All Access

A newsletter for members and friends of ARNSW,
facilitating access to all areas of Amateur Radio.

ARNSW is an affiliate of the WIA.

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Editor: Ray - VK2ASE

Editorial

Welcome to this edition of *All Access*. The lock down continues! One consequence is that we do not have a Trash and Treasure list this time around. However, we do have a DIY project from Mark VK2XOF. See below for details. It looks very interesting and is a well written article.

Please listen to the Sunday Broadcasts and watch forthcoming issues of *All Access* for further information. And, please heed government warnings and advice on health matters.

Ray – VK2ASE

DIY 100W Dummy Load

100W high performance dummy load.

Figure 1 Completed Load.

Background

During the Sydney lock down I have been looking at various projects to use some of the components and hardware that have accumulated over time. Having available several die cast aluminium boxes, heatsinks and RF load resistors I decided that it should be possible to assemble a few RF dummy loads.

Over the years ARNSW has received many requests to buy 50 ohm loads. What is available on the amateur market is generally of limited performance above 200MHz and even then the SWR is often quite poor on 2m. So to obtain good performance with a commercial load requires an expensive professional load. Good Bird loads are quite expensive even second hand.

For a while there have been available true RF resistors with power rating up to 1650W. ARNSW obtained some 250W rated good quality, USA manufactured, load resistors that were pulls from TV power amplifier modules.

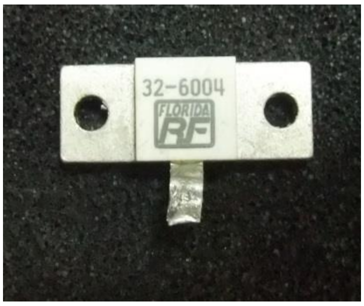

Figure 2 250W 50 ohm Resistor.

The specifications for this resistor do not seem to be available but similar products from Florida RF claim an SWR of 1.4:1 at 2GHz. Given the possibility of low SWR at 1.3GHz a prototype load was constructed. Similar resistors are available from EBay and Radio741. The parts list will have details.

So given the resistor is rated to 250W why rate the load to 100W. First to achieve 250W requires a very low thermal resistance heatsink and attachment of the resistor to the heatsink. What would be required is a thick copper heat spreader (copper plate) that covered most of the surface of the heatsink and then the resistor would be attached to the heat spreader. Also both the heat spreader and the heatsink would require very flat surfaces. This would entail machining to tight tolerances to get a very close fit. Then many screws would be required to attach the copper spreader to the heatsink and the use of high quality thermal grease between all parts.

All of this is beyond the capability of most amateurs and would add considerable expense to have this work done at commercial rates; you may as well pay for a commercial load! So to make the project practical and cost effective buying an overrated load is the answer. Typically the resistor will cost about $30 + shipping.

Some maths shows the required heatsinking. Typically these resistor are rated to 250W if the resistor can be kept under 100°C but at 250W and a room temperature of 30°C this allows 70°C rise and requires a thermal resistance of 0.28°C/W, not impossible but difficult. The largest Altronics heatsink has a thermal resistance of 0.37°C/W. Maybe better if fan cooled. So with a copper heat spreader this may add 0.1°C/W for a total of 0.47°C/w but not adequate for 250W.

Now if we reduce the power to 100W the allowed temperature is 130°C so a 100°C rise and a thermal resistance of 1°C/W more achievable. If the duty cycle of the load is reduced from 100% to say 50% then the important thermal resistance is between the load and heatsink. From practical experiments with a large heatsink (estimated to be 0.6°C/W) and a 75% duty cycle the case of the load did not exceed 100°C at 100W.

Construction.

The details of the components will be given in the Parts section, for now follow the construction and use this information to determine if this project is something you can take on.

Heatsink and box.

The aim is to have a diecast box which is of a size to accommodate at least the length of the heatsink. If there is some small overlap of heatsink over the box then this is OK so long as it does not impede access to the connector.

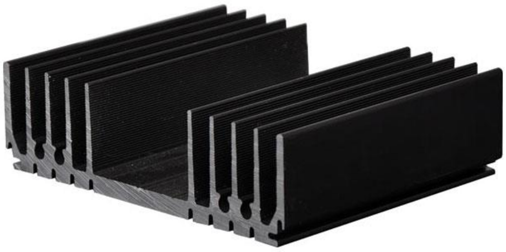

Figure 3 Typical Heatsink

Ideally the heatsink is of the type shown in Figure 3 where there is a channel in the middle. The advantage of this is all the mounting hardware for the heatsink and load resistor use holes through the diecast box and heatsink, without having to tap the holes. Of course if you have a heatsink that is all fins without the channel and suitable M4 and M3 taps you can tap all the required holes.

Figure 4 Diecast Box

For the box it is recommend using a diecast aluminium box as the connection to the resistor must be rigid to avoid placing stress on the connection strip. Also it is important to have a reasonable RF enclosure for the load. This helps with good grounding and reduced RF leakage.

The box will provide a small amount of heat dissipation in addition to other benefits. Diecast boxes are also easy to drill and cut larger holes.

The specific construction details will not be provided with dimensions as the box and heatsink will probably be different to the ones shown here.

The heatsink and RF power resistor must be attached to the bottom side of the diecast box so that the resistor can be accessed when the heatsink is assembled.

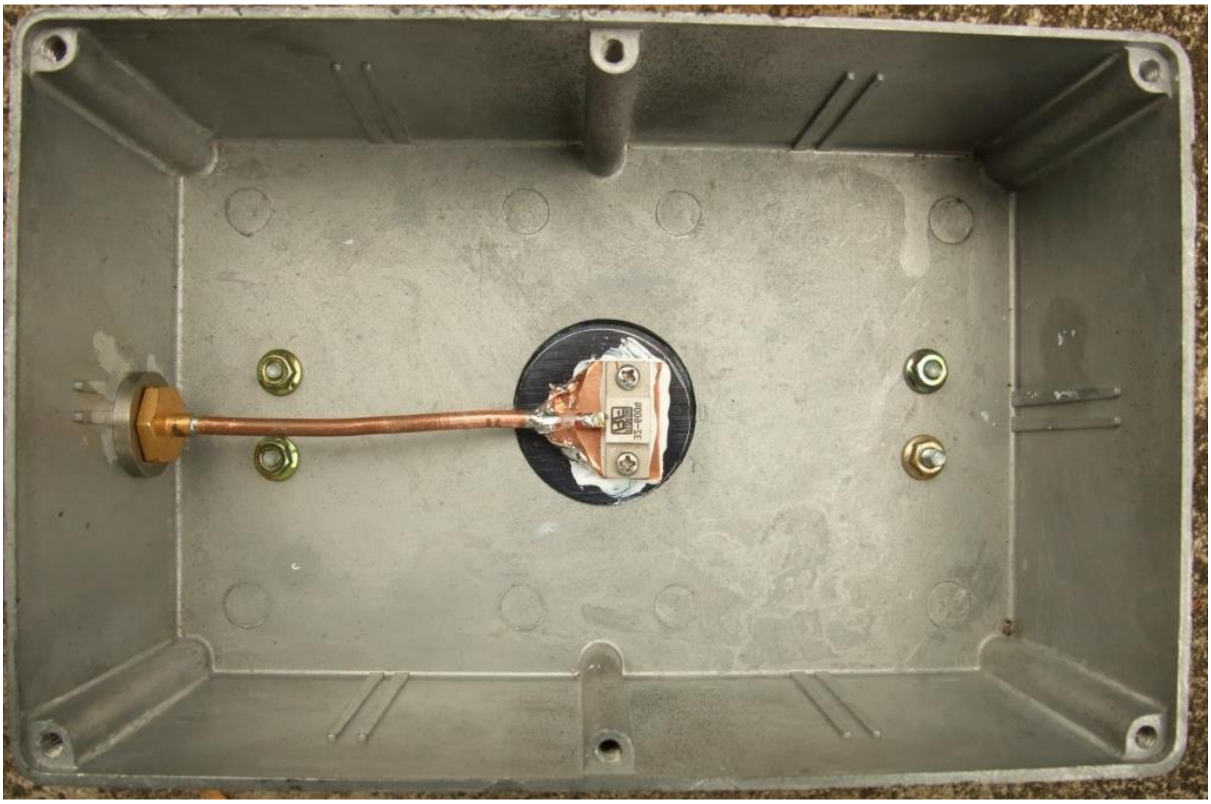

Figure 5 Completed Load

Attachment of the RF power resistor to the heatsink.

The RF resistor should be attached to the centre of the heatsink and directly to the heatsink. To facilitate this requires that a hole be cut in the diecast box as shown in Figure 5 Completed Load. A hole saw was used to cut the hole but any method that provides clearance around the RF power resistor will suffice. A square hole fabricated by drilling 4 12mm holes then using a hacksaw to cut between them would be an alternative.

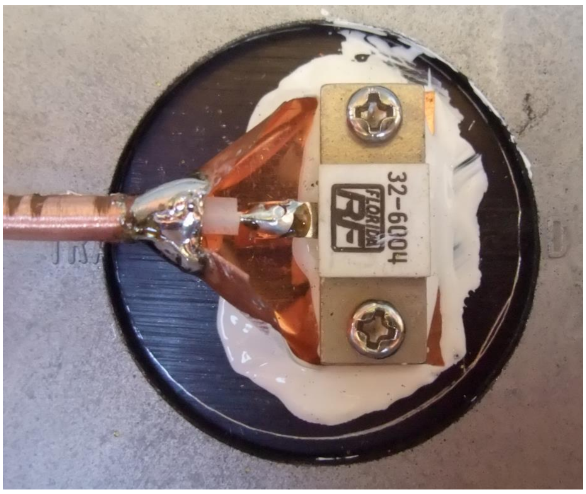

Figure 6 RF power resistor attached to heatsink.

Refer to Figure 6 RF power resistor attached to heatsink. The resistor is attached using two M3 x 20mm screws nuts and lock washers. Between the resistor and the heatsink is a piece of copper foil use to provide a low impedance RF connection to the earth flange of the resistor.

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This copper foil is essential to achieving good SWR to 1.3GHz. Earth lugs and braid were tried as a grounding method but this resulted in high SWR above about 300MHz as the inductance was too great.

This copper foil is about 0.1mm thick and could be brass foil or thin brass shim that is available from hobby shops. There are online suppliers of copper shim; one supplies an A4 sheet of 0.1mm copper for about $10.

Heatsink compound is applied to both sides of the copper shim to ensure good heat conduction.

The holes in the copper shim need to be free of burrs to minimise any gaps between the resistor, foil and heatsink. If the holes in the heatsink are drilled to 3.5mm then a pointed tool such as a scriber can be used to poke holes in the copper foil and the burrs will be inside the 3.5mm holes. For thin foil this will still allow the M3 screw enough clearance to pass through the foil into the hole.

Ideally the holes would be cut or punched but without a dedicated tool this may be difficult. Drilling thin copper shim is very difficult.

Attachment of heatsink to box.

The heatsink needs to be attached to the box such that it cannot move with respect to the box. For heatsinks with a central channel 2 M4 screws should fitted at each end of the heatsink channel to provide secure mounting. This method of mounting can be seen in Figure 5 Completed Load with two M4 nuts ate each end of the box.

For heatsinks without the central channel four holes should be tapped near the corners to secure the heatsink to the box with M4 screws and lock washers.

RF cabling.

As can be seen in Figure 5 Completed Load the load resistor is connected from an N connector, mounted on one end of the box, to the resistor with thin coaxial cable. In this case RG402 semi-rigid coax has been used but other Teflon coax could be used. Cable such as RG58 is prone to melting the centre conductor's insulation and should be avoided. The parts list has a supplier of RG316 Teflon flexible or QF141 semi-rigid Teflon coax in short lengths.

The connector can be whatever you prefer but avoid the SO239 as its performance above 200MHz is poor. Either an N or BNC is preferred. For best performance at 1.2GHz an N connector is best.

The parts list has connectors that terminate RG316 and QF141 in a coaxial fitting. It is preferable to use these connectors or similar to ensure the best impedance match between cable and connector.

If you use a BNC or N socket that does not have coaxial cable fittings then good grounding of the cable screen is essential. Just terminating the screen to a lug under one mounting screws will not give good results.

For a chassis mounted N connector with 4 mounting holes use 4 earth lugs and then wrap copper or brass foil around the 4 lugs and over the outer screen of the coax, soldering to both to provide a continuous, low impedance connection.

Thus the copper foil forms a cone between the lugs under the mounting screws and the coax screen; it must completely cover the coax centre conductor.

Terminate the cable to the load resistors as shown in Figure 6 RF power resistor attached to heatsink. Make sure there is no strain on the connection between the centre of the coax and the tab of the

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resistor. Also make sure this connection is rigid, if using flexible coax is would be preferable to anchor the coax to the box, near the load resistor, before soldering the connection.

Finishing off.

Fit 4 rubber feet to the lid of the diecast box such that they do not obscure the mounting screws.

Fit a strip of copper foil over the load resistor and connect to the screen of the coax as shown in Figure 7 - Finished load resistor. This improves the SWR at higher frequencies.

Make sure there is adequate (2-3mm) clearance between this foil and the centre conductor of the coax to prevent shorts.

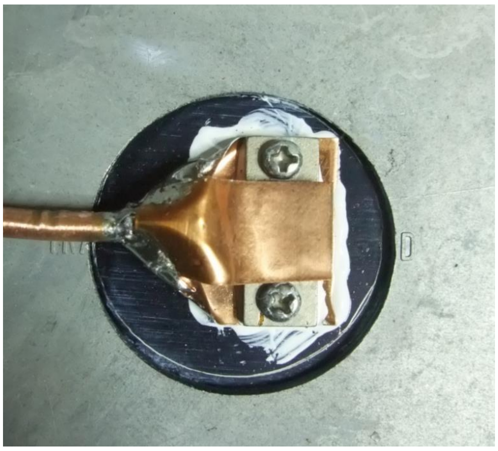

Figure 7 - Finished load resistor

Before fitting the lid to the box measure the resistance between the centre and outer of the coax connector, this should be 50 ohms +/-2 ohms if everything is wired up correctly.

Now fit the lid and the load is finished.

Parts List.

These are suggested components from local suppliers. Any good quality components from your junk box or other suppliers are suitable e.g. Element14, RS components.

Be careful with cable and connectors from E-bay and Chinese suppliers, while some are good there are a lot of poor quality parts as well. If you can buy branded components from USA or European manufacturers that lessens the risk.

The RFShop (Australia) can supply good quality connectors and cable.

Box:

Aluminium die-cast box approximately 185mm long x 120mm wide x 55mm high.

Jaycar HB5406

Altronics H0442

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Heatsink:

Finned with at least 25mm wide centre channel to fit on the dimensions of the box. 1.3ºC/W or less.

Jaycar HH8555

Altronics H0582 or H0563.

Mini-Kits HTSK10.

Connectors:

Mini-Kits BNC BNS04, BNS06,

Mini-Kits N NS13

EYOU electronics N type for QF141 or RG402 SKU 01-0320

Cable:

Mini-kits RG316/U, QF141 RG402.

Resistor:

ARNSW has a limited supply of 250W 50 ohm resistors.

Online Radio741 has Diconex 17-0375 250W 50 ohm resistors

Heatsink compound:

Mini-Kits SIL-10G

Altronics H1600A.

Jaycar NM2010.

Mark – VK2XOF

What have you been up to? Is there a project that you have been working on while in lock down? If so, why not let us know your experience. Most of us enjoy reading about what our colleagues have been doing. Just describe your article in an email to *editor@arnsw.org.au*. It doesn't have to be a highly polished piece. Your editor will happily work over the article if need be in preparation for the newsletter.

Until next issue,
73, Ray – VK2ASE

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