44666

In South Australia
VK5TRM, Loxton on 147.175 MHz
VK5RSC, Mt Terrible on 439.825 MHz IRLP node 6278, EchoLink node 399996

In Tasmania
VK7RTV 2 m. Repeater Stowport 146.775 MHz. IRLP 6616

In the Northern Territory
VK8MA, Katherine on 146.750, CTCSS 91.5, IRLP Node 6800

We are keen to have the net carried by other EchoLink or IRLP enabled repeaters and links in order to improve coverage. If you are interested in carrying our net on your system, please contact Paul via email. Frequencies and nodes can change without much notice. Details are put on the AMSAT-VK group site.

Become involved

Amateur satellite operating is one of the most interesting and rewarding modes in our hobby. The birds are relatively easy to access and require very little hardware investment to get started. You can gain access to the FM 'repeaters in the sky' with just a dual band handheld operating on 2 m and 70 cm. These easy-to-use and popular FM satellites will give hams national communications and handheld access into New Zealand at various times through the day and night. Currently only SO-50 is available.

Should you wish to join AMSAT-VK, details are available on the web site or sign-up at our group site as above. Membership is free and you will be made very welcome.

Silent Key — John Ward VK7NJW

It is with sadness that we announce the passing of John Ward VK7NJW, also fondly known as 'Whirlybird'. He was not a well-known operator, but was very active in the 80s and 90s and had been inactive until about a year ago. With some valued help from some old timers, he returned to the airwaves with new antennas and a DMR Radio.

He renewed some old contacts with great enthusiasm. With his failing health old mates rallied to help out. Ever friendly, he was a great operator well in to his eighties.

Vale John.