Radio Homebrew and Experimenter's Group

An official function of the
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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. Meetings are currently held at Amateur Radio House in Parramatta on the first Tuesday night of each month around 6:30pm to 9pm (doors locked by 9:30pm) **and** on the last Sunday of each ODD numbered month around 12:30pm to 4:30pm (that is after the Trash-n-Treasure). The Technical Book Shop and Technical Library are also usually open at these times for those who can't get in during the week. Cold drinks (leave your money in the fridge) and tea/coffee making facilities (FREE) are also available. Plenty of shops just up the road if you would like to grab something to eat in the hour or so break between the T&T and the Homebrew Meeting. Only a short walk from either Harris Park or Parramatta Stations and usually plenty of on-street parking for these meetings. The Sunday afternoon meeting is usually first a show-n-tell for any works-in-progress or completed projects members are working on and followed by a Technical discussion or demonstration. The Tuesday nights are an informal Technical meeting where people bring in works-in-progress to get help or ideas from the rest of those attending. These workshop meetings are informal get-togethers of amateurs interested in building, or repairing their own radio equipment. Some people bring their latest piece of equipment along to work on or to receive advice, while others offer their experience and advice in helping others.

The group has some pieces of test equipment at Parramatta, while others are brought in for the occasion. If you think that you may need some equipment, then **please contact Peter O'Connell VK2EMU by email or leave a message for him at the Parramatta office** and he will endeavor to have the appropriate piece of equipment available.

This Month

- **Radio Homebrew and Experimenter's Group News**
- **News from other Clubs or Groups which may be of interest**
  - **Incl apologies to Max AFE and Max ARZ**
- **Editors Comments – Apologies for delay on this Newsletter**
- **Technical – Make your own Printed Circuit Boards (2)**
- **Quick Projects – Crystal Test Unit**
- **Quick Projects – Constant Current Source for testing Zeners and LEDs**
- **Where do I get Parts for Homebrew Projects (2)**
- **Need Circuits and ideas for "Project Circuit Folder"**
- **Planned for next issue**

This Newsletter is online at Amateur Radio NSW webpage www.wiansw.org.au

Radio Homebrew and Experimenter's Group News

Sorry, I have not been very well over the last few months and have missed most of the meetings, so don't have much to report.

However the Experimenters Group is alive and well with a number of projects under way including:

10GHz Microwave Link

Peter VK2EMU is coordinating a project based on an EA project of the early 1980's using PWM of a little 10GHz door opener module. A number of us are involved and Peter using his you beaut ferrous bladed drop saw has cut up some aluminum panels to form a very substantial enclosure for this RX/TX unit. The sides of the box open out to provide access to the internal circuitry. Most of us have built our boxes up and another member with some good test equipment is testing and calibrating the microwave modules. Perhaps next issue of this newsletter we can present it as a project.

Fixed Channel HF Rx/Tx

A few of the members have acquired a number of early model Ozzy fixed channel land-mobile HF sets and are modifying them for Ham use. The general idea is to use them for fixed channel monitoring of say, weekly broadcasts, beacons etc. They are excellent sets and method of construction allows them to be readily modified.

A number of other projects are under way but too early to present at this time.

Next Meetings :

Tuesday 5th July 2005 (6:30pm at Wigram St)
Sunday 31st July 2005 (1pm after the Trash-n-Treasure meeting at Wigram St)
Tuesday 2nd August 2005 (6:30 at Wigram St)

News from other Clubs or Groups which may be of interest

As previously explained not much to report here, must chase up my contacts and get to some of the meetings so that we have something for next issue.

Apologies to Max VK2ARZ and Max VK2AFE

In the previous issue of this newsletter the following news article appeared:

Illawarra Amateur Radio Club: This is the only other club I have been to recently. I was invited down there by **Max VK2AFE** who was giving a talk on the G5RV antennae and its applications. Considering Max has problems with his eyesight, this was an excellent presentation accompanied with lots of practical suggestions on the application and installation of this versatile antenna.

It was actually Max VK2**ARZ** who gave the talk at the Illawarra Club. Max VK2AFE came up to me at the last Homebrew meeting and said that he must have used the Stargate transporter because he was at so and so meeting in Sydney and at the Illawarra meeting within five minutes of each other.

Sorry gents, I can only blame the auto correction feature of my word processor for this error, it is very handy but on occasions drives me insane correcting things that don't need correcting.

Editors Comments – Apologies for delay on the Issue

Sorry people but deaths in the family, private matters and ill health have conspired to keep me away from the keyboard over the past few months.

I sincerely enjoy gathering all the information, the production and presentation of the newsletter to all those interested in Ham Radio and in particular homebrewing. It is my way of giving something back to the hobby that has provided such interest and involvement over the years.

Hopefully we are back on line again with regular issues.

Technical – Make your own Printed Circuit Boards (2)
"How to get your circuits into the real world"

(This article compiled by your editor Brian VK2TOX from personal experience and items in various ARRL Handbooks and local journals)

Following is a review of the Circuit construction methods previously listed:

There have been articles in both overseas and local electronics journals involving home fabrication of printed Circuit Boards (PCB's), including an excellent series in recent Silicon Chip magazines on the use of "Autotrax" and making PCB's. A company here in Australia called "Airborn" even has available libraries and drivers for "Autotrax".

I was originally going to describe my efforts at producing (PCB's) by the iron-on laser toner method, but I realized that whilst writing this article I am actually building circuits using no less than seven of the following different methods. All produce excellent results, no one method is better than the other, rather each is uniquely suited to the circuit or equipment being constructed.

So, let's list a number of different methods of constructing or connecting up a bunch of electronic components. **Item 13 has been added to the original listing** as I have seen some very good examples of routing, in fact a small group within the Experimenters Group are working on building an X-Y-Z plotting table to allow machine routing and drilling of a PCB.

1. Tag Strip or Tag Board
2. Matrix Board
3. Wire Wrap
4. "Vero" ™ Board
5. Prototype Boards
6. "Ugly" or "Blob" type construction (sometimes referred to as "point-to-point" wiring)
7. Isolated Pads
8. Cut and Peal (score and peal the copper or score and peal a resist tape)
9. "Dalo" Pen and or stick-on pads
10. "Iron-on" Laser or Photocopier Toner (with or without "Blue" sheet)
11. Screen-print photo resist onto the copper board.
12. Photo-etch using positive or negative artwork
13. Routing or machining of tracks on a PCB

All of the above can be roughly divided into three categories:

A. Items 1 to 7 that **do not** involve etching of a copper clad board
B. Item 8 that may or may not involve etching of a copper clad board.
C. Items 9 to 12 that **do** involve etching of a copper clad board
D. Item 13 does not involve etching of the PCB

Items 1 to 7 rely heavily on the fact that in any circuit a large proportion of the components have one lead either to an earth or supply rail.

Note: The methods of actually producing the circuit diagrams and the PCB artwork is a world of its own which I will cover in another series of articles. Also the process of prototyping a circuit perhaps using one of the many styles of "Breadboards" available is not covered in this article. In this article we are concerned with actually soldering together components to produce a working circuit. SMD components and construction techniques will also be covered in a later article.

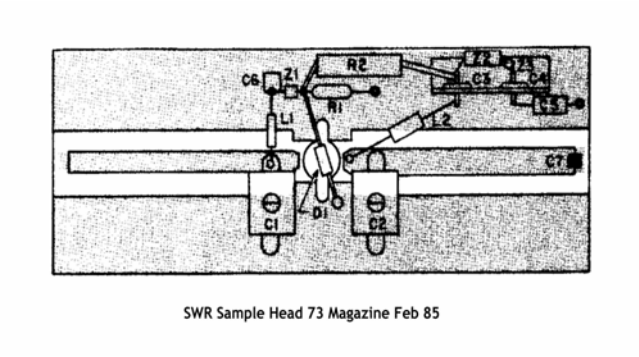
In Issue 02 of this Newsletter we covered Items 1 to 7, concluding with Isolated Pads method of circuit construction. This issue we will continue with methods that actually modify or etch the PCB.

Cut and Peal (score and peal the copper or score and peal a resist tape)

Single Sided Board - With this method we get closer to producing an actual PCB. There are two variations, one where we lift sections of the copper laminate away from the board and the other where we form a simple resist path and then etch the unwanted copper away.

Layout of the circuit board for both is similar to that of the "Isolated Pad" method, in that we have square or rectangular section of copper where we need to connect components. For the "score and peal"

method it is best if sections to be removed originate at the sides of the board and keep the unwanted copper strips fairly narrow.



SWR Sample Head 73 Magazine Feb 85

If the layout is not too complex as in the micro-strip for a sampling head of a power or SWR meter then simply use a steel ruler to guide a sharp blade and score the copper laminate around the sections to be removed. To make sure that wanted copper is not accidentally removed I usually color in the unwanted sections with a red marking pen. Then get your sharp blade and carefully lift the edge of the unwanted copper, heat the strip with a reasonably hot soldering iron and chisel the copper section loose. When a short section is lifted up you can grasp the copper with a small pair of pliers, then using the soldering iron to heat the strip and loosen the laminate adhesive, carefully remove the remainder of the strip. With a little care quite a lot of copper can be removed with minimal damage to the remaining copper laminate.

For more complex layouts or where large sections of copper need to be removed then the etching variation of this method is more appropriate. Here we cover the copper laminate with overlapping strips of adhesive tape. For small boards I use clear “celotape” but for bigger boards I prefer the brown shinny “packing tape” which comes in a few different widths. As with all etching processes carefully clean the copper laminate down to nice shinny copper and NO FINGER prints on it (best wear plastic gloves). Then carefully apply the overlapping strips of tape, just overlap enough to make sure copper is covered and etchant can’t find its way under the tape. Bunch up a soft tissue and rub the surface of the tape to make sure it is stuck down on the copper and there are no air bubbles.

Then use either a marking pen (red) and ruler or trace using carbon paper to transfer the layout pattern to the top of the tape. While again wearing your plastic gloves use a steel ruler and a sharp blade to remove sections of the tape where we want to etch away the copper. Examine the board to make sure all required sections of tape have been removed, any remaining red sections are easily picked up. On a cold day some of the tapes adhesive may be left on the copper that you need to etch, so using a cotton bud dipped in some solvent carefully remove any traces of the adhesive. Don’t slop the solvent on or you risk loosening the rest of the tape. We should end up with a board with the required copper neatly covered by a resistant layer of tape. It is the nature of this method that you will end up with a lot of sharp corners in your tracks, in fact if the etchant gets under the tape it will usually be at these sharp corners. So using your steel ruler and sharp blade go over the board and cut these sharp edges at a 45 deg angle. Check for and remove any adhesive left on the copper and then using your bunched tissue carefully rub down theses edges to make sure the tape is stuck down.

Make up a batch of etching solution using warm water. Yes, I know that a hot solution etches faster but it also lifts the tape off the board, so be patient. Agitate the board in the solution to assist the removal of the copper, when the unwanted copper is removed wash the board in clean water and dry it. Remove the resist layer of tape and clean the board with solvent. You should be rewarded with a nice shiny PCB. Spray the tracks with a “circuit board lacquer” (available in spray pak from your local components store) to protect the copper from corroding. Most of these lacquers can be “soldered through” when assembling the circuit although they are not generally conductive so lay down a pad of solder at the connecting point of you need a metal to metal contact of say a mounting post or terminal.

Double Sided Board – Quite obviously both of the above methods can also be applied to double sided boards regardless whether one side is simply a ground plane or has a pattern cut/etched in it. The ground plane type of layout can produce very stable electrical and mechanical layouts. Depending on what you need to “ground plane” or shield then either the top or bottom layer can be the ground plane, it is often useful to layout your circuit using first the top and then the bottom layer as the ground plane, one of them will usually produce a more compact layout.

If one side is to be a ground plane then simply cover it with a layer of tape observing the same procedures as the side with a pattern on it. If both sides have a pattern on them then obviously use the “single-sided” procedure to layout the pattern on the second side. BUT! Make sure that the patterns of both sides relate to one another, only once do you etch a board with the patterns incorrectly placed !!. It’s a hard way to learn. When I design the layouts for a double sided board I polarize both sides by cutting a corner away on the board and the layouts so that it can be seen at a glance that all is right.

This cut and peel method is particularly suitable for power supply modules, micro-strip lines and small component count RF circuits (PA’s or Pre-Amps). Some excellent examples of the etched version of

this method can be found in Drew VK3XU's series of circuit books where he has implemented both simple and complex circuits.

If you don't require a pattern etched on one side of the board then simply use a quick drying pak of gloss spray paint to coat the plain side of the board. Let it dry and then spray again to ensure a complete coat and that there are no pin-holes in the coating, then carry on with applying the pattern to the other side.

Variation of the above procedures - If the pattern on the copper is not too complex using paint as a resist often works well. Simply proceed as per the first method but instead of cutting away the tape covering the UN-WANTED copper, you remove the tape cover on the WANTED copper sections. Clean up the copper as before then apply a coat of gloss paint either from a spray pak or by a paint brush over the copper. When the paint has dried carefully remove the tape layer to expose the copper to be etched away. With a sharp blade clean up any unwanted paint (it sometimes "leaks" under the tape if you have not smoothed it down properly). Then etch as before, wash and dry the board and then carefully remove the paint with thinners, stubborn bits of paint can be rubbed off with a bit of steel wool. Don't slosh the thinners on or immerse the board in it as the copper laminate adhesive may be loosened with disastrous results.

"Dalo" Pen and or stick-on pads

This is really just an extension of the "Cut and Peal" method. The "Dalo" pen is just one of a number of proprietary brands of marking pens used to draw or paint an etchant resistive ink pattern on to the copper laminate which is then etched in the normal way. In my experience it is very hard to properly cover large areas of copper with these pens. The ink thickness varies and pin holes develop in the ink layer. If you need to retain a larger area of copper on a board for shielding or whatever then better to generate a cross hatch pattern on the board rather than try and "color-in" a large surface. These pens are excellent for repairing or touching-up other methods of pattern layout prior to the etching process.

Stick on pads and tapes can be used to very quickly generate a layout pattern on a copper laminate. Single donuts of various sizes, even complete edge connector or IC layouts are simply removed from their backing tape and placed on the board and tracks run with tapes of various widths. Most of the "rub-on" lettering can also be used in this fashion to provide ID and information on the board. All components are then carefully rubbed down to make sure they are in intimate contact with the board surface.

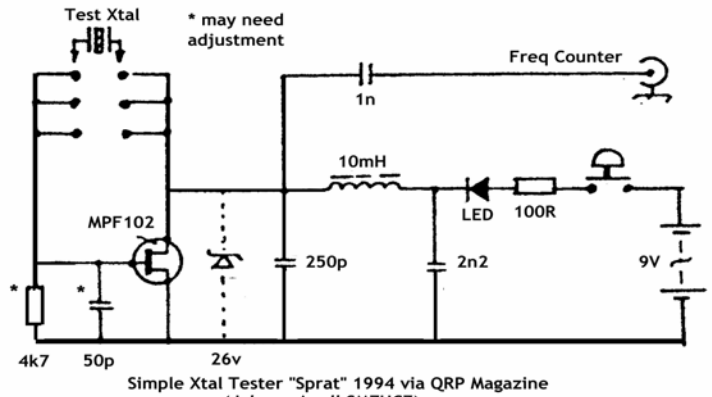
Combining both "Cut and Peel" and "Dalo Pen or Stick-on Pads"

No reason at all why not to combine both methods on a single board, use one method on one side and the other on the alternate side. Whatever gets the pattern on the board for you.
To be continued :

Quick Projects – Crystal Test Unit

While sorting out my own "stock" of various crystals and also a grab bag obtained from somewhere or other, I needed a quick checker to determine whether a particular crystal actually worked and some idea of its fundamental operating frequency. So while searching my own and some circuits Max VK2AFE had passed on to me, I came across a couple of interesting ideas.

The first was a article by Drew VK3XU in AR Feb 1988 for a "Handy Quartz Crystal Checker" which as described by Drew is based on a Colpitts configuration and uses a MPF102 as the oscillator element along with some diodes to detect and a single 2N3904/2N2222 + LED to indicate crystal activity. There is also an output to a frequency counter to measure the crystal oscillating frequency.



Simple Xtal Tester "Sprat" 1994 via QRP Magazine
(Johnny Apell SM7UCZ)

The second was an article by Johnny SM7UCZ in "Sprat" magazine via the QRP magazine here in Australia. It was a much simpler circuit, again based on a MPF102 as the oscillator. The activity or otherwise of the tested

crystal is indicated by a LED in series with the supply line to the FET. The circuit shown was presented (tidied up a bit) with a very brief description of operation. Now presuming that the text is correct the LED dims if the crystal is oscillating and remains bright if the crystal fails to oscillate. This I don't follow as I would have thought that the LED would brighten up as the FET drew current with an active crystal and would stay at a nominal brightness if the crystal failed to oscillate and the FET drew a standing current.

The original circuit was powered by 18Vdc, I have used only 9V and it seems to work OK. The zener diode shown was fitted for "protection" but no explanation of what it was protecting. I guess it either clips the output to the frequency counter or protects the FET from excessive oscillating voltage, either way with a 9V supply I would reduce its rating to 12 or 15 volt and a 400mW rated device should suffice.

As with Drew's circuit there is an output to feed a frequency counter. With both of these units any crystal will of course oscillate at or close to its fundamental frequency. Overtone crystals of 27MHz or 36MHz will indicate 9 or 12MHz respectively. The actual frequency of oscillation is dependant of the test circuit distributed capacitances, in a working circuit these would be kept to a minimum and with a small trimmer to adjust the crystal to the operating frequency.

The lowest frequency crystals in my box are marked I MHz (or actually 1000Kc/s) so I had no need of Drew's additional switched capacitor to get low frequency (455 KHz) crystals to operate, but I might fit it anyway. I did however have to adjust the 4K7 biasing resistor which I thought was rather low in value for a FET. I ended up with a 920K in this position to get reliable oscillation with some known good crystals.

The circuit could be at least initially built up "dead-bug" style on a scrap of PCB until you get it working. Then mount it in a small Jiffy box or my favorite Ham tin from Woolies or Franklins. Like Drew's project I used a pair of clips to grab the crystal leads (any crystal sockets in my junk box are usually needed in a project)

Quick Projects – Constant Current Source for testing Zeners and LEDs

As I get older I am sure they print the designations on components that much smaller every year. Certainly when you have a collection of Zener Diodes from various sources (even if they are sorted out and labeled) I still like to test all components before soldering them in.

Also like diodes I find that in grab bags of LEDs the actual light output can vary considerably, well enough so that if you mount a few on a panel, the brightness is different.

Theory – Testing Zener Diodes .. The "Zener" voltage is the reverse breakdown voltage of the zener diode junction at a specific dc current. By passing a fixed current through the diode and measuring the resultant voltage across the diode with a high impedance voltmeter we can measure the actual "zener voltage" of a particular diode. So that the current remains constant with varying supply and zener voltages it is best to use a "constant current source" to supply the test current.

The operating current of a zener diode is usually such that it dissipates around 0.25 of its rated power dissipation. Although you should drop this down a bit in temperature dependant circuits as the zener voltage is heat dependant, for low voltage diodes I think 6.2V is the cross-over from positive to negative temperature coefficient.

Anyway as a rough measure the diodes about the size of a 1N4148 are usually 400mW, the ones about the size of a half watt resistor are 1W and those around 4mm by 9mm are 5w units.

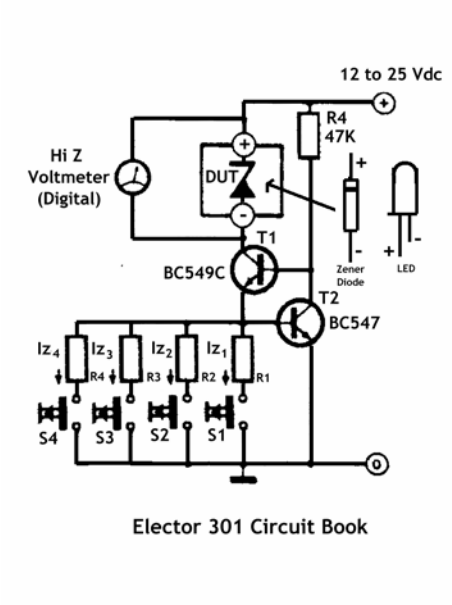
Theory – Testing LEDs .. A LEDs light output is dependant on the applied voltage and the current flowing in the device. Typical voltage drop across a LED is between 1.5 and 2.5volts depending on the size, light rating and color of the individual LED. These same parameters also determine the operating current of between 10 and 30mA although in specialist applications the current can be pulsed up to around 200mA in some units. Around 15 to 20mA is the usual DC current in most LED indicators.

CAREFULL !! As Zener Diodes are Reverse biased and LEDs are Forward biased AND NEITHER like being connected the other way around. See the diagram for connection details.

In this circuit T1 and T2 function as a voltage regulator. T1 receives a bias voltage from the supply through the device under test. However, if the emitter voltage should try to rise above the 0.6V base emitter knee voltage of T2, then T2 will draw more current, pulling down the base voltage of T1 and thus reducing the emitter voltage. Should the emitter voltage of T1 tend to fall below the bas-emitter voltage of T2, then T2 will draw less current, the collector voltage will rise, and with it the emitter voltage

of T1. This negative feedback system means that a constant voltage of approximately 0.6V appears at the emitter of T1.

If one or more of the switches S1 to S4 are closed then a current (I_{test} = 0.6 / R) will flow through one or more of the resistors R1 to R4. This current will also flow through T1 and the device under test (DUT).



Elector 301 Circuit Book

The voltage drop across the DUT should be measured with a high impedance voltmeter so as not to bypass any current around the device. With the switches S1 to S4 as shown there are fifteen different currents available for test.

Resistor values for R1 to R4:

For I_{test} of 5mA then R1 will be 0.6 / 0.005 = 120R
For I_{test} of 10mA then R2 will be 0.6 / 0.01 = 60R
For I_{test} of 20mA then R3 will be 0.6 / 0.02 = 30R
For I_{test} of 40mA then R4 will be 0.6 / 0.04 = 15R

This selection of resistors will provide a switch selectable current from 5mA to 75mA in 5mA steps which should provide the test current for most 400mW, 1w and 5W zeners along with most LEDs in general use. See the attached chart which shows the current provided by each switch (S1toS4) and the resultant test current in the DUT.

The supply voltage of between 12 and 25Vdc will also cover most devices to be tested. A higher supply voltage could be used for higher voltage rated devices although be careful not to exceed the voltage rating of T1 and T2 and of course set the voltmeter for a higher range.

S4	S3	S2	S1	I_{test} mA
0	0	0	5	5
0	0	10	0	10
0	0	10	5	15
0	20	0	0	20
0	20	0	5	25
0	20	10	0	30
0	20	10	5	35
40	0	0	0	40
40	0	0	5	45
40	0	10	0	50
40	0	10	5	55
40	20	0	0	60
40	20	0	5	65
40	20	10	0	70
40	20	10	5	75

The higher test currents of around 75mA are coming close to the BC549C's rating of 100mA so only use them in short bursts and/or fit a heat sink to T1. If the higher currents are used regularly then consider replacing T1 with a BC559 which has a 200mA rating or even a BD139 at 1A rating.

As before I suggest you build up the circuit on a piece of PCB when it is working then box it up in a Jiffy box or a Ham tin (the square ones from Woolies or Franklins). Fit terminals for the voltmeter so that you can leave it connected during tests and suggest you do use push buttons for S1 to S4 that way the tester only draws current or more importantly T1 dissipates power whilst the buttons are closed.

As Huey (the chef on TV) would say, feel free to change the resistor values to suit the devices you need to test. This is only one use for the "constant current source" we will explore more in a further article.

LEDs can not only be used as indicators but as a low voltage reference device also. I have seen them used as the reference element in a constant current source which not only provided a reference current through a calibration pot but could provide that current over a very wide range of supply voltages as well.

Where do I get Parts for Homebrew Projects (2).

I response to last issues article on sourcing parts for your projects I recently received an email from a Ham up near the Queensland border. He was interested in building a 1980's circuit which appears in a copy of the now defunct Electronics Australia and was having some trouble locating a number of parts for the project.

His main problems were the small signal dual-gate FETs and Neosid coil formers. I suggested some sources both local and overseas, however in the meantime he had located a suitable replacement from an Australian supplier. I checked Neosid's web page but could not locate the coil formers amongst

their present stocks, so sent an email enquiry. Quite quickly I received a reply indicating that in fact they still had stocks of the original former and core but it was now listed under a revised part number. Details of the new part numbers and pricing along with instructions for mail order were provided which I passed along.

With a little help from a local ham and this sourcing of parts the project is now well under way. Hopefully when it is finished we will get a review for this Newsletter.

Need Circuits and ideas for "Project Circuit Folder"

For the benefit of our members I would like to build up a file of "building-blocks", that is self contained circuits we can use to construct or modify a complete piece of equipment. It is usually easier to build up a piece of gear, be it a piece of test equipment or a RX/TX by breaking it up into a number of modules. It is also easier on the pocket book too. That way you can be assured of functionality before moving onto the next module and also get quite quick results, rather than quite a long time on a one piece of gear.

Also of interest are circuits of small pieces of test equipment that members could "knock-up" to assist them in testing or aligning the gear they have homebrewed.

Thanks again to Max VK2AFE who brought in another selection of circuits from his own "must-do" file. I have scanned these in and they will be most useful.

So scribble a circuit down on a piece of toilet paper, photocopy an idea or email ideas/circuits to Brian VK2TOX (as per Call-Book or email address on front page). You can even hand it to him as he is there at most meetings.

This compendium of circuits will be available at meetings and eventually in booklet form to members. I am currently putting together some circuits to get it started, but I need your support too.

At the Homebrew we have a growing collection of passive parts, xtal osc modules and other useful parts, also an interesting quantity of various IC's. Most of these are older types but still quite useful to build projects around. These bits are NOT currently for general sale as they are primarily to help in developing projects.

A series of one page projects will appear shortly in this newsletter, we are hoping to put together kits of parts (incl PCB) to help those interested who don't have ready access to electronic parts.

This Newsletter online at Amateur Radio NSW web page

The Radio Homebrew and Experimenters Group is on the net, just go to www.wiansw.org.au and look for "Homebrew News" for latest news on the group and a "pdf" copy of this newsletter. Let your friends know too. We will shortly have our own email address, meantime just send any email to Parramatta office.

Planned for next issue

In the next issue we will continue the series on the HF Impedance Bridge with Calibration and Testing of this very useful piece of equipment.

Hopefully a bit more news on the various Ham clubs around Sydney and news on the various projects being designed and built at the Homebrew meetings.

For "Quick Circuits" we will have a Transistor Tester and a Signal Tracer. I hope to have written up an article on behalf of Max VK2ARZ on his Audible Signal Strength Meter.

For our "BIG" projects there will be more information on the 10GHz transceiver, the fixed channel HF TX/RX and also some details on the X-Y-Z Plotting unit being worked on by a small group.

.END..