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JULY '83

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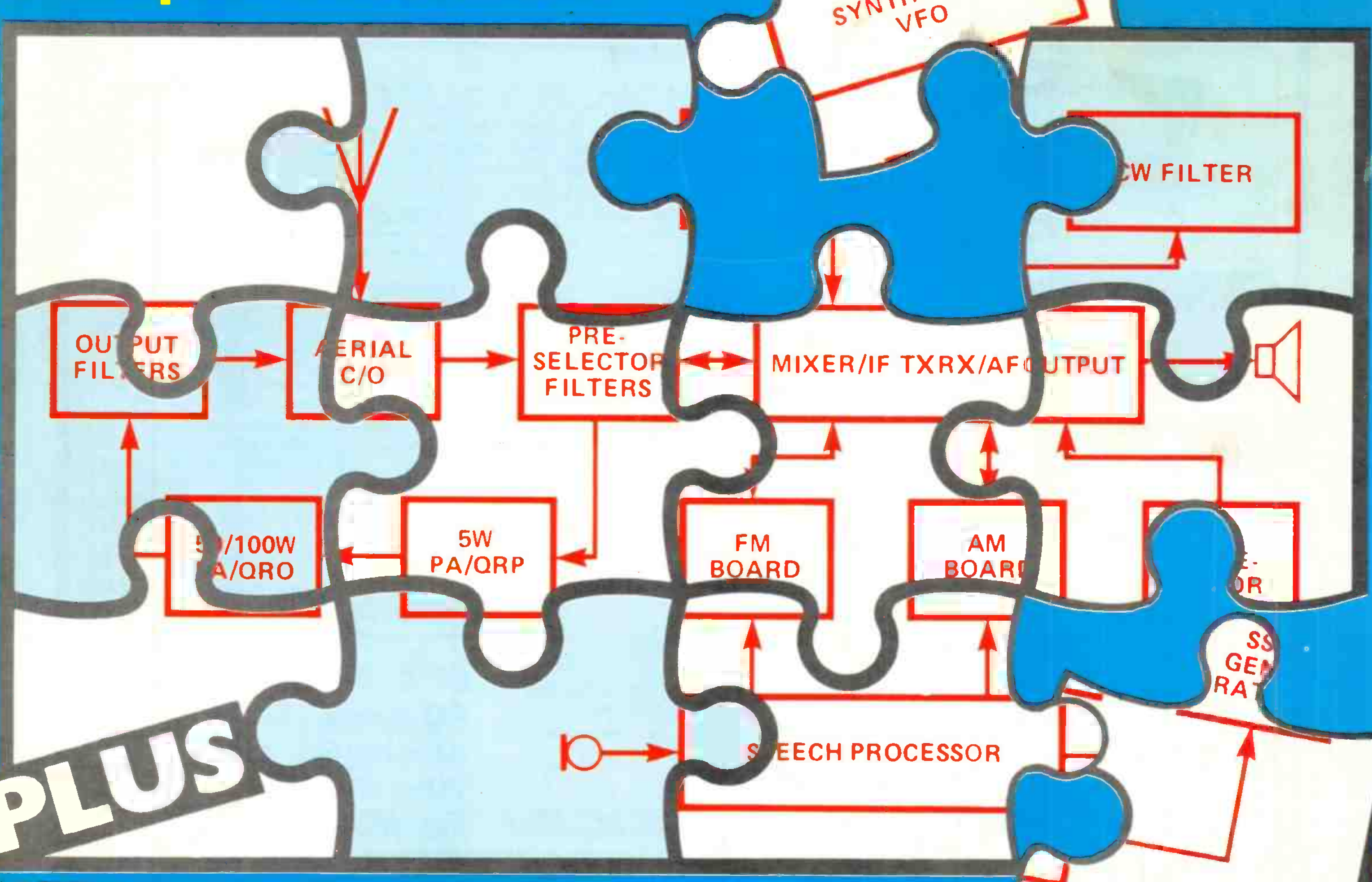

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HAM RADIO TODAY

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Please address correspondence to:
Frank Ogden G4JST
Ham Radio Today,
145 Charing Cross Rd,
London WC2 0EE.

S-METER SAGA

Sir, Your comment at the end of my letter printed in the May issue says "End of conversation". But you can't leave it there as your statement is incomplete and therefore misleading.

You say "Let OdB=0.5μV". Fine, but what notch on the S-scale should that input represent? To what authority do you attribute your definitions? I'd like to know if ITU, IARU, FCC or any similar body has produced an official recommendation about S-points and reference level. If so I've missed it.

The competition question in the January issue that sparked off my initial outburst involved a power increase from 10 to 40watts. The answer being sought was 1 S-point. But, as already indicated, KW users would measure 1½ S-points. Should they be failed?

In the February issue G3WPO covers the subject very well. The 1982 ARRL Handbook says that attempts were made to make S9 equivalent to 50μV and each S-unit equal to 6dB. This system never caught on probably because of design difficulties such as gain variations between bands and different AGC performance from receiver to receiver.

S-meters can give only an indication of relative field strength, not an absolute measurement thereof as commonly believed. In practice they are a mixed blessing to be taken with a pinch of theoretical salt.

RAY BURGESS, G3RXG

Sir, If I may update my last letter, I am indebted to the Editor of *Practical Wireless* for sending the enclosed IARU 1981 recommendations for S meter calibration. This is the first hard evidence I have seen of an official recommendation. It is interesting to note that the reference levels change between HF and VHF.

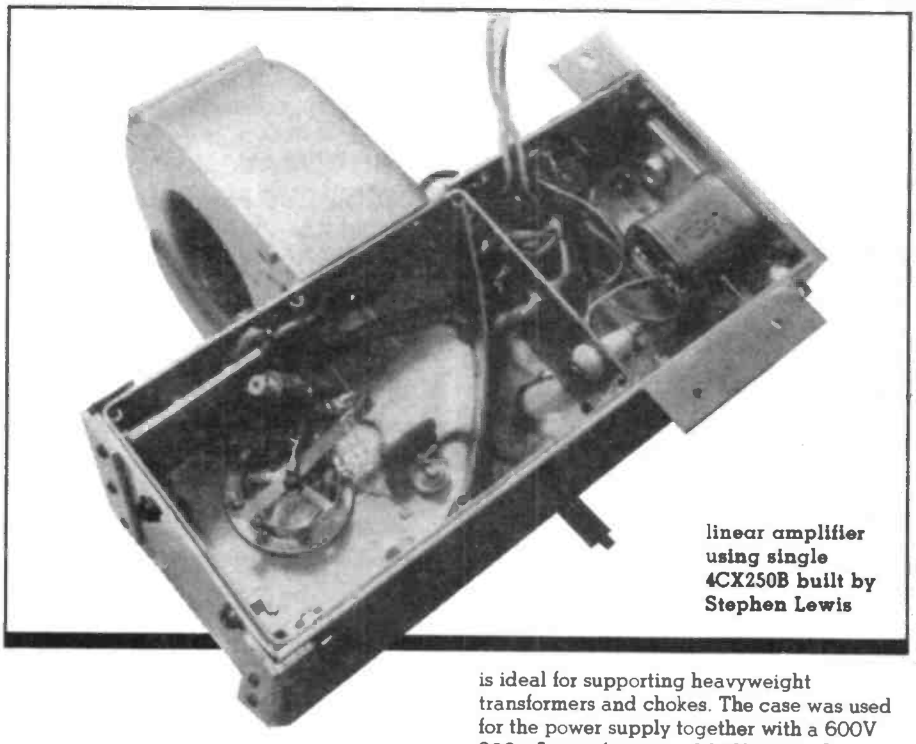
It is probably safe to say that most equipment in circulation does not comply with these standards. These are recommendations, not regulations, and unless an equipment specification states that the S meter conforms to IARU standard, there can be no guarantee that it does, in fact the chances are that it does not.

So I think most of my previous remarks are valid. I will continue to avoid any misconceptions by giving subjective reports, but with just half an eye of my definitely nonconformist S meters.

RAY BURGESS

HF LINEAR

Mr. Ogden, I took great interest in your article, *400 Watt HF Linear Amplifier* in May's edition of *Ham Radio Today*.



linear amplifier using single 4CX250B built by Stephen Lewis

I agreed with your argument that it may be technically far easier at HF to obtain the legal limit by using a relatively low voltage power supply (say 1.2kV) and increasing the number of valves, however, it is my view that it would be wiser and as economic to concentrate on designing a power supply capable of delivering 2kV+ and incorporating all necessary PA metering and a number of safety and valve protection facilities. Having constructed such power supply unit, it should then be possible to utilise it with any single valve 4CX250B amplifier designed for bands from 160 metres through to 70cm. I would point out that whilst the construction of a multivalve amplifier at HF is simple, at VHF the design of an amplifier with two valves or more is very complex.

I have recently completed the construction of a single valve 4CX250B 2-metre amplier and associated power supply. The power supply took six months to construct and develop whereas the amplifier took only three weeks to complete.

The power supply was very cheap to build since all expensive components were obtained from a Heathkit *DX100U* AM HF Transmitter which was purchased for £25. Prior to the advent of the semiconductor SSB era, many amateurs owned the *DX100U*, so it is not surprising that they are seen at most rallies with a price tag of £20 to £35. The *DX100U* is housed in a 19" steel case with a slide-in heavy gauge 19" steel chassis which is ideal for supporting heavyweight transformers and chokes. The case was used for the power supply together with a 600V 200mA transformer, a 1600V 500mA transformer, a 6H 500mA choke, a 7H 200mA choke, the panel meter, ceramic rotary switches and valve sockets, electrolytics, high wattage resistors and toggle switches. For the HF operator there are additionally all components required for anode and grid pi-networks, some SO239s, a high quality modulation transformer, two 6146s and two KT88s.

Not bad for £25?

STEPHEN LEWIS, T.Eng (CEI), G8JCT.

OM, Yesterday I saw your *HRT* mag on sale, so I bought a copy, attracted by the *400W HF linear*. I've been collecting parts for a *G2DAF*, but will try one based on your design, as I think it will be more easily driven by my *FT7*.

One point though: the grid circuit uses a 2:3 toroidal transformer. Will you please give me details of the type of core, and the winding details?

Second point: you have not incorporated any delayed switching of the 1300V supply, whereas elsewhere I have read that valves can be damaged if the HT is on before the cathodes have reached operating temperature. Any comments?

I like the look of your magazine, as do my mates G3US and G3HCX. I like the excellent typeface and the un-stodgy style of presentation. May you have much success in the future.

WALTER FARRAR G3ESP

Yes, I've got some observations. First of all, thanks for the kind comments. But to the matter in hand. Yes, I've heard that valve cathodes can be stripped by premature application of the HT supply. However the observed facts don't fit precisely. I have a number of old mains radios (they are something of a hobby with me) which warm up with HT present... they were designed that way. No ill effects. Secondly, although the HT is present all the time on my linear, the electron stream is cut off by keeping the grid 1 bias volts on and taking grid 2 to cathode potential. This cut-off phase also applies to the warm-up period.

It is interesting to note that you must keep the PA valves shut off during receive because the standing bias current causes a significant amount of white noise on the other side of the aerial changeover relay. This could adversely affect the receive path noise performance.

Re. your query on the step-up transformer in the grid circuit, that's just a simple autotransformer wound on a ferrite 'braid breaker' core. The core is a 1cm square of ferrite with two thin holes through the middle. The core is wound with a total of six turns of 24swg wire tapped at four turns for the drive input.

Frankly, the actual shape of the ferrite core used is relatively unimportant. Providing that the cross sectional area is equal to that of the average pencil, the permeability is at least 200 (most are) then it should be OK. Anything sold as a balun core will almost certainly be suitable. I suggest a 'suck it and see' approach. You can't do any damage. Good luck — Ed.

NORTH SEA OIL RIGS

Sir, The *Syledis* navigation system, used mainly in the North Sea by the oil exploration business, has caused problems to UK amateurs using the 432MHz band for some time. Initially *Syledis* chains were set up temporarily where and when required, but subsequently installations became permanently established. These permanent chains do not transmit continuously, but are switched on automatically by a mobile unit requiring a navigational fix.

Unfortunately for the amateur population, the 430-440MHz band is allocated on a primary basis in the UK to radio location, with amateurs having only secondary status. The amateur population has therefore no right to demand that interference from *Syledis* cease. What is also unfortunate is that the frequencies of operation chosen by the manufacture of the equipment, and subsequently allocated by the Home Office, coincide with part of the DX Communication end of the 432MHz band.

A paper presented at the *Electronics in Oil* conference held towards the end of last year in London gave some details of the system, and indicated the frequencies used by the service. The frequencies mentioned are 432.563MHz, 432.513MHz, and 432.463MHz for the Primary Group, and 432.383MHz, 432.303MHz and 432.144MHz for the Secondary Group.

Although the Home Office have been approached about the situation, at present they are not prepared to alter the status of amateurs on 432MHz. So for the time being, UK amateurs are, by the terms of their licences, obliged to avoid these frequencies, so as not to cause interference with the primary service. I would be grateful if you could convey this information to your readers so that they are aware of the situation, and realise which frequencies in the band they should avoid.

MALCOLM APPLEBY G3ZNU
CHAIRMAN, VHF COMMITTEE, RSGB

DISGUSTED, DEVON

Editor, I wrote to a component firm in Brentwood, Essex, to ask if they would let me have a key to the list of linear ICs which they advertise. Of course they referred me to their catalogue; but why should one have to pay to find out what they are advertising?

Now if you would publish a list of linears, showing what the things are for, you would please advertisers and constructors alike.

JIM BOURNE

TELEVISION BANDWIDTH

Sir, I was interested to see the article on ATV in the March issue. This seemed to give a fair picture of ATV as it is today, though I for one regret it. I have used ATV since 1964 but am rarely on now, and watch less and less as time goes on because over the last few years ATV, on 70cm anyway, has become largely a pointless black box activity with the usual black box disadvantages. That is, operation with minimum equipment and even less know-how!

Colour operation was mentioned but it was not pointed out that operation with commercially available transmitters on PAL colour is a contravention of the licence conditions. You work it out: they transmit a double sideband signal and a PAL signal requires over 4.43 (in practice over 5.5) MHz of information. That is, the transmitted bandwidth is in practice over 10MHz, in a band only 8MHz wide!

In several cases, including the Fortop transmitter, there is no provision for sound modulation, either in the middle of the passband or anywhere else, so use would represent another licence contravention. Now we all know that when it comes to policing the bands — even on sound — the HO/PO are pretty incompetent so the chances of anyone being done for such a breach on television is fairly remote. However it would indeed be a pity if a lack of information in a magazine article were to be the cause of one of these unknowledgeable black box operators losing a licence.

A JAQUES G3PTD

The notes on frequency checking equipment on the back of the amateur licence say that "When determining the proximity of an emission to band-edge, the bandspread due to modulation, on the appropriate side of the carrier, needs to be added to the frequency tolerance of the carrier.". So even the daftest of the daft need to take the bandwidth of their signal into account, whatever mode, television or not, they're using.

PAL colour signals can be contained in an 8MHz band by using a vestigial sideband filter, to cut off the high frequency components in one of the sidebands. Although this technique is universal in television broadcasting transmitters I've seen no mention of it in amateur circles. However I wouldn't be surprised if the BATC cogniscenti solved this one years ago. I'd like to publish a design for such a 70cm VSB filter. Any offers? — Ed.

SHOCKING

Sir, Tut tut! How long have the Channel Islands been off the tip of Cornwall? (Your map on p7 of *Ham Radio Today*, May 1983.)

You publish a great mag, but your geography is shocking!

H E HOGG

I cannot tell a lie. I haven't the foggiest idea why we printed the Channel Islands in such a Scilly place — Ed.

PERSONAL PREJUDICE

OM, An excellent and thoroughly readable magazine, spoilt only by the apparent personal prejudice of the Editor against the RSGB.

Reasonably low key in the first two issues, this prejudice shows up very clearly in the third.

The RSGB is a National Society (indeed the only National Society) which represents the interests of British radio amateurs. The only qualification for membership is an interest in amateur radio, and no licence of any sort whether Class A or Class B or whatever need be held.

There are no faceless beings at RSGB HQ who control our destinies. The administrative staff who work there are the paid employees of the Society, and the views, opinions, decisions and aims of the Society are those of its members and of their representatives as voiced through the various elected committees.

The RSGB membership embraces an extremely broad cross section of Society both men and women, young and old. The technical abilities of some of its members extend no further than the RAE whilst others are in the top bracket of technical expertise.

It comes somewhat hard therefore to find this large body of enthusiasts labelled as "benign", elderly and "fuddy-duddy". Now I am a member of the RSGB, and whilst I may admit to being benign on occasion, and whilst "elderly" may be a matter of opinion, I do not consider myself to be "fuddy-duddy" and I extremely resent being so called.

Reference the RSGB being against Class B CW on 144MHz. If this is true as you assert then there must be a valid reason for it, other than the curious and selfish reasons which you, by implication, put forward. Furthermore if, as you claim, some confidential information was "leaked" from a closed committee meeting then it seems to me that the corrupt attitude of the person who leaked it is equalled only by that of the person who purveys it in print as unsubstantiated second-hand gossip. It would be interesting to know whether the RSGB was asked for its reasons regarding the above before you knocked it so hard in your column.

Finally we come to the matter of the six metre licences. Requiring informed advice on this matter (a concession obtained only by the efforts of our National Society) to whom should the Home Office turn? To whom *could* they turn except to the National Society which represents British amateurs. Some may say they should have turned to G4JST the liberal-minded editor of our latest mag. Others may think it significant that they did not.

If as you claim you have all radio amateurs' interests at heart then I suggest you use your best efforts to persuade all new licencees to join the RSGB. This gives us maximum voice at the ITU conferences on frequency allocation, whilst those who think the RSGB unrepresentative can offer themselves for election, thus bringing about the 'change from within' which you yourself advocated in the February issue.

If you throw stones you must expect at least some of them to be returned, although you will notice that I am somewhat more selective in my target.

FRANK SIMPSON G3EFR

B-K OR G-M OSCILLATIONS?

Sir, Your article in the January issue, brought back many memories and the letter from K V Entinger's reference to Eric Megaw (G6MU) reminded me of his lecture to the RSGB on March 25 1931, published in the T&R Bulletin, July '31 (ten pages): *Electron Oscillations and their Application to Very High Frequency Communications.* In this, the history of the development of electron oscillations was given. He summarised to two forms as:

Barkhausen-Kurz (BK): oscillations whose wavelength was determined by the electrode dimensions and potentials.

Gill-Morrell (GM): oscillations whose wavelength depends only on the external circuit..

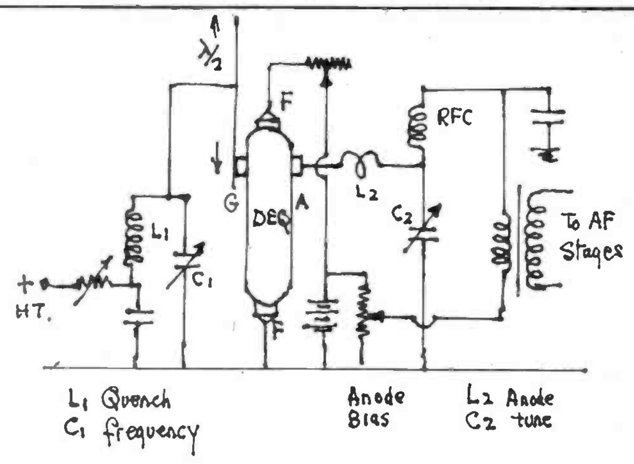
A British Patent was granted to Gill, Morrell and MWT Co (No. 108757). An abstract appeared in *Wireless World* in an article *Very Short Waves* by P R Coursey (17 Oct 1918).

The two different forms of electron oscillation was fully covered by Hollmann in *Proc. IRE* Feb 1920.

It appears to me, that the cross-channel link was most likely to have been using G-M oscillators rather than B-K.At that time, however, all electron oscillations were usually described as 'B-K type'. Eric Megaw spent most of his working life at GEC Research Labs, now known as Hirst Research Centre, working on the generation of Ultra High Frequencies and considerable work on the electron oscillators preceeded his work on the split-anode magnetron, the CWII produced 50W at about 1.5 metres.

I do not now recall the valves used in the cross-channel link, most were modified 'R' type, in which the anode and grid connections were brought directly through the bulb — see attached sketch. I still have one sample which looks as though it would still operate. A simple self quenching super-regen receiver using an electron oscillator is pictured on page 3 of chapter 1 of the new edition of the *VHF/UHF Manual.* The circuit of this detector is attached. I hope this information is of interest to you.

G R JESSOP G6JP.



Simple Super Regen · Electron Oscillator Detector

MOSCOW MUFFLER

Mr. Ogden, Reference the article/review *The Moscow Muffler* by T. Bailey in the May 1983 issue of *Ham Radio Today.*

With all due respects, the details given in this article about the so called 'Woodpecker' signals are not quite correct. Firstly, it is known that there are *four* Russian OTHR systems in operation and that the transmitter power output is *not* 4 Megawatts but varies between 20 and 40 Megawatts depending on the degree of ionospheric reflection necessary for the function of OTHR stations.

It is not known for absolute certainty whether the Russian OTHR systems are using back scatter technique as employed by the American *CONUS-B* OTHR or, forward scatter as used by OTHR stations operating in the Middle East and Australia. It is most likely however, that the Russian system uses the back scatter mode, in which case the antenna for transmission would of necessity have a very narrow beam width and therefore be capable of high ERP. The 'low power' experimental American *CONUS-B* OTHR at present operating has an ERP of 100 Megawatts (confirmed by the USA Air Force Electronics Division at Maine). The ERP from fully operational Russian OTHRs could well be in the region of 200 to 400 Megawatts.

With the Russian on-off pulse system the PRF is *always* 10 per second (100mS interval) and the pulse width 4mS. However, the transmissions are not always *single* pulses. For example, there are often short transmissions using a 4 pulse sequence (unmodulated) which are thought to be solely for ionospheric soundings; necessary with OTHR systems. In normal search and target interrogate mode, the pulses may be single or multiple and also *code modulated*, each pulse being 4 milliseconds with a spacing of 5 milliseconds, that is leading edge to leading edge, when a multiple pulse sequence is used. These are also repeated every 100 milliseconds. Note that pulse transmissions from other OTHRs (mostly American) use PRFs between 16 and 60 per second and which are often frequency modulated as well.

Whilst the so-called *Moscow Muffler* device may be effective in reducing, or even eliminating typical on-off pulse signals at one's own station it does not follow that the station with which a QSO has been established, will be receiving *your* signals through this type of transmission; unless a similar device is in use. This could well be the case since Russian OTHR signals (Woodpecker) are frequently heard just as strongly and at the same time as say in Australia or America as they are in the UK. Calling CQ or making any other form of transmission on the frequency in use by one of these stations *will cause no interference to them whatsoever*, as all CW, FM, AM or SSB telephony and teletype transmissions etc. are converted into broad band noise which is suppressed by the OTHR receiving system.

It should be mentioned that on-off Russian OTHR pulse transmissions can only be fully resolved for oscilloscope examination of the de-modulated pulse formations and encoded modulation, by using a receiver with a through bandwidth of at least 2 MHz and an oscilloscope with a wide band 'Y' amplifier. Spectrum analysis can and has been used to reveal the nature of the modulation on the Russian pulse transmissions.

Finally, it has been found that some noise blanker circuits on communications type receivers will greatly reduce 'Woodpecker signals', almost to the point of elimination if they are properly adjusted. Whilst the amplitude of wanted signals is reduced somewhat, readability is still acceptable although much depends on the relative strength of the wanted signals and the pulse QRM. At high level, the bandwidth of 'Woodpecker' signals can be in the region of half a Megahertz or more.

F C JUDD G2BCX

FIGHT AGAINST TV LINE TIMEBASES

Sir, I would like to raise the question of RFI and TVI and the recent USA legislation which requires the manufacturers of receiving apparatus to include filters to keep out the unwanted whistle, while admitting the wanted signal.

I seem to recall hearing Timothy Raison on this subject recently on the Radio 4 early morning programme discussing this subject.

We need a campaign mounted, to give the amateur some protection under the law, but I cannot see the RSGB (which acts like an old servant content to touch his forelock and murmur "Yes master" to the Home Office) doing anything about it.

I would dearly like to known the opinions of other amateurs when they have had the American legislation clearly explained, together with the background.

What about an article from you on the subject 'The Other Side of TVI', which could outline the benefits to the amateur of having the law recognise that the transmission is legal but the receiver is faulty, and a detailed write-up of the history and achievement of legislation in the USA.

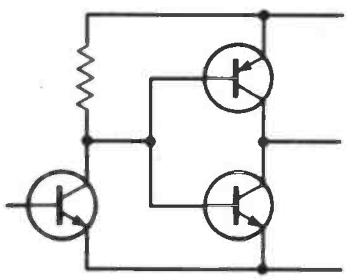
If you do not know much about the subject refer to Hilary G4JKS QTHR.

BASIL CAINES G4PAY

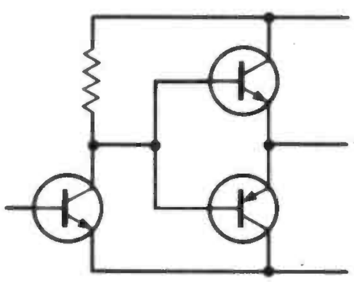
Yes. What a good idea. I'll be the first to join the campaign against 'noisy' appliances. Anybody out there like to write an article on the subject? — Ed.

CLANGERS

Frank, Ref. *HRT* May 83 page 15:



Should be



Whoever copied it out of the *Radio Amateurs' Examination Manual* should have checked. They *also* drew it incorrectly!

Later editions showed a transformer coupled amplifier. To simply correct the original drawing would have been to admit their mistake and that is something some people just cannot do!

Thank you for an interesting, if slightly 'cocky' magazine. I enjoy the apparent enthusiasm with which it is written.

RUSSELL KING G8YNY

Sir, please let me correct you on the RAE Answers which are on page 7 of the April edition (Q2 on radio theory). The correct answer should be C: Golf 2 Mike Uniform Romeo, which is the correct NATO alphabet is use now.

Thank you for a very good mag.

FRANK MARAS

METREWAVE

Frank, In stating that the adoption of directional antennae would reduce congestion on 2m (May issue) Jack Hum made no mention of the need for transmitter power levels to be reduced. If they are not then the area covered by each signal (and hence its effect on congestion) will be likely to increase.

RICHARD CLARKE G8UNO

CW IN COLCHESTER

Frank, In *Newcomers Forum* (May issue), Tony Bailey G3WPO, page 22 line 5, says that CW is "little used by comparison".

Maybe so round some QRA squares; down this way (Colchester) it is used quite frequently — there are CW learners' sessions nightly on 145.225 F2A, 144.150 A1A, 146.160 A1A, and others come on for general rag-chew as well.

Although many sweat to obtain a Class "A" purely in order to go HF, others obtain great pleasure and interest in CW hereabouts on 2m and 70cm.

Best wishes for a very professional publication,

LES G4NOZ

HOT GEAR

OM, In the *Technicalities* column of the March issue of *HRT*, you are mentioning "hot gear", ie. when the chassis of the rig is hot with RF. As I have been using all kinds of makeshift antennas, mostly long wires of just wires, as most of them have not been that long, I happen to know this problem very well indeed.

My solution to the problem is simple. I connect a 1/4 wavelength of insulated wire to the chassis of the ATU, insulate the other end then route it out of the window or just along the floor. For multiband operation I use one wire for each band and tape them together. I first saw this mentioned in an article about BCI and AFI, in CQ magazine many years back, and later I saw in *Amateur Radio Techniques* this same solution. In his article, G3VA said that this would also improve the radiation pattern of your antenna. I hope that this can help someone who has the problem of 'hot' gear.

SIGURBJORN BJARNASON TF3SB

MORSE TEST MELEE

Sir, I am an SWL who has passed his RAE and has just applied for a Sound B. I will soon follow this with my Morse test and a Sound A. I read your magazine each month; at least those bits of it which are not devoted to the Morse Test Melee. (Letters most months).

I think that it is essential for every HF operator to known the morse code. What would happen if you suddenly heard the following: ... --- ... .--. --- ... -. ..--- --... ...-- --... ..---... ..--- ...-- -----. -- -.-- ...-. ... .-.. .. .. - .-.-. - .. -. --. - --- ... .. -. -.- etc, and could not understand it? It would be some poor seaman who has had no reply on the marine distress frequencies and has tuned to the first station which he has heard working. Then he come in on top, desperate for some help.

If you can't read his signal you're going to be worse than ruddy useless to the poor blighter. If your readers were really keen amateurs, interested in self training, they would stop charping and learn the code. Remember the motto: Use it or lose it. Anyway if just one amateur saves just one life because of his knowledge, it must be worthwhile all of us learning the code, just in case.

Having said all that, I do think that the LWC should press for a restricted use of morse on 2m for teaching and practice. Isn't that what it is all about?

P M YORKE

PS You must know what LWC means.

APPEAL

Sir, Amateur radio forms part of the programme of self-training within many Venture Scout units but lack of finance limits the development of this interest in a newly formed group such as ours.

We feel that there must be much idle equipment lying dormant and semi-forgotten in attics throughout the land, and from personal experience I know that it is a painful decision to accede to the XYL's exhortations and 'throw it out'. If donating it to a worthy cause would lessen this pain we would very much like to hear from you. Any equipment or components thus received would, to us, have a usefulness far exceeding its value.

On a personal note — good luck *HRT* — I have been patiently waiting for you for years.

A MILLS G4KRV (for 29th Wigan Venture Unit) 38 Dunster Close, Platt Bridge, Wigan, Greater Manchester.

IT'S BEEN DONE!

Mr Ogden, Re. your comments on increasing the usefulness of the Mizuho *MX-2*. It's been done, and is called the Totsuko *TR-2100M!* This device lives in a case about the size of the ubiquitous *FT290R*, contains 10 AA size Nicads, a 1W PA for portable operation, 10W PA for fixed or mobile use and room for five crystals covering the whole bottom meg in 200kHz slices (the tuning dial has a reduction gear).

Circuitually the two rigs are very similar, the *2100* sporting an extra IF stage (IF at 9MHz) and a more sophisticated, amplified AGC system.

The price? Somewhat less than your estimate at £110 from a newly 'converted' emporium in Stetchford (Birmingham).

Purchased recently, after inspecting the NEC exhibition for anything better at the price, the rig has produced 5 & 7 reports from the Continent using an HB9CV at an admittedly good site (about 160ft above ground level) on the University of Aston campus in central Birmingham.

I would be interested to see a review of this rig although I have not see it on sale anywhere other than the above mentioned emporium.

N H HIGHFIELD G6AUV

RADIO TODAY

News about amateur radio compiled by Richard Lamont G4DYA

MOULD spreads

The Ministry of Defence's MOULD mobile radiotelephone system, which has been causing interference to amateurs on 432MHz in several areas of the UK, is on target for completion this year. Despite this, the MoD says it does not yet know how many of the remaining transmitters will be on 432MHz.

In this month's *Radio Today* we investigate the background to the MOULD system.

Home defence

Two years ago, the Government decided to revamp its Home Defence preparations. The new plans, which are detailed in the Defence Estimates, include a £7,000,000 contract with Pye Telecommunications for the MOULD system. Pye described the project in a press release in December 1981 as "mobile, single channel, all-informed, radio command and control systems for each of the Home Defence Regions of the UK mainland. The Commander of each Region will be able to talk directly to the forces under his command from his headquarters, irrespective of whether those forces are still in their peacetime barracks or deployed to operational areas. The all-informed, mobile communications available to him through MOULD will allow the Commander to exercise effective control over military operations in his Region.

"In order to provide the wide area of communications cover required in each Region, it has been necessary to adopt a communications system similar to that used by local authorities, police and fire services and other agencies such as gas and electricity boards. These rely on a network of static repeater or talkthrough stations, situated on suitable high ground and linked together to provide the necessary degree of intercommunications. In MOULD there are to be over 100 of these sites, located on existing military establishments or sharing facilities with other government or local government agencies. A limited capacity to expand the system or to replace unserviceable fixed sites will be provided using Land Rover-borne mobile repeaters.

"The MOULD user will be provided with a simple-to-operate commercial radio equipment which can be used as a desk-top, a mobile or a portable station, depending on the installation kit provided. Many radios will be provided with more than one installation kit so that the same equipment can fulfill more than one role."

The Home Defence Region covering London was the first to get MOULD in late 1981. Other Regions followed during 1982 and 1983. By the end of 1983 all Regions should be equipped.

What is it for?

It seems reasonable to assume that in wartime the Army would be rather busy. Yet there are a number of Home Defence duties that it would have to carry out, as well as fighting the war. Such tasks include the guarding of 'key points' (ie. protecting important installations from sabotage) and providing 'military aid to the civil power' (stopping riots etc.). The regular bits of the Army would have their hands full, so tasks like Home Defence would presumably be carried out by odd bits of leftover military like the Catering Corps. These odd bits of military have widely varying and incompatible radio systems. Some have no radios at all. MOULD appears to fill this gap.

EDITOR'S NOTE

Our object in publishing this story is to bring to the attention of the readership the growing number of incursions into the amateur radio frequency allocations. Our intention is not that of mischief making. What the Military decides to do in its own exclusive bands is not ours, or anyone else's business.

However, if the MoD or Home Office decides to place a covert communications system in a section of what is, after all, a public broadcast band, then it must expect the presence to be noticed and noted. Furthermore, our responsibility for amateur radio interests compels us to bring any further incursions into the public view.

G4JST

Why 432 MHz?

One question that is often asked is "Why did the MoD stick an allegedly classified system into one of the most public bits of the radio spectrum?". One possible clue lies in the choice of Pye as the supplier. (Military radios are usually made by firms like Racal and Plessey.) Pye's description of the equipment as "simple-to-operate commercial radio equipment" suggests the use of standard PMR-type equipment, which is not normally made for military frequency bands (eg. the 230-420MHz chunk). MOULD may have been stuck in the 432MHz band simply because PMR equipment could be used, at much lower cost than equipment specially made for the military frequencies. Such economies have been a common feature of Home Defence preparations in the past.

Interference

Amateurs who have studied MOULD report considerable interference — to both amateurs and MOULD itself. The transmitters that have been heard on the 70cm band are listed in **Table 1**. These transmitters are reported to be interleaved with the amateur repeater output channels by a 12½kHz offset. The Winter Hill transmitter, which apparently came on just before Christmas with about 500 watts, is said to have made GB3LL unworkable in parts of

Merseyside. The UK FM Group (Western) reports hearing female voices using Army RT procedures on the system. They also report hearing Pye personnel testing the system.

One source suggests that MOULD will provide each of the Regional Military Commanders with *national* coverage. This would be done by linking a MOULD site to the appropriate headquarters by a separate radio link or landline. This seems to explain why some sites have been heard using several different frequencies.

Unofficial secrets

In spite of the Pye press release already quoted, and coverage in at least one national newspaper as well as technical magazines, the RSGB claims it has kept quiet about the system "because there's a D-notice on it". *Radcom* describes MOULD as "Project X".

In fact, the only D-notice relating to MOULD is a general one asking journalists to consult with the Secretary of the Defence Press and Broadcasting Committee (that's what the 'D' stands for) before describing any new military communications system. (The whole D-notice system is in any case merely an informal arrangement between the MoD and the media to provide guidance for reporters. It cannot censor a story, and complying with D-notices does not protect reporters against prosecution under the Official Secrets Act. It has no legal standing at all.)

Allocations

In Region 1 of the ITU, which includes the UK, the 430-440MHz band is allocated on a primary basis to amateurs and radio-location. This was decided at WARC 79. There is a footnote allowing the UK and several other countries to use the band for radio altimeters on a secondary basis, but not for fixed and mobile services, which lost their allocation.

Individual governments are allowed to use bands outside 4-27.5MHz for services not listed in the WARC 79 frequency table. They must, however, notify the International Frequency Registration Board (IFRB). The UK Government has only just notified the IFRB of MOULD, which is a fixed/mobile service.

Also, if an individual country uses a frequency for a service not in the WARC 79 table, it must ensure that it does not interfere with services in other countries that *are* in the WARC 79 table.

So if MOULD interferes with, say, a Dutch amateur repeater, then the UK Government would have to take steps to prevent the interference.

A spokesman for the Home Office says they have not received any complaints about MOULD from abroad. He says that if they did the Home Office "would take steps to make sure the interference did not occur". Watch this space.

Site	Frequency	Site	Frequency
Winter Hill	433.0125	? (Heard in SE England)	433.1375
	433.1625		433.1125
Allport Heights, Derby	433.0125		433.1875
Sutton Common, Derbys	433.2125		433.3125
? (Humberside)	433.2625		433.3875
Barkway, Herts	— ? —	Barnacre, Northumberland	— ? —
Bentley Priory, Middx	— ? —	Knightsbridge Barracks, London	433.2125
Coldblow Farm, Kent	433.3625		
	433.3675		
	433.4625		
Old Palc, Cheshire	433.1625?		

Table 1. Suspected MOULD sites and frequencies in the 70cm amateur band.

IN BRIEF

'HAM' MAN JAILED

Anthony Lavelle, a partner in Ham International (UK), has been jailed for nine months for importing illegal CB radios. £1,000 costs were also awarded against him.

His brother John Lavelle, also a partner in Ham International (UK), received a sixth month suspended sentence. He was also ordered to pay £1,000 costs.

Mr Christopher Holland QC, prosecuting, told York Crown Court that they imported nearly £1,000,000 worth of illegal CB sets from Belgium, hidden in secret compartments behind the bulkheads of two lorries.

Mr Gilbery Gray QC, defending the Lavelle brothers, said they thought the Government would legalise the imports.

23cm NEXT ON MoD LIST?

Amateur stations using the recently reduced 23cm amateur band can expect increased interference from new air traffic control radar stations, both civil and military. Several new radars are being built in the UK, and others are moving out of the 582-606MHz band (between TV bands IV and V) to the 23cm band.

LICENCE FEES UP

The cost of an amateur radio licence is going up by 50% to 12 pounds, from 1st June 1983.

NEW UK PREFIXES

The Home Office has announced that the G0 (G zero) prefix will be used for Class A amateur licences when the G4 series runs out. Likewise the G1 series will be used for Class B licences when the G6s run out.

TWO MORE ON 50MHz

Two new stations have been issued with 50MHz research licences, in place of two of the original forty who were unable to operate. The new stations are GW3MHW and GM4IGS.

AMSAT LAUNCH DELAYED

The launch of the AMSAT Phase-IIIB satellite has been delayed by one to five weeks because of a problem with the engines on the launch vehicle, *Ariane 7*.

WRONG PRICE

We would like to apologise to SMC (again) for getting a price wrong in their advert in the June issue. The Yaesu *FT726R* multiband, multimode VHF/UHF transceiver costs 649 pounds, not 6489 pounds as stated.

ALL MODE TRANSCEIVER

By Frank Ogden G4JST and Tony Bailey G3WPO

In the beginning . . .

This magazine was launched some seven months ago with a series of three articles entitled *A synthesised general coverage HF transceiver*. The idea of a home made box which offered a comparable performance in its basic facilities to the off-the-shelf product created a substantial amount of interest. However, there were a number of shortcomings in that original series of articles which made duplication of the project rather difficult.

I designed the original transceiver some three years before this magazine came into existence purely for my own amusement. Some people do crosswords, I make radio equipment. As a result, the documentation was never intended for passing on to third parties. In particular it lacked the detailed artwork necessary for PCB manufacture. Although some errors occurred in the published circuits a number of sets were made which continue to perform satisfactorily. However it became clear that the majority of interest in the project was in adapting bits of the circuit to people's own requirements.

The result of all the lessons learnt from the earlier project is Omega. This brand new design has virtually nothing in common with the original project. It uses different circuit technology, a completely new design approach, offers substantially improved performance parameters, it can be user customised but — most important of all — the whole project can be constructed on ready made PCBs with easily available components, guaranteeing the reproducability that is lacking in most published designs.

G4JST

PROJECT OMEGA

Project Omega is to be more than just an all mode, all band HF transceiver system. The modular concept behind the design means that it can be built to any user defined specification without spending time and money on facilities which aren't required. Omega covers every need from a single band SSB receiver to an all mode, all band transceiver featuring the essential bells and whistles of £1000+ Japanese boxes. Furthermore, you will be able to build from readily available kits and update as you go along.

A new concept

The *Project Omega* HF transceiver system is modular. This means that any *Omega* module can be assembled and tested as a complete unit before progressing to the construction of other modules in the system. It also enables particular aspects of *Omega* to be adapted to other uses. For instance, the FM board could be used with a number of commercial transceivers as an extra facility. Or the IF central processing system could be used as the heart of a high quality 2m or 70cm transceiver. It is possible that a VHF/UHF customising pack will be available in the future. However, the initial scope of the project will encompass all the amateur bands 160 through to 10 metres.

Every module is rigorously troubleshooted and thoroughly tested before publication in these pages. We aim to build three prototypes of everything which appears in print to ensure that you don't have problems when you come to build yours. To give some idea of the amount of work which is going and has gone into the project, the IF central processing system published in this issue has occupied some 450 man hours of work.

Omega modules

The following is a list of present or planned modules:

Central IF processing module: comprises Schottky ring mixer, noise blanker, static crash remover, BFO, product detector, CW carrier oscillator, AGC system, AF amplifier

Notch filter: 50dB phasing crystal notch filter

CW filter: active variable bandwidth CW filter equivalent to at least four poles of crystal filtering

Synthesised VFO: provides high level local oscillator signal (+23dBm, 13dB pad) for up to ten 1MHz wide user defined bands. Digital readout and analogue style tuning. Single loop system provides output 10.7MHz above signal frequency for single conversion IF systems

SSB generator: USB/LSB signal at 10.7MHz for injection on CIFPU

FM board: detection and generation of NBFM. Interfaces with CIFPU

AM board: AM signal generator and full 6kHz AM receiver subsystem

Speech processor: for use with all voice transmission modes. Improved baseband system with VOGAD

Logic control unit: enables VOX changeover and full CW break-in capability. Copies between dots at up to 40wpm+.

Preselector filter: single control lowpass filter based unit

TX PA QRP: 5W power MOSFET system. Full ALC for hands-off operation. Acts as driver for

TX PA QRO: 50/100W PEP output system. Full ALC

PIN switch: PIN diode aerial changeover system for use with CW break-in operation

Output filter: operated automatically via bandswitch

With a system as ambitious as *Omega*, it is impossible to publish designs for all of the modules in one go. We estimate that availability will be one per month. What we do promise is that nothing will be published until it is fully debugged and ready to build. We aim to start with a core receiver system: CIFPU, VFO, Preselector followed by PAs and SSB generator. This also gives you a chance to get each module built, tested and debugged before starting on the next..

To give a better idea of what the system is about we have included a number of possible Omega permutations. See **Figs. 1** to **4**.

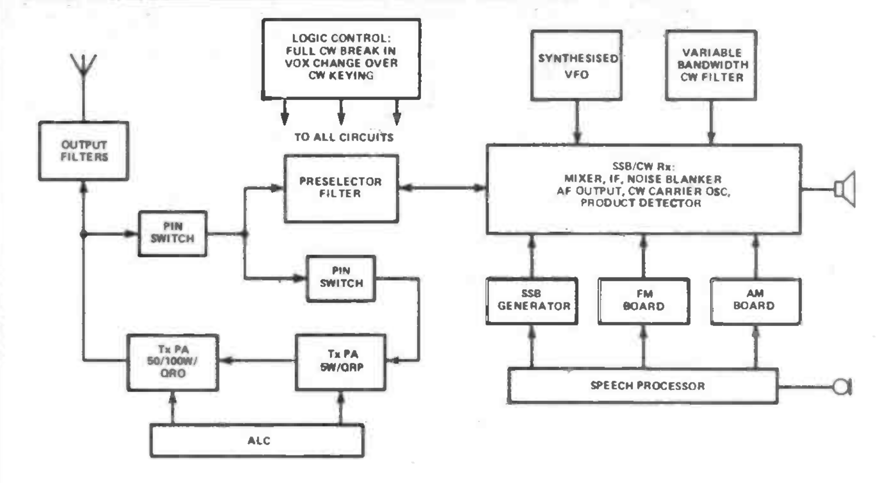


Fig 1. G4JST/G3WPO Omega transceiver system

Central IF processing unit

The theory of operation was described generally in the *Technicalities* column of the April issue. We won't therefore go into the subject in great depth but simply note a few aspects concerning the operation. A number of changes have been made to the original circuit as a result of prototyping.

Fig. 5 shows the block diagram of the module. The incoming signal is converted to the 10.7MHz IF by the ring mixer DBM1. The roofing filter comprising IFT1 and 2 limits the bandwidth of the signal before passing it to the IF pre-amp Q1. Here, the signal path splits into two. The main path passes through the noise blanker switch D2, D3 and Q2 to the high quality SSB filter F2 via a delay line F1. The delay filter F1 gives the noise blanker switch a chance to open before interference spikes can hit the main filter, F2.

The other signal path travels to the noise blanker side chain amplifier Q8, Q9. These two MOSFET amplifier stages raise interference pulses and crashes to a high enough level to turn off Q2 following rectification by D4 and 5.

Cutting the rubbish

This noise suppression circuit — block diagram detail in **Fig. 6** — received as much development time as the rest of the IF system put together. The result is excellent. It takes out interference of the 'woodpecker' variety completely just leaving 'holes' in the signal. It is quite possible to copy S2 SSB signals through S9+30dB woodpecker. To offer some idea just how effective the overall system is, we spent some time one afternoon just trying to find the woodpecker until we discovered that we had left the noise blanker switch 'on'. It also takes out random ignition noise and household interference such as the switching of domestic central heating thermostats.

Another pair of dual gate MOSFETs provide the main bulk of IF amplification (Q4, Q5) before passing the signal to the product detector (Q6) and the AF amplifier IC1.

The AGC generator IC2, D7 and D8 provides a direct AGC signal to the IF amplifiers and delayed AGC to the IF pre-amp. The S meter signal, derived from the AGC line can be applied directly to the meter, or through an optional 6dB/division correction network (to be detailed later). The AGC decay

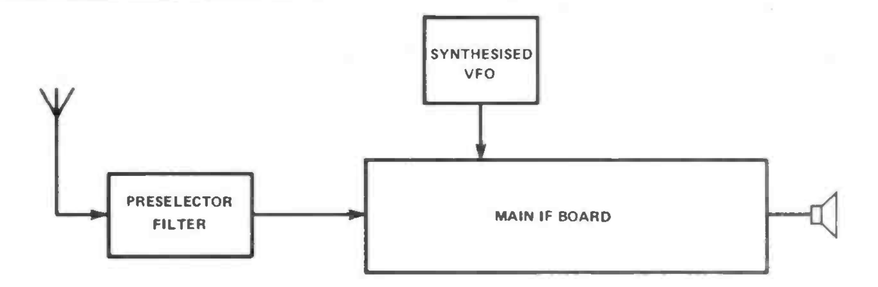
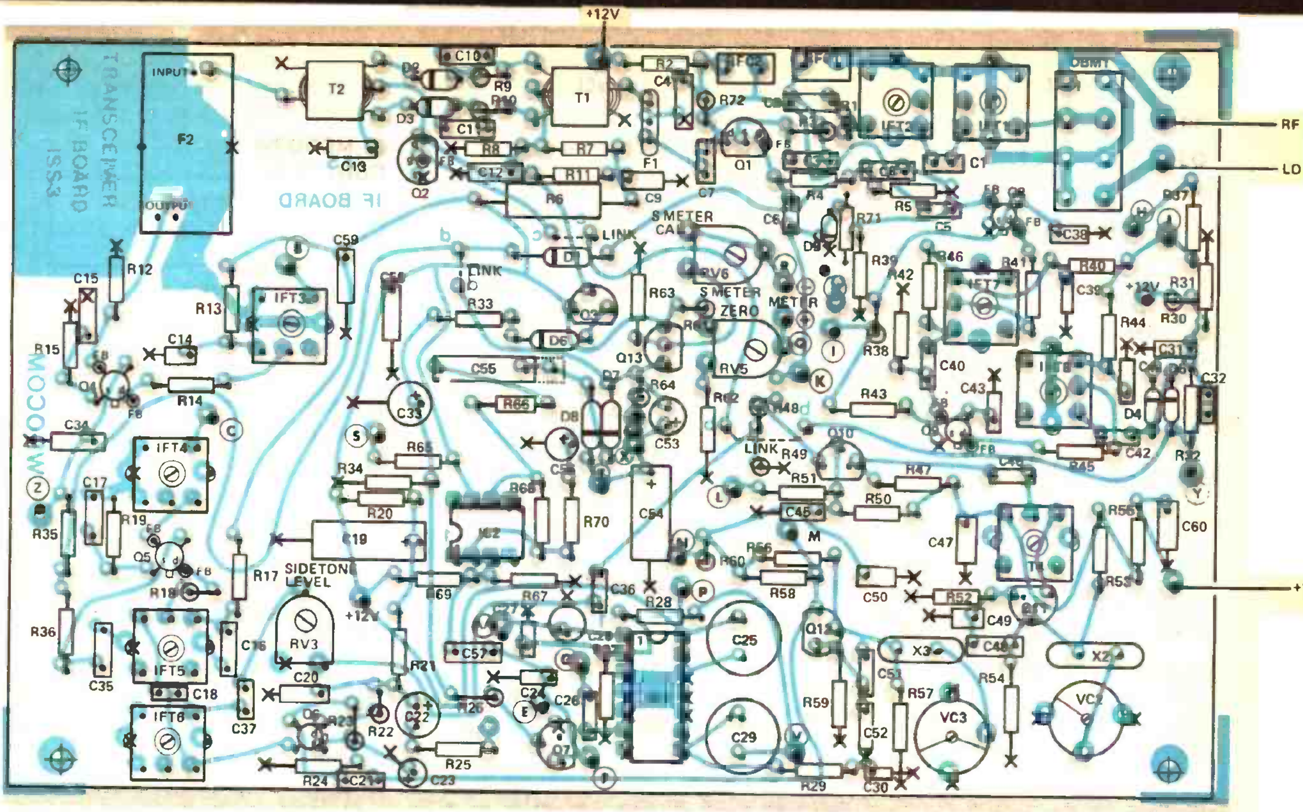


Fig 2. Minimum configuration amateur band receiver system



× = LEAD SOLDERED TO TOP FOIL O FB = FERRITE BEAD ON LEAD ● = CONNECTION PIN ⌐×¬ = CASE SOLDERED TO TOP FOIL

is continuously variable through a front panel control.

The phasing notch filter is mounted on a separate circuit board and can be used independently of the CIFPU board. The 50 ohm system produces a 50 dB notch when correctly adjusted. RV1 is for fine adjustment on notch depth. If the filter is not required, simply bridge points B and C.

CW only

In its uncustomised form, the CIFPU comes equipped to operate primarily in the transmit and receive CW mode. A BFO and TX carrier oscillator (Q12 and Q10/11 respectively) are standard equipment. In many ways the basic *Omega* system answers the basic quest for a high quality CW transceiver system. It can be further dedicated to the mode by fitting an active variable bandwidth CW filter between points E and F. See page 66 for constructional details of this module.

Note that the transmit signal injection point for all modes is point K. In transmit the grounded gate IF pre-amp Q1 acts as a source follower to the ring mixer circuit.

Sidetone for CW transmit is supplied by mixing a little of the keyed carrier oscillator output in the product detector.

A philosophical note

It might seem rather regressive to have used, in the main, discrete components in the CIFPU. There are a number of ICs from both Plessey and others which can perform many of the functions. We make no apologies for this. Although the Plessey 1600 range of ICs is without doubt the finest in the world, they are quite expensive and can be a little fiddly to use in the hands of inexperienced builders. There is another point. Discrete circuitry allows the designer to optimise on the features which he considers the most important. It would have been difficult to match the level of noise blanker performance with present IC technology. It may also have been difficult to provide enough circuit versatility which is the intended hallmark of the *Omega* system.

Kits

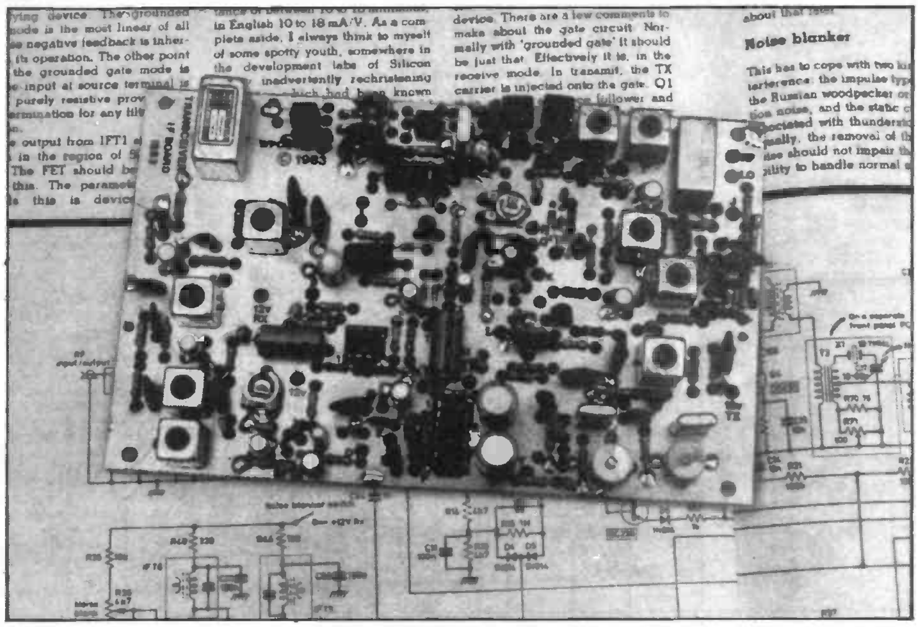
As this series progresses, complete kits of parts will be available from WPO Communications for each of the modules described. The board kit for this IF module, complete with drilled PCB, all components, potentiometers, wire etc costs £69.50 inclusive of VAT and post & packing. It does not include a speaker, the meter or diecast box which you may already have. The diecast box specified is also available at £5.50 inc. PCBs are available separately at £6.50 inc.

General notes on constructing the transceiver

Before starting this, we strongly advise you to use the PCBs available — you can then be fairly sure that the units will work as well as the prototypes. An awful lot of development went into the boards to get them right — for instance, this IF unit required three layouts just to get the Woodpecker blanker working correctly — the layout is critical in places and using ready-made PCBs will save you having to sort out the problems all over again.

Can I build it?

For those who are wondering if they can build this whole project, we would advise that it is not suitable for absolute beginners who have never used a soldering iron before, or who cannot understand the basic descriptions of the circuits. If you fall into this category then you should leave it until later, or make sure that you have a friend who can help you out.



Assembled main IF board

Wherever possible, prewound transformers have been used. These are also pre-aligned, which reduces alignment time. Detailed instructions are given for the transformers that you will have to make for yourself.

The instructions for assembling each unit will be as detailed as possible (expert constructors amongst you can skip over parts of the text), and will include where to look for any problems that may arise during testing. Long instructions don't necessarily mean that a unit is complicated — they are there for the benefit of less experienced constructors.

Test equipment

For alignment, you will need a high impedance voltmeter, and preferably a signal generator capable of running to at least 10.7MHz — borrow one if you don't possess one! If you own or can borrow a scope all the better. A frequency counter would be useful at times, although the transceiver has its own digital readout (ready built) which can be used. We will show how to align it without full test equipment, although you do need a signal generator of some sort to align the noise blanker in this IF unit successfully.

The finished transceiver will be housed in a readily available commercial case. To help you get a professional appearance after all your hardwork, there will be a ready screened overlay or panel available for the unit if there is sufficient demand.

This IF strip obviously needs a VFO to receive any signals! It can be tested using a signal generator (or any other oscillator) as a VFO.

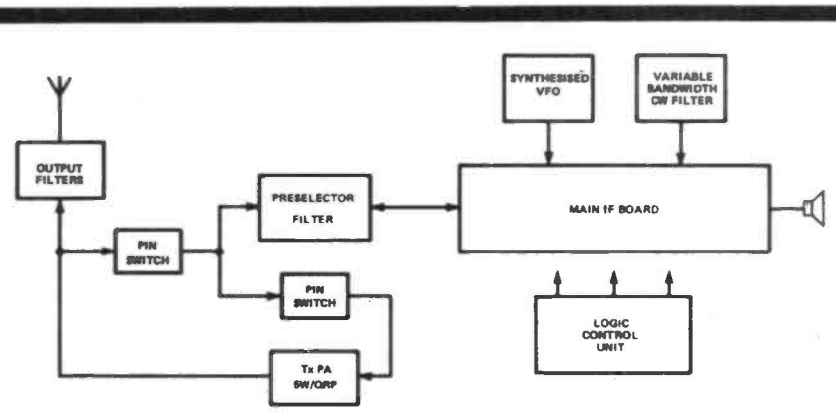


Fig 3. Minimum configuration CW only transceiver

IF strip construction

If you are building the whole transceiver, then the complete PCB assembly is required. For receive only, the TX 10.7MHz oscillator (Q10/11) and associated components can be omitted. before launching into the assembly, check the PCB for any solder bridges arising from the roller tinning process. These may not be obvious after soldering components in.

Note that the notch filter circuit is on a separate PCB, which will be described next month, so we have ignored the components associated with it for the present.

One of the semiconductors (Q2, VN2222LM) is sensitive to static so handle it by its body not its leads. Alternatively push the leads through some aluminium kitchen foil before use, and remove them after soldering. The MOSFETs (3SK45 or equivalent) do not need any special handling other than an earthed soldering iron. make sure your soldering iron is well earthed or is a low-leakage ceramic sheathed element type. Also, the SBL1 double balanced mixer must on no account have any DC applied to it, or it will probably fail rapidly.

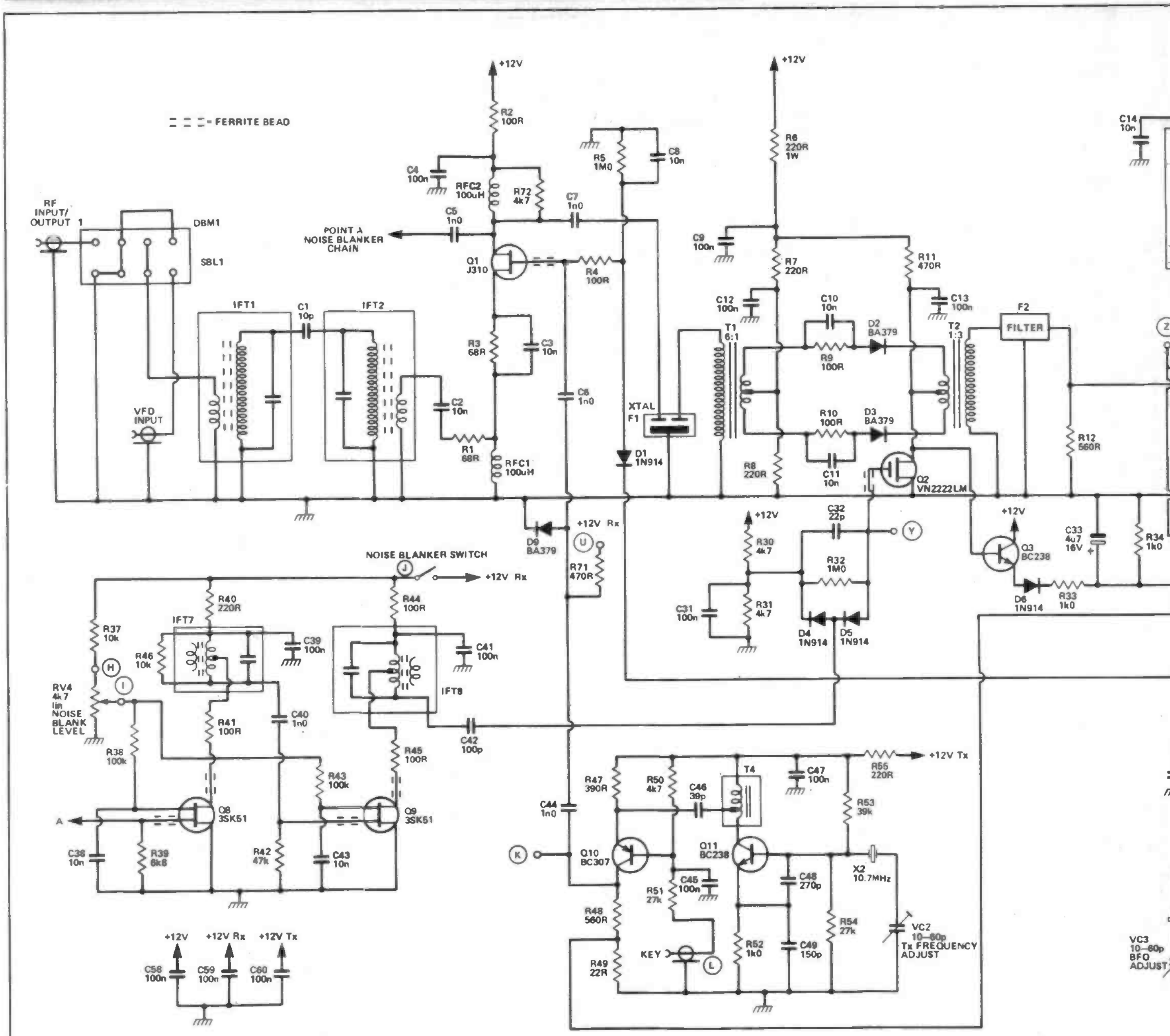
Order of assembly

We suggest you follow the order given here when assembling — this will ease assembly in some tight areas, and give you reference points when inserting components.

One of the errors made by many beginners in assembling this sort of PCB is leaving too long a lead length above the PCB. This can lead to instability and unwanted signal pick-up. Virtually all the capacitors can be pushed far enough into the PCB for the lower part off the body to either rest on the surface, or have leads no longer than 3mm, without damage to the capacitor — if they will go against the PCB then let them. The same applies to the resistors and semiconductors.

1) First, insert all the 1mm connection pins into their respective holes from the underside, and solder them into place. Each point where a pin is needed is identified by a letter on the upper surface of the PCB. They need to be pushed hard home so that the splines are inside the hole.

2) Insert and solder IC1 (LM380N) and IC2 (741), observing orientation. Solder all pins on the under-



Schematic diagram of central IF processing unit. The notch filter is shown, but construction is on a separate PCB

side and those pins on top which don't have clearance around them (pin 4 on the 741 and pins 3,4,5,7,10,11 and 12 on the 380N). Don't use sockets for these ICs.

3) Starting near one of the ICs, insert and solder all the resistors, working outwards around the board. This helps to locate the correct positions as you go along and is easier than starting at R1. All the horizontal mounting resistors have 10mm spacing where both leads go through the PCB (just bend the leads over gently at the ends). Where one end of the resistor is earthed (marked with a cross) to the top foil, bend one end only and cut the other to about 4mm in length before soldering in the position indicated.

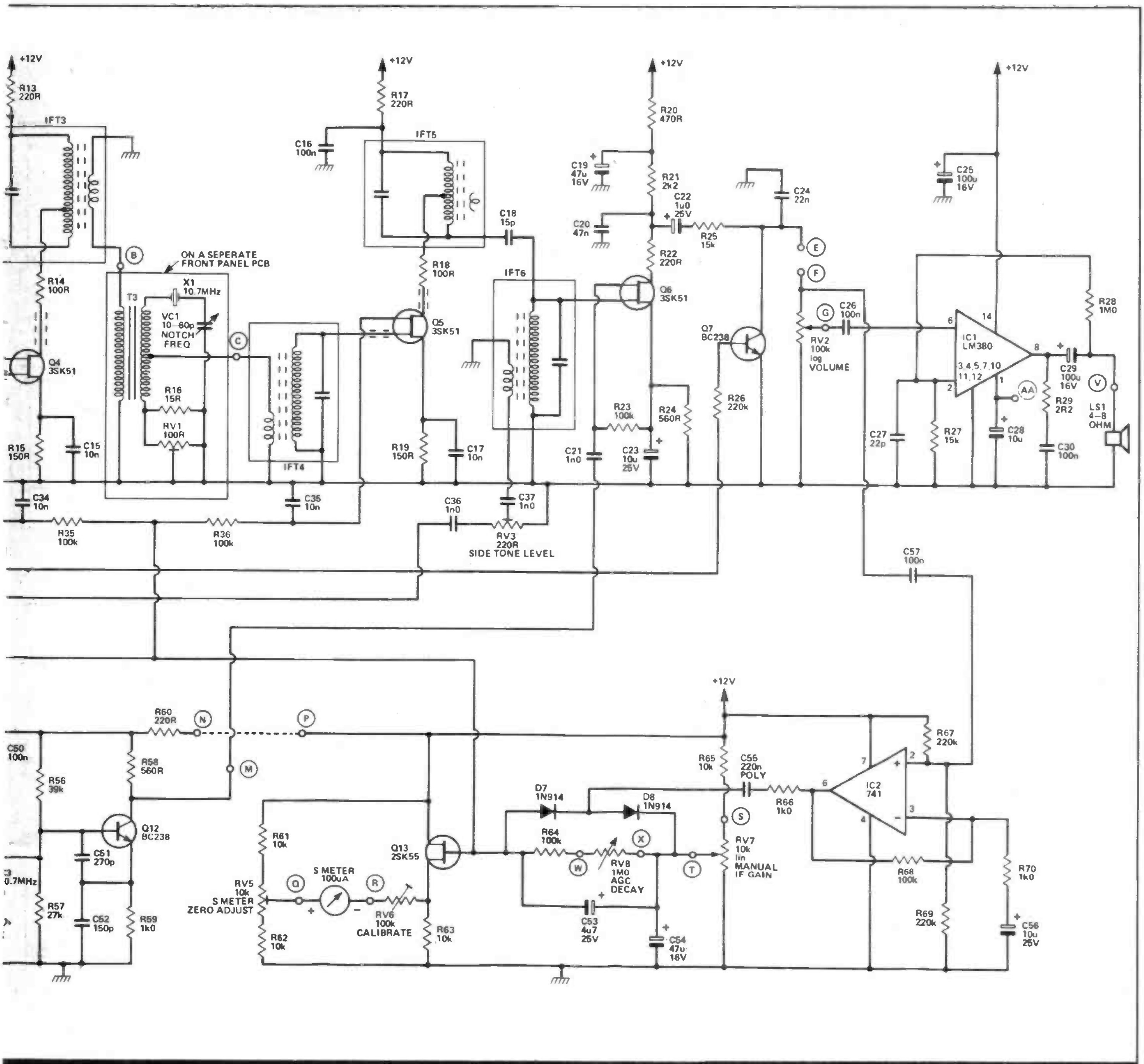
In the case of R5 the earthy lead is soldered to *both* the top *and* underside of the PCB.

Vertical mounting resistors just have one lead bent down against the body before inserting, and a small horizontal piece formed where they are earthed. Make sure the circular part of the resistor on the drawing corresponds to the body position.

4) Insert and solder the three preset resistors — note RV3 has one lead soldered to the top foil.

5) Insert and solder VC1/2. Bend the two leads which are on opposite sides of the body so that they are parallel to the PCB before soldering.

6) Insert C18, solder, and then all the 8 IF transformers plus T4. Each is marked with its code — sometimes the letter part of the code may be different — as long as the number part is the same, then they are OK. Make sure all the transformers are hard against the PCB, solder the under side pins *including* the two mounting lugs, then (you'll need a hot iron) solder one side of the can to the top foil one each transformer where indicated by a cross. If you tip the PCB at an angle so that the solder flows against the can and the



PCB at the same time you shouldn't have any problem. Don't adjust the transformer cores.

7) Insert and solder all the diodes. The spacing varies on these a little, but they all mount flat against the PCB. D9 has one end earthed to the top foil, and should have short leads. The PIN diodes may not be marked with ident numbers but they are square black packages with a silver line at one end, and fairly fragile leads.

8) Insert and solder RFC1 and 2 (green, marked 101 plus a letter).

9) Starting at one corner of the board, insert the capacitors. Those that have one end earthed have the lead bent up and cropped to 4mm before inserting and soldering into the position shown. Note that some of the capacitors have their earths made via tracks on the underside of the board, and may appear not to be earthed because they are not shown with crosses on the layout. C25 & C8 are cases in point. Where a capacitor has an earthed lead but the diagram does not show an extended lead to solder, both leads go through the PCB, and the earthed lead is soldered top *and* bottom (C4**).

Radial lead electrolytics may need a lead bent out from under the case if an earth is required. In most positions, axial types can be used by bending one lead parallel with the body. In all cases observe the polarity.

10) Insert all the transistors *execept* Q2 (VN2222L) observing the case orientations or tab positions. Some have small ferrite beads on certain leads — in the case of the MOSFETS, the transistor should be pushed down until the bead is contacting the PCB, and the case of the device is resting on the bead. With Q1, this will not be possible and the case should be as close to the bead as possible. Then solder. Q7,8 and 9 each have one lead soldered to the top foil.

11) Insert and solder F1, F2, X2, and X3 with the cans against the PCB. F1 can be inserted either way round (the centre lead is earthed via C4 on the underside). F2 has its input and output marked — the input goes adjacent to T2. A short tinplate screen (6mm x 30mm) connected on the underside of the PCB along the long axis of the filter between the earthed pins will be advantageous in preventing the pins 'seeing' each other.

Solder the case of F2 to the top foil in the same manner as the IF transformers.

12) Insert and solder the SBL1 mixer — pin 2 is located underneath the letter 'M' of MCL stamped on the top, or pin 1 may have blue insulation on the underside). Its earth connections are made via tracks on the underside.

All the components should now be in place with the exception of Q2 and T1/T2.

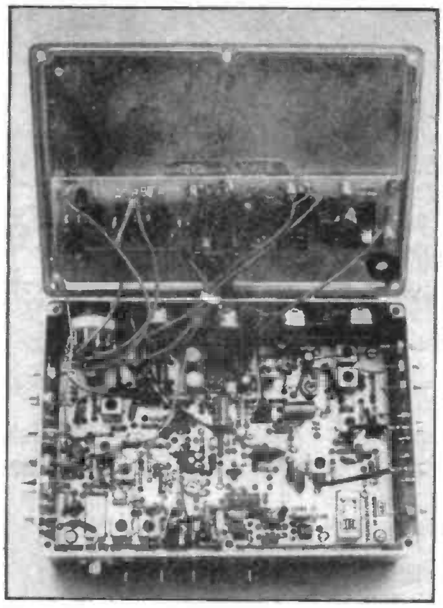
Winding T1/2

Both these are wound on small ferrite balun cores using the following procedure.

a) T1. Take a 130mm length of 0.25mm enamelled copper wire and strip 5mm insulation off one end. With 10mm of wire protruding from the core, carefully wind 6 complete turns through the core — one turn counts as a wire inserted through one hole and then back through the other — i.e. the wire goes through each hole once for one turn, and they should both end up at the same end after 6 turns. Keep the wire tight while winding but be careful not to strip off any insulation by rubbing against the core itself. Reduce the remaining wire to 10mm length and strip off 5mm.

Now take 2 lengths of the same wire, each 40mm long, and strip 5mm on one end of each. Twist the two stripped ends together and solder. Insert the free ends (one into each hole) of the core *from the end which currently does not have any free wire protruding,* and push the wires through until the join is against the core. Then fold the two wires you just inserted back over the *top* of the core so that they are on the same side as the tap. Cut these two wires to a 10mm overhang, and strip 5mm off the ends.

You now have a six turn primary, and a centre tapped one



CW filter and CIFPU mounted in diecast box

turn secondary (as only one turn is actually inside the core). T1 can now be soldered into place, core against the PCB, and with all leads short and symmetrical. It doesn't matter which lead of the secondary is earthed to the top foil.

T2 is very similar (except that the primary has fewer turns than the secondary), so wind 6 turns on another balun core as before. Again take 2 lengths of wire 40mm long, and strip, twist and solder as before. Put the lead through each hole in the core as before, but this time bring them back through the core, rather than over the top, so as to [illegible]urn centre tapped winding. Finish stripping off and solder into place as with T1.

Now make the three links indicated with short pieces of insulated wire on the underside of the PCB (connecting the two points marked 'b' together, then c-c etc.)

Finally, holding it by its case, slip a bead over the centre lead of Q2, insert as far as it will go into the board, and then solder the source lead to the top foil, and then the leads on the underside.

Before continuing, go round the PCB and check for solder bridges etc, and double check all the components are in place, and soldered to the top foil where they should be. If you are using the kit, there shouldn't be any components left over.

Testing

As you will see from the photograph, the IF unit is housed in a diecast box, to avoid unwanted signal pick up, both into and out of the unit. The enclosure also helps the noise blanker by backing the PCB with an earthed plane, so the unit must eventually be built into the box. For testing, it may be left out of the box, but bolted to the underside of either it or a piece of aluminium etc, so that it is easily accessible. We have not given full wiring diagrams for the unit as these will be given when the synthesised VFO, preselector, PA and switching unit have been described and can be connected. However, the wiring is quite straightforward, using the lettered points and circuit diagram as a guide. Use screened cable for the audio connections.

You will require a temporary VFO of some sort until the proper one has been built. This can be a simple signal generator, or a temporary oscillator, or even a VFO from another rig if you have a suitable one. A high oscillator level is needed — about 200mW (23dBm), which is fed via a 13dB pad to give 10mW (20dBm) to the LO port of the mixer. You can get away with less for alignment purposes, but the recovered signals, and the dynamic

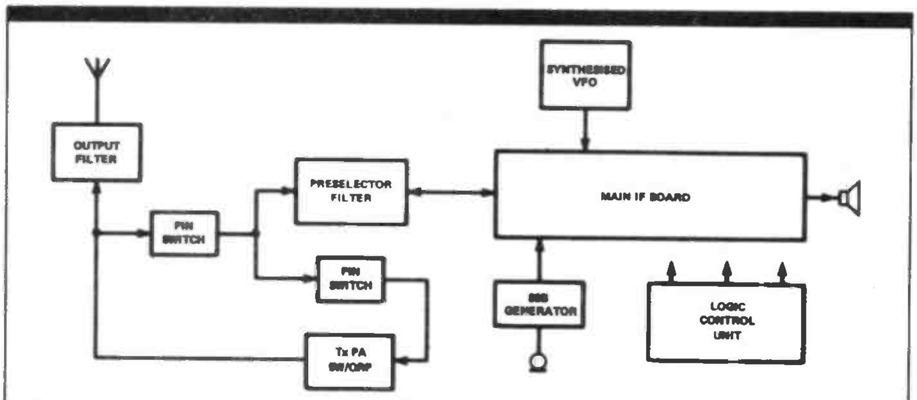


Fig 4. Minimum configuration SSB/CW transceiver

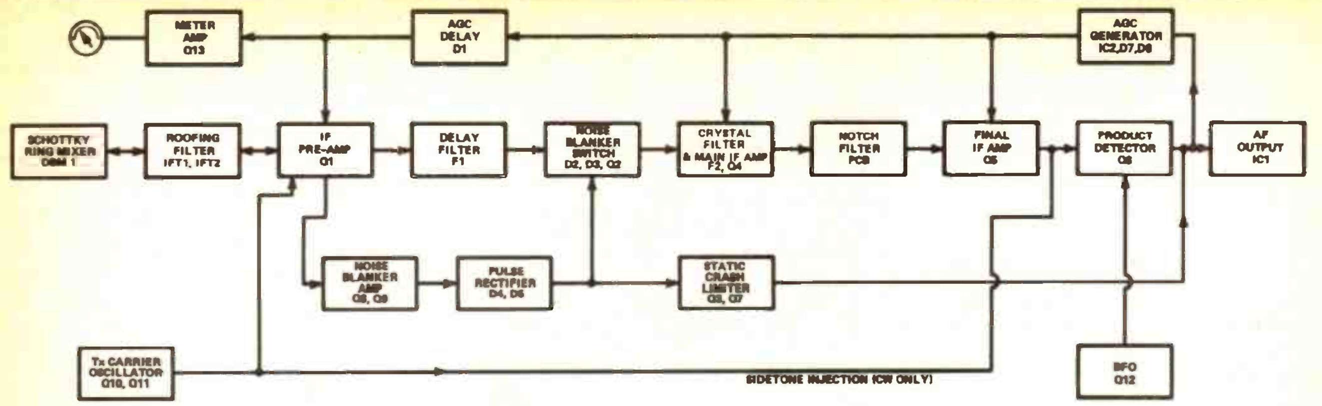


Fig 5. CIFPU block diagram. The basic mode is CW RX/TX and SSB RX

range will be reduced. Injection frequency is signal frequency + 10.7MHz, but you will also be able to receive signals at the image frequency with an external VFO eg. 3.5MHz could be received with either 7.2 or 13.9MHz injection. Also, the IF as it stands is really for CW only (the SSB board gives switched sideband selection), but there is enough range on VC3 to allow either USB or LSB to be received depending on whether VC3 is set for the crystal to oscillate high or low of 10.7000MHz (nominally 10.6985 or 10.7015MHz). Until the IF traps are in place on the preselector, there may also be some IF breakthrough while testing (more likely at night).

Connecting up

1) Link points N & P, C & B, E & F using short pieces of insulated wire.
2) Link the three points marked '+12V' with the '+12V RX' (U) terminal. Connect the meter across points R & Q, observing polarity.
3) Connect up the IF GAIN, AGC DECAY and NOISE BLANKER potentiometers following the circuit diagram, using about 150mm lengths of insulated wire. The ground connection should go straight to the top foil. The connection from point J to +12V RX is not made at present, nor are there any connections to points K, L, M, Y, Z, AA (these are connected with the break-in keying circuit and SSB adaptors).
4) Connect up the AF gain control using screened audio cable. Only two lengths are required, with the braid acting as the screen and earth connections for the pot. Connect the braids together at each end. Connect a speaker, one end to point V and the other direct to the top foil.
5) Set VC2/3 to about half mesh, RV3,5 and 6 presets to about half way, VOLUME (RV2) fully off (anticlockwise), IF GAIN (RV7) on full (fully clockwise).
6) Connect a power supply (+12-14v) to +12V, with the negative connected to the board's upper surface (preferably current limited to 200mA). Apply power and check that the current consumption is around 100 to 160 mA. If it is a lot more, switch off and look for shorts or component errors (eg. wrong value resistors, or incorrectly inserted semiconductors). If no power is taken, check all soldered joints, check that all +12V pins specified above are linked and that there are no breaks in the print circuit board tracks.

Once all is OK, switch off again.

Voltage Check Chart

This gives average readings at various points in the circuit for the voltages to be expected. All measured using a high-Z digital voltmeter. AF gain min, IF gain max, Blanker on but gain at minimum. No signals. Expect variations of 5-10% on these readings between individual models. 12.0V supply used.

Transistor	C	B	E	D	S	G1	G2
Q1				10.2	1.2	1.1	
Q2				5.4	0	.08	
Q3	12.0	.08	0				
Q4				10.8	0.6	0	5.6
Q5				10.8	0.6	0	5.6
Q6				7.6	0.8	0	0.8
Q7	0	0	0				
Q8				10.8	0	0	0
Q9				10.8	0	0	0
Q10	8.8	4.2	4.0				
Q11 (+12V Tx)	11.2	4.1	3.8				
Q12 (+12V Tx)	11.2	11.2	0				
Q13				12.0	5.7	7.1	
	IC1	IC2					
1	6.1	0					
2	0	6.0					
3	0	5.9					
4	0	0					
5	0	0					
6	.02	6.5					
7	0	12.0					
8	5.1	0					
9	0						
10	0						
11	0						
12	0						
13	0						
14	12.0						

Table 2: Components

R1,3	68R 5% carbon film.
R2,4,9,10,14,18,41,44,45	100R 5% carbon film.
R5,28,32,73	1MO 5% carbon film.
R6	220R carbon film 1 watt
R7,8,13,17,22,40,55,60	220R 5% carbon film.
R11,20,71	470R 5% carbon film.
R12,24,48,58	560R 5% carbon film.
R15,19	150R 5% carbon film.
R21	2K2 5% carbon film.
R23,35,36,38,43,64,68	100K 5% carbon film.
R25,27	15K 5% carbon film.
R26,67,69	220K 5% carbon film.
R29	2R2 5% carbon film.
R30,31,72,50	4K7 5% carbon film.
R33,34,52,59,66,70	1K0 5% carbon film.
R37,46,61,62,63,65	10K 5% carbon film.
R39	6K8 5% carbon film.
R42	47K 5% carbon film.
R47	390R 5% carbon film.
R49	22R 5% carbon film.
R51,54,57	27K 5% carbon film.
R53,56	39K 5% carbon film.
All resistors 0.25 watt except R6	
R73 is used with Active Filter only.	
RV2	100k ALPS log pot
RV3	220R 10mm carbon preset
RV4	4k7 ALPS linear pot.
RV5	10k 10mm carbon preset
RV6	100k 10mm carbon preset
RV7	10k ALPS lin pot.
RV8	1MO ALPS lin pot.
C1	
C2,3,8,10,11,14,15,17,34,35,	10p ceramic
38,43	10n ceramic
C4,9,12,13,16,26,31,39,41,45,	100n ceramic
47,50,57, 58,59,60	
C5,6,7,21,36,37,40,44	in ceramic
C18	15p ceramic
C19,54	47uF 16v axial electro
C20	47n monolithic ceramic
C22	1uF 16v radial electro
C23,28,56	10uF 16v radial electro
C24	22n ceramic
C25,29	100uF 16v radial electro
C27,32	22p ceramic
C30	100n monolithic ceramic
C33,53	4.7uF 16v radial electro
C42	100p ceramic
C46	39p ceramic
C48,51	270p ceramic
C49,52	150p ceramic
C55	220n polycarbonate/polyester
VC2,3	3-60pF 10mm Film trimmer
IC1	LM380N (14 pin)
IC2	741C/ 741S (8 pin)
Q1	J310
Q2	VN2222LM
Q3,7,11,12	BC237/238/BC107/108 etc
Q4,5,6,819	3SK45/3SK51
Q10	BC307/BC308
Q13	2SK55
D1,4,5,6,7,8	1N4148, 1N914
D2,3,9	BA379
X2,3	10.7MHz HC/18-U
DBM1	SBL-1 / SBL1-8 (Mini Circuits)
F1	10.7MHz 10M15A 15kHz Bwidth
F2	10.7MHz 10M22D Nikko Denshi
M1	100/200uA FSD meter
Also required:	
Dicast Box	RS Components type 509-995
Speaker	4-8 ohms
10 off	miniature ferrite beads

Alignment

It is perfectly possible to align the IF from off-air signals using an aerial, or you may use a signal generator, either connected to the RF input pin using coaxial cable. Bear in mind that with a likely impedance mismatch at the RF input, signals are going to be reduced. Also, unless you have a good ATU on an aerial, image and IF breakthrough problems may exist for the moment. To avoid damage to the cores, the correct trimming tool for the IF transformer must be used (one is supplied with the kit).

1) Connect a suitable LO source to the LO pin, and antenna or sig gen to RF pin. You can align the IF at any signal frequency you like, say around 5-8MHz, as you will always find signals here at any time of the day or night.

2) Apply power, turn up the volume a bit and adjust the VFO until something can be heard. If you can't hear anything, adjust VC3 slightly while tuning, as this oscillator may be outside the filter passband. Once you find a signal, carefully peak all the IF transformers (except the one with the black core, and IFT7 and 8) for maximum signal strength, using the S-meter. The latter will have to be 'zeroed' using RV5 with no signal input, and later set to FSD using a strong signal with RV6.

Once signals hit the end stop, either reduce the signal generator injection, or find a weaker signal. Once you are sure everything is peaked up, leave well alone. If your sig gen is calibrated you should be able to hear a signal of 0.5uV or better into 50 ohms.

3) Adjust VC3 for either a natural sounding recovered SSB signal, or set to 10.6985MHz using a frequency counter (measured at point M).

4) Check that the AGC DECAY pot has the desired effect. As the rotation is increased, the S Meter should drop much more slowly once a signal goes. Fast decay is used for CW slow for SSB. It will also be possible to switch off the AGC at a later date for use under certain circumstances.

Decreasing the IF GAIN should not affect the signal strength until the S-meter reading increases above that of the signal (it is correct for the S-meter reading to increase as the gain is decreased due to the nature of the circuit).

Noise blanker

As the blanker is a wideband device, it isn't possible to successfully align it using off-air signals from an antenna as you have no guarantee the signal you are peaking is at exactly 10.7MHz. Nor do we advise injecting 10.7MHz direct into it — it is a very high gain circuit and the high level of 10.7MHz RF resulting tends to have a disastrous effect on the rest of the circuit!

By far the best way is to use a signal generator as a signal source, or any oscillator capable of giving a single signal within the current receive coverage for the VFO being used. If you have a scope, all the better.

1) Temporarily connect a 1n capacitor from point Y to earth (to simulate the effect of the 1n feed-through capacitor that will connect to this point later.)

2) Connect point J to +12V, and turn the BLANKER LEVEL control fully off (anticlockwise — wiper at 0V). using a suitable single signal source, locate the signal with the VFO. Then:

a) If a scope is available (set to DC coupling, 1V/cm) slowly advance the blanker level until the scope reading starts to go negative. Peak IFT7 and 8 (reducing the blanker level if necessary) for best deflection. Once aligned, peak deflection (maximum blanking) should be around 4-5 volts.

b) If no scope is available, advance the blanker level until you hear the audio from the receiver starting to be cut off. Then adjust the cores of IFT7 and 8 while backing off the BLANKER LEVEL if needed, until the blanking action starts at as low a level as possible. Turning the control fully clockwise should turn the audio off completely well before the stop is reached, if the signal being used is fairly strong.

Using the blanker

If you now connect an aerial, it should be possible to eliminate impulse and 'woodpecker' noises completely by advancing the control. If the control is advanced too far, or the level of interference is not much higher than adjacent signals (say a broadcast band nearby), the normal audio may well be blanked as well. It is in the nature of a blanker that the unwanted interference to be eliminated must be of much higher amplitude than the wanted signal, which it normally is with, for instance, the Woodpecker.

Also, under certain conditions, notably at night, it may not be possible to blank the Woodpecker at all. This is because its level is likely to be much closer to adjacent signals, and because of the composition of the pulses themselves. There may well be multiple pulses, with one pulse of lower amplitude than the others. This smaller pulse will tend to be missed by the blanking action. Propagation effects can also reduce the blanking efficiency.

In the main, you can expect the Woodpecker to disappear completely, or be very much reduced, and be replaced by holes of silence.

Don't forget that as the blanker is wideband, it will pick up pulses that you cannot hear through the narrowband IF filter, so you may notice blanking when there is apparently nothing to blank!

If loud clicks are apparent instead of near silent 'holes' in the audio, then either you haven't got the board on its mounting plate, or the transformers T1 and 2 are incorrectly wound or connected. (In which case the signal path will probably not be blanked properly, either, with signals only marginally attenuated.) Alternatively D9 is not connected properly. Keeping leads above the board too long can lead to the same effect. If you laid out your own PCB — try again and look at keeping the 10.7MHz signal from Q12 getting back into the IF input. If this is the problem, then the AGC may also be exhibiting a very slow attack time.

Transmit

At this stage you can only check the functioning of the TX oscillator.

1) Remove power from the +12V Rx terminal (U) only and connect points Y and Z to earth. Connect the +12V supply to +12V TX.

2) Screw the core of T4 carefully to its lower limit. Connect point L to earth with a temporary lead and then slowly screw the T4 core upwards until the oscillator (heard via the sidetone) stops — then screw the core back in one eighth of a turn. Adjust VC 2 for a beat note of about 800Hz.

Keying point L to earth should give a good CW note, whose level can be adjsted over a limited range by RV3. If you have a scope or RF voltmeter, there should be about 100mV of signal coming from the RF terminal on the mixer when it is terminated in 50 ohms (providing you have sufficient LO injection).

Finishing off

You should now be in a position to use the IF as a receiver for a while if you have a temporary VFO, to check it out and get the feel of it, pending building the correct VFO. You may also wish to build it into its diecast box as follows. This box also houses the AF filter (described in a separate article in this issue) which is mounted underneath the lid, and the AF, RF, BLANKER, AGC DELAY and filter switching controls.

The PCB should be placed in

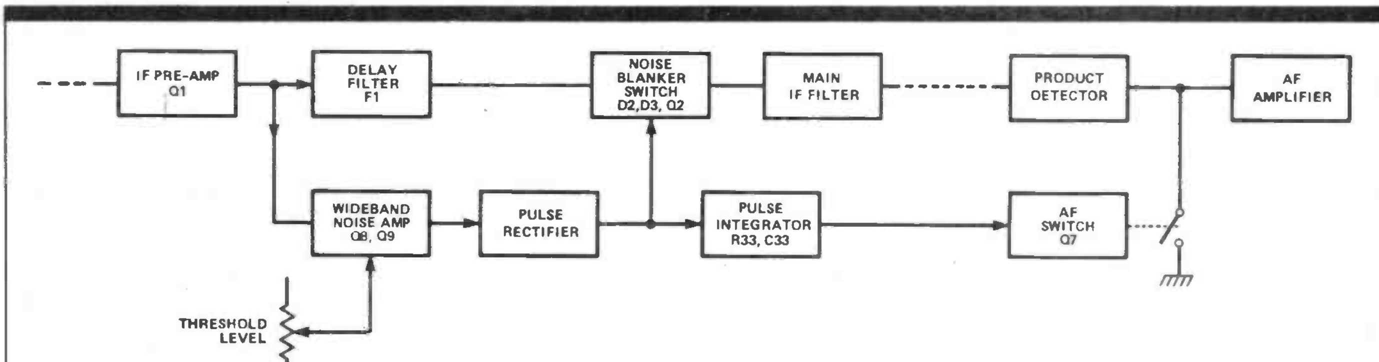
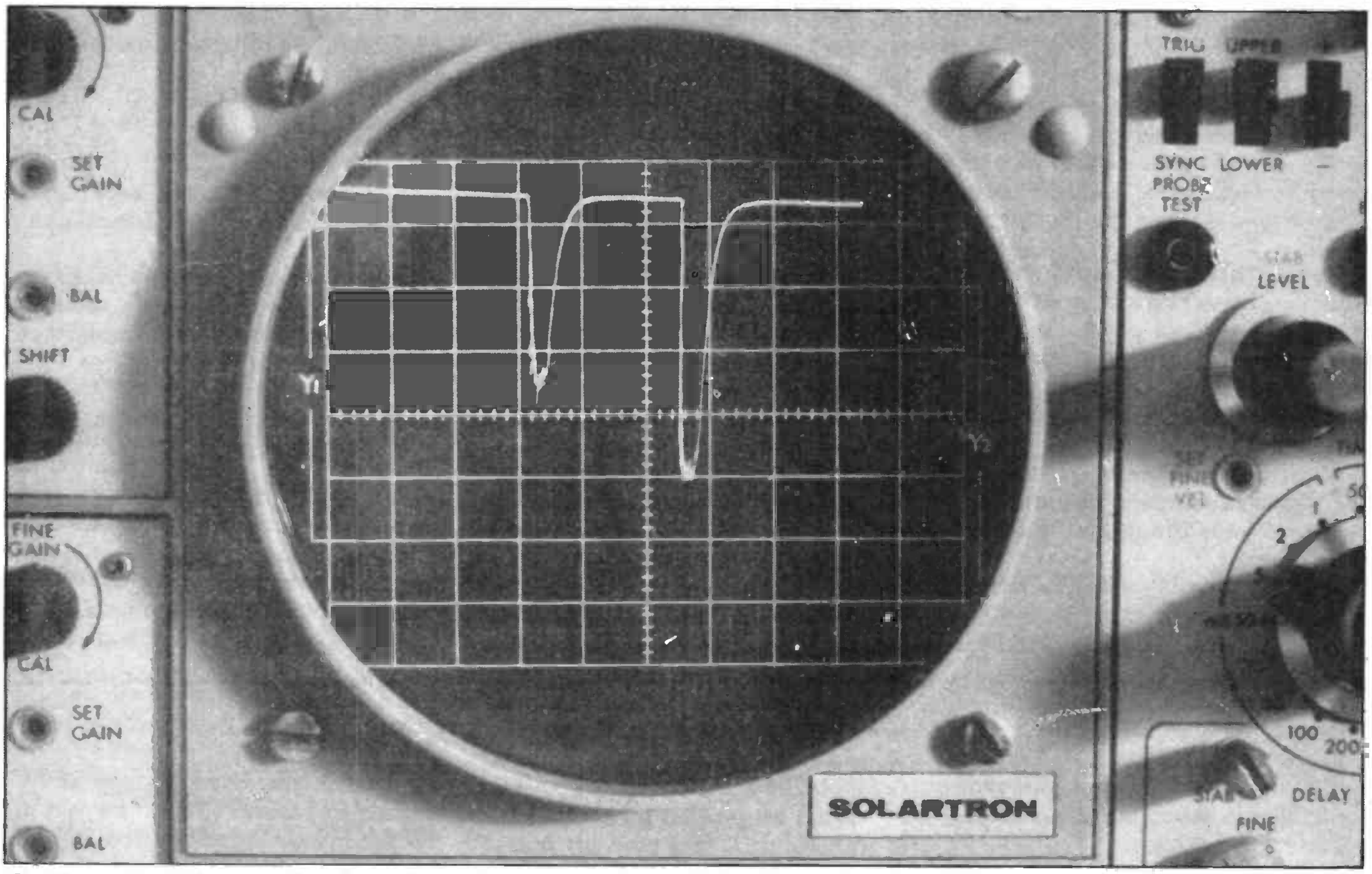


Fig 6. Block diagram of pulse and static crash blanker. The actual circuitry is incorporated within the CIFPU



Getting rid of the woodpecker. An actual scope shot of blanking signal at Q2

the bottom of the box, and the hole positions marked through, before drilling four 3mm holes. The board mounts on four 6mm spacer pillars (or three 6BA nuts) to space it from bottom of the box, using 6BA bolts.

The four controls mount on the front of the box, and eventually against the front panel of the rig. The box specified has a pillar which will have to be filed or ground off to allow the central control to be fitted. The four holes are drilled with 31mm spacing between them, 13mm below the box top.

You will also need to drill a series of holes around the outside edges of the box, 13mm from the top edge and of a diameter to suit the 1000pF feedthrough capacitors for the following connection points: +12V, +12V RX, +12V TX, Z, Y, AA, J, L, N, P, Q and R. If you can't find any screw-in feedthroughs, you can use solder-in ones by using strips of tinplate or PCB as a carrier, bolted to the inside of the case. Alternatively you can use insulated feedthrough terminals with 1n ceramics across them for decoupling.

The speaker connections from point V should be taken to a feed-through using screened cable, with the braid earthed at the feedthrough via a solder tag. The output then goes to the speaker cable, which has one lead earthed by another solder tag on the outside of the box. All connections should be as near to the points they go to as possible, and a suitable legend written at each on the outside of the box. A double row of feedthroughs was used on the righthand side of the box illustrated, 10mm below the first row to avoid crowding.

Coaxial inputs

In addition, coaxial sockets are required, one for the LO, and one for RF — use Belling Lee, miniature Belling Lee, BNC or whatever you prefer, located above the terminal pins they connect to and wired to the PCB using miniature coaxial cable.

If you are going to be using the IF notch filter, two more coaxial sockets will be needed, with a temporary coaxial link between them, again connected to the PCB using coaxial cable (points B and C).

For those who will be adding the SSB adaptor, another pair of coaxial sockets are needed, going to points M and K. Thus there will be six sockets required if the complete unit is being built. The photograph will show the approximate locations for each if you follow the wiring (full details in a later part).

Audio filter

If you are going to use the audio filter, this mounts on the underside of the lid, with the front edge of the PCB 26mm from the front of the lid (to clear the internal switch). All connections to it are made with screened AF cable with both ends of the braid earthed. (If a 12 way 1 pole switch is used, locked to the 8 positions required, one of the spare tags can be used as a braid anchor point.) The input of the filter (A) goes to point E, and the output (from the switch via point L on the filter) goes to point F (remove the link between E & F!). An additional 1M0 resistor (not shown on the circuit diagram but R73) should be connected from the input of the filter (A) to earth. Power comes from +12V on the main PCB. ●

Next month: The IF Notch Filter and Preselector Filter modules.

Aerial Farming at HF

By Malcolm Healey G3TNO

Many HF operators like to try out different homemade wire aerials. This article shows how six years of such trial and error led to a multiband system that not only beats a half-wave dipole for low-angle DX working, but reduces the strength of European stations as well.

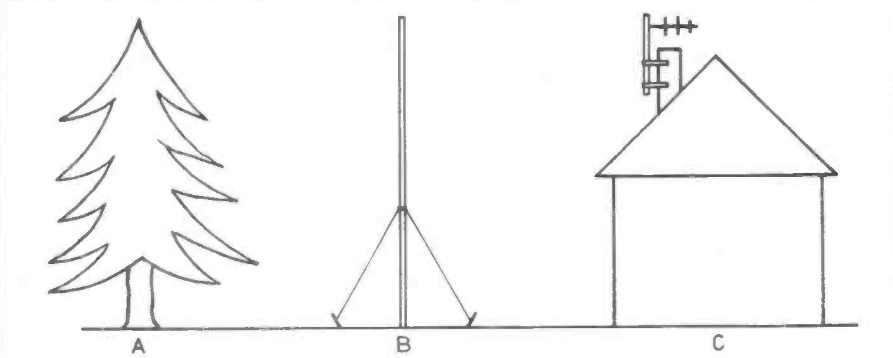


Fig. 1 35ft supports available at author's house

Over a period of years the writer has operated on the HF bands from a number of different locations. It soon became apparent that the most important part of the station lay in the aerial system. It is far better to spend a few hours and a pound or two on getting the radiating system performing well, rather than a few hundred pounds on a big linear amplifier and using a lot of power in trying to counteract the short comings of a poor aerial system, not forgetting that with a good aerial you get advantages on receive too!

It is hoped that this article may give you food for thought in making an aerial system which will work well in your QTH. I have found that an aerial system which works well at one site may, due to local effects, perform very differently at another. The differences are in some part due to local effects such as soil conductivity, local screening due to hills, buildings and even trees.

When carrying out aerial experiments I always put a simple two line entry in the log book, describing the aerial system, including dimensions, height, type of feed and not the least important the earthing system if needed.

When planning new aerial ask yourself a few questions:

1) What band(s) do you wish it to work on?
2) What space do you have?
3) Are there any natural sky hooks (trees, buildings etc.)?
4) At what times of day are you able to operate? (It is no use putting a monster beam for say 80 metres firing at the USA or Canada if you can only get on the air at lunch times as band conditions would, in the main, be unsuitable to use such a device).
5) Decide what would be socially acceptable at you QTH (your neighbours may well not consider your latest 6 element 20 metre beam a thing of great beauty), especially in urban locations. Your family may well be put right off your hobby, especially if their once friendly neighbours stop being friendly "Cos her OM has gone mad, trying to compete with the aerial farm at Daventry!"
6) Consider any planning permission you may need *before* buying any aerials or towers etc. I have always found my local planning department to be very helpful with any queries. But ask *first*. We have all seen the adverts of the unwise, "For sale, unused tower and beams unable to get planning permission. Offers (Please!)"

Before putting up any aerials, make a plan of your garden including any natural help such as trees, buildings and don't forget that the TV aerial pole on the roof can be very useful as a support as well. Mark in all dimensions, possible feeder runs etc. In my own case I wished to work on all bands 160-10 metres, and hoped for an aerial that would provide contacts with the majority of stations called.

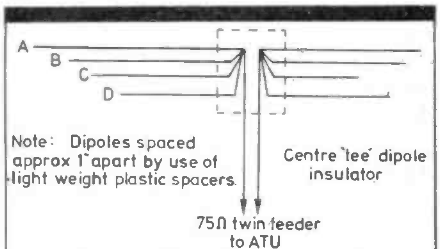


Fig. 2 Parallel dipoles

The set up in **Fig. 1** was arranged. 'A' is a fir tree and 'B' is a 35ft aluminium pole. 'C' is the pole which supports the TV aerial and is 35ft to the top of the pole. Each support has an endless nylon rope from the top of each support to ground level. The advantage of this arrangement is that two or more aerials can be supported at any one time — for example a trapped dipole between A and B and a reference dipole between B and C. Then it is easy to compare the performance of the various aerials to be tested. It is also good practice to interchange the position of the two aerials under test, to reduce the possibility of errors due purely to the location.

Table 1 lists some of the results obtained over the period 1965 to 1971 using the methods described.

It is interesting to note from **Table 1** the TVI/BCI problems cause with coax feeding a balanced aerial system with coax without the use of a balun transformer. This, it was felt, was due to a combination of radiation from the coax feeder, caused by feeding a balanced load with an unbalanced line and getting RF into the mains wiring at points near to the feed point in the shack. The chassis of the rig was in fact 'hot' to RF on some bands: Tests using coax feeders were not persisted with due to the obvious social problems encountered. It is also interesting to note that a dipole cut to 1½ wavelengths long and centre fed seemed to perform very well when working DX. It also was a fair match to 75 ohm twin feeder and fed either with a balun transformer (1:1) or via an ATU, it seemed to have no nasty vices. The radiation pattern appeared pretty much as the text book polar diagrams, having four major lobes like a four leaf clover pattern with the wire of the dipole pssing through two of the nulls. This of course is much the same as the much used full sized G5RV on 20 metres. See **Fig. 3** for polar diagram.

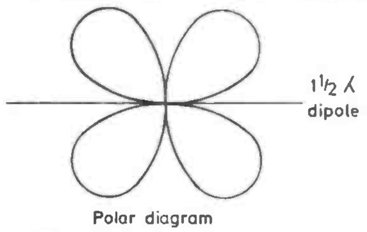


Fig. 3. Polar diagram

Table 1

AERIAL BEING TRIED AGAINST REF DIPOLE	BAND	COMMENTS
Trapped Dipole Similar to W3DZZ Fed with coax.	160	Feeders strapped. Tuned against counterpoise. 3-4 S points down on ref. dipole around UK.
	80	Fed as a dipole but **note** use of coax feed. ½-1 S point down on ref dipole, both EU and DX. Fed a dipole coax fed.
	40	No difference to ref dipole noted
	20	1-1½ S points up on EU. 1-2 S points *down* on DX.
	15	1-2 S points up on EU. Poor for DX working.
	10	Worse than dipole! Only DX raised was 1 PY but DX workable using dipole. Tests using coax feed were suspended after approx. 4 weeks due to TVI.
As above, but using 75 ohm twin feeder to ATU. Balanced ATU output.	160 to 10	Results using this set-up similar to above but TVI vanished. Tests carried out for approx. one year.
G5RV using open wire stub, rest of feeder 75 ohm balanced twin balanced ATU output	160	Feeders strapped. Tuned against counterpoise. 3-4 S points down on ref dipole around G. No DX.
	80	Fed as dipole. ½-1 S point down on EU, 2-3 S points down on DX.
	40	Good results to EU, and sometimes, dependent on direction, 1 S point up for DX.
	20	Very good for DX. But dependent on band conditions, down for EU.
	15	Fair results to EU. Some DX cotacts were up on ref dipole. Others the same
	10	Fair for short skip but worse than ref dipole for DX.
FAN DIPOLES 1½ wavelength centre fed (one 1½ wave length dipole per band) using 75 ohm balanced feeder. Fed via balanced output ATU.	40, 20, 15, 10	EU signals down compared with ref dipole approx 1-1½ S points. 2 S points up for DX. Very good for DX: ZL, VK, W, PY etc.
SINGLE ELEMENT Quad Loop fed via 75 ohm twin and balanced output ATU	20, 15, 10	Results on 10, 15, 20 metres were very good to DX at right angles to plane of aerial *Consistantly outperformed dipole* by 1-2 S units.

Fan dipoles

Experiments using one or more dipoles with a common feeder were tried next and an arrangement as in **Fig. 2** was gradually evolved. It consists of a half-wave dipole for 80 metres, a half-wave dipole for 40 metres, a 1½ wavelength long dipole for 20 metres and a 1½ wavelength dipole for 10 metres. For 15 metres, the 40 metres ½ wave dipole behaves near enough as 1½ wavelengths centre fed. The aerial was assembled as in **Fig. 2** and initially the dipoles were cut to length using the standard formula

$$\tfrac{1}{2}\text{-wave dipole length (ft.)} = \frac{468}{f(\text{MHz})}$$

Table 2 gives the dimensions to cut each dipole element, to start with a certain amount of pruning of each dipole will be needed, cutting an equal amount from either end of the dipole in question. Observations should be made of the VSWR at various frequencies across each band. Aim at getting the VSWR down to its lowest at your favourite part of the band ie. Phone or CW. The reason for the dipoles not working out at the exact, calculated lengths, is due to capacitance between the various dipoles and nearby objects. Always put the aerial back to its full height before attempting to measure VSWR as the height of the aerial above ground has a significant effect on VSWR. **Fig. 4A** shows a diagram of the feed arrangement used during setting up. However once set up I prefer to use a balanced output ATU, replacing the 1:1 balun with an ATU (See **Fig. 4B**). This helps to reduce any harmonics present in the transmitter output being fed to the aerial system. As this is a multiband aerial system, any harmonics present will be effectively radiated unless you do use some method of reduction of the harmonic level, so the ATU is really a must. This is of course true of any multiband aerial system!

The aerial described in **Fig. 2**, having been constructed and tuned, was compared as previously described against reference dipoles for the different hands, using one reference dipole at a time. The results of the tests may also be seen in **Table 1.** Although there are some slight changes to the basic aerial which was tested (the 'dipole' for 40 metres was cut to be 1½ wavelengths long for that band and an extra 1½ wavelength dipole added for 21MHz and 80 metres left out, the aerial in **Fig. 2** *has* been constructed exactly as drawn. The only difference in performance was noted on 7MHz where it performed exactly as the reference dipole, and as a consequence seemed down in performance on DX. The same is true of 80 metres.

Why go to all the trouble of cutting and tuning several dipoles? It is possible to put up a 132ft dipole and centre-feed it with tuned feeders, and most of the text books show some really pretty polar diagrams. But, what most of the books don't (or won't) show is the vertical angle of some of the lobes being radiated. On the higher hands particularly, some of these lobes turn out to be at almost uselessly high angles for working DX. Fine for setting fire to your neighbours gardens.

In short I have found the following advantages of the aerial in **Fig. 2.**

1. Low impedance feed.
2. Works DX.
3. Costs virtually nothing except an hour or so of your time, and a few feet of wire.
4. No nasty heavy traps dangling in mid-air, getting hot with your precious RF.
5. Low angle of radiation.

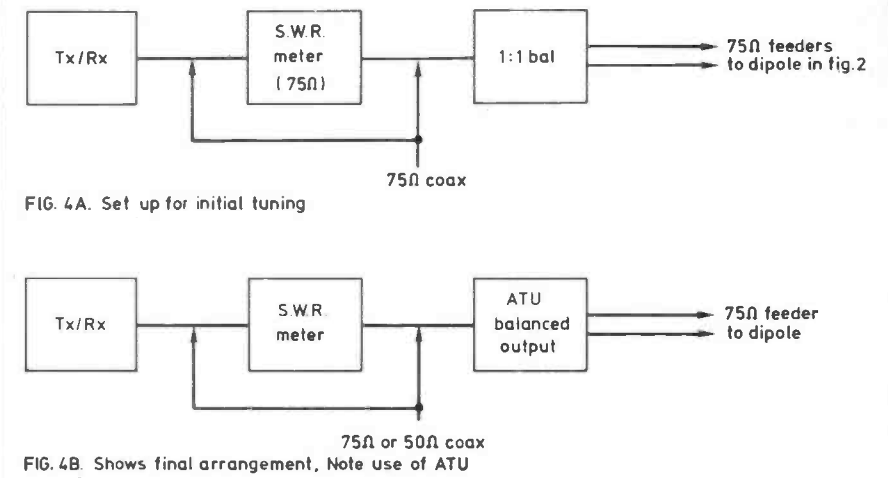


Fig. 4B. Shows final arrangement. Note use of ATU

Table 2. Dipole Dimensions for multi-band aerial of Fig. 2.

DIPOLE	MODE OF OPERATION	LENGTH IN FEET	TUNED AT
A	½ wave 80 metre dipole (also approximates to 1½ wavelengths centre fed on 10MHz band)	131.83 feet*	3.55MHz
B	½ wavelength on 40 metres 1½ wavelengths on 15 metres	66.38 feet	7.050MHz
C	1½ wavelengths on 20 metres	99.92 feet	14.050MHz
D	1½ wavelengths on 10 metres	50.05 feet	28.050MHz

*NOTE: I actually cut mine to 134ft. and accepted a slight mis-match on 80 to improve SWR at 10MHz.

NEWCOMER'S

Getting a first rig for HF

Several people have asked how best to get a start on HF, especially wishing to know what rig to go for. Advising what equipment to buy is akin to advising what car to purchase, a task which is tied up with personal preference. But there are some basic guidelines. It is much the same with radio equipment — you can probably find a dozen rigs which meet your main needs, but in the end, the purchase may well depend on factors such as appearance and plain 'gut' feel. This is quite normal for humans, but everything that glisters is not gold!

You will have to battle against the recommendations of the various dealers and the advertisements, trying to decide whether the features offered are what you require, ignoring the dolly birds which seem to be popping up much as they do in car adverts.

TX/ RX or RX only?

Your first decision is likely to be influenced by the depth of your pocket, or the generosity of your bank manager, and with very little available new for under £400 (except one semi-kit design at under £300) you may fell obliged to go for something in the secondhand market. I would suggest that there is another decision to make — do you initially need a transceiver, especially if you are to embark onto HF without any experience of it whatsoever?

In one of these past columns, I did mention that the act of initiation into the hobby is no longer by a period of general short wave listening, during which you pick up all the operating jargon, band characteristics, etc. Now it's more often than not via CB, with a wish to expand your horizons in more than one sense. There are also those who have a professional background in electronics, but still have no basic amateur radio experience. Whatever route you take, the day-to-day operating knowledge can only be gained by experience — no amount of reading, nor PhD can replace this.

It's a bit like the driving test — few would suggest that at the moment you have passed your driving test, however well, you are fully equipped to drive a car. What I am leading up to is to suggest that you buy a receiver only, or if you do want a transceiver, discard the microphone for a while and control the urge to get on the air. This will give you the opportunity to listen, and gain a basic knowledge of what goes on in the world of HF, where things are rather different to the world of VHF FM. You won't necessarily have to flog the RX afterwards, especially if it is a general coverage type (ie it covers say 500kHz-30Mhz, rather than just the amateur bands). Such a receiver can be valuable in later years.

Take your time

Whatever you do, take time before parting with your hard-earned cash. There are many rigs to choose from, including a vast number of second-hand ones. Ask around, look at as many magazine reviews as you can (reviewers should be fairly impartial) and try to get your hands on as many as possible. If you ask people what they would recommend, bear in mind that personal opinions will always creep in — after about the tenth request you should be getting a idea whether any particular peice of equipment is getting a lot of mention (good or bad).

I will make no attempt at recommending particular models myself — I'll just say that there are plenty of very good rigs to be found on the s/h market for £100—200. Some may be up to 20 years old, but will still transmit and perfectly adequately, which is the most important thing. Yaesu and KW both made early models which will conduct themselves with perfect dignity today. Save your pennies for the LED's, PBT, VBT, memories etc., until the time comes when you can appreciate them and decide whether you actually need them. Frank and I are both of the opinion that eventually there will be a revolt, against the mass produced, high price 'bells and whistles' commerical gear in favour of simpler, cheaper gear which you might stand a chance of maintaining yourself.

There are still a number of good 'separates' (ie, independent transmitters and receivers) around, of which some can transceive if required. As a matter of interest 'transceive' is a modern phenomenon tied in with the advent of SSB and co-channel working. With separates, if you wanted to work co-channel, you find the station you wanted on the receiver, then 'net' the separate transmitter onto the frequency for zero-beat using a low power transmit mode. It takes slightly more time, and is a positive disadvantage during contests, but otherwise perfectly OK for run of the mill contacts.

Evaluating rig

You will have to judge a s/h piece of gear mainly by a short on-the-air test, and this is essential — I doubt you would buy a car without a test drive. There may be something you cannot live with, and even if you positively dislike a rig, there may be a couple of good points you can bear in mind in the future. The receive side is likely to be the main thing as there is little you can gain from transmitting except for audio quality reports. One tip — if the chap you are buying from has to look up in the manual before tuning it, or takes a long time to do so (or doesn't look as though he knows what he's doing) start asking why he doesn't use the rig much! There may be some perfectly valid reason, on the other hand, he may be concealing something nasty. Most private sales are usually genuine, with the ever present urge to upgrade being a factor, and a lot of people can't help telling you the odd foible about the rig.

A few points to look for are stability of the VFO (leave it listening to a contact while you are talking, and see if it stays on frequency). Also sensitivity (difficult to judge without a comparison — try listening for electrical interference on the lower frequency bands, if it is absent either there is a good blanker, or the rig is insensitive). Strong signal handling is another thing to check (try listening on 40m after dark or amateur CW stations. Can you only make out a mass of noise and rubbish?).

Controls

Are the controls arranged in a convenient way for you, bearing in mind that you will be tuning around for long periods. Would you prefer a tuning knob that can be spun rapidly, rather than have to crank the thing continually? If you feel you may become a CW addict, then is the IF selectivity adequate, or can extra filters be added? (If so, at what cost?) Do you need a digital display (unlikely) or is an analogue version adequate? There are dozens of other considerations — try talking to fellow club

FORUM

By Tony Bailey G3WPO

members to get a feel for what you should look out for.

Power

If you're thinking of buying a transceiver, consider whether you actually need high power. There are basically two power levels with commerical transceivers — 10W output or 100-150W output. Remember that it isn't the PA that gets the signals to the other station, it is the aerial. A few pounds spent improving it is a much better investment than a few extra Watts. Also, if you can't hear them you can't work them! There is no doubt that low power (QRP) operation (although 10 Watts is a bit high for QRP) is more demanding in operator expertise than high power (QRO) and you will have rather more difficulty in working DX using 10W to a simple aerial, than with full legal power to a 3 element beam, but which will give you the greater satisfaction? I would suggest that the expertise gained under more difficult conditions will stand you in good stead in years to come.

Buying from a dealer

If you buy a new rig, or even secondhand via a dealer, one point to bear in mind is servicing. One of the reasons why some dealers are cheaper than others is that they cannot provide full servicing facilities. Any sensible dealer will include an amount to cover possible maintenance in his price and something towards getting hold of all the test equipment needed to service modern equipment. He also has to carry a stock of spares for each rig if he is going to do the job properly. So although you pay more initially, you have the advantage that if something goes wrong, the chances are that it can be put right quicly, without waiting for the rig to go off to a service centre, or for spares to arrive from overseas.

Buying secondhand

The dictate *Caveat Emptor* or 'Buyer Beware' is very much to the fore in the secondhand market. Hence the reason for suggesting that you get your hands on the rig for a while before buying. Most amateurs are honest when asked about any problems with the rig, but if you have doubts then consider whether you should buy. If you are misled, then you do have recourse in law, but it can be a long job and may not be worth pursuing.

Home construction

You can of course build all or some of your equipment yourself. I always admire anyone who can say during a contact that his equipment is home built, especially if his signal is first class. It is a satisfying experience to build your own and get it working, even if you didn't design it. At the end you will have learned a lot, and probably be keen to move onto something more complicated. I doubt that you would want to reproduce one of the black boxes on the market, as the thing with home brew gear is that you can design in the features you want, not what the manufacturer thinks you want. The cash angle looks different of course, and it is possible to get on HF CW for under £10, even under £5 if you want. You can certainly build something decent for £50-£100. Most magazines, including this one, carry designs for transmitters/receivers and a browse through past issues (you can beg or borrow copies of most magazines from other amateurs or get back copies from the publishers in most instances) should provide inspiration. Check that you can get all the parts before you start though — some of the older designs contain components which may be difficult to replace. A case in point is the LM373 multimode IF chip which was used in a variety of designs, but is now obsolete and cannot be replaced without major circuit changes.

The shack

All of us have to operate from somewhere, be it the living room, bedroom, cupboard under the stairs, or a purpose built/adapted room. The complexity and facilities required will depend on your interests. If you are a non-constructing, single-band VHF operator then very little space will be required, and your ancillary equipment should be reasonably limited. The multi-band operator with several rigs, tuning units etc will need more space, and if you construct as well then even more must be allocated if possible (XYL allowing etc). The shack should be designed for operator comfort, convenience and not the least safety.

Taking the last point first, whatever you operate will almost certainly need the mains supply, either direct to the rig, or via a power supply unit. Make sure that everything is correctly fused as recommended by the makers, and that each piece of equipment has its own outlet — never use multiway adaptors. One sensible precaution is to have a prominent master switch, away from the immediate operating position, with its purpose clearly marked. In the unhappy event that someone has to get the power off because you're attached to the mains somehow, they won't have to grope for the switch under the bench, and possibly endanger their own lives in the process.

It's volts and jolts but 'mils' that kills

Always respect any potentially lethal voltage. Not so long ago, one of my locals was found dead after inadvertantly electrocuting himself. It does happen, and he was a man of long practical experience. The old adage of 'one hand behind the back' while working on live equipment is still a good one.

If you do a lot of constructing, try to avoid using the operating position as the work bench. There is nothing worse than scrabbling around under a pile of debris for the log, or a pencil, and you will scream when a piece of molten solder ends up melting your rig's meter cover, or a piece of wire ends up inside the ventilation holes and does a nasty.

To strike a lighter note, there can be hazards involved in using the shed at the bottom of the garden for the shack. Many years ago, one of our club members was peering inside a piece of equipment tyring to work out why the thing kept drifting about in frequency. After a short period we noticed a slight movement at one place, and after a closer look saw an insect emerging from inside a tubular ceramic capacitor in the VFO! So, if your rig drifts around, try spraying it with insecticide rather than *Electrolube* — it might do the trick!

Operator comfort

So many people ignore this, but it is one of most vital aspect of any shack. Like many things, a happy and comfortable operator is a good operator (unless he also has the whisky bottle handy) so pay attention to layout.

The main TX/RX should be in the middle, with everything else positioned around it for maximum accessability depending on use. The rig is generally at bench level so that you don't have to reach to operate it and it should be placed so that your arm doesn't tire after extended periods of operation. It needs to be far enough back on the bench to get a log book and notepad in front of it. ●

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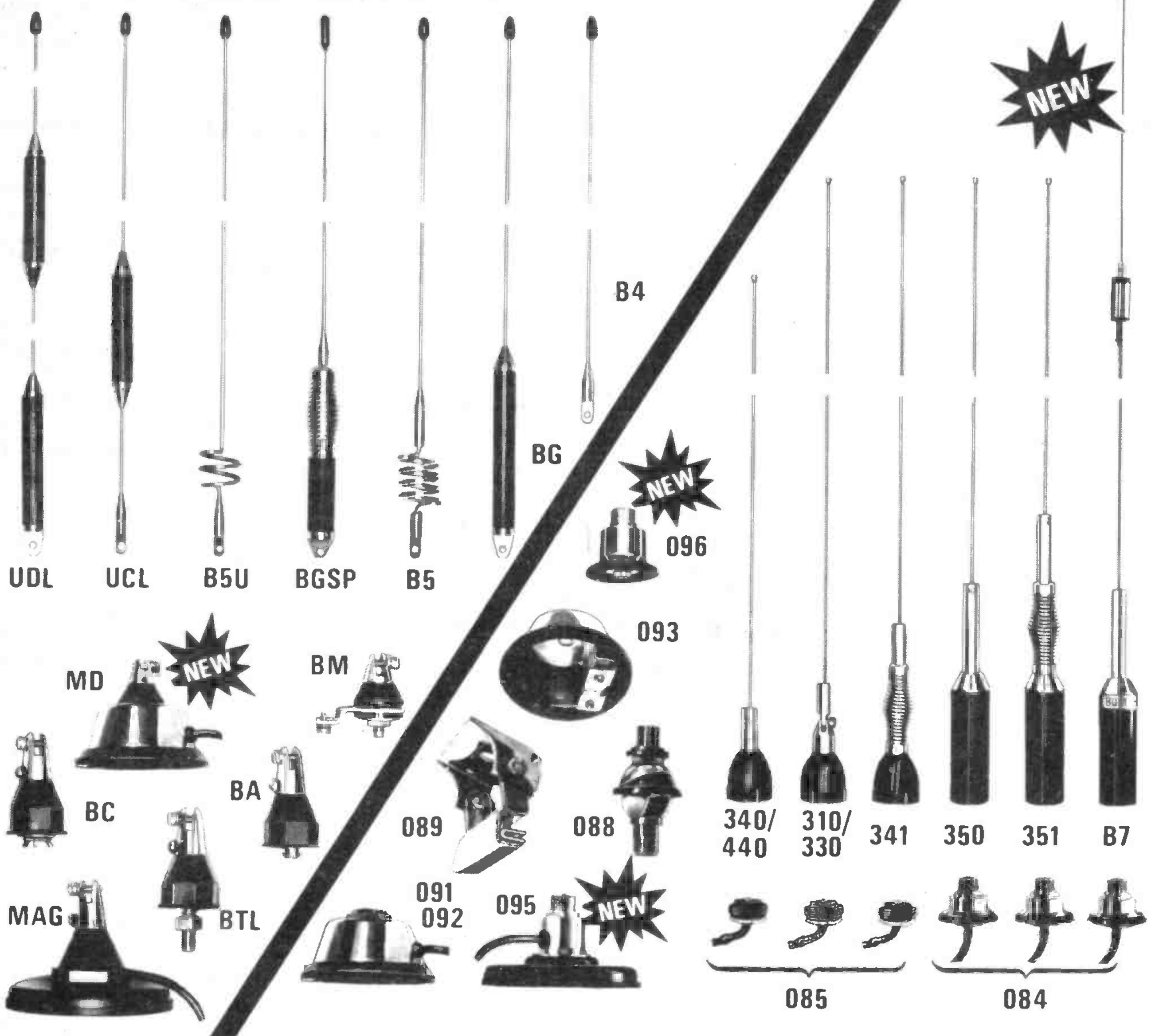

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021 DEALER

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Using 10 Metres

By Tony Bailey G3WPO

A casual tune around during the day (and it is primarily a daytime band) may tend to give the beginner the impression that there is little activity, or that the Europeans have a hold on the band to the exclusion of other areas. For those that know it, and how to use it, the band can be very exciting, especially in its sometimes unpredictable behaviour.

During the past few years, the band has been at its best, with DX stations there for the taking using low power and simple aerials, often open for much of the day to virtually all of the world at once. However, we are now well on the downward path and it will not be long before the DX has to be worked a lot harder for, although this can still be done with low powers and simple antennas. As well as DX, Ten is an ideal band for local QSOs and much of the traffic passed on 2 metres by the Class A licencees could usefully be rerouted to 10 metres to relieve the VHF band of some of its congestion on the FM channels.

Ionospheric propagation

There are a number of ways in which signals reach other parts of the world. Most of these depend on the reflection of the signal by the Ionosphere, or more correctly, one of the Ionospheric layers, of which there are several.

The majority of real DX signals are propagated by the F2 layer which is the highest, with the height depending on the season, time of day, latitude and the state of the sunspot cycle. The other layers (D and E) are of no interest to us at 28MHz as they do not reflect at this frequency.

The 10 metre band appears to be viewed in a strange light by many amateurs. There are those who rate it as the best of the HF bands, and those who seem to think of it as a rather strange band that is only of use during sunspot maxima periods such as we have just been through.

Usually around 120-260 miles above the Earth's surface, the F2 layer is present during both day and night during the peak of the sunspot cycle, but once the sun has set the reflective properties rarely extend as far as 28MHz. Hence the band is only 'open' during the hours of daylight, plus maybe an hour of two into darkness during the peak of the sunspot cycle.

The maximum ionisation level occurs at around mid-day for the mid-point of a given path during the Winter, and a bit later in the Summer. The earliest time at which a QSO can start over any given East-West path thus depends on the position of the Earth relative to the Sun, and the state of the Sun itself.

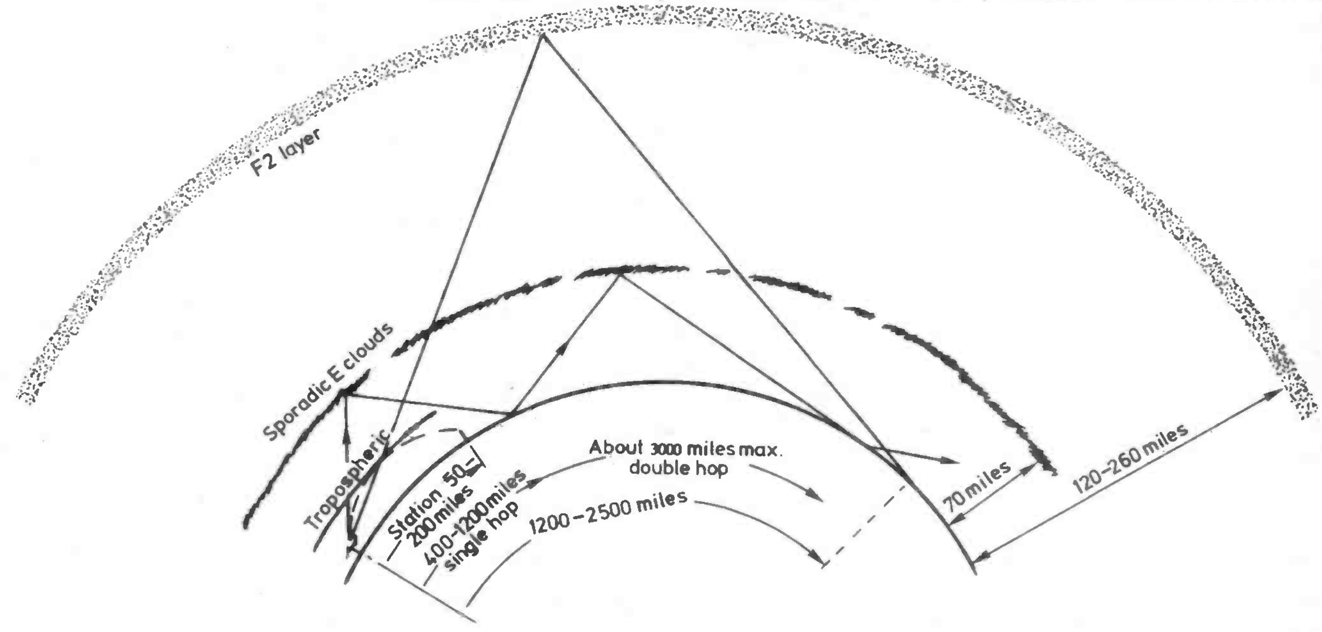
MUF

Whether or not 10 meters will support DX propagation via the F2 layer depends on this highest frequency or MUF (Maximum Usable Frequency) at any given time — if the MUF is below 28MHz then signals are not reflected and little propagation will take place. At sunspot minima times, there is usually a two to three year period, mainly affecting East-West paths, when the MUF very rarely gets to 28MHz, although contacts with Africa are still possible around midday on a few days of the month.

As one might expect, during sunspot maxima periods the incidence of the MUF being above 28MHz is high — it can get as high as 70MHz, and it is during these times that the 6 metre band supports propagation over the Atlantic, allowing cross band QSOs via 10 metres with the States (and possibly direct on 6 metres if we get full access to the band).

The distance your signal will travel via F2 propagation depends on the angle at which the signal hits the layer (dependent on the angle of radiation of your antenna), and on the number of hops it makes between the layer, the earth, and back again. A single hop signal can cover up to a maximum of about 2500 miles, with a minimum of about 1200 miles (the distance will vary with ionospheric conditions, and the angle at which the signal is reflected, and the critical angle for the frequency). For communications at distances below this skip distance, other modes of propagation take over.

One interesting effect occurs when the MUF is only just above 28MHz. Under these conditions the F2 layer acts as an almost perfect RF ▶



MAIN 10 metre propagation modes

mirror and signals are readily reflected at good strength. On the other hand, the areas covered at each end of the path will be relatively small. This makes activity appear low — especially if the local time at the other end of the path corresponds with a period when activity would be low anyway.

This is one of the reasons why 10 metres is famous for signals suddenly appearing from an apparently dead band — one minute you can be hearing nothing, and the next working a juicy piece of DX as you find a path which coincides with some activity. Low power can give some surprising results under these conditions, so a CQ on what appears to be a dead band can be very worthwhile.

Backscatter

You may have heard weak and watery signals from other British and European stations when they have been working into some other part of the world at the same time. The phenomena is known as 'back-scatter', and occurs because whenever the reflected signal hits the earth, a small part of it is scattered in all directions. When the F2 layer is highly reflective, some of this scatter will be reflected back to the source area again, giving rise to these very weak signals.

This mode of communication works best using CW and, if you are using beams, you need to direct this towards the DX location, *not* at the station you are hearing, otherwise the signal will almost certainly be weaker, if audible at all.

Sporadic-E

This is another term familiar to the VHF operator, but equally responsible for propagation on 10 metres. The distances involved are usually 400-1200 miles and the mode is useful for working into Europe. When you find the band full of strong European stations, Sporadic E short skip will be the reason.

The reflection occurs as a result of the formation of highly ionised cloud layers at about the height of the E layer (70 miles). They are random in nature, and only last up to a few hours, hence the name. They are thought to be caused by wind-shear, and are not directly related to Sunspot activity, so they can happen at any time within the Solar cycle.

The Es season is May-August, with another small peak in midwinter. During thr summer it can occur at any time of the day, although early evening and mid-morning are the most likely times.

Due to the height of the clouds, a single propagation hop has a maximum distance of around 1200 miles. However, in the summer when large areas of cloud may form, multiple hops via more then one cloud are achievable, extending the communication range to 3000 miles or more.

The antennae and power needed for Es are highly non-critical. Anything from a piece of wet string to a beam will work, and low power will often be more then adequate. Received signal strengths can be extremely strong, and, as the phenomena is short lived, in the summer the band can often be full of activity one hour, and apparently dead the next.

Tropospheric propagation

The 10 metre band is largely ignored for local communications, but is in fact capable of supporting this well up to about 50-70 miles at any time of the day or night, and at any season. With the decrease in the likelihood of DX QSOs during the coming years, anything that increases the usage of the band will be welcome.

Tropospheric propagation at 28MHz is much like VHF, although not so markedly affected by the weather. Signals will follow an air mass boundary such as the common temperature inversion, where a boundary forms by one layer of air being cooler than another by virtue of the differing densities. The best conditions occur in the evening as things are cooling, and just before sunrise. A reasonable aerial helps in keeping the angle of radiation low, but almost any antenna can be used. This mode is really a ground wave phenomenon, with the really strong link between the two stations, with no refraction or reflection involved.

Meteor scatter

Meteor scatter propagation is normally associated with 2 metre work, but occurs much more often and more intensely on 28MHz, with a single small meteor capable of ionising an area 50 feet in diameter and over a mile long in the E layer. Signal strength increases of up to 40dB are possible.

A single meteor trail is very short lived (giving rise the 'pings' of signal) but if the earth encounters a shower of these objects, then almost continuous propagation is possible at 28MHz. Being primarily a single hop phemomenon, the communications range is limited to about 1300 miles, as for other E-layer reflections.

Aerials for Ten

While we would all like a rotatable beam for 10 metres, the local council and the neighbours may have other ideas. If you do want to try a beam, but don't fancy a full size version, there are some small beams available. The writer uses an *HQ-1 Minibeam* (not the same as the G4MH type) and can recommend this. It isn't so clever on 20 metres (it covers 20, 15, 10 & 6 metres) but does possess very good directivity and gain on 10 in a reasonably small space.

Simpler aerials can be used to good effect, and there are a large number of designs to be found. One of the simplest is the humble dipole, which even the smallest house should be able to accomodate. Used in inverted-Vee fashion, it provides reasonably omnidirectional coverage with a fairly low angle of radiation for those distant contacts, even with the apex only 0.2 wavelengths above ground if you are really restricted for height. A possible unobtrusive mounting point is over the roof of the house, using the chimney as the mounting and feed point. Most lofts will accomodate a dipole should you be forced to keep it out of sight.

The equally humble 1/4 wave ground plane works well on 10, and it is relatively easy to give it a good earth to work against — remember that the feed impedance of a true ground plane with 90 degree radials is 35 ohms, so there will be a mismatch is using 50 ohms cable. This is unlikely to have any serious effect, but if it makes you happier, the impedence can be raised by dropping the radials somewhat. If mounted in the clear, the angle of radiation will be low, and as well as DX, it can be used for local working providing the other station is also vertically polarised. The provision of a good earth system (as the other half of the antenna) also applies to any vertical systems such as the trapped multiband types.

Summary

10 metres if a band full of surprises and capable of supporting many forms of propagation, despite the poorer conditions now looming up. Even with low power, plus a bit of knowledge and some patience, DX will still be there for the taking, so don't neglect it. Also, the band is used for satellite downlinks — yet another area of interest for many people.

A simple beam for 10 metre FM

By M Hadley G4JXX

Trying to get a good signal out from an urban area can be a problem especially if you have limited space.

Vertical antennae seem to be the only answer, but in addition to spraying RF in all directions their susceptability to manmade interference can be a problem.

Being the sort of person that believes in "Why buy it when you can build it yourself?" it was decided a simple beam would be to some advantage.

The main design is derived from the basic HB9CV. Both elements were made from readily available CB dipoles (purchased by the author for just £2.50 each).

The construction of the original CB dipole is not strong enough to withstand horizontal mounting so some modification is necessary. **Fig. 1** shows how the centrepiece is formed. Strip the plastic moulding of all metal pieces and discard the top cover. To make the boom drill a piece of thick wall aluminium tube in the centre and fit it into the top of the moulded centrepiece. The cutouts in the sides are made with a Stanley knife and must be a close fit to the tube. Pass the 6mm bolt with the solder tag through the centre, fit the whole assembly to the boom and tighten up. The coaxial feed hole must face backwards.

After the two moulded centres have been modified and fitted to the boom, fit the elements and hold them in place with self tapping screws, with the seams of the elements facing uppermost. Permanent fixing of the overall length is made after final adjustment.

Gamma match

The gamma match is made from a strip of aluminium 8mm wide by

1.5mm thick shaped into the dimensions shown in **Fig. 2.** If necessary two shorter pieces can be joined where the gamma match crosses the boom. Fix the corners of the gamma match to the moulded centrepieces using two M3 screws, the front screw having a solder tag on the inside. Mix epoxy putty and form it between the boom and gamma match to produce an insulating and securing block in the centre. Be careful to keep the 10mm distance between the gamma match, and boom and elements. Using self tapping screws, drill and fix the ends of the gamma match onto the front driven and rear reflector elements.

Strip the coaxial cable at the end and push it through the hole in the front driven dipole centre. Solder the braid to the solder tag and connect a temporary 100pF variable capacitor between the coax centre conductor and the solder tag on the M3 screw.

To match the antenna to the transmitter, set the tuning capacitor to approximately half mesh and the dipole elements to the dimensions shown in **Fig. 2.** Apply a small amount of RF and check the SWR. *With the transmitter off* adjust the capacitor then check the SWR again. Repeat the adjustments until minimum SWR is obtained. Fine

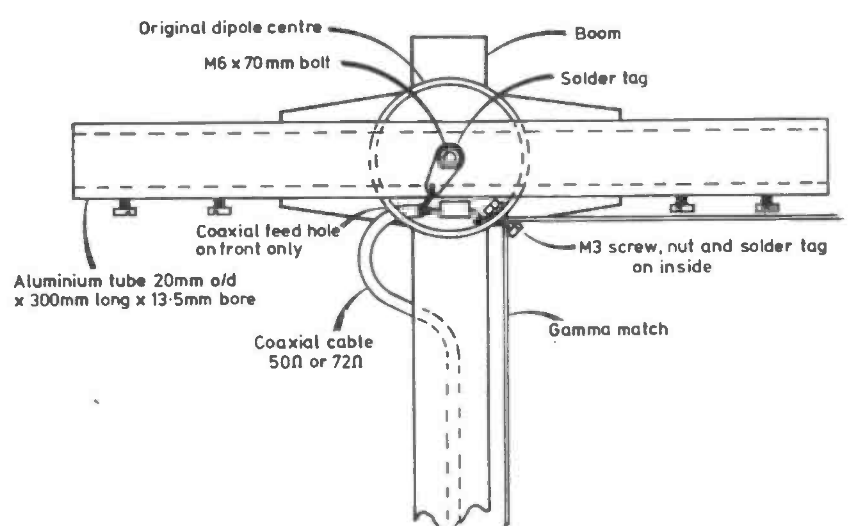


Fig. 1 Showing modified dipole centrepiece

adjustment for resonance can be made by altering the length of elements 5mm at a time, but remember, adjustments to the front director length involve equal adjustment to the rear reflector length. Resonance should be fairly broad centreing at around 29.5 MHz.

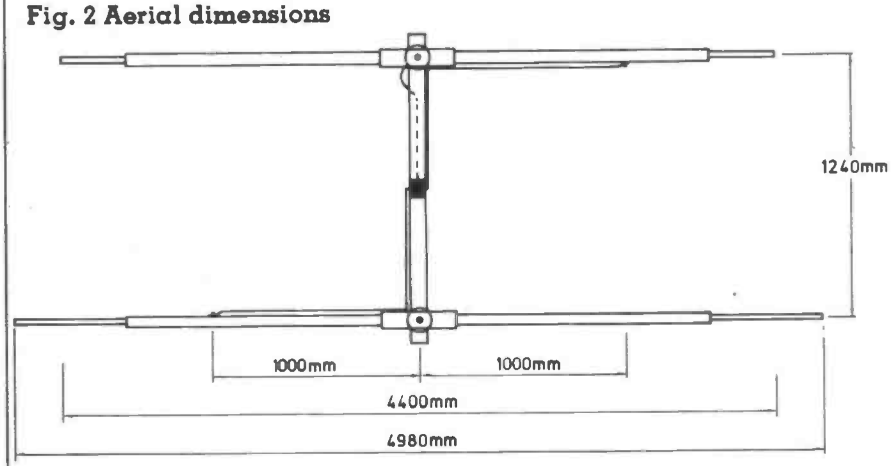
When final adjustment is complete lower the antenna and fix the elements permanently with self tapping screws. Remove the tuning capacitor and replace it with a fixed capacitor of the same value as the minimum SWR setting of the tuning capacitor. If capacitance measuring equipment is not available it may be necessary to estimate the value from the adjusted position of the tuning capacitor. In the author's case this was achieved with 60pF. A 100 volt working capacitor is more than adequate for powers up to 10 watts.

Fill the moulded dipole centres with epoxy putty paying close attention to sealing around the coaxial cable entry. When it has set, seal all joints and screws with clear varnish to prevent corrosion. Run the coaxial cable underneath the boom and lead it away down the supporting pole.

Performance of this simple antenna far exceeds that of a vertical and in the author's case many Japanese, North American and Soviet stations have been worked with just 5 watts of FM.

Although no originally is claimed for the design, the final dimensions were obtained through trial and error. The simplicity of the design does allow further experimentation.

Fig. 2 Aerial dimensions



Front driven element length 4400mm
Rear reflector element length 4980mm
Gamma match feed point 1000mm from boom
Element spacing 1240mm
Boom 25 mm O/D x 1350 length (aluminium)
Gamma match 8mm×1.5mm×3265mm (aluminium)
Distance between gamma match and elements 10mm

Value for Money?

When contemplating the purchase of new amateur band transmitting equipment most operators do take the power rating into consideration — but what do all the figures mean? Which rig is the most powerful? "200W" or "100 watts output"? Are the printed figures there to enlighten your mind, or lighten your pocket? Whatever the intentions, the net result is confusion, and I honestly doubt if some makers even know what the figures used in their specifications are supposed to mean!

by Harry Leeming G3LLL

Ham radio equipment power levels in the UK have for many years been stipulated on the basis of DC input power to the final amplifier. On most amateur bands the maximum allowed was 150 watts input, and so if the final amplifier was a valve and was supplied with 1000 volts, the maximum current it could legally be run at would be 150 milliamps ($P = V \times I = 1000 \times 150/1000 = 150$ watts). This is not really a fully satisfactory way of rating a radio transmitter, as strength of signal is dependent upon the output power and not its input power. In the 1920s, however, when the regulations were drawn up, the measurement of input power was probably the only practical way to legislate amateur power levels, as few hams (or Post Office inspectors for that matter) had any simple method of accurately measuring radio frequency power. Technology does advance rather faster than officialdom (they have only just taken the reference to spark transmitters out of the licence!), so whilst since World War II there has been no need to retain rather archaic methods of measurement, the UK, and many other countries until recently have still based their amateur licence conditions on DC input power.

The latest UK licence write up (or 'cockup' dependent on your point of view) does regulate power expressed in decibels above one watt 'dBW'. How this can logically be enforced when commercial power meters are scaled in straightforward watts and the RAE syllabus has never previously required a knowledge of dBs is one of life's mysteries. (Perhaps the guy at the Home Office who has never heard of front end or masthead preamp overload and thinks 934MHz will cause less TVI than 200MHz dreamed this one up as well.) In reality the new licence is a straight translation of the old one into 'dBW Output', allowing for normal efficiency in the PA stage.

Input power measurements have the advantage of simplicity where AM or CW transmitters are concerned, but caused a problem upon the advent of SSB. A single sideband transmitter running in class AB1 or B has an input power which is controlled by the loudness of the speech with which it is being modulated. The DC input power, therefore, is continuously changing thousands of times per second, and the power amplifier current meter can only give an average input current reading dependent upon the peak-to-trough ratio of the operator's voice. Whilst this meter can give an experienced operator a good indication of the current operation of his equipment it *cannot* measure SSB input power.

The relationship of SSB and AM ratings

Fig. 1A and **Fig. 1B** respectively show the familiar patter of an unmodulated, and then modulated 100% by an audio tone. We will presume that this is the output of a 150 watt transmitter operating at average efficiency (usually 60 — 70%) giving an output power of, say, 100 watts into a 100 ohm dummy load. The RMS voltage of the wave form shown at A will be 100 volts and the current into the dummy load 1 amp, RMS. In **Fig. 1B** it will be seen that at audio peaks the voltage is doubled to 200 volts RMS. When the voltage doubles, by Ohm's Law so does the current; (hence the formula $P = V^2/R$.) 2 amps. at 200 volts produces 400 watts RMS and so to use SSB terminology, 400 watts peak envelope power (PEP) is produced.

This shows the sense behind the Home Office ruling that SSB output has to be limited to 400 watts PEP on the bands licensed for 150 watts DC input power. 400 watts PEP is the output power that an average efficiency 150 watt fully modulated AM transmitter might be expected to give when operated at 60 — 70% efficiency.

The quoted figures?

Thirty years ago a '150 watt' AM transmitter weighed several hundred weights, an *FT101E* 250W PEP transmitter with built-in DC and AC power supplies is portable — what's the difference? Technology marches on, yes; miniaturisation, yes; no high level modulator, and now a solid state PSU, yes; but quite apart from all this the 150W input transmitter of the early 1950's had to operate continuously on AM and produced a 100W carrier and 400W PEP output power. The *FT101E* has a maximum PEP input power of 250W and produces a PEP output power of around 150W. The *FT101* like all modern SSB ham rigs is not rated continuously at 250W input (note the 10 second maximum tune-up warning in the instructions), and it is intended to be run at full power

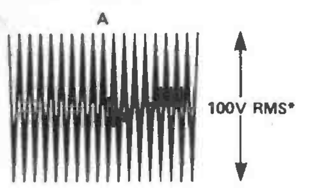


Fig. 1A

* (141.4V PEAK)

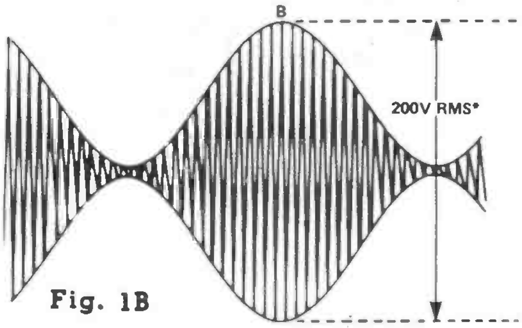


Fig. 1B

*(OR 282.8V PEAK AT PEAK OF AUDIO ONLY)

only on voice peaks. In the CW mode (quite apart from the UK licence regulations) it is recommended that the power be reduced to below 180W input, and on AM, slow scan (or FM suitably adapted) 80W input is about the limit. Due to a fall of efficiency at low power the maximum continuous carrier that the *FT101E* (or any similar modern 250W SSB rig) can provide without overheating is around 30W, so that in real terms this modern 250W rig can only deliver continuously one third of the power a '150W' rig of yesteryear could provide!

The figures in adverts

The object of advertising is to sell, and so with plenty of figures to choose from we can hardly blame the manufacturers for, in many cases, publicising the largest. (You may advertise your old car and state "brakes just re-aligned", but I doubt if you would add "clutch 8 years old and badly worn". It's against the law to deliberately falsify figures, but particularly as purchasers of amateur radio transmitters can be expected to be "duly qualified persons" there is no obligation on the manufacturer's part to explain them. Input power is a meaningless figure unless the efficiency of the power amplifier stage is known, and whilst good design will usually produce an efficiency of at least 50% there is no guarantee that this is so, if the output is not quoted. (The biggest and fasted cars usually consume the most petrol, but however deep your pocket I doubt if you would choose brand Y simply because it used more petrol than brand X). When reading any type of specification the old legal maxim "let the buyer beware" is good advice. And so with this in mind let us have a look at a few figures quoted by makers and retailers in advertisements in US and UK publications (no names but if the cap fits . . .!!!).

Solid state linear amplifier "200W PEP"

No qualification of the figures is given, hence we presume that this is SSB PEP DC input rating. It's solid state so efficiency is probably around 45-55%; hence we guess the PEP output power at 100W, but the amplifier would probably have to be run at much reduced power on AM of FM to avoid overheating.

Another unit labelled *"100W solid state linear amplifier"*. Further reading confirms that these people are talking about output power in all modes and that unit will deliver 100W continuously in the AM or FM mode, probably more than double the power in these modes of the above "200W" amplifier!

VHF multimode transceiver labelled "15-18W output". It's a pity they didn't say whether it is a continuous carrier RMS, or only PEP on SSB, but at least they have been honest enough not to claim the unit as a 30W transceiver. On this basis probably their other ratings are unambiguous and 15-18W represents the continuous power output on FM as well as the PEP output on SSB.

Multimode transciever labelled "15W". Reading the small print we find the statement "10W minimum output all modes" which with normal manufacturing tolerances is fair enough.

Multimode transceiver labelled "30 watts". No more information is given in the small print, but investigation confirms that the 30W referred to is the DC input power. The output power in all modes of this unit measures around 12-15W; just about the same as "15 watt" rig.

Linear amplifier, labelled 1200W. This turns out once again to be input power hence possible PEP output power could be expected to be around 600 or 700W. Just a little outside the UK licence limits, but long life and a clean signal could be expected if this unit was throttled back to the legal UK limits.

HF transceiver labelled "RF input power SSB 200W." All the transceivers I have come across have a power amplifier which takes in DC input power and puts out RF. This rig has a measured power output of around 100W and hence whilst it has claimed "RF input power" in its adverts for several years, I doubt very much if it would appreciate 200 watts of RF being squirted into any of the multitude of sockets. Perhaps no one wishes to upset the bloke at the embassy who did the transaction in his lunch hour as a favour, by changing it!

Power consumption 350W. No further comments, just a picture! Actually the RF power output measured at around 100W PEP and the maker's leaflet says 180W input power. What the advertiser is quoting is the total power consumption from the mains supply which includes such items as dial lamps, valve heaters, blower etc. You could triple the power rating of a typical transceiver by wiring in a bar from an electric fire using this principle!

Power isn't everything

I hope the above gives you some idea of the state of the art of confusion, but do remember that power is not everything. Doubling your power output will only make a half-an-S-point improvement at the receiver, and in most cases the extra cash will be much better spent on improving the antenna system, or even purchasing a better microphone.

To make valid comparisions between equipment it is, however, necessary to know the RF output power in all modes so as to ensure you are getting what you want and what you think you are paying for. It is quite possible to purchase a "200W linear" that will only run 30W output on the NBFM calling channel at 29.6MHz, or a "100W linear" that will give a full 100W out continuously — an extreme example maybe, but *it does pay to ask questions and read the small print before parting with your money.* ●

Technicalities

A spectrum analyser for five pounds!
By Frank Ogden G4JST, Editor

Regular readers of this column might get the impression that we have permanent access to thousands of pounds worth of test gear. Well, that is certainly true when it comes to the testing of review equipment although all my design work is carried out with much more modest facilities.

I am a very firm believer in the philosophy that if your hobby costs you a sizeable proportion of your income, then it is not a hobby worth having. In short, I do things on the cheap and I'm proud of it. Half decent RF test equipment comes with a prohibitive price tag. A synthesised signal generator weighs in at around £2000, a 100MHz scope around £1000, frequency counters £250 and a spectrum analyser breaks the bank at £8000+.

One might think that £12000 is the minimum investment needed to produce a synthesised transceiver design. Not true. I've produced *fully working* transverter systems, three synthesisers, several crystallised VHF boxes, numerous PAs of all kinds, any number of receivers with: one ex-WD AVO signal generator (£35 from GWM in Worthing) one D52 double beam scope (£50 from GWM) one Pullen 10kΩ/V multimeter (donated by a kindly uncle) and not much else. I do not say this to brag, but to make the point that you don't need to spend a fortune on test equipment. However I must state that my meagre core of test gear has been used to build a range of add-on bits and pieces to make it tell me infinitely more than it otherwise would. In a word, it's not what you have, it's the way thaf you use it. Expensive equipment offers absolute accuracy and convenience (hopefully) but these two extra assets can only be realised if the gear is used correctly and the results interpreted sensibly.

Absorption wavemeter

When amateurs lapse into reverie about test gear, the piece they tend to dream about most often is a spectrum analyser. I propose to show how an oscilloscope and signal generator can be persuaded to perform most of the functions of this extortionately priced piece of tackle.

A box that can resolve both the amplitude and frequency content of an RF signal is invaluable, especially when looking for parasitic oscillations on a transistor PA stage or lining up a transverter. In both these cases there are a number of signals present. Some will be harmonically related to a fundamental tone, others will represent mixing products, unwanted oscillations, etc. It is easy to find harmonic problems of a known fundamental because you know where to look. Things which are unrelated pose much more of a problem, especially if they come and go with some tuning adjustment further down the line.

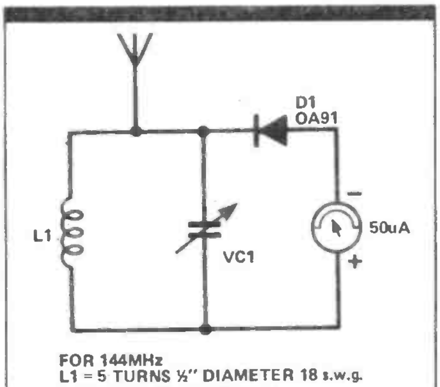


Fig. 1 Simple absorption wavemeter

The simple absorption wavemeter, beloved of the Home Office licence regulations and the City and Guilds examiners can tell quite a lot about a circuit provided that it is used with caution. **Fig. 1** represents a typical example. Provided that the coupling into the instrument is kept fairly light, then it will reliably sort out unwanted harmonic products from the fundamental but that is about all. For instance, if a parasitic product falls within about 10 per cent of an expected harmonic, then you don't stand any chance of detecting it with such a simple instrument. The calibration accuracy won't be much better, especially if the coupling detunes the tank circuit. The instrument's resolution can be improved substantially by tapping the diode detector and the input coupling right down towards the cold end of the coil. It is possible to achieve around 5 per cent resolution although the sensitivity does suffer.

Absorption spectrum analyser

The rather unpromising idea behind the absorption wavemeter ie. checking a sample RF signal for

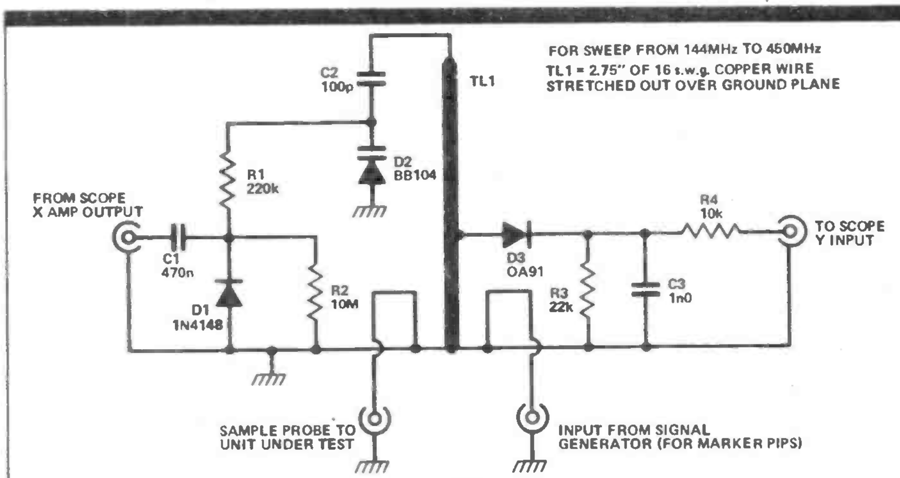


Fig. 2 This circuit turns your oscilloscope into an absorption spectrum analyser

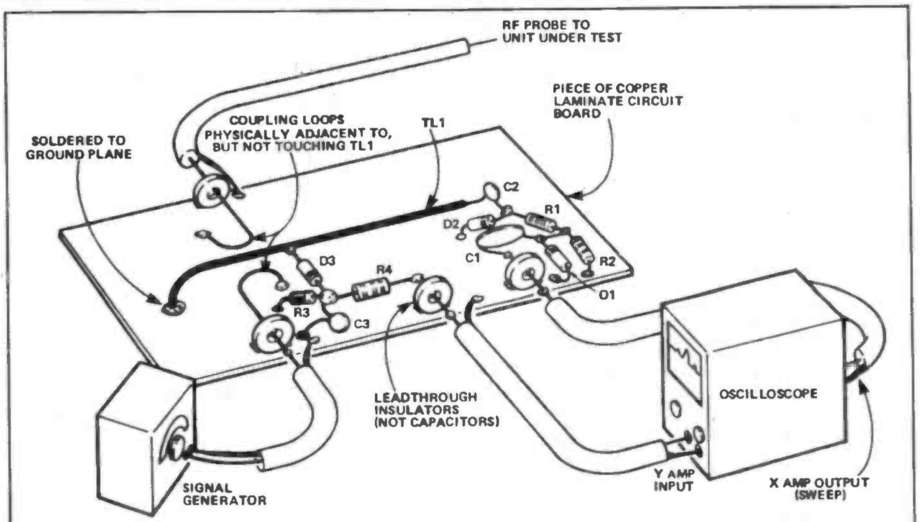


Fig. 3 The physical layout shown actual size. A line of this length enables a frequency sweep from around 140 to 450MHz. Precise lengths are not important because the signal generator accurately calibrates the response of the unit

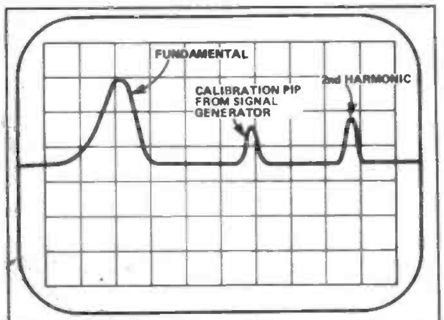


Fig. 4 Typical oscilloscope trace derived from absorption spectrum analyser

resonance in an external tuned circuit can be turned completely on its head to very good effect. If the coil of the wavemeter is replaced by a high Q stripline, and the variable capacitor by a varicap diode (a device that exhibits a capacitance inversely proportion to an applied DC voltage) then you have all the makings of a spectrum analyser. If you replace the classic meter movement by the input to an oscilloscope and drive the varicap from the timebase sweep voltage, then the stripline circuit will tune in step with the sweep voltage at any given moment; as the spot progresses from left to right, the trace will be deflected by incident RF signals as the stripline tuning passes through them. The result is the typical spectrum analyser display.

Fig. 2 shows the circuit of an absorption spectrum analyser suitable for looking at the rubbish from two metre boxes. The dimensions, tuning arrangements and component values can be scaled for any other frequency. There is no reason why the basic circuit cannot be adapted for anything between HF to SHF. C1, D1 and R2 ensure that the sweep voltage takes the varicap diode over the full tuning range without going into conduction. Note that the sweep voltage should be around 30V peak-to-peak: any more and it will have to be attenuated with a resistive divider and any less will demand external amplification. As shown, the circuit responds to a 3:1 frequency range. It is interesting to observe that the drive voltage need not be a linear ramp. Almost anything, including a mains derived sine wave will do provided that it has the necessary amplitude, that it is applied to both the unit and the scope X input, and that it should be slow enough so that the LF circuits can have sufficient time to respond.

Limitations

Fig. 3 shows the component layout, actual size, and the interconnections with the external test instruments. **Fig. 4** is a redrawing of a typical display. (Sorry, I don't have a scope camera.) Note the role of the signal generator. By injecting the generator signal onto the line along with the sample, a realtime calibration of the complete system can be arranged. The generator inserts a pip which can be moved up and down the trace to calibrate received signals. When the generator and incident signals precisely coincide, the combined pip develops a beat ripple. The frequency is simply recorded from the signal generator and the trace blip thus identified.

The complete system is as useful as it is simple although there are some limitations. But considering that you would receive £7995 change out of the price of a proper spectrum analyser, the drawbacks can be lived with. In essence they are lack of linearity in the frequency sweep, and lack of logarithmic response on the display. You also have to watch that incident RF signals don't overload the unit which then cause the whole trace to 'tilt'.

The first problem, non-linearity of frequency sweep, is largely offset by direct calibration using the sig gen. For absolute accuracy, the generator can run in tandem with a frequency counter. The amplitude response is a difficult one to get over. As the circuit stands the display range is around 30dB in the traditional sense. Turning up the Y amp gain on the scope doesn't really help because all diodes have varying degrees of band gap voltages which the input RF has to exceed before any response occurs. The basic circuit will usefully display signals down to the 50mV level. If the signal generator has an accurate attenuator, it can be used for amplitude calibration as well but a relative response is generally all that is needed.

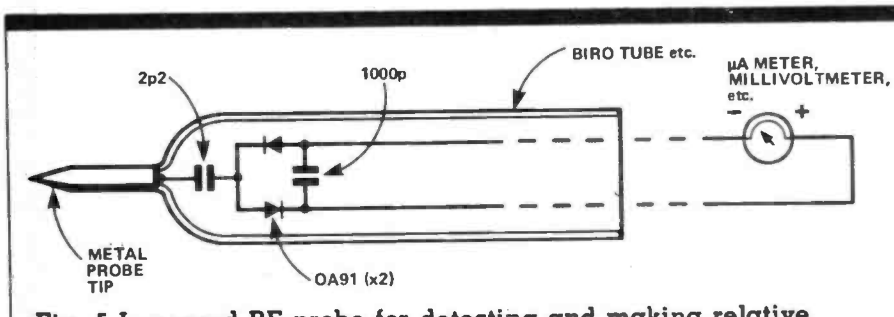


Fig. 5 Improved RF probe for detecting and making relative measurements of signal levels in conjunction with a millivoltmeter or DC multimeter

Uses

The device performs best when you want to know more about frequency content and relative amplitudes rather than as a precision measuring instrument. An excellent application is tuning up a frequency multiplier strip. I have personally found the unit the best tool yet devised for tuning up Pye Pocketphones, in fact for dealing with any set of unknown quantity (or quality!). Transverters are another worthy application. Its ability to track down spurious oscillations is formidable and has already been dealt with.

By way of a technical aside **Fig. 5** offers a circuit of an RF probe for use with a DC multimeter. It effectively detects fairly low level RF signals and measures higher level ones with good accuracy. Of all the probe circuits that I have tried, I have found that this one offers the least detuning. Be careful not to exceed the reverse breakdown voltage of whatever diodes are in use. Germanium types seem to work OK up to around 20V of RF.

"...using the XYL's rig here..."

Radio Maths Made Simple

Basic Maths for RAE Students by Bill Sparks G8FBX

Part 1: decimals and indices

Most students taking the RAE course have had little reason for studying maths since their school days and in most cases have forgotten even their school maths. Accordingly they came up against the immediate problem of sorting out the elementary maths needed at the start of the course. These notes are an attempt to clear the air by providing a simple explanation of the maths necessary for the course. Initially the most important factor is an understanding of the decimal system.

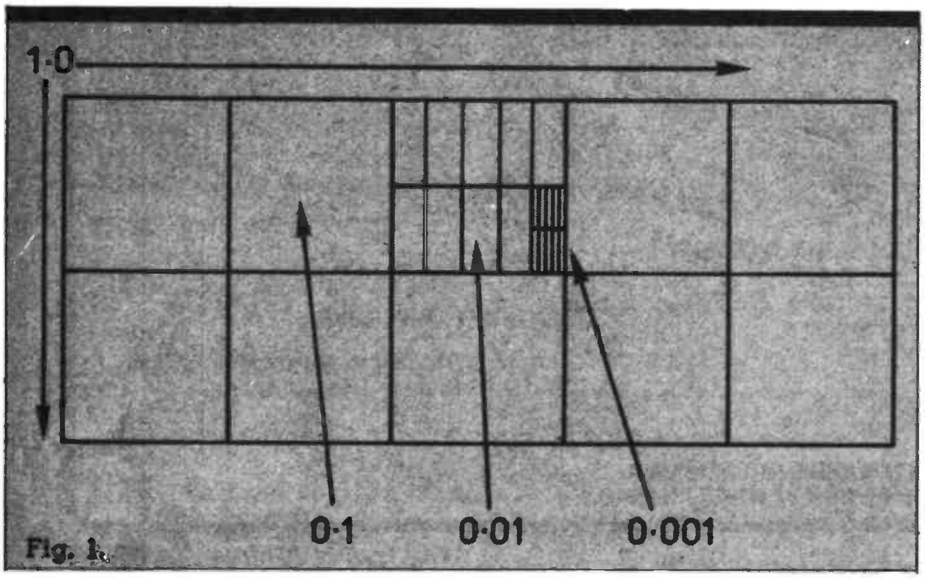


Fig. 1.

The decimal point of it all

Consider the rectangle shown in **Fig. 1.** The main rectangle is shown as having a unit area of 1.0 and is made up of ten equal small rectangles. (shown as 0.1). Therefore each small rectangle is $^1/_{10}$ th of the large one. We show this $^1/_{10}$ th as .1 , where the point is called a decimal point and the Latin *deci* means $^1/_{10}$ so by putting the point in front of the 1 we are indicating that we have divided the 1 by 10. To make certain of the position of the point and also to show that the value indicated is less than 1, we normally write the fraction as 0.1. This means that the value shown is less than 1.0 but greater than '0'.

Referring back to the rectangle, we can further divide by another factor of 10. So that we are now dividing by 10 × 10 or 100 which is generally shown as:

$$\frac{1}{100}$$

The method of indicating this by decimal notation is to put another 0 in front of the 1 but behind the decimal point:

$$\frac{1}{100} = .01$$

Further reference to the rectangle shows that the .01 rectangle can be divided by 10 and thus we are now dividing by 10 × 10 × 10 or:

$$\frac{1}{1000}$$

The decimal notation for this value is .001. At this point a rather significant fact is displayed.

$\frac{1}{10}$ = 0.1 = (no '0' in front of 1)

$\frac{1}{100}$ = 0.01 = (one '0' in front of 1)

$\frac{1}{1000}$ = 0.001 = (two '0's in front of 1)

The number of '0's in front of the 1 but after the decimal point is always one less than the '0's in the fraction thus:

$\frac{1}{1000}$ has three 0's in the fraction but only two in the decimal. The thing to remember is that the decimal point in itself always counts as a '0'. The number of '0's in the fraction below the line is called the denominator. The number above the line is called the numerator.

$$
\begin{aligned}
& 3 \times 1{,}000 \times 17 \times 10{,}000 \\
&= 3 \times 10^3 \times 17 \times 10^4 \\
&= 3 \times 17 \times 10^3 \times 10^4 \\
&= 3 \times 17 \times 10^7 \\
&= 51 \times 10^7 \\
&= 510{,}000{,}000
\end{aligned}
$$

Indices

Here is a series of numbers offered as a typical example:

$$0.0001 = \frac{1}{10000} = 10^{-4} \times 1$$

$$0.001 = \frac{1}{1000} = 10^{-3} \times 1$$

$$0.01 = \frac{1}{100} = 10^{-2} \times 1$$

$$0.1 = \frac{1}{10} = 10^{-1} \times 1$$

and

$$
\begin{aligned}
1.0 &= 1.0 && = 10^0 \times 1 \\
10 &= 10 && = 10^1 \times 1 \\
100 &= 10 \times 10 && = 10^2 \times 1 \\
1000 &= 10 \times 10 \times 10 && = 10^3 \times 1 \\
10{,}000 &= 10 \times 10 \times 10 \times 10 && = 10^4 \times 1 \\
100{,}000 &= 10 \times 10 \times 10 \times 10 \times 10 && = 10^5 \times 1 \\
1{,}000{,}000 &= 10 \times 10 \times 10 \times 10 \times 10 \times 10 && = 10^6 \times 1
\end{aligned}
$$

You may notice that the number of '0's following the 1. in the left-hand column series of numbers is the same as those in the centre column, that is it indicates the number of tens in the answer. Typically, $10 \times 10 \times 10 \times 10 = 10{,}000$, ie four 0's after the 1. By showing this as 10^4, all we are meaning is that this number (10^4) is 10 multiplied by itself four times, and is a simple shorthand way of writing large numbers. As can be seen above it is much easier to write 10^6 than 1,000,000 and also takes up less space. It also helps accuracy since you can easily miss a '0' when counting such large numbers but the little number at the top of the 10 (this little number is called in index and two or more are called indices) always tells you how many 0's there should be.

In order to understand fully the system, here is another look at the sequence in more detail. We have shown $10 \times 10 \times 10$ as 10^3 and 10×10 as 10^2 so we can say there are three 0s in the first sum which is 1,000 and two in the second which is 100. Logically therefore 10 on its own has only one '0' so we can show it as 10^1, and since 1 has no '0's we can show it as 10^0.

An interesting feature now arises. If $100 = 10^2$ and $1{,}000 = 10^3$ $100 \times 1000 = 100{,}000 = 10^5$ but $10^2 \times 10^3$ does not equal 10^6 but 10^5. Do *not* multiply the indices, add them. A further example would be:

$$1{,}000 \times 10{,}000 = 10{,}000{,}000 = 10^7 \times 1$$

$$10^3 \times 10^4 = 10^{3+4} = 10^7 \times 1$$

This technique enables the handling of very large numbers with a fairly simple operation and since it can deal with numbers as small as one millionth of a millionth of a millionth and as large as 1,000,000,000,000, the importance of this technique cannot be over-emphasised.

Take for example a multiplication of $3{,}000 \times 170{,}000$, we would rewrite this as:

$$
\begin{aligned}
& 3 \times 1{,}000 \times 17 \times 10{,}000 \\
&= 3 \times 10^3 \times 17 \times 10^4 \\
&= 3 \times 17 \times 10^3 \times 10^4 \\
&= 3 \times 17 \times 10^7 \\
&= 51 \times 10^7 \\
&= 510{,}000{,}000
\end{aligned}
$$

(Note 7 0's).

Here is an example combining knowledge of decimals with knowledge of indices:

$$
\begin{aligned}
& 3{,}140 \times 175{,}600 \\
&= 3.14 \times 1000 \times 1.756 \times 100{,}000 \\
&= 3.14 \times 10^3 \times 1.756 \times 10^5 \\
&= 3.14 \times 1.756 \times 10^8 \\
&= 5.51384 \times 10^8 = 551{,}384{,}000
\end{aligned}
$$

or 5 with 8 '0's

or $5 \times 100{,}000{,}000$ plus a bit

= 500,000,000 plus a bit.

Obviously such calculations are normally done on a calculator but the above shows how to get the actual value of the answer. The calculator only gives a string of numbers with no indication of whether it is in thousands or millions, because it does not often show the position of the decimal point.

The whole technique is about manipulating numbers, and using the numbers just like a mechanic uses his tools. We are arranging the numbers to do things for us.

Since $1 = 10^0$ and $10 = 10^1$ then any number between 1 and 10 must have a value of index between 0 and 1. For example if $10^0 = 1$ and $10^1 = 10$ then 5 must have a value between 10^0 and $10^{1.0}$ (between 0 and 1). The actual value is .698; and $100^{.698} = 5$. (0.698 is a value between 0 and 1.) The actual index for any number between 1 and 10 is not a direct relationship but is a relationship which alters in a special form. This relationship is called a logarithmic relationship. The actual index value is called the logarithm of the number and actual logarithms for numbers of 1-10 are shown below:

1 = 0.000
2 = 0.301
3 = 0.477
4 = 0.602
5 = 0.698
6 = 0.778
7 = 0.845
8 = 0.903
9 = 0.954
10 = 1.000

Referring back to these original notes we use the indices in multiplication exactly as described previously. $2 \times 2 = 4$ or $100^{.301} \times 100^{.301} = 100^{.602}$ and $2 \times 2 \times 2 = 8$ or $10^{.301} \times 10^{.301} \times 10^{.301} = 100^{.903}$

Next month: square roots, logarithms and decibels.

QRX I'll just tune for a lower SWR!

by Tony Bailey G3WPO

SWR — this little abbreviation seems to have developed into a cult over the years, worshipped almost as a God! Achieving a low SWR of 1:1 is given a priority almost equal to that of breathing, on the assumption that as the reflectometer shows the reflected signal must be increasing by the amount of power shown on the reflected power scale. This is unfortunately (or fortunately, depending on how you look at it,) a load of rubbish.

As we will show — there is no reason why you cannot radiate just as good a signal with an indicated SWR ratio on your feeder of 2 or 3:1 as at 1:1!

Without delving into complex equations, or using Smith charts, there are a number of other common misconceptions that can be dispelled, and SWR can be put into the context into which it truly belongs. We will have to assume that you know some of the basics behind the term, otherwise the article could take up the whole of this issue.

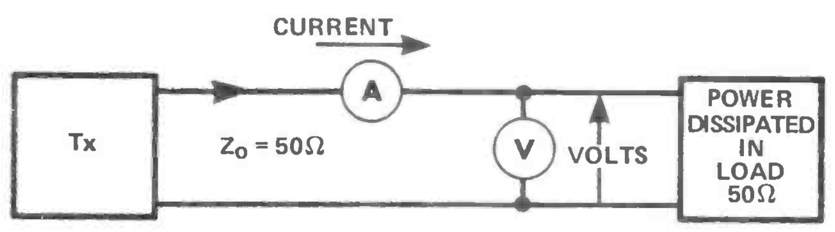


Fig. 1 Perfect matching: Power in load = VxI

A point to start from

Let us assume that we have a transmitter connected via a piece of coaxial cable with a characteristic impedance of 50 ohms, and that a dummy load of resistance 50 ohms is connected across the far, or load, end. Also assume that the cable is lossless (ie. it doesn't have any resistance or introduce dielectric losses), and that there is a perfect lossless reflectometer/power meter inserted in the line. When you apply power to this set-up, and adjust the transmitter for maximum power transfer (as shown by the power meter,) current will flow along the feedline and end up being dissipated as heat in the load resistor.

It is important to realise that it is *current* that is flowing along the line, not power. The definition of power is the 'rate of expenditure of energy'. In our case energy can only be used up when the current meets some resistance — in this example the only resistance is that of the load resistor. Hence in our perfect transmission line, no energy is wasted and all the energy generated by the transmitter ends up as heat in the load.

If we assume that our power output is 100 watts, and we now replace the 50 ohm resistor with another, such that the SWR will be 3:1, what happens if we don't (or can't) adjust the transmitter? If you look at the reflectometer under these conditions, it will be indicating an SWR of 3:1. From the standard formula you can calculate that this represents an apparent reflected power of 25%, or if the meter is calibrated to 100 watts full scale deflection, it will be saying there are 25 watts of power being reflected. The question is, what has happened to this 25 watts? The common answer is that it is being absorbed by the transmitter (and that this is likely to cause damage). It isn't — what has happened is that the transmitter, because we didn't readjust it, isn't properly tuned to deliver full

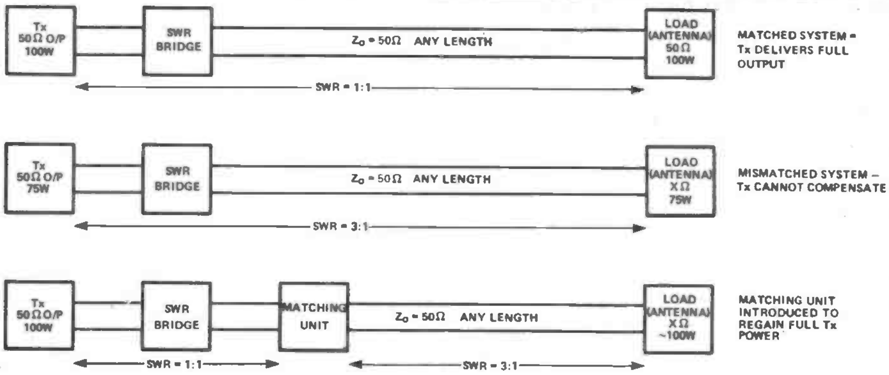


Fig. 2 Transmitter can only give full power with a suitable load

power into what is now an impedance mismatch, and so its power output reduces.

The best way of looking at it is to say that the reflected power meter is telling you by how much the TX power output has reduced ie. it has dropped by 25 watts, so that we now have 75 watts of output into the mismatch rather than 100 watts.

If you also had an RF ammeter in the line after the reflectometer you would see that its current reading had dropped, which verified the drop in power going to the load. Of course you would get a different absolute reading depending on where in the feeder the ammeter was, but we are only interested in the relative current.

So subtract the reflected power from the forward power in watts and you will have the actual power being passed on to the load.

Getting power back

If your TX is equipped with an adjustable output network (ie. tuning and loading controls) such as many valved rigs have, you will almost certainly be able to adjust these controls to compensate for the mismatch, and regain your full power output of 100 watts. In effect, what you are doing is adjusting the TX output circuit so that its impedance equals that which exists at the line, and it can therefore deliver maximum power output again.

Most rigs specifiy the maximum SWR that can be handled, and this is an indication of how far you can compensate — if the SWR you have got at the end of the feeder is outside this range it will be necessary to take additional steps as we will see.

Semiconductor PAs

Those of you with solid state PAs aren't going to be so lucky. Due to the current driven nature of semiconductors, rather than voltage (as in valves) they can only deliver their maximum power when they are seeing the impedance for which they were designed, or something very close to it. This is normally 50 ohms, and in the majority of cases you probably haven't got any controls to adjust anyway. So if you try working into our theoretical 3:1 SWR system, the PA cannot be returned to compensate for the impedance mismatch, with the result that it will draw excess current, overheat and lead to an expensive repair bill. If it is working into a reactive mismatch such as there might be with an aerial connected, things can be worse although that doesn't concern us here.

To overcome this sort of damage, the great majority of solid state PAs have some form of SWR protection circuit built in these days. When an SWR of possibly 2:1 or more is detected by an inbuilt bridge, the drive to the PA is reduce to protect it. This is in addition to the reduction in power that the mismatch will produce itself. Obviously some form of matching network, external to the system, will have to be introduced.

Adding an aerial

Moving on a bit, if we now replace our resistive load at the end of the cable with a real aerial, you will know that if the aerial has the same impedance at its feedpoint as that of the feeder cable, then you will feel extremely happy, because the meter will be indicating an SWR of around 1:1. The aerial can of course present a much higher impedance and still be resonant, either by design, or depending on where you are feeding it etc., so lets assume that the resulting impedance is such that the SWR is 3:1.

At this point, note that just because there *is* an SWR present, it doesn't mean that the antenna is losing the power being sent to it. What the SWR is telling you is that there is a mismatch present between the source (TX) and the load, however it has arisen.

We have already said that you should not rely on everything a reflectometer tells you. Let's say that your SWR meter normally reads 1;8:1, and despite all your valiant efforts it won't go any lower on a particular aerial. If some friendly person came along in the night and soldered a 50 ohm resistor across the feeder in place of the aerial, you would have a nice 1:1 SWR reading the next morning! A bit extreme, but if your cable had deteriorated, and small resistances had developed in all the joints etc, it is perfectly possible for the system to start looking like a resistance of near 50 ohms. A low SWR can sometimes be very bad news.

So, at this point, although the theory is outside the scope of this article, try to bear in mind that an SWR of 1:1 does not necessarily mean that the antenna is resonant, or that it will radiate more power, or that the system is efficient. Many aerials, depending on the design, will radiate just as much power with an SWR of 20:1 on the feeder as 1:1. Basically, an aerial will radiate all the current that gets applied to its feedpoint, even when the feeder is mismatched at the antenna feed point, and even with the antenna off resonance.

Going back to our newly generated mismatch with an antenna connected, if we have a PA with tuning and loading controls we will probably be able to compensate for the mismatch by twiddling with the controls, and end up delivering 100 watts again.

The ATU?

If we have a semiconductor PA or if the adjustable TX won't load up properly then we have a problem. As you are no doubt aware, this is wher an 'ATU' comes in. Firstly, the ATU doesn't do what it says — it does not tune the aerial (at least not when there is a coaxial feeder involved)! It would more correctly be termed an Aerial Matching Unit or AMU, as what it does is to introduce some more variables into the system and allow the impedance seen by its output (which is currently a mismatch to the TX) to be transformed into the correct impedance at is input terminals for the TX, again usually 50 ohms to suit the cable which will be connecting the two together.

Another point arises here and that is the correct way of using the matching unit. Normally you firstly tune up the TX into a (50 ohm) dummy load, both to get it tuned for its optimum output, and secondly to avoid poluting the airwaves with carrier. Having done that you then adjust the matching unit, with a reflectometer inserted between the TX and matching unit, for an indicated SWR of close to 1:1, thus showing that the TX is now seeing 50 ohms again.

If you have a filter in the line for harmonic rejection, you shouldn't then readjust the TX controls, as you may destroy the 50 ohm impedance you have just created. Otherwise if you move frequency a little you can either readjust the AMU, or the TX, providing the latter still allows you to achieve a proper transfer of power. Of course there will be a small power loss in the matching unit through losses in the inductors and capacitors, but in a decent unit these are small enough to forget about.

So far we have used the SWR reading to tell us about, and compensate for, mismatches between the TX and the feeder, so that the transmitter can deliver its maximum power into the load.

The 'aerial tuning' syndrome

It is at this point that the biggest stumbling block arises when using a matching unit. So many times you will hear stations announce that they have just tuned the antenna for a 1:1 SWR with the ATU, when they have in fact done nothing of the sort. What they have done is simply to adjust the matching unit so that the transmitter can see its correct load impedance — the SWR on the feeder from the output of the matching unit is still whatever it was in the first place!

Earlier on, we started with the assumption that we had a perfect lossless feeder system, which of course we don't have in practice. Now, the only way we can lose power is by dissipating some of the current in resistance in one form or another. We have already shown that it is possible by one means or another to get the full TX power into the feeder cable, but what happens along this cable which still has an SWR on it — does this mean we are losing lots of power?

Once there is a mismatch, we introduce standing waves along the cable, where the ratios of current and voltage vary at any point along the line, but repeating at half-wavelength intervals (electrical half-wavelengths). In fact, the average current and voltage is higher overall on a mismatched line than a matched one. The power meter will tell you this by reading a higher forward power on a mismatched line than it did for the same line when matched.

There isn't actually a higher forward power as such — what *is* happening is that the 'reflected power' shown on your SWR meter is again reflected by the AMU back towards the load but is now in phase with the forward current, and adds to the forward power reading — it's known as *conjugate matching* and is really what this article is all about, were we to be discussing mathematics. The result is that the higher voltage introduces some loss of power by dielectric heating, and the extra current a bit more by resistive losses in the conductor.

How much loss?

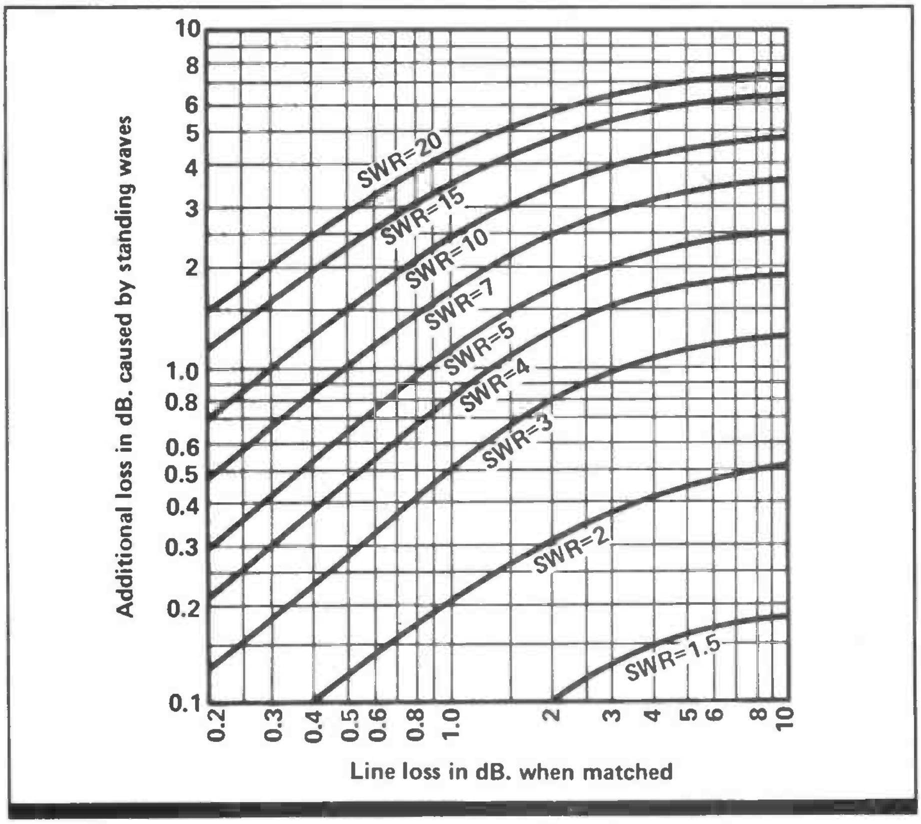
Contrary to popular belief, these losses are *small* in the normal system, and do not contribute much loss to the signal that is reaching the antenna. At HF, say 7MHz, a 100 metre length of typical 50 ohm coaxial cable will have an additional loss over that which will be there anyway when it is perfectly matched, of only 0.27dB at an SWR of 3:1! This is a 6.4% power loss, insignificant if you look at it in S-meter terms where one S point requires a 6dB increase in power.

As long as the transmitter is delivering its rated power into its correct load impedance, by whatever means, then all but that lost in the matching unit, and the fraction of dB in the feeder will get radiated by the aerial into space. If you insert an SWR bridge into the feeder, it will correctly tell you that we have a 3:1 SWR, and also that this represents 25% power loss — however this latter fact is irrelevant as a bald statement of fact. We know that the SWR is 1:1 at the *input* to the matching unit, because we already adjusted it to be so.

Therefore, if you believe the 'reflected power' reading, then 25 watts most be being absorbed by the matching unit, as it can't be going anywhere else — if it is being absorbed then it will be converted into heat so that the matching unit will get rather hot. Which of course it doesn't.

You should be able to deduce from all this that if you have a PA which is adjustable, or a suitable matching unit, then once you have compensated for the mismatch, and managed to get all your power going into the feeder, there is little point in trying to do anything about the SWR on the feeder itself. It will have next to no effect. Of course, with very long coaxial feeder runs, and at VHF/UHF, the mismatch loss in the feeder becomes much more important as it may be high enough to affect the signal. What we have been trying to say is that there is little point trying to achieve a low SWR for its own sake. Other factors may modify this decision but at HF it is probably a wasted effort.

With something like an 80 metre dipole, there is consequently no point at all in considering where in the band to adjust it for resonance as indicated by a 1:1 SWR. Providing you can compensate for the mismatch at the TX end, you should be radiating the same signal at 3.5 as at 3.8MHz, despite high SWR at one end and low at the other.



Finale

As a final note, if your transmitter loads happily into the feeder, you might be better off not being influenced by an SWR meter in the first place. It may even be telling you lies! Unless you are using a good quality instrument that is designed for exactly the same impedance cable as you are using it in, then you are unlikely to be getting an accurate reading anyway, although it may be correctly indicating that the ratio is low.

Most of the cheaper instruments on the market give varying readings depending on the frequency and the power level in use. They may even change reading as you watch them and give you the impression that your power is falling off. The writer has a selection of bridges — few of them agree on the ratio obtained.

The Resistance SWR Bridge

By Tony Bailey G3WPO

For most pieces of equipment in our hobby, there are many designs. In the case of the well know SWR bridge some are fairly simple, others are complicated. The degree of accuracy depends on the design, and the amount of effort put into the construction and calibration.

The principle behind this type of bridge is simple. A suitable sampling device is used to obtain a small voltage from the line under test, which is then rectified by diodes. By comparing the voltages obtained from the forward and reflected currents in the line, a meter can indicate the Standing Wave Ratio on the line.

The three most popular circuits are the trough type, where a pair of short sampling lines are placed adjacent to a central conductor carrying the RF current, and the voltage induced in each line is used to provide the reference for the measurements; the 'Monimatch' which uses a similar principle, but uses a sampling line threaded down through a piece of coax cable between the outer and inner conductors; and the current transformer type where a toroidal transformer samples the current flowing through the line — the primary of the transformer being a single stretch of wire carrying the RF current and passing through the toroid, with the secondary wound round the toroid itself.

The first two types suffer from frequency consciousness, as the electrical length of the sampling line varies with frequency, hence the readings and sensitivity also vary. Some care in contruction is needed for reliable results. The transformer type is more accurate, but is much more elaborate and complicated to build. It does have the advantage of being frequency independent though.

A simpler bridge

There is a simpler type of SWR bridge which seems to have been given little attention in recent years, but which is ideally suited to the beginner, and is easy to build. It does have the disadvantage of only being suitable for low power, and cannot be left in circuit once the tuning operation is finished. However, it has a minimal parts count, and with a little care in construction gives accurate results. It is ideally suited to QRP work, and could form the basis of a combined QRP antenna matching unit and SWR bridge.

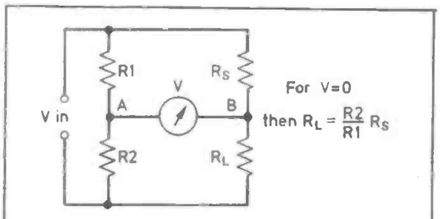


Fig. 1 Theoretical resistance bridge

The resistance bridge

Fig. 1 shows a simple resistance bridge which basically consists of two voltage dividers in parallel placed across a voltage source. Whenever the voltage drop across R1 equals that across R2, then the drops across the other two resistors are also equal. The two junction points of the divider chains are therefore at equal potentials and the meter reads zero, giving a balanced bridge.

If the voltage drops across R1 and 2 are not equal, then the two junction points are at different potentials, the bridge becomes unbalanced, and the meter will read the difference potential.

SWR bridge

If we now make R1 and R2 of equal value, then a balanced condition will exist whenever the other two resistors are equal in value. If R_s is made equal to the characteristic impedance of our transmission line (say 50 ohms), and R_L is replaced by a feeder, then the bridge will be balanced whenever the load impedance is equal to 50 ohms. (See **Fig. 2.**)

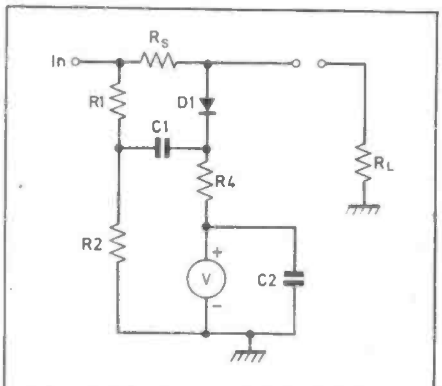


Fig. 2 Theoretical SWR bridge

If the bridge becomes unbalanced then as RF current travelling towards the load only 'sees' the impedance of the line until it reaches the load, the bridge is still balanced for forward current, as it has to pass through R_s en route. The power reflected from the load doesn't see the bridge circuit and hence this registers on the voltmeter.

If we measure the forward voltage at point A (which is equal to half the applied voltage), and compare this with the measured reflected voltage, we can calculate the SWR from the usual formula:

$$SWR = \frac{V_f + V_r}{V_f - V_r}$$

Points to note

To prevent inaccuracies, the voltmeter must have a high resistance, otherwise the current taken by it will be large compared with the current flowing through the arms of the bridge. Alternatively, a high value resistor can be placed in series with the voltmeter, which will also suit the germanium diode rectifier we shall use for converting the RF to DC voltage.

If you wish to measure accurately the actual SWR value, it is also necessary to be able to measure the input forward and reflected voltages separately. When we measure the forward voltage the load has to be disconnected at R1 (either by shorting it out or disconnecting it). When R1 is reconnected (in the shape of our feeder), the load on the voltage source will be different, and could affect the applied voltage leading to errors in the readings.

However, in line with keeping things simple, you can almost certainly get away with just using the reflected voltage meter — this will enable you to tune for a null in the reading, informing you that the SWR is now at a low figure, which is more than adequate.

Hence our practical circuit dispenses with the input rectifier and meter and uses a bit of switching to enable calibration. One advantage of the circuit is that due to the presence of the series resistor, the transmitter sees a relatively constant impedance during tuning up operations which may be of benefit with semiconductor PAs.

Practicalities

The circuit of the practical meter is shown in **Fig. 3.** As shown, it will be suitable for a *maximum* applied RF output of 5 watts or so, providing the resistors are of the specified power rating — they *must not* be wirewound types which have too much inductance. The diode must be germanium — an 0A90/91 (not gold bonded) is suitable. The meter can be any 1mA type — it should be possible to achieve full scale deflection with around 50mW of RF power in this circuit.

Construction is not particularly critical except for one point. The bridge arms should be positioned so that coupling between them is minimised. Also avoid coupling between the rectifier diode and the remainder of the circuit. The two 47 ohm resistors should be equal in value (although not necessarily exactly 47 ohms — one can be carefully filed if necessary to bring its value up to that of the other) and have equal lead lengths, both as short as possible. Also, keep all other leads as short as possible to minimise inductance, which would spoil the bridge performance at high frequencies.

The coaxial cable which bypasses the unit should be grounded at both ends. A practical layout is shown in **Fig. 4** — this can either be wired using the S0239 sockets and a few tagstrips as supports, or the bridge could be built on a printed circuit board.

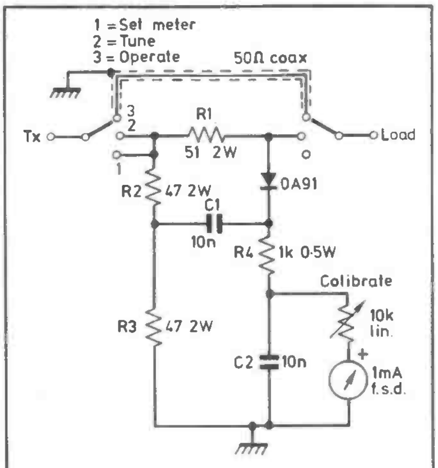


Fig. 3 Practical bridge layout

Using the meter

To check out the finished meter, place the switch in the SET position (which removes any load from the bridge output) and apply a maximum of 5 watts to the input socket (or use the TX at lower power). Now adjust the potentiometer for full scale deflection on the meter. Connecting a suitable dummy load to the output terminals should now give a reading of zero at all frequencies from 1.8 — 30MHz. If the reading increases as the frequency increases, there is some unbalance in the bridge, probably caused by the stray capacitance or inductance in one arm of the bridge not being exactly equal to that of the other. Slight movement of components may cure this. If the meter shows a constant reading ie. it cannot be nulled, then the load resistor is not equal to that of the series resistor (R3).

To use the bridge with a matching unit inserted in the line after the unit, load up the transmitter as before in the SET position, and adjust the pot for FSD on the meter. If the TX is fixed tuned, simply adjust for FSD. Place S1 in the TUNE position with the feeder or antenna connected, and adjust the matching unit for a minimum reading on the meter showing that the SWR is now at a low value, and then switch to the OPERATE position to bypass the unit.

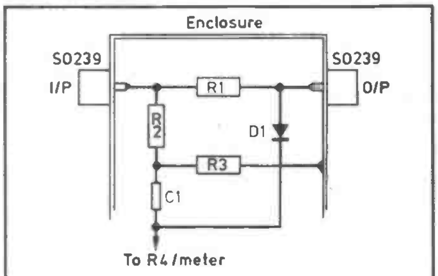


Fig. 4 Bridge layout

"He claims it's something to do with contest operating."

NEW PRODUCTS

FT290R preamp

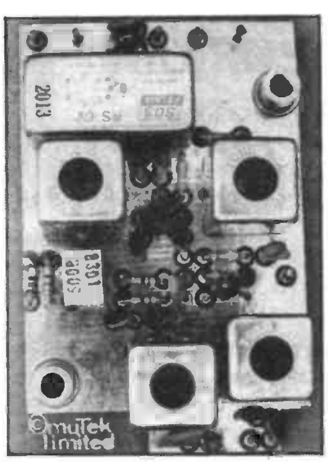
Mutek Ltd. is introducing a new 2m preamp specifically for the Yaesu *FT290R* transceiver. The *SLNA 145sb Transceiver Optimised Preamplifier* is intended to cure the *FT290R's* alleged deafness, and it has been designed to fit inside the transceiver.

Mutek claims it provides a sensitivity improvement sufficient to ensure that external noise is the limiting factor, while minimising dynamic noise degradation.

Other benefits claimed for the preamp are improved front-end selectivity, and an on-board nitrogen-filled changeover relay (to eliminate the losses in Yaesu's diode switching).

The provisional specification is: noise figure 1dB; gain variable 0-15dB; input third order intercept +2dBm; input 1dB compression point -14dBm; 1dB bandwidth 4MHz; 20dB bandwidth 12MHz; relay power handling 40W (VSWR less than 2:1); size approx. 53×35×15mm.

The *SLNA 145sb* retails at £24.90 inc VAT. For further details contact Stephen Prior or Chris Bertram at Mutek Ltd., Bradworthy, Holsworthy, Devon EX22 7TU Tel 0409 24548



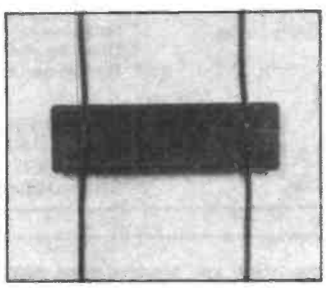
Feeder spacer

If you have found making open wire balanced feeders rather time consuming this product should be of interest. The *G4OGP Spacer* is simply a bit of plastic that can be clipped on to a pair of wires to hold them 63mm (2½") apart.

The spacers are made out of ultra-violet stabilised co-polymer polypropylene, which means they shouldn't decay when exposed to the weather.

The characteristic impedance of feeders made with these spacers is normally in the 300-600 ohm range, depending on the guage and insulation of the wires used.

The recommended retail price is £10 for a pack of 20 spacers. They are also available by post from the manufacturer at a cost of £10.99 inc. postage and packing. Orders/enquiries to G4OGP Electronics, 116 Darlington Street East, Wigan, Lancs. Tel 0695 27948.



10MHz traps

KW-30 aerial traps allow trapped dipole coverage of the 10.1-10.15MHz amateur band. The manufacturer says that a high Q-factor is obtained by "optimum form factor on polystyrene".

The coil is designed to handle 2kW PEP and it weighs six ounces. It is 5.5" long by 1.8" diameter, and has a tensile strength of 800 lbs. An acrylic lacquer waterproof coating and all-aluminium hardware help to prevent corrosion.

A pair of *KW-30* traps costs $32. Further details from Emily Bostock, Microwave Filter Co., Inc., 6743 Kinne Street, East Syracuse, NY 13057, USA. Tel (0101) 315-437-3953.

Double balanced mixers

PM Electronic Services now carries two new types of double balanced mixer, the *M-8* and *M-18*, made by R&K Laboratories, in place of the *MD108* and *SL1* formerly stocked. These plug-in, broadband mixers cover the 500kHz-500MHz range (down to DC on the IF port) with input/output impedances of 50 ohms. They are housed in an 8 pin, 0.2 inch pin spacing package, and can be mounted either by plugging into miniature relay sockets with a 0.2 × 0.2 inch grid, or by soldering directly to the PCB.

The *M-18* costs £7 inc. VAT. The *M-8*, which has hermetic sealing and more than 90dB of radiation shielding, costs £9 inc. VAT.

Further details from PM Electronic Services, 2 Alexander Drive, Heswall, Wirral, Merseyside L61 6XT. Tel 051-342 4443.

Specialist VHF aerials

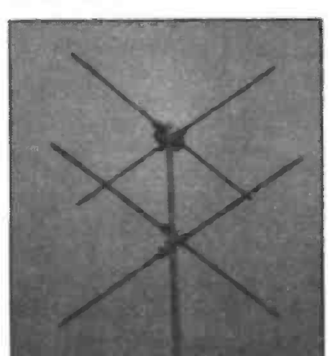
South West Aerial Systems is introducing a number of aerials for the amateur VHF enthusiast, having previously been concerned mainly with long distance broadcast reception.

One of the new aerials is a crossed dipole/reflector arrangement for satellite working on 2m (shown in photo).

Two other aerials are designed for the experimental 50MHz band. The *NB52* is a two-element beam covering 50-52MHz at a nominal impedance of 50 ohms. The *NB54* covers the full 50-54MHz range. (75 ohm versions are also available.)

The claimed specification for these 50MHz arrays is: midband gain 4.7dBd; front/back ratio 8-9dB. The boom is 4' 9" long and 1" in diameter.

The 50MHz arrays cost £22.75 inc. VAT and Securicor delivery from South West Aerial Systems, 10 Old Boundary Road, Shaftesbury, North Dorset. Tel 0747 4370.



BOOK: VHF/UHF Manual

The RSGB's *VHF/UHF Manual* already has a reputation for being something of a 'bible'. This new fourth edition looks like boosting that belief. At twice the size of the earliest editions, this book is stuffed solid with 528 pages of invaluable information for the VHF/UHF experimenter.

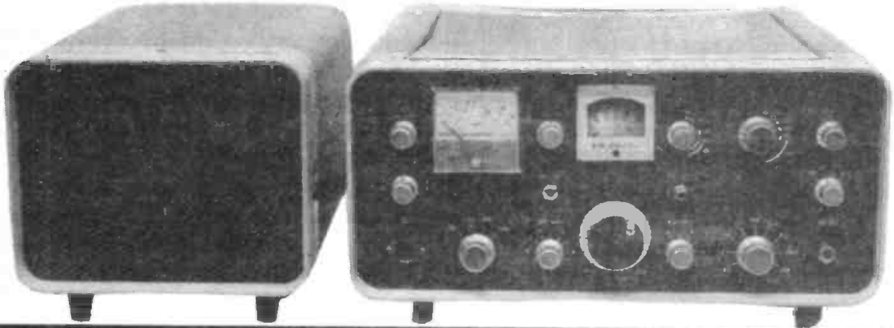
As well as chapters on background and theory, there are many practical designs, often with a choice of technologies — for instance there are designs for valve, transistor and power-FET 144MHz transverters. Many of the designs have not been published before.

The chapter titles are: Historical perspectives; Propagation; Tuned circuits; Receivers; Transmitters; Integrated equipment; Filters; Antennas; Microwaves; Space communications; Test equipment. There is also an appendix with data such as colour codes for resistors and fixed ceramic/tantalum/polyester capacitors, charts showing the inductance of coils and graphs showing the characteristic impedance of PCB tracks on double sided boards. This appendix also contains a wealth of data on coaxial cables, waveguides, coaxial connectors, PA valves, power transistors, double-balanced mixers, power FETs, broadband cascade amplifier modules and batteries. There are also tables of wire guages, decibels against voltage/power ratio and dBm against voltage (for 50 ohm and 600 ohm systems), and a table of resistor values for 50 ohm T-attenuators.

The *VHF/UHF Manual* is available from the RSGB, Alma House, Cranborne Road, Potters Bar, Herts. EN6 3JW for £8.50 (£10.31 by post worldwide).

This book is excellent.

Upgrading the KW2000 series of HF transceivers



Part 5 More Mods

by M.T. Healey, G3TNO and R. Charles

Improving the CW note

The note on most *KW2000s* leaves a little to be desired to the CW purists and the example at G3TNO was no exception. A number of critical reports on the note were obtained from local and more distant stations, including a most useful tape of the transmission from an SWL (needless to say, he received a QSL by return). It became obvious from the tape, various reports and local monitoring that the signal suffered from clicks on 'make', and thumps on 'break', and that the tone had a rather odd 'flutey' sound. Various experiments were tried with the usual key click/thump filter circuits, but none really cured the problem, so thoughts turned to an alternative method of generating the CW signal.

The *KW2000* was tuned up into a dummy load, and another receiver was used to monitor the signal produced. The balanced modulator was then temporarily unbalanced by shorting one side of the balance control RV14 to chassis, and the resultant carrier monitored on the outboard receiver; the note was perfect. So an external power supply was lashed up via a key to the junction of C6 and C7, a CR network being connected across the key contacts. The monitored note was now perfect with no trace of click or thump. This set up performed well on the lower bands, but on 21&28MHz a severe lack of drive was apparent, caused by the fact that the carrier in most SSB rigs is set to a frequency which is about 20dB down one side of the filter passband, as shown in **Fig. 105**. So a crystal in the centre of the passband was plugged into the socket normally occupied by the LSB carrier crystal, and again the note was monitored and the drive level checked; the note was still OK and there was now plenty of drive available on all bands. A few local contacts were made using this lash up, and everyone reported a great improvement in the transmission.

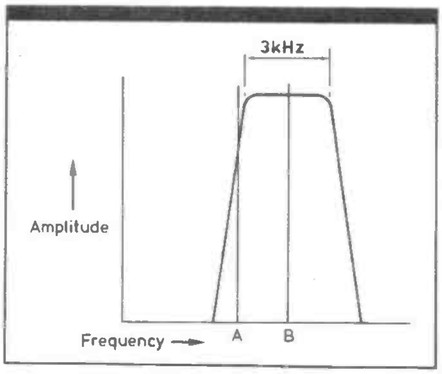


Fig. 105 The position of the carrier with respect to the filter passband. For SSB operation the carrier frequency is normally set to position A, some way down the skirts of the filter response, so that the filter passes the upper sideband and filters out the lower. For CW operation more drive will be obtained if the carrier is moved to position B, in the centre of the passband.

A list was now drawn up of the requirements for a permanent modification:

1) The ability to unbalance the balanced modulator with the key, without using an external power supply.

2) The automatic switching in, in the transmit mode only, of a carrier crystal in the centre of the SSB filter passband, reverting to the normal carrier crystal on receive.

After many trials and errors the circuit of **Fig. 106** was evolved. The advantage of this circuit, apart from an improved CW note, is that, at the flick of a switch (S1*), it is possible to revert to the unmodified state; thus the SSB performance is unchanged, and comparison between the modified and unmodified states is very easy.

The operation of the circuit is as follows. With S1 set to ON, and under key-up conditions, TR4 and TR5 are biased off, so no voltage will appear across R1003 or across the coil of relay C. The sidetone oscillator will be cut off, and with the rig set to VOX the contacts of the VOX relay RL4 will be open; thus the rig will be in receive with the CW filter switched into circuit. At the instant of closing the key contacts, TR5 is biased on, relay C is energised and a carrier crystal in the centre of the SSB filter passband is switched into circuit. The sidetone oscillator in the *KW2000* will at the same time activate the VOX circuit, putting the rig into transmit. This will close contacts RL4/2 and will keep TR5 biased on via D112. This latter feature is very important, as without it relay C will follow the keying, and the

* Note that the switch 'S1' referred to in this article is not the same switch as on the original KW circuit.

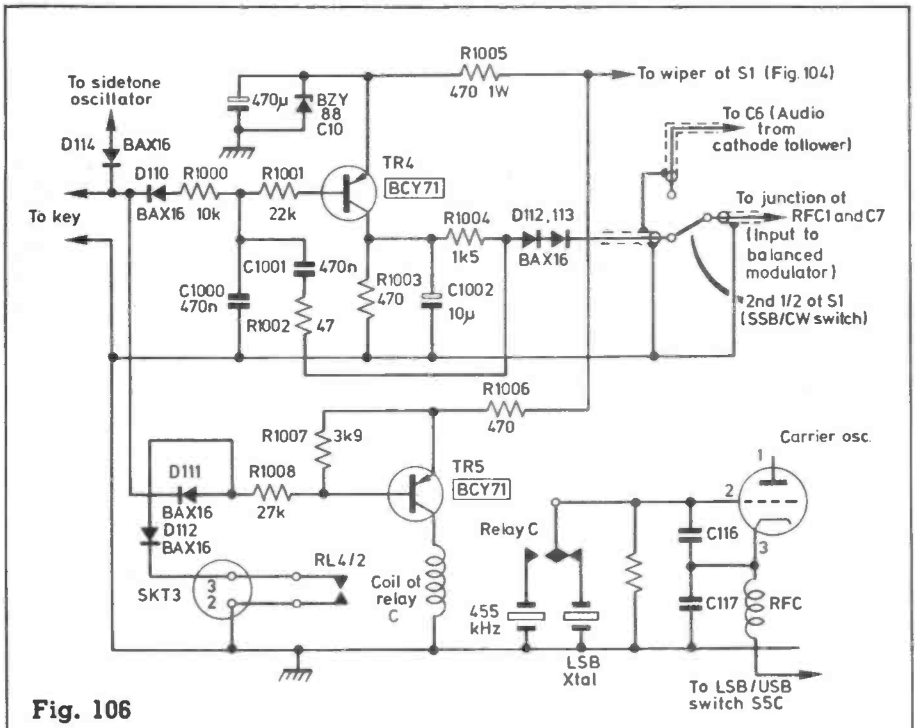


Fig. 106

outgoing transmission will sound like a cross between FSK and normal on/off CW! TR5 will stay biased on during the hold-in time of the VOX cirucit, or for as long as the rig is held in transmit by the INT MOX setting or by an external send/receive switch, provided that Sl is set to the CW position. Also under key down conditions TR4 is biased on via D110, R1000 and R1001, the turn-on and turn-off times being controlled by R1000, R1001, R1002, C1000, C1001 and C1002. These components are required to completely remove any thumps or clicks on the signal; there is therefore no need for further key click filters across the key or keyer contacts, and in fact they are positively harmful to the operation of this circuit.

When TR4 is biased on (key down), a voltage is developed across R1003 and C1002. This voltage is fed via R1004, D112, D113 and the second pole of S1 to the LF input of the balanced modulator, thus unbalancing it and producinga carrier at its output. This carrier will, of course, be fed on to the later stages of the transmitter. The two diodes D112 and D113 are used to prevent any slight leakage in TR4 unbalancing the modulator, which would, or course, produce a carrier under key-up conditions. D114 prevents this circuit being activated in the TUNE mode.

Variable transmitter output power

It has been found useful to be able to vary the output power of the *KW2000* when, for example, driving a transverter or linear amplifier. As the rig stands there is no way of doing this except by adjusting the MIC GAIN control, which is a very undesirable way of varying power output, particularly at low output levels. Although the ratio of *peak* output power to the suppressed carrier at normal mic gain settings may well exceed 40dB, as the mic gain is reduced the carrier level due to leakage round the balanced modulator will remain the same while the peak output power will be reduced. Thus the effective carrier suppression will be reduced. The writers feel that it is best to vary the output power *after* the balanced modulator, and this can most easily be done by varying the gain of the transmit IF amplifier V3, which is in any case a variable-mu valve controlled by the ALC.

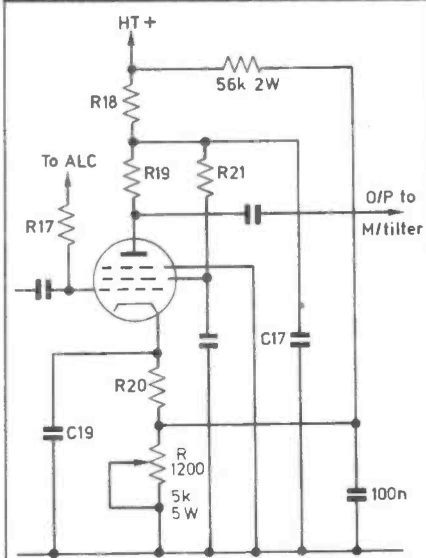


Fig. 120

The simplest way of controlling V3 without upsetting the ALC action is to insert a variable resistor in the cathode circuit to vary the bias. A circuit for doing this, employing only three extra components, is shown in **Fig. 120**. At full gain the output level is the same as with an unmodified *KW2000*, while at minimum gain it is possible for the output to be reduced to below one watt! This method leaves the mic gain control set as for normal operation, giving the advantage that at low power output levels the carrier suppression is not degraded.

IRT IN USE indicator

A small but useful extra feature has been the addition of a warning LED to indicate that the IRT/ITT selector switch is on. The extra switching for this is already fitted, although left unused. There is a spare pole on S4, which can be wired as shown in **Fig. 121.** The LED is conveniently mounted approximately 1¼ " to the left of the switch. The value of the series resistor depends on the particular LED used and the brightness required.

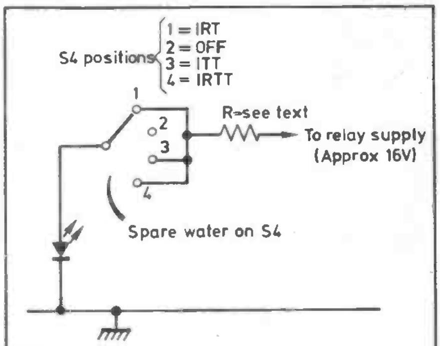


Fig. 121

The next article, in our September issue, will deal with the important question of modifying the *KW2000* to cover the 10, 18 and 24MHz bands, as well as the missing sections of the exisiting bands.

HAM RADIO TODAY NEXT MONTH

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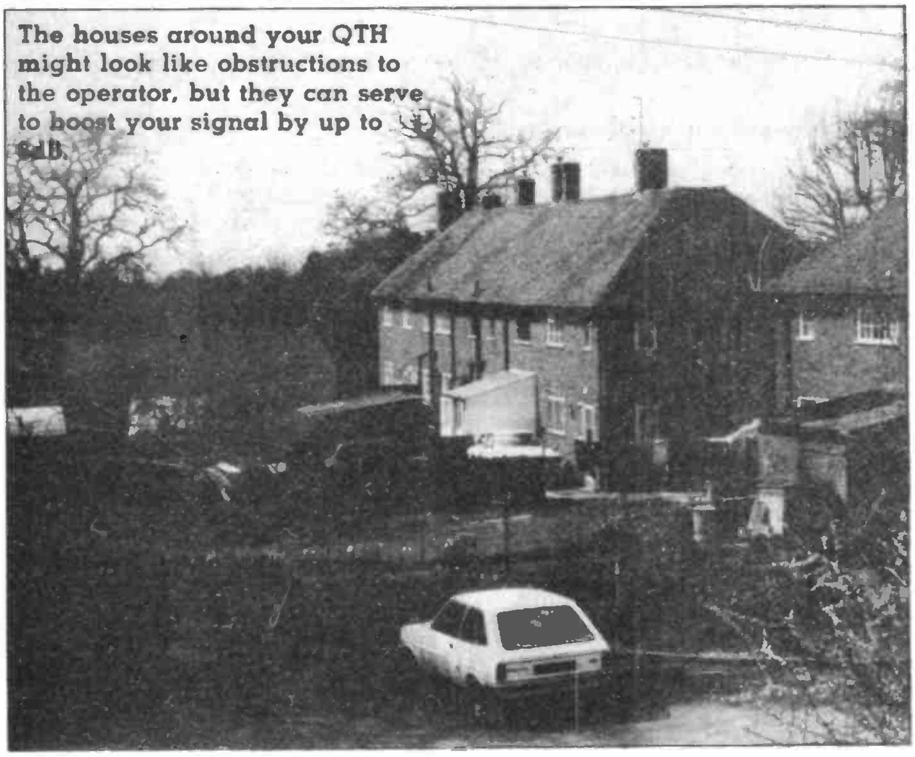
My QTH isn't very high...

A good take-off?

Ever dreamt of moving your house to the top of a mountain somewhere? You might be better off on the low ground than you think you are.

By Frank Ogden G4JST, Editor.



The houses around your QTH might look like obstructions to the operator, but they can serve to boost your signal by up to 6dB.

There seems to be only one general view of the optimum VHF QTH: at the top of a hill with nothing obstructing the view for miles. If at all possible, it should be arranged that the ground around slopes gently down on all sides to the plain way below. For preference, there should be no trees, pylons, buildings or anything else to break-up the smooth contour of the land.

A QTH fitting the above description would be a desirable place to set up a VHF/UHF station in one respect only, line of sight communications. Height, pure and simple, does not affect tropospheric DX as much as one might imagine.

Not a perfect mirror

To understand the point, one needs to appreciate a few of the subtleties of VHF/UHF tropo propagation. The sky is very much less than a perfect mirror. The refractive index interface which produces DX conditions is a) not a continuous sheet and b) a refractor rather than a reflector. Tropo bending occurs under inversion conditions: dense but humid cold air sits on top of warmer, dryer air close to the surface of the ground. This produces something like a dielectric waveguide which has, on one side, the warm air close to the ground, and on the other, the rarefied thin stratosphere on the other. The conducting strand of cold but humid air sits trapped between the two.

This duct can carry signals for 100s and occasionally 1000s of miles along the whole length of a weather front. Once signals have entered into the duct, they will not emerge and radiate back to earth until a local atmospheric disturbance such as a strong thermal lets the signal out. The graded index optical fibre provides an excellent analogy to tropospheric propagation. The refractive index of the fibre alters across its cross section such that light entering the fibre tends to be reflected towards the middle where it stays for the passage down the fibre.

If one makes a nick or a break in optical fibre, the light floods out at the discontinuity and scatters in all directions. Tropo ducts behave in precisely the same way. Even though DX paths may exist within a plate of tropo ducting (remember that a tropo duct is more like an elongated plate than a wire) you won't necessarily gain access to it unless your aerial is sufficiently close to a discontinuity to fire into it.

Height no advantage

The effects of these 'holes' can be heard during any lift. There are large numbers of discontinuities in the sheet, each of which has a constantly changing characteristic. This translates into the peaks and fades in received signal strength. Signals from the other side of the country may come in at 30dB over S9 while closer stations (or stations further out) may produce signals at the limits of audibility. This situation can reverse itself in the course of a couple of minutes.

The actual height of the station aerial has singularly little to do with the operator's ability to gain access

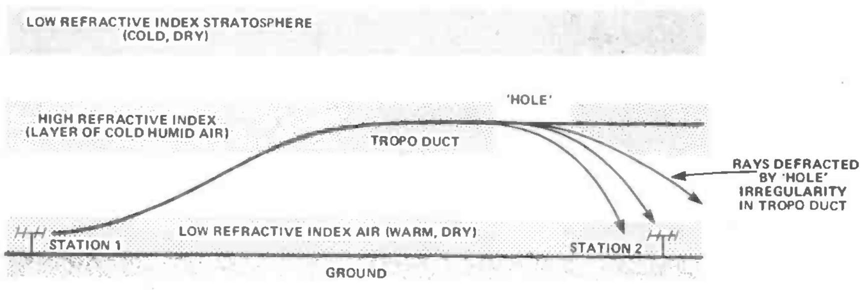


Fig. 1 Tropo ducting is the dominant propagation mode during a 'lift'. The duct comprises a layer of cold damp air caught between warm dry air near the ground and cold dry air above.

into the holes. If the aerial can 'see' a hole in the horizon sky then the signal will propagate into the duct, provided that the angle of incidence is not too great. The horizon is viewed almost equally well at any height. There is a slight advantage at being high because the angle of incidence will be a bit smaller. Radiation tends to enter (and emerge from) holes most effectively when the beam is almost tangential to the surface of the earth. However the advantage is not worth going up the top of a mountain for.

The great surface waveguide

The radio horizon chart tends to be only of limited value. OK, so you know the height of your QTH and that of the station with whom you are in contact, look up the horizon in the table and then find out that the QSO which you have been having for the last half an hour is an impossibility!

Even when conditions are completely 'flat', a half decently equipped station (particularly in respect of the aerial system) will consistently achieve distances in excess of the radio horizon regardless of whether the location is on a flood plain of some estuary or other or on a hilltop. Using just 25W of SSB each way on 2m, a colleague and friend of mine, Pete Metcalfe G8DCZ, has been able to establish a regular link up to Leicester from his home in Sussex. Neither location is particularly high — perhaps a couple of hundred feet ASL — although a workable QSO is something like an 80 per cent certainty.

All that is needed for this type of performance is an expanse of clear countryside before the first set of hills or other apparent obstructions. The aerial itself does not need to be mounted on a massive tower either. It simply needs to be high enough to see across the rooftops of the near neighbours.

The transmission mode is troposcatter, a reliance on small local disturbances in the atmosphere to forward scatter signals to a distant reception site. If you look up 'troposcatter' in the great and wise books of reference, they will tell you that you need enormous power and massive parabolic aerial to work the mode. This is (possibly) true to achieve a 99 per cent certainty of contact but the statement is, in the main, bunkum.

Troposcatter works on such a modest level because the surface of the earth comprises one great director system. In essence, the undulations in the surface of the earth and the obstructions upon it (houses, powerlines, trees, etc) serve to make a surface waveguide aerial system of truly massive proportions.

The importance of topography

The microwave fraternity have long been aware of surface waveguides. If you make an open metal channel with sinusoidal undulations in the bottom, it becomes possible to propagate a wave along this structure with virtually no loss. The ground surface can act in the same way. Of course, the action will not be nearly so efficient because the undulations are random in comparison to the operating wavelength. However, 'natural selection' takes place on the weak troposcatter wavefront. The ground illuminated by the wavefront will be covered with weak standing wave nodes, some in phase with the incoming signal, others out of phase. Those out of phase tend to radiate their surplus energy isotropically, ie in all directions, while those which are in phase 'tend to keep on coming' re-enforcing the original wavefront.

The precise value of this surface waveguide gain can be more than 6dB in a good location. It is easier to say where you won't get it than where you will. If you are in the lee of a hill, you won't get it. If the ground around you slopes down sharply before rising much higher, ie on top of a small hill in the shadow of a larger one. If the aerial view is significantly obscurred by a gas holder or block of flats. If you happen to be situated on the side of a hill (even near the top of high one)

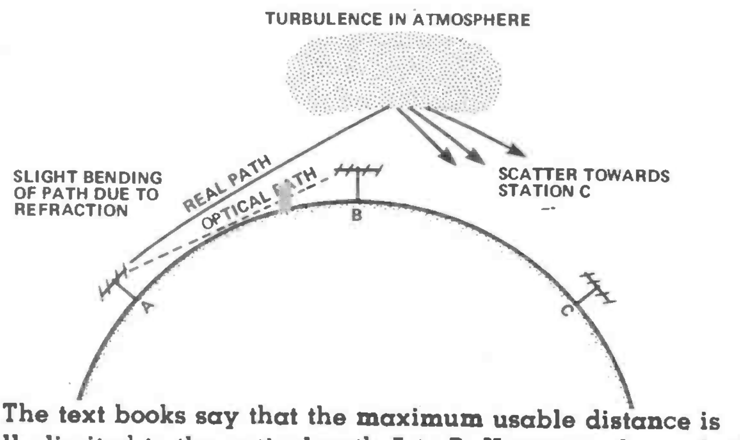
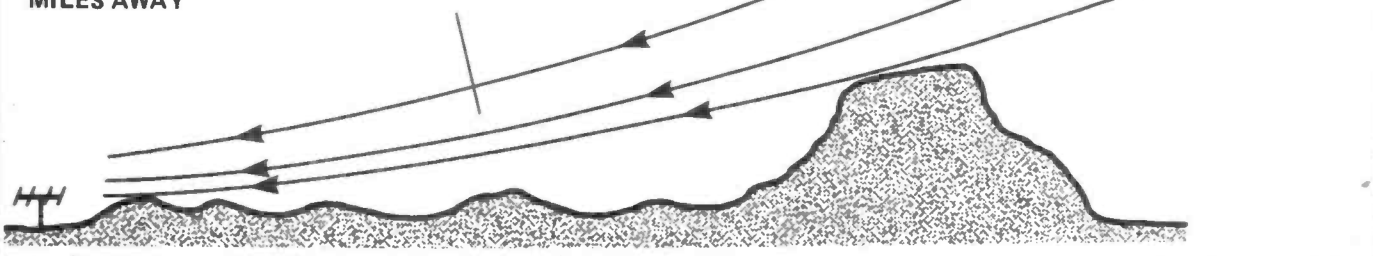


Fig. 2 The text books say that the maximum usable distance is normally limited to the optical path A to B. However, the path A to C will be likely, even under normal condition through refraction and forward troposcatter. The effect is useful on two metres and substantial on 23cm.

Fig. 3 The surface waveguide effect

DOWNWARD INCIDENT WAVES ARE ACTUALLY BENT TO FOLLOW A PATH PARALLEL TO THE TERRAIN. THIS ENABLES A STATION TO WORK 'OVER THE TOP' OF AN OBSTRUCTION PROVIDING THAT 1) IT IS NOT TOO HIGH, 2) THE OBSTRUCTION IS SEVERAL MILES AWAY



opposite from the direction you wish to transmit to.

The greater the operating frequency, the greater the bending effects. While a poorly sited station will suffer greater signal attenuation with a rise in operating frequency, refractive, troposcatter and 'surface waveguide' effects will be enhanced. With these peculiar characteristics it is often possible to work more reliable DX on 70 and 23cm than on 2m. It is the superior refractive effects which tend to make UHF operation more interesting than 2m VHF.

Generally, the ground effect requires about five miles of level terrain to be useful. However, there are large areas of the country which fit the category. Gently sloping ground will not constitute a barrier. In contrast, the hills within the mountain ranges of Wales have to be regarded as a very poor location with knife edge diffraction being the only thing which could help.

The ideal location for a station has to be on a high, wide plateau. However, you won't be missing out on the lifts providing that you have a number of miles of flat ground between you and the nearest hill. ●

CLUB NET

by Cyril Young, G8KHH

As of next month, we will be changing the format of CLUB NET.

The column is to be incorporated into a new diary feature, RADIO TOMORROW. Entries will be limited to event, venue, time and date. News originating from club activities will be published in our RADIO TODAY column as part of the magazine's regular news service to amateurs.

Please continue to send us your lists of forthcoming club events together with any news items for wider circulation.

All material should be addressed to Richard Lamont G4DYA, Ham Radio Today, Argus Specialist Publications, 145 Charing Cross Road, London WC2 0EE.

A IS FOR ABERGAVENNY

ABERGAVENNY AND NEVILL HALL AMATEUR RADIO CLUB is running three special event stations, the first is on the 4th of June at the Nevill Hall Fete: the station's callsign is GB2NHF. The next one is the Abergavenny Castle special event where the callsign will be GB4AC; this takes place on the 24th of July to commemorate the Year of the Castles in Wales. The Club's third special event station for now (I understand there could be more!) will be at the site of the Abergavenny and Border Counties Show, the callsign to be used is GB2ABC, on the 30th of July. We wish the Club every success in their marathon task of running all these stations. How about some photographs for the *Club Net* from all these events? David Jones GW3SSY, the Club's secretary, tells me there's a lot more going on in the Club, like on the fourth Tuesday of each month when a section of the Club meets to play with the *ZX81*. David says they are on the lookout for any suitable programs or lectures on the micro with ham radio connotations. If you can help, contact David GW3SSY at 2 Dalwyn House, Llanover Road, Blaenaron, Gwent NP4 9HY with an SAE or phone 0495 791617. Just in case you were wondering, they do have normal club nights, these are held every Thursday at 7.30 pm above Male Ward 2 at the Penyfal Hospital. Meanwhile RAE classes are held at the Nevill Hall Hospital. (Both of these are in Abergavenny.) This sound to me like an ailing club, Hi.

A mine of information on Satellites, whether they are used commercially or by amateurs, makes little difference to **AMSAT-UK**. Ron Broadbent G3AAJ leaves few stones unturned while compiling *Oscar News*. You don't have to be into amateur satellite communications to appreciate the wealth of knowledge packed into each issue of *Oscar News*. If you want to find out about all those metal birds flying around up there, join AMSAT-UK. Write to Ron Broadbent G3AAJ at 94 Herongate Road, Wanstead Park, London E12 5EQ with an SAE if you want a reply.

Just to let the **BANGOR AND DISTRICT AMATEUR RADIO SOCIETY** know that Northern Ireland is not precluded from Club Net, like it is from some insurance companies. This was a viewpoint raised in the Club newsheet recently. The Club's callsign is GI3XRQ and it is on the air from the Sands Hotel, Bangor, County Down at 8 pm on the 1st Friday of each month. It appears that Club members and visitors alike are getting great satisfaction from the Club's new 70cm repeater, which came into operation earlier in the year. GB3UL is on the same site as the 2 metre repeater at Craigantlet. The Club has a very neat pocket size newsheet produced by Stewart Mackay GI4OCK, the club's PRO. For more details of the Club contact Stewart at 11, Dellmount Park, Bangor, County Down BT20 4UA including an SAE.

BIGGIN HILL AMATEUR RADIO CLUB hold their meetings at 8pm in the Biggin Hill Memorial Library, where on June 14th they hold an antenna evening. On the 26th June they are holding a foxhunt, on Tuesday July 12th there is a talk on vintage radios, and on the 19th July there is a visit to a power station.

SECRET WEAPON

Mark Goodfellow G4KUQ tells me he has just landed the job of PRO for the **BRISTOL AMATEUR RADIO CLUB** and has taken me to task for not including some of his previous press releases. Sorry about this chaps, only the Editor was propping his desk up with your copy. (Such is the life of a PRO.) The Bristol Amateur Radio Club is one of the oldest clubs in the Bristol area and it hopes to increase its membership this year. Hopefully, to take advantage of the Club's expanding facilities on both 2 metres and 70cm, they anticipate competing using Club callsign G3TAD in a number of contests, hopefully using their secret weapon in the VHF Field Day: a 10 ft diameter dish for use on 23cm. The Club meets at 7pm every Tuesday with the 4th Tuesday every month kept for the Computer Club night. Details of forthcoming events are available from Mark G4KUQ at 99 Somerset Road, Knowle, Bristol, BS4 2HX or by phone 0272 716093.

A number of interesting items come from the spring edition of **CENTRAL SCOTLAND FM GROUP** News. One which is causing a lot of concern to members is the Home Office announcement of the end of repeater licensing. It seems that down in England just about every inch is covered by a repeater, but the Home Office has forgotten they have things called mountains in Scotland! I hear the Government has a large stock of bulldozers going cheap.

3rd July is a good day to be in Dumfries. **THE DUMFRIES CLUB** is holding an open day at the Carhenholm Hotel, New Abbey Road, Dumfries. Just a few weeks later the Scottish Convention is to be held at Cardonald College, Glasgow on the 27th August. There will also be a dinner-dance in the Bellahouston Hotel in the evening so bring along the YLs and XYLs. For all the latest information call Colin Dalziel GM8LBC at 12 Dunure Drive, Earnock, Hamilton ML3.

A short note from John Alldridge G6LKS, Secretary of the **CHESHAM AND DISTRICT AMATEUR RADIO SOCIETY**, tells us that the Club meets on every Wednesday at the Stable Loft, Bury Farm, Pednor Road, Chesham at 8pm, where new members will be more than welcome. I don't have any programme details, so I suggest you contact John G6LKS at 15 Whichcote Gardens, Chesham, Bucks. I'm sure he will be only too pleased to tell you what's going on in the Stable Loft. Sounds like they may have plenty of 'horsepower' to generate watts, Hi!

LOGO

Crammed with items to interest everyone is the **CHESHUNT AND DISTRICT AMATEUR RADIO CLUB** Spring Newsletter. You can even win a fabulous prize for designing a new badge and logo for the club. From the newsletter I see that they have QTH problems, or more to the point a place in which to build a shack, so they can have on-the-air nights using the Club callsigns G4ECT and G6CRC. For the time being they have natter nights on June 1st, 15th and 29th and an event to be announced on June 8th, and a 2 metre portable operation on Baas Hill Common on June 22nd. The club meets at 8pm in the Church Room, Church Lane, Wormley, Herts every Wednesday. Roger Frisby G4OAA, the Club's Secretary, will provide any more information required (2 West Field Road, Hoddesdon, Herts EN11 8QX or 0992 464795).

CHICHESTER AND DISTRICT AMATEUR RADIO CLUB tell me they have a meeting on the 7th June and a barbecue on the 16th, with another club meeting on the 5th July. On Friday 8th July they are running a special event station GB2CHI at Priory Park, Chichester. Sunday 17th July sees the Club taking part in the Sussex Mobile Rally at Brighton Race Course, where they will all be in charge of the bring-and-buy stall. On 21st July there is another Club meeting, which are held in the Green Room, Fernleigh Centre, 40 North Street, Chichester, on the 1st and 3rd Tuesdays of each month at 7.30pm. There is a club net on 145.275 MHz (S11) every Wednesday at 7pm. It would appear from the March newsletter that they are getting themselves involved in the Vintage Wireless Day at the Chalk Pits, Amberley on the 5th June and the RNARS Mobile Rally, HMS Mercury, Petersfield on 12 June. The man to contact for more information is T Allen G4ETU at 2 Hillside, West Stoke, Chichester or phone West Ashling 463.

CORBY AMATEUR RADIO GROUP meets every Friday at the Hightrees Scout Centre, The Nook, Corby, Northants, where they have a chat, followed by QSY to the George Inn at Weldon, for a further chat. Occasionally visits are organised from time to time, when they are not in the George deciding on the 1983 programme. One event they hope to be running is a special event station GB4CHG at the Corby Highland gathering on 16 and 17th July. The following weekend is Castles contest weekend, when they will be operating another special event station GB4RC, from Rockingham Castle (near Corby), on all bands. More information from Jon Ainge G4LGZ at the above address.

PERSEVERANCE

The sign of a good PRO is perseverance! Simon Rodda G4PEM is one such PRO. I suggest that **CORNISH RADIO CLUB** committee insists he keeps the job! (That's fixed him for giving me a couple of lefts to the jaw, for not including the Club a couple of months ago.) The Club meets on the 1st Thursday of each month at the SWEB Club rooms, Pool Canbourne at 7.30pm, where on June 2nd there is a talk on repeaters by G3NPB and on July 17th when the Cornish Rally is to be held at the Cambourne Technical College. (Take note all you Hams on holiday.) If you have trouble in finding the site I expect there will be a talk-in. For all the details on the Club and the Rally, contact Simon Rodda G4PEM at the Cliff Hotel, Penzance, Cornwall TR18 2HH. Trust all is forgiven Simon.

The **CRAWLEY AMATEUR RADIO CLUB** has been kind enough to send me a couple of their recent newsletters. Having been an old member of the club I find them very interesting, but I am racking my brains and scouring through the newsletters to find out how frequently they meet at the Club's QTH — the Trinity Church Hall, Ifield, Crawley. Unfortunately I am not able to give you details of the forthcoming programme for this month, but full information is obtainable from the clubs PRO, Al Mahabir G4LGQ at 122 Forrester Road, Sth Gate, Crawley Tel. Crawley 37583.

WRONG CALLSIGN

DENBY DALE (Pie Hall) AND DISTRICT AMATEUR RADIO SOCIETY meets at the Denby Dale Pie Hall every Wednesday at 8pm. The Club seems to be getting rather steamed up about forthcoming rallies. On the 1st and 15th June they have rally meetings, for their rally on June 19th, at Shelley High School Skelmanthorpe, Huddersfield. On 22nd June they try to find out what went wrong or right with it. And just for a change, on July 13th they have a lecture by G5RV, and on 24th July they go rallying again to Scarborough. With all this galloping around it's a wonder they've had time to read *Ham Radio Today*, but obviously their Secretary did as somehow we dropped the 'F' in his callsign last month. Sorry about this old man, we haven't found it lying around, but just to put things all square J. Clegg is G3FQH, as I'm sure you all knew anyway.

DUDLEY AMATEUR RADIO CLUB G4DAR meet at the Dudley Central Library on every 2nd and 4th Tuesday at 7.45pm. For details contact the programme secretary, John Tisdale G4NRA, at 12 Digby Road, Kingswinford, West Midlands including an SAE, or phone him on Kingswinford 278300.

Photo: Northamptonshire Evening Telegraph

Nene Valley Radio Club station — for 73rd anniversary of Girl Guides foundation day.

154FT CRANE

Re-reading the **EAST LANCASHIRE AMATEUR RADIO CLUB** February newsheet (the latest I have) I'm intrigued by the last sentence on the sheet. I quote: "We have been promised the use of a 154ft crane and a 50ft tower." — The tower's OK, but how and where are they going to use the crane? After all, they are only going to put a *Slim Jim* on it, Hi! Anyway, the Club meets on the 1st Tuesday of each month at 7.30pm in the Shadsworth Leisure Centre, Blackburn. No doubt the man to ask about cranes, towers and anything else to do with the Club is Grayham Pountain G4MWY, the Club's PRO. He can be found at "Lynbrook", Whalley Old Road, Billington, Blackburn, Lancashire. Tel Whalley 2767.

EXETER AMATEUR RADIO SOCIETY, whose callsigns are G4ARE and GB3EX, meet at the scout hut, Emmanual Road, Exeter at 7.30pm on the 1st and 3rd Mondays of each month. On the 13th June they have a quiz with Torbay ARC. On 26th June they are going on a coach trip to the Longleat Rally. I must admit they look an active club and more information is available from Francis Stover, 4 College Road, Exeter. I trust these details are correct but the multi-copied newsheet was most difficult to decipher, hence no callsigns are given. Can we have a good copy next time please?

FAREHAM AND DISTRICT AMATEUR RADIO CLUB are having a natter night on the air on June 8th or June 15th *getting started* is the subject of a talk by G4ITG. On 22nd June they are back nattering on the air, and on the 29th Andrew Sinclair tells them about his computer. They natter on the air again on the 6th and 20th July. On the 13th July G8VOI is telling them all about switch mode PSUs. The meeting for July 27th is listed as HF Antennas. All these meetings take place at the Porchester Community Centre, Westlands Grove, Porchester at 7.30pm. The Club Secretary in charge of this lot is Brian Davey G4ITG, who lives at 31 Somervell Drive, Fareham, Hants. He is the man to contact for more information.

FARNBOROUGH AND DISTRICT RADIO SOCIETY will be trying to improve on their 16th position in last year's VHF NFD on the 2nd/3rd of July. With that in mind they have a VHF field day review on June 22nd. On June 8th G5RV will be revealing all the facts on HF antennas. The July Club meetings are yet to be arranged: the Club's PRO Chris French G8ZAJ will advise you of all the goodies in store. You will find him at 26, Wood Street, Ash Vale, Nr Aldershot, Hants. GU12 5JG. The club meets on 2nd and 4th Wednesday of each month at 7.30pm in the Railway Enthusiasts' Club, Access Road, Hawley Lane, Farnborough, Hants.

POSH JUNK

The **FYLDE AMATEUR RADIO SOCIETY** are holding a posh junk sale, or as they list it, an *equipment sale* on June 7th; and on the 21st June they're logically talking on repeaters. I am sorry I can't give you the July programme as I haven't heard from them recently. But I presume they're still holding their meetings in the Kite Club at Blackpool Airport on the 1st and 3rd Tuesday of each month. Harold Fenton G8GG is the man with all the answers, he can be found at 5 Cromer Road, Lytham St Ann's, Lancs. How about an update Harold please?

I see the **HASTINGS ELECTRONICS AND RADIO CLUB** are holding a summer social on 15th June in other words, they are going for a paddle along the front! What they are getting up to for the rest of the month is anyone's guess, as their newsheet *Vital Spark* seems to have eluded me. I'm sure George North G2LL will be only too pleased to give you all the info on the club's activities. Contact him at 7 Fontwell Avenue, Little Common, Bexhill-on-Sea with an SAE or phone Cooden 4645.

This month's extractions from *QUA* the quarterly magazine of the **IPSWICH RADIO CLUB** consists of an item we rarely think of until it's too late — a sturdy bench. G6CRN gives some very sound advice on the practicalities of engineering for the ham, in his *Ints and Tipses* and how to build a solid bench. Valves are not completely dead in East Anglia, as an article on refurbishing valve receivers proves, obviously written by a man with much valve experience. As for the Club generally on June 8th they have a treasure hunt and barbecue. June 27th finds the Club planning their demo station for an event at the Suffolk Showground. On 25th and 26th June they are operating a demonstration station for the Boys Brigade Centenary at the Suffolk Showground. June 29th: planning for VHF NFD. July 2nd/3rd finds them working hard looking for points in the VHF NFD Contest. The Club meets on the second and last Wednesday of each month in the Club Room of the Rose and Crown, Norwich Road, Ipswich at 8pm. The Club Secretary is Jack Tootill G4IFF, 67 Fircroft Road, Ipswich, Suffolk IP1 6PX phone 0473 44047.

LEIGHTON LINSLADE RADIO CLUB have the callsigns G4LLR and G6LRC. They hold their meetings in room A64 at the Vandyke Community Centre, Vandyke Road, Leighton Buzzard, where on June 6th they have a Club meeting, on 12th June they take part in the 70 MHz contest from a welsh mountain. 20th June is another club meeting, 26th June is a DF Hunt. The man in charge of this little lot is Peter Brazier G6JFN, and he can be found with all the answers on the Club at, Kingsway Farm, Miletree Road, Heath and Reach, Leighton Buzzard, Beds LU7 9LA or phone Heath and Reach 270.

I guess Carol Finnis G6LKP (the new Secretary of the **MID-WARWICKSHIRE AMATEUR RADIO SOCIETY**) is having no problems in keeping her members together. The Club meets on the 1st and 3rd Tuesday of each month at 8pm at 61 Emscote Road, Warwick. The next meeting is on aerial and feeder systems by G8MWR on June 7th, on June 21st they have an open house meeting, all are invited. As for July, I'm still waiting for details. Carol says "New members and SWLs are always welcome". Drop her a line with a SAE to 37, Stowe Drive, Southam, Warwickshire, CV33 0NZ or ring on Southam 4765.

As I reported last month the **NENE VALLEY RADIO CLUB** could do with some more members, but it could be they, like me, have a problem in finding the club's QTH. Wherever they meet on June 8th they have a natter night, on 15th a talk on RNIBC by G8HEV, June 22nd another natter night, June 29th a talk on Satellite tracking by G3FOZ. On July 2nd the club is running a special event station GB4WCR at Wellingborough Carnival Radio at Bassetts Park, Wellingborough, Northants. There is yet another natter night on 6th July. Lionel Parker G4PLJ is the Club Secretary who will no doubt tell us where the club meets, he can be found at 128 Northampton Road, Wellingborough, Northants NN8 3PJ.

From the June meeting listed for the **NEWARK AND DISTRICT AMATEUR RADIO CLUB** I imagine they are going to grill the VHF field day operators on their performance and fun, I could be wrong, but the June meeting is straightforward enough: a DF Foxhunt. The club meets at 7.30pm on the 1st Thursday of each month at the Palace Theatre, Appleton Gate, Newark. Enquiries to Roger Hiscock G4MDV at 17 The Green, Elston, Nr Newark, or phone Mike Gaylor G6NMP on Newark 702076 during evenings only.

POOLE AMATEUR RADIO CLUB got the year off to a flying start by getting rid of such mundane problems as the AGM. They meet monthly at the Poole College, North Road, Poole. Sorry to say there are no more details given in the club's newsletter "QSP". Perhaps Tony Laycock, the Club Secretary would like to QSP some more information about the club and their forthcoming programme. In the meantime you can make enquiries via the weekly net on Wednesday at 8pm on 28.300MHz, or on Sundays at 10am on 3.615MHz, or contact the Club's Chairman Albert Gapper G4JYX at 8 Fernside Road, Poole, Dorset BH15 2QX.

Recently I have had several contacts enquiring about QRP operating, if I can meet a few people interested in one small town, then there must be a lot more in the rest of the country. So let's see what the **G-QRP CLUB** has to offer. Founded in 1975, the Club is truly world wide, having members in 27 countries all operating with a maximum of 5W of RF. *Sprat* is the excellent quarterly club journal received by all members, edited by the Rev. George Dobbs, the legendary figure of the QRP world! It's chock full of constructinal items and news from around the world. The club runs its own QSL Bureau, a data sheet service, many taken from overseas magazines. The Club issues a number of operating awards to licensed operators and SWLs. To become a member write to the Secretary: Rev. G Dobbs G3RSV, 17 Aspen Drive, Chemsley Wood, Birmingham B37 7QX.

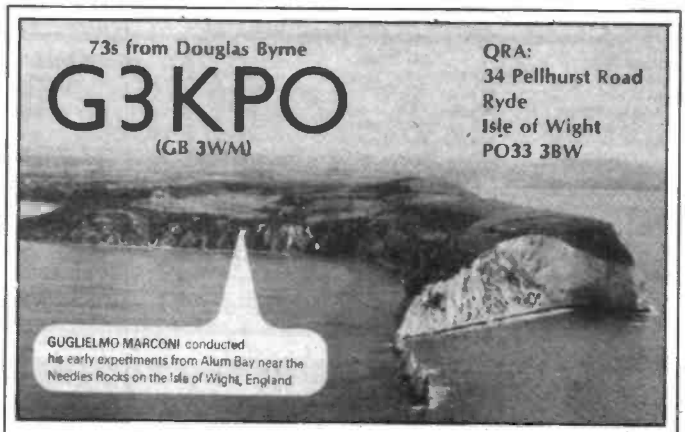
RHYL AND DISTRICT AMATEUR RADIO CLUB have an activity night on June 9th, with a demonstration on ATV on June 23rd. July 4th is another activity night, two weeks later July 28th is a DF Hunt. The club meets at the 1st Rhyl Scout HQ, Tynewydd Road, Rhyl. If you wish to know more, Bryan GW8OYT (on Rhyl 37284) or Paul GW4NLD (on Rhyl 31227) will give you all the answers.

RIPON AND DISTRICT AMATEUR RADIO CLUB have changed some officers after the AGM earlier this year, the Secretary is now Peter Fautley G6CUG, at Parkside, Thornton Le-Street, Thirsk. (Phone Thirsk 24945.) The club continues to meet every Thursday at the St John Ambulance Hall, Ripon. Meetings start at 8pm. Those requiring RAE and morse instruction should arrive at 7pm. A line to Peter G6CUG will bring a list of future events and meetings.

SOUTH BIRMINGHAM RADIO SOCIETY whose callsigns are G3OHM and G8OHM meet on the first Wednesday in each month for talks and junk sales etc at 7.45pm. Then every Thursday is HF night with G3OHM on the air from 7.45pm. Every Friday is the VHF/UHF chance to be on the air from 7.30pm. While all this is going on, morse classes and general nattering also takes place, so Tim Scrimshaw G8RGQ tells us. He gets worked up about all the other activities the club performs, "It fair makes your head spin!" All this takes place at the West Heath Community Association Hamstead House, Fairfax Road, West Heath, Birmingham. Tim G8RGQ can be found at 10 Somerdale Road, Northfield, Birmingham B31 2EG or on 459-8312. Thanks for your few kind words about *HRT* Tim.

BANGERS AND BEER

I have just received the **SOUTHDOWN AMATEUR RADIO SOCIETY** newsletter for March from which I discover the club meets at the Chaseley Home for Disabled Ex-Service-men Southcliff, Eastbourne at 8pm. On June 6th G5CRD will talk about North American licensing — followed on 20th June with a committee meeting — then out into the air on July 4th with Bangers and Beer at Butts Brow. For more information contact Tom Rawlance G4MVN at 18 Royal Sussex Crescent, Eastbourne, BN20 8PD.



The Isle of Wight Tourist Board supplies local amateurs with free QSL/postcards like this one from Douglas Byrne G3KPO.

SPALDING AND DISTRICT AMATEUR RADIO CLUB have a natter night on June 10th. Their only meeting in July in on the 8th: this is a two metre DF Hunt starting from the White Hart at approximately 7.45pm. Now we know why it's the only meeting of the month, you can just see them all staggering around in the flower fields with their loops at the ready! Hi. Ian Buffham G3TMA is in charge as Club Secretary and can be found at 45, Grange Drive Spalding, Lincs PE11 2DX or on Spalding 3845. Otherwise the club always meets at the White Hart Hotel Market Place Spalding.

STRATFORD UPON AVON AND DISTRICT AMATEUR RADIO CLUB meet in the control tower at Bearley Radio Station, Bearley, Nr Stratford on 2nd and 4th Monday of each month at 7.30pm, with talk in on S22. June 13th is test-your-rig night using some very sophisticated test equipment, June 20th a talk on making use of OSCAR by G8MWR. July meetings are to be announced — probably by now programme secretary Ian Hopwood G6CWK will be able to tell you what they have planned for those meetings, Ian can be found at 52 St Mary's Road, Stratford upon Avon, Warwickshire (phone S-O-A 68863.)

Carrying on through their Golden Jubilee Year **THAMES VALLEY AMATEUR RADIO TRANSMITTERS SOCIETY** will hear Pat Hawker G3VA talk on clandestine radio on June 7th at 8pm in the Thames Ditton Library meeting room, Watts Road, Giggshill, Thames Ditton, Surrey. And in the same QTH on July 5th there is a talk on HF antennas and equipment from 1927 to 1983 by G5RV (also 8pm). On August 2nd 50 Years' History on TVARTS by G8SM. If you wish to know more contact Julian Axe G4EHN 65 Ridgeway Place, Wimbledon, London, SW19 4SP or on 01-946-5669.

WAKEFIELD AND DISTRICT RADIO SOCIETY whose callsign is G3WRS have on June 14th a two metre foxhunt. July 12th is an on the air natter night, with a car treasure hunt on July 26th. The club meets at Holmfield House, Denby Dale Road, Wakefield, on alternate Tuesdays at 8pm to which all are welcome. The Club Secretary is Rick Starry, G4BLT on Wakefield 255515.

And there we arrive at the end of the net. 73's from Cyril Young G8KHH.

G4JDT
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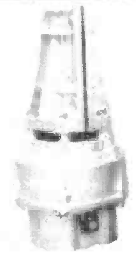

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REVIEW: TRIO TS-930S HF TRANSCEIVER

By Tony Bailey G3WPO

When this rig arrived for review, I had been looking forward to the event for some time, as the few people I had heard who had the transceiver seemed very impressed by it with such comments as "The best rig I have laid my hands on so far". Having had the opportunity to use it for some time, I can now say I have 'joined the club', and am also very impressed with its facilities and performance from a user's point of view.

So, if you are thinking of buying this box of tricks, and have around £1000 to spare — read on.

The review unit was a basic transceiver, without any of the extras available. Judging by the comments in the manual, it is a late model which has some extras, although whether early versions were ever available here is not known (these 'extras' are Noise Blanker 2, Auto SWR Meter, and Full Break-in).

For the record, the additional accessories available for internal fitting are an Automatic Antenna Tuning Unit (*AT-930*), which fits in a space behind the front right hand panel with the necessary control switch and indicator already present on the front panel; and a selection of extra filters such as 500Hz and 250Hz bandwidths for CW use. There are a number of additional outboard accessories designed to match the transceiver, such as a linear amplifier (*TL-922A*), station monitor, external speaker and a 'digital world clock (for the avid DX chaser). The unit comes well packed with accessory plugs, but yet again, no microphone. The mic used was a Trio *MC-50* — if you use this then the plug has to be changed for the special 8-pin version needed — the correct mic is the *MC-60*.

A manual is supplied which explains the operation well, but it is let down by the presentation of the circuit diagrams (try to follow them!) and lack of any servicing data whatsoever. Trio could learn from Yaesu in this repect.

Basic facilties

The transceiver is all solid-state, mains powered (no 12V input) unit with facilities for transceive operation on all amateur bands between 1.8 and 30MHz, including the new 'WARC' bands. It also functions as a general coverage receiver between 100kHz and 30MHz, using 1MHz synthesised increments in conjunction with the 1MHz coverage digital VFO.

In order to prevent transmission on other than amateur frequencies, the rig locks out the transmit function out-of-band. Unfortunately the WARC bands were also locked out and on mention was given in the handbook of how to reinstate these. As the rig was on loan, no attempt was made to do this, and hence no transmission was possible on 10, 18 or 24MHz.

(NB: just as this review was being finished, and the unit about to disappear, the method of enabling the WARC bands was found hidden inside a folded page under Section 8 at the back of the manual. The statement that transmission on the WARC bands is not possible as supplied, and that a minor wiring adjustment is needed is *preceded* by how to do the adjustment! A few hours were spent on 10MHz and 18MHz with satisfactory results.

The ususal facilties of VOX, RIT, RF attentuator, selectable AGC, RF processor, full metering, noise blanker (2 actually) and a sort of passband tuning are included. In addition, the *TS-930S* is one of, I believe, only two readily available rigs that feature full break-in (QSK) operation on CW. Other useful extras are variable CW bandwidth tuning, CW audio filter, 100kHz calibrator (for setting up the display), CW pitch control, and an IF notch filter.

Modes of operation are SSB, CW, FSK and AM. There is no FM facility even as an add-on. The transmitter uses a solid-state PA (2 x Motorola MRF-422 in push-pull) running at 250 watts input on all modes except AM where it is 80 watts. The output power can be monitored on an automatic VSWR/power meter built into the rig. An aerial matching unit can be correctly adjusted using the VSWR bridge. There is no RF output power adjustment other than by varying the mic gain or carrier injection.

Caution!

One point to note. The manual warns against operating the transmitter into a VSWR of greater than 1.5:1, which is to be expected with a solid state PA, and like most solid state designs, power reduction/protection circuitry for the final is built in if you exceed these limits. However, an additional leaflet comes with the manual repeating the warning that "the power transistors might be damaged if the final stage is adjusted poorly" — by "final stage" it is assumed they mean the matching to the final stage. So it is reasonable to assume that some rigs have been returned with blown PAs — you have been warned — watch the VSWR (do your initial tuning at the lowest power possible).

Front panel

Keeping up with modern traditions, there are some 50 controls to play with on the front panel. However, they seem to be sensibly arranged and proved easy to get the hang of. Especially the frequency changing arrangements — if you have battled with the controls on an *FT-ONE*, then this rig is childs' play by comparison.

The most impressive thing is the pleasant off-white fluorescent 6-digit display, which doesn't glare like LEDs, and shows up well in bright light. An additional smaller display alongside the main one shows the RIT status in kHz/100Hz.

There is also a digital analogue display, if such a thing is not a contradiction in terms. It comprises a fluorescent analogue type scale with a moving red bar graphic type vertical bar underneath which increments at 20kHz intervals, and is very useful when tuning rapidly across the band (the VFO also speeds up at fast knob tuning rates so this quite easy).

Metering

A range of metering functions are provided — processing level (in dB), ALC level, power output (only of real use on AM or CW), SWR (from the automatic device provided, so no calibration is required), PA current (12A max) and PA voltage (nominally 28V). Plus of course S-meter on receive, calibrated to S9+60dB.

Moving to the top left of the panel, we find pushbutton switches for VOX/MANUAL, FULL or SEMI break-in (for CW), MONITOR ON/OFF (for listening to your transmit audio (this one works well), and a brightness control (2 levels) for the display, the latter being useful at night.

Underneath these are rocker switches for SEND/RECEIVE, AUTO/THRU (for automatic antenna matching control if fitted, otherwise inoperative), PROCESSOR ON/OFF, and NARROW/WIDE if extra filters are fitted. To the right of these are the METER switch and AGC control (OFF/FAST/SLOW).

The benefits of switching the AGC off may not be immediately apparent. If a very strong signal appears in the passband when listening to a weak station, it will activate the AGC and cause unwanted gain reduction. If you then turn the RF GAIN down, until the meter reading just starts to increase, then turn off the AGC, you should find that the wanted signal is then much easier to copy.

The remaining controls on this side are the PROCESSOR IN/OUT levels, MIC/CARRIER level, and mode selection switch (TUNE/CWUSB/-LSB/AM/FSK).

Frequency control

The main tuning knob is pleasant to use with a rubber surface, and can be spun easily (one MHz in about 5-6 seconds) for rapid QSYing — as you spin in excess of about 5 revs per second the VCO step rate increases. The standard tuning rate is 10kHz per revolution. One note for any blind operators who are considering this transceiver — there is no way of resetting to the band edge for reference, other than switching off all power to the rig. Nor are there any markings on the main tuning knob to identify one complete revolution.

To change bands, there are two choices. You can either select an amateur band of interest from a set of 10 momentary push buttons, or move up or down in 1MHz steps from the STEP UP/DOWN buttons (these are also accessible from the mic socket). This seems a much easier arrangement than keying in via a keypad, unless you prefer it.

There are in fact two VFOs (A and B) with facilities for transfer of frequencies between the two (A=B). Because of the broadband tuning, it is possible to instantly change from Top Band to 10 metres if you wish (always assuming that your antenna also switches, or is a good match on all the bands you want). Used in conjunction with the memory facilities, this feature could be very helpful in contests.

Eight memories are provided, and transferring frequencies to and from these is just a matter of using three pushbuttons (VFO/MEMO, M IN and MR (recall), plus the MEMORY CHannel switch. A further switch is provided which allows the VFOs to be mixed for transmit and receive, ie. you can receive on VFO A and transmit on VFO B, or vice-versa. Memory backup facilities are provided by a battery, and the rig will store all the memory and last VFO frequencies until next switched on. If you don't have the battery fitted, then you still retain everything provided the AC power plug is not removed.

Which reminds me — the rig comes with a European type mains plug which needs changing for UK use.

The remainder

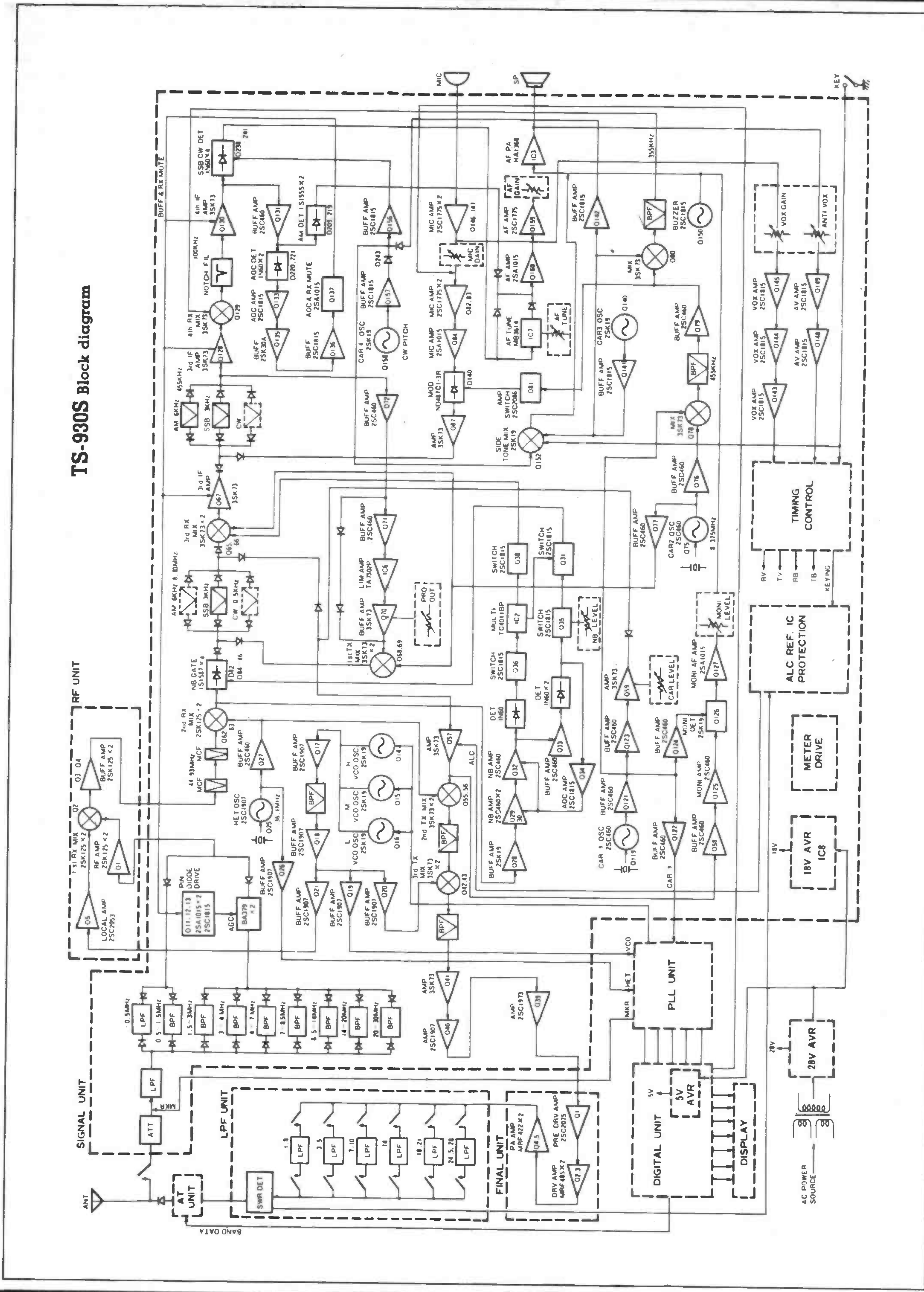
An RF attenuator is provided (0/10/20/30dB) should you need it. The dynamic range of the *TS930S* seems good enough not to require much use of this, even on 40 metres at night. Either the calibration of this control, or the S-meter is adrift however, as they do not agree. Inserting 10dB on the attenuator reduces the S meter by about 18 — 20dB, if it is calibrated at 6dB per S-point as would be expected.

Noise blankers

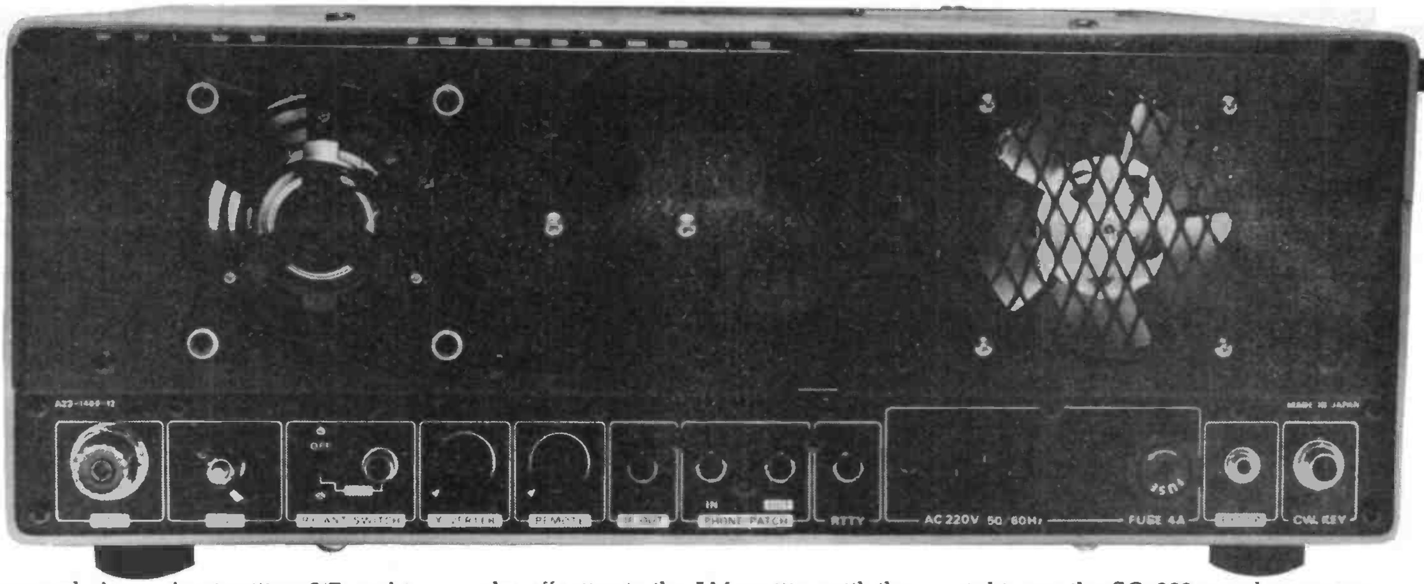
There are two types fitted — the first (NB1) suppresses impulse noise such as ignition interference, and is fairly effective. A variable blanking level control sets the threshold for this. The other blanker (NB2) is intended to cope with the 'woodpecker' radar pulses and provides a longer blanking pulse (also switching in NB1 at the same time).

NB2 is reasonably effective providing the woodpecker is fairly strong (above about S7) which is when you really need it. The effectiveness of this blanking does depend on the type of woodpecker being received, being much better on the one pulse type than the multiple pulse version.

Both blankers reduce the dynamic range of the receiver considerably if ad-



TS-930S Block diagram



vanced above about setting 6/7, and introduce lots of distortion products. Until this was realised, one station was about to get told he was occupying 50kHz bandwidth on 80 metres — switching off the blanker solved the problem!

A further row of pushbutton switches control T-F SET (allows momentary listening on the transmit frequency when both VFOs are in use), the IF notch filter (claimed at better than 40dB and effective, it is very critical to tune indicating a narrow notch), AF TUNE (selects the AF audio filter for CW), and a DIAL LOCK facility which disables the tuning knob.

RIT is controlled by two of these pushbuttons. One selects/deselects the function by repeated pushing, and the other is a CLEAR control. A rotary control beneath varies the RIT offset up to ±9.9kHz maximum, a useful range for DX-pedition split frequency working without involving the dual VFOs. If an RIT offset has been set, the original frequency can be returned by pressing RIT again, but the offset is held and displayed — it can be reactivated by pressing the control again. Pressing CLEAR either deletes the offset from memory, or, if RIT is active, resets to the nominal frequency and also clears the offset.

Further rotary controls set NOTCH FILTER frequency, and AF and RF gain (concentric).

Passband tuning

The remaining controls are concerned with the various forms of passband tuning and CW reception facilities.

CW VBT (CW Variable Bandwidth Tuning) allows reduction of the bandwidth in theCW mode, but does not affect the centre frequency. The actual bandwidths obtainable depend on the filter in use. The review rig came without any CW filter as such so the SSB filter (2.4kHz) is used. This gives control over 2.4kHz-600Hz bandwidth. If you have a CW filter fitted, then the control allows 500Hz-150Hz bandwidth. This control is also effective in the AM position with the same bandwidth control!

As it stands the CW received beat note is around 800Hz, which suits most people. If you want to use a different pitch then there is a PITCH control, which allows you to alter the pitch to suit and varies the filters centre frequency to match. It also adjusts the sidetone frequency to be the same as that of the received signal.

Effective only in the SSB mode are the SSB SLOPE TUNE controls (HIGH/LOW) arranged as two independant concentric controls. One sets the upper edge frequency of the filter, and the other the lower, so that the bandwidth can be set to suit the conditions. These controls are easier to use than the Yaesu *FT-102* equivalents which are friction locked together and very stiff to operate. Being able to set the bandwidth with the upper and lower cutoff frequencies defined is a very useful operating aid, especially when as effective as this version.

The back panel

Having disposed of the front, we move to the back, via a small slider panel on top which covers the memory back-up battery compartment, and the VOX controls, plus a calibrator on/off switch.

The first thing that is very noticeable is the presence of two cooling fans. One is for the power supply (and this one comes on a lot even on receive) and the other for the PA. The later has two speeds — the fan first comes on at a heatsink temperature of 45°C. If you manage to get the PA heatsink above 75 — 80°C, probably because you have insufficient convection cooling, the fan speeds up, the TX circuits are disabled, and will only be re-enabled when the temperature has dropped below 65-70°C.

Both fans are quiet and unobtrusive, except when the PA one is running at fast speed, although still acceptable and both are guarded against prying fingers.

Along the lower rear apron, left to right, are the SO-239 aerial connector, an earth terminal, RX aerial switch (for using an external receiver rather than the *TS-930S* itself), and the external RX socket (phono). Output for a transverter is provided (no output level quoted) via an 8-pin DIN socket, and for external accessories such as linear amplifier via another 8-pin DIN.

If you have a monitor scope, you can view the received signal waveform via the IF OUT jack, taken just before the product detector, and if you are going to the USA, you have the usual phone-patch facilities. Of course, these IN/OUT jacks also enable you to transmit tape recordings (of the right kind!), and take AF output from the rig for recording, SSTV, AFSK etc (at 600 ohms impedance).

The remaining connectors are for RTTY keying (low level only — *not* current loop), AC power, external speaker (3.5mm) and CW key jack (0.25"). Plus of course a fuse (AC, 4 amps).

Construction

Externally the *TS-930S* is a very impressive unit to look at, finished in two-tone grey (light case, dark panel) with a faultless finish. The controls are all smooth and easy to use, with no excessive pressure needed for the switches.

Internally, the standard of workmanship is high, with most of the circuit boards arranged on the underside. The PA, output filters and PSU are on the top. Some screening of individual sections is provided, which must help towards eliminating sproggies, as there are very few to be found. Some adjustment points are marked in the manual, for sidetone, monitor and buzzer levels, Mic impedance (high or low) and notch filter adjust).

As noted earlier, there is little service info provided if you do want to tackle this yourselves, but there may possibly be another manual available. This is akin to buying Lotus or Ferrari and not being able to get hold of a service manual!

Note that the fans need lubricating every six months or so.

Circuit

As with previous reviews, it is not intended to do a full circuit analysis, other than an overview, so as to leave more space for the on-the-air results which are hopefully of more interest to the average reader.

The *TS-930S* uses a quadruple conversion technique for receive and triple conversion for CW, with IFs at 44.93, 8.83MHz, 455 and 100kHz, with the latter only used on receive. All received signals are up-converted to the first if via the VCO output, which is itself controlled in 10Hz steps (and thus sounds virtually continous).

The claimed dynamic range of 100dB (two-tone, 20 metres, 500Hz bandwidth, 0.25uV, S/N 10dB) is not designed in by omitting RF amplification ahead of the 1st mixer, as with the *FT-102* and others, but by using 2SK125 JFETs in a parallel RF amplifier circuit, with similar devices in the 1st mixer, buffer amp, and second mixer in order to achieve high signal level handling capability. The variable bandwidth controls use two variable carrier oscillators at 8.83 and 8.375MHz.

The notch filter works at the 100kHz IF, with the noise blanker operation taking place at the 2nd IF (8.83MHz) — this uses a 4 diode switch immediately ahead of the main filters.

The RF output is solid state switched to achieve full break-in operation on CW, with only a few relays to be heard for the TX lockout and attenuator switching. The PA is broadband it and the aerial for removal of any spurious signals. Another bank of nine bandpass filters is used on receive ahead of the RF amplifier.

The *TS-930S* on the air

The rig was used over a period of 4 weeks on most of the bands available — both transmit and receive — except on the WARC bands for reasons already explained. Conditions on 10 metres were poor for the majority of the time so few contacts were made on this band. You will have to be very careful trying to keep the power down on Top Band (if you bother!). As far as the transmit side goes, not one adverse quality report was received, even with the processing wound right up, although a level of around 10dB indicated seems about best.

The PA showed no signs of stress except when a piece of paper had fallen over the rear of the unit, and caused the heatsink to overheat and bring the protection circuits into operation (at least proving they work). The rig stays

TRIO TS-930S LAB TEST RESULTS

All tests were carried out using the equipment in upper sideband mode

RECEIVER SECTION

Receiver sensitivity for a measured receiver SINAD of 12dB. Voltage quoted as PD

2MHz	0.2uV
3.5MHz	0.2uV
7MHz	0.22uV
14MHz	0.22uV
21MHz	0.18uV
28MHz	0.18uV
29MHz	0.2uV

Test for dynamic range of equipment. The intermodulation performance was measured by connecting two generators through a hybrid combiner. Generator 1 was set to 7.051MHz and generator 2 to 7.101 MHz. The equipment was tuned to 7.000MHz. The generator levels were increased until an intermod product was observed equivalent to an S4 (2uV) input signal.

The generator output levels required to induce this were 14.2mV. This is equivalent to a dynamic range of 77dB. The same test was carried out with the noise blanker switched in. No adverse effect was noted

Susceptibility to internally generated spurious signals.

The aerial input was loaded with a 50 ohm resistive source and the receiver tuned over its entire range and all spurious whistles and birdies noted. All were below AGC threshold, ie no meter indication. The frequency given was that indicated by the display

498.5kHz	13.634MHz
4.638MHz	16.745MHz
4.804MHz	18.179MHz
6.146MHz	18.440MHz
8.370MHz	19.998MHz
8.829MHz	25.119MHz
9.138MHz	29.764MHz
9.998MHz	

The S meter calibration was checked at 7MHz

Meter reading	input level	dB change
S1	1.1uV	0
S3	2.0uV	5
S5	3.8uV	6
S7	10uV	8
S9	32uV	10
S9+20dB	280uV	19
S9+40dB	2mV	17
S9+60dB	18mV	19

TRANSMITTER SECTION

Measurements carried out with either a single 1kHz tone or two tones of 1100, 1700Hz Intermod products quoted as dB below each tone and harmonic products dB below fundamental

Frequency	power	intermod products (3rd, 5th order)		harmonics (2nd, 3rd)	
1.8MHz	105W	27	37	40	60
3.5MHz	130W	35	40	58	47
7.0MHz	130W	40	47	60	63
14 MHz	135W	34	35	70	–
18 MHz	135W	30	35	–	–
21 MHz	140W	33	35	–	–
24 MHz	140W	28	34	–	–
28 MHz	140W	28	31	–	–
29 MHz	140W	38	32	–	–

Blanks indicate that measurements have been limited by analyser range

Ham International of Bucklands Road, Leicester supplied the review unit

The engineering tests were carried out by Redifusion Radio Systems, Crawley, Sussex

OUR OBSERVATIONS

The practical aspect of the review conducted by G3WPO showed that the TS-930S performed immaculately. As the man said, he almost shed a tear when it went. I have used the equipment myself and confirm that it is a beautiful and desirable piece of gear. However the lab test (conducted independently and impartially) showed up a discrepancy between perceived and measured performance.

In every electrical parameter bar one, the machine showed itself to justify the praise from those who used it. However, the measured dynamic range fell considerably short of the manufacturer's stated figure of 100dB. We measured 77dB to be precise. It is possible but doubtful that we have made a measurement error. The manufacturer specified his figure at 14MHz, CW, 10dB SINAD. We measured ours at 7MHz, SSB, 2uV intermod product. After all, 40m at night is where it counts. Having said that this crucial measurement doesn't compare well with an FT-102 (90dB) night-time 40m operation didn't show up any nasties or even mandatory use of the attenuator.

As I said at the beginning, the perceived performance is flawless.
G4JST

reasonably cool, even after extended periods of operation and as noted earlier, the cooling fans are quiet.

Tuning up is of course no problem with the broadband PA, but a matching unit is almost a necessity if you are using any form of multiband antenna. All tuning was done at low power (around 10 watts) before increasing to full output for final tweaking. The presence of the automatic VSWR meter is of considerable assistance here, although I have some doubt as to the accuracy of the actual readings, although the null seems OK.

On SSB, it is necessary to get the ALC reading well up when transmitting — if the meter is only just kicking off the stop you will be losing a lot of available distortion-free power output. Several stations commented on the noticeable increase in received signal strength with the ALC well into its allowable limits, against a low reading, with no degradation of the signal quality, either on or off frequency. You can use the MONITOR facility to set up the processor level effectively and convince yourself that things sound OK. Power output was virtually constant across all the bands, the meter indicating in excess of 100 watts.

One of the joys of this rig is for the CW addict, as the benefits of full break-in working level the semi-break-in method (which this rig can also do) a long way behind. With full QSK, it is possible to return to receive between the individual dots and dashes of the transmission, allowing the other station to break-in (just like VOX working on SSB) or alert you to interference on the frequency. The lack of TX/RX relays makes this a very quiet operation and most enjoyable in practice.

Receive

Most of the subjective evaluation of the transceiver was done on receive, and considering that you will spend a far longer period receiving than transmitting, it is the more important mode.

The sensitivity of the rig is such that one need not consider any extra RF amplification, and it is quite feasible to operate with the attenuator in on the lower bands without realising it. Dynamic range appears to live up to its claimed specification, with little sign of any problem except on 40 metres on occasions. The only untoward signs occur when the noise blanker is in use, and the blanking level above setting 6 or 7, when the dynamic range is greatly reduced, and distortion products become very apparent.

Suppression of the static clicks which abound most days using NB1 was effective, and this blanker was usually left on about setting 4 most of the time. Switching it out after a period of use showed how effective it was.

Selectivity

Selectivity from the fitted standard filters was excellent, and the various passband tuning controls did their job very effectively. The SSB controls enabled virtually any interfering signal to be reduced or removed completely by varying the upper and lower filter cut-off frequencies which appear to be sharp, and in conjunction with the deep notch filter, anything left within the passband of the actual signal being received could be mostly eliminated. On CW, the VBT control is fairly effective, but the steepness of the skirts in the narrower positions could have been better. Reciprocal mixing from adjacent stations was non-existent unless the stations themselves were wide in the first place.

The AGC coped with all signals well, using SLOW for SSB and FAST for CW. Attack and recovery times were adequate with little 'pumping' on strong signals. When an unwanted strong signal was within the passband of a wanted weak signal, it was necessary to switch the AGC off, and reduce the RF gain to allow proper reception, but this is not a fault with the rig itself.

Good audio

The audio system is one of the best I have heard, with no detectable distortion, even at volume levels from the internal speaker way above that possible with other rigs. You are unlikely to want an extension speaker even in a large room! The tone of the audio is pleasant and not tiring, although no adjustments such as tone control are provided.

Tuning around

One of the other little extras is a bleeper! Well, no modern rig is complete without one. This one is not too obtrusive, and gives a stomachable utterance each time any frequency change is made with the select buttons, the RIT is selected or cleared, or the MEMORY button pushed.

Using the memories and dual VFOs is fairly easy after a few attempts, and besides split frequency working, it allows you to jump round bands and frequencies keeping an ear on QSOs, pile-ups etc, ready to jump in when the time comes.

Frequency stability is excellent, with just a slight shift during the first few minutes after switch on, but within specification. The 10Hz step rate of the VFO makes you think you have continuous tuning — you can only just detect the steps if you listen carefully. The only slight criticism is a clicking noise every even 2kHz as you tune rapidly, more apparent on AM than any other mode. The nicely balanced tuning mechanism is a treat compared to some rigs with stiff controls, and although you can spin the dial effortlessly, it stops with a positive action, then only needs a light touch to get things just right.

General coverage receive

Although I have no particular interest in general Short Wave DXing, the general coverage mode on receive makes this rig a natural for the purpose. You can hop around in 1MHz steps easily, using the amateur band buttons for rapid QSY near the band you want. Incidentally, continual pressing the UP/DOWN 1MHz buttons does not result in stepping, just a continuous bleep.

On AM, many DX stations were copied on the MW band, and the variable selectivity sorted them out at night with no problem. The reproduction quality of broadcast stations was adequate, although if you want to relax and use the RX for Radio 2, 3, or 4, you could do with a better speaker. It will go down to 100kHz, although the manual says 150kHz.

For frequency checking all the Standard Frequency and Time Transmissions are available of course. The receiver as supplied checked out accurately (within the digital readout resolution) on WWV and other transmissions.

Conclusions

In my opinion there is no doubt that this transceiver is the best to pass through the shack so far. It is effortless to use and importantly, very quiet in operation with no RX/TX relay clatter. It has all the facilities you are likely to want and these all seem to perform as required, the only possible exception being the noise blanker, and even then only when blanking level is set high.

For the CW user, it is one of only a few rigs designed with CW in mind, and with the addition of one of the optional CW filters should please all but those who don't want to pay for SSB facilities.

I would criticise the manual in terms of lack of servicing info, but there again, the transceiver is a complex machine, and not suited to anything but expert twiddling. The lack of FM facilities may annoy some, especially if you want to use it for VHF transverting.

Bearing in mind the warnings about keeping the VSWR down, there appear to be no problems on transmit, and very few to receive.

If you want to spend the money, then if the review sample is representative, you should be very happy with your choice for some time to come. I shed a tear when it had to go. ●

(Our thanks to Ham International for the loan of the review sample — Ed.)

Active SSB/CW

PROJECT

This switch selectable active audio filter not only forms part of the *Project Ω* transceiver, but can be used to improve many other rigs as well.

Those of you who have built the *DSB80* transceiver featured in the March issue will hopefully have a neat little transceiver with excellent sensitivity for double sideband and CW use. The one area where an improvement can be made is with the selectivity. Being direct conversion, the receiver bandwidth is that of the audio stages — around ±6kHz. On a sparsely populated band this is not a major problem, but after dark the level of activity, both commercial and amateur requires a means of reducing the bandwidth to improve copy.

The answer for a direct conversion receiver, where constructing a variable frequency crystal filter is something of an insurmountable problem, is an audio filter. To take advantage of modern technology an active design, rather than passive, was chosen. This has the constructional advantage of not requiring any inductors, just Rs and Cs and a few op-amps, so that size is kept to a minimum. It requires no alignment, and with this design, you can switch just the bandwidths most suited for your applications, or have all the selectivity options switch selectable.

The filter can be used with the *DSB80,* or any other direct conversion receiver, and is designed to be placed immediately before the AF power amplifier stage of the RX, or some other suitable low-level AF point. There is no reason why a single IC AF amplifier could not be added for driving a low impedance speaker making the unit self contained. It operates off +12V DC and consumes about 15mA.

This project is also intended to be used in conjunction with the HF transceiver design started in this issue, and will provide the main CW selectivity for the basic transceiver. As with the transceiver, a kit of parts the PCB will be made available to constructors. The assembly is not difficult and the project is suitable for all levels of contructor.

Circuit

The design is split into two basic sections — that for SSB and that for CW use.

For SSB, a bandpass characteristic is required, with a low cut-off point around 300Hz, below which received audio contributes nothing to the intelligibility of the signal, and a high cut-off between 1.5 and 3kHz. If greater than 3kHz you are receiving unwanted interference and no enhancement of the signal, while below 1.5kHz the intelligibility suffers.

Unfortunately it is not possible to design an active filter circuit which can accommodate both these high and low pass bandpass requirements in one circuit while still maintaining a flat passband. Hence it is necessary to split the filtering into separate high- and low-pass sections.

Before the active filters, a buffer amplifier IC1 is used to isolate the filter input proper (IC2 on) from the AF input, as varying loading on the input to IC2 would affect the response characteristics. A 741 op-amp is used as an inverting amplifier, with R6 setting the overall gain.

For most applications a unity gain configuration would be needed in which case R6 would be 2k2. If some additional gain is required in the system, the value of this can be increased to suit. For the *DSB80,* this can usefully be increased to 15k. This will be found especially helpful during the daytime when signals tend to be weaker. Point C allows direct connection to the buffer amp output if needed without any filtering having been introduced.

C1 provides DC isolation from the audio circuitry being used.

Supply rails

To avoid the need for both positive and negative supply rails, where the non-inverting inputs would be taken to the negative rail, the non-inverting inputs to all op-amps are biased to half the positive supply rail voltage via a resistive divider (R2/4 for IC1), creating a virtual zero voltage at +6V, and allowing signals to swing either side of this as though

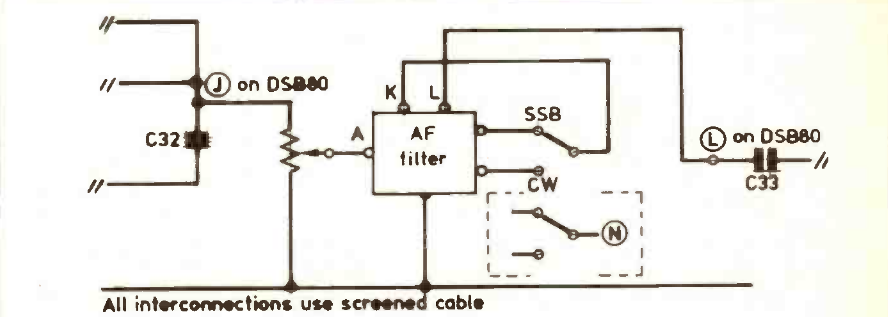


Fig. 1 Wiring the filter into the SDB80

filter

by Tony Bailey G3WPO

there were two supply rails at + and —6V.

The remainder of the circuitry utilises LF353 dual BIFET op-amps for low noise contribution. The first section of IC1 is configured as a high pass filter, with a —6dB cut-off at 300Hz, which reduces all signals below this frequency, but passes those above virtually unattenuated.

All the filter components were designed via a computer program to allow selection of values close to preferred value components. In some cases non-standad values of capacitors and resistors are needed, however, to maintain the required characteristics, and the parts list shows how these can be synthesised by series or parallel connection of two other values. It is important that the tolerances of the components are as specified — using normal carbon film resistors will result in inferior performance, with non-specified cut-off frequencies, varying gain, and wrong Q values. The capacitors should be 10% or better types — if you have a capacitance meter, they can be selected for best value.

The first of the low-pass sections follows in IC2b, with a nominal —6dB point of 2.2kHz. This will remove most of the high frequency chatter from a direct conversion receiver at output D, without impairing reproduced quality at all, and also reduce any hiss which may have been introduced by the receiver's IF or early audio stages. Signals higher than 2.2kHz are attenuated progressively as the frequency increases, those below are not affected.

To reduce the bandwidth slightly if needed to a nominal —6dB point of 2.0kHz, IC3a is cascaded with IC2b, improving the rolloff on the high cut-off side in the process. Audio intelligibility will still be satisfactory however. Further reduction in bandwidth is by another cascaded stage (IC3b), with a nominal cut-off of 1.5kHz. This is useful when there is a lot of interference about, but the received audio bandwidth is now a little narrow and the signal may sound restricted. With three filters now cascaded, cut-off on the high frequency side is very good. The 1.5kHz position is also useful for tuning around on CW.

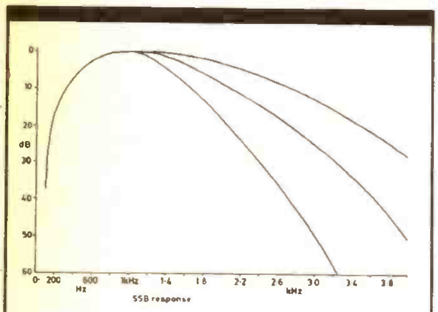


Fig. 2 Measured filter response

CW

For CW use, advantage is taken of the SSB filtering by passing all signals through the cascaded high- and low-pass sections prior to the narrowband CW filtering.

Filters for CW, with much narrower bandwidths possible, require a different approach to that for SSB. There are two schools of thought as to the type of filter required with some people preferring a similar type of filter to that of SSB ie. with a narrow but flat passband, so that some idea of activity near to the wanted frequency can be obtained while operating. This does have the disadvantage that signals very close in pitch to the wanted one cannot be eliminated very well.

The other approach is to have a 'peaked' passband. The problem in the past has been that to achieve very steep slopes to the skirts, the filter has to have a fairly high Q of around 10 or higher, which causes the filter to momentarily break into oscillation, or 'ring' as signals pass through it, with a very sharp response which can be tiring to listen to for long periods. This can be avoided by designing in a low enough Q to prevent this happening, while still maintaining adequate stopband rejection when using cascaded filter sections.

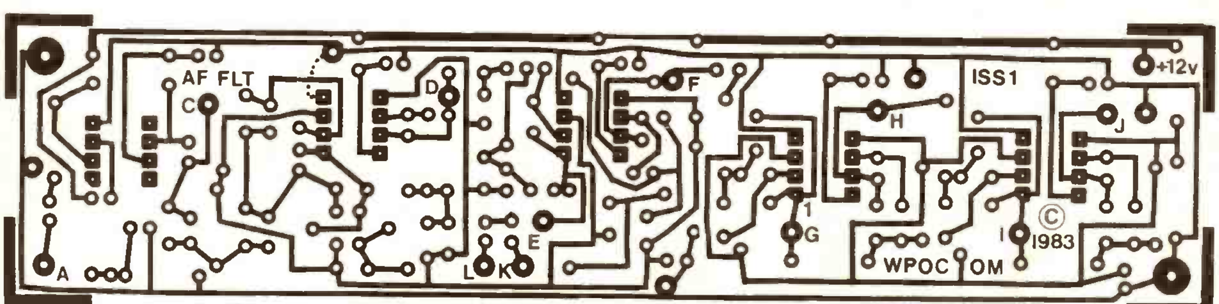
For the peak response sections used here, the Q is fixed at 4.5, with just sufficient filter gain in each stage to overcome the loss of that stage, at the fixed peak frequency of 800Hz. The —3dB bandwidth for one section is 170Hz.

The four cascaded sections of IC4a/b and IC5a/b are each identical (except for the input resistor which sets the gain without unduly affecting the peak response), with outputs available from each stage if required. With all four sections in use (output J) the response is very sharp, with very little tendency to ring if interference pulse are present.

Final output from the filter is taken via C31/R40 to isolate any of the outputs with dc voltages present from the subsequent audio circuitry.

Contruction

The construction of the filter is not particularly critical, either PCB or Veroboard type layouts are satisfactory. Leads should be kept short and all connections to the input and output sockets, and the switch, must be made with screened audio lead. The power supply used to drive the filter needs to be well smoothed. If



NOTE. Dotted line from 2nd IC on left is trackside wire link

Fig. 3 Printed circuit layout for active filter — track side hum problems are experienced, extra decoupling via a 100 ohm resistor and 100μF capacitor on the +12V line to the filter would be needed. This extra decoupling would also be required if the power leads feeding the unit are very long.

If you are using the ready made PCB, the following order of construction is advised:

1. Insert 1mm PCB connection pins through all larger pads from the underside and solder into place.

2. Following the layout and parts list carefully, insert and solder all the resistors, making sure you use metal oxide 2% types where specified. The 9.1k resistor can be 8.2k and 1k in series (the PCB allows for this).

3. Insert and solder all the capacitors, keeping the bodies as close to the board as possible. Again several capacitors may be needed in some places to make up the value — these are designated 'a' and 'b' on the layout and values are given for each in the parts list. Make sure the polarity of the electrolytics is correct.

4. Finally insert and solder the 4 ICs, with the pin 1 identifier correctly placed. When soldering, be careful not to bridge the pads.

5. Carefully inspect the PCB for solder bridges etc, before applying power.

No alignment is required so it should work first time. If it doesn't, try to isolate the stage which isn't working first by trying each output in turn. Then have a look at the components to see if any values are wrong. The voltage check chart will be of help here, but allow for the fact that there will be some variations due to component tolerances.

Table 1 Component list

R1, 3	2k2 5%
R2, 4, 7, 8, 25, 26	27k 5%
R5, 12, 29, 40, 41, 42	56R 5%
R6	2k2 5%/ 15k 5% (see text)
R9, 28, 32, 35, 38	2k2 2%
R10	9k1 2% (8k2 + 1k)
R11	100k 2%
R13, 14, 16, 17, 18, 20, 21, 22, 24	10k 2%
R15, 19, 23	20k 2%
R27	68k 2%
R30, 33, 36, 39	180k 2%
R31, 34, 37	82k 2%

All resistors marked 2% should be 2% or 1% tolerance metal film types. Those marked 5% can be 5% tolerance or better carbon film.

C1, 2, 3, 4, 5, 10, 20, 21, 24 31, 32, 33	10μ/ 16V radial electrolytic
C6, 7, 9	27n (22n+4n7) mylar
C8, 12	12n (10n+2n2) mylar
C11	15n (10n+4n7) mylar
C13, 19	2n2 mylar
C14, 18	22n mylar
C15	18n (10n+6n8) mylar
C16	1n5 polystyrene
C17	33n mylar
C22, 23, 25, 26, 27, 28, 29, 30	10n mylar

IC1	741N (8 pin DIL)
IC2, 3, 4, 5	LF353N

Also required: 15 1mm PCB connection pins
Screened audio cable
PCB
1-pole 8-way switch (if all positions used)

The PCB and complete set of parts including a rotary switch is available from WPO Communications for £15.45 inc. VAT & p&p.

Table 2 Voltage check chart

All voltages measured with high impedance digital voltmeter, no AF input.

PIN	IC1	IC2/3/4
1	nc	6.1
2	6.1	6.1
3	6.1	6.1
4	0	0
5	nc	6.1
6	6.1	6.1
7	11.9	6.1
8	nc	12.0

nc = no connection

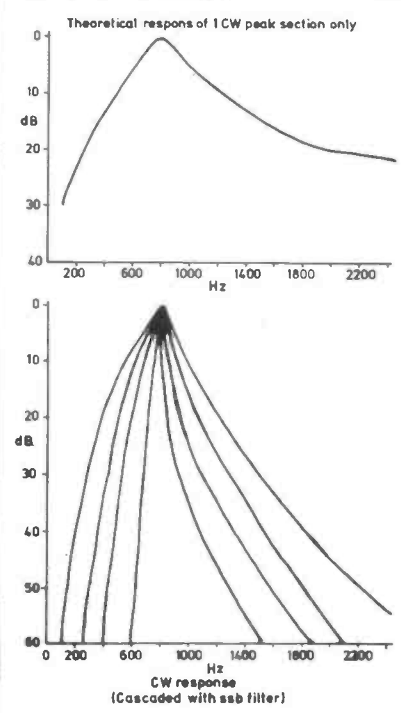
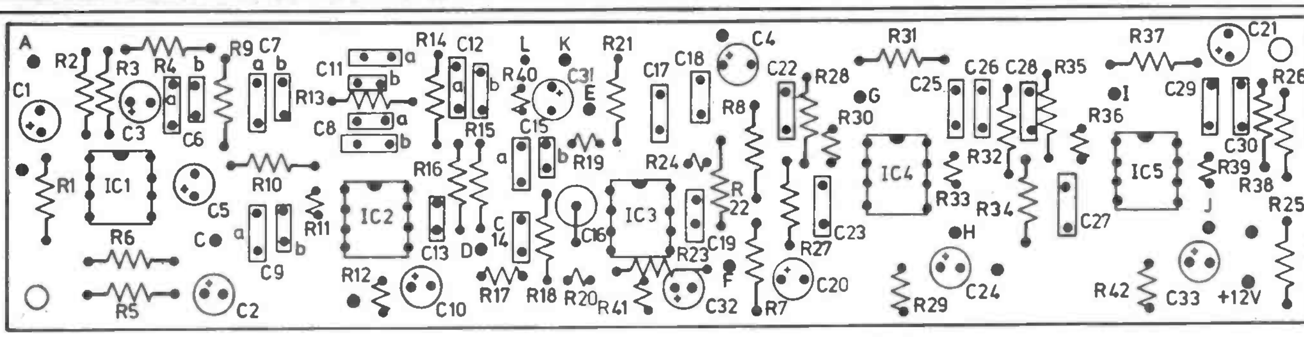


Fig. 4 Frequency response of CW filter sections



N.B. Capacitors marked a and b are paralleled on p.c.b. to make up value shown on circuit diagram,
● = Connection pin.
Unlettered connection pins are earth.
Active audio filter – Component layout

Fig. 5 Layout of components on PCB

Avoid mounting the unit near to any AC mains supply or AC-carrying leads. If you are going to use it as a 'standalone' unit with an additional AF amplifier, the input, if driven from the speaker or headphone output of your receiver will need to have its input impedance reduced — connect a 4.7 ohm 1 or 2 watt resistor between point A and ground.

Use with Project Ω transceiver

As mentioned earlier, the gain can be varied by changing the value of R6. For the HF transceiver project, R6 should be 2.2k for unity gain. As IC2b (the 2.2kHz low-pass section) is somewhat superfluous with this design which already uses a 2.2kHz SSB filter, it can usefully have the component values changes to the same as IC3a (ie. C11=.022µF, C12=.018µF and C13=.0015µF). This gives an additional 2.0kHz low-pass section in cascade which will improve the skirt rejection still further.

Using with the *DSB80*

When used with the *DSB80*, the unit can be mounted behind the main PCB with the input at the left-hand side of the board. The switch for SSB/CW on the transceiver was specified as a double-pole changeover type — this was to accomodate the switching of this filter. It is suggested that the 2.0kHz bandpass output is wired for the SSB position, and one of the H, I or J outputs for CW, depending on your preference.

If you want more positions available, then a rotary switch will be required. If the digital display of the *DSB80* is not being used then the switch can be mounted on the front panel (don't forget to use screened leads), otherwise it will have to go on the back as there isn't much room elsewhere. The drawing shows how to connect up the filter with the DSB80 as a two position unit only. ●

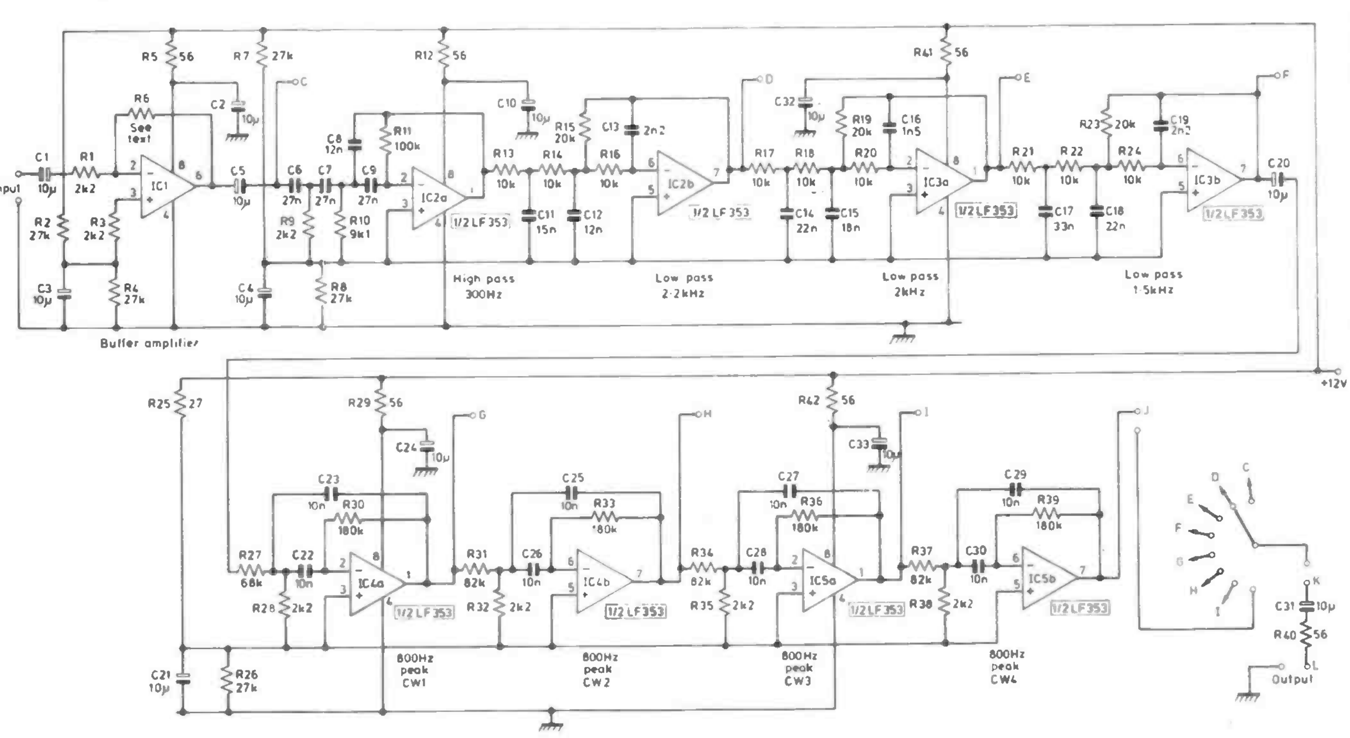


Fig 6. Active audio filter circuit

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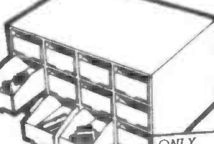

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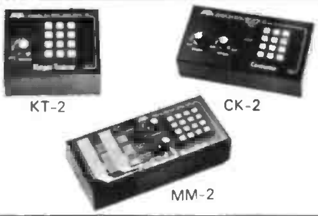
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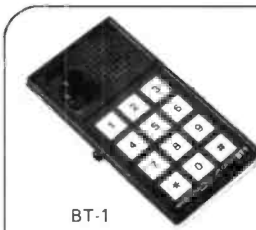
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