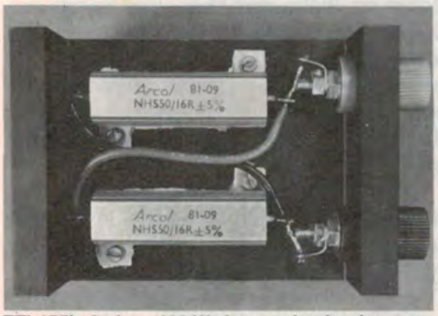
High power 'dummy loads' for audio amplifier testing

Apart from a multimeter and perhaps an oscilloscope, a resistive dummy load of 4, 8 or 16 ohms impedance capable of dissipating up to 100 watts is just about the most useful item of test equipment the audio enthusiast could have. Here are several ways to build one.

Andrew Kay
Roger Harrison



ETI-155b 8 ohm, 100 W dummy load using non-inductive resistors.

WHEN IT COMES to designing electronic equipment — from the very simple to the very complex — if one asked several designers how they would go about a certain design problem undoubtedly you'd get a different answer from each. Here again, we see a fine example illustrating that old saying — "... there's more than one way to skin a cat."*

The project staff at ETI have spent some considerable time over the past two years developing a variety of amplifiers. The fruits of these labours have been duly published and enjoyed by many readers. However, we've always lacked a *decent* dummy load for such work and have sort of *made do* with such contraptions as a string of one ohm 5W resistors dangled in a tub (plastic!) of water, lengths of electric jug element, etc, etc. Whilst jury-rigging such things is in the finest traditions of electronic design and development, the (more than) occasional mishap is not just a frustrating interruption but often a decided nuisance giving rise to dark mutterings, steam from the ears and shouts of "we'll have to get a *decent* dummy load ? ! !"

As no doubt many of our more intrepid readers, and/or do-it-yourself audio fanatics, have discovered, such things are hard/difficult/impossible (... delete whichever not applicable) to come by.

Then, Everest Electronics came to the rescue. Eagle-eyed readers will have seen the item we ran in News Digest in the March 1981 issue concerning the *Arcol* range of metal-clad power resistors carried by Everest. When the information arrived, quick as a flash we organised some non-inductive types for a dummy load. Several weeks later two 16 ohm 50 W non-inductive Arcol resistors arrived on the Editor's desk. An hour later we had a working dummy load! Naturally, everybody thought it would make a good project ...

In the meantime, a freelance associate of ours, Andrew Kay, had desired exactly the same thing. Andrew, however, went about solving the problem a different way. He purchased a batch of one watt 1% resistors and made a 50 W dummy load. But, he figured, why not have a little more versatility and make two the same, allowing parallel and series connection to obtain a 4 ohm, 100 W dummy load or a 16 ohm 50 W dummy load as well as a twin 8 ohm 50 W dummy load enabling testing of both channels of a stereo amplifier at the same time! Frankly, we don't know why we didn't think of it earlier ourselves.

So — here follows the description of several ways to skin a cat/rockmelon/whatever, or build some high power audio dummy loads.

Multi-resistor method (ETI-155a)

By parallelling resistors of an appropriate value, one can obtain an effective resistance of the wanted value and ▶

ETI-155a 4, 8 or 16 ohm dummy load (50 or 100 W) using 98 390 ohm 1 W resistors.

** For cat lovers we'll modify that to "... skin a rockmelon", or something similar!*

wattage rating. Now, the cheapest, most common power rating for carbon film resistors is one watt (1 W). To obtain a 50 watt resistor, 50 would need to be paralleled. To obtain an effective resistance of eight ohms, each 1 W resistor would have to have a value of 400 ohms. The nearest preferred value is 390 ohms. Fifty in parallel would give an effective resistance of 7.8 ohms which is about 2½% lower than the ideal eight ohms. However, 49 in parallel gives an effective resistance of 7.959 ohms — less than ½% out. If you require the tolerance of your load to be within 1% or better, then you'll have to use 1%, 1 W resistors. If you only require a tolerance of +/−5%, then the common 5%, 1 W variety will do the job. Either way, you're better off using 49 resistors so that the effective resistance of the load comes closer to the ideal eight ohms.

The dummy load described here consists of two eight ohm loads, which enables the testing of both channels of a stereo amplifier.

The idea itself is not at all new or original, having been used by radio amateurs for years to obtain resistive dummy loads for terminating radio transmitters while they are on test. The advantages of a dummy load for any kind of power source are:

- the power source (in this case an AF power amplifier) is presented with an ideal resistive load of the correct value,
- the chances of damaging expensive loudspeakers during experimental phases of construction are eliminated, and
- completely silent "full power" testing is made possible even for extended periods of time; which is great for public relations and your ears.

Essentially each dummy load consists of 49 high stability 1% metal film resistors connected in parallel to give a terminal resistance of 8 ohms. The author used cheap, readily available Beyschlag type MBE 0414 1 W series. Since the tolerance rating of the resistors is 1%, the upper tolerance limit for the combination is 8.04 ohms and the lower limit is 7.88 ohms. The number of resistors to be bought was a compromise between the desire for a result of exactly 8 ohms and the need to keep the cost to a minimum. Obviously, larger numbers of resistors could be used (say 70 x 560 ohms in parallel) and the reader can easily vary the circuit to suit the pocket and availability of the resistors. The resistors used in this project can be obtained from Crusader Electronic Components at 81 Princes Highway, St. Peters NSW, for about 6¢ each. This price is for quantities of 100 up, but since the dual circuit uses 98 resistors there is no difficulty here.

Separate terminal posts are provided for each load so that two separate 50 W sources can be terminated in 8 ohms each or the two halves may be connected in series to give a single 16 ohm 50 W load; and last but not least parallel connection of the two halves will result in a 4 ohm 100 W load. Because metal film resistors are used there are no inductive effects to worry about such as could occur if wirewound units were employed. The stray capacitances present are so low as to be insignificant.

Construction is simple, if somewhat tedious. Lots of soldering is involved! The author used two ordinary household tin cans; one can has a lid (e.g: a coffee tin) the other is a smaller one of the throw-away type (baked beans etc!). The top and bottom of the smaller can were used as soldering planes for terminating the ends of the resistors while the larger can was used to house the project with the lid carrying the terminal posts. Since the coffee tin is virtually leak proof you could fill it with some kind of insulating fluid such as transformer oil and thereby increase the dissipation capability of the dummy loads.

Tin-plated steel is very easy to solder but the sharp edges are dangerous to careless fingers. Blank copper clad printed circuit board could be used instead but does not withstand heat as well as the plain metal sheet.

The arrangement of tin cans may not seem very glamorous but it is highly effective and very cheap — the whole cost of the project comprises about $7 for the resistors and about $2 for the terminal posts. The tin can housing can be spray-painted and the terminal posts labelled and marked to suit individual needs.

Before starting choose a medium sized coffee tin with a resealable lid for the case and select a tin can of smaller diameter which will fit easily into the coffee tin. About eight or nine centimetres in diameter should be fine for the smaller tin can. Using a can opener remove the top and bottom of the smaller can and discard the contents (maybe you should eat the contents — but that's really outside the scope of ETI!). Also, discard the remaining cylindrical portion of the can! Mark up one of the tin-plated discs so obtained with a grid of ten by ten lines as shown in Figure 1 to give 100 intersections.

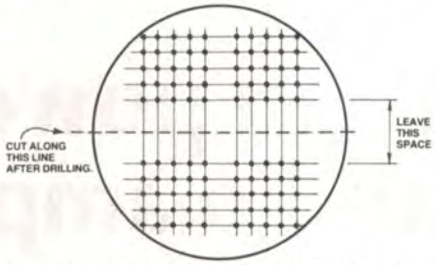


Figure 1. **Drilling and cutting details for the tin-plated discs obtained from a small can.**

Allow a space of about 10 mm along one diameter as shown. This will allow the discs to be cut in half later. Clamp both discs together onto a drill bench or a block of wood, ensuring that they are exactly superimposed. Drill a hole on each intersection of the previously marked lines. Make the holes slightly larger than twice the diameter of the resistor leads; this will assist assembly later on. Take care that your hands are kept clear during drilling since if the drill bit grabs, the two tin discs will whirl around very much like a meat slicer, and almost as sharp! Only 98 holes are needed so don't get carried away.

When the holes are drilled, cut the two discs along the middle space left along one diameter so that you end up with four half discs each with 49 holes. Tin the area around each hole with solder and proceed with assembly.

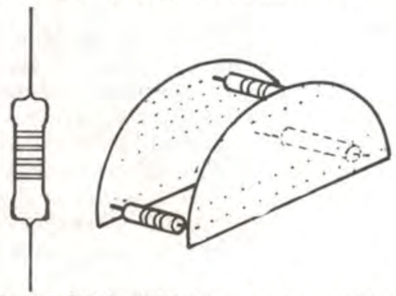


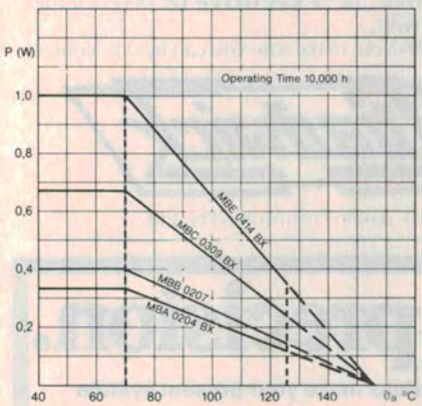
Figure 2. **Cut the resistor leads as shown at left and then solder three resistors to two half-discs as shown to make a rigid assembly.**

Trim all the resistor leads as shown in Figure 2 so that one lead is longer than the other on each component. Take two matching half-discs and using three resistors assemble a rigid structure as shown in Figure 2. Insert the resistors, one row at a time, in between the two tin plates with the leads poking through the holes. If you insert the longer lead of each resistor into its hole first, the other end should be short enough to allow manoeuvring into the hole in the second plate. After one row of resistors is in place solder all the leads of that row on both plates, then proceed with the next row.

Repeat the assembly for the second half of the unit then trim all excess leads flush with the surface of the tin plate. Using a stiff brush (e.g: an old toothbrush) scrub the soldered surface with methylated spirits to remove deposits of flux.

Connect an ohmmeter between the plates of each load — the reading, believe it or not, should be pretty close to 8 ohms. Inspect all solder joints and re-solder if the reading is not correct. Install the four terminals in the lid of the coffee tin using one red and one black terminal for each half of the unit. Lay the two assembled resistor pads side by side as shown in Figure 3. Using fairly stiff copper wire connect the upper plates to one terminal each. Use the same colour terminal for both plates as this will be important later if the loads are to be connected in series or parallel. Using the same sort of wire, but insulated, connect the lower sides of the resistor assemblies to the other two terminals. You should finish up with an assembly which will be supported under the lid of the coffee tin and which is so positioned as to allow it to be inserted into the container and for the lid to be sealed.

To prevent the two halves of the load from shorting together, install an insulating spacer between them using a scrap piece of copper-clad board or matrix board. If using the pcb material, ensure that enough copper is removed to insulate the two halves from each other. If using the matrix board, you will have to drill a couple of additional holes and use small screws to attach the spacer to ▶



The upper curve in this graph shows the typical dissipation characteristics of the Beyschlag resistors used in the ETI-155a dummy load. Power dissipation is derated at operating temperatures above 70°C.

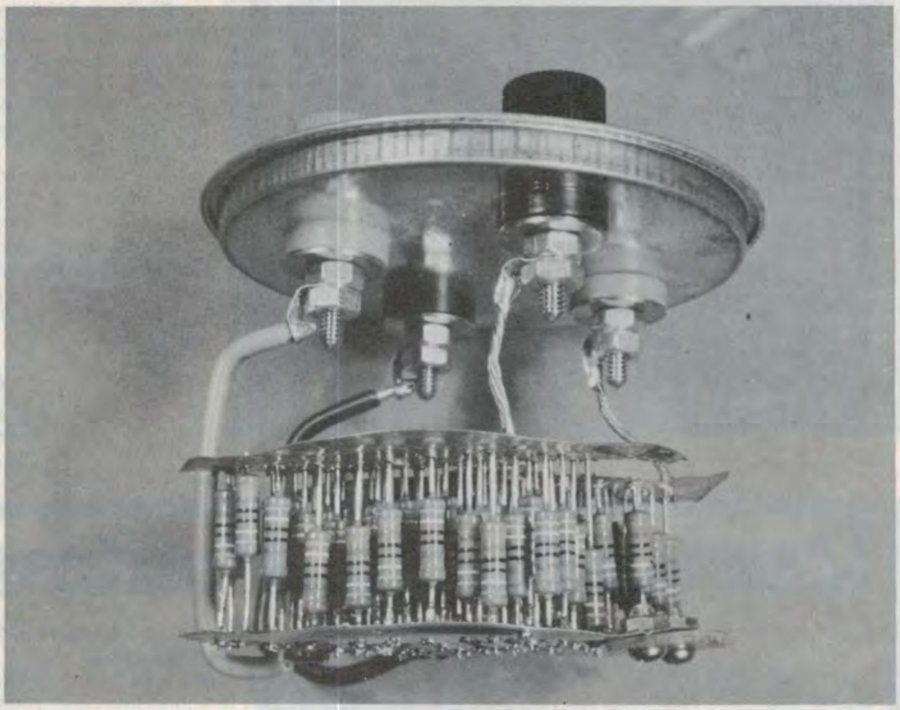


Figure 3. **The two half-disc pairs are assembled side-by-side and heavy gauge wire soldered between the discs and the terminals. An insulating spacer of matrix or pc board holds the two assemblies apart.**

the resistor assemblies.

Before inserting the assembled unit into the coffee container, mark the lid to indicate which terminals are connected by the resistive pads.

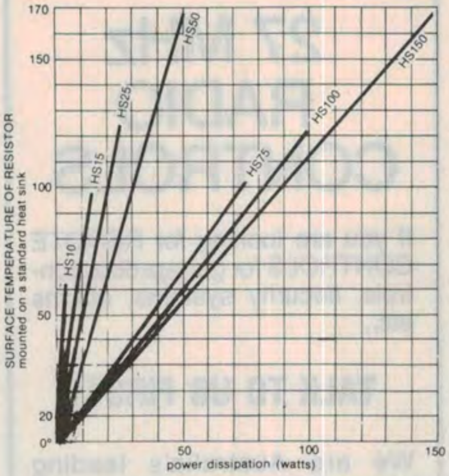
To test the unit, connect each load across a known working amplifier or if this is not convenient, use a car battery (not more than 12 V) as the driving source. If using an amplifier, connect an ac voltmeter across the load under test. If you can use a sinewave generator to drive the amplifier, all the better. Adjust the amplifier volume control to give about 10 to 15 volts across the loads. Check by feeling the resistors with your hand that they are in fact warming up. Increase the output of the amplifier until the voltage across the loads is about 20 volts. This should result in the resistors getting quite hot after a couple of minutes.

If using a car battery, connect the two loads in parallel and connect the battery across them. Check the current drawn; it should be approximately 3 A with a 12 volt battery.

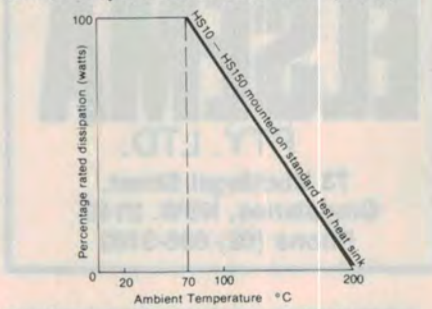
When testing is satisfactorily completed, install the whole assembly into the coffee container and press down the lid. If you plan to use the loads continuously, fill the container with insulating oil before assembling.

Metal-clad resistor method (ETI-155b)

This has to be just about the world's quickest project! Two 50 W, 16 ohm Arcol resistors connected in parallel were used as a single 8 ohm, 10 W resistor is more expensive. The Arcol resistors have two diametrically opposed mounting tags drilled to take 6 BA bolts. We mounted them on a short (71 mm) length of heatsink obtained from Autotron Australia, of P.O. Box 202, Glen Waverley 3150 Victoria. We unaerstand a number of component suppliers keep stocks of this product.



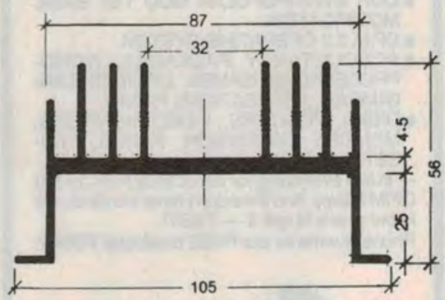
Temperature-dissipation characteristics of the Arcol metal-clad resistors. The curve marked 'HS50' applies to the types specified for the ETI-155b dummy load. (Temperatures shown are surface temperatures at reduced dissipation).



Power derating graph for the Arcol resistors.

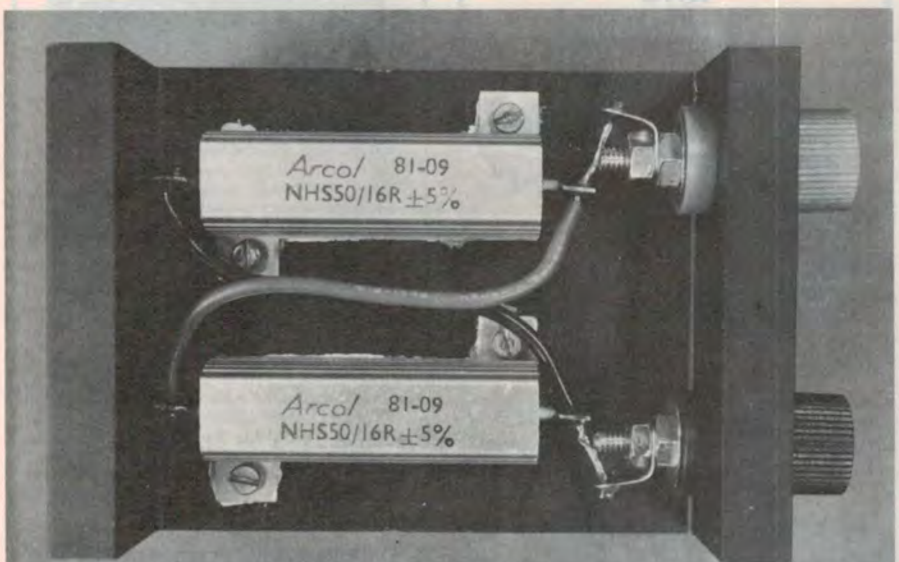
We chose it because its shape is very convenient for this application but almost any suitable heatsink on which the Arcol resistors can be comfortably mounted will suit.

The two resistors are mounted in the 'well' beneath the fins, positioned such that the securing bolt holes do not foul any of the fins. The photograph makes this clear. Two large terminal posts are mounted on one side to provide convenient connections and the resistors are wired in parallel in the manner shown in the photograph.



Cross-sectional profile of the Autotron type XA heatsink used for the ETI-155b dummy load. This style of heatsink is obtainable in a variety of lengths.

With the heatsink used, at a dissipation of 100 watts, the heatsink temperature rapidly rises and will reach 150°C after some minutes! Fan cooling keeps it within bounds, but if you expect to use the dummy load for lengthy periods then a larger section of the Autotron heatsink or whatever you wish to use is recommended. To keep the resistors at 70°C or below, (their maximum temperature at full dissipation before derating) we suggest either a single 500 mm length (standard size, natural finish) or two 200 mm lengths (standard size, black anodised). ●



The ETI-155b assembled — the world's quickest project!

PARTS LIST — ETI 155

ETI-155a
98 x 390R, 1 W, 1% or 5% carbon resistors.
4 x large binding posts, two black, two red.
Tin cans to suit — see text; high current wire (see text and pics).

ETI-155b
2 x Arcol 16R, 50 W, 5% non-inductive resistors, type NHS50.
2 x large binding posts, one black, one red.
Heatsink (see text); high current wire (see text and pics).

Price estimate

ETI-155a	**$7 - $9**
ETI-155b	**$18 - $22**

Note that these are **estimated** prices only and **not** recommended prices. A variety of factors may affect the price — cost price movements, whether you use 1% or 5% resistors, type of heatsink employed, etc, etc.