THE PROPAGATOR

MONTHLY NEWSLETTER OF THE ILLAWARRA AMATEUR RADIO SOCIETY

PO BOX 1838 WOLLONGONG NSW 2500

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MEETINGS ARE HELD ON THE SECOND MONDAY OF EACH MONTH (EXCEPT JANUARY) AT 7.30 P.M. IN THE CONGREGATIONAL HALL, CORNER OF COOMBE AND MARKET STREETS, WOLLONGONG. VISITORS ARE WELCOME TO ATTEND MEETINGS.

NOTICE OF MEETING: The next meeting of the I.A.R.S. will be held on March 12th and will be the Annual General Meeting and Election of Officers. All positions will be declared vacant and we particularly ask for nominations for: Broadcast Officer, Propagator Editor, Storepersons, and Publicity Officer. Don't leave it all to the other fellow, the Club needs YOUR help.

QUESTIONNAIRE: You will note the inclusion of a Questionnaire in your Propagator. Jo. Harris, the VK2 Historian, has taken on the enormous task of compiling a "Who's Who" of past and present hams and callsigns in N.S.W., and asks you to complete and send the form to her at the address given. Any questions you feel you don't wish to answer just leave blank. We ask for your co-operation.

NEW CALLSIGN: Fisher's Ghost Amateur Radio Club (Campbelltown) is now VK2FFG, was previously VK2PFG. This Club holds a 10 metre Net every Sunday night on 28520 kHz and an 80 metre Net every Friday night on 3580 kHz. If you want to join in these Nets you will be made very welcome.

LAST MONTH'S MEETING: The first meeting of the I.A.R.S. for 1984 was held on February 13th in the Congregational Hall, and was attended by about 50 members. There were two visitors, both ladies - Noran who is attending classes at Tech., and Angie, Graeme VK2CAG's attractive XYL who had come to give members the chance to buy I.A.R.S. Tee Shirts. Both ladies received the usual warm welcome. Opening the meeting, President Dave VK2DFL told us that Jim VK2QU was in Shoalhaven Hospital and that Jim VK2EJM had that day arrived home from hospital. We wish both a speedy recovery. Roy VK2KO proposed the formation of a committee to look into the holding of an annual Field Day. If you're interested, see Roy. Ken VK2DOI asked members to consider submitting articles or ideas for articles for the Propagator. We will do any re-writing necessary. Dave VK2EZY told us that there had been 4 entries for January in the Kilometre Kontest, and as there were 4 prizes each would receive one. Dave VK2DFL drew the attention of the meeting to the Club's monthly RTTY broadcast which thanks to Mike VK2DFK was for the first time computer-generated. Denis VK2DMR then conducted an auction of various gear from Keith VK2OB.

On display was a selection of ICOM and Kenwood gear put on by Barry VK2FE from Macelec. Unfortunately Barry was unable to be present to demonstrate the equipment.

NO SMOKING: Members' and readers' attention is drawn to the No Smoking signs now up in the Congregational Hall, necessary due to insurance risks etc. There will be a 5 minute break every 30 minutes or so during the meetings to allow smokers to have a puff outside.

SUBSCRIPTIONS: The Committee regretfully advises that due to increase in running costs, a rise in subs to the Society will have to be made, these being: Full Members $10.00 Pensioner/Student $5.00 due and payable as from the March meeting.

FEBRUARY REPEATER REPORT

SUBLIME POINT WAS HIT BY LIGHTNING ON 7/2/84. EXTENSIVE DAMAGE WAS DONE TO 7275 REPEATER. 5 CMOS IC'S, ONE TANTALUM CAPACITOR, A ZENER DIODE AND A FUSE GOT THE REPEATER WORKING AGAIN AND THE BATTERY CHARGER HAD TO BE ALMOST REBUILT. 8725 SEEMS TO HAVE ESCAPED WITH JUST A BLOWN FUSE.

LIGHTNING APPEARS TO HAVE STRUCK THE POWER POLE NEXT TO THE AERIAL MAST, SENDING A SURGE THROUGH THE MAINS WIRING. THE METER BOX SUPPLYING POWER TO THE REPEATER AND ADJOINING PROPERTY WAS BLOWN APART. IT TOOK THE I.C.C. AND AN ELECTRICAL CONTRACTOR 2 DAYS TO REPAIR THE WIRING AND RESTORE MAINS POWER. WE WERE THE LUCKY ONES --- YOU SHOULD HAVE SEEN THE DAMAGE DONE TO THE COMMERCIAL SERVICES SHARING THE SAME SITE. EVEN THE TELECOM LINE CONTROLLING THE COMMERCIAL BASE STATIONS HAD MELTED WHERE IT PASSED UNDERGROUND A FEW METRES FROM THE BASE OF THE POWER POLE.

THE BATTERIES WENT FLAT AFTER ONLY ONE DAY WITHOUT POWER, SO THEY WERE REPLACED WITH GOOD ONES DONATED BY BARRY VK2BUB.

REPAIRS TO SUBLIME POINT WERE COMPLETED AND THINGS BACK TO NORMAL ON 14/2/84.

ANNUAL REPEATER REPORT

FEB 83
------ CONSTRUCTION OF 7275 REPEATER COMPLETED. SITE NEGOTIATIONS FINALISED AND CUBICLE AND BATTERY BOX INSTALLED AT SUBLIME POINT

MARCH 83
-------- AERIALS FOR 7275 AND 8725 CONSTRUCTED AND INSTALLED AT SUBLIME POINT.
7275 REPEATER INSTALLED ON SITE AND COMMISSIONED ON 14/3/83.

APRIL 83
-------- NEW CMOS IDENT UNITS CONSTRUCTED FOR ALL OF OUR REPEATERS AND ONE EACH FITTED TO 6850 AND 8225.
NEW BATTERY CHARGING SYSTEM FOR MT. MURRAY MADE UP AND INSTALLED.
CONSTRUCTION STARTED ON UHF REPEATER 8725.

MAY 83
------ NEGOTIATIONS SUCCESSFULLY CARRIED OUT WITH THE OWNERS OF COMMERCIAL SERVICES LOCATED AT SUBLIME POINT RESULTING IN FREE POWER AND ACCOMMODATION FOR OUR REPEATERS AT THAT SITE.

JUNE 83
------- NEW 9DB GAIN TRANSMITTING AERIAL INSTALLED AT MT. MURRAY.
SURVEYS WERE CONDUCTED TO CHECK THE FEASIBILITY OF SOLAR POWER FOR MT. MURRAY.
8725 REPEATER CONSTRUCTION COMPLETED AND THIS NEW UHF REPEATER WAS INSTALLED AT SUBLIME POINT AND COMMISSIONED ON 29/6/83.

JULY 83
------- A NEW ENCODER SYSTEM WAS DEVISED AND BUILT AND COMMISSIONED FOR MT. MURRAY FOR REMOTE SWITCHING OF RECEIVERS BY A NUMBER OF OPERATORS. THIS ENSURED RELIABLE RELAYS OF THE W.I.A. BROADCASTS.
DECISION WAS MADE TO USE WIND POWER RATHER THAN SOLAR AT MT. MURRAY.

AUGUST 83
-------- RTTY REGENERATOR FOR 7275 BEING DESIGNED AND BUILT.

SEPTEMBER 83
---------- THE GPV5 RECEIVING ANTENNA AT MT. MURRAY WAS DAMAGED BY WIND AND WAS REPLACED WITH A DIPOLE.
THE WIND GENERATOR WAS PURCHASED AND INSTALLED AT MT. MURRAY.
ALSO BATTERY CHARGE LEVEL SIGNALLING WAS FITTED TO THE IDENT UNIT.
A NEW BATTERY CHARGER WAS MADE UP TO REPLACE THE TEMPORARY ONE AT SUBLIME POINT.

DECEMBER 83
---------- MT. MURRAY LANDLINE FAILS MAKING THE REPEATER TOTALLY DEPENDANT UPON WIND POWER.
CONSTRUCTION STARTS ON A REMOTE CONTROL TELEMETRY SYSTEM FOR 6850.

JANUARY 84
---------- TROUBLE FREE OPERATION OF ALL 4 REPEATERS OVER THE HOLIDAY PERIOD --- A GOOD TEST FOR MT. MURRAY WIND POWER SYSTEM.

FEBRUARY 84
---------- EXTENSIVE REPAIRS DONE TO SUBLIME POINT INSTALLATION AFTER DAMAGE BY LIGHTNING.
NEW BATTERY BANK FITTED AT SUBLIME POINT.
PUBLICITY CAMPAIGN STARTED TO INCREASE AWARENESS OF THE MEANING OF THE BATTERY LEVEL SIGNALLING OF ALL USERS OF 6850 MT. MURRAY.

FINALLY I WISH TO THANK THE REPEATER COMMITTEE MEMBERS AND ALL WHO HELPED OUT DURING THE YEAR IN MAINTAINING AND IMPROVING OUR REPEATERS, AND MAKING MY JOB SO MUCH EASIER.

GRAEME VK2CAG

U.H.F."KILOMETRE" 1948

Realizing that quite a few "Explorer" rigs are still under construction, entries for the first month of the contest were down on expectation- but the blokes that had a go have established points at least.For Prospective entries in the month to come,please hand to me (Dave VK2EZY) at the monthly meetings or in my absence Graeme VK2CAG and he will pass them along.
Results for the January leg are:
1 Reg VK2EMI - Vincentia- Port Stevens - 5 points
2 Ian VK2EXN - Warilla - Newcastle - 4 points
3 Lyle VK2ALU - Ulladulla - Thirroul - 3 points
4 Graeme VK2CAG - Robertson - Dural - 2 points
5 Roy VK2KO - Barrack Pt. - Port Kembla - 1 point
An interesting point to note,Reg's entry was using only 800 mW,Lyle with an indoor ground Plane Antenna,Ian,Graeme and Roy using "Explorer" rigs,with no entries using over 10 watts.So to the chaps who have their Rigs "almost"finished - fire up the soldering iron and get to it. I beleive there are still some of those beaut Antenna Kits in the Store Looking for more results in the next few month.Good luck for the Duct!!!

Dave VK2EZY

PHONE PATCHING.
Telecom has released guidelines on phone patching in this country, which includes the amateur service.
Australian amateurs will be able to use type approved phone patch equipment that was wired in place by Telecom.
For further details contact your nearest Telecom Business Office.

Moonbounce Report March 1984.

Further information was sent to D.O.C. in support of our application for a High Power Permit for EME operation.

Details of equipment capability at VK2AMW and of our Moon window etc. were forwarded to SP5CIC/SMØ, who is the EME Skeds Coordinator, to allow him to integrate our station into proposed test programmes at times and on frequencies which are not set down for use by other stations. This information is then forwarded to all EME stations each month to cover the scheduled activities on 432 and 1296MHz during the next 4 weeks, as well as their reports on results of tests, equipment modifications etc. carried out over the previous month.

Changes were made to our transmitter 144MHz Frequency Source keying circuit to clear up the bad 'chirp' on our CW carrier which had been reported following the EME test with G3LTF on 22/1/84. A subsequent report on our signal by VK5MC indicates that this problem is now cured.

An EME test was carried out with VK5MC on 16/2 but it did not result in a contact. Signals were heard at approx. 0dB above noise level but callsigns and signal reports could not be completely copied. VK2ALU and VK2EXN were present for this test.

Another EME test was carried out on 18/2/84 (Sunday 19/2 our time) with OE9XXI and OK1KIR. Flood rains in the Wollongong area over the previous 24 hours and continuing heavy cloud during the test period did little to assure us of chances of success. Nevertheless, contacts were made with each of these stations!

By good fortune, the dish was pointed at the Moon with sufficient accuracy to allow us to hear OE9XXI even though we could not hear our own echoes. After adjustments were made to dish pointing to maximise his signal strength, it was possible to copy him at 3 to 5dB above noise. '0' grade reports were exchanged during the contact.

OK1KIR was then heard calling us at his scheduled time. His signal was not as strong as OE9XXI but was sufficiently above noise level to allow 'M' grade reports to be exchanged.

We then listened for VK5MC until the Moon went down as had previously been arranged, but nothing was heard from him or from any other station. VK2ALU and VK2KAJ were present for this test period.

The new preamplifier, which uses a GAT6 transistor, is now available. It has a noise figure of 0.5dB (35 degrees Kelvin Noise Temp.) and a gain of 16dB. As it is fitted with SMA input and output connectors it has been necessary to send overseas for mating items. It also requires a specially designed power supply to minimise chances of damage to the GASfet. This is being built.

The next EME tests are tentatively scheduled for the weekend of March 17th-18th.

Lyle VK2ALU.

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PRESIDENTS REPORT February 1984.

I am pleased to present my first report as President of the I.A.R.S., and to basicly outline some of the achievments of the club during past 12 months.

Firstly the upgrading of the Mt. Murry repeater to Wind power, the installation of the UHF and UHF repeaters at Sublime Point to service the Northern Suburbs and beyond, the excelant UHF site at Hill 60 at Port Kembla have all been achieved by the untiring efforts of Graeme VK2CAG and his repeater committee. No doubt an excelant result that any club would envy having 4 working, trouble free repeaters on call at any time, and these are also well supported by outside use as well as our own club.

Secondly the culmination of many man hours of hard work by Lyle VK2ALU and more recently with the help of some volunteers, the successfull reactivation of the E.M.E., Project with the first contact being into Zimbawe in October last year, and now many more skeds arranged with stations wishing to work VK2AMW. Congratulations Lyle....

To you! The members of the club, for the support given in fund raising to help these projects to become a reality, THANK YOU...

With the AGM being the next meeting i would like to see a good roll up of members to help fill the positions available on the committee.. Please don't stay away because you may be afraid of landing a job, as it IS your club and you should have the say as to whom should be running it. We would like to see a few new faces have a go at the committee , as the same old few have been about for quite a while, BUT this may also mean that you as members are satasfied with the way that things are run. If not , then come along and change it. IT'S UP TO YOU.....

On Saturday 18th February, I recieved an official call for help from Denis VK2DMR, to arrange to have 3 stations stand by to assist the State Emergency Service with Communications via RTTY to list the names of the Evacuees from the floods in the Dapto and Lakeside area's. These stations were needed at 6.30 pm that night and were on the air 1 Hour after being called in . It shows that we as Amateur Radio op's can assist the Emergency Network with the knowledge and equipment at our disposal. Many thanks to Mike VK2DFK, Morry VK2EMU, Ian VK2EXN, Ray VK2XCC/PHD, Sep VK2KIH and to my XYL Jenny for the help given on the night. It proved to be an invaluable exercise, both for the club and also the SES and other organizations.. To the club members involved , THANK YOU! from Denis and myself.....

This year the club hopes to establish a Field Day, and to run this we need a field day committee, so see Roy VK2KO, at the meeting if you are interested in joining in something that the committee feel will be a worthwhile addition to club activities to promote the I.A.R.S. and to help with fund raising..

Cont.. 6 pp.

I regret to advise that due to increased running cost's, the due's to the Society will have to rise. As from the AGM, Fee's will be, FULL MEMBER $10.00..
STUDENT $5.00..
PENSIONER $5.00..
This is , compared to other associations still quite resonable and we hope that you will still support the club with your membership..

In conclusion I wish to thank you, the members of the I.A.R.S. for the support shown to the Committee and Myself in the running of the Society. I hope that 1984 will be a kind year to you all and that I may be able to serve you again in a position on the committee during 84/85. 73,

Dave VK2DFL.
President, I.A.R.S.

Below is a list of Positions available at the AGM. Please look them through and make a note of who you wish to nominate..

ANNUAL GENERAL MEETING

At the forthcoming Annual General Meeting, Monday March 12th, the following committee position will need to be filled - please lend your Club your support.

President	-	*1*
Vice President	-	*1*
Secretary	-	*1*
Treasurer	-	*1*
Auditor/Registrar	-	*1*
Committee	-	*8*
Broadcast Officers	-	*3*
Repeater Chairman	-	*1*
EME Co-ordinator	-	*1*
Propagator Editors	-	*2*
QSL - IN	-	*1*
- OUT	-	*1*
Publicity Officer	-	*1*
Store	-	*2*

Murray VK2MY

INTRUDERS:

contributed by Bill Martin, VK2EBM,
Federal / VK2 I.W. Co-ordinator.

Strange transmissions heard on the Amateur bands cannot, arbitarily, be immediately classified as intruder stations. It depends on where they are in the HF spectrum, and what type of signal is being used.

Here is some information which may clarify the position as regards when and where an apparent intruder IS IN FACT an intruder.

1800-1825 kHz: Amateur Service is the PRIMARY Service. EXCLUSIVE to Amateur Operators.

1825-1875 kHz: Amateur Serivce is the SECONDARY Service. NOT EXCLUSIVE TO AMATEUR OPERATORS.

3500-3700 kHz: In IARU Region 111, the 80-metre band is shared with fixed Services. It is not exclusive to the Amateur Service. RTTY/CW signals CANNOT be considered to be intruders. BROADCAST stations, however, ARE intruders.

3794-3800 kHz; AS ABOVE.

7.000-7.100 MHz. The Amateur Service is the PRIMARY Service. This segment is exclusive to Amateurs. Any non-Amateur signal is an intruder.

7.100-7.300 MHz. This segment is shared with BROADCASTING STATIONS ONLY. Any non-Amateur signal other than broadcasters can be considered to be intruders. Non-Amateur RTTY/CW signals ARE intruders.

10.100-10.150 MHz. This band is presently shared with fixed stations. The Amateur Service does not have exclusive rights. Broadcast stations ARE intruders.

14.000-14.250 MHz. The Amateur Service is the PRIMARY Service. This Segment is EXCLUSIVE to Amateur Operators. Any non-Amateur signals are intruders.

14.250-14.350 MHz. This segment is shared with Iran, The Peoples' Republic of China, and the USSR fixed Services. It is NOT exclusive to the Amateur Service. RTTY/CW signals cannot be considered to be Intruders. Broadcasters ARE intruders.

18.068-18.168 MHz. The Amateur Service SHARES this segment with fixed Services. Non-Amateur RTTY/CW are NOT intruders. Broadcasters ARE intruders.

21.000-21.450 MHz. The Amateur Service is the PRIMARY Service. This segment of 15 metres is EXCLUSIVE TO AMATEUR OPERATORS. Any non-Amateur signals are intruders.

24.890-24.990 MHz. This band is shared, and non-Amateur RTTY/CW are not intruders. Broadcasters ARE intruders.

28.000-29.700 MHz. The Amateur Serivce is the PRIMARY Service. This segment is exclusive to Amateur Operators. Any non-Amateur signals ARE intruders.

So identifying intruders is not as easy as it first seems. You must satisfy yourself where they are, and who is entitled to be there, and what kind of transmission is authorised to be there.

George Hovorka WA1PDY
John Hovorka, Jr.
674 Brush Hill Road
Milton MA 02186

The Oily Resistor Wattmeter

-- how to put 20 W into a 1 W resistor

Often after an FM rig becomes a few years old, it is desirable to retweak the final output stage. But if you don't have a dummy load and an inline wattmeter, this job can be a problem. Here is a simple device to tune up your two meter transceiver for maximum power output. It is both a dummy load and an rf indicator, and can be built for less than a dollar. It can be used for FM rigs up and into the 20 Watt output class.

The usual problem with constructing a dummy load is finding a resistor which will handle enough Watts and also remain relatively nonreactive at 146 MHz. In our design, this problem is solved by using a 50 Ohm, one Watt composition resistor, and immersing it in a small jar of oil. We can run 18 Watts into this setup for a few minutes without the oil even getting warm. I have used this method successfully to tune up my Regency HR2B and my TR-22. The diode and the capacitor serve as an rf indicator.

This device is constructed by wiring the diode, capacitor, and resistor together as shown in the wiring diagram. Then this assembly is wired to the leads of a piece of RG-58 coaxial cable. Run a separate piece of hookup wire out from the diode and then punch a hole in the top of a baby food jar. Slip the assembly through, and seal the hole with epoxy. Then fill the jar with a high viscosity motor oil, such as SAE 30 or 40. Close the jar top tightly. Then connect a PL-259 connector to the end of the piece of coaxial cable.

To use your dummy load-rf indicator, connect the PL-259 to the back of the radio. Put your VOM on the plus 10 volt dc scale, and connect the positive lead of the VOM to the wire which runs out from the diode. Connect the negative line from the VOM to the braid of the coaxial cable or to the chassis of the radio. Place the transmitter on a frequency which falls in the middle of the frequencies which are used (146.52 MHz). Tweak the capacitors in the final output stage and driver stages with a plastic alignment tool, until you have the maximum indication on the VOM.

With this setup, you can peak your transmitter for maximum output both simply and inexpensively. ■

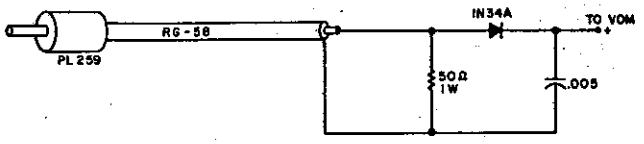
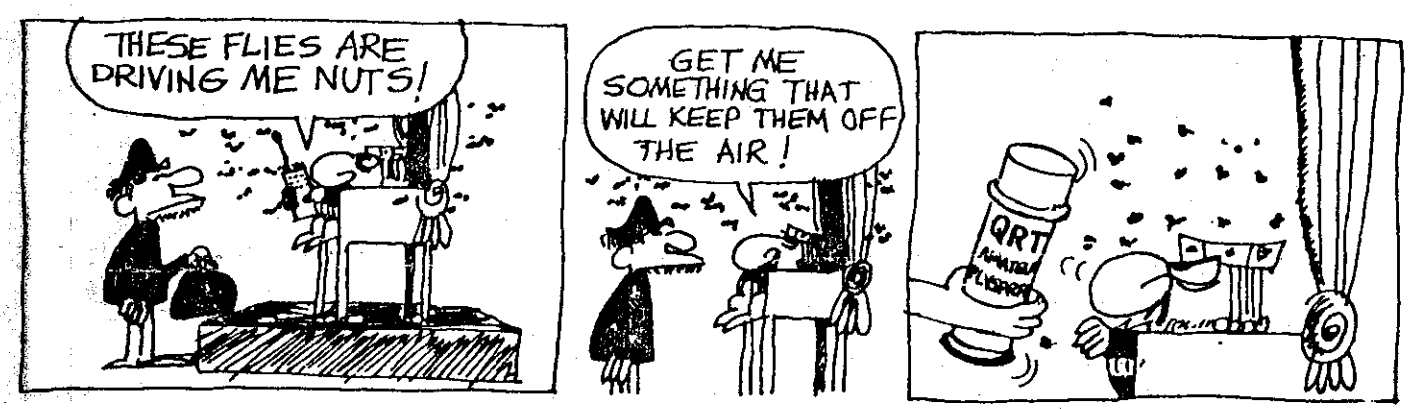


Fig. 1. Wiring diagram.

Parts List

PL-259 connector
18" length of RG-58 coaxial cable
1 W 50 Ohm composition resistor
1N34A or equivalent germanium small signal diode
.005 disc ceramic capacitor
Hookup wire
Baby food jar
SAE 30 motor oil
VOM
Epoxy

From "73"



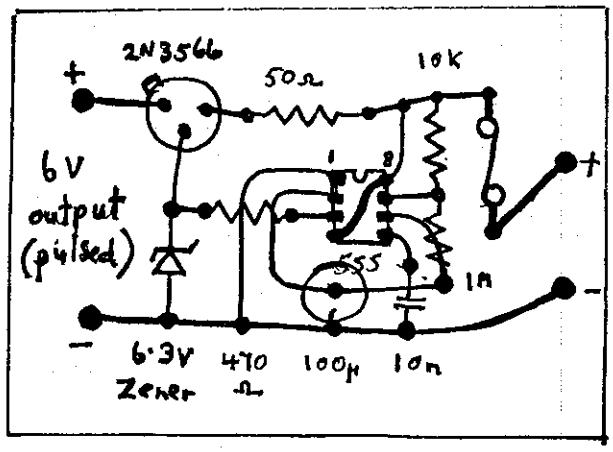
DOI DOINGS de VK2DOI

"Home Theft Soars to $60m" - The Daily Telegraph, January 5th, 1984.

Do headlines like these worry you, especially when you are away from home on holidays? Or do you have a failsafe burglar alarm system, probably costing hundreds or thousands of dollars, which lets you leave your house unattended with an easy mind? Most of us don't have such a system; rather we take the obvious precautions of cancelling mail and papers, lock up and hope for the best.

But accumulated 'junk mail' and unmowed lawns are big giveaways, and so is the 'dead' look of closed and shuttered windows and absence of lights at night. Sure, you can get someone to call in and clear the letter box, water the garden and mow the lawn, but how do you make the house look occupied? Well, I calculated that I could leave a couple of fluorescent lights on twentyfour hours a day for little more than the cost of the electricity 'standing charge', one light being allowed to illuminate the shaded back patio through a window. The second one, a desk lamp, gave a light in the lounge room visible through partially closed venetians, giving I hoped the impression of light from a television set. A mains-powered FM radio tuned to Channel 4 TV sound on 101MHz completed the illusion. A time clock is not necessary with such low power devices, better to let them run continuously.

For the rest of the house I brought into use an old car battery that would not hold sufficient charge to start a car. However, it lasted three months in the following circuit which uses the ubiquitous 555 timer, to provide regulated 6v to an old battery transistor radio, pulsed approximately 90 secs on and 90 secs off. I decided that this time interval would deter any prospective intruder and give the impression of a human presence even if the mains supply should be interrupted. Of course, I have no way of knowing if this system fooled anyone, but at least we returned to an unburgled house. The next step is a concealed alarm system in addition, several designs of which have been published. Comments and experiences of their relative merits would be welcomed by the editor.



COMPONENTS

1	555 Timer i.c.
1	n.p.n. transistor
1	50 ohm ½W resistor
1	10k resistor
1	1 megohm resistor
1	470 ohm resistor
1	6.3 volt zener diode
1	100 uF 16v electrolytic
1	10 nF ceramic capacitor
1	250 mA fuse and holder

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THE SHOW CAN'T GO ON - An English provincial newspaper has published the following bulletin from the local drama club: "We regret to announce our January production, The Last of The Red Hot Lovers, has had to be postponed because one of the cast became pregnant during rehearsals."

DAILY TELEGRAPH, December 5th 1983

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The maximum power transfer theorem

Why do we not match loads to the output resistance?

by S. W. Amos B.Sc., M.I.E.E.

ELECTRONIC equipment contains many examples of signal sources connected to loads: a microphone feeding an amplifier, an amplifier driving a loudspeaker and an i.f. stage leading to a diode detector are a few typical examples.

In each of these a signal is transferred from a generator to a load and the circuit can be represented in essentials as in Fig. 1, in which the generator is shown with an internal resistance r_g and the load is a resistance R_L. If it is desired to transfer maximum signal voltage from generator to load then R_L should be large compared with r_g but if maximum signal current transfer is required R_L should be small compared with r_g.

To transfer maximum power from generator to load, R_L should be equal to r_g. This can be shown readily by mathematics. The current in the load is given by $I = E/(r_g+R_L)$ and therefore the power I^2R_L is equal to $E^2R_L/(r_g+R_L)^2$. This is a maximum for given values of E and r_g when $R_L=r_g$. When R_L equals r_g the voltage across the load is one half the open-circuit voltage of the generator (i.e. the value obtained across an infinite load resistance) and the current in the load is one half that delivered by the generator into a zero-value load resistance.

Now transistors and valves behave approximately as resistive generators and Fig. 1 is often used as the equivalent circuit for an active device, r_g being replaced by r_a, the anode a.c. resistance of a valve, or r_c, the collector a.c. resistance of a bipolar transistor, or r_d, the drain a.c. resistance of a field-effect transistor. It is rare, however, in practical circuits to find an active device driving a load equal to its own internal resistance. For example a rule of thumb commonly advocated to obtain maximum output power from triode valves is $R_L = 2r_a$ whereas for pentode valves the recommended optimum load is usually a small fraction of r_a (e.g. a pentode with r_a = 100 kilohms might require an optimum load of 7 kilohms). For transistors there is in general no apparent relationship between the optimum load and the transistor internal a.c. resistance.

Fig. 1 can also be taken as representing the output stage of an amplifier as indicated in Fig. 2, and here the generator internal resistance is shown as r_{out}, the output resistance of the amplifier. If the output stage of the amplifier consisted of a single transistor without feedback r_{out} would be equal to r_c but it is common practice in linear amplifiers to apply considerable negative feedback, one effect of which is to reduce the effective value of r_c. Thus r_{out} is normally small compared with r_c and in high-quality amplifiers is commonly only a fraction of an ohm – smaller than likely values of load resistance. The ratio of load resistance to output resistance is known as the damping factor and a typical value is 25. For maximum power output the load resistance should, according to the maximum power transfer theorem, be equal to r_{out} so here is another example where the theorem is apparently ignored.

Consider a typical transistor stage which is required to deliver appreciable power. An example is the final i.f. stage in a receiver which is required to feed a diode detector. The mean collector current of such a stage might be 3mA and the mean collector voltage 9V. For a silicon planar transistor the collector a.c. resistance might be 1 megohm but if the circuit connecting the transistor to the diode is designed to present the transistor with an effective load of 1 megohm then it is immediately obvious that full advantage cannot be taken of the collector current swing available. The maximum undistorted current swing available is 3mA but this, in a 1-megohm load, will generate a collector voltage of 3kV! In fact only a 9-V collector voltage swing is possible without distortion and this can be generated across a 1-megohm load by a current swing of 0.009mA – less than one three hundredth of that available! The power output under these conditions is less than 0.05mW, certainly insufficient to drive a diode detector.

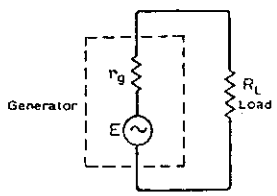


Fig. 1. *A purely-resistive load R_L connected to a purely-resistive generator r_g.*

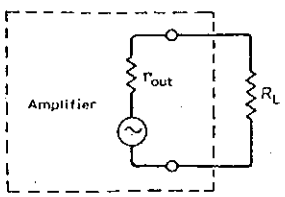


Fig. 2. *The circuit of Fig. 1 arranged to represent conditions at the output of an amplifier.*

Thus in this example the transistor could not be presented with a load equal to its own r_c because of the enormous collector voltage excursion which would be required to make full use of the current swing available. A more practical value of collector load resistance is 3 kilohms, for this makes full use of the current swing of 3mA and the voltage swing of 9V. The power output so obtained is 13mW, quite adequate for diode detector operation.

Now consider an emitter follower stage and suppose the emitter current is 1mA. The emitter a.c. resistance will be of the order of 25 ohms and, according to the maximum power transfer theorem, this should also be the resistance of the optimum load. Let us suppose that the transistor has a supply of 9V. The emitter potential swing is then limited to ±4.5V but to generate such a value across a 25-ohm load requires an emitter current swing of 180mA! The maximum swing possible is only 1mA; giving a maximum output voltage swing of 25mV. In this example we could not use a load resistance equal to the output resistance because of the very high emitter current required.

In the two examples described above use of a load resistance equal to the output resistance necessitated a very high output voltage or output current. This was because we were attempting to obtain the maximum output power of which the active device was capable with the given values of quiescent collector voltage and current: in fact we were trying to make maximum use of the available voltage and current swings, which is a normal design procedure for stages required to deliver appreciable power. But suppose instead we give the transistor an input signal so small that even with a load resistance

equal to the collector a.c. resistance the swings in collector voltage and collector current are small compared with the quiescent values. Admittedly this is an impractical form of amplifier because the output power would be minute, but the point is whether with such a small signal the optimum load is equal to the collector a.c. resistance.

It is interesting and instructive to try to answer this question using the transistor characteristics. Fig. 3 shows an idealised set of I_c-V_c characteristics, the slope of which is equal to the reciprocal of the collector a.c. resistance. Q is the quiescent point representing the static values of collector voltage and current. Through Q is drawn the load line PQR, the slope of which is equal to the reciprocal of the load resistance. If the small input signal swings the base current between the limits of I_{b1} and I_{b2} then the output current swing is given by PS and the output voltage swing by RS. The area of the triangle PRS is proportional to the power output: in fact if the area is expressed in terms of the horizontal and vertical scales it is equal to four times the power output. As the load resistance value is varied, the load line pivots about Q and the area of the triangle varies. For very small load values PR is nearly vertical and side RS tends to zero, whereas for very high value loads PR is nearly horizontal and PS tends to zero. Between these two extremes there is a position of PR which gives maximum area of PRS.

The solution to this exercise is that the area is a maximum when the slope of PR is equal to that of the characteristics, i.e. when the load resistance is equal to the generator resistance, thus confirming the maximum power transfer theorem. As we have seen this is true provided very small signals are used, and this is a useful reminder that the equivalent circuit for active devices applies only to small signals.

What has been said about the impracticality of using the theoretical optimum load in an amplifier with normal signal amplitude will help us to understand the observation made earlier that the load resistance for a high-quality amplifier is usually many times the output resistance. Let us assume initially that the output stage is a single class A amplifier. The I_c-V_c characteristics of a bipolar transistor are shown in idealised form in Fig. 4. The collector current swings above and below the quiescent value when an input signal is applied and there are limits to both swings if distortion is to be avoided. On the upward swing the collector current must not exceed the maximum value $I_{c(max)}$ prescribed by the manufacturer. Moreover the collector dissipation must not exceed the maximum $P_{c(max)}$ quoted by the maker.

There are other causes of current limitation: in valves, for example, attempts to drive the anode current above a certain value cause the grid to go positive with respect to the cathode so that distortion occurs in the input circuit as a result of damping due to grid current. A similar limitation occurs in junction field-effect transistors, the input circuit of which also conducts when the gate potential equals that of the source. Because of these limitations collector current must not enter the upper shaded area in Fig. 4: the boundary of this area consists of a straight line representing $I_{c(max)}$ and a curve representing $P_{c(max)}$.

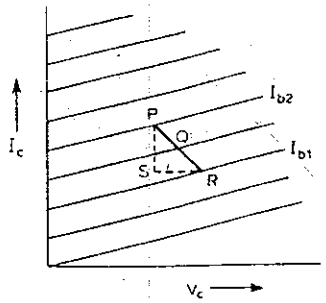
Similarly the greatest negative excursion of the collector current is that which causes its value just to reach zero. Thus the area below $I_c = 0$ is another region which must not be used. The quiescent point Q is located midway between the base line (which we can call the floor) and the lower limit of the upper shaded area (the ceiling). The load line must pass through Q and, to use the full range of collector current, must touch the ceiling and the floor at its ends. It should also use the full voltage excursion between zero and twice the supply voltage: its position is thus fixed at PQR. This represents a load resistance given by the supply voltage divided by the mean collector current. It is thus independent of the a.c. resistances of the transistor.

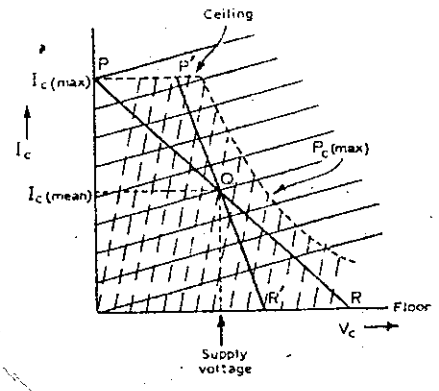
The effect of applying voltage-derived negative feedback is to replace the I_c-V_c characteristics shown solid in Fig. 4 by a new set (shown dashed) much more vertical (implying a lower effective collector a.c. resistance), more evenly spaced (showing improved linearity) and more closely spaced (indicating reduced gain). The manner in which these new characteristics may be deduced was given in an earlier article.* According to the maximum power transfer theorem the slope of the optimum load line should be equal to that of the dashed characteristics (as shown by P'QR') but clearly this is impractical because, to utilise the full voltage excursion, the current would extend well into the shaded areas as in the emitter-follower example considered earlier. The application of feedback has no effect on the position of the floor and ceiling: it, therefore, has no effect on the load line and on the value of the load resistance.

It is, of course, more usual to use a push-pull pair operating in class B in the output stage of a high-quality amplifier. The output voltage is not now accommodated between a ceiling and a floor because the half cycles of signal are handled alternately by the two transistors. There is therefore no floor as in Fig. 4. Instead the load line is bounded by two ceilings, the lower of which can be regarded as a skew-symmetrical image of the upper ceiling situated below the zero-current axis (Fig. 5). Nevertheless the result is that the optimum load line is confined between the two ceilings and fixed in position by the need to exploit the available swings in current and voltage. As before, the application of feedback replaces the near-horizontal characteristics by near-vertical ones but has no effect on the position or slope of the load line. Thus the value of the optimum load is unaffected by feedback which is used to improve linearity and to reduce the value of the output resistance. □

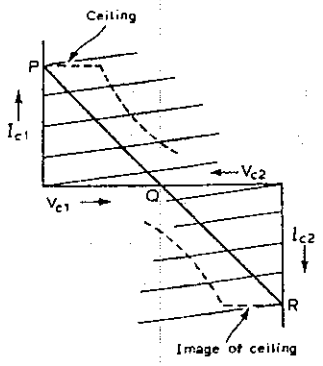
* *Wireless World* August 1976, p.66.

Fig. 3. *A load line PQR superimposed on a set of I_C-V_C characteristics. The shaded area represents the power output.* ▼





▲ **Fig. 4.** *The ceiling and floor which limit the current excursions in a class A amplifier. PQR represents the optimum position of the load line. The dashed characteristics show the effect of negative feedback.*



◀ **Fig. 5.** *In a push-pull amplifier the floor is replaced by an image (skew symmetrical) of the ceiling.*

THE ILLAWARRA AMATEUR RADIO SOCIETY - P. O. BOX 1838 WOLLONGONG 2500

Meetings: Second Monday of every month except January at 7.30 p.m. in the Congregational Church Hall, Coombe Street, Wollongong. Committee Meeting - 3rd Monday of each month.

Repeaters: VK2RAW - 6850 VHF Mount Murray. VK2RIL - 7275 VHF Sublime Point.
VK2RUW - 8225 UHF Hill 60 Port Kembla. VK2RIL - 8725 UHF Sublime Point.

Broadcasts: On Sunday night prior to Club Meeting - 7.00 p.m. RTTY on 6850 VHF Repeater; 7.15 p.m., Voice on 6850 VHF, 7275 VHF and by relay on 3.562 Mhz. Call backs after the WIA relay at 7.30 p.m.

W.I.A. Relay: On 6850 VHF at 11.00 a.m. and 7.30 p.m. weekly on Sunday.

Club Nets: 3562 Khz SSB on Sunday at 8.00 p.m. and slow morse net on 28.440 Mhz on Tuesday at 8.00 p.m.

Newsletter: "The Propogator", published monthly to reach financial members in week prior to meeting. All articles, ads etc. to the editor, Leo Kleeborn, VK2YJK at 33 Lombard Avenue, Fairy Meadow 2519. Telephone 84.9751. Copy deadline 3rd Tuesday each month.

Membership: The Secretary, I.A.R.S. P. O. Box 1838, Wollongong 2500. Full membership is $7.00 per annum; students and pensioner concessional members $4.00 per annum.

QSL's: For financial members who are also financial members of the W.I.A. ONLY.
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