

**Radio**

**Homebrew**

and

**Experimenter's**

**Group**

An official function of  
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**Newsletter Issue 10**

**July 2008**

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The Radio Homebrew and Experimenter's Group workshop meetings are free to Amateur Radio NSW (WIA NSW) members. A \$5 cover charge **may** apply to non-members. Currently we have two "meetings" a month with an extra one on the Trash and Treasure Sundays as follows :

**First Tuesday** of each month 7 - 9 pm at McDonalds, cnr Church St and Victoria Rd, Parramatta (upstairs dining room)

Buses stop outside and plenty of parking. We usually arrive around 6:30 and have something to eat before the meeting.

**Third Tuesday** of each month a Radio Net on 2m using the VK2WI Dural Repeater (147.00) duplex at 7:30pm. We get together on-air and discuss our latest projects, antennas and radio gear. All welcome.

**Technical/Presentation Meeting** after the Trash and Treasure Meets which are usually on the last Sunday of each odd-numbered month. The meetings starts about an hour after the Trash and Treasure and runs from around 1:00pm to 4:30pm, they are at our VK2WI site, 63 Quarry Rd, Dural (first right turn after the round-about at Dural and follow your nose about 2km down the road, look for the tower on your left hand side, plenty of parking on site.

These meetings are informal get-togethers of amateurs interested in building, or repairing their own radio equipment, there is usually a "show and tell" segment, where Amateurs can bring along their latest project (or even an old one)] and show others what they have been up to. This is usually held before the demonstration or lecture organized for that particular meeting. We are always interested to see how others get a circuit working or sort out various hardware problems.

If at a meeting you need some test equipment either to fault find, calibrate or demonstrate something, then **please contact Peter O'Connell VK2EMU by email or leave a message for him at the office** and he will endeavor to have the appropriate piece of equipment available.

Check out the "Homebrew" page on [http://www.arnsw.org.au/html/news\\_homebrew.htm](http://www.arnsw.org.au/html/news_homebrew.htm) for the latest news on the Homebrew Group. If you would like an extra copy of this newsletter, you will find a PDF version also on this page. Suggest you visit this site regularly to keep up to date with what is happening at ARNSW and for lots more information of interests to Hams.

#### **This Month**

- **Editors Comments –Comments on this issues content**
  - **Keep track of the Homebrew Group on the Amateur Radio NSW (VK2WI) Web site.**
- **Project – Portable Workshop and Test Bench**
  - **Mains and DC Supplies**
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  - **Signal Tracer and AF Voltmeter in a UB1 Panel**
- **Theory – 13.8VDC from a PC Power SMPS Supply (Bob VK2CAN)**
- **Quick Projects – Signal Tracer (2) – Speaker mods and RF probe**
- **Project – New metering head for a remote RF Power Meter**
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**This Newsletter is online at Amateur Radio NSW** [http://www.arnsw.org.au/html/news\\_homebrew.htm](http://www.arnsw.org.au/html/news_homebrew.htm)

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## Editors Comments – As usual this Newsletter is devoted to “Members” ideas and projects.

This issue is as usual devoted to members “homebrew” equipment. A number of our members have some very nice projects under way. A couple have “Software Defined Radio” (SDR) circuits and accompanying software under test. As the circuits become more complex and in many cases utilize surface mount components we need ever more complex PCBs to build the project. As a result a few of us are busy teachig ourselves the various PCB editors available and then have to take the project to “burning” the PCB pattern in various ways.

Your editor is in the same boat, hence not a great deal of actual equipment up and running for this issue. Instead we will be catching up on a few small projects from previous issue. The “Portable Work bench” is something I have been working on and off for a period of time. Many of us have accumulated a number of small pieces of test gear (mostly battery powered) all in different sized boxes, with different leads and connectors. This can be a bit of a problem when you need to use a couple of different instruments at one time. Also many of us do not have the luxury of a dedicated workspace, having to “share” the available space with other interests and even family members. Thus have to keep packing the current project away till next time, then find a connect all the test gear again.

So this project is a effort to gather a number of different pieces of gear into an “integrated” work bench. The information presented is simply one way of doing it, the end result depends on what space and materials you have available. The concept could also be used even if you have a “workshop” in order to standardise on certain connector types and save on the rats nest of leads needed to connect up to a project. This issue we will deal mainly with the planning and concepts, next issue with actual circuits and (hopefully) PCBs for the projects. In the meantime have a look at what you have available, good time to make use of that old analog multimeter in the “junk box” for those partially built kits picked up at Trash and Treasure events.

### Keep track of the Homebrew Group on the Amateur Radio NSW (VK2WI) Web site.

So keep track of the Homebrew Group please check the pages of the ARNSW WEB site, look for details in NEWS, Meetings or the Homebrew Page itself on [www.arnsw.org.au](http://www.arnsw.org.au)

A few of the Homebrew Groups members and visitors do not have Internet/Email facilities, if you have contact with one of these guys could you please pass the above information along to them and also check this page for information on future meetings/venues so that you can keep them up to date. Thank you.

## Project – Portable Workshop and Test Bench – The “bench” and equipment housing

(Brian VK2TOX)

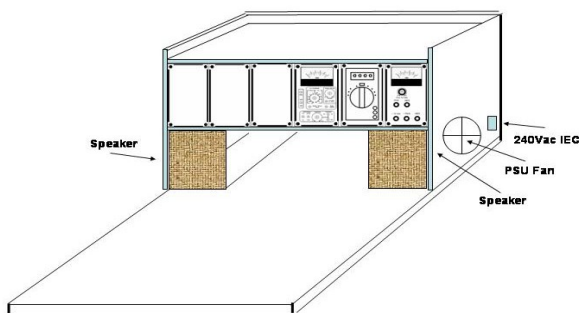
Living in a small flat (again) and not having a garage or spare room for my project building, makes a compact work area very important. Now, like many of you, I can’t devote a specific area to electronics/Ham projects but have to share the available space with other interests and mundane things like beds and clothing space. At least I live alone, I would guess most of you have to share “your” space with “she/he who shall be obeyed” and even various harmonics, all intent on cluttering up “your” valuable space.

Many years ago whilst sharing a small flat I hit upon the idea of a “portable workbench” which in those days was simply a piece of chipboard about 18” square with a small vice mounted on it. This ensured that hacksaw work and soldering did not mark “our” kitchen table. Having come the full circle I am now setting up a similar work space that can be just slipped under the bed when not in use. However I would like to make it a bit more useful by having a power supply and some other test equipment mounted in it. Perhaps even a couple of small speakers to allow testing/repair of car radios, ham gear and small audio equipment.

Firstly I have to say that the following are just my ideas and projected use of this “facility”, it is presented for you to glean ideas from and improvise upon as you wish. We all have different needs and facilities.

### Bench

For me the most practical size is around 18” (450mm) square workspace, anything less is a little cramped. So at my local hardware store they were having a special on melamine (white) coated chip board pieces which were 450mm wide and 1600mm long, just right for the bench and some shelving.



### Shelving

To make the bench more useful I would like to mount some test gear in a shelf at the back of the bench and also a power supply (12VDC etc), along with a 240VAC “power board” for soldering irons etc. I had a previous version of the bench where the test gear was mounted level with the bench and found it a nuisance as with something on the bench the test gear was difficult to access. So this time I would like to allow a small space under the test gear for leads and small tools so that the test gear is around 8” (200mm) above the deck of the bench. Might just clutter this space a bit with a couple of small speakers (protected by a baffle or grill). To get some dimensions to work with I have chosen a standard UB1 “Jiffy” box from Jaycar (Altronics and Dick Smith have similar units), I will use the lid as the front panel of the test gear so that if I need to the gear can be dismantled from the bench, placed in it’s accompanying box and taken to a meeting or used outside the “workshop” area. Initially

the lid will be used in an upright (portait) position but no reason why not to build yours around the lid in a sideways or “landscape” position. In fact strangley it is usually easier to layout a panel in the landscape mode.

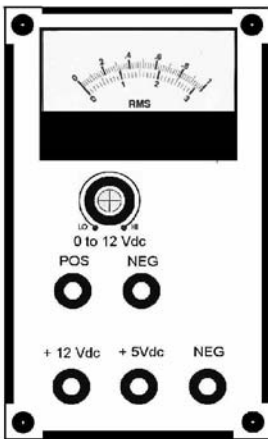
An extra shelf area on top of the built-in test gear would also be handy for other equipment and test gear, such as dummy loads and things which really should not be buried in a panel.

NOTE: Most of the following ideas and suggestions are based on being right handed, if the user of the bench is left handed then you might consider reversing the suggested positions of equipment to make it easier to use.

**Power Supply and 240Vac** (in the bench)

Just for starters I will mount an unused PC power supply in the equipment part of the shelving. For the time being no mods to the supply just bring the +5V, +12V, Comm and the negative supplies out to terminals on the front of the panel. Might put a 5 or 10Amp meter in the 12VDC line as this would be the supply most used. To ensure regulation of the supply will also fit a resistive load to the +5VDC supply so the internal regulator has something to feed off. However if you have the components or even a complete linear power supply you could mount it in this space instead of the SMPS unit. I intend to “re-visit” the SMPS unit and modify it to make it more useful. Check out the following article for details of the power supply and 240Vac setup.

So following is what we have come up with so far:

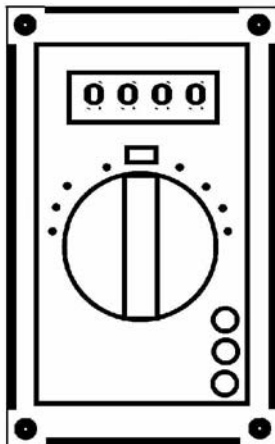


**Portable Workshop and Test Bench – Mains and DC Supplies**  
(Brian VK2TOX)

As mentioned I am going to use a standard AT or ATX SMPS unit to supply low voltage for both the test gear units and for powering up things I am building or testing. As these supplies have an inbuilt cooling fan I will mount the fan/IEC input side of the box against an outside surface of the shelving assembly, both to allow air cooling and to readily plug in the mains to the supply. To allow soldering irons and other test gear to be powered “from the bench” a small 3 or 4 plug “power board” can be attached to the side of the shelving unit. If you have to shuffle off to eat dinner or answer the phone you can simply “pull” both mains plugs and nothing will cook while you are away.

Next we will detail some test gear that can be mounted in the shelf panels, meantime why not get the power supply mounted and working. Also get one of your multimeters (what!! you only have one !! need to fix that) and mount it on one of the test gear panels as follows.

**Multimeter in a UB1 Panel**



(Brian VK2TOX)

The work space provided by the bench is not exactly huge so a multimeter is best mounted in one of the test gear panels. You can simply secure a meter to the front of one of the jiffy box lids, but it will stick out a bit and make getting to the battery compartment a bit difficult. So better to cut away the lid and mount the meter into the panel, thus the battery compartment is easily accessible for replacement.

Although I am talking about a small digital multimeter this location could be just a well filled by a small analog multimeter (still available) which are still a valuable service tool as changing voltages/currents are more easily seen, especially for “peaking” a particular setting in a piece of gear.

My suggestion is to place this “Multimeter Panel” over to the right of the test gear shelf to make it more accessible. The loose length of the leads can be tucked under the test panel shelf and a couple of clips could be fixed to the panel to hold the test probes when not in use. In fact you might consider a low shelf space below the test gear just for the purpose of storing test and connection leads for all the gear.

I used a simple DMM one of my usual suppliers had on special, when I actually got around to cutting the hole in the UB1 box lid, I found that the top half of the meter case is slightly tapered to the front of the DMM, thus was able to make the opening only just slightly larger than that of the meter and push it through from the back. A few quick beads of “hot glue” were used to secure the meter in place, then checked to make sure it did not foul any part of the UB1 box (so that I could use

the DMM away from the bench if needed. When all ok then run a continuous bead of glue around all four sides. The back of the DMM is then readily accessible to replace the battery in the normal way.

Note: I actually tipped my meter slightly forward (at the top) to counteract the slope of the panels, so as to make sure I could read the display easily.

**Signal Tracer and AF Voltmeter in a UB1 Panel**

Brian VK2TOX

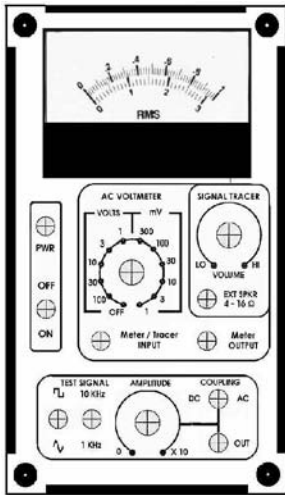
I have built a number of similar instruments over the years, the original ones based on a great ETI magazine project back in the seventies. That project was fairly “goof” proof as the inputs were protected such that if you actually connect the signal tracer to a high voltage point (such as the mains), the input did not self destruct. Although this is not quite so relevant these days with solid state gear, if you may be using it on valve or similar equipment you might consider protecting all inputs/outputs with a high value isolation resistor and/or a decoupling capacitor with three or four hundred volt rating.

With this project I have actually amalgamated a number of separate bits of test gear all in small boxes that seem to hide away whenever I need them. The unit is powered from the benches own power supply (12VDC), but to mount the panel in the UB1 box and make it portable there should be plenty of room in the case for a set of batteries or fit leads and/or connector to run it from an external battery.

The complete unit consists of:

**Test Signal ..** which is just a couple of twin-tee sine wave oscillators running at 1KHz and 10KHz along with a sine to square wave converter then followed by the op-amp stage from an audio signal generator. Could just as easily have been a logic circuit generating a square wave followed by a couple of filters to get the sine wave component out of them. No great "purity" is required as the signals are used simply to generate a staple signal for various service tests on equipment. Allowance is made to AC or DC couple the output signal. The AC coupling is used for the sine wave signal and puts a blocking capacitor in series with the output to protect it from external DC voltages. The DC coupling could be used for the square wave signal so as not to degrade the waveshape of the output.

**AC Voltmeter..** Most DVMs are calibrated only for mains frequencies and do not respond with any degree of accuracy to various audio frequency signals. While servicing or testing a piece of audio equipment we often need to measure the amplitude of interstage signals but no great accuracy/resolution is required, hence this instrument even with a small meter movement this is a very useful piece of test gear. If you need to make very accurate measurements then you obviously will need an instrument with a much larger meter movement or even go to an AD converter feeding a digital display. Actually quite good results can be obtained using this simple meter and a calibrated attenuator (1% resistors are cheaper than a 1% meter) but more about that in a future issue.



This voltmeter is a very useful part of the unit and again can be another project re-worked into this panel. Lots of circuits around in publications and on the net. Quite handy circuits available in most issues of the ARRL Handbook from simple transistor/FET to dual op-amp circuits, just need to re-work the input stage and perhaps add a detector/rectifier circuit to suit your requirements. Also a number of projects in older copies of ETI and Electronics Australia some using out dated ICs but easily reworked to utilise more readily available components. This is a good project for the meter out of an old analog multimeter, the range setting being adjusted to suit the meter calibration

I just know someone is going to say that surely the 1 and 3mV ranges will not be very much use because of "noise", yes you are correct, but the input to the voltmeter is also the input to the Signal Tracer stage, so these very sensitive ranges are provided for that function when a Demod probe is used. The meter Output function was originally the DC signal from the actual meter movement to feed into a chart recorder, in this project it is actually the AC signal from the input buffer. You can plug a CRO into this jack and look at the signal you are measuring or tracing.

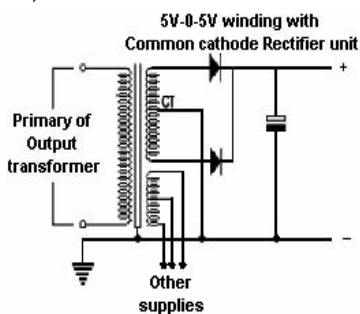
**Signal Tracer..** The part of the unit is actually an audible output of the input to the AC Voltmeter, that way when tracing a signal through a piece of gear you can measure the voltage and listen to the signal. Again you can re-use a simple audio amplifier from another project or an old AM radio. If built from scratch then a LM386 chip gives good results with a wide range of speaker impedances.

Normally the amplifier would drive a speaker either in the UB1 box (when used external; to the Test Bench) or a speaker fitted to the test bench itself. The jack is so that an external speaker or low

impedance headphones can be used to trace the signal or even test another speaker.

### Theory – 13.8VDC from a PC Power SMPS Supply (Idea by Bob VK2CAN)

Note: The following is only theory at present as I am still trying to find a supply that HAS a center tapped winding, will let you know how I go in the next issue  
(Editor)

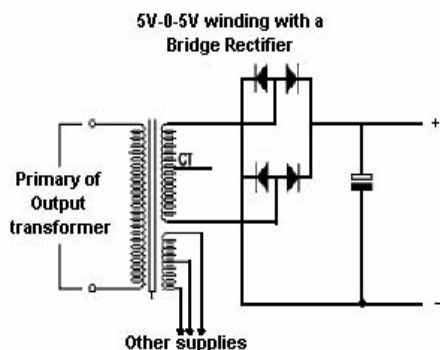


There are plenty of ideas around on making an old PC SMPS power supply more "useful" for an Amateur Radio operator. All of these units have two main outputs, the "5VDC" at lots of amps and the "12VDC" at not so many amps. Also in most of the units the "5VDC" supply is the one that is closely regulated and essentially controls the other outputs. Although in the newer supplies the "12VDC" is also monitored by the internal control circuits and is thus better regulated.

One of the "conversion" concepts is based on making the "12VDC" output the primary control, thus allowing it to be adjusted to a nominal 13.8VDC. Most units will give around 10 amps at this voltage, which is quite useful but does not fully utilize the supply as the "5VDC" winding at lots of amps is then ignored.

The other concept often employed is to strip out all the low voltage supplies, remove and rewind the main switching transformer, then rework the low voltage side of the supply and the control circuits to give 13.8VDC at lots of amps. This method which involves a lot of work, certainly more fully utilizes the amazing output power of these supplies.

However at a recent "Homebrew" meeting Bob VK2CAN put forward an idea which is truly a case of "lateral thinking". His idea was as the "5VDC" output of most PC SMPS supplies actually has a center tapped winding which is full wave rectified to produce the nominal 5VDC. So, why not simply rework the rectifier side of things by "lifting" the center tap and apply a full wave bridge rectifier to the whole winding and thus produce a nominal "12VDC". Then modify the control circuit sensing so as to provide a regulated 13.8VDC. Obviously there are no free lunches, "watts is watts" as you have doubled the voltage then you only get half the amps previously available from this winding. Bob also suggested that the easiest way to do this was to retain the existing "common cathode" rectifier (usually a pair of diodes in a TO220 package) and add a "common anode"



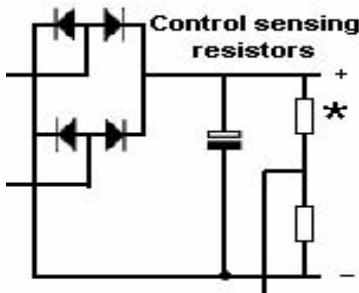
package of similar current capacity to the existing heatsink. This concept is especially applicable to the newer and higher wattage supplies which can provide 30 or 40amps out of what was the "5VDC" winding, thus we can easily get 20amps at 13.8VDC with this mod.

Here are a couple of circuits showing the original "full wave center tapped" supply and also the modified "bridge rectifier" with the center tap disconnected.

NOTE: About half the supplies I checked did NOT have a center tapped secondary, so you will need to check out your "collection" of PSU's and find one that is center tapped for this mod to work. Otherwise you will have to utilize one of the other two methods mentioned above. Though I guess the "complete strip and rewind" is the only way you will get use of the full power from a supply.

A quick check of suppliers showed that you need to go to a company like WES Components in Ashfield to obtain this "common anode" package, although I guess there would be similar companies in other capital cities. Someone, who shall remain nameless !!, piped up, as to why not simply use one of the readily available 35amp bridge rectifier units generally available, this "person" was gently reminded that in carrying out this conversion we are NOT rectifying the a 50Hz mains frequency supply BUT a 50KHz switch mode supply which need high speed rectifiers. However the reverse is also true in that the SMPS rectifier units make very convenient heat sinked rectifier stacks for a 50Hz supply. A side benefit of the higher frequency is of course that smaller value filter caps can be used, although they should be of the 'Low ESR' variety intended for SMPS circuits.

A working formula for the value of a filter capacitor is (at least this is what I usually use) based on around 2000uF per amp of load current for a 50Hz supply that is full wave rectified (i.e. ripple freq of 100Hz). So if we look at a SMPS running at 50KHz then the ripple freq will be 100KHz so the filter cap will be 1/1000 of the 2000uF value. So for a SMPS running at 50KHz the filter cap only has to be 20uF to get the same results. Hence the reason why you will typically find 50 or 100uF caps as filters in small SMPS units.



Some careful surgery around this area of the board will enable the mods to be carried out and don't forget to locate and modify the control sensing circuit to "fool" the control into thinking it is still regulating a 5V output. The input side of the sensing usually involves a voltage divider, locate the "top" resistor and for a start, double its value. This is easily done by "lifting" one end of the resistor off the PCB, solder a resistor of the same value into the hole just vacated, then solder the other ends of the two resistors together above the board.

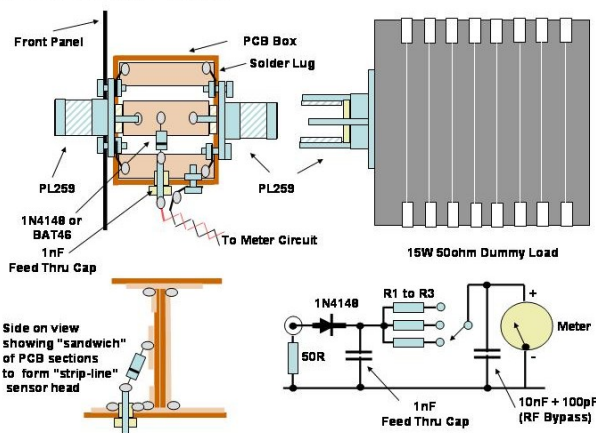
The resistor to modify is the one marked by an asterix in the circuit to the left. Up closer to the actual control chip (typically a TL494) there is usually a small pot which will allow you to "tweak" the output to 13.8VDC. If you can't quite get the 13.8V then the new resistor will need to be increased slightly in value. Conversely if the output is too high then reduce its value slightly. Maybe even fit a pot temporarily to that position, adjust it to get your 13.8V, carefully remove and measure its resistance setting and fit a fixed resistor of similar value in the new position. This method is actually better as it leaves all the other supplies at their original voltages.

OOPS!! Nearly forgot, while you are doing the mods you had better first check the voltage rating of the filter capacitor (may be only 10V) and replace with at least a 16V unit (low ESR Cap), or you will let all the smoke out of the original one by putting twice the original voltage across it. Perhaps do this BEFORE changing the sensing resistor, so that you don't forget it !!.

While we are on the subject of SMPS supplies for the Amateur operator, a recent article in "Amateur Radio" magazine details some mods to an existing range of 13.8VDC SMPS available under various brand names and able to provide 15 to 25amps for the larger HF rigs. They revolve around making the cooling fans in the supply a bit quieter at lower output powers and also filtering the DC output to reduce the switcher noise into the rig under low signal conditions. Your editor and a few other "Homebrew" members are in the process of applying these ideas to not only commercial power supplies but also to converted PC supplies. A future article in this newsletter will detail the results of this work which is a good idea with any of "our" converted/reworked SMPS units.

## Project – New metering head for a remote RF Power Meter (Brian VK2TOX)

PCB and Circuit for QRP RF Power Meter

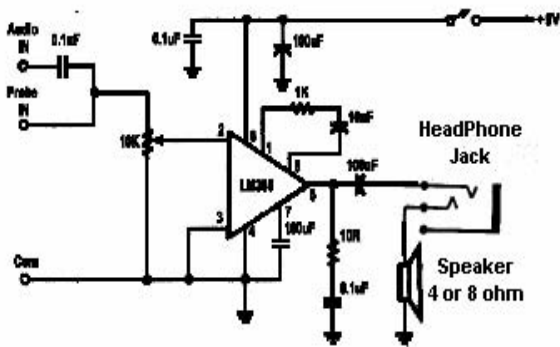


Recently I provided a new home for what initially appeared to be a very nice little RF Power meter, the front panel of which purported to provide a correction factor for the load from 100MHz to 1.5GHz and had full scale ranges of 2, 6 and 15 watt. Very nice, but on closer inspection I realized that there was no RF connector on the case, only a small audio style jack on the back panel. It was of course only the "metering head" and required the remote "sensing head" to make a complete instrument. A quick check of the web and found that the sensing head was available but at a horrendous price, far beyond my meager budget. As I already have a quite decent (200W) RF Dummy Load for testing "normal" transmitters, it seemed that this metering head could form the basis of a compact QRP RF Dummy Load. So as to get it up a running quickly I decided to utilize a small dummy load element in the form of a 15W load inside a circular heatsink and complete with a PL259 male plug. They are available in various brands from most Ham Radio suppliers and are intended to plug straight into the RF output of low power transmitters for off-air tests.

Upon checking the internal dimension of my case I discovered that the 15W load would fit in the case behind the current correction factor control. The hole for the shaft of this control would provide a convenient location for an RF connector. As the metering head is very simply a calibrated meter along with a range and the correction factor control which responds to a DC voltage out of the original remote sensing head, I would need to convert the RF voltage across my 15W load element to a DC voltage, in other words the "guts" of a small power meter. However careful construction would be required to maintain the loads 50ohm impedance over a reasonable frequency range. As the load I was using is rated out to 500MHz I needed to make sure it was still useful out to 70cm, so a small "strip-line" sensing head was needed. To be quite honest I simply used the general dimensions of the sensing head from the old Electronics Australia RF Power Meter and constructed it out of a few scraps of single sided PCB.

Note: The strip-line of the sensor head is made up of a 5mm wide strip of copper on the top board separated from the ground plane underneath by two thicknesses of PCB material as per the sideways view.

### Quick Projects – Signal Tracer (2) – Speaker mods and RF probe



Hands-On Electronics Aug 1988

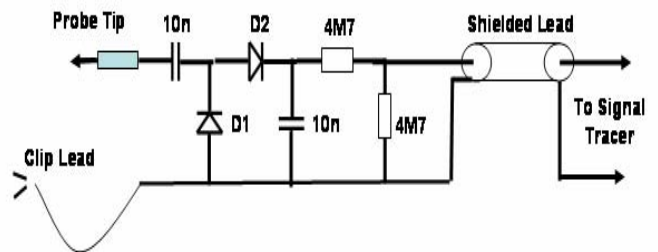
Diodes whose voltage drop is typically 0.2V such as OA90 to OA95 or even an 1N60, the main difference in these devices is the voltage rating as the OA90/1N60 are only 50V whereas the OA91 is 115V. If you don't need to check very low level signals you could use 1N914/1N4148 whose voltage rating is 100V but the drop across these Silicon (Si) Diodes is typically 0.7V thus reducing the sensitivity of the probe.

In Drew's project this probe is actually used to feed a Digital Multimeter or VTVM to measure RF Voltages. However in this project we are using the probe as demodulator probe so as to trace a modulated signal through the stages of a radio. Following is an example of construction of such a probe.

When testing or constructing either analog or digital equipment it often very useful to be able to trace a signal through a piece of equipment. In most cases all that is required is a self contained audio amplifier with reasonable gain and a speaker output.

If you need to trace very small signals then a suitable pre-amplifier in a probe housing would be required so as to reduce the lead length between the tested circuit and the audio amplifier. It would also minimize loading and disruption of the circuit under test. To trace RF or modulated signals a Demodulator or Detector probe would be required again to minimize loading and detuning of the RF circuits.

In this issue we will look at a simple Detector or Demodulator Probe. In the circuit below D1 and D2 are typically Germanium (Ge)



Based on the RF Probe in "Radio Projects" No.2 [VK3XU]

See you in the next issue