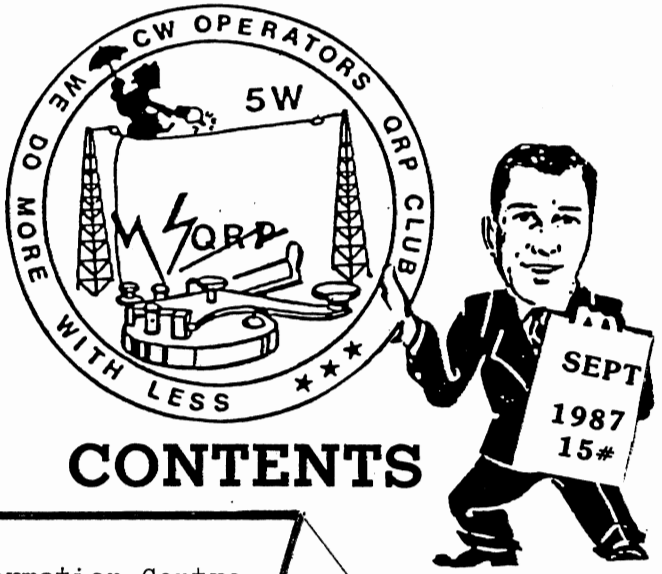
QUARTERLY

NEWS BULLETIN

L O - K E Y



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INFORMATION CENTRE

PRESIDENT. Len O'Donnell VK5ZF (1)
33 Lucas St Richmond
South Australia 5033

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South Australia 5040

SECRETARY. Rai Taylor VK7VV (3)
25 Twelfth Ave
West Moonah
Tasmania Australia 7009

PROJECTS. Rod Green VK6KRG (28)
72 Yelverton St South
Donnybrook
West Australia 6239

CO-ORDINATORS

Lindsay Lapouple VK3DXH (47)
41 Ternse Road
Upwey Victoria 3158

Rai Taylor as above

EDITOR Rai Taylor as above

PUBLIC RELATIONS
Len O'Donnell as above

Club information net- ssb. qro. 3675. I030z
Club call sign VK5BCW. Controller MAX VK5OS.

CW. Activity. Wednesdays 0930z- 3535mhz
Controller Brian VK2BVH.

ZL QRP CW ACTIVITY FRIDAYS 0800z 3530mhz

Club DX net Saturdays and Sundays 0630z
I4060mhz Controller Rai VK7VV

LO-KEY PUBLISHED MARCH-JUNE-SEPTEMBER-DECEMBER

ANNUAL MEMBERSHIP FEES INCLUDING LO-KEY

VK $A10 ZL $A12 DX $A14

IRC'S NOT ACCEPTABLE.

THE PRESIDENT'S PAGE

From Len VK5ZF/QRP (1)

CLUB POLICIES

I think it is about time, that I had a word about our Club policies, and in particular the following three, but before I begin there are a couple of points that I wish to make.

Our Club was conceived of an idea, to bring together as a group, those Amateurs in the VK and ZL areas, as well as from other countries, who are interested in Low Powered (QRP 5W) Operation, the CW Mode, and Home-brewing of equipment. The Club has no constitution, and I hope that it will never find the need for one. It is not run on any sound, efficient, or modern business principles. Rather it is run for Amateurs, by Amateurs, who do not like to make and enforce rules, hassle members or be hassled by the members. I would like to imagine that we are a happy group, enjoying our hobby with what we have got as best we can. Having established these points, I will again return to the three policies I mentioned earlier.

(1) CLUB KIT-SET ACTIVITY CENTER

I believe the Club needs such a project, and I believe it will come and come very shortly. Rod VK6KRG can no longer take care of this chore for the Club over in W.A. (See "Bits and Pieces" article this issue of Lo-Key), so I am looking into the possibility of setting up the center in Adelaide. The ice has been broken by Rod's great effort, and now it is up to the Club Management Committee, to implement such an activity, on a well managed and monitored basis. So far volunteers for this activity are Don VK5AIL and Len VK5ZF, and both of us are at this very moment, flat out working out if we can put a kit of parts together for the Club Communicator project for $75 or less. If it can be done we will do it. Perhaps you know where it is possible to buy suitable electronic parts, cheaply and in bulk quantities, if so please write and tell me the details, and the Club will act on your information. There is of course room for many others to help in many ways. If you let your imagination dwell on what could be achieved, if we can get this center off the ground, the possibilities are endless.

(2) AFFILIATION WITH THE W.I.A.

Let me say at this point in time, our Club has not even considered affiliation with the W.I.A., and I doubt if it ever would. If in the future the Management Committee believed it was in the best interests of our Club to affiliate with the W.I.A., then I would not hesitate to recommend this course of action.

I personally have a very healthy respect for the activities of the W.I.A. In the past they have been very helpful to our Club, in promoting our activities. In fact I believe you would find that 75% of our members, are also members of the W.I.A., and that is real good as far as I am concerned. Personally I am just not interested in Amateur Radio Politics. If we were to loose a few members through affiliation, then so be it, I will always put the overall good of the Club, before members personal gripes.

(3) CW MODE ONLY

It has been suggested to me on several occassions, that the Club should drop the CW from our title, and become an all mode Club. It has also been said, that all our problems, like low membership, small finances, lack of interest, etc. etc., will magically disappear. Well they are probably right, but at what price?. Inside of twelve months the Club would be geared to SSB, and the CW mode would be pushed into the background. If most of your members were SSB addicts, a magazine full of CW articles, would go down like a ton of bricks. There are many SSB and State of the Art Clubs already in existence, but very few CW only Clubs. I know that our Club will never ever be large in numbers of members, or be state of the art, using the

PRESIDENTS PAGE (cont.)

so called exotic modes, but we will be around as long as the CW mode of transmission, is legal in our Amateur Service. Along the way I know we will be able to help many new-commers to Amateur Radio, with Home-brewing their first SIMPLE rigs, and helping to give them, their first QSO's. We are just trying to put the Amateur back into Radio

****

ALTERNATIVE NET FREQUENCIES

A.....3675 KHZ.

B.....3620 KHZ.

C.....3590 KHZ.

D.....3580 KHZ.

Please keep these frequencies handy on your operating table.

****

SCRAMBLE NEWS

A number of members have requested that we hold some more of our scrambles, so I am very happy to inform you that the next two scrambles will be held on..... (1)..... Tues. 20 th. Oct.....1000Z..... to...1300Z

(2)..... Tues. 24 th. Nov.....1000Z..... to...1300Z

These two scrambles will be held on the 3.5 mhz. band, and the idea is to contact as many CW stations as you can in the 3 hour period .
Scoring will be calculated as follows.....

For contacting non member DX stations..... 10 points
" " member " " ..... 15 points
" " non member VK stations..... 2 points
" " member VK " ..... 5 points
" " Club station VK5BCW.....25 points
" " Mystery station.....50 points

All logs submitted to Len VK5ZF (1), must certify that they were operating with an output not exceeding 5 watts to the antenna. Goodluck, they should be fun nights.

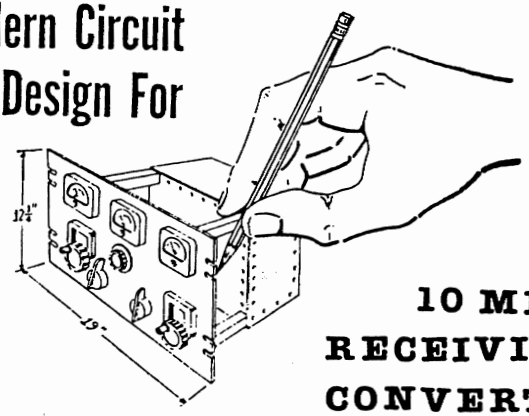
****

STOP PRESS

Just received letter from Matt ZL1ATW saying, the ZL boys have a QRP activity net each Friday evening on 3530 khz at 0800Z. Calls to listen for are, ZL1ATW, ZL1VT, ZL1BYY, ZL1BSL, ZL1TBH, ZL3LP, ZL3AAO, ZL4DD, ZL4BP. Take a listen before coming up on our net. You never know your luck. The ZL boys are all using "CHELMSFORDS".

Len VK5ZF (1)

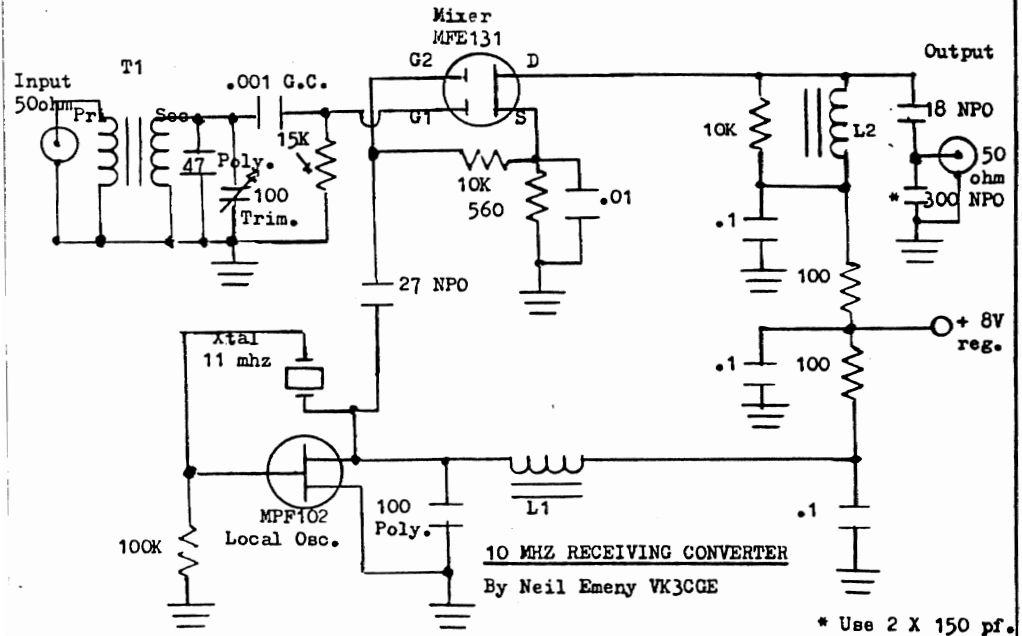
Modern Circuit Design For



10 MHZ RECEIVING CONVERTER

DESIGN AND TECHNICAL INFORMATION BY NEIL VK3CGE (19)
Article Presentation by Len VK5ZF (1)

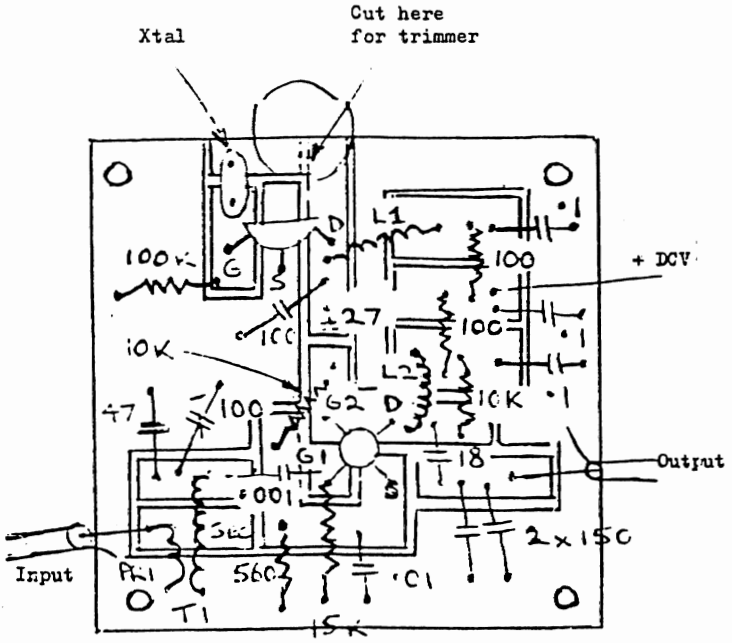
Recently I put together a 10mhz receiving converter, to get myself activated QRPwise on this very interesting band. It turned out to be very good indeed, so I thought I would like to share it with the members of our club. Of course I am hoping that many QRPers will have a go at building it, and I will be able to have a QSO with you, on this fascinating band. Team this little converter with either a 10 mhz. version of the Universal QRP Tx., or Rod VK6KRG's Sure-fire 10 mhz Tx., and you are ready to go 30 meters, easily and cheaply. Here is the circuit diagram.....



10 MHZ. RECEIVING CONVERTER (Cont.)

SOME SPECIFICATIONS

Input..... 10.000 to 10.500 mhz.
Output..... 21.000 to 21.500 mhz. (Tuneable I.F.)
Local Oscillator. 11.000 mhz.
The converter has some gain, is completely stable, and works very nicely with my FT7 as the tuneable I.F.
T1....T50-6 Toroid....Primary 3 turns No. 22 enamel. Secondary 25 turns No. 24 enamel.
L1....FT37-61 Ferrite Toroid.... 10 turns No. 24 enamel.
L2....T50-6 Toroid....25 turns No. 24 enamel.
(T1 Secondary and L2, Approx. 2.59 uh.) (L1 Approx. 5.5 uh.)
P.C.B. 65mm X65mm. The style is Drew VK3XU's islands of copper method.
The finished unit is housed in a K and W box 128 mm X 67mm X 40 mm.
Input and Output sockets are SO239.
Power Supply can be 9 Volt battery or 8 volt regulated from adjustale power supply unit
After everything is soldered in place, and orientation is checked, connect your 9 volt power supply. Check and adjust 11.000 mhz. oscillator as necessary, then align input tuned circuit to about 10.1 mhz center frequency, using a GDO, or your ear receiving a signal and adjusting for maximum loudness. A good check is WWV on 10.000 mhz. for and input adjustment.
Note. Its OK to substitute Polystyrene for NPO ceramics, and visa-versa.
A trimmer may be needed in series with the Xtal to pad the frequency to 11 mhz.
This converter is straight forward and very simple to build and put into operation. Beginners can tackle the construction with every confidence, as there are no hidden problems.



Actual size PCB outline can be found on PCB page

BITS AND PIECES LOOK

From....Len VK5ZF (1)

Here it is September again, and that means the start of Spring, the best season of the year, as the nice warm sunny days make you feel great. I have a good deal of information and Club chit-chat to pass on to you in this issue. This column is where you will read about it, so please write and tell me things happening to you in the field of QRPing, and I can pass them on to your mates right here. So here we go.....

THE "CLUB COMMUNICATOR" KIT-SET.

I am sorry and I do apologise for stopping the production of these Kit-sets. As I write this column, there are four of our members, who have paid their $75 for a kit and have not received one as yet. Each of these four members have had their cheques refunded, and received a letter of explanation. Of course there is a reason for stopping the production of the kit-sets, and it is two-fold. Firstly Rod has no longer time at his disposal, since he has to get ready for a re-classification in his employment in the next 18 months. The assembling and procuring of parts for kit-sets is a very time consuming job, believe me. Secondly Rod had need to alter his overall price, because of changes in the prices of individual items. This would have meant a substantial increase to the quoted $75, and I could not allow that, so a halt has been called temporarily, until the matter is looked into. It must be remembered that Rod was doing the kit-sets on his own initiative, without any financial help from the Club, and we sincerely thank him for his great effort. Now it is time for the Club to step in and take over, and this is what is happening right now. A Kit-set Activity Center will be set up, operating out of Adelaide, with adequate Club supervision and financial monitoring. So far Don VK5AIL and myself are the only two volunteers for the work. We are both flat out on checking out the possibility of again producing the Club Communicator kit. Apart from the Club Communicator kit, I want to see the Center produce many simple QRP kits in the near future. Our first effort was a little premature, and we have learned by it, this effort will be better organised, and a great asset to our Club Home-Brewing program.

PROCESSING MEMBERSHIP APPLICATIONS

Up until now Kevin our Treasurer, has been looking after this job, but he has been finding it increasingly difficult, to find time to carry out the work involved. Kevin has a number of other activities, that are constantly demanding more of his attention. To lighten his work load a little, I will be processing all future membership applications. Kevin will continue on as Treasurer, and keep an eagle eye on the finances of our Club. So from here on, please send all correspondence and enquiries about membership to Len O'Donnell VK5ZF (1) (address as shown page 2). Just to round off this paragraph, a big thank you to Kevin, for what he has done in this department previously.

OUR FIRST LADY MEMBER

A very big and warm welcome to LIZ RANDALL VK3PSG (1[illegible]), our first lady member, and I hope you will enjoy your membership with us. It has taken the Club almost three years to sign up a YL or XYL member, I am hoping it does not take that long to get number two. I believe Liz signed up, because of information supplied in an article in a local district club magazine. The article was by Graham VK3BTH, and this information is from Lindsay VK3DXH, our VK3 State Co-ordinator. Nice work boys.

POSSIBLE VK3 QRP BBQ

Lindsay VK3DXH (47) the VK3 State Co-ordinator, would like to get the feeling of Melbourne members, as to holding a BBQ after Christmas, in an appropriate spot. If you agree with Lindsay, that it is a good idea for the Melbourne QRPers to get together to talk shop, please drop him a line, to his QTH of 1/31 Nelson St., Balaclava, Victoria 3138, or come up on the SSB net on Friday evenings. Then something can be worked out. The Labor Day week-end in March, might be a good date. (I would not mind being there myself, Len.)

****

OPERATE CW QRP ON MORE BANDS....SHOW THE FLAG

ITS AND PIECES (Cont.)

RICLES FROM DX MEMBERS.

I feel that our Club is lacking in information, about what is happening to QRP in ther countries, and what our members in these countries are doing with QRP. So far I m receiving very little direct input from most of our DX members. We in VK QRPland, ould like to get to know you more. So that I can change this position somewhat, I ould like to receive articles on QRP in general, a profile on yourself, (for inclus- on in Lo-Key), Technical articles on QRP projects, Field day participation by you or our group. I am asking all DX members to please help me bridge this gap, because aft- r all this is your Club to, and I want you to feel as though you belong. To start the all I am wondering if any of you state-side guys can tell me what Ed Weis QRP publi- ations are available right now, and to what address would I write to get details of he price, postage etc. I want to try and circulate this type of QRP material, mongst the VK QRPers, via the "Travelling Circuit Books. Another point that some of our DX members may be able to help me with, is the QTH of some one in Japan that is connected with the running of a QRP Club in that country. For a couple of years now I ave been trying to put our club in touch with a similar type of club in JA territory, nd although I have sent several letters, so far I have not made any contacts. Seeing ow good the DX QRP path to JA is, I believe we could benefit by a close liason with a Japanese QRP Club. Can any of our DX friends put me in touch with a JA QRP fanatic please.

IN CHARGE OF KIT-SET ACTIVITY CENTER.

Since writting the previous note in this column on the Kit-set activity center, I ave had a chat with Don VK5AIL (75), and he is willing "to have a go", at running this activity. I will be assisting Don what ever way he desires my help. Rod VK6KRG (28) has already volunteered to make up the VFO tuneable coil parts. So you see things are coming together in this area very quickly. Can you, and do you want to help the Club in this activity, if so get in touch with Don, and volunteer your help.

SCRAMBLE NEWS.

As you will see from a notice elsewhere in this issue of Lo-Key, I have re-intro- duced a couple of scrambles. A number of members have requested this, so please sup- port the scrambles, so that they will become an on-going activity again. They are a very enjoyable event, with a lot of fun to be had from just participating. The usual rules will apply, and the Club station VK5BCW and a "MYSTERY STATION", will be oper- ating for these BONUS points.

SIMPLE TRANSCEIVER BUILDING CONTEST.

In a letter to the Club Malcolm VK5BA (8), suggests that as a project, to celebrate the Australian Bi-Centenary year 1988, the Club organise a Simple Transceiver Building Contest amongst our members. As a guide line I would suggest, that the Trcvr. should have as few parts as possible, but still capable of good reliable QRP QSO's over a long distance. In other words they would need to be a useful and practical circuit, rather than a gimmick that is barely working, and not suitable for reliable communi- cation. The contest would start in Jan. and finish in Dec. 1988, and could be solid state or valve design. At this point I am trying to gauge the members re-action to such a proposal. There is no point in holding such a contest, if no one wants to be in it. So I would like each member to write to me, or talk to me on the net etc., stating your willingness to participate, make suggestions as to how it should be run, and what guide lines should be laid down on construction and circuit standards. If you think about it, it could be a lot of fun, and it could give the Club a wealth of good QRP ideas and circuits to use in future issues of Lo-Key. Are you interested, then please write to me soon. I will need to know your feelings on the matter, so that I can let you know in the Dec. issue of Lo-Key, whether the project is on and if so all the details you will need to know.

TRAVELLING CIRCUIT BOOK NO. 2

This issue of our popular TRAVELLING CIRCUIT BOOK is getting close to completed, and will soon be put into circulation. Is your name on the list to receive it. If not this is your last opportunity to get your name on that list. Here are the names of those who have advised me of their wish to be on the list.....

(56)	Stephen.....VK2ESR	(104)	Kerry.....VK4LKF
(75)	Don.....VK5AIL	(2)	Max.....VK5OS
(3)	Hai.....VK7VV	(27)	Bob.....VK4NFE

BITS AND PIECES (Cont.)

COPIER FUND UPDATE

As mentioned in the last issue of Lo-Key the Copier Fund is in the $500 region, in fact it has reached $567. Naturally donations are going to slow down from now on, but I believe we must set our sights on the target amount of $700 minimum. From enquiries made, this amount is needed to obtain a good reconditioned copier. It would be foolish to jeopardize the project, by settling for something inferior for less money. I strongly believe we should wait till the target is reached.....but in the meantime here is the latest list of donations....

(57) VK5BJF.....Jeff.....$30:00.....(Sale of PSU)
(74) K7DAP.....Alan.....$04:99.....(Change)
(66) VK6NNN.....Peter.....$00:06.....(Change)

Thank you Gentlemen.

A HELPING HAND STORY NO.1 and NO.2

Here are a couple of stories I do not mind passing on to you at all.....It just shows what this Club stands for.....Over the past few weeks I have been trying to raise a couple of 30 ft, antenna poles by myself, and found the task beyond my capabilities, owing to a condition I had. Max VK5OS (2) learnt of my difficulty, and promptly came around and put the masts up on the mounting posts, so I can now raise them easily by myself now. Thank you Max, possibly you will never realise how much I appreciated your spontaneous gesture of help.....Here is the second story of a member helping another member. One of our members from Canada Bob VE6AAO (72), read in Lo-Key where another of our members Paul VK2DMV (95), was looking for a particular type of transistor to complete a project. After looking through his "Junk Box" Bob came up with a direct substitute. The substitute transistor was mailed to me, and I was able to mail it on to Paul. Truly a long helping hand. Good on you Bob VE6AAO.

SSB INFORMATION NET.

Max VK5OS (2) who runs the Friday evening SSB Information Net at 1030Z, passed on the following IMPORTANT CHANGES TO THE NET FREQUENCY. On the present net frequency of 3620 KHZ, Max is finding it almost impossible, to conduct the net without QRM coming up on the frequency, during the net. Many of our members checking into the net, do complain about the diffuolty of hearing Max's signals through the interference. Max has come up with the following alternative frequencies, that will be used if there is interference with a frequency that Max is using. These alternative frequencies will be known as A. B. C. and D. Where A. = 3675 KHZ, B. = 3620 KHZ, C. = 3590 KHZ, and D. = 3580 KHZ. If during a net Max is being QRM'ed, he will check out an alternative frequency, and tell the net to move to A. B. C. or D. as the case may be. Please copy these frequencies on to a piece of paper, and "sticky-tape" it to your rig. This also means that if you do not hear Max at the starting time of the net on his usual frequency, he will probably be on one of the alternative frequencies, owing to QRM problems. (He also could be late, sorry Max.) While on the subject of the net, is there a member who would care to take the net on, to give Max a break now and again. He feels that a VK2 or VK3, would be in a better position to control the net, rather than a VK5, because of the more central location. If you would like to give Max a hand please drop him a line. Finally Max is looking at changing the night of the net to another more suitable night, if sufficient members indicate that this would be more desirable. Please check in on the net and make your views known.

NEW MEMBERS

Here is the latest up-date on our New Members, to whom I extend a very warm welcome to our ranks.....

(103) Warren Mead VK6MX, 15 Valance Way, Gwelup, W.A. 6021.
(104) Kerry Fielding VK4LKF, 22 Ellis St., Lawnton, Qld 4501.
(105) Robert Tymms VK3BDU, 9 Flinders St., Mitcham, Vic 3132.
(106) Richard Lucas WB0NQM, 1906 Edgelea Rd., Lawrence, Kansas 66046, U.S.A.
(107) Andrew Morrison KZ1L, 2 Rustic Rd., Stoneham MA 02180, U.S.A.
(108) Liz Randall VK3PSG, P.O.Box 378, Ringwood, Vic., 3134.
(109) Dennis Goodland VK2KEZ, P.O.Box 158, Nowra, N.S.W. 2541

If you hear these members on please give them a call.

****

TALK ABOUT OUR CLUB AND QRP ON THE AIR. WE NEED NEW MEMBERS

BITS AND PIECES (Cont.)

MATERIAL FOR LO-KEY

The other night on the net, I passed on to a member the info that Lo-Key would be a little late this issue, and he replied to the effect that it was nothing new. On reflection maybe he is right, but why is he right. I have found the biggest contributor to Lo-Key being published late is the lack of information and Technical articles needed for each and every isue. There are no magic wands for Rai and I to wave to get Technical articles and information when we need them. To make each issue bright, interesting and informative is no easy task. Most amateurs have a large amount of tech-nical information on hand, that they put on shelves or file it away, and rarely share it with other amateurs. Take another look at the material that you have, then take some photo copies of the likely articles, and post them into me. You can rest assured that I will make good use of them. I know that I have asked for this kind of help on several occasions, but apart from an odd article or two from a member, the response has been zilch. In a paragraph on the Presidents Page I make mention that I do not like to hassle the members, so this is going to be my last request for Technical articles and information for Lo-Key. From now on Rai and I will be leaving more blank pages in future issues. If Rai and I had more material to work with, I can assure you that the production date of each issue of Lo-Key, would most certainly be on time. All Rai and I need is about 250% more response than what we are getting now. Thank you gentlemen .

G QRP CIRCUIT HANDBOOK

Rai VK7VV (3) advises me that he is still getting many requests for reprints of this popular QRP book. Unfortuneately Rai is unable to make any further copies. When and if the Club gets the copier I am trying to obtain for it, I will be only to happy to carry on where Rai has left off, and turn out as many copies as are required. Of course the printing of our own QRPing Down-Under can not progress much more, because of the same reason. Not to mention VK3XU's Handbook, and other QRP literature, and of course Kit-set Handbooks in the near future. I kid you not when I tell you that the Club needs a copier URGENTLY.

PCB MANUFACTURE

The Kit-set Activity Center is looking to make contact with somebody who is able to make good quality PCBs, at a reasonable cost. If you can help us, or know of some one who can help us in this regard, please contact Don VK5AIL (75) with the information. He will be pleased to hear from you.

OLD POTS ¼" shaft type.

This is a very unusual heading in this column, but I am looking for old unserviceable potetiometers, that are worn out, and you have no further use for. The reason I need them for, is to obtain the ¼" bush from the pot. These are needed to help Rod VK6KRG put together the VFO kits for future projects. Can you help me in this matter. It seems rather silly to me, that we will need to spend good money to buy new pots to wreck, for the bush from each pot. Lets have a look in our junk boxes, and help keep the costs of the VFO kits to a minimum. If you have some old pots please send them to Len VK5ZF (1), and I will see that your postage is refunded. In fact you could remove the unwanted part of the pot, and just send the bush if you would like, as that will save on postage considerably.

ONER QRP TX CIRCUIT

Elsewhere in this issue you will find an article on the Oner, which is a little QRP TX kit marketed by the G QRP Club in England. It is a simple little kit that could easily be produced by our Kit-set activity center fairly cheap. A suitable filter for the band required, could also be supplied in the form of a kit. How do you the members feel about the club supplying such simple kits at low cost. I would like to gauge your interest and reaction to the idea. Please write and tell me your opinion.

CLUB STICKERS

Up until now Kevin VK5AKZ (43) has been handling this job, but pressure of other interests has restricted Kevins involvement. From now on Club Stickers will be available from Len VK5ZF (1) at the price of $2.00 per 100. Plus postage.

****

I guess that about covers Bits and Pieces for this issue, and I hope you have found it interesting and informative. I would like to re-ceive any items of interest or humor from members, that could be shared through this column. God Bless.... Len VK5ZF (1)

VARIABLE INDUCTOR VFO

This vfo is very stable and can be scaled up or down to any hf frequency readally, the circuit is a well tried one using the common drain hartley.
Rather than using a variable capacitor for the main tuning I have opted for a slug tuned inductor.
By using a slug tuned inductor you will have a few options for instance, the pitch of the metal screw thread will determine the ratio of tuning. My prototype is set at 25 to I so that each turn of the knob tunes 20ks covering the 5 to 5.5mhz vfo nicely, with a bit of time spent inexperimenting with spreading the turns of wire on the last third of the inductor an almost linier bandspread is possible.

I have found that stability is better using a brass core for the slug, however you will find that the frequency will decrease as you turn the tuning knob clockwise, if this concerns you use a left handed thread for the tuning screw or a more conventional powdered iron core.

Long term stability depends mainly on the componants used to remain constant during changes in thermal and rf heating, stability can be improved dramatically if care is taken in the selection of the capacitors used for cI and c2. First find the capacity needed by using a variable capacitor then experiment with a combination of polystyrene and npo ceramic capacitors, by using several capacitors in parallel the rf currents will be divided between them this will lessen the internal heating of each capacitor, a carefull mix of npo ceramics and polystyrene capacitors will further reduce the effect thermal drift. Although many designers do recommend silver mica capacitors I have found them to be rather unpredictable. MPF I02's have been used as they are easy to obtain and cheap, but the thermal stability varies a lot from one to another, so select the best one out of the bunch.

VK7VV (3) RAI

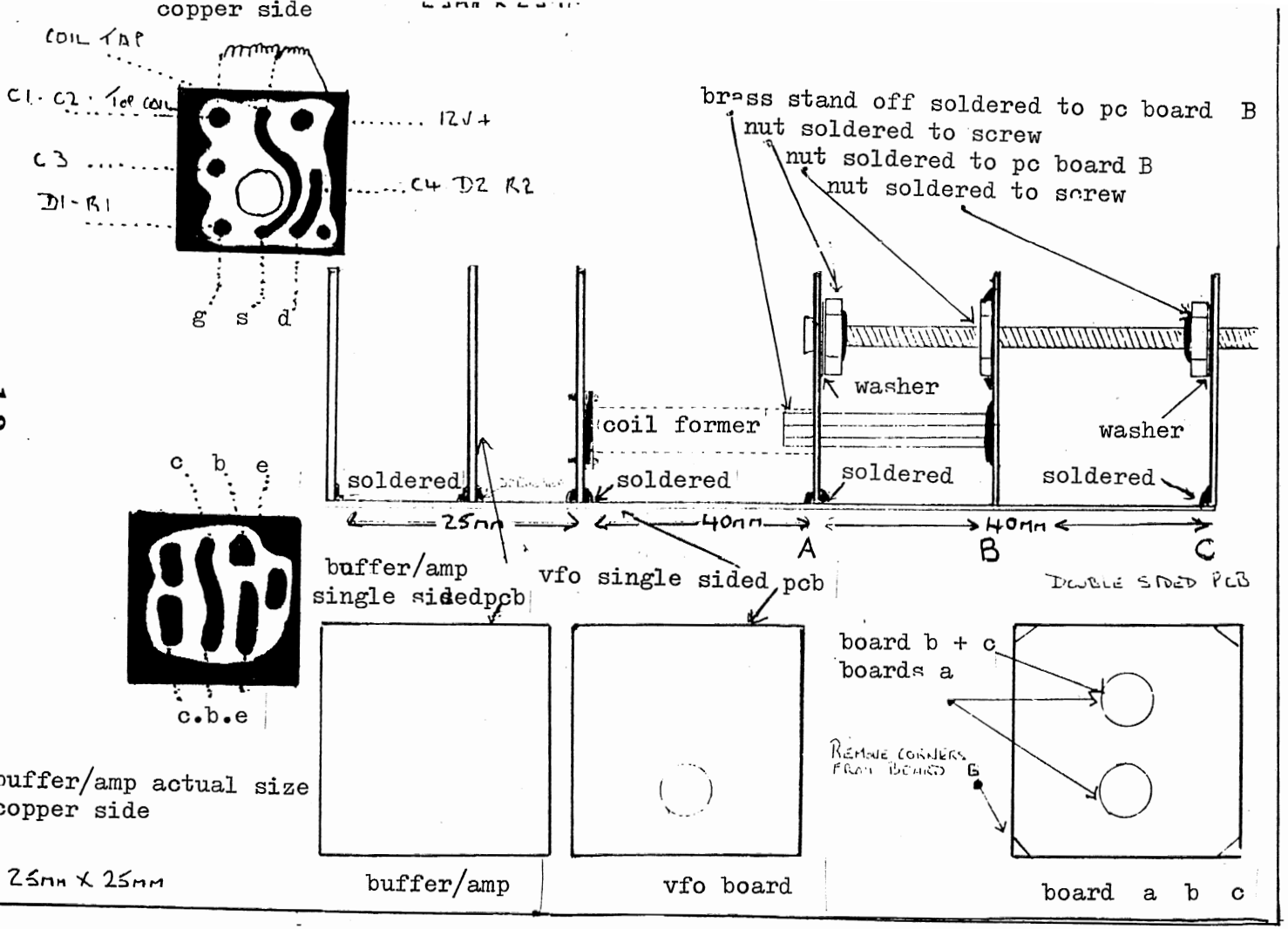
The prototype, tuning 5 to 5.5mhz is now used as an external vfo with my TS820, a second unit has replaced the vfo in my Tassie Devel rig, a similar unit could be used in the Club Communicator or with any of the kits presently on the market.

Double sided pcb soldered directly to each other is used to completely enclose the vfo module, carefully cut panels and neat soldering will produce a rigid well sheilded unit, apart from the modules electical and mechanical virtues, it also looks good.

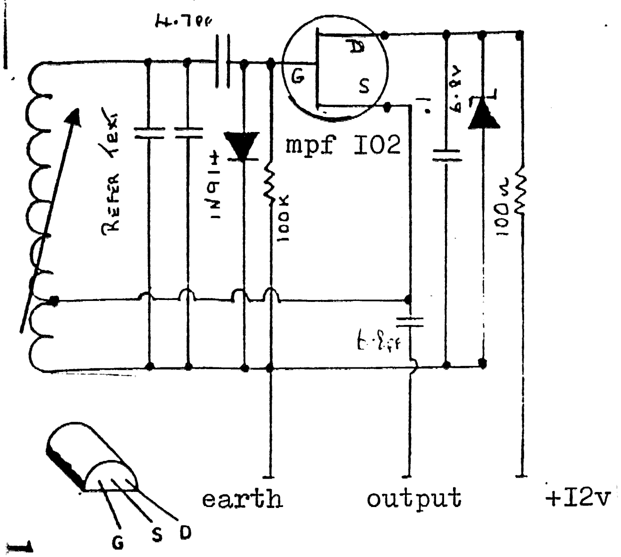
Double sided pcb can cause some problem evident by the capacitance developed between the two copper plates that form each board, to negate this effect it is wise to drill a few small holes through the boards and electrically bond both sides together with wire.
The vfo output, offset control if used, and the I2v supply are via feed throughs mounted on the side or rear panel of the module, do not use capacitive type feed throughs for the vfo output.

The physical size can be made to suit the individual needs those odd bits of pcb, coil formers, long drive metal threaded screws found in your junk box will most likely dictate this.

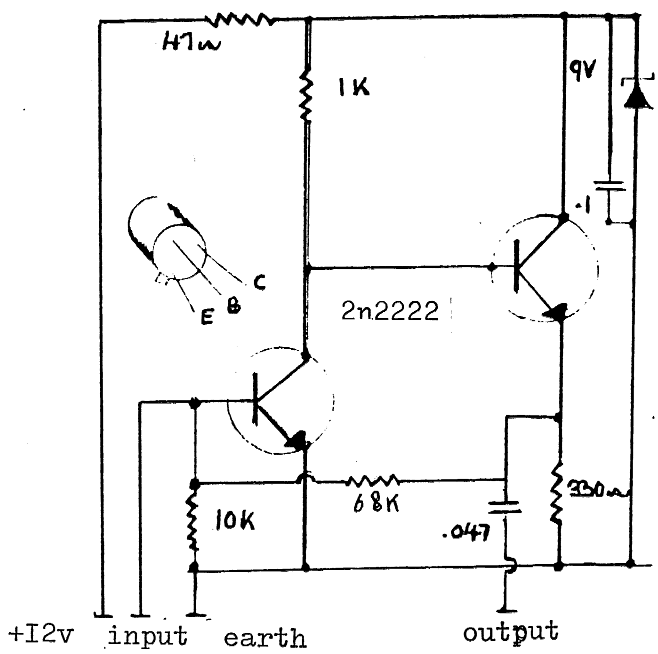
The mechanical principle was developed out of pure frustration with the difficulty of locating suitable variable capacitors and reduction drives apart from the frightfull cost if you do find them.
Mechanical smoothness and the degree of reduction is directly related to the care you take in selecting and fitting the main screw drive and associated nuts, and the alignment of them.


copper side
COIL TAP
C1 · C2 · TOP COIL
12V+
C3
C4 D2 R2
D1 - R1
g s d
brass stand off soldered to pc board B
nut soldered to screw
nut soldered to pc board B
nut soldered to screw
washer
coil former
washer
soldered
soldered
soldered
soldered
25mm
40mm
40mm
A
B
C
DOUBLE SIDED PCB
c b e
c.b.e
buffer/amp
single sidedpcb
vfo single sided pcb
board b + c
boards a
REMOVE CORNERS FROM BOARD G
buffer/amp actual size
copper side
25mm X 25mm
buffer/amp
vfo board
board a b c

vfo



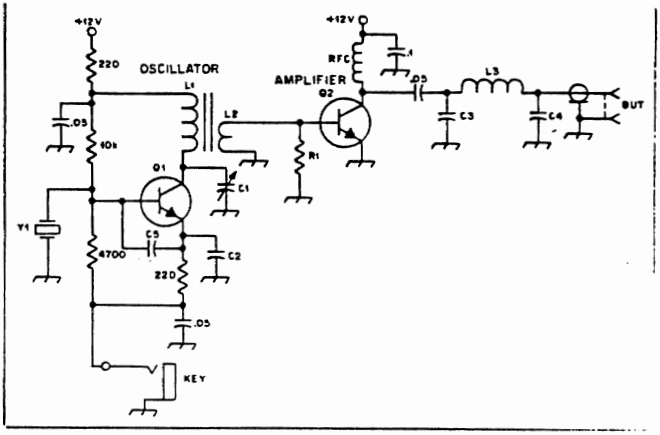
buffer/amp



HOME - BREWER'S CORNER

From... Len VK5ZF/QRP (1)

Welcome again to "Home-brewers" Corner, the section of our magazine, written mainly for those of us, who are beginners in the art of "rolling your own". This issue I want to get into the basic circuit of the Universal QRP transitter, and see if we can find out a few things, about how the CW QRP rig works. The asic circuit is a two transistor, xtal controlled CW transmitter, that for a ciruit voltage of 12 volts, and the stipulated output transistor, will give you approx .5 watts output, on the H.F. bands from 1.8mhz to 28mhz. An extra Keying transistor as added to the 24 to 28 mhz model, to counter-act a slight tendency to chirp at his frequency. So here we have a simple single band transmitter, that can be put n any frequency in the HF area, by changing the xtal frequency and the tuned ciruits. Q1 is a xtal controlled oscillator stage, which has Q2 the PA stage, inductvely coupled to it, through L2. For no better reason than I would like to hear ore QRPers on other frequencies than 3.5 mhz., I have chosen to put this particular odel of the Universal QRP transmitter on the 10 mhz. band. Of course you can put our model on your own favourite frequency, from the information supplied. To reresh your memories or for those of our new members who have not seen the last isue of Lo-Key, here again is the basic circuit and frequency/part chart information.



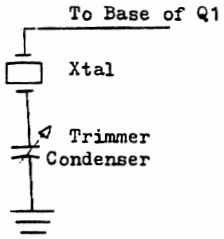
	C1	C2	C3	C4	C5	L1	L2	L3	R1	RFC
M	400 pF MAX	1800 pF	1800 pF	1800 pF	360 pF	73t No. 28 T-50-2	8t	30t No. 26 T-50-2	18Ω	50 µH
M	400 pF MAX	100 pF	750 pF	750 pF	200 pF	43t No. 26 T-50-2	5t	21t No. 22 T-50-2	39Ω	25 µH
M	180 pF MAX	100 pF	470 pF	470 pF	–	35t No. 26 T-50-2	4t	14t No. 22 T-50-2	39Ω	15 µH
M	120pf	68pf	330pf	330pf	–	30t	3t	13t	47	15uf
M	60 pF MAX	33 pF	210 pF	210 pF	–	27t No. 24 T-50-6	3t	12t No. 22 T-50-6	47Ω	15 µH
0 M	60 pF MAX	33 pF	105 pF	130 pF	–	17t No. 24 T-50-6	3t	9t No. 22 T-50-6	47Ω	15 µH

You will find on another page a PCB outline drawn actual size, which will give you another option in buiding this fine little rig. Of course you can use your H5610 Blob-Boards if you so desire. If you do use your Blob-boards, do not forget to keep the track side up when you mount the board. This enables you to experiment, and make changes to the circuit, without removing the board. Another point about using your blob-board is that you can solder three or four of the small pads together to make a series of larger pads. The H5610 is indeed a very versatile board. When using your blob-board lay out the parts on it, in a similar patern to the PCB designed for this rig. In that way you will not be fussing about how to lay out your design and what pads you should be using.

Let me say at this point that I am not going to go into theory in this article, rather I intend to touch on some practical points that may just help sort out a few doubts and uncertaincies in the minds of some of us beginners. So here we go....

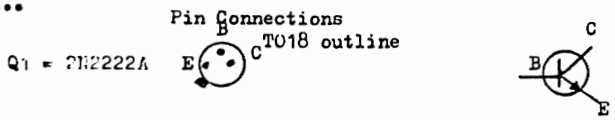
Xtal Oscillator Stage

This contains all those parts between the Xtal, and the output of L2. Let us start with the Xtal, and see what we can find out about it. Firstly in this particular type of circuit for the bands from 1.8 mhz to 21 mhz a fundamental frequency type of xtal is employed. In such application the ouput tuned circuit is tuned to the fundamental frequency of the xtal. Most of the xtals on the market these days come in a sealed metal case, but if you search around and make some enquiries to some of the more senior aged amateurs in your neighbourhood, you might unearth some of the more older pressure holder types of xtal. The FT243 style of xtal, is one of this group, that were around in abundance after WW2. This type as well as the larger DC11, will oscillate easily in this circuit. One other factor to remember if your oscillator does not work, when you switch it on, is that the xtal you are using could be faulty. If you are seriously considering becoming a home-brewer then I strongly urge you to make your-self a Xtal Checker and GDO also, because you are not going to get very far without these two pieces of test gear. Before I leave the Xtal, and move on to the other parts of the xtal oscillator circuit, I would urge you to read up on your Tx theory, and how xtals operate and the way they are cut to oscillate at their fundamental frequency or a harmonic. Once again I urge you to obtain a copy of Solid State Design for Amateurs, it has a good deal of excellent basic information. If anybody is interested I can supply about 50 sheets of basic info on Tx design, including info on this QRP Tx. The only other point that needs to be mentioned in regard to the xtal is the socket, in which you put the xtal. This needs to be of the type to suit the xtal, as pin size and spacing differ with different styles of xtals. Finally if you do wish to make your xtal oscillator stage into a VXO or Variable xtal, just insert a 60 to 100 pf. trimmer condenser in series with the lead from the xtal to earth, like so.....



I have tried this circuit in my own 10 mhz model, and with a HC6 type of Xtal, I can shift the frequency about 3 to 4 khz.

Q1 is a 2N2222A which means it is a NPN type of Transistor. NPN type transistors use a negative earth voltage supply. Here are the pin connections and circuit symbols for Q1.....



The choice of a 2N2222A transistor for the xtal osc. stage is a good one, because it is cheap, reliable, and will supply adequate drive for the next stage, which is the power amplifier stage. Many other transistors are also suitable for service in this circuit. You can also use PNP types by making your voltage supply a positive earth type. Here are a few extra notes, circuit, and ideas as to what you can do with one transistor.

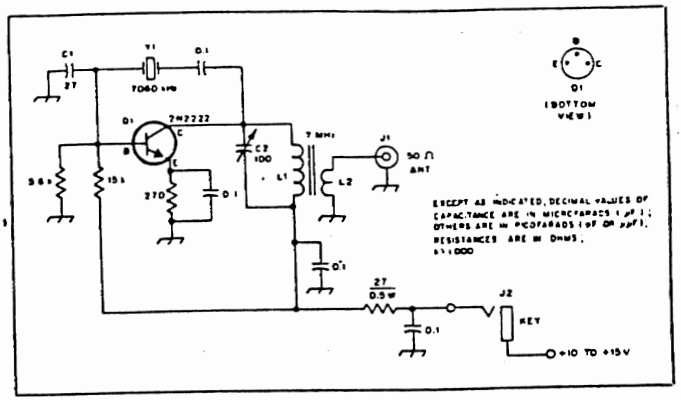


Fig. 1 — Circuit of a one-transistor QRP transmitter. Fixed-value capacitors are disc ceramic, 50 volts or greater. Resistors are 1/4- or 1/2-watt composition, 10% tolerance. C1 described in text. C2 is a 100-pF mica trimmer. L1 is a 6-μH winding of 34 turns of no. 26 enam. wire on an Amidon or Palomar T50-2 toroid core. L2 is 6 turns of no. 26 enam. wire, wound over L1 winding (see text). J1 is a phono jack, and J2 is a 2-circuit phone jack. Y1 is a fundamental surplus or new crystal for the standard 40-meter QRP frequency (7060 kHz).

Connect antenna through Output Filter from specifications supplied on page 1 of this article. You may choose your own favourite band.

The Simplest Transmitter

How uncomplicated can a transmitter be for experimental work? Factually, a one-transistor oscillator qualifies as a transmitter. Many beginners have had exciting results with such a circuit while operating with only 50 milliwatts (0.05 watt!) of power output. For example, the circuit in Fig.1 was tacked together one lunch hour in the ARRL lab and was connected to a 28-foot (8.5-m) base-loaded vertical antenna with buried radials. On the third CQ an answer came from a W8 in Ohio. A signal report of RST 569 was received for our 50-mW signal on 7060 kHz. A second QSO with a W2 station in New Jersey netted an RST 589 report!

Y1 of Fig. 1 determines the operating frequency. C2 tunes L1 to the approximate frequency of Y1. If it is set for resonance at exactly 7060 kHz in this example, the cw signal may become chirpy. With this type of oscillator it is best to tune the C2/L2 circuit for the best sounding note consistent with reasonable power output. Maximum power will not coincide with the cleanest cw note when connecting an antenna to this type of oscillator unless very light coupling is used (L2) between the tuned circuit and the antenna. The lighter coupling will, in itself, reduce the available power to the antenna.

Continued next issue

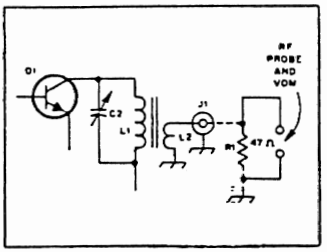


Fig. 2 — Details for measuring transmitter output power with a dummy load (R1), an rf probe and a VOM (see text).

The circuit of Fig. 1 can be used on 160, 80, 40 or 20 meters by using a fundamental-cut crystal for the desired frequency. C1 is part of the feedback network and will have to be chosen for the crystal we use. This is because some crystals are more active than others. The more sluggish a crystal is, the greater the feedback voltage required to make the circuit oscillate reliably. Values between 15 and 100 pF are typical for use at C1 in this particular circuit. We can experiment with the number of turns in L2 to extract maximum rf power output from the circuit.

cw operators qrp club

TOROID TURNS

By Don Callow VK5AIL (75)

12 July 1987

Often a circuit for a project specifies a toroid core, the number of turns of enamelled wire and its gauge.

If you want to use a different toroid and need to obtain the same inductance, e.g. for a tuned circuit, what you DO NOT do is to pick a core of different material and use the specified number of turns. The inductance depends greatly on the permeability of the material - so how do you estimate the number of turns ?

The accompanying TABLE OF EQUIVALENT TOROID TURNS may help. From it you can work out the number of turns of wire to be wound on your core, for some of the common sizes of toroids.

Example:

Specified - 20 turns on a Neosid 4327R/1/25 core.
How many needed on a Philips 14 x 9 x 5mm violet coloured substitute ?

* Both cores are of ferrite material; the Philips is catalogue no. 4322-020-97180.

* From the table, 63 turns on the Philips core are equivalent to 100 on the 4327R/1/F25, size 12.7 x 6.4 x 3.2mm. So you need -

$$\frac{20}{100} \times 63 = 12.6 \text{ turns.}$$

* As usual, it pays to wind extra turns on the core and later adjust them as necessary by removing the one or more excess turns. And in any case, the table gives only a rough guide.

* So try starting with 14 or 15 turns on the Philips core.

It is quite easy to extend the table for other cores, as long as you know (or can work out) the Inductance Index A_l in μH per 100 turns. If the figure you have is in mH per 1000 turns, just multiply it by 10 and you have the figure in μH per 100 turns.

The figure in the table is equal to

$$100 \times \sqrt{\frac{A_l \text{ of Specified core}}{A_l \text{ of Substitute core}}}$$

For more detail refer to the article TOROID TIMES which appeared in LO-KEY No. 11, September 1986. It was reprinted in the Club's Travelling Circuit Book No. 1, with the tables in an upgraded format. Table B - MATERIALS is reproduced here.

. o 0 o .

BRAND	MIX ID	COLOUR CODE if coated	INITIAL PERMEABILITY μ_i	USEFUL FREQUENCY RANGES MHZ: TUNED CIRCUITS	USEFUL FREQUENCY RANGES MHZ: BROADBAND TRANSFORMERS
MATERIAL GROUP: IRON POWDER					
AMIDON	2 (E)	red	10	2 - 10	0.5-30
"	6 (SF)	yellow	8	10 - 20 ? 90	2 - 50
MATERIAL GROUP: FERRITE					
AMIDON	43	(none)	850	0.01-1	1 - 50
"	61	(none)	125	0.2-10	10-200
NEOSID	F14	red	220	?	0.1-5
"	F25	?	50	?	1 - 50
PHILIPS FERROXCUBE	4C6	violet	100	?	0.1-50

NOTES :

* Iron powder has much better temperature stability than ferrite and is preferred for tuned circuits.
* Amidon Associates suggests you use larger sizes of iron powder cores for lower frequencies in the range and smaller sizes for the higher frequencies.
* High permeability gives high inductance or fewer turns for a given amount of inductance. Ferrite is preferred for broadband transformers.

TABLE OF EQUIVALENT TOROID TURNS

15 July 1987 VK5AIL

SPECIFIED TOROID			SUBSTITUTE TOROID: IRON POWDER / AMIDON T-68-2 17.5x 9.4x 4.8	T-50-2 12.7x 7.7x 4.8	T-37-2 9.5x 5.2x 3.3	T-68-6 17.5x 9.4x 4.8	T-50-6 12.7x 7.7x 4.8	T-37-6 9.5x 5.2x 3.3
	II	T-68-2 17.5x 9.4x 4.8	100	108	119	110	119	138
	OI	T-50-2 12.7x 7.7x 4.8	93	100	111	102	111	128
S	NA		84	90	100	92	100	115
	IM	T-37-2 9.5x 5.2x 3.3	91	98	108	100	108	125
P	PI							
	OD	T-68-6 17.5x 9.4x 4.8	84	90	100	92	100	115
E	WO		73	78	87	80	87	100
	DN	T-50-6 12.7x 7.7x 4.8						
C	EI							
	RI	T-37-6 9.5x 5.2x 3.3						
I								
F		FT-50B-43 12.7x 7.9x12.7	>	>	>	>	>	>
		FT-50A-43 12.7x 7.9x 6.4	>	>	>	>	>	>
I	A		958	>	>	>	>	>
	M	FT-50-43 12.7x 7.1x 4.8	858	926	>	945	>	>
E	FI		345	373	412	380	412	476
	ID	FT-37-43 9.5x 4.7x 3.2	311	336	372	343	372	429
D	EO							
	IN	FT-50-61 12.7x 7.1x 4.8						
	RI							
		FT-37-61 9.5x 4.7x 3.2						
T	R							
O	I	4327R/1/F25 12.7x 6.4x 3.2	175	189	209	193	209	242
R	TI	4327R/2/F25 12.7x 6.4x 6.4	248	267	296	273	296	342
O	EE	4327R/3/F25 12.7x 6.4x 9.5	304	328	363	335	363	420
	IO	4327R/1/F14 12.7x 6.4x 3.2	368	396	439	405	439	507
I	SI	4327R/2/F14 12.7x 6.4x 6.4	520	561	620	572	620	716
D	ID	4327R/3/F14 12.7x 6.4x 9.5	638	688	762	703	762	879

SUBSTITUTE TOROID: FERRITE / AMIDON FT-50B-43 12.7x 7.9x12.7	FT-50A-43 12.7x 7.9x 6.4	FT-50-43 12.7x 7.1x 4.8	FT-37-43 9.5x 4.7x 3.2	FT-50-61 12.7x 7.1x 4.8	FT-37-61 9.5x 4.7x 3.2	NEOSID 4327R/1/F25 12.7x 6.4x 3.2	4327R/2/F25 12.7x 6.4x 6.4	4327R/3/F25 12.7x 6.4x 9.5	4327R/1/F14 12.7x 6.4x 3.2	4327R/2/F14 12.7x 6.4x 6.4	4327R/3/F14 12.7x 6.4x 9.5	PHILIPS 4322-020-97180 14.0x 9.0x 5.0	4322-020-97170 9.0x 6.0x 3.0
<	10	10	12	29	32	57	40	33	27	19	16	36	48
<	<	10	11	27	30	53	37	30	25	18	15	33	45
<	<	<	10	24	27	48	34	28	23	16	13	30	41
<	<	<	11	26	29	52	37	30	25	17	14	33	44
<	<	<	10	24	27	48	34	28	23	16	13	30	41
<	<	<	<	21	23	41	29	24	20	14	11	26	35
100	141	148	165	409	454	807	571	465	385	272	222	508	685
71	100	104	116	290	321	571	404	329	272	192	157	360	484
68	96	100	112	277	308	547	387	315	261	184	150	344	464
61	86	90	100	249	276	490	346	282	234	165	135	309	416
24	35	36	40	100	111	197	139	113	94	66	54	124	167
22	31	33	36	90	100	178	126	102	85	60	49	112	151
12	18	18	20	51	56	100	71	58	48	34	27	63	85
18	25	26	29	72	80	141	100	81	67	48	39	89	120
22	30	32	35	88	98	174	123	100	83	59	48	109	147
26	37	38	43	106	118	210	148	121	100	71	58	132	178
37	52	54	61	150	167	297	210	171	141	100	81	187	252
45	64	67	74	185	205	364	257	210	174	123	100	229	309

The figures in the table are number of turns to be wound on SUBSTITUTE toroid for each 100 turns on SPECIFIED toroid.

> means that the figure is = or > 1000 i.e. Substitute core needs at least 10 times number of turns on Specified core.

< means that the figure is < 10 i.e. Substitute core needs less than 1/10th number of turns on Specified core.

No figures are shown in these two situations because substitution is probably not practical.

The dimensions given are outer diameter x inner diameter x height, all in mm.

Philips ferrite cores are shown only as Substitutes because I have not seen them specified in circuits.

Ferrite is NOT recommended for tuned circuits mainly because of poor temperature stability. Amidon iron powder mix #6 is very stable, with a temperature coefficient for inductance of about 1/300th of that for ferrite mix #43 !

THE TAMING OF THE SCREW ?

SCREW THREADS

by don callow vk5ail (75) CW OPERATORS QRP CLUB

MAJOR DIAMETER			USA/UNIFIED 60°			BRITISH				METRIC 60°	METRIC PITCH
mm	inches dec.	inches frac.	No.	UNC tpi	UNF tpi	BSW tpi 55°	BSF tpi 55°	BA 48° No.	BA 48° ptch mm	ISO COARSE pitch mm	in tpi
5.49	0.216		12	24	28						
5.00	0.197									0.80	31.8
4.83	0.190		10	24	32						
4.76	0.188	3/16		24	32	24	32				
4.70	0.185							2	0.81		31.4
4.50	0.177									0.75	33.9
4.17	0.164		8	32	36						
4.00	0.157									0.70	36.3
3.97	0.156	5/32		32	36	32					
3.60	0.142							4	0.66		38.5
3.51	0.138		6	32	40						
3.50	0.138									0.60	42.3
3.18	0.125	1/8	5	40	44	40					
3.00	0.118									0.50	50.8
2.84	0.112		4	40	48						
2.80	0.110							6	0.53		47.9
2.51	0.099		3	48	56						
2.50	0.098									0.45	56.4
2.38	0.094	3/32				48					
2.20	0.087							8	0.43		59.1
2.18	0.086		2	56	64						
2.00	0.079									0.40	63.5
1.85	0.073		1	64	72						

1-7-87

NOTES & HINTS

* The table shows the main screw thread types and pitches in use in the range of sizes commonly met with in radio chassis work.

* The range of major diameters in the table is from just over 1/16" to just under 7/32"

* UNC & UNF are Unified National Coarse & Fine.
The even fractions of inch sizes are actually UNS Unified National Special
Designation examples: 3/16-24 means 3/16" diam. and 24tpi. #2-56 or 2-56 x 1/4" means diameter is No.2 size, 56tpi and 1/4" long.

* BSW is British Standard Whitworth.
BSF is British Standard Fine.
BA is British Association.

* METRIC ISO (International Standards Organisation).
Designation example: M2.5 x 0.45 means 2.5mm diam. and 0.45mm pitch.

* The thread angles are given in degrees in the headings.

* It may be that a badly fitting nut is of a different thread form and/or major diameter than the screw e.g. a #10-24UNC nut will fit on a 3/16" 24tpi BSW screw - but will be loose.

* If you don't have a tap drill chart for 60° threads, use:

Metric:
Drill diam. = major diam. - mm pitch

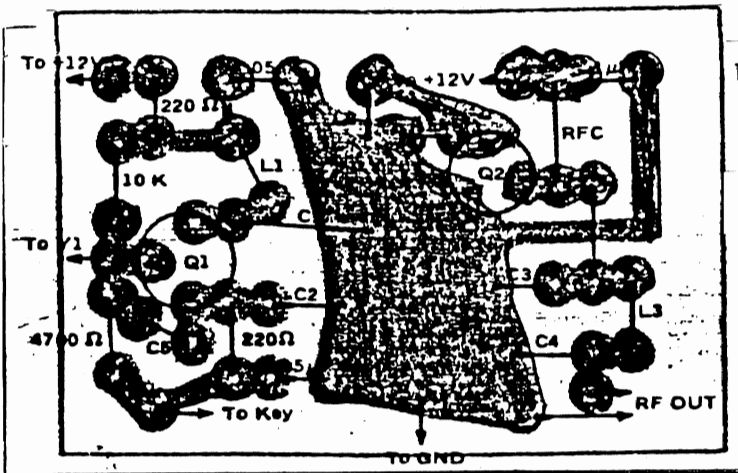
Unified:
Drill diam. = major diam. - 1/tpi

The latter also works well for British 55° threads.

* For the numbered series of UNC/UNF/UNS threads:
major diam. = (No. x 0.013) + 0.060"

* As a matter of interest, in the larger sizes such as on pots, small switches and rotary switches, some examples of typical threads found are:

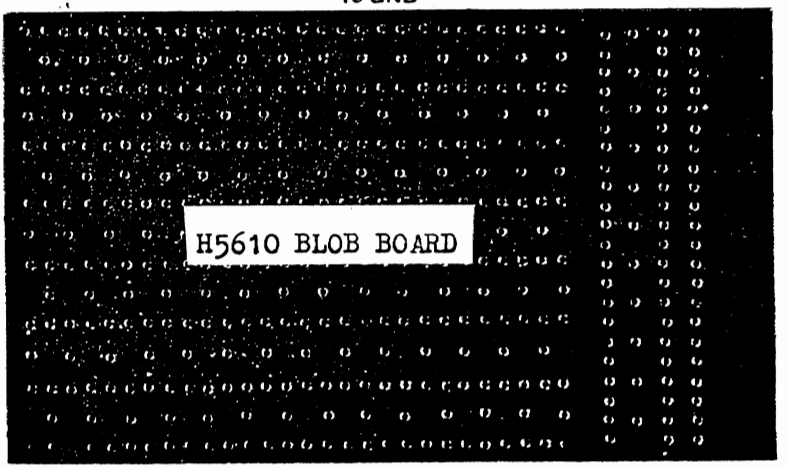
Spindle size 1/4": 3/8-32 UNEF (where E = Extra)
Spindle size 6mm : M9, 8 OR 7 x 0.75
Small switches : M6 x 0.75
Larger switches : M12 x 0.75

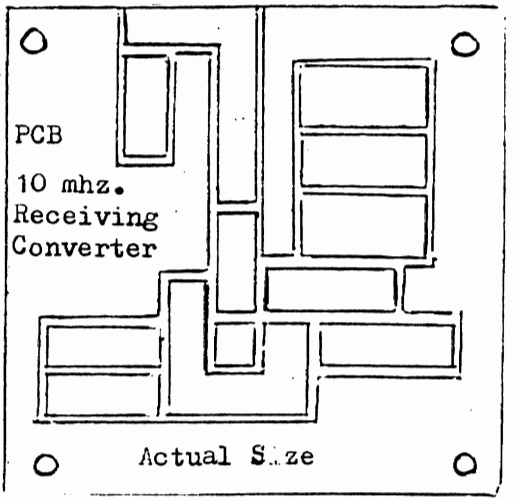


UNIVERSAL QRP TX.

PCB LAYOUT

(ACTUAL SIZE)

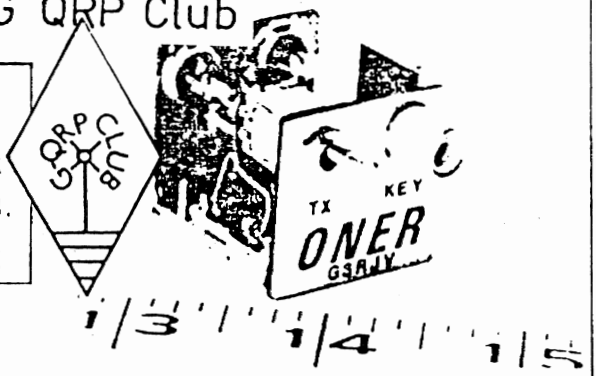




ONER

THE H.F. BANDS TRANSMITTER
ON A ONE INCH SQUARE P.C.B.

GEORGE BURT GM3OXX

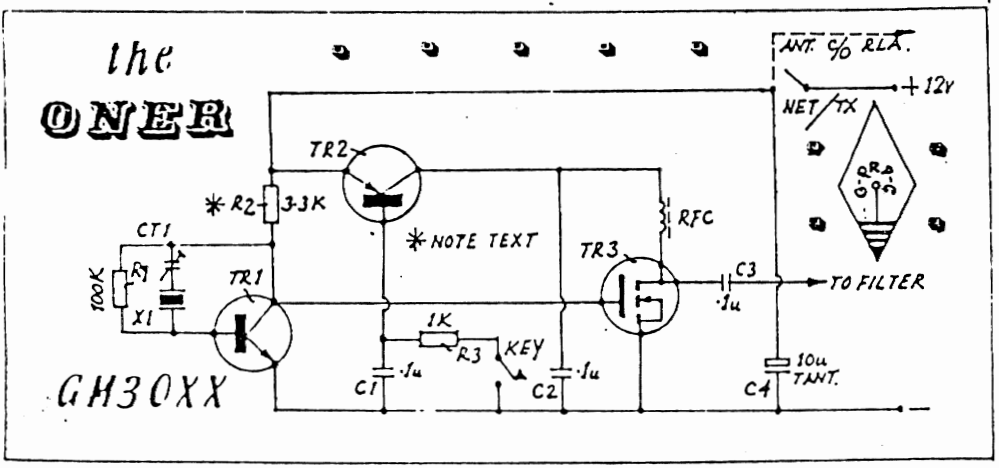


By George Burt GM3OXX

The Oner is a small transmitter built on a one inch square PCB that gives at least 1 watt output to 10MHz. It is useable on 14MHz at a reduced power output of some 750mW.

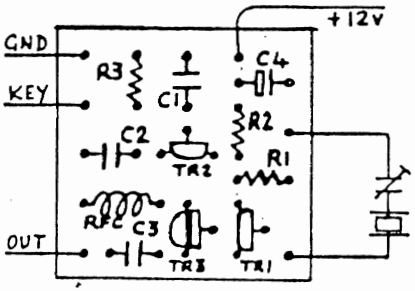
R2 (3.3K) in the circuit is the collector load of TR1, and also sets the bias for TR3. It is possible to reduce the value as low as 1K to squeeze more power from TR3, but care must be taken not to cook the PA! Beginners stick to 3.3K!! (I get well over two watts out of my Oner on 80 metres with 3.3K - G3RJV.)

Construction notes - the only real problem was pushing six veropins into such a wee board!, and trying to find the PCB after laying it down!!

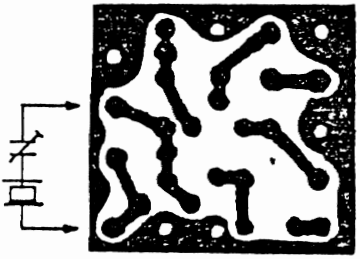


TR1 = 2TX651 TR2 = 2TX751 TR3 = VN10KM (all availabke from R.S.)
RFC = as many turns of 30SWG enamelled wire as will fill a small ferrite bead, usually 10 to 12.
CT1 = trimmer for frequency offset about 60pF.

Results - with a single section filter, ATU and a 44 feet-Zepp, lots of good QSOs have been had on 3.5, 7 and 14MHz. Now no one has an excuse for not getting started in QRP.

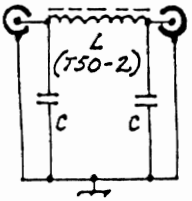


TOP



PCB (ACTUAL SIZE)

BOTTOM



FILTER VALUES			
80m	750p	750p	21t
40m	470p	470p	14t
20m	210p	210p	12t

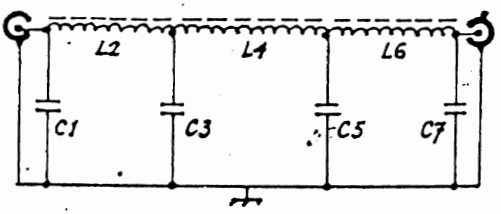
FILTERS AND THINGS

A simple transmitter like the Oner requires a low pass filter to reduc the harmonic output. If the Oner is used with an ATU, a simple filter lik the one on the left, wound with 22SWG wire, will serve the purpose. A better solution is to use a seven element filter, designed by W3NQN from the table below. The toroid formers can be had from TMP Electronic Supplies, Unit 17, Pinfold Workshops, Pinfold Lane, Buckley, Clwyd, CH7 3PL, (Tel: 0244.549563).

Seven Element Low Pass Filters

C1/7	C3/5	L2/6	L4	Wire	Band
470pF	1200pF	25t	27t	28SWG	80
270pF	680pF	21t	24t	26SWG	40
270pF	560pF	19t	20t	26SWG	30
180pF	390pF	16t	17t	26SWG	20

C1 = C7 C3 = C5 L2 = L6
80 metres inductors on T-37-2 cores
40 metres inductors on T-37-6 cores



CRYSTALS Fundamental amateur band CW crystls are available on the International QRP frequenoies: 3560, 7030 and 14060 from P.R. Golledge Electronics, Merriott, Somerset, TA16 5NS. £3.50 each inc. VAT and postage for G-QRP-CLUB members, £4 to non-members.

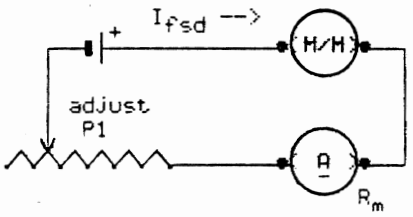
PROTECT THAT METER (cont.)

MORE ABOUT METERS

What follows is an experimental method to set up a chosen level of meter protection. In the process you find actual I_{fsd} current for full scale deflection (fsd) and R_m internal resistance of the meter. The value of voltage drops across the diodes is not assumed, but they should be about the same.

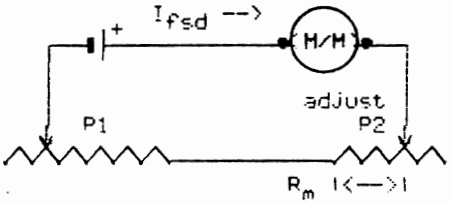
Step 1: Select a pot P1 of resistance found by substituting in R = E/I the nominal value of I_{fsd} (if unknown use 50uA, the lowest figure likely to be met with) and E = 1.5V (or other low battery voltage). This gives R = 30kΩ minimum so try 50k.

Step 2: Connect circuit shown, after pre-setting the tap on pot P1 to give maximum resistance. M/M is a multimeter to measure current.

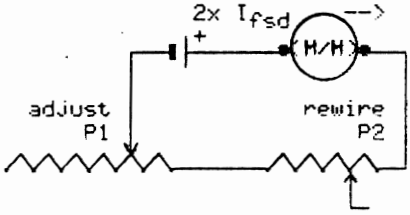


Step 3: Adjust pot P1 until meter under test reads full scale deflection (fsd). Current read on M/M is actual I_{fsd}. Can repeat from Step 1. if assumed value of I was wrong.

Step 4: Replace meter with pot P2, just less than half theoretical value of P1, from Step 1. Adjust P2 to give the same current I_{fsd}. Disconnect battery and measure P2 tap resistance, which equals R_m internal resistance of meter.

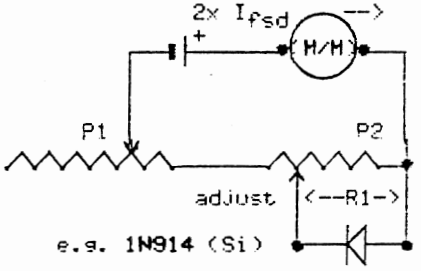


Step 5: Rewire circuit as shown, then decrease pot P1 resistance until the current is I_{fsd} x factor of voltage (and current) chosen as the point at which the diode should start to conduct when meter is overloaded e.g. current = 2x I_{fsd}. Change value of pot P2 if necessary.



Step 6: Connect diode to the tap of pot P2, with the tap preset to give zero resistance. Adjust the tap until the current starts to increase (by 1 or 2%), which indicates start of flow through the diode. Measure resistance R1.

Note: That part of the pot resistance R1 equal to R_m is equivalent to the meter under test, for our purposes.



Step 7: Use a series resistance R_s = R1 - R_m (approx.) as in Fig. 1 and the meter protection aimed for should be achieved. Test it out using higher range meters to observe current through meter and total current, while the latter is progressively increased.

Note: If R1 < R_m then the diodes may start to operate before the meter reaches fsd, upsetting accuracy.

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