HAM RADIO TODAY

AN ARGUS SPECIALIST PUBLICATION

SEPTEMBER '83

90p

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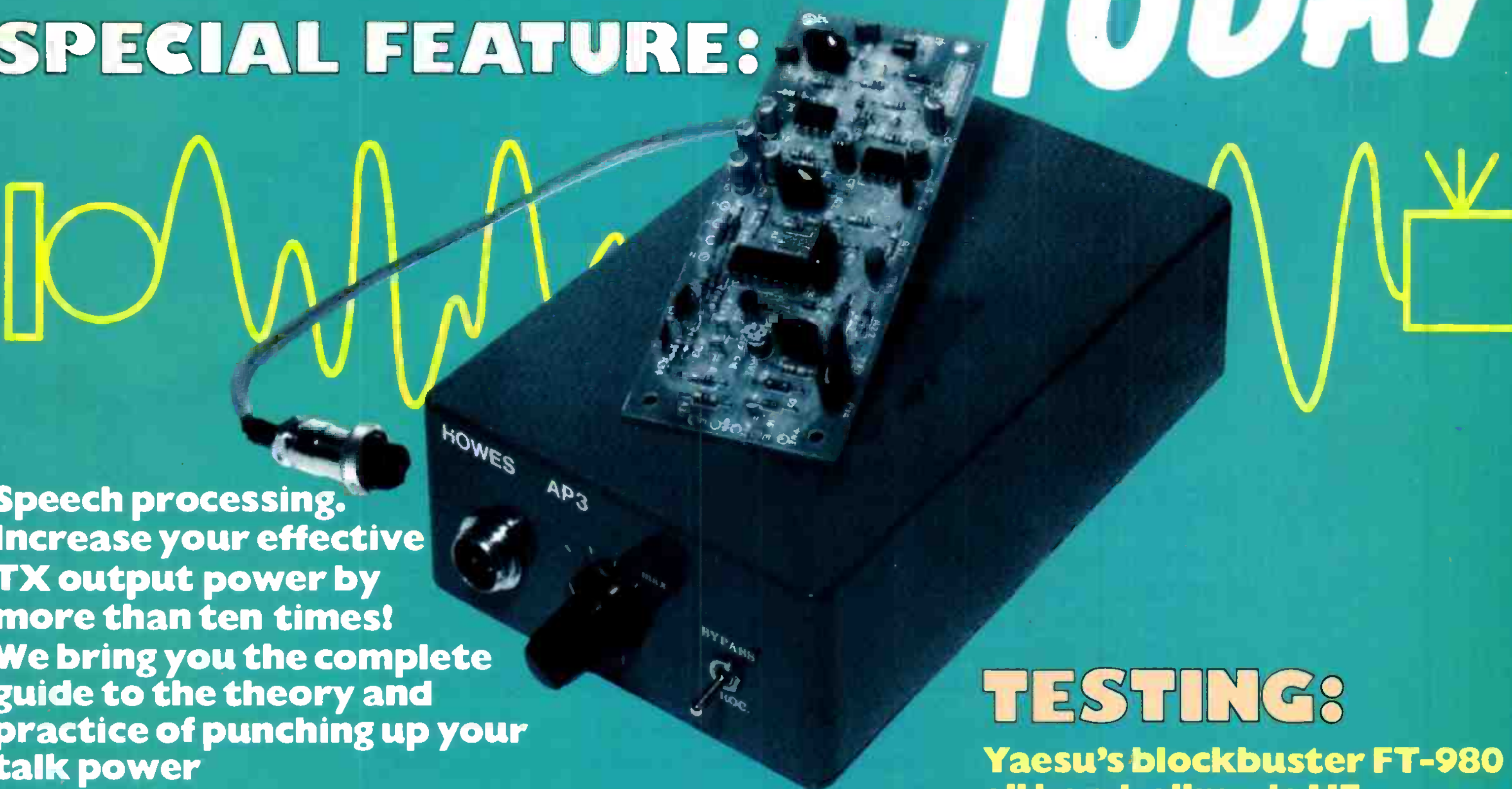

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HAM RADIO TODAY

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REGULAR COLUMNS

CONSTRUCTION

FEATURES

REVIEWS

Part 6 of the KW2000 series 'converting to the new bands' will appear in next month's issue

LETTERS

Please address correspondence to:
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145 Charing Cross Rd,
London WC2 0EE.

RADIO YESTERDAY

Sir, I've been looking through the June edition of *HRT* and came across a very interesting article by Jack Hum. It took me back a number of years because Mr. Leslie McMichael and myself knew each other right back before the first War, and that of course is going back some time.

Now the heading of this article was "There was a time when they were all two-letter callsigns". Well, back before the War they were three-letter callsigns — Mr. Leslie McMichael's call was MAX, and my call was DNX, Wimbledon Technical Institute was WNX, Mill Hill School was (if I remember rightly) MHX and Mr. Perrier PFX. Gammidges in those days issued a list of amateur callsigns. It wasn't a very large list as you'll appreciate.

We used to contact Mr. Leslie McMichael — on spark of course. I used to live in Worcester Park in Surrey. I forget where he lived but it couldn't have been very far away because real DX in those days was 50 miles. If you did 50 miles on spark you were really doing something.

After the War amateurs were issued with two-letter callsigns, almost always appropriate to their name. I had a business then called Dean Brothers, and my callsign was 2DB. And I see Jack Hum's callsign is G5UM — 5UM to begin with.

If I remember rightly Leslie McMichael was one of few who founded the BBC — the British Broadcasting *Company* to begin with. As time went on he got in conjuction with a B. Hesketh of Slough, who had a very small factory there making radio bits and pieces — condensors, HF transformers and resistances. He went in conjuction with B. Hesketh to produce a radio set, and the name then was "L. McMichael in conjuction with B. Hesketh". The Trade Mark then was "MH". Later on it turned into L. McMichael, then it went into L. McMichael Limited as a public company. Now I joined McMichael Radio when it was "McMichael in conjuction with B. Hesketh Limited", and I brought out a portable set then. Of course, portable sets were more or less unknown, and we developed a portable set on an Armstrong circuit. Mr. Mac was very interested and we went along to their research department to more or less get the set in production, but it had a peculiar whistle with it which you couldn't get rid of — the quench frequency. We tried all sorts of ways of getting rid of this whistle, but they decided not to carry on with our set, and went on with a four valve set of their own.

Incidentally, I think Mr. C.G. Allen was the first person in England to receive American Broadcasting, WJZ. He had quite a lot of publicity over it. Later on I think he was the first person to receive an Australian broadcast, because I know that later on the 2LO microphone was presented to Mr. Allen, and the last time I saw him he had it displayed very proudly at home.

You weren't allowed to use CQ before the War, you had to call "test". Incidentally, the old SOS signal, years and years ago, was "CQ D". I think the first ship to use SOS was the *Titanic,* but I'm not quite sure on that.

LESLIE DEAN DNX

USING 10 METRES

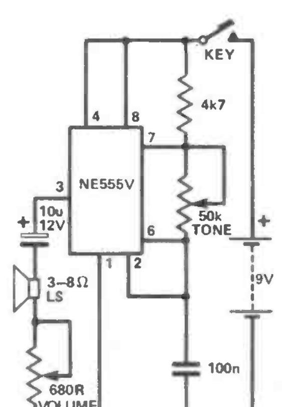
Sir, The article on 10m by G3WPO was very good. It is an interesting and oft neglected band. As an SWL (and now G6) who had, as one of your writers put it, "a flirtation with 11m" I am fully aware of the possibilities of this band. Of course the antenna requirements are much easier for those of us with a small garden. 28MHz on a flat day is still more pleasant than a flat 2m band.

This brings in my second comment. I use the much maligned *Liner 2* by Belcom which can be obtained secondhand for under £100. In company with a BNOS 100W linear, a ZL special beam and Piezo *DX354* mike, it has yielded some continental DX and one or two people have complimented me on the audio. The antenna incidentally is only 20ft AGL and we are surrounded by trees.

The *Liner 2* uses a very similar system to the Mizuho you mentioned and puts out 10W using a 12V supply.

Finally, on morse. A pleasant way to learn is to invest a small sum in a few of the morse tapes that are available. I have found these useful and several have the characters sent at 12WPM which is important since one gets to recognise the right speed. After the listening has progressed, and not before, a decent key (not a nasty buzzer!) should be purchased. It's worth spending out on a key that has an adjustable gap and tension. The practice oscillator published in several RSGB books works well, although a 680R pot was substituted for the 2k5 one shown for the volume to make it sound better.

Thus:



There may be some who have not seen this circuit — I built one with a small mains PSU. As always your mag is interesting and lively.

PETER G6NSU

BACK ISSUES

Sir, Today, I purchased the July issue of *Ham Radio Today*. I also have every issue since launch except the June issue. It seems that *no* newsagent in Southend ahs been able to get any copies of the June issue. W H Smith, who normally supply my magazines, have had no luck in obtaining a copy for myself and other radio amateurs.

I would be most obliged if you could advise me if you have any back issues available? From where do I obtain same? And the cost with postage.

For all that, it's a damn good mag and more interesting than some of the others available. One suggestion, how about a mods page for those of us who like to rummage about inside the works?

R H REYNOLDS G6WEM

Back issues are available from our Subscription Dept for £1.50 each including postage. The address is 513 London Road, Thornton Heath, Surrey CR4 6AR — Ed.

GOT AN MC3401?

Frank, Could you please let me know where the Motorola MC3401 device mentioned in Bill Sparks excellent article on 10m conversions in June's HRT is obtainable, as a fair number of component suppliers have never heard of it.

Glad to see your mag is becoming such popular reading, the format chosen seems to be about right with not too much emphasis on what John Smith's club is doing next Tuesday night!! and enough constructional projects to keep us soldering iron addicts in the workshop for hours!

TIM BALDERSTONE

Yes. It is also known as an LM3900 — Ed.

DISGUSTED, BRENTWOOD

Frank, Really now, I thought we might have been able to look forward to a more constructive relationship than that implied by your efforts to publish Jim Bourne's comments on page 5 of your July rag. Are you under orders to be facile, or does it come naturally?

A "component firm in Brentwood, Essex" sells a great many catalogues, and by selling these for money is able to: (a) Provide a lot more information and up to date pricing on the page, and not tucked away in some awkward price supplement; (b) Offer three £1 discount vouchers, so that the majority of our regular customers are actually 'paid' to buy a catalogue.

Correspondents such as Mr Bourne offer a reasonably good indicator as to why, as you have yourself observed, the amateur radio components market is not exactly oversubscribed with specialist suppliers, and why most respectable professional distributors shudder at the prospect of engaging in the sort of business dealings where there are two enquiries to every order.

It is therefore surprising that the Electronic Component Industries Federation "Distributor of the Year" is still doing its best to provide a relatively unique service to a market that revels in raiding the "firm's stores" for most of its bits (being near to an "electronics firm in Chelmsford" we get to hear all about the electronics equivalent of filching the firm's paper clips and pencils). And even more surprising that this wicked firm has a standing offer of free bits to men (and women) of ideas, who undertake a project with the aim of publishing a feature (even in magazines published by firms in "Charing Cross Road").

Come, come Mr Ogden, next thing you'll be publishing letters about us glorying in the slaughter of innocent "Ham Radio publications".

Love to you all,

BILL POEL
(Ambit International)

Dear Bill, I always look forward to receiving letters from you. As to your plea for a more constructive relationship, I take pleasure in sending you a rate card. No, seriously folks, the cost of making a sale is something which I presume that you put into your retail price margins so there is little scope for moaning about the retail component business.

Having said that, Ambit offers an exceptionally useful service to people with an interest in building radio gear. While most other retail component suppliers have all but forsaken the market in favour of digital whizzbangs, the company has stuck with it and expanded its stock lines. I have no hesitation in pointing our readers in the direction of Brentwood. Far from it. Most of the bits for HRT projects can be purchased from Ambit. Good luck to you, Bill and no more wingeing about your lot — Ed.

TV TIMEBASES

Sir, I read G4PAY's letter (July 83) on TV timebase QRM with considerable sympathy.

Would it be possible for *HRT* to run a *Which?* style survey of televisions giving details of their relative spurious outputs and sensitivity to TVI?

Obviously we cannot dictate which brands of TV our neighbours buy, but we can at least put our own houses in order.

MARK PALMER G8IQV

Well, we can't at this moment because we haven't got the information. I've got an ITT 340 chassis and that's pretty good. If readers with an interest in combating line timebase TVI would send in a report to this office about the relative emissions from their own set (and note about susceptibility to TVI) I will publish the results as a league table provided that we receive enough — Ed.

UPSIDE DOWN

OM, Your ideas of an inversion are inverted! (*HRT*, July). In the normal atmosphere both temperature and humidity fall with increasing altitude (normal "lapse rate").

Under inversion conditions the inverse occurs ie. the temperature or humidity or both *rise* with increasing altitude. Hence your statement that "dense but humid cold air sits on top of warmer, dryer air close to the surface of the ground" is not correct. Subsidence would occur.

Many mechanisms of inversion formation exist but the commonest cause of inversions, maybe of limited extent and duration is ground cooling by radiation to a clear, night sky, especially in Spring and Autumn. In this case the Earth loses heat, cooling the lower layers of air which in turn can lose moisture (radiation fog), whilst the higher layers remain warmer and moister — the exact reverse of your explanation. Several layers may form in this way in which case ducting occurs which is often very directive. I do agree with you on the fact that the higher the frequency the more often tropo effects can be 'seen' and would urge the VHFer to move higher in frequency! One common effect in this part of the World is that GB3MLE on 70cm often disappears when there is inversion around and I start to look for Continental DX — that's because the height of the beacon antenna is often *above* inversion level and the signal is refracted into space rather than contained.

MIKE DIXON G3PFR

Thank you very much for your most interesting letter, Mike. I accept every point that you make. In my defence, I approached a large number of people for a definitive article on VHF propagation but no one came forward. In the event I had to write it myself and I am the first to admit that I am more at home with a soldering iron than a barometer! However, the practical implications in my article hold good and that is probably what counts at the end of the day — Ed.

HELP WANTED

Sir, Is there an amateur who owns a signal generator living in the High Wycombe area who would kindly realign a Trio *JR500S* communications receiver at a reasonable price for an OAP? The receiver is only slightly out of alignment, but even so, I would not like to try the trial and error method. A service manual with trimming details is available.

E. VAUGHAN

Any offers to HRT please, and we'll pass them on — Ed.

SLAVE SYNTHESISER CHIPS

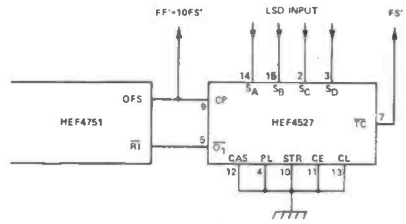
Sir, I read with interest your article in Ham Radio Today featuring your general coverage transceiver.

I am at the moment building a synthesiser to operate in conjunction with a multimode 2m transceiver.

I'm also using the Mullard HEF4750 and 4751. At the moment I'm using a second 4751 in slave mode and I am experiencing difficulty in getting this to work correctly. I noticed in your article you refer to being able to replace the slave 4751 by four CMOS chips and wonder if you could supply further information on this.

R.T. MIFLIN G8KLG

Yes. The slave chip can be replaced with a pair of cascaded 4527 rate multipliers programmed individually by a pair of 4029 up/down counters. Unfortunately, I haven't had the time to produce a full account of stepping down to 10Hz resolution with the chips but it can be done and the sketch below illustrates the basic idea (courtesy of Mullard). One decade is added for each 4527 put into circuit. I will leave you bright people to work out how to hang the other bits of circuitry on (such as the programming arrangements. . . I suggest dual rate frequency stepping. One rate uses the existing 4029's. The high resolution stepping puts the new decade counters ahead of the programming string. Oh yes. Don't forget to increase the PLL time constant. Once again, good luck — Ed.



HANDITALKIE AERIAL

Sir, It is my painful duty to inform you that the "improved handitalkie aerial for 2m", the design of which you published on page 10 of the June issue, is indeed very good.

I use an *IC2E* and, with its 'rubber duck' was unable to work PI, our local repeater, from indoors, although I could hear it very well all over the house. (PI is situated some 15 miles away). I was unable to work the repeater even when someone had opened it!

I built your design and can confirm, with some excitement, that I can now open the repeater and get very good reports — may I thank you very much for it and also for your excellent magazine.

With very best wishes to you and all your colleagues for the success of *HRT*.

J.C. TOURNANT G5MZI

Sir, Referring to your article in the June issue of your magazine (which is a very good one by the way) on VHF and UHF aerials.

I own a Yaesu *FT208R* handitalkie and so read with interest your article on the halfwave aerial for the 2m hand held operation.

Three times I tried to put this aerial together and three times failed. Not being the best of aerial builders I persevered, but now I am about to give up hope of ever completing a working one.

In the article you don't state how big the gap should be between the turns, which I'm sure must be quite important.

Any ideas or suggestions you may have would be appreciated, on what material to use, how best to build it, and whether you can buy them on the open market or not.

Hope that you can help as I'm looking forward to trying out this antenna very much. All the best and keep up the good work.

S. DIXON G6TJN

Thanks for your letter. I provided the very abridged building instructions re. a half wave 2m aerial for handitalkies as the basis for individual experimentation rather than a firm recipe. It is worth pursuing because the hand held performance improvement is dramatic. It is roughly equivalent to running 100W of RF rather than the typical 1W!

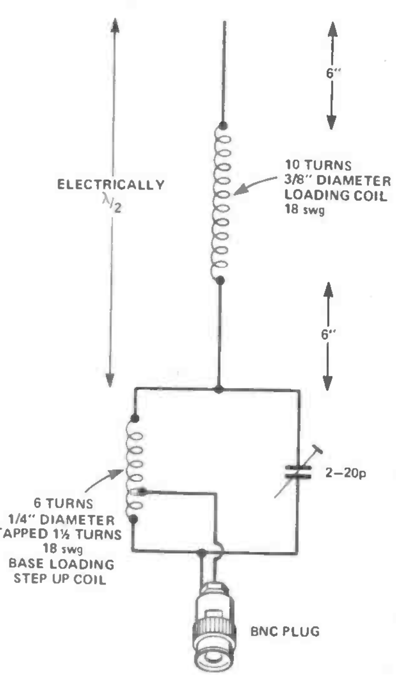
Yes, gaps and things like that are important but so is the guage of wire, the material on which the loading coil is wound and the diameter of the whip sections. However, the general points are these. The first thing you will need is a miniature bulb rated at 28V 0.04A. Lower voltage ratings can be used but you must be careful not to blow the bulb. The current rating must not be higher than 0.04A though. Solder on a piece of bare copper wire to the outer casing of the bulb. This is held in the hand with the centre contact as the RF sensing point. Next, get the base loading step up network to resonance. Connect an SWR meter to the output socket of the rig and plug the BNC step up coil assembly into the 'aerial output' socket on the meter (you will probably need an adaptor).

With the aerial assembly removed, tune the trimmer on the coil until something happens on the SWR meter. The needles should thrash about near resonance but you won't get a sensible reading at this stage. Next touch the bulb centre contact to the top of the coil. At resonance, the bulb should light quite brightly. If you can't get it to light, then play around with the number of turns on the base step up coil and/or trimming capacitor values. Don't proceed further until you are sure that resonance does occur. With the lamp lit brightly, the SWR reading should begin to make some sense.

Without readjusting the trimmer, connect the rest of the aerial assembly. Run the bulb contact over the length of assembly and note positions where it starts to glow. These should be at the ends of the centre loading coil with a null in the physical centre. If there are no clear voltage nodes on the aerial, then start playing with the number of turns on the centre loading coil.

If the bottom section lights the bulb but the top doesn't, take some turns off. If the top does but the bottom doesn't, put turns on.

Eventually, some sort of balance between top and bottom should be achieved. At this point, start looking at the SWR again. Adjust the trimmer for lowest reading. Proceed with fine adjustment of centre loading coil alternately with adjustment of the trimmer. Somewhere, there will be a balance between SWR and a nice deep voltage null at the centre of the middle loading coil. Good luck — Ed.



'Improved handitalkie aerial' described in June Technicalities

RADIO TODAY

News about amateur radio compiled by Richard Lamont G4DYA

BELGIUM BANDS AXED

Belgian amateurs have lost three microwave amateur bands, and they face new restrictions in every part of the radio spectrum.

Officials of the *Union Belge des Amateurs Emetteurs* (UBA) were summonned to a meeting on June 24th by the Belgian Government, and told of several changes to the amateur licence that would come into force on July 15th. The 70cm band was cut from 430–440 to 434–438MHz, making international and amateur television contacts more or less impossible.

The 1.3, 2.3 and 5.6GHz bands were cut completely. On 10GHz and above, there is a new power limit of 100mW.

The Class C licence, which allowed 500W on the HF bands, is being scrapped. All Belgian amateurs will be restricted to 125W. On 2m and 70cm, the power limit is cut from 125W to 30W output.

The Belgian Government is bringing in a new 'introductory' licence, which will allow people to use 15W of FM, anywhere in the 2m band, with minimal technical qualifications.

The official reason given for these 'changes' is to protect other users, including *Syledis* on 70cm.

Comment: the address of the Belgian Embassy is 103 Eaton Square, London SW1.

Photo: Mike Ellis G4ROM

23cm aerial used by the South Manchester Radio Club on High Edge, near Buxton, Derbyshire for VHF NFD. All four of their contest stations managed to break down at some point. The 70MHz transverter would only work with the lid off, and it didn't care too much for the local beacon. The 2m transceiver was less subtle — it just packed up. On 70cm, the preamp switching failed. On 23cm, the dish had to have its rotator repaired at midnight!

RADIO DEPT. RESHUFFLE

The Radio Regulatory Department (RRD) has been transferred from the Home Office to the new combined Department of Trade and Industry. This is a result of Mrs. Thatcher's post-election Cabinet reshuffle.

The new Department, headed by former Tory Party Chairman Cecil Parkinson, will (according to the Home Office's final press handout on the matter) take over "band planning and general use of the radio spectrum in the UK; representation of the UK in international frequency negotiations and liaison with foreign administrations; frequency co-ordination with neighbouring administrations; licensing of the civil use of radio; and general responsibility for the Wireless Telegraphy Acts, including enforcement and the control of interference".

British Telecom will eventually disband its Radio Interference Service, and it will cease to carry out the amateur morse test. As yet the DTI has not said how, or when, it intends to replace these functions.

Alex Fletcher MP is the new Parliamentary Under Secretary for Corporate and State Affairs at the DTI, and "radio frequency regulation" will be one of his (many) responsibilities.

The Home Office is still responsible for broadcasting, including satellite and cable TV, and its Directorate of Telecommunications will still look after the communications systems for police, fire, nuclear early warning and civil defence services.

AUSTRALIAN TV SNAG

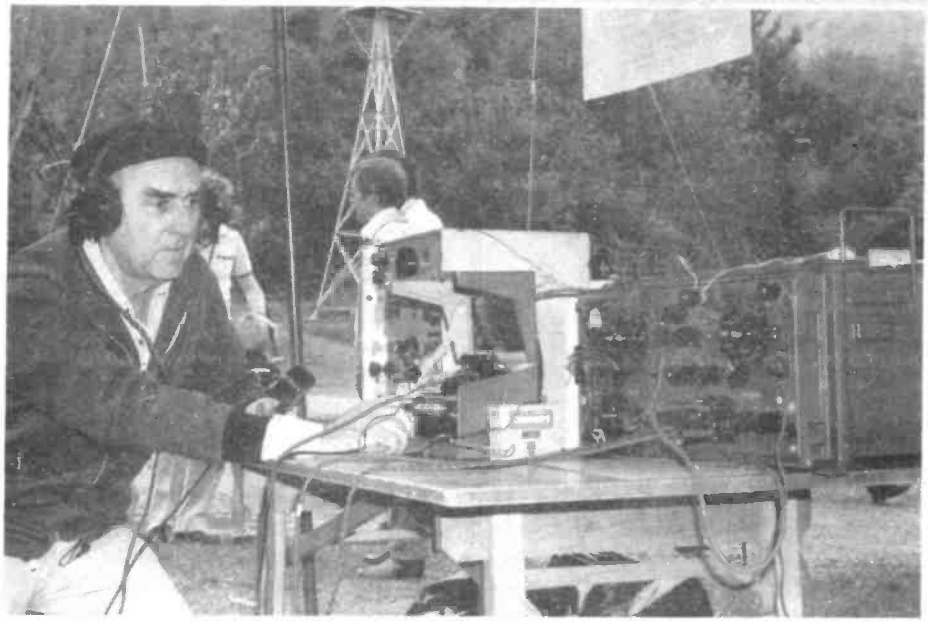
A plan to broadcast films about amateur radio and courses for aspiring amateurs on amateur TV has raised eyebrows at the Australian Department of Communications and upset local commercial broadcasters.

The plan made headlines in one Sydney newspaper which described VK2DTK, a club station, as "an alternative to the soapies" and "television for the boffins".

It appears that amateur service regulations do not allow for this type of operation where the signal is not directed at one or more particular known stations.

The plan now depends on the DoC's interpretation of the regulations. The question of the legality of broadcasts by amateur stations also brings into doubt the weekly Wireless Institute of Australia broadcasts.

— Amateur Radio Action



WIRELESS DAY WASHOUT

Vintage Wireless Day at the Chalkpits Industrial Museum, Amberley, Sussex was marked by a shower of hailstones the size of golfballs which tore into the exhibitors' stands, and literally broke the event up.

The annual gathering of steam radio buffs (the Editor included), attracted a fair number of people despite a date clash with HF National Field Day. A number of stations were operational at the Amberley venue including the 400W installation at the permanent vintage radio section manned by the all amateur Brownlow family headed by Gerry G3WMU.

There was plenty to see and buy until the storm struck. Fortunately, the permanent museum exhibits, a fascinating collection given to the Industrial Museum by Ron Ham and David Rudlam, were not at risk from the freak weather.

The Industrial Museum is well worth the £1.40 entrance fee although a visit to the vintage wireless section is compulsory for anyone with half an interest in the subject. It covers both the civilian and military developments in radio technology from spark gap transmitters onwards; the driving force of military development is particularly evident. To anyone under the age of about 35, the exhibition of domestic radios and televisions is a real eye opener. How anyone could have tolerated these magnificent monstrosities in their living rooms remains a mystery.

'84 CALLBOOK

The RSGB's 1984 *Amateur Radio Call Book* will not be published until early next year, in order to include the new licencees who passed the May 1983 Radio Amateurs' Exam. In the past the book has been published in time for the annual ARRA Leicester exhibition.

NEW STATION ON 50MHz

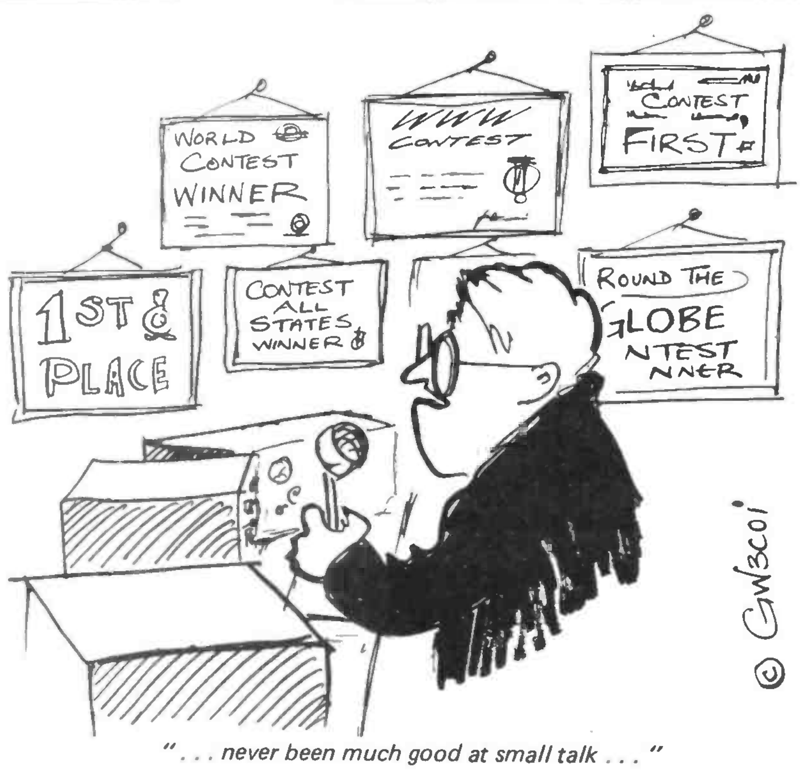
GJ4ICD has given up his 50MHz research permit, and it has been allocated to GU2HML — the first Guernsey station to be allowed on this band.

SPACE SHUTTLE SETBACK

The 'Ham in Space' proposal in which Dr. Owen Garriott W5LFL will take a 2m rig on the Space Shuttle has hit a snag. NASA is proposing that frequencies above 146MHz be used for the uplink. Hopefully this will be changed.

VALVE WANTED

Anybody out there kind enough to sell the Editor a 12Q7 valve?



". . . never been much good at small talk . . ."

OUTER SPACE COLLISION DENTS OSCAR 10

The European Space Agency has admitted that its latest *Ariane* launch went badly wrong when the rocket crashed into a satellite which it had just put into orbit.

Ariane 6 launched both the European Communications Satellite *ECS1* and *Oscar 10* perfectly. The trouble came 53 seconds later, when the rocket squirted unused liquid oxygen fuel into space. The force of the jet was more than ESA engineers expected, and it rammed the rocket into *Oscar 10*, damaging the 2m aerial and the 'bell housing' on the kick motor. This could have caused the motor to burn for too long, putting the satellite in the wrong orbit.

AMSAT hopes to be able to rescue the satellite by a second burn of the motor to put it in the correct orbit. At the moment the satellite spends much of the time in the Van Allen radiation belt, which could shorten its life by between two and four years.

The outer space collision – believed to be the first ever – is extremely embarrassing for the ESA. After several failures, *Ariane 6* was widely seen as the Agency's last chance to prove itself as a credible alternative to NASA.

'2MT' BACK ON THE AIR

The callsign 'Two Emma Tock', used by Marconi's original Wireless Telegraph Company to introduce Britain's first entertainment broadcasts way back in the 1920s, was re-launched by members of the new Marconi Radio Society after a 60-year interval. Over 50 club members, company and VIP guests gathered at Marconi Space and Defence Systems' Stanmore headquarters to witness the start of a weekend in which the callsign, with a 'G' in front, was used to contact over 150 amateur stations around the world. One of the VIPs present was Eric Godsmark, Regional Secretary of the IARU (right of picture). He is seen here presenting a pennant to George Benbow, Chairman of the Marconi Radio Society.

TALKPOWER: a guide to speech processing

Whether it's a pile-up or just random noise that is spoiling reception of your signal at the far end, there are just two ways to improve your signal. One is to stick more ERP in the appropriate direction. The other is to use your existing ERP more effectively. Any other method, such as a change of mode or frequency, needs the cooperation of the other operator. If he can't hear you, he can't cooperate with you.

By Richard Lamont G4DYA

Bandwidth and noise

Any electronic system for recording or transmitting information, of any sort, has two fundamental limitations on it. One is bandwidth, the other is noise. There is not a lot we can do about the bandwidth of amateur speech transmissions; we are stuck with using about two or three kilohertz in the case of SSB. As for noise, whether random, 'white noise' (hiss) or man-made interference, there are a number of things that can be done at the transmitting end to improve the signal at the receiver output. One way is to improve the signal-to-noise ratio of the RF chain, from modulation in the transmitter to demodulation in the receiver, by increasing transmitter power or by building better aerials.

The only other way of sending out a better signal is to change the speech waveform, if possible, so that it is more intelligible for a given peak-to-peak level. Fortunately, speech has a number of quirks that allow this to be done.

Speech waveforms

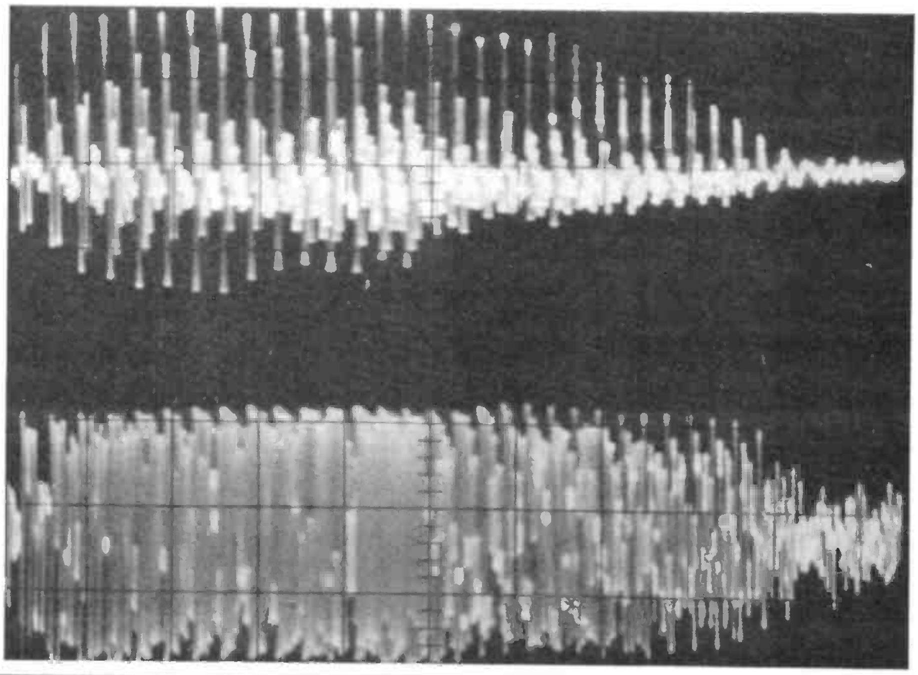
If, as I imagine most *HRT* readers know, you look at a speech waveform on an oscilloscope one of its most striking characteristics is the existence of high-amplitude peaks with relatively little in between. These peaks tend to be produced by vowel sounds, with consonants forming only brief, low-amplitude transients. But it is the consonants that carry most of the information. If the level of the consonants can be boosted, without increasing the existing peaks, then the signal will be much easier to understand at the receiving end.

In fact, the peak-to-average ratio of speech is typically about 14dB, and can be as high as 20dB. The consonants may be 30dB below peak level. The exact figure depends on the many factors that make up the sound of an individual's voice — sex, age, language, accent, personality, mood etc. (Even for a given individual the ratio can vary a lot — people's voices go up and down a lot in both level and pitch when they are excited, much less if they are relaxed.)

As well as being peaky, speech waveforms can be asymmetrical, with positive and negative peaks differing by up to 8dB.

The other important characteristic of speech is its frequency

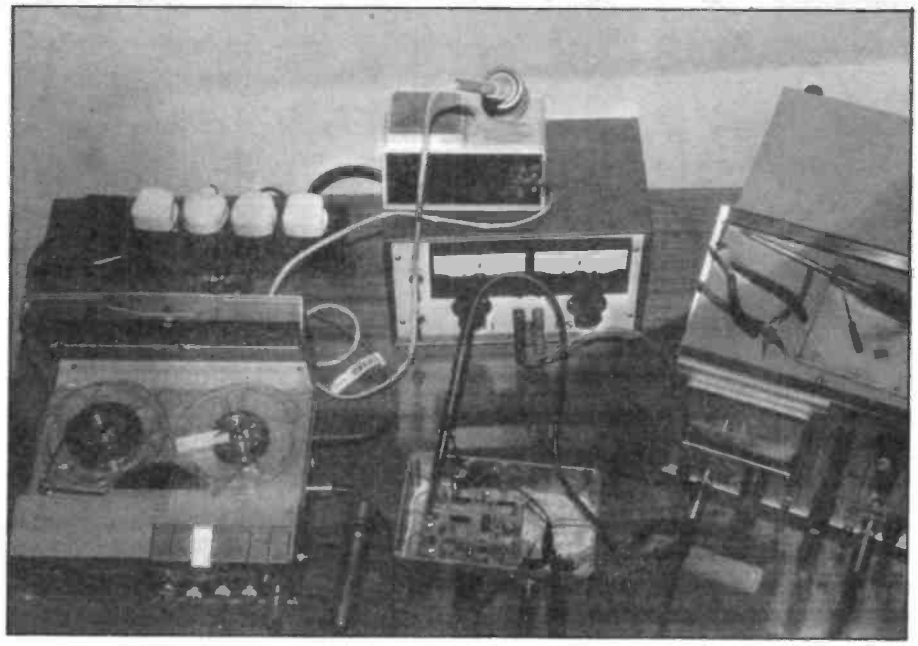
Speech before (top trace) and after clipping (lower trace). Note how the low level transients are boosted in between the large peaks. This doesn't happen with compression



spectrum. Although a bandwidth of 2kHz or so is needed for intelligibility, and about 3kHz for easy recognition of the speaker, most speech energy — the vowel sounds — consists of frequency components below 1kHz. It is the information-carrying, transient, consonents that need the extra bandwidth.

It is possible to improve the intelligibility of speech transmissions by attenuating the low frequency components. This, as we shall see later, also helps reduce distortions produced by processing the amplitude of the speech waveform.

Thus there are two characteristics of speech — amplitude distribution and frequency distribution — that can be altered to improve intelligibility. Good speech processing uses a combination of both techniques.



Test set-up used to get the oscilloscope photo on opposite page

Overmodulation

In practice, any transmitter has some form of protection against overmodulation. (At least it should have.) If the audio level going into the transmitter is too high, then the protection system will be working continuously, by either clipping or compressing the signal. As it is impossible to predict exactly what level your voice is going to peak to, it is inevitable that either the transmitter will be undermodulated, or the protection system will occasionally drop the level.

Compression and clipping, AF & RF

Fig. 1 is the classic textbook graph comparing the four basic methods of processing the amplitude of speech. As it claims to show the precise improvement in intelligibility for a given peak-to-peal level, I can only assume that the graph is based on trials with *tape recordings* of speech. It is only by recording that you can predict the exact peak level of the sample of speech that you use for your experiments.

Real, 'live' speech cannot be predicted so precisely. You have to either undermodulate or compress/clip. In other words, **Fig. 1** should be treated with a king-sized pinch of salt. If AF compression only produces one solitary dB of improvement, ie. hardly any improvement at all, why does every BBC and IBA medium wave transmitter use AF compression?

Amplitude processing

There are two basic methods of improving the average-to-peak ratio of speech — compression and clipping. Both of these methods can be used in either AF or RF stages in the transmitter. I will avoid the term limiting as it means different things to different people — to the RF minded it means clipping, to audio buffs it is a severe form of compression.

Compression is achieved by using the output level of a stage to control its gain (see **Fig. 2**). If the output is too loud the gain is turned down. The output of the rectifier charges up the capacitor in the time constant circuit, which increases the control (sidechain) voltage, reducing the gain of the voltage controlled amplifier.

It is important that the compressor can respond to sudden loud peaks extremely rapidly if a significant 'overload' of the transmitter is to be avoided. This 'attack' time constant needs to be around a millisecond or less. On the other hand, when the gain is recovering during a pause in the speech input, it is important that the gain recovers slowly. If both attack and 'decay' (recovery) had very rapid time constants then the sidechain control voltage would tend to follow the audio waveform. The compressor would then act either as an amplifier with negative feedback, or as a clipper, depending on the 'threshold'. (The threshold of a compressor is, roughly speaking, the level at which gain reduction begins.)

A fast attack and slow decay

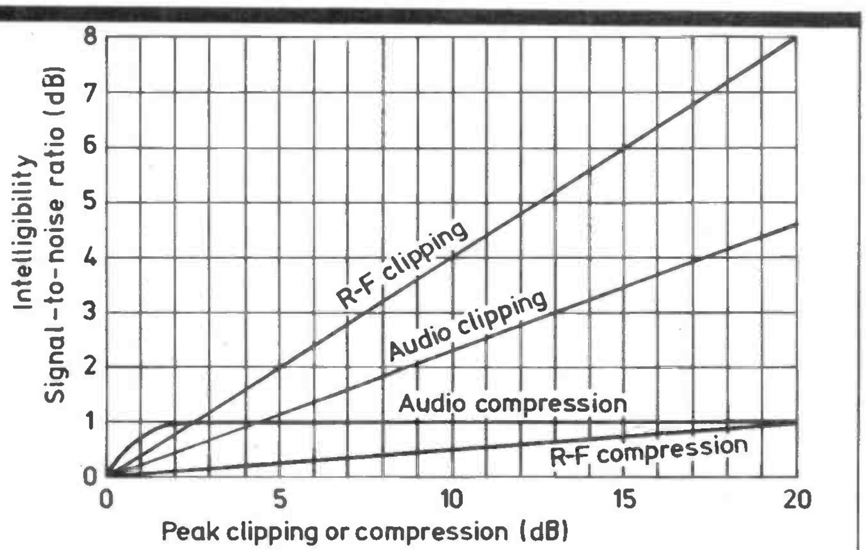


Fig. 1. Theoretical comparison of speech processing techniques often found in the textbooks

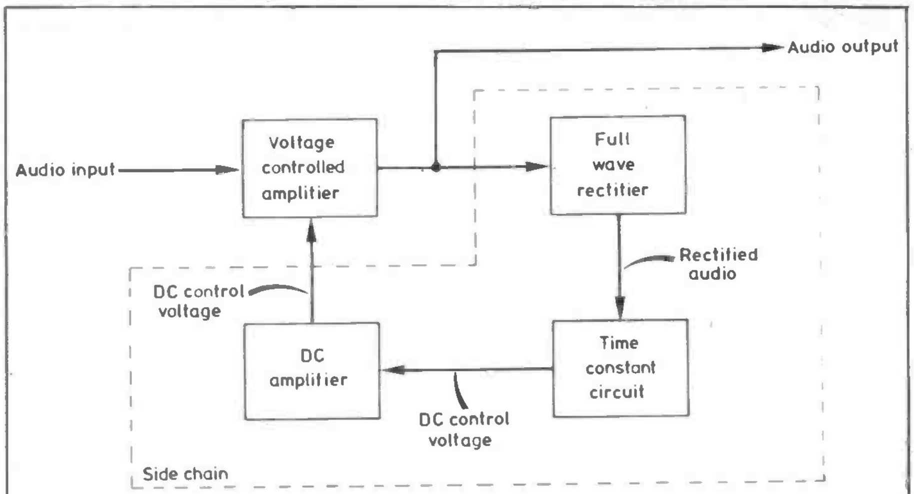


Fig. 2. Block diagram of AF compressor

characteristic can be achieved by charging the time constant capacitor from a low impedance source, and loading it with a high impedance (hence the DC amplifier in Fig. 2). One way of doing this is shown in Fig. 3. TR1 is a phase splitter stage that drives emitter followers TR2 and TR3 with audio signals that are equal in amplitude and opposite in phase. These antiphase signals, after having their DC components matched by R7, 8, 9 and 10, and C3 and C4, are rectified by D1 and D2. The DC output is used to charge C5. The source impedance is merely the (low) output impedance of the emitter followers, C3/4 and D1/2. This source impedance, when multiplied by the value of C5, gives the attack time constant. Assuming a very high input impedance for the DC amplifier, the decay time constant is the product of C5 and R11. As a rough guide, a decay time constant of, say, 200mS is about right for speech. (The IBA uses a time constant of about 500mS for medium wave commercial radio — this is a compromise between ideal figures for speech and music. More sophisticated broadcast compressors use a dual time contant that boosts the average level, prevents overloads and at the same time preserves the contrast between loud and soft passages of music!)

Compression can also be done in the RF stages. In this case, the DC control signal is derived from the PA. When it is on the point of being overdriven, the output valves (sorry, yes, valves!) will begin to draw grid current. This will make the grid go negative. This voltage, suitably filtered, can be used to reduce the gain of earlier stages. Such RF compression is normally termed Automatic Level Control, ALC.

The great problem with compression, whether it is done at AF or RF, is that it cannot follow the speech waveform rapidly enough to boost consonants much. It does, however, make sure that the transmitter is fully modulated on speech peaks.

Audio clipping

Audio clipping is just a question of amplifying the whole signal and then lopping off any bits that are too big. See **Fig. 4**. By comparing (a) and (c), it is clear that although the loud peaks have been savaged unmercifully, the low-level, transient sounds are a lot stronger. Note that although the signal has been amplified by a factor of two (6dB), the peak level of the clipped signal is the same as the peak level of the input signal. Thus there is 6dB of clipping.

AF clipping does produce severe harmonic distortion, but there are a number of ways of alleviating the damage. Firstly, by making sure that the clipping is symmetrical — ie. both positive and negative peaks are clipped to the same level — only odd harmonics will be generated. Secondly, careful audio filtering at both the input and the output will reduce the distortion products — more of this later.

6dB of clipping is not a lot. The Voice of America, for example, uses 9dB on its HF broadcasts. The clipping is obvious but not objectionable. Amateur stations tend to use still higher clipping levels without problems.

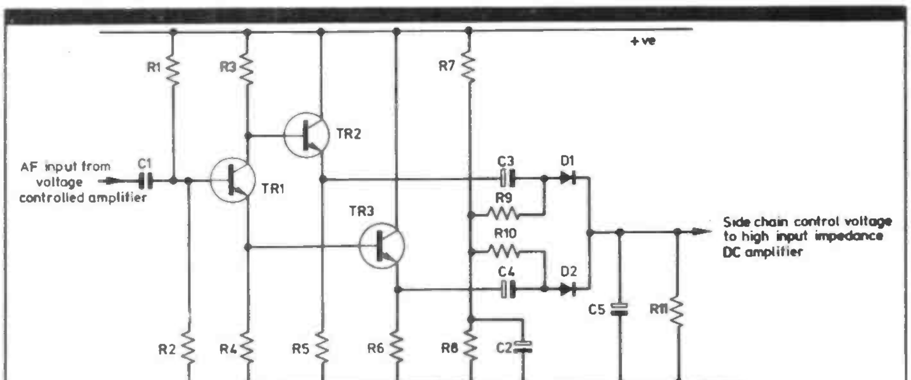
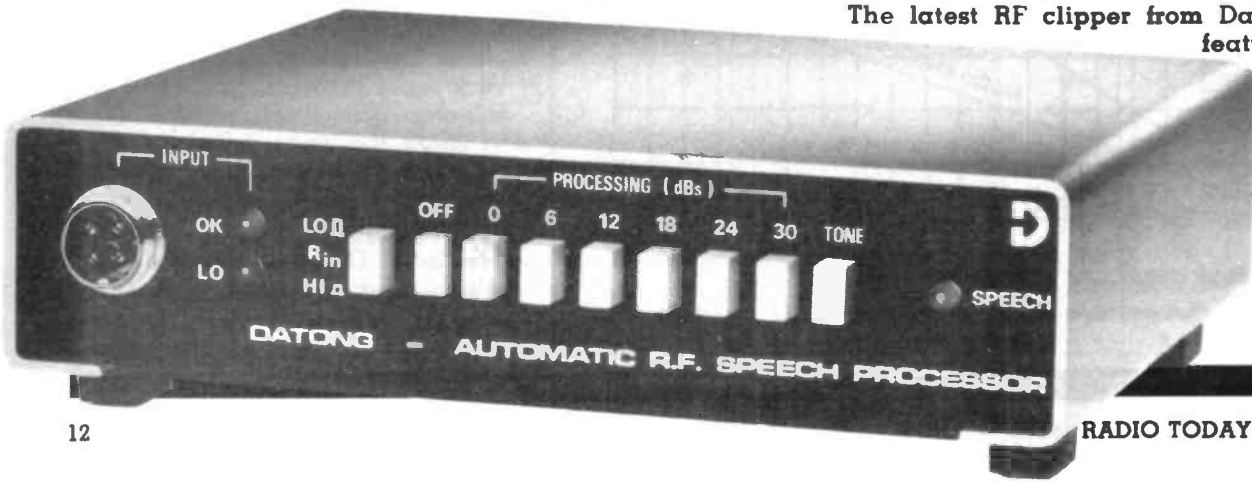


Fig. 3. Circuit for achieving fast attack and slow decay characteristic in AF compressors



The latest RF clipper from Datong. This one features automatic control of the level going into the clipping stage – as does Dave Howes' design in the next article

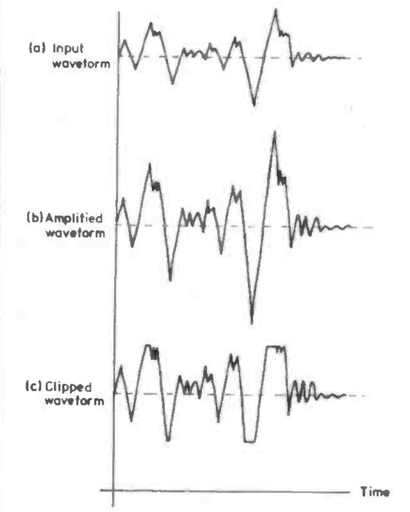


Fig. 4. Effect of AF clipping on speech waveform

As well as harmonic distortion, there is intermodulation distortion produced whenever two or more signals of different frequencies are passed through a non-linear stage. Sometimes in-band components can be generated from intermodulation between an in-band and an out-of-band component, or from two out-of-band components. For example, an 8kHz and a 6kHz signal could mix to produce a 2kHz intermodulation product. This is one reason for filtering the input as well as the output.

Filtering

The harmonics produced by audio clipping must be filtered out before modulation, or they will produce sidebands a rather naughty way from the carrier. A great deal of care is needed with the design of a suitable low pass filter to make sure it does not introduce excessive ringing on the waveform, otherwise the intended peak level will be exceeded. For more information on the transient, step response of low pass filters see references (1) or (2).

When designing low-pass filters for an outboard speech processor, bear in mind the existing transmitter filters.

As far as the input of the clipper is concerned, the usual trick is to have a high pass filter with a gentle slope of 6dB/octave, and a cut-off frequency (−3dB point) of about 1kHz. This has a number of effects. First, it reduces the level of the vowel sounds, which as well as being high in amplitude tend to be low in frequency. Second, the harmonic distortion produced by clipping these sounds is also reduced considerably.

The best filter response depends on the operator's voice, the frequency response of the microphone and the existing response tailoring in the transmitter.

RF clipping

In the early seventies there was a great deal of excitement about RF clipping. This is doen by clipping an SSB waveform instead of raw audio. The advantage of this is that the harmonics produced by the clipping process will be out of the wanted channel, and can be filtered out easily. Fig. 5 is a block diagram of such an arrangement. RF clipping can take the form of an outboard speech processor, that converts audio to SSB, clips it, then turns it back into audio. Alternatively, in SSB transmitters, the clipping can be carried out in the IF stages, where there is an SSB signal ready to be clipped. Many modern rigs do this anyway.

RF clipping does get round the problem of the in-channel harmonics that beset AF clippers. They do, however, suffer from exactly the same intermodulation distortion produced when two or more different frequencies are clipped simultaneously. Also, bandpass or any other filtering will affect the shape of the precisely clipped flat top of the waveform. Thus the only advantage of RF clipping over AF clipping is the ability to remove harmonic distortion completely. As we've already seen, tailoring the response of the signal before clipping can do a great deal to solve this problem at much less complexity than RF clipping. You pays your money and takes your choice.

AF clipping is perhaps not so good for SSB, because the squared-off waveform tends to produce a rather peaky SSB envelope. This effect can be offset to a large extent by the LF role-off filter at the input.

Duty cycle

Any effective method of speech processing will, as intended, increase the average-to-peak ratio of the transmitted signal. It is important that the ratio — known as the duty cycle — is not more than the transmitter can handle. Some transmitters, especially those with PAs that use line output valves, are simply not man enough for the job. They will get very hot and therefore unreliable. Valve life will be greatly reduced. Most modern rigs have quite adequate speech processing in them anyway, and additional processing can do more harm than good. The most important thing is to avoid overdriving the rig — speech processors tend to have plenty of spare gain in them — as this will not increase your power output, except by adding distortion, which may be out of channel. Also, excessive gain will increase background noise and shack reverberation, thus *spoiling* intelligibility.

Many older rigs, and the simpler rigs, do not have any speech processing. In that case then an outboard processor can be a great help. If you want the ultimate then build/buy an RF clipper. If you want something that is a lot cheaper and simpler, that you can build yourself, yet very nearly as good as an RF clipper, you can do little better than read Dave Howes' article in the next few pages.

REFERENCES

(1) D.C. Hamill, Transient response of audio filters, *Wireless World*, vol. 87, p.59-64, August 1981.
(2) F.F. Kuo, Network analysis and synthesis, 2nd edition, Wiley, 1966.

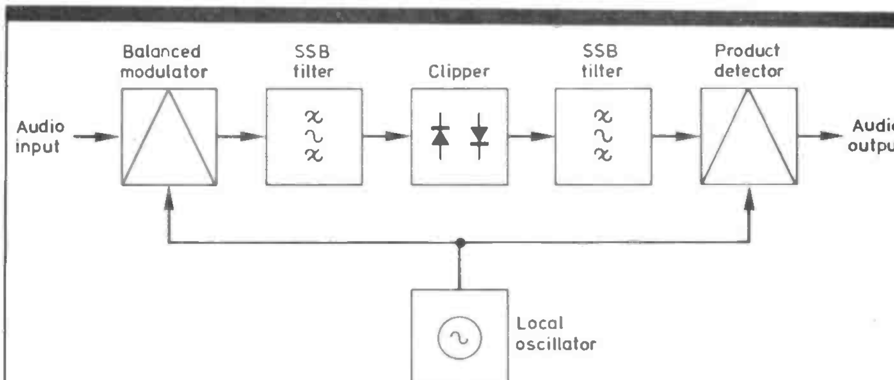


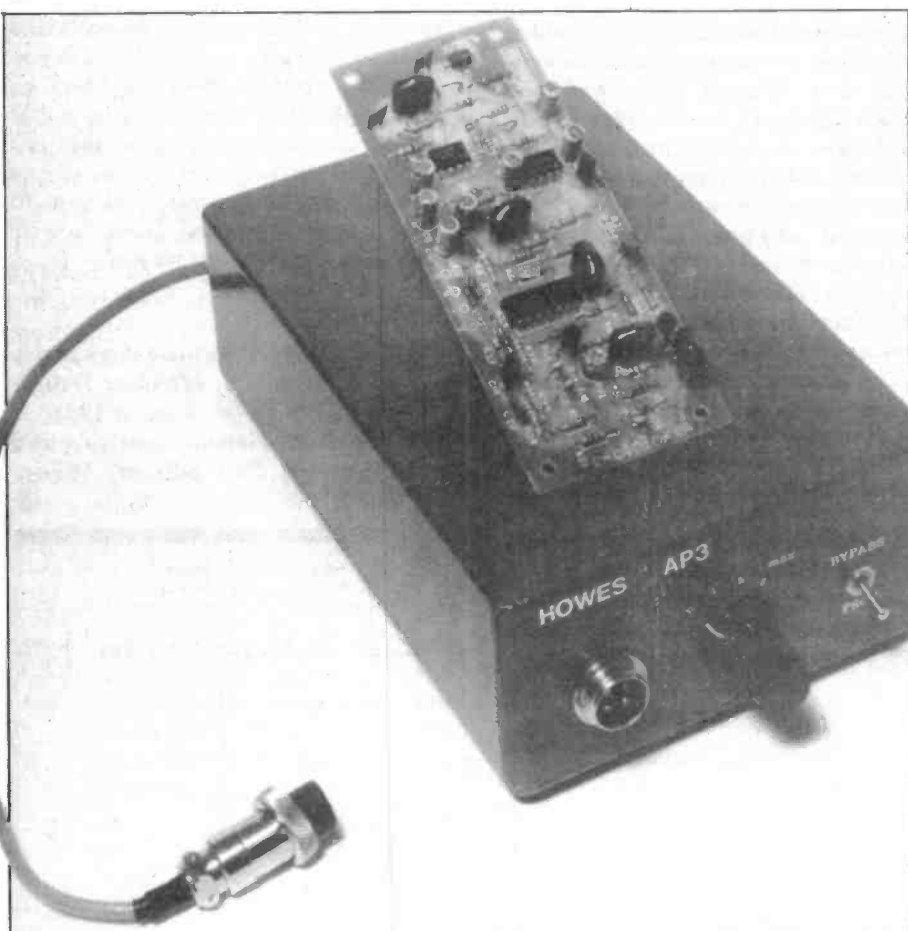
Fig. 5. Block diagram of RF clipper

Automatic audio processor

By Dave Howes G4KQH

Most amateurs from time to time wish they could put out a stronger, punchier signal, often when having failed to work some exotic DX after hours of trying. Their thoughts often turn to big linear amplifiers, but there is a much cheaper way of adding extra punch to your signal.

If you were to examine undistorted human speech with an oscilloscope, you would notice that the peak level of energy in the voice is very much greater than the average level. The ratio of peak to average level varies from person to person, but research work points to a value of around 14dB as being typical. This variation of amplitude of the human voice helps us to be expressive with our speech and adds some individuality to the speaker, but nature has not optimised our vocal chords for communication under low-level, or noisy, radio conditions. It is easy to see that with a weak SSB signal being received on a communications receiver, the peaks of speech could be above the background noise level and the average speech level below the noise, and therefore inaudible. As a large amount of the information is carried in the lower level sounds, this signal would be difficult to copy. To effect an improvement, we could amplify the total transmitter power to overcome the noise level at the receiving end — but this is expensive and could lead to TVI problems. Now if we could raise the level of the quieter vocal sounds nearer to the level of the peak amplitude, our weak signal would have more energy above the noise level, and we could copy it a lot more easily. So without transmitting any higher peak power we could, with the aid of a suitable box of tricks, transmit a signal that is effectively stronger than before. The piece of equipment described here sets out to achieve this.



A device that modifies speech to make it more intelligible under difficult radio conditions is usually referred to as a speech processor. There are different methods of speech processing, but basically they fall into two camps, compressors and clippers. Compressers are simply a type of automatic volume control that keeps the transmitter fully modulated for a larger proportion of the time. A clipper does what its name implies and clips off the peaks, leaving a signal that has a much smaller ratio of peak to average level. The processor described here combines both techniques, along with some frequency response tailoring and filtering, to give a really punchy signal with a useful increase in intelligibility under difficult signal conditions, and let's face it, the weak signal QSOs are often the most interesting ones. The Automatic Speech Processor described here really can make the difference that enables your signal to get through.

Features

The processor is automatic in

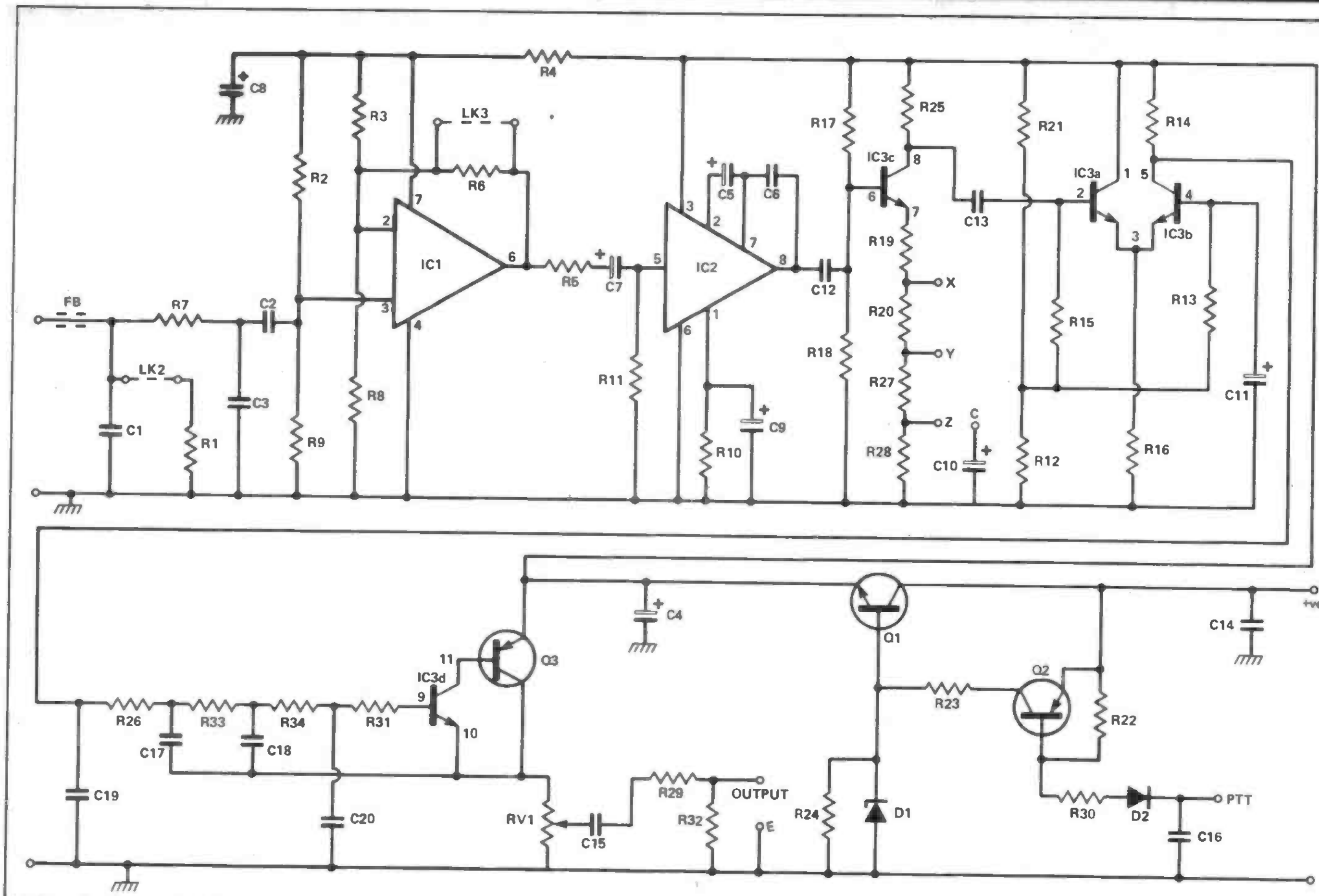


Fig. 1 Circuit diagram.

two senses: the first being that it automatically adjusts its gain to suit your speech level and distance from the microphone, so giving a constant clipping level irrespective of whether you shout or whisper. The second automatic feature is the on/off switching, whereby the unit consumes virtually zero power until the PTT button on the microphone is pressed. This enables the unit to be battery powered if you wish, while reducing the possibility of it being left on and draining that expensive battery.

It is designed to accept high or low impedance microphones by the simple addition or removal of one wire link on the PCB. The pre-amp gain can be raised by approximately 10dB, in a similar manner, in case you wish to use a low output microphone.

The output level is adjusted by a preset resistor and should drive most rigs without any problem. If a higher output level is required, then up to approximately 3 volts peak-to-peak is available by simply changing one resistor. In fact I use this circuit to modulate my homebrew 2m FM rig. By a change of R29, I use the output to drive the modulating varactor diode directly.

Four switch-selectable clipping levels are provided, increasing from just very slight clipping up to maximum in approximately 6dB steps. The unit could not be simpler to set up, you only have to adjust RV1 to give the correct drive level to your rig. There are no other adjustments to make. In operation, you simply switch in the amount of clipping you require, push the PTT and speak into the microphone, the rest is done automatically.

Circuit description

To keep down the size of the unit and make for easy, repeatable, construction, the processor uses three integrated circuits and only three discreet transistors (**Fig. 1**). IC1, a TL071 FET-input low noise opamp, is the microphone input stage and has a gain of approximately 10dB if link LK3 is omitted. With LK3 in place the gain is unity and the IC simply acts as an impedance matching device. The input to IC1 is filtered to remove any RF that might make its way down the microphone lead, by a ferrite bead, C1, R7 and C3. The TL071 is pin-compatible with the popular 741 opamp but it is far superior in terms of noise and slew rate performance. The extra expense is well worthwhile in many applications. The output of ICI is fed via R5 and C7 to the input of IC2. IC2 is a Plessey SL6270 'VOGAD' chip (VOGAD stands for Voice Operated Gain Adjusting Device), and is the simplest way I know of achieving 60dB of audio AGC. C6 determines the high frequency roll-off whilst R10 and C9 set the AGC recovery time-constant. This chip is relatively expensive, but is well worth it in terms of simplicity and reliability of operation, compared with 'discreet' circuitry. The output of IC2 should remain at about a constant 90mV RMS for all input speech levels. This constant amplitude signal is then applied to the input of a common emitter amplifier which uses part of IC3, a CA3046 transistor array. The CA3046 contains five well matched transistors in one dual-in-line package. C10 is switched in to bypass one or more of this amplifier's emitter resistors, which sets the audio gain of the stage. It is this switchable gain that determines the level delivered to the balanced clipping stage, and therefore the amount of clipping introduced. The output of the clipper (pin 5 of IC3) is then fed to an active lowpass filter, that rolls off at approximately 18dB per octave. This removes much of the harmonic energy introduced by the clipper. By using a balanced clipping stage, even order harmonics are kept to a low level. Coupled with the good filter characteristics this gives an audio response that many stations have complimented over the air as being very clean and punchy.

The output level from the filter is adjusted by varying RV1 and this is fed via the output attenuator, R29 and R32, to the microphone socket of your rig.

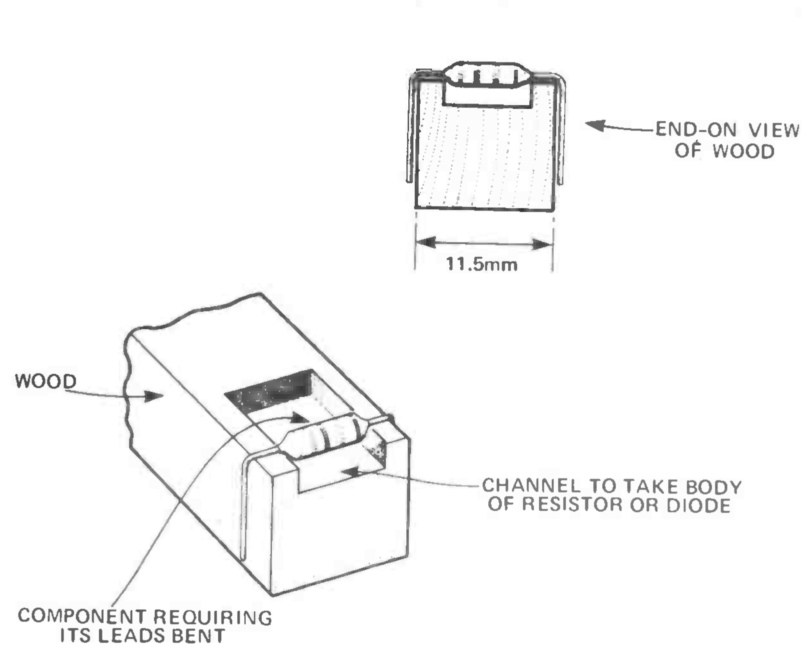


Fig. 2 Component lead bending tool.

Battery saving

TR1, a BC237, serves two functions. First, it acts as a voltage regulator in conjunction with a Zener diode D1. Second, it acts as an on/off switch in conjunction with TR2. It might be of interest if I go into the operation of this stage a little further as it makes a useful battery saving device, and I have not previously seen a similar circuit in print anywhere.

The operation of TR1 with D1 as a voltage regulator is quite conventional and has been seen in many designs. However, in this case the bias current is not simply fed via one resistor (R23), but also via a PNP transistor, TR2 in series with the resistor. R22 serves to bias TR2 off unless the PTT line is earthed. When the PTT line is earthed TR2 turns on and bias current flows to TR1 and D1, so switching on the regulated voltage for the processor. When the PTT line rises in voltage because the button on the microphone has been released, TR2 turns off, this in turn cuts the bias to TR1 and D1, R24 now keeps TR1 turned off.

"... you're lifting the squelch here ... "

The current drawn by this circuit in the off condition is smaller than I can detect with a 50 microamp meter, so a battery should last a long time. There is a snag however! If you leave this circuit connected to the PTT line of your rig, when you turn the rig off, the PTT line goes low and the processor switches on — net result a flat battery. However the simple additon of a diode in series with the PTT lead to the rig will cure this. Most rigs will tolerate a germanium diode in series with their PTT input without any problems. If there is any complication with your particular set, you can always fit a conventional on/off switch instead and forget the extra diode.

Construction

The speech processor can be bought in kit form from C.M. Howes Communications at the address given at the end of the article, or you could gather all the parts together yourself. The Howes kit contains all the board mounted components, a set of instructions, and a glass-fibre PCB which is drilled and tinned, and has the component locations screen printed on the component side for easy assembly. You could of course make your own PCB or wire the processor up on *Veroboard*. The latter method is fairly straightforward, but I find that things built on a PCB are more likely to work first time.

To assist in making assembly of the kit as neat and simple as possible, all the resistors require the same lead lengths. If you do not have a component lead bending tool in your tool-box, you may like to make a simple one as shown in **Fig. 2**. This tool helps make for neat assembly, but the kit will work just as well if you bend all the leads by hand! D1 and D2 require to have their leads bent at the same spacing as the resistors and can be treated in the same way.

I suggest fitting the resistors in the PCB first, then the capacitors, and finally the semiconductors. The layout is shown in **Fig. 3.** There are two links on the board to select gain and input impedance. There are easily made by using a couple of off-cut component leads when you have finished fitting the other parts.

The kit instructions include the

Table 1: Component list

R1	1k2
R2	100k
R3	22k
R4	470R
R5	100R
R6	100k
R7	470R
R8	22k
R9	100k
R10	1M5
R11	22k
R12	33k
R13	22k
R14	10k
R15	22k
R16	10k
R17	100k
R18	47k
R19	150R
R20	150R
R21	47k
R22	10k
R23	1k2
R24	10k
R25	1k2
R26	56k
R27	330R
R28	470R
R29	47k
R30	4k7
R31	22k
R32	470R
R33	56k
R34	56k

All resistors are 0.25W 5%

RV1	4k7 preset
C1	100p ceramic 63V
C2	100n mylar 100V
C3	100p ceramic 63V
C4	22u electrolytic 25V
C5	1u electrolytic 63V
C6	4n7 mylar 100V
C7	1u electrolytic 63V
C8	22u electrolytic 25V
C9	22u electrolytic 25V
C10	1u electrolytic 63V
C11	1u electrolytic 63V
C12	100n mylar 100V
C13	100n mylar 100V
C14	100n mylar 100V
C15	100n mylar 100V
C16	1n ceramic 63V
C17	1n ceramic 63V
C18	1n ceramic 63V
C19	10n mylar 100V
C20	220p ceramic 63V

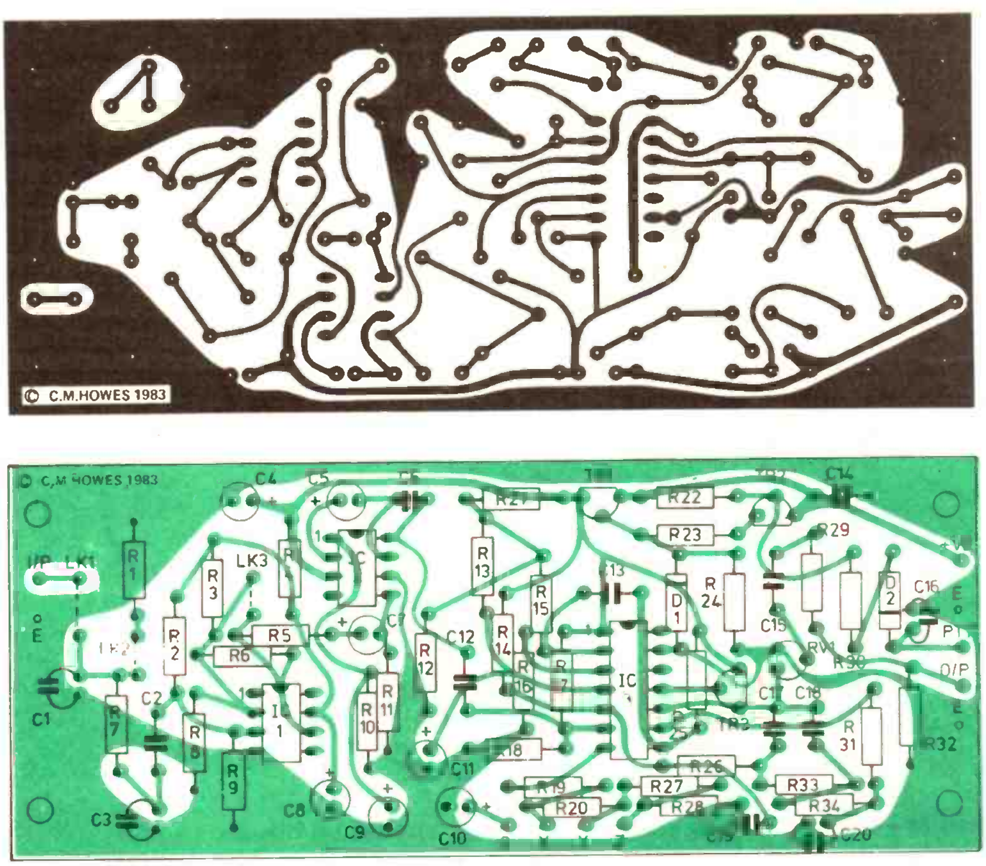
Tolerance of all non electrolytic caps is 10% or better.

D1	BZX79 6V8
D2	1N4148
TR1	BC237
TR2	BC307
TR3	BC307
IC1	TL071
IC2	SL6270
IC3	CA3046

colour codes for each resistor, and identification details for all the other components, so that you do not need to have had any previous experience of construction to end up with a working speech processor.

When you have installed all the parts in the board, examine your handy-work under a good light and resolder any joints that look doubtful. It is a good idea to hold the PCB up to a bright light so that you are looking at the wiring side of the board, the light shining through the board so that the printed tracks are in silhouette. Check for any solder splashes or whiskers that may be shorting out the wiring. If there are any shorts, simply remove them with a hot soldering iron, or if they are small, scrape them away with the

Fig. 3 Printed circuit board.



blade of a small screwdriver.

If you have put all the components in correctly, and have soldered them well, the unit is almost certain to work, and you can turn your attention to installing the PCB module either in your rig or in a separate case. It is important to screen the PCB in a metal box. A plastic case may look smart, but it is not suitable for this application, as RF will probably find its way in and upset the operation of the unit. You can make a very presentable enclosure with an easily obtained diecast box, a drop of ordinary household paint, and some dry transfer lettering. White letters on dark grey paint will match most rigs nicely. A word of advice though, do not squeeze the PCB into the smallest possible box. You will find that the microphone cable will tend to pull a light weight box across the operating desk. A reasonable size box with stick-on rubber feet on the bottom will tend to stay where you put it.

Connect up the PCB as shown in **Fig. 4**. Note the extra ferrite beads on the microphone socket to help keep RF out, and the 0A91 diode in the PTT lead as mentioned earlier. The extra ferrite beads and the diode are included in the C.M. Howes Communications kit.

You will have to refer to your rig's handbook for the correct microphone connections for your particular set. The ones shown in the diagram are only an example. When you have double checked the wiring, it is time to switch-on.

Testing and operating

The unit is suitable for use with FM, AM, and SSB rigs, but it is easier to set up the output level with it connected to an SSB rig.

With your SSB transmitter on a dummy load, connect the processor to the mic socket, plug a microphone into the processor, and make very sure you connect the battery or power supply the right way round. Failure to this could well result in a heavy heart and a light wallet, due to the early demise of the semiconductors. Set the unit to minimum clipping, and with the rig's mic gain control in its normal position, adjust RV1 to give a small indication on the ALC meter. Now back off RV1 so that the rig's ALC falls to zero. Your speech processor is now aligned. Do not run your rig with bags of ALC when using a speech processor — you will get no extra power in the wanted sideband, only more power in the unwanted intermodulation products! Monitor your rig's output power, and check that the average power level increases as you increase the amount of clipping. If all is well, call a trusted local for an audio report, just to make sure nothing is amiss — remember, using large amounts of clipping on local QSOs tends to be fatiguing for the listener, and the test of your processor's effectiveness will come when working under noisy or weak signal conditions. You should find that this little processor will enable you to work further for a lot less money than that big linear you were dreaming of! If you had the linear as well though, now that's a thought...

Kits

A kit of parts to build the automatic speech processor is available from C M Howes Communications, 139 Highview, Vigo, Meopham, Kent DA13 0UT. The kit, called the *AP3* includes a drilled and tinned PCB and all board mounted components. The price is £14.80 plus 50p for post and packing per order. Delivery should be about one week, but may increase if demand is very high. ●

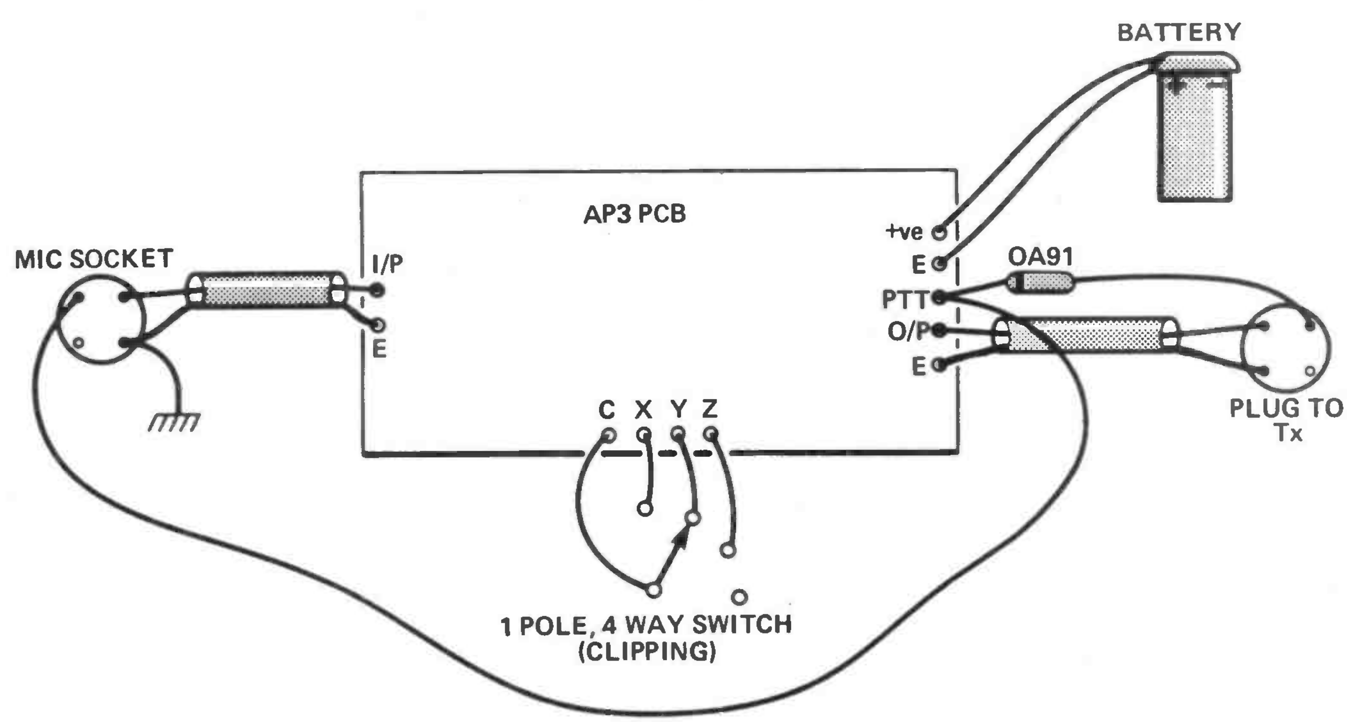


Fig. 4 Connections to processor board. Extra ferrite beads should be fitted to the microphone socket.

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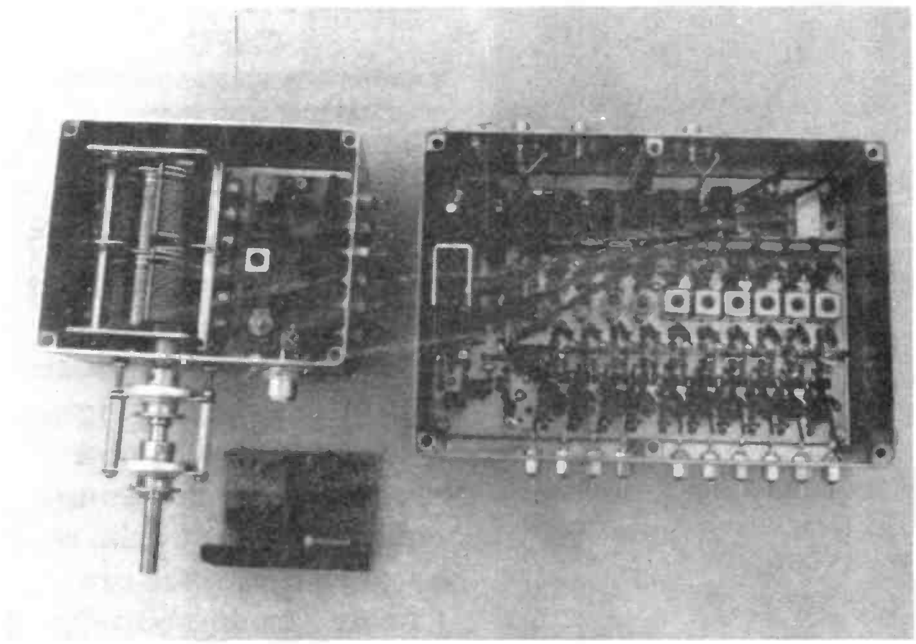

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Full circuits, constructional details and artwork for the module that's at the heart of the Omega all band HF transceiver project.

The Omega VFO/LO offers sensational performance on all the HF bands 1.8 through to 29.7MHz. Can be used with other SSB/CW IF systems to offer all band operation with PW Helford, G3ZVC and G4CLF boards, and the latest Radcom transceiver by G3OGQ.

DATONG NOTCH FILTER

Datong claims that its new box can rid the world of tuner uppers, whistles and heterodynes almost before they occur... without affecting the intelligibility of wanted signals. True or false?

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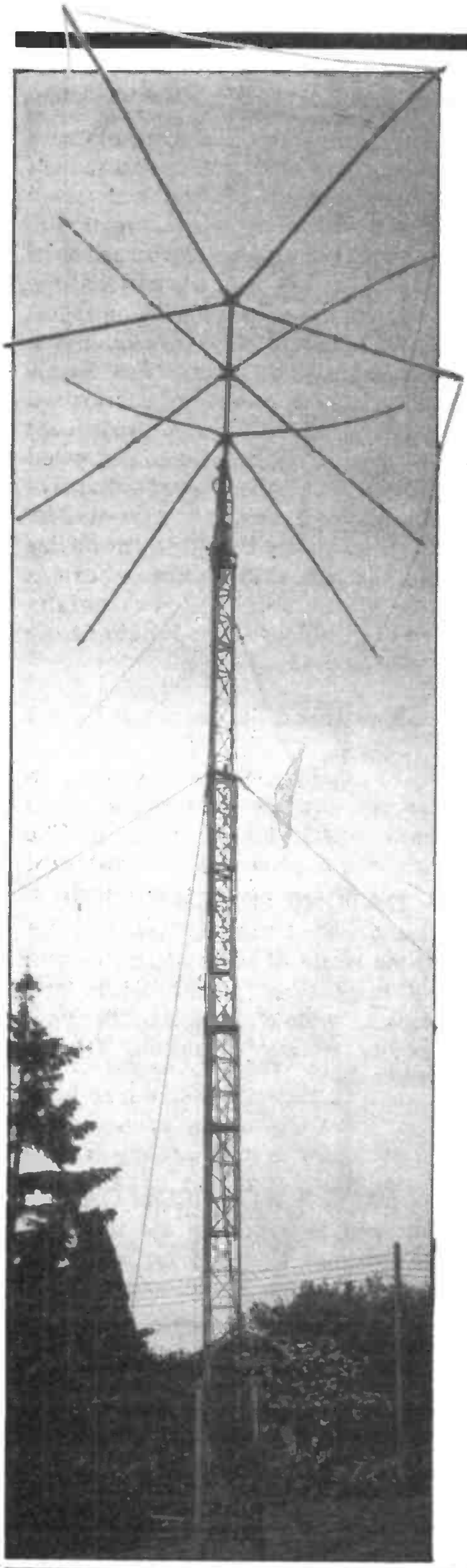
Aerials for DX working



By Sant Kharbanda C.Eng, FIERE, FSCTE, G2PU

During the years of maximum sunspot activity, interest in working DX on the 7, 3.5 and 1.8MHz bands tends to wane because of the favourable propagation conditions on the higher bands. We are now approaching the trough of the 11-year cycle, so once again we are seeing an increase in activity on the lower bands.

The widespread availability of commercial transceivers and comparatively inexpensive 14/21MHz beam aerials has resulted in little skill being required to set up an amateur station which provides excellent DX communication from all but very poor locations. Obviously the fellow who is fortunate enough to have an unobstructed view of the horizon at all points of the compass, coupled with good electrical ground characteristics, is going to get better and more consistent DX results than someone surrounded by hills.

Nevertheless there has been a gradual erosion of signal strength differential between the best amateur stations and the 'average' over the past two decades as far as operation on the 14, 21 and 28MHz bands is concerned.

This degree of uniformity of DX results does not appear to exist so markedly on the 1.8, 3.5 and 7MHz bands because all but a small percentage of the amateur fraternity are compelled to use aerials, the performance of which falls far short of that which they can obtain on the 14/21/28MHz bands using one of the popular Yagi or Quad aerials.

Low angle radiation

It is well known that a low angle of radiation is needed for long range communication on the HF bands; also that aerials consisting of one or more half-wave elements should be elevated at least one half-wavelength above ground to avoid wasting power at high angles.

For this reason the popular 14/21/28MHz beams are frequently erected at a height of 10m or more. Indeed the availability of modestly priced masts and towers allowing a lightweight tri-bander to be elevated to a height of about 20m has resulted in a significant proportion of serious DXers having an aerial arrangement of no mean capability.

Table 1 shows the angle of elevation of the lowest lobe (where more than one exists) of a horizontal dipole for heights of 10m and 20m above reasonably flat and good conducting soil in a direction at right angles to the axis of the dipole.

Band	Angle of radiation	
(MHz)	Height=10m	Height=20m
28	14°	8°
21	20°	10°
14	30°	14°
7	90°	30°

Table 1

Clearly, given that the average amateur is severely limited with regard to height of the aerial above ground, the DX capabilities of a horizontal aerial deteriorate as the frequency is reduced.

The use of a multi-element

horizontal Yagi aerial at the same height does not in itself reduce the angle of radiation but concentrates more energy in the lower lobes at the expense of reduced radiation in any higher angle lobes. Additionally the beam widths of the lobes are reduced.

Having refreshed our memory regarding some of the elementary fundamentals which have been amply documented in manuals dealing with HF aerials let us examine the requirements in particular for 7/3.5/1.8MHz aerials.

Unfortunately we are now confronted by sets of dimensions of frightening proportions if we try to scale up what we do on the higher bands. The writer has seen one or two full size 7MHz Yagi beams and one almost full size 3.8MHz rotary beam. Needless to say problems of cost, local authority and neighbourhood relations rule out such ambitious projects for all but a tiny proportion of the amateur fraternity.

Back to reality

After day-dreaming about 3-element 3.5MHz Yagis at heights of 40m or more we come back to reality and settle for something far less spectacular. A good starting point in our deliberations is the fact that a horizontal dipole at a quarter-wavelength or less above ground is an excellent high angle radiator, which is good for short skip contacts but pretty poor for consistent DX working.

Over flat ground we need a height of a half-wavelength to achieve an angle of radiation of 30° which after all is not low. This means a height of 20m for 7MHz, 40m for 3.5MHz and 80m for 1.8MHz. Whilst no doubt heights of about 20m are reasonably practicable for a good number of amateurs, heights of 40m and above are not easy to obtain except in special circumstances.

To get the aerial problem for the lower amateur bands in perspective we should reflect that a typical 3.5MHz horizontal dipole erected at a height of 16m is equivalent to a 14MHz dipole at a height of only 4m. Few amateurs would use such an arrangement for DX.

From the foregoing it is easy to understand why the vast majority of amateurs have to settle for a compromise aerial for DX working on the lower frequency bands. Clearly the problem becomes harder to solve the lower the frequency and we need to look at the three bands 7, 3.5MHz and 1.8MHz separately.

7MHz

This is a difficult band for the telephony operator because he suffers more than a CW operator from saturation strength commercial signals. Moroever a CW enthusiast needs only to cover a very narrow frequency band but the telephony operator needs to receive from 7.04 to 7.30MHz even though in Europe he may not transmit above 7.10MHz. The writer remembers well the 7.0 - 7.3MHz band of the early Thirties when simple aerials and low power yielded worldwide contacts and it was a sheer joy to operate. Nowadays receiving a weak DX SSB signal on the skirt of a 100kW broadcasting station may be a tribute to modern receiver design as well as to the directional discrimination of the aerial in use, but it hardly makes for comfortable listening!

Without doubt the relatively few amateurs who have the resources and environmental conditions to erect a 7MHz rotary beam have a great advantage over less fortunate amateurs due to the appalling level of interference on this band. Positioning the beam to minimise the interference is usually more important than getting the maximum signal from the DX station it is desired to receive.

Size reduction

Constructional details of 7MHz rotary beams are outside the scope of this article. However several designs have been published (eg references 1, 2 and 3) and they have laid emphasis on shortened elements in an endeavour to keep the overall size to manageable proportions. Size reduction is achieved by inductive or capacitive loading or both (Fig. 1). An unfortunate practical result is narrower bandwidth and increased resistive losses. The author prefers capacitive loading rather than the use of inductors although, in practice, capacitive loading restricts the degree of size reduction which can conveniently be achieved. It should also be remembered that both gain and directivity will be inferior to that of a full size array possessing a similar number of elements, and a good impedance match may only be achieved over a very narrow bandwidth.

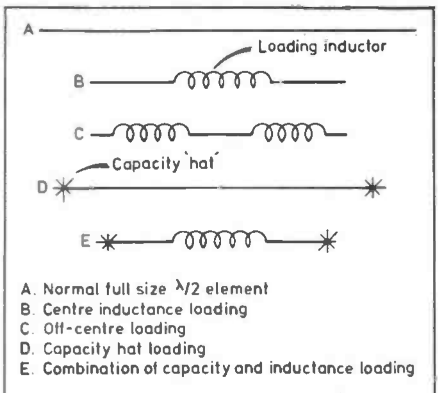


Fig. 1. Shortened half-wave resonant elements.

What are the non-rotatable wire alternatives? Of course these are many including the dipole, inverted 'V' dipole, long wires, verticals, slopers and loops or combinations of such radiators. If we assume that the average amateur has somewhat restricted real estate we can eliminate thoughts of long wires, Vee beams and rhombics especially if it is desired to cover a number of different directions. High dipoles and inverted 'V' dipoles can give a good account of themselves if erected at least 20m above ground although even at this height short skip signals are a problem on receive. Horizontally polarised full wave loops suffer from similar limitations.

Verticals

Vertically polarised aerials, in general, provide better low angle characteristics for DX operation. The vertical half-wave is a little awkward to feed and although theoretically it yields some 3dB more signal at low angles compared with a vertical quarter wave, nevertheless a good deal of the radiation from the lower part of the ½λ vertical may be absorbed by obstructions surrounding the aerial. It has been the author's experience that a ¼λ ground plane aerial using elevated radials will often outperform a ½λ vertical. The radials can slope downwards at about 45° so that they can be conveniently anchored to short posts or trees. See Fig. 2. This also has the effect of raising the driving point impedance and provide a reasonable match to 50/52ohm coax. Four ground plane radials are commonly used although the author has used from three to eight radials without noticing any dramatic change in performance.

A wooden mast is strongly recom-

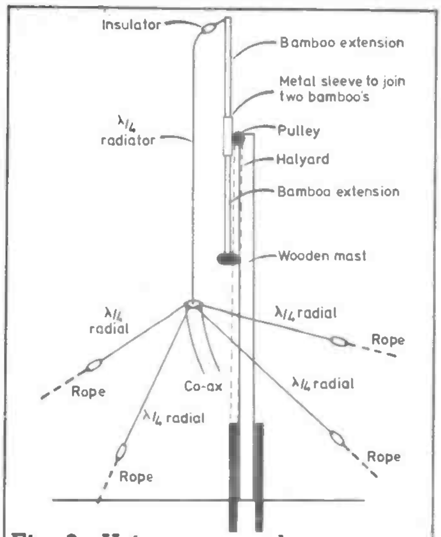


Fig. 2. Using a wooden mast to support an elevated quarter-wave vertical

mended and the top of the aerial can be anchored to a strong bamboo extension drawn up by a halyard attached to the top of the wooden mast. The writer uses two 5m bamboo's inserted into a 2m long aluminium tube to give an effective length of the bamboo section of some 10m. The centre of this is attached tothe halyard and the bottom end pulled vertically downwards by a suitable rope. Hence the top of the bamboo projects some 5m above the top of the main wooden mast.

A variant of the evergreen ¼ ground plane is the 0.32 ground plane, shown in Fig. 3. The feed point then becomes reactive and so it is necessary to feed the base via a series capacitor of approximately 100-150pF. A 200 or 250pF max air-spaced variable can be used enclosed in a water-tight plastic box. In this case 75ohm co-ax should be used and the capacitor adjusted (with the aerial lowered for the capacitor to be within reach) until the VSWR is at a minimum at the operating frequency. Raising the aerial to full height has little effect on the optimum setting of the capacitor and an excellent match should be maintained. This extended version of the ground plane aerial provides marginally better low angle performance than its shorter brother.

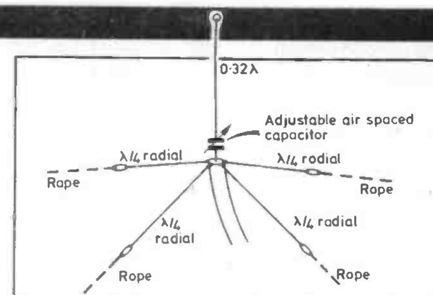


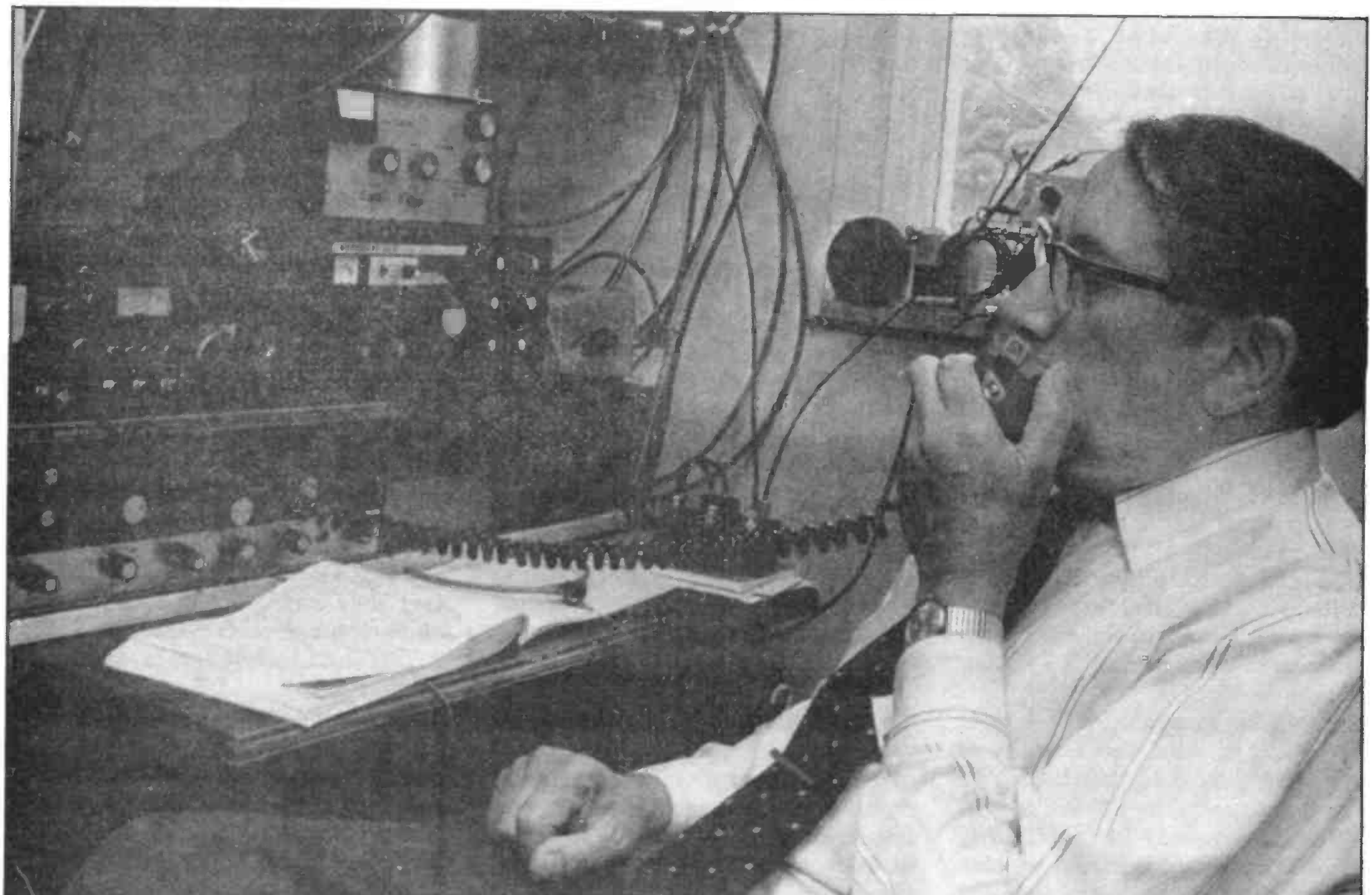
Fig. 3. A 0.32 wavelength vertical matches 50ohm cable when the reactance is tuned out by a series capacitor.

The omni-directional characteristic (in azimuth) of the vertical aerial is both a strength and a weakness. It is fine from the point of view that every direction can be covered without adjustment — it is bad at discriminating against unwanted signals (except, of course, short skip signals which will be weaker than on a horizontal dipole or inverted 'V').

Directivity

Adding a director and/or a reflector is perfectly feasible but then one is restricted to a single direction. It is also possible to erect a circle of

As Sant Kharbanda's qualifications and callsign show, he's no newcomer to radio. As recently retired Chairman of Labgear, he has been working at the other end of the spectrum — on aerials and receivers for home reception of satellite TV. He was clear winner of the ARRL International Phone Contest over 10 consecutive years from 1947 to 1956. He has been a radio amateur since 1936.



directors (or reflectors) around the axis of the vertical radiator and electrically select the one(s) required for the direction needed. However the practical difficulties soon become as complicated as building a shortened 7MHz rotary beam and if the objective is toconstruct a simple and inexpensive aerial the project may become self defeating! An alternative approach to a switchable directivity vertical array is described in reference 4.

A worthwhile increase in gain (3-4dB) may be achieved by erecting a second similar ground plane aerial and feeding both simultaneously. See Fig. 4. A spacing of about ⅝ will achieve maximum broadside gain when the aerials may be fed in phase by parallelling the two feeders which should be of equal length. Alternatively a close spaced (eg ⅛-¼) end fire arrangement can be tried for directivity through the plane of the two vertical elements. In this case antiphase connection will result in a bi-directional pattern. A phase shifter or delay line is required for undirectional operation (reference 5).

To be continued

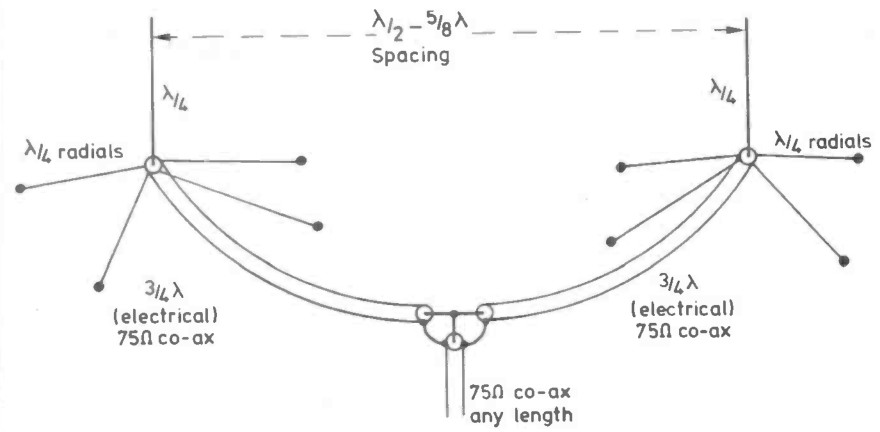


Fig. 4. Phased quarter-wave ground plane aerials – for bi-directional broadside radiation

REFERENCES

1) *A compact 40m Butterfly beam* — Wiliam Orr — Beam Antenna Handbook — 3rd edition — p158-161.
2) *A Yagi antenna with helically wound elements* — The ARRL Antenna Book — 13th edition — p219-221.
3) *A small Yagi for 40m* — The ARRL Radio Amateurs' Handbook — 1979 edition — Chapter 20 p19-20.
4) *A 360° steerable vertical phased array for 7MHz* — The ARRL Radio Amateurs' Handbook — 1979 edition — Chapter 20 p13-15.
5) *Phased Verticals* — The ARRL Antenna Book — 13th edition — p197-198.

NEWCOMER'S

Receiver parameters

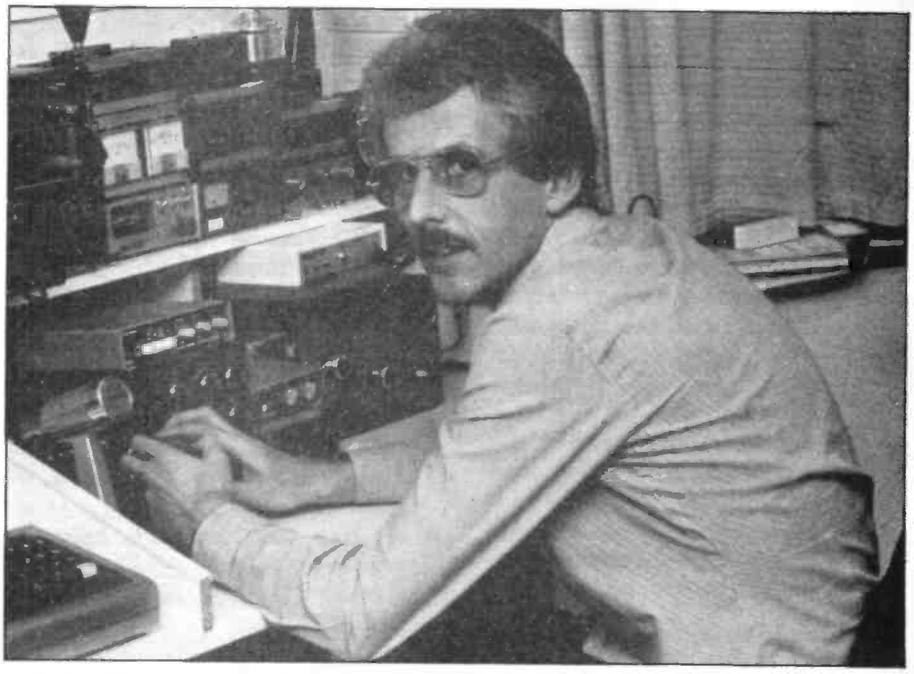
When you look through the technical reviews in *HRT* or read about receiver designs, you may well be coming across a number of terms used in describing performance, that are not familiar to you. Or, you may not be exactly sure what they are actually describing. Over the next few months we will take a look at some of these terms, and try to describe in plain language what each means.

Dynamic range is a term that has appeared more and more over the past few years and is very 'in' at the moment, with manufacturers claiming all sorts of figures up to 100dB +, although not always borne out in practice, as you will see from some of the lab results in this magazine and others.

What exactly do we mean by dynamic range? Well, simply put it is a measurement which tells us how well the receiver can cope with more than one strong signal being present at the input, without generating any unwanted spurious signals.

Some years ago, the accent on receiver specification was on sensitivity, with a sensitive receiver being judged as one which made a lot of noise when the aerial was connected, even when no signals were about! Unfortunately, this excessive front end gain did nothing for the dynamic range, and many of the bands covered probably contained more spurious signals than wanted ones.

The side effects of a poor dynamic range are mostly well known — Cross-modulation, where a wanted signal is modulated by another signal outside the immediate receiver passband is the best known. This may take the form of the wanted signal literally being modulated by spurious audio signals, or CW being heard on the wanted signal. Desensitisation is another effect — many of you will have met this when a local signal has come up further down the band, and wiped out the signal you were listening to. This effect mustn't be confused with a similar effect that can occur when a very strong station comes up very close to your frequency — this is more likely to be due to poor skirts on the IF filter in the receiver, or 'bleedover' as it is now often known in other circles.



IMD

One of the other parameters you will spot in the reviews are IMD products (InterModulation Distortion), normally of interest in the transmit section. IMD arising from the mixer in a receiver can also cause problems, and leads to spurious signals appearing in the band, when a strong signal appears somewhere else. Again, the cause is poor dynamic range, and it is the evaluation of this figure which is of interest.

Before we look at how the figures are defined and measured, there is another related measurement we must understand, and that is the Minimum Usable Sensitivity, which is related to the Noise Floor level of the receiver. Obviously, signals below the noise level of the receiver will not be heard, and those that are exactly at it won't be much better either. There are specialised techniques available nowadays to extract signals from the noise, but these don't concern us here.

For practical purposes, the minimum usable sensitivity is conveniently defined as a signal 3dB above the noise floor level — this is a figure rather lower than the minimum sensitivity usually quoted by manufacturers, which is normally for a 10dB signal + noise/noise ratio. However, it sets the level at which we will be measuring our dynamic range.

Measuring dynamic range

In order to actually measure dynamic range in the lab, we will need two high quality signal generators, free of any spurious outputs (as the whole purpose of the test is to measure some spurious signals), with which to generate two strong signals. These will be applied to the input of the receiver through a combining attenuator pad, to prevent interaction between the two generators). See **Fig. 1.** The two signals will be spaced from each other by a specified gap, usually 20 or 50kHz. With a ham-band receiver, the test is usually conducted at 14MHz, and

FORUM

By Tony Bailey G3WPO

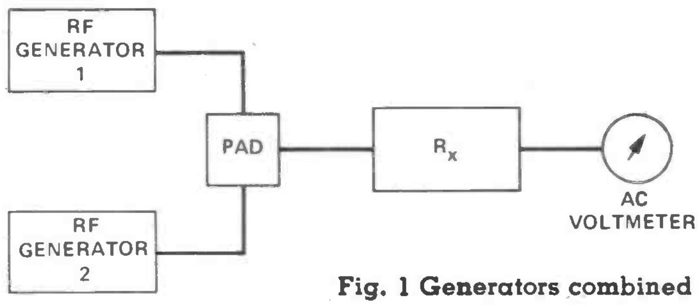


Fig. 1 Generators combined by pad

as the bandwidth used affects the results, this has to be quoted. The narrower the bandwidth the better the dynamic range in general, which is why most manufacturers quote the figure with a 500Hz CW bandwidth!

The effect of injecting the two signals at the same time is to generate within the receiver a number of distortion products. These will be 2f1 — f2, and 2f2 - f1. For instance, if we were using 14.200MHz and 14.250MHz as our signals, then we will expect to find distortion products at 14.150MHz and 14.300MHz. (see **Fig. 2.**)

For the above reason, this is called a Two-Tone Dynamic Range test. There is a single tone test as well, but this measures what is normally termed as blocking.

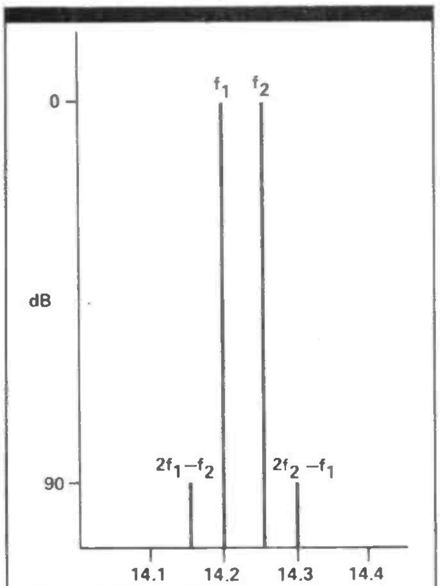


Fig. 2 Distortion arising from 2-tone input

To carry out the Two-Tone test, one of the two input signals only is applied to the receiver and the injection level measured which gives a signal 3dB above the noise floor of the receiver (using an AC millivoltmeter coupled to the audio output of the receiver). This is our reference level and we will assume that it is 0.3uV.

The other generator is then switched on, and the output of each increased at equal levels while listening at the frequency of one of the expected distortion products. When the level of the distortion product reaches 3dB above the noise floor, the generator output level is noted, taking into account the loss through the combining pad. Let's assume that it was 10mV.

What we now have are two figures, the ratio of which gives us the dynamic range of the receiver, ie. we have measured how much signal needs to be injected to give rise to unwanted distortion products, at the same level as a minimum detectable wanted signal. These two figures are normally expressed as a dB ratio, and in the case above this would be 90dB — a good result.

What about 70dB?

I say a good result, so what is a bad result? Difficult to say, but you should expect any half decent rig to manage at least 80dB, even then it will have problems on 40 metres after dark. 100dB is bordering on the excellent, and would be unlikely to suffer from any problems, unless an extremely large antenna array is attached to it.

If you consider the actual figures, it might mean more than the dB equivalents. In our example, the dynamic range was 90dB. If the dynamic range had been 74dB (doesn't sound a drastic amount less does it?) the figure would have been only 1.6mV, and if 96dB then 20mV. It doesn't need much imagination to see the effects of these differences.

The single tone test referred to above measures blocking, or how well the receiver can cope with a very strong signal on an adjacent channel. It can be measured using the same equipment, by setting one of the generators to provide a signal of around S7 on the receiver, then increasing the output of the other until the wanted signal is reduced in strength by 1dB. This measures the onset of blocking — you could expect a very good receiver to show a figure of over 120dB for this, and a poor one less than 100dB with 110dB as an average.

Improving results

Most modern receivers take great care in the design to achieve a high dynamic range figure. The distribution of gain in the RF and IF stages can have a terrific effect on the figure, which is why many receivers go straight into a high level double balanced mixer, or, if they do use RF amplification, high voltage devices are employed to reduce the IMD products. Single conversion designs are often favoured because there is only one mixer to generate IMD products, although good results can be achieved with multiple conversion, as witness the TS930 and similar rigs.

If your receiver is not in this category, is there anything you can do to improve things? One of the ways to reduce strong out of band signals, without affecting the wanted signal strengths is to use a high selectivity preselector unit. This needs to be a passive unit without gain, as if extra gain is added, this may compound the problem in-band although it reduces the signals out-of-band.

The way round this, and one which can be used alone with the receiver, is a switched attenuator. These are often seen on modern rigs, with steps of 10, 20 and 30dB of attenuation. It might seem strange to improve copy by reducing both the wanted and unwanted signals, but of course what you will actually do is to reduce the unwanted signals to a level where they no longer cause IMD products, and the wanted signals can then be copied. The actual dynamic range of the receiver is not changed in any way. (See **Fig. 3.**)

If you have never heard the effect of an attenuator on a poor receiver it is quite an experience. The 40 metre amateur band is always quoted as a testing ground for dynamic range, due to the extremely high level of broadcast station signals, close to (or in) the amateur band. A poor receiver will be just a mess of noise and heterodynes between 7.0 and 7.1MHz. Switching in a suitable level of attenuation results in all the noise disappearing, and the sudden appearance of amateur signals from nowhere.

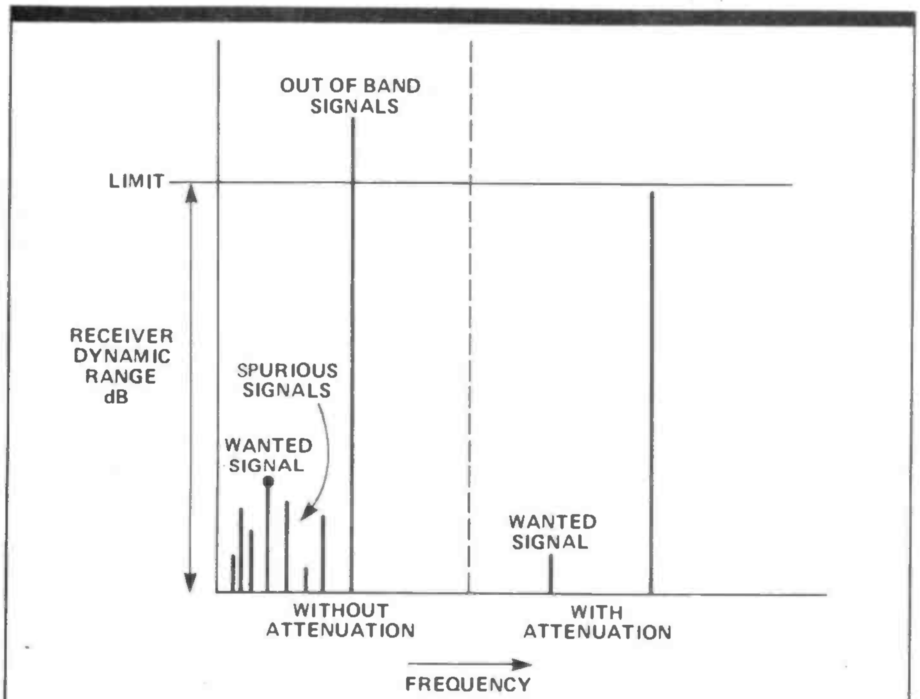


Fig. 3 Attenuation cuts spurious signals more than wanted signal.

Building an attenuator

The drawing (**Fig. 4.**) shows a suitable method of constructing an attenuator for amateur use. The switches should be of the slide type, with the tags cut short to reduce capacitance (which will affect the accuracy at higher frequencies) and for best effect, screens should be soldered between switches to reduce coupling. The resistors are soldered directly across the tags for minimum lead length. The resistor values have been selected from the standard ranges, and are for a 50 ohm in and out system. With careful construction, the unit should be useful up to 2 metres, especially if housed in a screened enclosure.

Building your own

As you will know, both myself and Frank are avid home constructors, and we don't seem to be alone. To all those who haven't wielded the soldering iron for years, we suggest that you find it (or go and buy another if you have lost it) and have a go at something. I have been building my own equipment for the past 18 years, and there is still something very rewarding in getting a piece of equipment going after all the trials and tribulations of building and testing it. Reactions over the air to home built equipment are usually very favourable, and lead to quite long QSOs, with the simpler equipment often getting the most interest.

You shouldn't expect to be able to reproduce an item of equipment such as an FT-101, or IC240, nor would you probably want to. However, you can build acceptable high performance equipment at home, providing you have the time and interest, or just limit yourself to accessories which will enhance the day-to-day operational ability of your set-up.

The basics for home brewing need not be extensive. Besides a good modern soldering iron with a small (3mm or less iron-coated tip) and a damp sponge to keep it clean on, you need a pair of sidecutters, a pair of tweezers (which become a third hand after a while), plus a few files, drills, and somewhere to work. A de-solder pump (solder-sucker) is very useful when working with solid state circuits and avoids damage when extracting ICs and transistors. You may find a magnifying glass of help on PCB work — and if you do a lot of PCB construction, do it under a good light, or your eyes will definitely suffer after a few years at it.

Printed circuit boards do suffer from bridges, flux blocked holes, tracks that need cutting etc — RS Components market a set of tools with 6 different heads for dealing with these sort of problems and they can be thoroughly recommended to the busy constructor.

Tinplating

If you make your own PCBs there is a magic liquid available which can both enhance their appearance, and assist in soldering. This is a tinplating solution in which the PCB is dropped after cleaning. When removed a minute or two later, it is covered with a thin layer of tin.

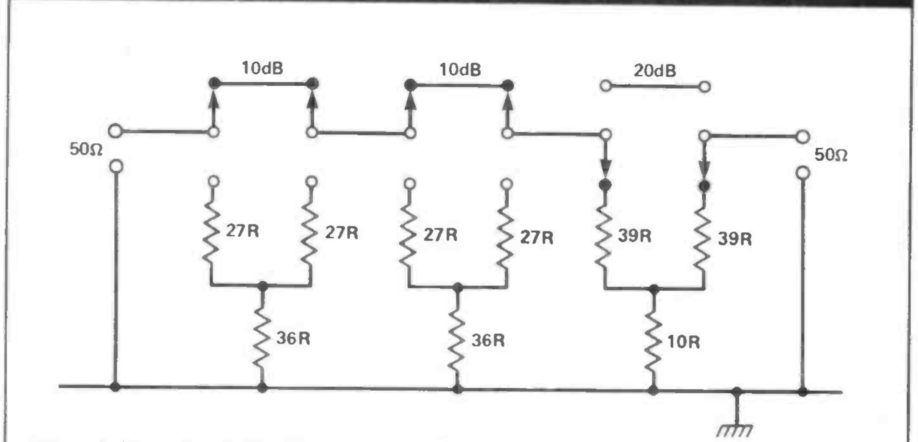


Fig. 4 Circuit of 50 ohm switched attenuator.

OPERATING AMTOR The AMT-1 reviewed

By Tony Bailey G3WPO and Ken Michaelson G3RDG

The advent of the home computer has had a major effect on RTTY (Radio Teletype) communications. AMTOR typifies this superbly.

No longer does one hear the sound of Creed *7Bs* or *75s* clattering away in the amateur shack — instead many stations have replaced the mechanical side with a VDU, and the Teleprinter keyboard with a computer keyboard. Operation is quite a lot quieter (even if rather more expensive) and you can always have a printer attached for a permanent record of QSOs.

Having the computer brings other benefits — pre-programmed messages concerning the station set-up and standard details can be sent with little effort on the operator's part. You can even program the computer to have QSOs for you, or to only respond to calls directed at your station.

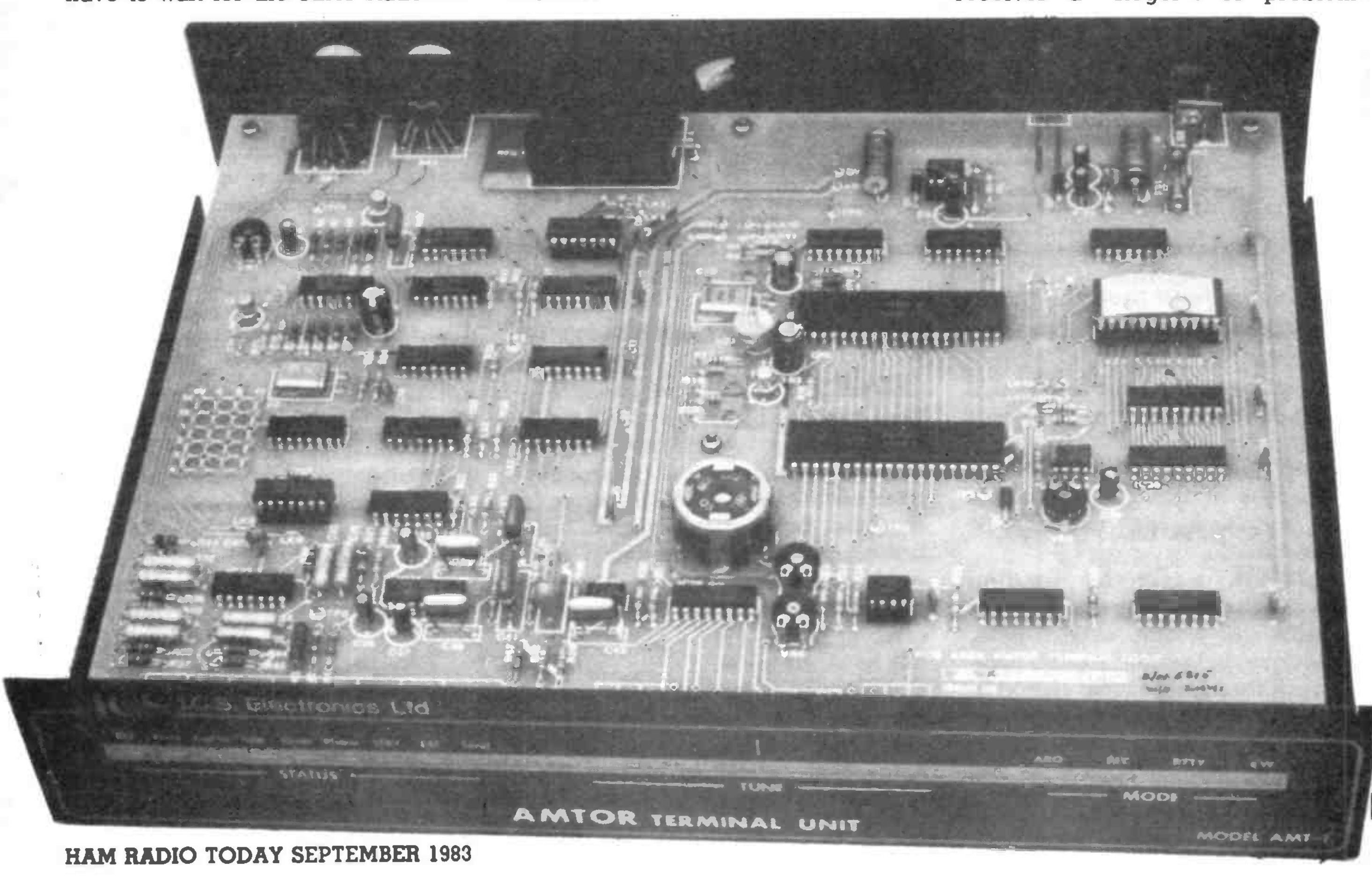
One of the problems that the computerised RTTY set-up won't solve quite so easily is the loss of copy resulting from fading, interference or errors in the decoded signal resulting from these two factors. If you want to get a repeat, you have to wait for the other station to cease transmitting and ask for a repeat — under poor conditions even your request can be lost, so the QSO is abandoned.

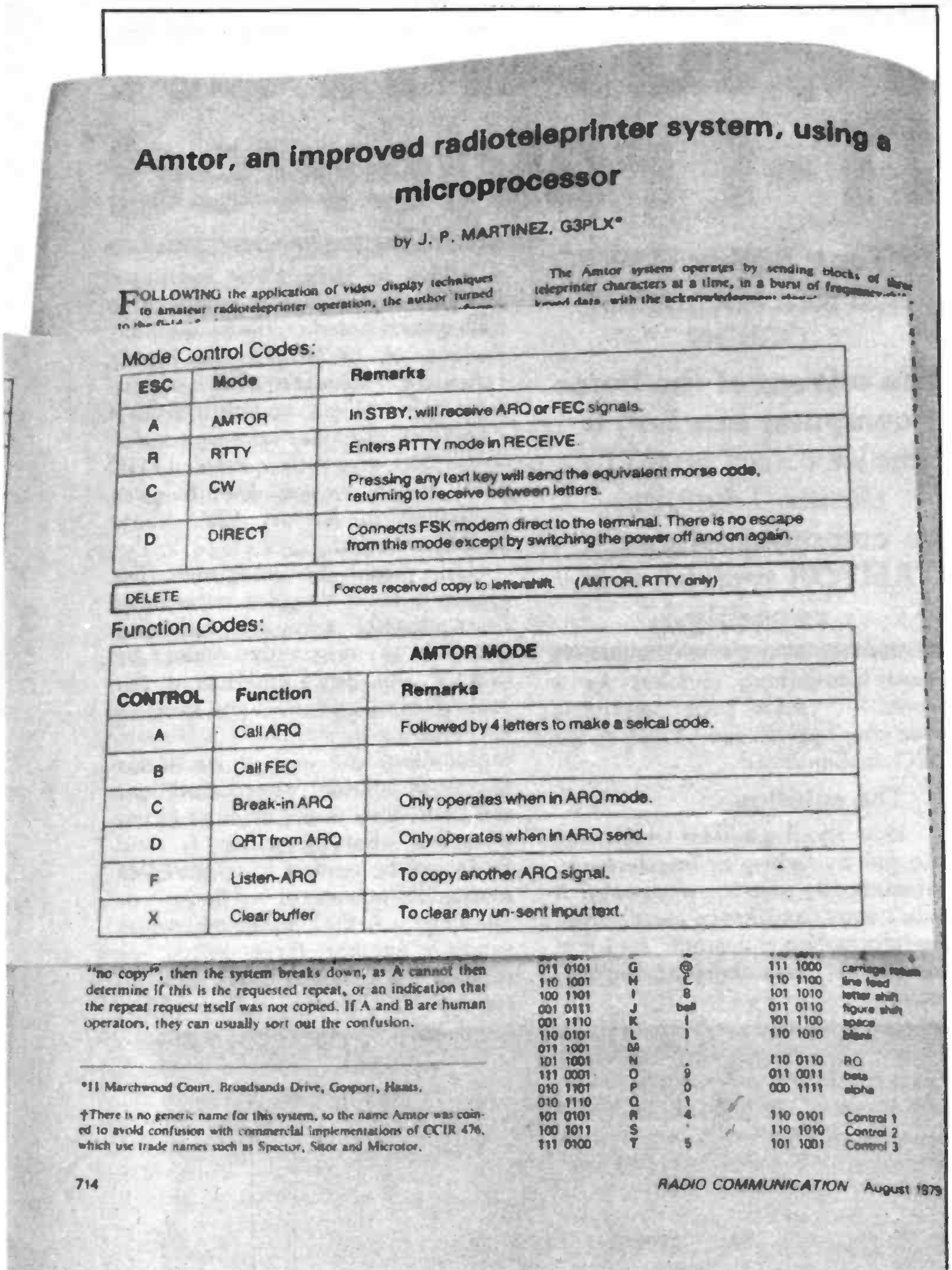
The solution

How about a system which isn't affected by fading or interference, automatically asks for a repeat if it didn't copy, and keeps asking until the information is correct? And that does its own error checking and correction?

Back in 1979, Peter Martinez, G3PLX, first released details of a new system based on the recommendations of CCIR 476, a highly reliable commercial radio teleprinter system, and christened it "AMTOR" (amateur microprocessor teleprinter over radio), using a 6800 MPU based system. Details were published in August 1979 *Radio Communication*.

As might be imagined, the system is fairly complex in terms of programming and the following parallel as originally given by G3PLX will help understand the method of operation. If you imagine two stations in simplex voice communication who wish to exchange messages reliably when conditions are poor, they might arrange to use a system whereby station A send three words, reverts to receive, an awaits B's answer of a "Roger" or "no copy". A then either carries on sending another three words, or repeats the original three until he receives a "Roger". A problem





Amtor, an improved radioteleprinter system, using a microprocessor

by J. P. MARTINEZ, G3PLX*

FOLLOWING the application of video display techniques to amateur radioteleprinter operation, the author turned

The Amtor system operates by sending blocks of three teleprinter characters at a time, in a burst of

Mode Control Codes:

ESC	Mode	Remarks
A	AMTOR	In STBY, will receive ARQ or FEC signals.
R	RTTY	Enters RTTY mode in RECEIVE.
C	CW	Pressing any text key will send the equivalent morse code, returning to receive between letters.
D	DIRECT	Connects FSK modem direct to the terminal. There is no escape from this mode except by switching the power off and on again.
DELETE		Forces received copy to lettershift. (AMTOR, RTTY only)

Function Codes:

	AMTOR MODE	
CONTROL	Function	Remarks
A	Call ARQ	Followed by 4 letters to make a selcal code.
B	Call FEC	
C	Break-in ARQ	Only operates when in ARQ mode.
D	QRT from ARQ	Only operates when in ARQ send.
F	Listen-ARQ	To copy another ARQ signal.
X	Clear buffer	To clear any un-sent input text.

"no copy", then the system breaks down, as A cannot then determine if this is the requested repeat, or an indication that the repeat request itself was not copied. If A and B are human operators, they can usually sort out the confusion.

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†There is no generic name for this system, so the name Amtor was coined to avoid confusion with commercial implementations of CCIR 476, which use trade names such as Spector, Sitor and Microtor.

011 0101	G	@	111 1000	carriage return
110 1001	H	£	110 1100	line feed
100 1101	I	8	101 1010	letter shift
001 0111	J	bell	011 0110	figure shift
001 1110	K	(	101 1100	space
110 0101	L	)	110 1010	blank
011 1001	M	.		
101 1001	N	,	110 0110	RQ
111 0001	O	9	011 0011	beta
010 1101	P	0	000 1111	alpha
010 1110	Q	1		
101 0101	R	4	110 0101	Control 1
100 1011	S	'	110 1010	Control 2
111 0100	T	5	101 1001	Control 3

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AMTOR modes — and the original *RadCom* article

arises if the request for a repeat is garbled or not copied as A doesn't then know whether he is being told "no copy" or has just missed the actual repeat. With human operators such problems can ususally be sorted out.

AMTOR works by sending blocks of three standard teleprinter characters at a time, as FSK data, with acknowledgement signals coming back from the receive station in the same manner. The miscopy problem is overcome by using two coded signals called Control 1 and Control 2. When the receiving station is copying OK, he acknowledges with Control 1 and Control 2 signals sent alternately after each block, and if an error is detected, he repeats the same control signal as last time. Thus if A sends a repeat request, B does just that (or if B receives an error the same happens) until a perfect copy has been made.

With voice communication, errors are recogniseable by human operators, except those which the human ear can misinterpret, such as the classic of "send reinforcements, we are going to advance" becoming "send three and fourpence we are going to a dance"!

In an RTTY system, the possible number of errors is limited by the 32 characters used, these being obtained by using all the combinations of the five elements of the Baudot Code. With AMTOR, seven data elements are used, giving a possible 128 combinations, so that if only 32 are valid, reception of any of the others must be due to an error. The codes used out of these 128 combinations were specially selected to minimise errors, by choosing only those which had three '0" and four '1' elements, making error detection by the MPU reasonably easy.

Combinations

There are in fact 35 possible combinations using this rule — of the remaining three, one is used as a repeat request character, known as the "RQ" character, one is an idle character, known as "beta", and the third, "alpha", is also idle but also has a special control function.

Once A has finished his message, the QSO has to reverse direction, but such that both stations do not try and send at the same time. With AMTOR, when B wants to start a message, he stops sending Controls 1 & 2, and instead sends Control 3. When A receives this he sends a block consisting of beta, alpha, beta. When this is copied by B, B changes to transmitting blocks, and receiving control codes. The timing of all this is quite critical, and readers are referred to the original article (*Radcom*, August 1979) if they are interested. Also, because of the small time delay between sending and transmitting, there is a practical limit on the distances that can be covered with AMTOR, depending on your exact RX/TX and its changeover delay.

Because of the error detection and correction used, the system is much more reliable than ordinary RTTY, in fact very much more reliable.

Synchronisation

Obviously this is required to maintain the accurate timing needed, and is achieved using a series of sync blocks sent by the master (station A) until the slave (station B) has received and recognised 21 successive blocks. Further checks are done by both stations in case the sync blocks were due to random noise, before the QSO proper starts.

AMTOR modes

The method of AMTOR operation just described is known as ARQ (Automatic Request) and gives rise to the familiar chirp-chirp signal heard on the air. Another mode known as FEC (Forward Error Correction) is available in which the 7 bit codes are sent twice, and the receiving station computes which is less likely to contain an error (by using the fact that the ratio of 1's to 0's should be 4:3 in each character). Up to half the received codes can thus be in error before errors occur in the output. The second transmission of each character is delayed relative to the first so that a prolonged fade or burst of QRM will only result in one transmission of several characters being mutilated, rather than both transmissions of a few adjacent characters. If both transmissions are mutilated the receiving system suppresses printing completely.

ARQ is very much better than FEC in terms of least received errors. However, FEC is needed because with ARQ, only two stations can take part, whereas with FEC one station can transmit to any number of others.

The AMT-1

With AMTOR now permitted in many other countries, including the USA, its use has increased noticeably over the past year or so. ICS has come into the market with a very useful piece of equipment designed to interface with a home computer or ASCII Terminal, and gives fairly instant AMTOR operation for anyone requiring it.

The *AMT-1* comes in a professionally finished low-profile case, which must be unique in amateur circles by not having a single knob or button on the front panel. Instead, a long row of LEDs, hidden behind a translucent panel cutout show the status of the unit at any moment — the control over the unit being via the computer keyboard of course.

The status displays are split into three parts — on the right hand side are four red LEDs indicating which of the four principal modes the *AMT-1* is in (ARQ, FEC, RTTY, CW — yes it copies those as well!). In the centre is a tuning display with a high frequency signal appearing at the left of the display, and low at the right. When correctly tuned to RTTY, the display lights continuously. The remaining LEDs comprise a status display, with RQ, ERROR, TRAFFIC, IDLE, OVER, PHASE, STBY 1, ESC and SEND indicators.

There are a number of internal adjustments which can be made to suit your own set-up and these are very fully described in the manual.

It requires +12V DC for operation, introduced via a coaxial socket on the rear panel, which also has two DIN sockets for connecting the terminal and transceiver. Full details of the connections are given in the comprehensive instruction manual which accompanies the unit, together with a set of plugs and leads for interfacing. A very useful summary card which can be placed by the operating position is also provided — this saves delving through the main manual when first learning to drive the unit from the keyboard.

One point to note, which is fully explained, is the need for a reasonably fast changeover from transmit to receive on your transceiver. If this takes longer than 50mS, then the unit will not operate correctly in ARQ mode, and a much shorter changeover time is in fact preferred. The shorter the delay the longer the distance that can be worked. The reason behind this is that radio waves take a finite time to travel and the ARQ mode allows a maximum of 170mS for the radio signals to travel from one station to the other and back. If there were no other delays, this would give 170 x 300km between ARQ stations or 25,500km. Thus ARQ will not work at greater distances, and any additional delays will reduce this figure. With changeover delays of 10mS at each end, it is just possible to work from one point of the globe to the opposite point on the Earth's surface.

A number of hints on reducing these delays are given, together with a list of rigs which are known to work. Most modern transceivers are covered.

The internal appearance of the unit could not be faulted, and ICS are to be congratulated on a fine piece of workmanship.

G3WPO

THE AMT-1: an owners review

The *AMT-1* Unit contains everything that is needed to convert an amateur station into a fully operational data communication system with optional error correcting facilities. I use it myself with the Commodore *VIC 20*, having an RS232 interface plugged into the user port of the *VIC 20*. There are

Typical AMTOR copy

```
CQ CQ CQ CQ CQ CQ CQ CQ DE G3RDG G3RDG G3RDG G3RDG G3RDG G3RDG PSE KK
CQ CQ CQ CQ CQ CQ CQ CQ CQ CQ DE G3RDG G3RDG G3RDG G3RDG G3RDG PSE K K
CQ CQ CQ CQ CQ CQ DE G3RDG G3RDG G3RDG PSE K K K  GJGJGJUEXUXDC
G3RDG GJYH3RDG G3RDG DE UB5UCT UB5UCT OK R U RST 5NN 5NN =MY QTH
IS KIEV KIEV KIEV = NAME IS G EG T E  GEORGE GEORGE = G3RDG G3RDG
DE UB5UCT UB5UCT FGHDHFGGGF RRRRRRR UB5UCT UB5UCT DE G3RDG G3RDG
R R R R OK OM I COPY. NAME HERE IS KEN KEN KEN KEN. QTH IS LONDON
LONDON . RST 589 589 589 OK ? UB5UCT UB5UCT DE G3RDG G3RDG KKK
DE UB5UCT OK MNY TNX FER CALL MY BEDFSFST 73 73 G3RDG DE UB5UCT
KN   DE G3RDG VA VA
```

only three wires needed: Data in, Data out and Signal ground, and all the instructions to the *AMT-1* are given from the computer keyboard. A suitable program for the *VIC 20* was supplied by the manufacturers, ICS Electronics Ltd, and this was written in BASIC, so that any alterations could be made very easily. It was only necessary to make the connections between the *AMT-1*, the *VIC 20* and my transceiver (I use the Trio *TS820S*) and load the program to start everything working. The screened leads and DIN plugs are supplied with the *AMT-1*.

When the program is loaded and run you are asked to insert your callsign and press 'return'. You are next asked to insert your SELCALL. This comprises the four letters of your call, leaving out the figure, or any other combination of four letters you wish to input. In my case the SELCALL is 'GRDG'. After this, the next request is for the number of characters you wish to print before the automatic carriage return linefeed operates. For those who are using the standard VIC 20 without the 40/80 columns card, the number is '15'. Having pressed 'return' you are then asked which mode you require. 'R' for RTTY, 'A' for AMTOR, 'C' for CW transmit or 'D' for direct ASCII in and out. For the first QSO it was 'R' for RTTY. There are cards supplied to fit over the function keys of the *VIC 20,* so that whichever mode is in use the necessary reminders of the usage of the keys is there to see. This is a great help at the start as I wanted to be reminded when to press the correct key!

With the card for RTTY over the function keys, I tried my first QSO. There was no difficulty at all. The *AMT-1* has a line of green LEDs which when nothing is being received light up in a random fashion. What has to be done is to tune in a station until one LED either side of the centre line is brightly lit, and the ones in the middle are dim. You just tune the receiver until this occurs and fine copy results. The instruction to transmit is given by the *VIC 20* (Control 'R', F3), and when this is done the Send LED lights and you are away. There is no need to think about Figure shift, Letter shift, Carriage return or Linefeed, its all done for you in the *AMT-1*. Wonderful. As regards the speed of RTTY: on switch-on this is at 45.45 bauds, but can be varied to 50 or 75 bauds by merely typing 'B' followed by the speed you require and pressing 'return'. Other facilities which I have incorporated in my program and which are controlled by keys on the *VIC 20* are: A line of 'RY' 'Quick brown fox', CW ident (which uses the callsign previously entered), call CQ, call CQ Contest, and sending the Time. This last one requires that the internal clock of the VIC 20 be set to the correct time before loading the program, and of course, each time the program is used, unless the computer is always left switched on. I used the AMT-1/VIC 20/TS820S combination in the BARTG Spring HF Contest and everything behaved perfectly.

I then turned my hand to AMTOR. To do this one has to press 'Escape' when the menu will be displayed. 'A' is pressed followed by 'return. The 'ARQ' led then lights up, and if you wish to listen first, 'ARQ listen' is pressed. The lefthand indicator light will change from STBY to PHASE, and you are then ready to receive AMTOR.

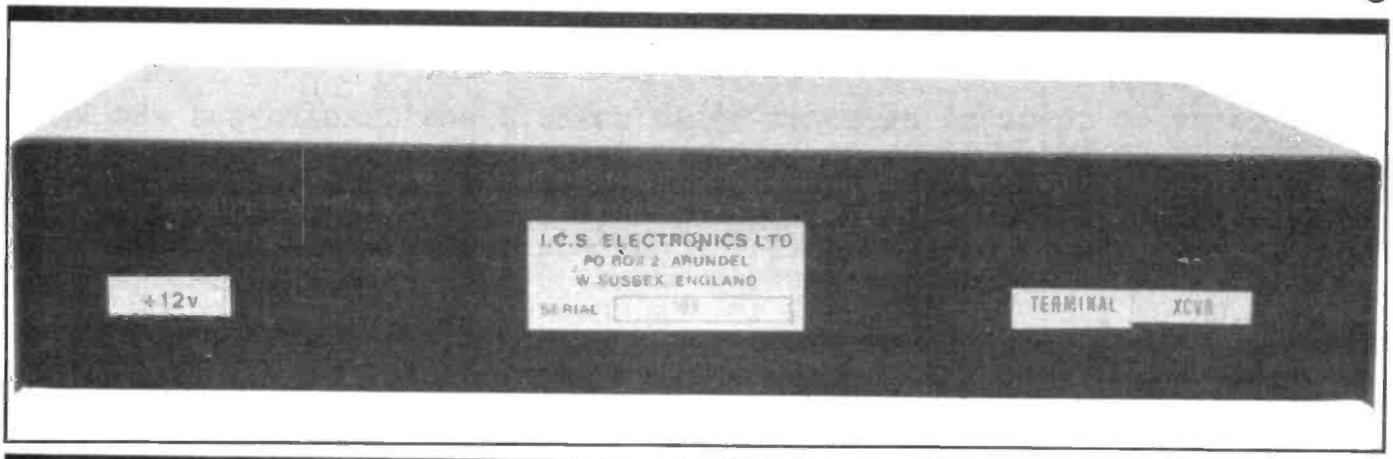
When the familiar chirp-chirp is heard one has to tune it in slightly differently to RTTY. The AMTOR chirp-chirp when correctly tuned in, will appear as two dots either side of the centre line, with the middle blank. When this is achieved text should appear on the screen. I must emphasise that it requires a little practice to resolve the signals satisfactorily, as I soon discovered. Having been used to the two ellipses on a Monitor scope, it was a little while before I mastered it. In the end, however, it turned out to be as simple as the old arrangement. Rather like driving a different make of car.

The beauty of operating the *AMT-1* is its flexibility. Its all in one strong steel box measuring 310mm (W) X 235mm (D) X 60mm (H), and that's it. No odd boxes and birds nests of wire connecting it all. The printed circuit board is very businesslike in appearance, and the User's Manual most explicit in its description of the various functions of the equipment. The *AMT-1* is not self-powered and requires a supply of 12/14 volts DC at 800mA. There was no difficulty here for me since I already had a 12 volt supply to run my transverter, but in any case 800mA is not a great load, and a small power supply can easily be made from parts in the 'junk box'.

I have been using an ST6 Terminal Unit with a CW filter in the *TS820S,* and on some occasions, the Datong FL2, to receive copy, but I find that the four section audio filter/discriminator demodulator of the AMT-1 is equal if not superior to that setup. All in all, as far as I am concerned, I would recommend the *AMT-1* without reservation to anyone wishing to have a complete RTTY/AMTOR/CW station in one unit. As a user, I am completely satisfied.

G3RDG

Thanks go to ICS Electronics of Arundel, Sussex for help in the preparation of this article.



Technicalities

By Frank Ogden G4JST
Building RF projects

Talking to people both on the air and over a pint, it becomes clear that many potential constructors are put off from building involved RF projects because they consider such things a black art which they stand no chance of mastering . . . even less of getting a finished project to work.

I have to confess that RF things require a different sort of skill in building than, say, a photographic -darkroom - timer - cum - baby -alarm. The logic (as in digital) part of this hypothetical design will work without problems providing that the builder has put the chips in the right way round. Similarly, the baby alarm portion will nearly always work first time even though there may be a bit of hum on the output because of an unintentional earth loop.

Ridiculous? Perhaps but it does illustrate a serious point. RF design and construction does require a special appreciation which is what makes it about ten times more interesting and rewarding than any other facet of the electronics hobby. Furthermore, the joy of powering up a £1300 Japanese black box comes nowhere near to that of making your first cross town 2m contact with a tacky looking bird's nest that you built yourself. Even better, you've still got the £1300 left to spend on food, coke or whatever may happen to be your money burning interest.

For those with some knowledge

It's not possible to provide a complete guide to RF engineering in the space of one monthly column but it is quite realistic to outline a few of the most common problems. Furthermore, it is quite amazing how a great variety of symptoms can be traced to a small handful of faults almost regardless of the piece of equipment being worked on. I propose to use a 2m RF pre-amplifier as a discussion example although many of my comments could be applied equally to a receiver IF strip, transmitter output stage or whatever.

There is nothing particularly special about the pre-amp circuit of Fig. 1. It shows a dual gate MOSFET connected as a receiver pre-amp with the basic configuration suitable for use at any frequency between 2 and 200MHz depending on the tuned circuit values.

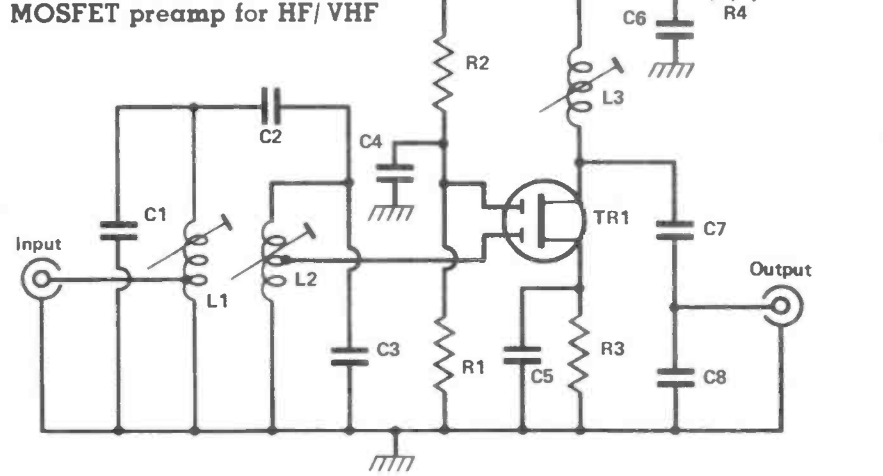
The input signal feeds into the bottom of L1, resonated by C1. A core inside L1 adjusts the first tuned circuit for resonance. The 'live' end of L1 feeds the signal voltage to the 'live' end of L2 via a low value coupling capacitor, C2. A tap towards the top end of L2 couples the signal into gate 1 of the dual gate MOSFET. Resistors R1 and R2 form a potential divider ensuring that the DC voltage on gate 2 biases the transistor into the region of maximum gain. Capacitor C4, the gate 2 decoupling capacitor, is crucial since it ensures that the transistor, RF wise, is isolated into two halves: the input and the output. Resistor R3 sets the transistor drain current (the higher the value, the lower the standing current and gain) while the parallel capacitor C5 short circuits RF current present on the source circuit to ground. L3, tuned in the main by C7, provides both resonance and DC feed for the drain circuit (from the supply via R4) while C8 offers capacitive matching from the high impedance of the transistor drain to the 50 ohm nominal output impedance of the amplifier. C6 decouples the pre-amplifier as a whole from the supply. As a general point the amplifier will draw in the region of 10mA and, when adjusted correctly, provide around 20dB of gain (a voltage gain of ten times) at 144MHz.

Here are a few symptoms and their causes. Remember that they could be applicable to many kinds of RF circuit although the discussion example is a 2m pre-amp.

1) "I've built it as per the instructions and it acts more like an attenuator than an amplifier . . . The amplifier seems to be drawing the right amount of current but nothing much else happens. . . Turning the slugs of L1, L2 and L3 seems to have little effect. I can't find any tuning point for maximum signal no matter what I try."

The starting point for this particular problem will depend very much on the source of the circuit. If the unit was built from a reliable kit, the outlined fault symptom will almost always be due to incorrect assembly and hardly ever from unserviceable components. For instance, it is all too easy to identify ceramic capacitors wrongly. I've spent many a miserable hour trying to locate an intractable hiccup in my latest masterpiece only to find that I have confused Ks, Js, Ns and, just occasionally, Zs. The hallmark of a healthy RF circuit is the presence of clear resonance points in the tuning of the various inductors. Naturally, it would be very unhealthy

Fig. 1. Typical dual-gate MOSFET preamp for HF/ VHF



for specifically broadband RF circuits to show resonnce but that is another story!

Given the symptoms outlined in 1), the cause could be very different if you have designed and built the thing from scratch. Assuming once again that the DC circuit conditions are OK (all the resistors are of the correct value to bias the transistor into what should be a working condition) then failure to function correctly will once again be due to lack of resonance.

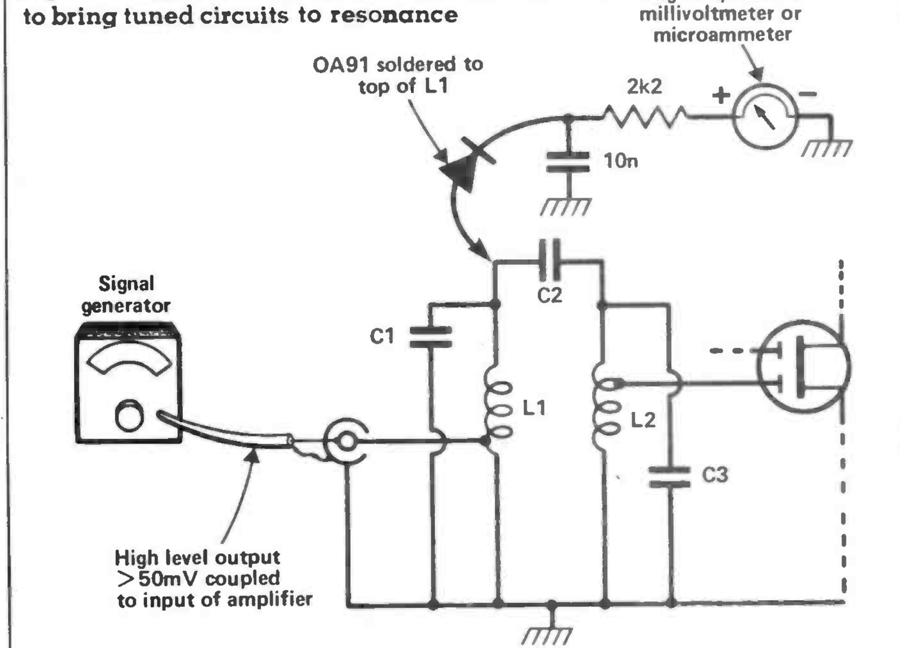
In this case, you must work through the circuit methodically checking that tuned circuits are capable of resonance at the operating frequency. At this point, the standard textbooks would suggest "that a GDO (grid dip oscillator) should be loosely coupled to the circuit under inspection and the frequency noted at which the GDO produces the maximum dip". With modern miniature components and circuits this kind of advice is seldom practical or even possible. Even worse, every GDO that I have come across has been less than accurate in its calibration. Just to blackball the traditional methods completely, you are just as likely to measure the resonant frequency of the coupling loop rather than the circuit under inspection. **Fig. 2** shows the effective way of bringing tuned circuits to resonance. With the amplifier connected to the supply inject a high level signal — greater than 50mV — directly into the first tuned circuit. At the same time, temporarily solder an OA91 germanium diode (it must be this type of device as any other will be hopelessly insensitive/or impose a severe circuit loading with both resistance and capacitance) to the hot end of the tuned circuit under inspection. The other end of the diode connects to a grounded 10n capacitor and a microampmeter via a low value series resistor. The frequency of the signal generator is then swung about until a reading is obtained on the meter. Although tuning will be much broader than without the diode probe connected, a distinct hump in the reading will show the precise resonant frequency without ambiguity. Having adjusted L1 into the resonance ballpark, the probe is then moved to the top end of L2 and the performance repeated.

This time, the maximum of the hump will be much less although still readily discernable. This is because the value of C2 will have been chosen for optimum coupling between the tuned circuits without taking the loading of the diode probe into account.

By the time that the two input tuned circuits have been brought close to resonance, some action should be evident at the output of the pre-amplifier. The next thing to do is to tune L1 and L2 for maximum smoke. The tuned circuit L3 can also be adjusted by switching the generator signal source from the input to the output socket. However, beware. The application of supply volts to the amplifier is necessary for this kind of cold tuning exercise. Without them, the transistor appears as a low value resistance effectively connected directly across the L3 tuned circuit as far as RF is concerned. It only goes to a high resistance state when passing its normal operating current. Furthermore, the earth return on the measuring meter will have to be made to the cold end of L3.

When designing from scratch some curious tuning anomalies may be noted in the behaviour of L1 and L2. This is most likely due to over-coupling. If a very pronounced double tuning hump is noted then the value of C2 is probably too high. Dropping its value or removing it altogether may effect an improvement.

Fig. 2. Using a signal generator and diode probe to bring tuned circuits to resonance



Instability

2) "The circuit seems to work but every time I attempt to adjust the inductors for maximum signal output, the wretched thing bursts into oscillation".

A common problem. What you need to know is the type of instability which the circuit exhibits. There are basically two kinds. That which occurs in the region of signal frequency (perhaps not so common with dual gate MOSFETs) and the other where oscillation occurs at a far removed frequency (either higher or lower but more usually higher).

Let's examine the simple case first. The pre-amp bursts into uncontrollable oscillation as the inductors approach optimum setting. You measure the frequency of oscillation (assuming that some kind of counter or absorption meter is to hand — see *Technicalities* in the July issue) and find that it goes off within a few MHz of signal frequency. There is only one explanation: you have built an amplifier but inadvertently coupled the output back to the input.

There are three kinds of RF feedback loops: capacitive, inductive and resistive. You may count a combination of loops as a fourth condition. The most usual cause of instability is through capacitive feedback. The top ends of L1, L2 and L3 are at very high impedance — several thousands of ohms when at resonance. Very little capacitive reactance between them is required to provide a feedback path sufficient for oscillation. At 144MHz the effective stage gain will be around

20dB. It requires just 0.01 to 0.02 pF of capacitive coupling for sustained oscillation. At the very close component spacings of modern equipment, some kind of static screen becomes essential. **Fig. 3** shows the usual format.

A single screen may provide sufficient electrostatic screening but do little to prevent magnetic coupling between the coils. This poses a real problem. While vertically mounted coils require the least space a single flat screen between the input and output coils does little to intercept the connecting magnetic flux. The only way to preclude all magnetic coupling is to enclose totally one set of coils — usually the input — in a screen can. For HF through to VHF, the same effect can be obtained by winding the resonant coils on toroidal cores. This way the flux is trapped totally within the core and cannot leak out to cause feedback problems.

The screen shown in **Fig. 3** may provide sufficient isolation although a better layout would have been to arrange L3 flat on the PCB groundplane so that its stray flux is at right angles to the input coils with the consequent reduction in stray coupling.

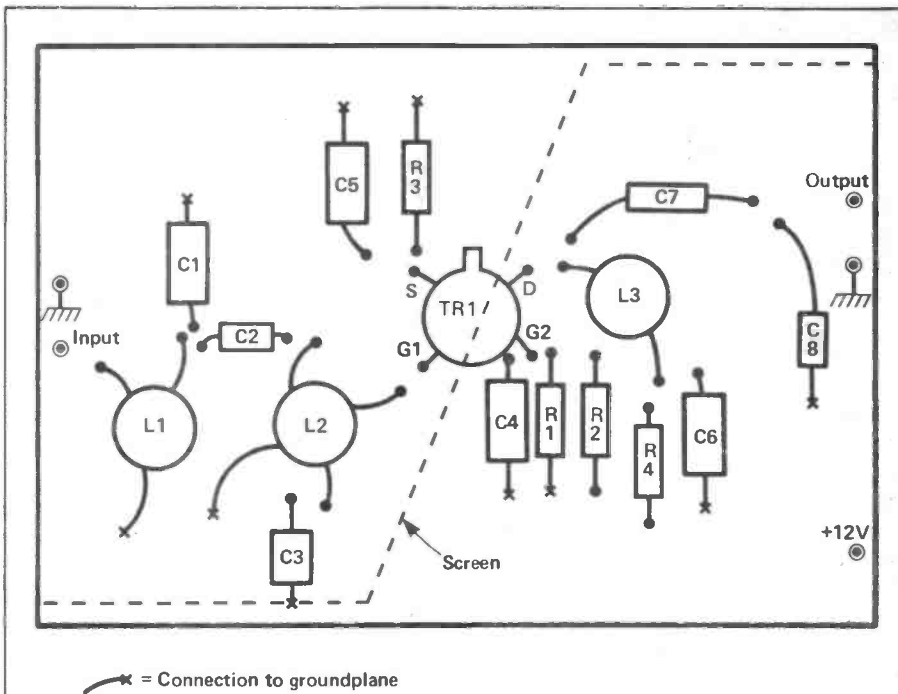


Fig. 3. Typical layout of VHF dual-gate MOSFET preamp

Pretty rather than functional

Excessive component lead or PCB track lengths can also cause problems. When a circuit oscillates around signal frequency even though the screening appears satisfactory, then you have either done something very silly like leaving off the gate 2 decoupling capacitor or, more likely, you have employed more artistry than common sense in the PCB layout. For instance, excessive track length or component lead length in the source circuit of the hypothetical example will turn what should be a nice, stable predictable design into a low stability Colpitts oscillator. **Fig. 4** indicates the feedback mechanism. Careless layout can also lead to other stability problems which are much more difficult to tackle.

UHF not VHF

3) "I've built the pre-amp and it appears to tune up OK although the supply current seems rather on the high side. It's a bit strange . . . the gain doesn't seem to be particularly high and it seems to affect the squelch control setting. Bringing my hand close to the pre-amp output lead seems to make the squelch open for no apparent reason. The amplifier doesn't appear to make the rig more sensitive either."

What you have in this case is almost certainly UHF instability. As a general point, the problem has become exacerbated in recent years paradoxically because semi-

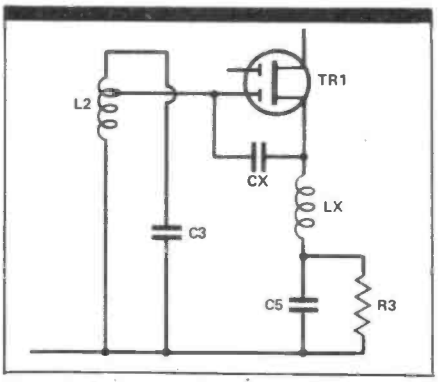


Fig. 4. Pretty rather than functional layouts can lead to excessive stray inductance and . . . oscillation

conductor devices have improved beyond measure. Most parts which are specified for HF or VHF service will show respectable gain right through to UHF. This is particularly true of dual gate MOSFETs and the RF type JFETs. Unless one of these devices is operating near its cutoff frequency, it will nearly always require some kind of parasitic suppression very much like the grid and anode stopper resistors of valve designs. The rule is that the source terminal should be taken to ground by the shortest, lowest inductance route while a ferrite bead on the gate 1 terminal, and possibly on the drain lead as well will preclude tendency to UHF oscillation. In addition, it is essential to decouple G2 with a low inductance capacitor. A small 1nF unit is often preferable to a physically larger 10nF part. Low value resistors — in the region of 100 ohms — placed in series with the gate 1 and drain leads cause no drop in performance at VHF and virtually ensure parasitic stability. See **Fig. 5**.

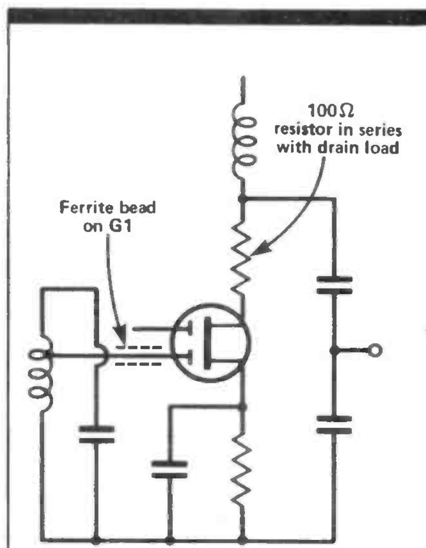


Fig. 5. Parasitic stoppers

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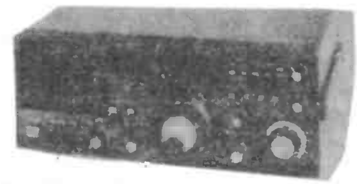

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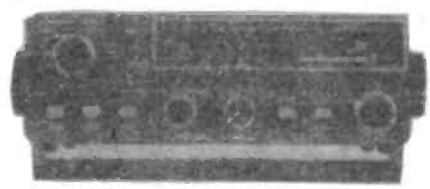

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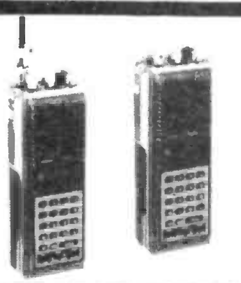

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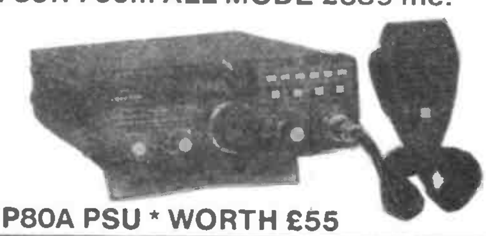

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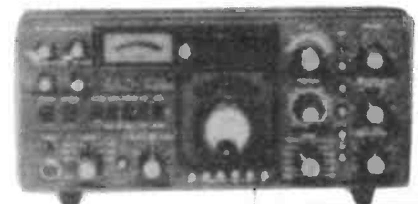

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5XY/2M	Yagi 5 ele crossed	7.8dBd	£28.17	£2.50
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SEVENTY CM				
C8/70	Colinear Omni Vertical	6.1dBd	£62.10	£2.50
D8/70	Yagi 8 over 8 slot	12.3dBd	£25.87	£2.50
PBM18/70	18 ele Parabeam	13.5dBd	£32.20	£2.50
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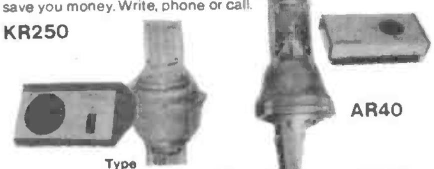

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FS500H	1.8-80MHz 20/200/2000W Pep	£69.75	FOC
FS500V	50-150MHz 20/200W Pep	£69.75	FOC
FS300H	1.8-60MHz 20/200/1000	£46.40	FOC
FS300V	50-150MHz 20/200W	£46.40	FOC
FS200	1.8-150MHz 20/200 Pep	£50.60	FOC
FS001M	1.8-20 MHz 20/200W Pep	£51.35	FOC
FS601MH	1.8-30MHz 20/2000W Pep	£51.35	FOC
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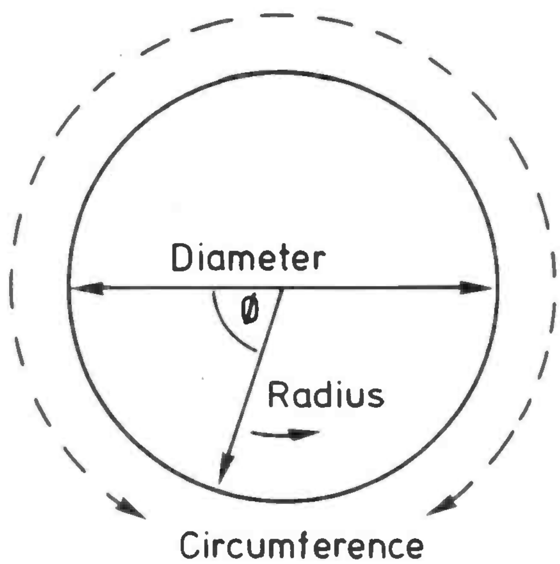
Radio Maths Made Simple

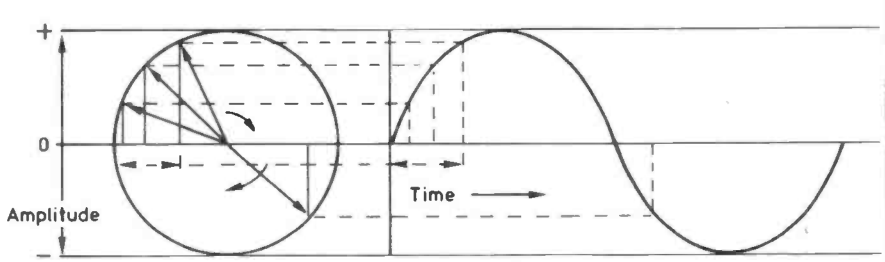
Basic Maths for RAE Students by Bill Sparks G8FBX

Part 3. Ohm's Law



Circumference = π x Diameter = 3.142 x dia.
Diameter = 2 x Radius (R)
So Circ = 2 π R
ϕ is angle radius subtends at centre

Using above to illustrate formation of sine wave. As can be seen, angle ϕ varies from 0-360° during rotation of radius through one revolution.



Showing how rotation of radius round circle creates sine waves, when rotating on a constant time rate. Notice when radius is in top half of circle net effect is forward movement. ie positive direction. When radius moves to bottom half net effect is reverse direction ie negative direction so top half of cycle is positive, bottom is negative.

Continuing from the August article, this technique is used in Ohm's Law calculations since **V = I × R** where **V** is any voltage we may find. **I** is the corresponding current and **R** is the value of resistor that makes the equation come out to the correct answer. Variations on the above give **V/R = I** and **V/I = R** so we can use the basic **V = I × R** formula to give values to **I** and **R**. We can therefore say if **V = I × R** then **I = V/R** and **R = V/I**.

This is the same as saying: if **a = b × c (a = bc)** then **b = c** and **c = b**. You will note that this is different to the original explanation and the difference is that originally we said that **ab = c**, now we are saying **bc = a**, we could have said **ac = b**. The actual letters in use are not important. The relationship of one side of the equation to the other is the important fact.

As a proof of the above, substitute numbers for letters.

If $a = 4 \quad b = 8 \quad$ and $c = 2$

then $\frac{8}{4} = 2 \quad$ so $\frac{b}{a} = c$

According to the formula:

if $\frac{b}{a} = c \quad$ then $\quad b = ac$

or $\frac{8}{4} = 2$ then $8 = 4 \times 2$

This can be further amplified to another formula:

$$\frac{ab}{c} = d$$

In order to find **d** we carry out our calculation

$$\frac{4 \times 8}{2} = d$$

so $\frac{32}{2} = 16$ which equals d

but if $\frac{ab}{c} = d$ then $ab = cd$

or $4 \times 8 = 16 \times 2 = 32$ again correct

but if $\frac{ab}{c} = \frac{ab}{d} = c$ or $\frac{4 \times 8}{16} = 2$

again we have a correct answer.

The algebraic forms needed to be understood for the exam are as follows

1) If $a = \frac{1}{d\sqrt{bc}}$ then $a^2 = \frac{1}{d^2bc}$

and $b = \frac{1}{d^2a^2c}$ and $c = \frac{1}{d^2a^2b}$

and $d = \frac{1}{a\sqrt{bc}}$

This is the form of the resonant circuit formula, $f = \frac{1}{2\pi\sqrt{LC}}$ and we have substituted a for f, d for 2π and b and c for L and C.

2) If $a = b^2 + c^2$ then $a^2 = b^2 + c^2$
and $b = a^2 - c^2$ and $c = a^2 - b^2$

This is our impedance formula

where $Z\sqrt{= X^2 + R^2}$ (See later)

From **Fig. 3** which introduces pi we can see that **R** is the radius of the circle, ie it is one half of the diameter so **2R = D**. If π**D** = the circumference then **2πR** = circumference.

One other relationship requires explanation and this time you can blame the Greeks again. The fellow concerned is a chap called Pythagorus, but don't get too upset. He's been dead for 2000 years or so.

Old Pythagorus said that in any right angle triangle, the sum of the squares on the two shorter sides was equal to the square of the longer side as in **Fig. 4.** In our case this is the impedance triangle and we can find that the second triangle in **Fig. 4** shows the relationship. This is always true and can be proved mathematically. If you want to check it, make up a triangle as in the third triangle in **Fig. 4** and measure the length of the dotted line. You will find it to be 5.

$$3^2 + 4^2 = 5^2 \ (9 + 16 = 25)$$

Situations where we may use the subjects discussed so far!

Indices
In calculating the resonant frequency of a circuit and reactance calculations.

Decibels
The logarithmic method of establishing ratios of one level to another.

Pythagorus
In calculating impedance values.

Algebraic Forms
Working out Ohm's law relationships and values of power in watts.

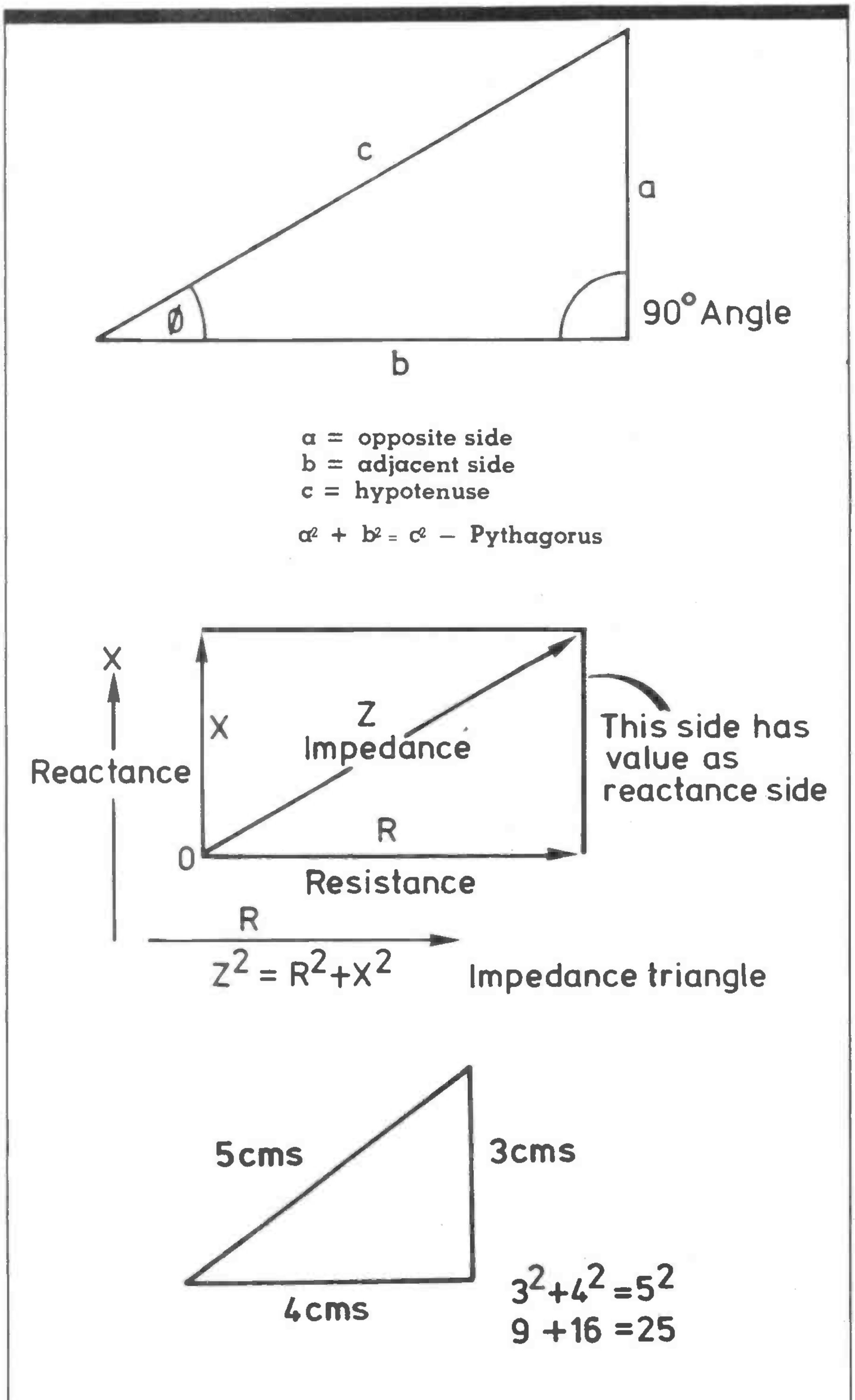
Glossary

Various prefixes are used in radio.

giga	= One thousand million	$= 10^9$
Mega	= One million	$= 10^6$
kilo	= One thousand	$= 10^3$
deci	= One tenth	$= 10^{-1}$
milli	= One thousandth	$= 10^{-3}$
micro	= One millionth	$= 10^{-6}$
nano	= One thousand millionth	$= 10^{-9}$
pico	= One million millionth	$= 10^{-12}$

Note how easy it is to write 10^{-12} instead of writing

$$\frac{1}{1,000,000,000,000}$$



RADIO Tomorrow

7 Aug	RSGB National Mobile Rally, Woburn.
	UK FM Group (Western): DF hunt.
	Cambridge & DARC: dress rehearsal for contest.
9 Aug	Aylesbury Vale Rs: *Intruder Watch* by Stan Cook G5XB.
	Bristol ARC: film evening (RSGB and Spielberg).
	Bury RS: DF hunt.
	Stevenage & DARS: DF hunt.
10 Aug	Cheshunt & DARC: natter nite.
	Farnborough & DARS: *Basic Computers* by G6HIT.
	Lincoln SWC: on air.
	Nene Valley RC: natter nite & on air (HF).
14 Aug	70MHz Trophy and SWL Contest (rules in June *Radcom*).
	Derby rally.
	Six Castles Award: GW4OXB/P operating from six *1983 Festival of Castles* sites on the Gower Peninsula on 145.3MHz FM; proceeds (award costs £1) to RAIBC.
	Cambridge & DARC: 2m DF hunt.
15 Aug	Braintree & DARS: *A History of Teleprinting* by Len Crane G3PED.
	Leighton Linslade RC: meeting.
16 Aug	Bristol ARC: Computer Group meeting.
	Fylde ARS: informal meeting.
	Kidderminster & DARS: informal meeting.
	Mid-Warwickshire ARS: planning meeting for exhibit at Town and Country Festival.
	Stevenage & DARC: construction evening.
17 Aug	Cheshunt & DARC: equipment evening.
	Nene Valley RC: *Resonating Aerials* by G3NVK.
18 Aug	Chichester & DARC: meeting.
19 Aug	Cambridge & DARC: visit planned.
21 Aug	Boys Brigade Centenary: *Anchor Chain* amateur radio link-up.
	Hamfest 83 rally at Wimborne, Dorset, nr. Bournemouth; 11am-5.30pm, talk-in GB2FRH.
	Mid-Warwickshire ARS: family day out and picnic at Ragley Hall, with HF station (G3UDN) on air.
	Stevenage & DARS: club picnic at Hampson Park.
23 Aug	Deadline for November *Radio Tomorrow.*
	Bristol ARC: business meeting.
24 Aug	Cheshunt & DARC: natter nite.
	Farnborough & DARS: *VHF Propagation* by G3LTP.
	Lincoln SWC: on air.
	Nene Valley RC: *Alternative Power* by Dr. J. Graham (CEGB).
26 Aug	Cambridge & DARC: external social event.
27 Aug	Scottish Amateur Radio Convention, Cardonald College, Mosspark, Glasgow.
27-28 Aug	24th All Asian (CW) Contest (rules in June *Radcom*).
27-29 Aug	GB4TCF at the National Town and Country Fetival, Royal Showground, Stoneleigh, Warwickshire (4 miles South of Coventry on the A444); large amateur radio display; special QSL.
28 Aug	ROPOCO 82 Contest.
	Leighton Linslade RC: DF hunt no. 9.
29 Aug	Braintree & DARS: second family day out.
30 Aug	Bristol ARC: on air.
31 Aug	Cheshunt & DARC: junk sale.
	Nene Valley RC: natter nite & on air (HF).
2 Sep	Cambridge & DARC: informal evening; morse class; on air; final plan for Region 1 IARU SSB Contest.
3-4 Sep	144MHz Trophy & SWL Contest (IARU) (rules in June and July *Radcom*).
	SSB Field Day (rules in May *Radcom*).
5 Sep	Enrolment for Dacorum College (Hemel Hempstead) RAE course.
	Braintree & DARS: quiz evening.
	Leighton Linslade RC: AGM.
	Stourbridge & DARS: informal meeting; formation of Stourbridge Carnival and JOTA groups.
5-7 Sep	Enrolment for North Trafford College of Further Education RAE course.
6 Sep	Enrolment for Bradford & Ilkley Community College RAE course.
	Aylesbury Vale RS: *An Introduction to Microwaves* by G4KNZ.
	Chichester & DARC: meeting.
	Mid-Warwickshire ARS: junk sale.
	Stevenage & DARS: *Aluminium for Antennas, Ideas on How To Use It* by G4MEO.
6-7 Sep	Enrolment for Langley College of Further Education RAE course 12.30-8 pm
7 Sep	Cheshunt & DARC: natter nite.
	Nene Valley RC: *Satellite Working* by G4HME.
8 Sep	Edgware & DARS: informal meeting.
	Stevenage & DARS: beginners evening, at Fairlands Community Centre.
9 Sep	Cambridge & DARC: talk on aerials.
10 Sep	Stourbridge & DARS: demonstration station at Stourbridge Carnival.
11 Sep	Vange rally.
11-12 Sep	International Amateur TV Contest (rules in May *Radcom*).
12 Sep	Enrolment for Arnold & Carlton College of Further Education RAE course 10am-4pm.
13 Sep	Bury RS: *Japanese Morse* by Norman Kendrick G3CSG.
	Kidderminster & DARS: AGM.
13 & 14 Sep	Enrolment for Arnold & Carlton College of Further Education RAE course 2pm-8pm.
14 Sep	Cheshunt & DARC: visit to Brookmans Park MF transmitting station.
18 Sep	Peterborough R & ES mobile rally.
	UK FM Group (Western): DF hunt.
19 Sep	Braintree & DARS: *From Erk to Test Pilot* by Sqdn. Ldr. A. S. Murkowski.
	Leighton Linslade RC: meeting.
	Stourbridge & DARS: main meeting.
20 Sep	Mid-Warwickshire ARS: DF hunt (starting 7.30pm 145.350MHz)
21 Sep	*Deadline for December Radio Tomorrow.*
	Cheshunt & DARC: natter nite.

21 Sep Nene Valley RC: *QRP* by Rev. George Dobbs G3RJV.
22 Sep Edgware & DARS: *The BBC Microcomputer* by John Bluff G3SJE.
23 Sep Medway AR & TS: junk sale.
24 Sep Clipperton DX Club 5th Convention, Le Raincy, Paris.
25 Sep Harlow rally.
28 Sep Cheshunt & DARC: *RSGB Headquarters* by John Nelson, Assistant General Manager, RSGB.
1 Oct 432MHz-24GHz & SWL Contest (IARU) (rules in June *Radcom*).
Braintree & DARS: *Autumn Fayre* (show in Braintree Community Centre).
3 Oct Braintree & DARS: setting up JOTA.
Leighton Linslade RC: meeting.
Stourbridge & DARS: informal meeting; contest season de-friefing.
4 Oct Aylesbury Vale RS: *A 160-10m Transceiver* by Robin Hewes G3TDR.
Mid-Warwickshire ARS: natter night.
Stevenage & DARS: *Making a Homebrew Lattice Tower* by G8EKU.
5 Oct Cheshunt & DARC: natter nite.
6-8 Oct 12th ARRA Amateur Radio & Electronics Exhibition, at Exhibition Centre, Doncaster Racecourse, Leger Way, Doncaster.

CONTACTS

Bury	Brian Tyldsley	Burnley 24254
Cheshunt	Roger Frisby	Hoddesdon 464795
Mid-Warwicks	Carol Finnis	Southam 4765
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". . . Ten 'Tecs here . . ."

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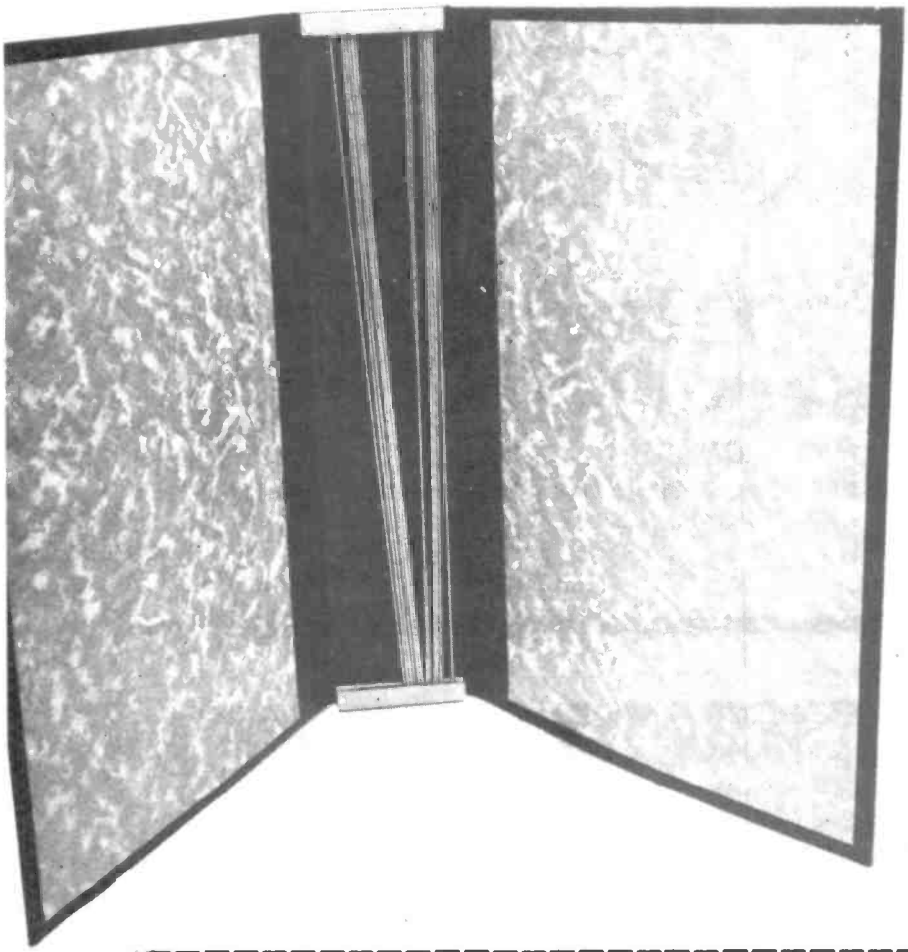

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QTH/QRA Locator Program for the ZX81

by Bob Fuller G8CEZ

As a result of producing a QRA program for contest use at my local club I decided to improve it and make it as foolproof as possible. The final program was of interest to other *ZX81* users and the idea of making the program available to other *ZX81* users came about, but the original QRA program was not enough to justify producing tapes. Having seen the difficulties that arise from finding QRA locators it was decided to write a program to cover this problem. How many QSL cards have you received with a QRA locator overprinted?

If you are going /A or /P on holiday or DXpedition you are able to work out all possible QRA locators, or draw the QRA squares on a map, from the information derived from Program A. The other possibility of course is to take the *ZX81*, a 12 volt television and battery cassette player with you to the /A or /P location. Although the *ZX81* should run on 12 volts I used a simple transistor dropper from 12 to 9 volts to avoid any thermal problems. This arrangement also doubles up on caravan holidays to put invaders and other games on the portable television for wet days. The most significant problem with using the *ZX81* near radio equipment is one of interference. No attempt has been made to reduce the interference level, I simply work out the QRA locator (Program A) first and the distances, etc (Program B) after. No doubt somebody will produce a suppression kit in the future.

The first two attempts at this program proved to be abortive, as 20K+ of RAM would have been needed and a complete rethink was necessary to produce a version in about 8.1K. Machine code was avoided so that each program can be understood and modified to individual requirements (eg. adding a printer to output scores with times and callsigns). Most subroutines are headed with a REM statement to aid the understanding of the program.

Program A

After loading you are presented with an introductory caption. This clears and you are invited to input your latitude in degrees, minutes and seconds. These are all assumed to be north of the equator. Next you input EAST or WEST and the degrees, minutes and seconds longditude. The best place to find this information is from an Ordnance Survey map, 1 inch to the mile or the later metric series 1:50000. If an Ordnance Survey map is not available, any reasonably scaled map can be used. On completion of your longditude the screen will clear as the *ZX81* goes into FAST mode. A 'noughts and crosses' grid is generated and presented to the screen. By removing the line of code with FAST in it (2150), you can watch the grid being generated, but with the penalty of it taking much linger. The program will work out your QRA locator and write this in the centre square. The relative position is shown with a flashing pixel. If the pixel flashes on an axis you are on a boundary. This now requires very careful checking to see which square you are in. In the unlikely event of being on a boundary you can chose your QRA locator or even have an aerial in each! The program now works out the QRA locator of the remaining eight squares and finds the latitude and longditude for the corners of your square. With this information you are able to plot on a map your square and the adjacent ones. On completion the pixel of your relative position will flash again in case it has been overwritten. Looking at the listing, eg. lines 1860 or 2060, there are some unusual lines of code. The best way to explain the reason for this is to try the following short program.

```
10 LET A = 1
20 LET A = A/3
30 PRINT A
40 LET A = A*3
50 PRINT A
60 LET A = INT A
70 PRINT A
```

By running this the reason for the 'fixes' in code should be seen. The size of the program is about 8.1K and loading takes about 3½ minutes. The area covered by this program is

LAT 40 00 00 NORTH to 62 59 59 NORTH
and
LON 11 59 59 WEST to 39 59 59 EAST

If you input below 40 degrees latitude you will be prompted to the fact that there is an identical QRA locator above 40 degrees latitude.

Program B

This program can be regarded as a standard QRA program, but with several significant improvements on all other versions seen. The program is loaded in the normal way. After the introduction you can name the contest and input your base QRA locator. For every QRA locator the corresponding latitude and longitude for the bottom left hand corner of its square is given. The flashing prompt will invite you to input the distant station. The following items are worked out and presented on the screen: latitude/longitude, distance in kilometres, bearing, points for RSGB contests, total points for IARU (ie. points per kilometre), total points for RSGB, number of contacts and best DX so far. A void bearing is given for a QRA locator which is the same as the base QRA locator.

The input of a QRA locator is checked for 5 characters, letters only in first and second characters, the third and fourth holding a value between 01 and 80, and a valid letter in the last character. No invalid inputs are accepted; all invalid inputs produce an error report without affecting the total score etc. The size of this program about 7.5K and loads in about 3 minutes. The area covered by this program is LAT 36 00 00 NORTH to 65 57 30 NORTH, and LON 12 00 00 WEST to 38 56 00 EAST.

Copies of the tape and instructions are obtainable from:

R Fuller, 35 Chichester Walk, Wimborne, Dorset, BH21 1SL. The price is £3.50 (including £1 for RAIBC funds and P&P).

It is hoped to produce a *Spectrum* version in the near future which will be distributed exclusively by *Ham Radio Today*.

Program A listing

```
  10 REM FIND YOUR QRA PROGRAM
         FOR ZX81+16K RAM
  20 REM COPYRIGHT R.FULLER
         G8CEZ QTHR 10 JAN 1983
  30 REM PLEASE DO NOT COPY THIS
         PROGRAM,IF YOU DO YOU
         ARE DIVERTING MONEY
         FROM RAIBC FUNDS
  40 REM FOR EVERY TAPE SOLD AT
         FULL PRICE ,ONE POUND
         IS TO BE SENT TO RAIBC
  50 LET UD=2.5/60
  60 LET LR=4/60
  70 LET SHIFT=0
  80 DIM Z(3,3)
  90 LET Z(1,1)=[illegible]
 100 LET Z(1,2)=42
 110 LET Z(1,3)=41
 120 LET Z(2,1)=44
 130 LET Z(2,2)=47
 140 LET Z(2,3)=40
 150 LET Z(3,1)=45
 160 LET Z(3,2)=38
 170 LET Z(3,3)=39
 180 LET A$="G8CEZ"
 190 LET B$="RAIBC"
 200 FOR S=1 TO 5
 210 PRINT AT 1+S,1;A$;AT 1+S,7;
A$
 220 PRINT AT 1+S,24;A$;AT 1+S,1
8;A$
 230 PRINT AT 20-S,24;A$;AT 20-S
,18;B$
 240 PRINT AT 20-S,1;A$;AT 20-S,
7;B$
 250 PRINT AT 11,5;"WELCOME TO T
HE                  ""FIND QRA"
" PROGRAM"
 260 LET C$="      "
 270 PRINT AT 1+S,7;C$
 280 PRINT AT 1+S,18;C$
 290 PRINT AT 20-S,24;C$
 300 PRINT AT 20-S,1;C$
 310 NEXT S
 320 PAUSE 200
 330 POKE 16437,255
 340 CLS
 350 PRINT AT 4,1;"WHAT IS YOUR
LATITUDE"
 360 PRINT
 370 PRINT "DEGS ";
 380 INPUT LATD
 390 IF LATD>62 THEN GOTO 0430
 400 IF LATD<14 THEN GOTO 0430
 410 IF LATD<40 THEN LET SHIFT=1
 420 GOTO 0450
 430 GOSUB 3070
 440 GOTO 0360
 450 PRINT LATD
 460 PRINT
 470 PRINT "MINS ";
 480 INPUT LATM
 490 IF LATM>59 THEN GOTO 0510
 500 GOTO 0530
 510 GOSUB 3110
 520 GOTO 0460
 530 PRINT LATM
 540 PRINT
 550 PRINT "SECS ";
 560 INPUT LATS
 570 IF LATS>59 THEN GOTO 0590
 580 GOTO 0610
 590 GOSUB 3110
 600 GOTO 0540
 610 PRINT LATS
 620 PAUSE 50
 630 POKE 16437,255
 640 CLS
 650 PRINT AT 4,1;"WHAT IS YOUR
LONGITUDE"
 660 PRINT
 670 PRINT "INPUT ""E"" OR ""W""
 ";
 680 IF INKEY$<>"" THEN GOTO 068
0
 690 IF INKEY$="" THEN GOTO 0690
 700 LET E$=INKEY$
 710 IF E$="E" THEN GOTO 0800
 720 IF E$="W" THEN GOTO 0800
 730 CLS
 740 PRINT "[illegible]     INPUT E OR W
 "
 750 PRINT
 760 PRINT "YOUR INPUT WAS ";E$
 770 PRINT
 780 GOTO 0660
 790 PRINT
 800 PRINT E$
 810 PRINT
 820 PRINT "DEGS ";
 830 INPUT LOND
 840 IF LOND>11 AND E$="W" THEN
GOTO 0870
 850 IF LOND>39 AND E$="E" THEN
GOTO 0870
 860 GOTO 0890
 870 GOSUB 3060
 880 GOTO 0810
 890 PRINT LOND
 900 PRINT
 910 PRINT "MINS ";
 920 INPUT LONM
 930 IF LONM>59 THEN GOTO 0950
 940 GOTO 0970
 950 GOSUB 3110
 960 GOTO 0900
 970 PRINT LONM
 980 PRINT
 990 PRINT "SECS ";
1000 INPUT LONS
1010 IF LONS>59 THEN GOTO 1030
1020 GOTO 1050
1030 GOSUB 3110
1040 GOTO 0980
1050 PRINT LONS
1060 PAUSE 50
1070 POKE 16437,255
1080 IF SHIFT=1 THEN GOSUB 3140
1090 GOSUB 1650
1100 GOSUB 2130
1110 LET N3=(10*N1)+N2
1120 GOSUB 2570
1130 GOSUB 2670
1140 GOSUB 2330
1150 GOSUB 2260
1160 GOSUB 2810
1170 GOSUB 2440
1180 REM BOTTOM CENTER
1190 LET LAT=LAT-UD
1200 GOSUB 2330
1210 GOSUB 1650
1220 PRINT AT 19,13;CHR$ A1;CHR$
 A2;N1;N2;CHR$ Z(K,H)
1230 REM BOTTOM RIGHT
1240 LET LON=LON-LR
1250 GOSUB 2330
1260 GOSUB 1650
1270 PRINT AT 19,26;CHR$ A1;CHR$
 A2;N1;N2;CHR$ Z(K,H)
1280 REM MID RIGHT
1290 LET LAT=LAT+UD
1300 GOSUB 2330
1310 GOSUB 2480
1320 GOSUB 1650
1330 PRINT AT 11,26;CHR$ A1,CHR$
 A2;N1;N2;CHR$ Z(K,H)
1340 REM TOP RIGHT
1350 LET LAT=LAT+UD
1360 GOSUB 2330
1370 GOSUB 2510
1380 GOSUB 1650
1390 PRINT AT 2,26;CHR$ A1;CHR$
A2;N1;N2;CHR$ Z(K,H)
1400 REM MID TOP
1410 LET LON=LON+LR
1420 IF LON>0.000001 THEN LET E$
="W"
1430 GOSUB 2330
1440 GOSUB 2540
1450 GOSUB 1650
1460 PRINT AT 2,13;CHR$ A1;CHR$
A2;N1;N2;CHR$ Z(K,H)
1470 REM TOP LEFT
1480 LET LON=LON+LR
1490 IF LON>0.000001 THEN LET E$
="W"
1500 GOSUB 2330
1510 GOSUB 1650
1520 PRINT AT 2,2;CHR$ A1;CHR$ A
2;N1;N2;CHR$ Z(K,H)
1530 REM MID LEFT
1540 LET LAT=LAT-UD
1550 GOSUB 2330
1560 GOSUB 1650
1570 PRINT AT 11,2;CHR$ A1;CHR$
A2;N1;N2;CHR$ Z(K,H)
1580 REM BOTTOM LEFT
1590 LET LAT=LAT-UD
1600 GOSUB 2330
1610 GOSUB 1650
1620 PRINT AT 19,2;CHR$ A1;CHR$
A2;N1;N2;CHR$ Z(K,H)
1630 GOSUB 2810
1632 POKE 16418,0
1634 PRINT AT 22,12;"FINISHED"
1636 PRINT AT 23,8;"PRESS RUN/NL
 TO GO AGAIN"
1640 STOP
1650 REM FIND QRA
1660 IF LOND+LONM+LONS=0 THEN LE
T E$="E"
1670 REM ####FIRST ALPHA####
1680 LET D=(LONM/60)+(LONS/3600)
1690 LET B=LOND/2
1700 LET A=(LOND+D)/2
1710 IF E$="E" THEN LET A1=INT (
B+38)
1720 IF E$="W" THEN LET A1=INT (
64-A)
1730 REM ####SECOND NUMBER######
1740 LET C=(B-INT B)*10
1750 LET D=(D*5)+C
1760 IF E$="E" THEN LET E=D
1770 IF E$="W" THEN LET E=10-D
1780 LET F=INT E
1790 LET N2=1+F
1800 LET G=E-F
1810 IF N2=10 THEN LET N2=0
1820 IF N2=11 THEN LET N2=1
1830 LET G=(G*3)
1840 IF E$="E" THEN LET G=G+0.00
00000001
```

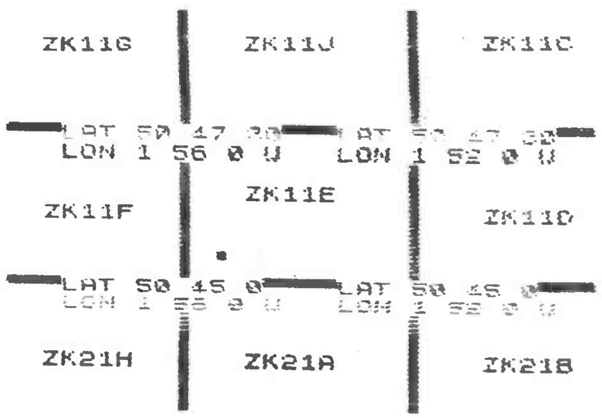
```
1850 LET JLON=G-INT G
1860 LET H=INT (G+1.000001)
1870 REM ***SECOND LETTER A2****
1880 LET A2=LATD-2
1890 IF A2<38 THEN LET A2=A2+26
1900 IF A2=37 THEN LET A2=63
1910 REM ****FIRST NUMBER N1****
1920 LET A=LATM/60+LATS/3600
1930 LET A=A*8
1940 LET B=8-A
1950 LET N1=INT B
1960 IF A-(INT A)=0 THEN LET N1=
N1-1
1970 IF N1=8 THEN LET N1=7
1980 IF N2=0 THEN LET N1=N1+1
1990 REM ****LAST LETTER****
2000 LET C=A-INT A
2010 LET C=(C*3)
2030 LET JLAT=C-INT C
2040 LET Y=12
2050 IF JLAT<0.5 THEN LET Y=10
2060 LET K=C+1.000001
2070 LET K=INT K
2080 IF K=4 THEN GOTO 2100
2090 GOTO 2120
2100 LET N1=N1-1
2110 LET K=1
2120 RETURN
2130 REM DRAW GRID
2140 CLS
2150 FAST
2160 FOR A=0 TO 43
2170 PLOT 19,A
2180 PLOT 44,A
2190 NEXT A
2200 FOR A=0 TO 63
2210 PLOT A,29
2220 PLOT A,13
2230 NEXT A
2240 SLOW
2250 RETURN
2260 LET FLON=INT (24*JLON)+20
2270 IF JLON<0.001 THEN LET FLON
=FLON-1
2280 IF JLON>0.9999 THEN LET FLO
N=19
2290 LET FLAT=INT (15*JLAT)+14
2300 IF JLAT<0.001 THEN LET FLAT
=FLAT-1
2310 PRINT AT Y,13;CHR$ A1;CHR$
A2;N1;N2;CHR$ Z(K,H)
2320 RETURN
2330 LET ALPHA=LAT
2340 GOSUB 2870
2350 LET LATD=DEG
2360 LET LATM=MIN
2370 LET LATS=SECS
2380 LET ALPHA=ABS LON
2390 GOSUB 2870
2400 LET LOND=DEG
2410 LET LONM=MIN
2420 LET LONS=SECS
2430 RETURN
2440 REM PRINT
2450 PRINT AT 15,3;"LAT ";LATD;"
 ";LATM;" ";LATS
2460 PRINT AT 16,3;"LON ";LOND;"
 ";LONM;" ";LONS;" ";E$
2470 RETURN
2480 PRINT AT 15,18;"LAT ";LATD;
" ";LATM;" ";LATS
2490 PRINT AT 16,18;"LON ";LOND;
" ";LONM;" ";LONS;" ";E$
2500 RETURN
2510 PRINT AT 7,18;"LAT ";LATD;"
 ";LATM;" ";LATS
2520 PRINT AT 8,18;"LON ";LOND;"
 ";LONM;" ";LONS;" ";E$
2530 RETURN
2540 PRINT AT 7,3;"LAT ";LATD;"
";LATM;" ";LATS
2550 PRINT AT 8,3;"LON ";LOND;"
";LONM;" ";LONS;" ";E$
2560 RETURN
2570 REM FIND LAT
2580 LET LAT=40
2590 IF SHIFT=1 THEN LET LAT=14
2600 LET LAT=LAT+(A2-38)
2610 LET LAT=LAT+(7-INT ((N3-1)/
10))*0.125
2620 IF K=1 THEN GOTO 2660
2630 LET LAT=LAT+0.125/3
2640 IF K=2 THEN GOTO 2660
2650 LET LAT=LAT+0.125/3
2660 RETURN
2670 REM FIND LON
2680 LET LON=0
2690 IF A1>57 THEN GOTO 2720
2700 LET LON=LON-2*(INT (A1)-38)
2710 GOTO 2730
2720 LET LON=LON+2*(91-(INT (A1)
+27))
2730 LET N3=N3-1
2740 LET Z=INT (N3/10)*10
2750 LET LON=LON-((N3-Z)*0.2)
2760 IF H=1 THEN GOTO 2800
2770 LET LON=LON-0.2/3
2780 IF H=2 THEN GOTO 2800
2790 LET LON=LON-0.2/3
2800 RETURN
2810 REM FLASHING POINT
2820 FOR A=0 TO 25
2830 UNPLOT FLON,FLAT
2840 PLOT FLON,FLAT
2850 NEXT A
2860 RETURN
2870 REM DEGREES CONVERSION
2880 LET TEMP=INT ALPHA
2890 LET DEG=TEMP
2900 LET MIN=(ALPHA-TEMP)*60
2910 LET TEMP=MIN
2920 LET MIN=INT MIN
2930 LET SECS=(TEMP-MIN)*60
2940 LET SECS=SECS+0.5
2950 LET SECS=INT SECS
2960 IF SECS>=60 THEN GOTO 2990
2970 IF MIN>=60 THEN GOTO 3020
2980 GOTO 3040
2990 LET SECS=0
3000 LET MIN=MIN+1
3010 GOTO 2970
3020 LET MIN=0
3030 LET DEG=DEG+1
3040 RETURN
3050 REM  ERROR
3060 PRINT
3070 PRINT
3080 PRINT "ERROR      OUT OF RAN
GE"
3090 RETURN
3100 REM  ERROR
3110 PRINT
3120 PRINT "ERROR  VALUE IN EXCE
SS OF 59"
3130 RETURN
3140 CLS
3150 PRINT AT 5,1;"NOTE:-THERE I
S ANOTHER ORA             LOCATOR
 OF THE SAME CODE         ABOVE 4
0 DEGREES LAT."
3160 PAUSE 250
3170 POKE 16437,225
3180 RETURN
3190 SAVE "FINDOR[illegible]"
3200 GOTO 0010
3210 PRINT USR 32304
3220 PRINT PEEK 16404+255*PEEK 1
6405-16509
3230 REM ISSUE 2 :20 JAN 83
```

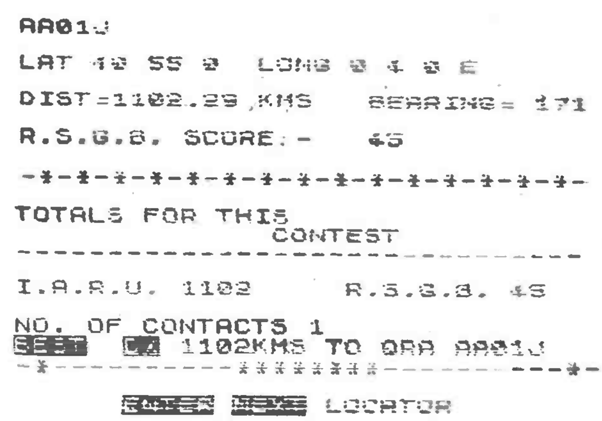
Program B listing

```
  10 REM "DISTANCE,BEARING AND
         CONTEST SCORE PROGRAM
         1 NOV 1982"
  20 REM COPYRIGHT G8CEZ NOV 82
         ZX81+16K RAM
  30 REM PLEASE DO NOT COPY THIS
         PROGRAM,BUT IF YOU DO
         PLEASE SEND A DONATION
         OF A POUND OR MORE FOR
         RAIBC VIA G8CEZ QTHR
  40 REM FOR EVERY TAPE SOLD AT
         FULL PRICE ONE POUND
         WILL BE SENT TO RAIBC
  50 LET FUNC=PI/180
  60 LET DA=0
  70 LET DB=0
  80 LET DC=0
  90 LET NC=0
 100 LET DX=0
 110 FOR S=1 TO 5
 120 PRINT AT 1+S,1;"G8CEZ";AT 1
+S,7;"G8CEZ"
 130 PRINT AT 1+S,24;"G8CEZ";AT
1+S,18;"G8CEZ"
 140 PRINT AT 20-S,24;"G8CEZ";AT
 20-S,18;"RAIBC"
 150 PRINT AT 20-S,1;"G8CEZ";AT
20-S,7;"RAIBC"
 160 PRINT AT 11,1;"WELCOME TO T
HE ORA PROGRAME"
 170 PRINT AT 1+S,7;"     "
 180 PRINT AT 1+S,18;"     "
 190 PRINT AT 20-S,24;"     "
 200 PRINT AT 20-S,1;"     "
 210 NEXT S
 220 PAUSE 200
 230 POKE 16437,255
 240 CLS
 250 FOR S=1 TO 18
 260 LET K=20
 270 PRINT AT K-S,4;"NAME OF CON
TEST?"
 280 NEXT S
 290 PRINT AT 21,2;"MAXIMUM OF 1
6 CHARACTERS"
 300 INPUT N$
 310 IF N$="" THEN GOTO 0300
 315 IF LEN N$>16 THEN GOTO 0240
 320 CLS
 330 PRINT AT 11,1;"PLEASE INPUT
 YOUR ORA CODE "
 340 LET J$="0"
 350 GOSUB 1580
 360 GOSUB 1380
 370 GOSUB 1220
 380 CLS
 390 PRINT AT 7,1;"BASE LOCATOR.
.....";L$
 400 GOSUB 1890
 410 LET ALPHA=L1
 420 GOSUB 2260
 430 PRINT " LAT ";DEG;" ";MIN;"
 ";SECS;" ";
 440 LET ALPHA=L2
 450 GOSUB 2260
 460 PRINT "LONG ";ABS DEG;" ";M
IN;" ";SECS;" ";B$
 470 LET LONG=L2
 480 LET LAT=L1
 490 PRINT
 500 PRINT "-*-----------*******
-----------*-"
 510 GOSUB 1040
 520 GOSUB 1580
 530 CLS
 540 GOSUB 1380
 550 GOSUB 1220
 560 PRINT L$
 570 PRINT
 580 GOSUB 1890
 590 LET ALPHA=L1
 600 GOSUB 2260
 610 PRINT "LAT ";DEG;" ";MIN;"
";SECS;" ";
 620 LET ALPHA=ABS L2
 630 GOSUB 2260
 640 PRINT " LONG ";ABS DEG;" ";
MIN;" ";SECS;;" ";B$
 650 PRINT
 660 GOSUB 1130
 670 LET U=D
 680 LET U=INT (U*100)
 690 LET U=U/100
 700 LET V=U+0.5
 710 LET D=INT V
 720 IF U<1 THEN LET U=0
 730 PRINT "DIST=";U;" KMS";
 740 IF U<>0 THEN GOTO 0770
 750 PRINT "  BNG VOID [illegible] SAME OR
A"
 760 GOTO 0790
 770 GOSUB 2440
 780 PRINT "   BEARING= ";BNG
 790 PRINT
 800 PRINT "R.S.G.B. SCORE:- ";
 810 GOSUB 1830
 820 PRINT AT 6,19;DD
 830 LET DA=DA+D
 840 LET DB=DB+D
 850 LET DC=DC+DD
 860 PRINT
 870 PRINT "-*-*-*-*-*-*-*-*-*-*-*
-*-*-*-*-*-"
 880 PRINT
 890 PRINT
 900 PRINT "TOTALS FOR THIS ";N$
 910 PRINT "               CONTES
T"
 920 PRINT "--------------------
-----------"
 930 PRINT
 940 PRINT "I.A.R.U. ";DA;"      "
;" R.S.G.B. ";DC;
 950 PRINT
 960 PRINT
 970 LET NC=NC+1
 980 PRINT "NO. OF CONTACTS ";NC
 990 IF D>DX THEN LET J$=L$
1000 IF D>DX THEN LET DX=D
1010 PRINT "[illegible] [illegible] ";DX;
1020 PRINT "KMS TO ORA ";J$
1030 GOTO 0500
1040 REM "FLASHING PROMPT"
1050 FOR L=1 TO 5
1060 PRINT AT 21,6;"            L
OCATOR"
1070 PRINT AT 21,6;"[illegible] [illegible] L
OCATOR"
1080 FOR M=1 TO 10
1090 NEXT M
1100 NEXT L
1110 PRINT AT 21,6;"ENTER NEXT L
OCATOR"
1120 RETURN
1130 LET Z1=LAT*FUNC
1140 LET Z2=LONG*FUNC
1150 LET Z3=L1*FUNC
1160 LET Z4=L2*FUNC
1170 LET Z=COS (Z1)*COS (Z3)*COS
 (Z4-Z2)
1180 LET Z=Z+(SIN (Z1)*SIN (Z3))
1190 LET D=(60*ACS (Z))/FUNC
1200 LET D=D*1.850
1210 RETURN
1220 LET A$=L$(1)
1230 LET B$=L$(3 TO 4)
1240 LET C$=L$(5)
1250 LET L2=0
1260 IF A$>="U" THEN GOTO 1290
1270 LET L2=L2-2*(CODE (A$)-38)
1280 GOTO 1300
1290 LET L2=L2+2*(91-(CODE (A$)+
27))
1300 LET Z=VAL (B$)-1
1310 LET Z1=INT (Z/10)*10
1320 LET L2=L2-((Z-Z1)*.2)
1330 IF C$="F" OR C$="G" OR C$="
H" THEN GOTO 1370
1340 LET L2=L2-.2/3
1350 IF C$="E" OR C$="J" OR C$="
A" THEN GOTO 1370
1360 LET L2=L2-.2/3
1370 RETURN
1380 LET A$=L$(2)
1390 LET B$=L$(3 TO 4)
1400 LET C$=L$(5)
1410 LET L1=40
1420 IF A$>"U" THEN GOTO 1440
1430 GOTO 1500
1440 PRINT AT 5,4;"IS THE STATIO
N N OR S OF              40 LA
T ? "
1450 INPUT D$
1460 PRINT AT 8,11;D$
1470 PAUSE 50
1480 POKE 16437,255
1490 IF D$(1)="S" THEN LET L1=14
1500 LET L1=L1+(CODE (A$)-65+27)
1510 LET L1=L1+(7-INT ((VAL (B$)
-1)/10))*.125
1520 IF C$="F" OR C$="E" OR C$="
D" THEN GOTO 1560
1530 LET L1=L1+.125/3
1540 IF C$="G" OR C$="J" OR C$="
C" THEN GOTO 1560
1550 LET L1=L1+.125/3
1560 CLS
1570 RETURN
1580 INPUT L$
1590 REM TEST FOR 5 CHAR
1600 IF LEN (L$)<>5 THEN GOSUB 1
920
1610 REM TEST FIRST CHAR
1620 LET E$=L$( TO 1)
1630 IF (CODE (E$))<37 OR (CODE
(E$))>64 THEN GOTO 1960
1640 REM TEST SECOND CHAR
1650 LET E$=L$(2)
1660 IF (CODE (E$))<37 OR (CODE
(E$))>64 THEN GOTO 1990
1670 REM TEST FOR VALID CHAR 3/4
1680 LET E$=L$(3)
1690 LET F$=L$(4)
1700 REM TEST FOR 00
1710 IF (CODE (E$))<=28 AND (COD
E (F$))<=28 THEN GOTO 2020
1720 REM     TEST FOR 81 OR MORE
1730 IF (CODE (E$))>=36 AND (COD
E (F$))>28 THEN GOTO 2060
1740 IF (CODE (E$))<=27 OR (CODE
 (F$))<=27 THEN GOTO 2130
1750 IF (CODE (E$))>=37 OR (CODE
 (F$))>=38 THEN GOTO 2190
1760 REM       TEST ON LAST CHAR
1770 IF L$(5)="A" OR L$(5)="B" O
R L$(5)="C" OR L$(5)="D" THEN GO
TO 1820
1780 IF L$(5)="E" OR L$(5)="F" O
R L$(5)="G" OR L$(5)="H" OR L$(5
)="J" THEN GOTO 1820
1790 CLS
1800 REM ERROR FOUND
1810 GOTO 2160
1820 RETURN
1830 LET DD=1
1840 FOR A=50 TO 10000 STEP 50
1850 IF D<=A THEN RETURN
1860 LET DD=DD+2
1870 PRINT AT 6,19;DD
1880 NEXT A
1890 LET B$="W"
1900 IF L2<=0 THEN LET B$="E"
1910 RETURN
1920 CLS
1930 PRINT AT 8,1;"   YOU [illegible] I
NPUT 5 CHARACTERS            IE.
 ZK11F"
1940 PRINT
1950 GOTO 2180
1960 CLS
1970 PRINT "ERROR IN FIRST CHARA
CTER MUST BE ALPHA I
E.A-Z"
```

```
1980 GOTO 2180
1990 CLS
2000 PRINT "ERROR IN SECOND CHAR
ACTER MUST BE ALPHA
 IE.A-Z"
2010 GOTO 2180
2020 CLS
2030 PRINT "ERROR IN CHARACTERS
3/4 VALUE TO BE BETWEEN
01 AND 80"
2040 PRINT " VALUE FOUND T
O BE:- LESS THAN 01 OR
IS AN ALPHA"
2050 GOTO 2180
2060 CLS
2070 PRINT "ERROR IN CHARACTERS
3/4          VALUE TO BE BETWEEN
01 AND 80"
2080 PRINT " VALUE FOUND TO BE
:- MORE THAN 80 OR
IS AN ALPHA"
2090 GOTO 2180
2100 CLS
2110 PRINT "ERROR IN CHARACTERS
3/4 VALUE FOUND TO BE AN
 ALPHA              OR IS 90"
2120 GOTO 2180
2130 CLS
2140 PRINT " INVALID CHAR IN CHA
R 3/4"
2150 GOTO 2180
2160 CLS
2170 PRINT "  ERROR IN LAST CHAR
ACTER **MUST BE ABCDEFGH
OR J**"
2180 PRINT
2190 PRINT "      *** TRY AGAIN **
"
2200 PRINT
2210 PRINT "YOUR INPUT WAS  - ";
L$
2220 PRINT
2230 PRINT "                    12
345"
2240 GOSUB 1040
2250 GOTO 1580
2260 REM DEGREES CONVERSION
2270 LET TEMP=INT ALPHA
2280 LET DEG=TEMP
2290 LET MIN=(ALPHA-TEMP)*60
2300 LET TEMP=MIN
2310 LET MIN=INT MIN
2320 LET SECS=(TEMP-MIN)*60
2330 LET SECS=SECS+0.5
2340 LET SECS=INT SECS
2350 IF SECS=60 THEN GOSUB 2380
2360 IF MIN=60 THEN GOSUB 2410
2370 RETURN
2380 LET SECS=0
2390 LET MIN=MIN+1
2400 RETURN
2410 LET MIN=0
2420 LET DEG=DEG+1
2430 RETURN
2440 REM BEARING CALC
2450 LET Y=LAT*FUNC
2460 LET X=-LONG*FUNC
2470 LET N=L1*FUNC
2480 LET E=-L2*FUNC
2490 LET B=COS N*COS Y*COS (E-X)
+SIN N*SIN Y
2500 LET A=SIN N-B*SIN Y
2510 LET B=ATN (SIN (E-X)*COS N*
COS Y/A)+PI*(A<0)
2520 LET BNG=INT ((B+(PI+PI)*(B<
0))/FUNC+0.5)
2530 RETURN
2540 REM    BY R.FULLER G8CEZ
              COPYRIGHT 1982
 PROGRAM FOR ZX81+16K RAMPACK.
2550 STOP
2560 SAVE "OR█"
2570 GOTO 0030
2580 PRINT PEEK 16404+256*PEEK 1
6405-16509
2590 REM VERSION 2 WITH BEARING
          4 JAN 82
```

On screen displays





REVIEW:

Yaesu *FT980*

Computer Aided Transceiver

By Tony Bailey G3WPO

Yaesu have established a pretty good reputation for themselves over the past decade with an ever changing range of amateur equipment, doing well in keeping up with the apparent needs of the modern amateur. The *FT-980R* is probably comparable with the Trio *TS930S*, which was reviewed in the July issue.

The *FT-980R* is the latest offering and appears to be a slightly cheaper version of the *FT-ONE* at first glance. It is a fairly bulky beast, which may be a consideration for the smaller bench, at 380 x 165 x 465mm overall. Power requirements are 240V 50Hz, at 530VA in transmit mode — there is no provision for 12V operation. However, I doubt that anyone would seriously consider this model for mobile operation!

As usual, the transceiver came well packed, with a good range of plugs for the rear apron outlets. Also, as usual, the plug on the end of the mains lead was a European type — can't someone at Yaesu manage a British version? (Presumably they sell enough here to make it worthwhile.) A couple of microphones were supplied with the review equipment, but they are not normally supplied.

Add-ons

The sample came with a number of options fitted. The keyer unit (using a Curtis 8044 chip), 600Hz CW filter and FM and AM units with appropriate filters. The FM and AM units are supplied at standard.

What it does

Like most modern rigs costing in excess of £1000, there are a considerable number of facilities offered. The 'innovation' with this one is the 'CAT' system, which enables remote control of virtually all the facilities by computer, via an optional interface.

The rig covers all amateur bands on transmit, and is a general coverage unit on receive, powering up on 7MHz. Modes of operation are USB/LSB/CW/FM/AM/FSK.

As you can see from the illustration, the front panel sports a lot of knobs and switches, providing about 65 functions in all. All the usual ones are there, with the less common extras being ALC meter hold (so you can see the ALC peaks easier), Audio Peak Filter, Notch filter (a disaster — see later), Tone control, Keyer speed (if fitted), TX monitor (and sidetone), and SWR Calibrate for the built in SWR meter. The latter is not of the automatic type as in the Trio *930S*.

Frequency displays

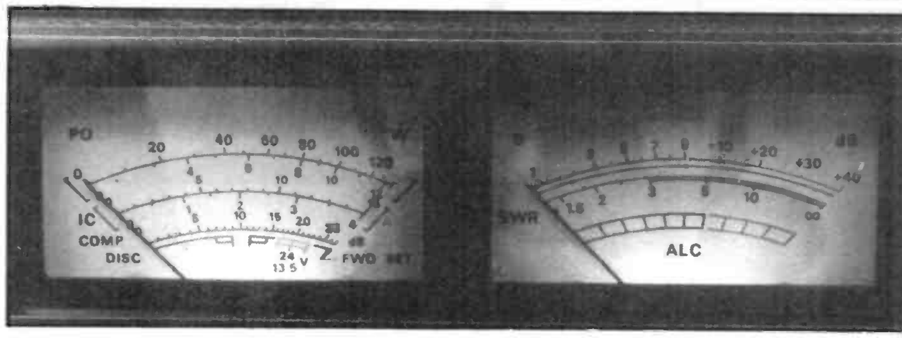
The *980* has two digital readouts — one of which is a 'synthesised analogue display' or, if you like 'a digital analogue display'. The idea is to provide a scale type readout for those who prefer this method of reference over a digital display. In this respect it fails miserably.

Virtually all of the people who saw the rig commented on the wierd readout under the main dial! To explain the way it works is a bit difficult, but what you get is a scrolling set of figures at 50kHz intervals, with a cursor underneath which indicates steps of one kHz. It is a bit confusing to say the least as the cursor moves in the opposite direction to the scrolling scale, and it takes longer to decipher it than read the main display. Maybe there is someone who likes it.

The main frequency display is green fluorescent, and is slightly unusual in that the display down to 10Hz is available if required, although this can be changed to 100Hz by means of one of the keys. A DIM/BRIGHT control is fitted for the night owls working the DX at 2am in the morning. A set of indicators backs up the switches, showing which mode the rig is in. One nice touch is that with rapid tuning the display freezes until the new frequency is reached, and you aren't faced with a rapid blur of figures.

RIT

Receiver and transmitter independent tuning is provided but does have some disadvantages in its implementation. Pressing one or other of the RIT buttons puts it into this mode, and the main tuning knob then becomes the RIT control, with up to ± 10kHz of shift available. The problem is that once you cancel RIT



Meter scales

you lose the setting, and if you want it back, you have to start all over again. This is a definite disadvantage — I don't recollect any other rig that doesn't allow you to recover the RIT setting if needed. If you are in a 'net' and one station is off-frequency, the RIT will be needed to listen to him. Once someone else comes up you have to cancel it, or retune. Then set it up again when his turn comes round next time.

Scanning

As you might expect from a heavily microprocessor based rig, scanning is offered, via three push switches under the main tuning knob, or via the microphone, or through the external computer. Stepping frequency (the synthesiser increment) is 10Hz and the rate either 300Hz per second or 30kHz per second. I found the slow rate too slow and the fast rate too fast! The high speed would have been better at about 5kHz/second, or even better, settable via the microprocessor to suit the mode. After all, scanning FM requires a different speed to CW, or AM.

Both microphones supplied had scan buttons, but for some reason, the desk mic refused to operate the scan function.

Frequency control

This is under supervision of the micro, and provides several options to arrive at your intended destination. Other than the main tuning knob, any frequency can be entered directly from the bank of buttons at the right centre of the front panel, to an accuracy of 10Hz. Larger changes in frequency are possible — either via a 5kHz UP/DOWN button, which may be single stepped or continuous, or using the UP/DOWN buttons which move the frequency in whole amateur bands at a time (except in General Coverage mode when the step is 500kHz.)

The 980 does have two separate receive modes — either HAM or GEN, button selectable, which does speed up moving around as against a general coverage only mode.

A 'TABBING' function is also provided, and can be used to set upper and lower frequency limits on either HAM or GEN bands in the scanning mode.

More frequency options

Trying to use the micro to its full extent, there are four buttons which set the source of the controlling frequency for the receiver, transmitter and main display. Selecting the VFO button lets the main general coverage VFO control everything — the normal power-up mode. The MR button selects Memory Recall (see later), while the RX V/RX M buttons allow split frequency operation. The V option lets the VFO control receive, and whichever memory channel is selected on transmit, and the M option the reverse of this. There are LEDs to remind you that split frequency working is being used.

When using split frequency, another button OFFSET FREQ allows the main display to show the frequency difference between the VFO and memory channels. This is useful when wanting to work DX-peditions and you need to know how many kHz you are away from his transmit frequency, without doing mathematics.

If you want to have a look at your memory channels without changing frequency in the process, a CHECK button permits this. Another button V/U allows a unique feature that displays the 100s of MHz digit when a VHF/UHF transverter is in use. I haven't seen this on any other rig and it is a nice cosmetic feature if nothing else.

Memories

12 of these are provided, of which four are 'protected' in that two buttons have to be pressed simulataneously to enter the frequency into positions 9-12 on the memory selector switch. The other eight just need one button pushed to get the displayed frequency into a memory. Memory back-up can be provided by means of batteries if required.

There is one potential problem with the memories — the rig stores the mode as well as the frequency. Hence if you store a frequency when in SSB mode (which you might well do when tuning around the CW end of the bands), you are stuck in SSB mode when you reselect that memory channel, and nothing you can do will change this (except retuning with the main VFO). I would have thought the storage of the frequency alone would have been adequate — although I would not have been surprised if it had also stored the RF and AF gain settings, and the height of the operator's chair.

Bandwidth controls

Variable selectivity controls are almost obligatory in the modern transceiver and can go a long way to eliminating interference on our crowded bands. The *980* is supplied with WIDTH and SHIFT controls. The former adjusts the IF bandwidth of the receiver during all reception modes, the maximum bandwidth being dependent on the filters fitted. Moving the inner of the two concentric controls counterclockwise moves the lower skirt of the passband higher in frequency, while clockwise shifts the upper skirt lower. The other SHIFT control provides the 'missing' half by moving the relative position of the IF passband with respect to the frequency to which the receiver is tuned.

Hence, by using both controls together it is possible to eliminate interference on both sides of a signal, once you have got the hang of it. The SHIFT control is indented every 100Hz of shift for reference.

Notch filter

Additional selectivity is available from an Audio Peak Filter, for CW, with variable frequency control, and a Notch filter for removing heterodynes. Unfortunately this latter function must rate as the worst I have come across, with a notch depth barely above 20dB according to the meters. The subjective performance wasn't any better, with only weak heterodynes which you wouldn't worry about anyway being reducable to any extent. The handbook doesn't state any figure for Notch Depth so this may or may not be typical of the filter. This compares with 40dB for the *FT-102*.

Metering

Extensive metering facilities are available via the two front panel meters, what they tell you depending on the mode and a selector switch. The first meter is mainly used for transmit, and can show the supply voltage, SWR forward voltage, processor compression (in dB), PA stage collector current, or power output. It also functions as the discriminator meter for FM receive.

The second meter is the S Meter on receive, and either ALC, or SWR reading on transmit.

Transmit

A very useful feature on the CW transmit side is the provision of a reference tone against which you can zero beat an incoming signal, works by generating a tone whose frequency is exactly equal to the difference between that of the third IF and the BFO. The level of the tone is variable via the MONITOR control, which is essential when trying to zero beat varying strength CW signals. The pitch is also adjustable to 500/600/700Hz via the rear panel. I would have thought that 500Hz was a bit low for most people, and that 800Hz, which is the most common pitch would have been preferable.

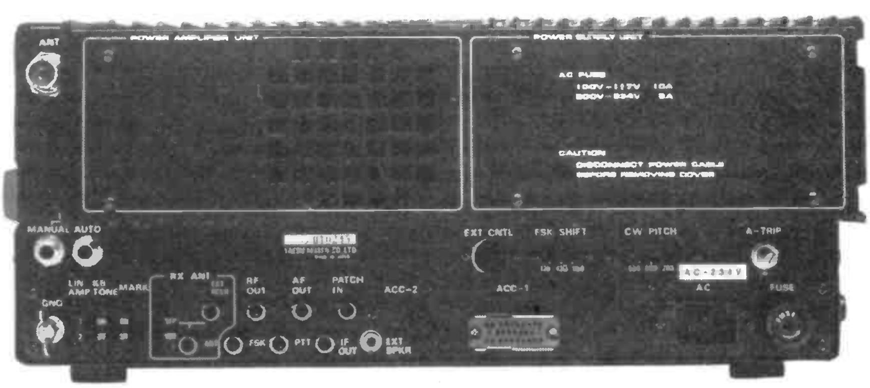
for proper transceive operation. It

The MONITOR control also lets you monitor your transmitted signal at audio frequencies, and helps in setting up the compressor (processor). Use of headphones for this is almost mandatory if you want to avoid acoustic feedback. The headphone jack will accept either stereo or mono headphones.

Full break-in operation is available for CW, although not as fast as that on the Trio model. Still pleasant to use though. Normal VOX controls are fitted, with the DELAY and LEVEL controls being on the front panel for a change — the ANTI-TRIP control is on the rear panel.

On the rear panel

There are 14 further connectors on the rear panel. In addition to the antenna socket (SO239), Key (switchable manual or auto), and grounding terminal, there are switches to control a bleeper which will sound when certain front panel controls are depressed, and a CALIBRATE function to provide 25kHz marker signals for the receiver. If your linear amplifier is capable of break-in operation, this can be catered for, as can a separate antenna for the receiver section only. FSK keying, RF out (100mV rms into 50 ohms — which is rather low for effective transverter operation), and a constant level low level AF signal for recording are also provided. The remainder of the sockets are for various accessories, PTT (external such as foot switch) and the computer interface.



Power supply

One of the consequences of having a lot of electronics in a small space is that they need a lot of power. The 980 comes with a fairly beefy transformer, and a very large heatsink, plus a fan. The fan does a good job of keeping things cool, the only problem is that it isn't very quiet, and it tends to run all the time, even on receive. This is a positive distraction and would seem to indicate that something isn't quite right with the PSU rating or cooling arrangements. The fan could be expected to run on transmit, but on receive?

Circuit

The *FT-980R* is a triple conversion superhet, with a claimed receive dynamic range of 95dB (using the narrow CW filter). Certainly, listening didn't show any problems with respect to this, and it will be interesting to see the lab figures, as some of the other rigs reviewed haven't matched their claimed figures. A switched attenuator (10/20/30dB) is provided but it wasn't needed during the review, except to help with one very local station running maximum power.

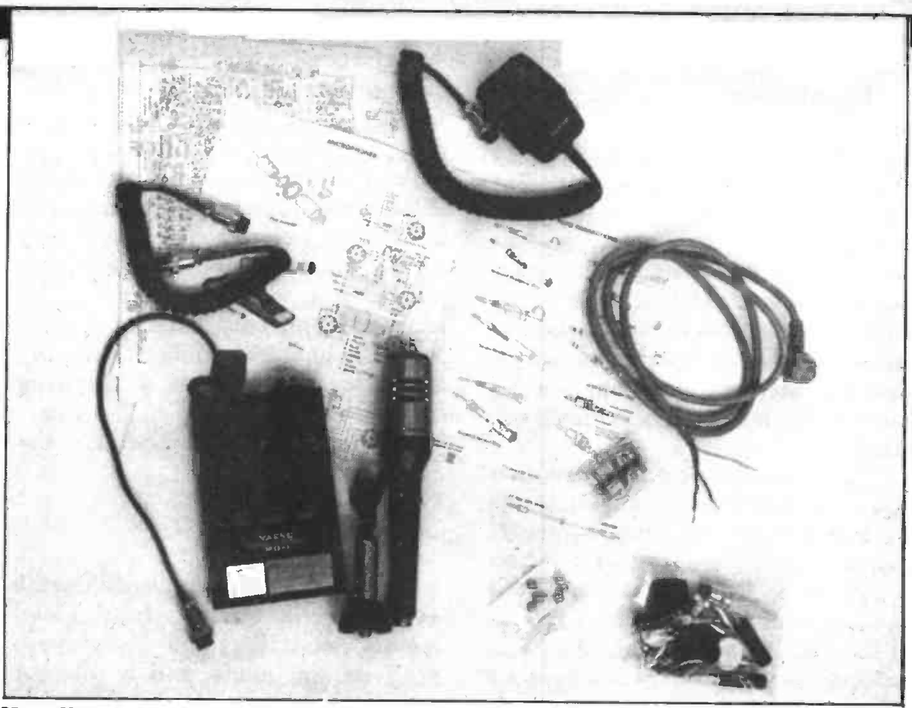
RF amplification is used at the front end (2SK125s) preceded by lowpass filtering, then by bandpass filtering (separate banks for general coverage and amateur bands). 2SK125s are also used in the first and second IFs, all to aid strong signal handling. The majority of the main selectivity is at the second IF of 9MHz, with the optional narrow and FM filters at 455kHz (the third IF).

As can be seen from the block diagram, the synthesiser circuit is quite complex, using a 30MHz reference oscillator (this can just be heard on receive but isn't of any consequence). With 10Hz steps, the tuning is smooth and very similar to a continuously tunable VFO.

The PA unit uses two MRF422s to develop 100W PEP SSB output, and 50W on FM/FSK. The power output meter seems fairly accurate, as does the SWR meter.

The 980 on the air

The rig was used for a period of several weeks with the usual set up of a G5RV multiband antenna, and an HQ-1 beam, plus a *Transmatch* type ATU. Conditions on 10 metres were not at their best, so other than the odd CQ little use was made of this band. The majority of QSOs were on 80,40 and 20 metres, with some CW on 10 and 18MHz.



Handbook and extras supplied with the rig — but the microphones are extra. The mains lead came with a European-type plug.

Table 1 Lab test results

Receive Mode

1) Receiver sensitivity for 12dB SINAD, USB mode

Frequency (MHz)	Sensitivity (μV p.d.)
2	0.2
3.7	0.18
7.05	0.2
14.2	0.2
21.2	0.25
28.5	0.25

2) Set to CW (minimum bandwidth), repeat at 14.2 MHz: 0.36μV p.d. for 12 dB SINAD.

3&4) Dynamic range measurement: unfortunately there were problems with the dynamic range test which only came to light after the rig had been returned to the supplier. This makes it impossible for us to calculate the dynamic range figure. However, the Australian magazine *Amateur Radio Action* measured 103dB, which is quite a bit *better* than Yaesu's claimed figure of 95dB with the 300Hz filter in circuit.

S-meter Calibration

5) Set to 7.05 MHz.

S-meter reading	Input Level
S1	4μV p.d.
S3	14μV p.d.
S5	36μV p.d.
S7	80μV p.d.
S9	180μV p.d.
+10	450μV p.d.
+20	1.2mV p.d.
+30	3.6mV p.d.
+40	11.0mV p.d.

6) A 50 ohm dummy load was plugged into the aerial socket and the receiver tuned across the amatuer bands. No spurious whistle above

The receiver's input sensitivity was more than adequate for use with any half decent HF antenna, and no problems were experienced with intermod products on any band. If anything, some reduction in the RF gain control seemed useful on the lower bands.

One of the few problems on the performance side was with the audio reproduction. The AGC time constants seemed a little out, with too fast a decay time on both the fast and slow modes, certainly too fast a decay for SSB use. This meant that the AGC circuit was continuously having to start from scratch, with continual pumping of the background noise — it also seemed that the attack time was a little slow. The recovered audio was noticeably distorted at the start of speech, each time the circuit charged up. The effect was of course more apparent on stronger signals.

Selectivity without the optional filters was perfectly adequate, and sensible use of the shift and width functions made elimination of adjacent channel QRM really easy. The selectivity could be screwed right up if needed, and the rejection on the skirts didn't seem to suffer very much in the process. It was possible to reduce the bandwidth to effectively zero with no signals audible at all (useful on some 80 metre nets!).

Ergonomics

The front panel is well laid out, except for the MOX switch (manual TX/RX), which is immediately below the POWER on/off switch. Several times I switched the rig on, and unknowingly put it into TX mode at the same time. At one stage, the rig was sitting on transmit for 3 hours before I noticed, but no harm seemed to have resulted as no carrier was being radiated. If there had been carrier present, and the ATU on a band other than that selected, I doubt the PA would have survived.

Reverting to performance, the audio quality from the internal speaker was a little on the bassy side, without much character. The tone control was mainly used in the full treble boost position in an effort to overcome this.

Talking of audio quality, the rig cam with two microphones — the hand mic type MH-1B8, and a desk mic type MD-1. The hand mic was by far the better performer, and was preferred by virtually every station worked. The desk mic was 'orrible and didn't get one favourable report — the 3 switched tone settings on the base didn't appear to make much difference either. One Stateside station described it as stuffed with cotton wool, and our Editor didn't make any more favourable noises about it.

As with the *TS-930S,* it is necessary to keep the ALC meter reading well up when on SSB, if you want maximum undistorted talk-power. If you want less power on SSB, you have a problem.

Although the drive power can be varied on CW, there is no provision for varying the SSB drive, or so the book says. The DRIVE control does in fact have some effect on SSB, but it is all cramped down at the low end of its travel, and not really of much use. The other way to get the power down is to reduce the mic gain, but this does have the disadvantage of making the residual carrier suppression that much worse by comparison with the speech signal itself.

Break-in operation on CW was no problem, but speeds above 30 WPM would not be possible as the changeover circuit isn't fast enough on the review sample. The Keyer was of course very good, being built around the Curtis 8044 keyer chip.

One transmit facility which wasn't mentioned earlier is the AMGC (Automatic Mic Gain Control). This establishes a relative threshold level at the microphone audio input, below which audio will not provide any output. This proved very useful, as it prevented the cooling fan from modulating when not speaking into the microphone!

The noise blanker fitted to the

AGC threshold was found.

Transmit Mode

7) The equipment was set to USB and a 2-tone audio generator connected to the microphone input. The PEP output and 3rd and 5th order IPs were recorded.

Frequency	PEP Output	3rd Order	5th Order
1.9 MHz	116W	26dB below tones	42dB below tones
3.7 MHz	116W	27dB below tones	45dB below tones
7.05 MHz	110W	28dB below tones	43dB below tones
14.2 MHz	118W	28dB below tones	42dB below tones
21.2 MHz	128W	27dB below tones	40dB below tones
28.5 MHz	117W	24dB below tones	35dB below tones

8) As for 7, but the input level at each point was backed off to give half power output. The single tone output on full power was measured.

Frequency	PEP Output	3rd Order	5th Order	Single Tone
1.9 MHz	58W	29dB below tones	43dB below tones	109W
3.7 MHz	58W	32dB below tones	48dB below tones	109W
7.05 MHz	55W	35dB below tones	48dB below tones	105W
14.2 MHz	59W	35dB below tones	42dB below tones	111W
21.2 MHz	64W	35dB below tones	43dB below tones	123W
28.5 MHz	58W	30dB below tones	40dB below tones	113W

9) The harmonics were measured at maximum single tone output. (figures are dB below the single tone.)

Frequency	2nd harmonic	3rd harmonic
1.9 MHz	70+	70
3.7 MHz	70+	70
7.05 MHz	66	65
14.2 MHz	70+	65
21.2 MHz	70+	70+
28.5 MHz	70+	70+

Our thanks to SMC Ltd. who kindly loaned the review rig and microphones to us.

980 works very well, and is capable of virtually eliminating the Woodpecker when the threshold level is correctly set. It didn't seem to upset the dynamic range much, unless well advanced, and was very effective on the random pulse type interference we get on the lower frequency bands most of the day. Most of the time saw it switched into circuit.

Frequency stability could not be faulted, and the display is easy to read in any light. The provision of 10Hz accuracy on the main display is a little superfluous, but this can easily be blanked if preferred.

The transmitter didn't show any funnies on any band, except for one session on 21MHz when the PA seemed to be self oscillating, driving the 2 metre monitor berserk. After checks on the antenna system, the fault persisted, then suddenly cleared and couldn't be re-induced. TVI on UHF TV was also apparent, so something certainly was coming out that shouldn't have been, but the cause remains unknown.

There were no spurious signals on the receive side within the amateur bands, except for some at very low level which wouldn't constitute a nuisance. With the complexity of the synthesiser, this is quite commendable.

General coverage

Tuning from 150kHz to 29.000MHz, the *980* offers versatile general coverage for those who require it. The AM and FM modules are effective (there is a SQUELCH control for FM), and the variable selectivity is very useful on the short wave broadcast bands. The audio response is a bit bassy for this type of work, although this does add something to Radio 4 on a communications receiver if you listen that low in frequency.

Conclusions

A difficult one. The *FT-980R* offers many facilities, probably more than anyone is likely to need at any time, including the option to have a computer controlled station if desired. There doesn't seem to be much missing in the way of facilities, although the manner of implementing them could be queried in some cases. Overall, the rig was easy enough to use once the multiple buttons were mastered, but it may be a bit formidable for the newcomer to the hobby. With the right microphone, received reports were complimentary, and the performance of the receive side was mainly very good.

On the debit side, the AGC and noisy fan were not good features — possibly the AGC is not representative. The manual does mention that the fan may run on receive if ventilation is poor, but the reviewer's set-up is not unusual, and no other similar transceiver has shown this continual fan running. The lack of frequency storage on the RIT control could be lived with but is annoying, as is the mode storage in the memory system.

At a price in excess of £1000 the *FT-980R* is at the top end of the market — if you want the sort of facilities it offers then it is worth considering along with the *FT-ONE* and Trio *TS-930S* as other contenders.

CORRECTIONS

We bring to your attention a number of errors which have slipped in to some of our constructional articles despite our best endeavours to keep them out!

Omega Part 1 (July)

There is an error in the PCB layout and the legends around Q7 resulting from some last minute changes to the way that the Active Filter module is connected into the circuit. These changes did not get translated onto the final PCB layout so the following alterations are needed:

Points E and F on the PCB layout diagram are transposed ie, E should be F and F should be E. Also point D is shown on the PCB foil but not on the overlay or circuit diagram. It is located on the right hand side of R25.

Next, break the curving track which joins points E and F on the PCB foil.Then, using an insulated wire link, connect point D to the new point E. These changes will now make the PCB agree with the circuit diagram and the instructions, except that C24 is now attached to point F and not point E (this makes no difference to operation)

If you are not using an Active Filter module, then simply join D and E together. (E and F will already be joined on the PCB) and ignore the other changes listed so far.

One component not shown on the PCB overlay is C44. This located in the holes immediately to the right of R48. This is not the electrical position as shown on the circuit diagram but this will be allowed for in those future modules which connect with point K.

D9 and R71 are located slightly lower on the PCB than the overlay indicates (about 3mm) as shown up by the incorrect registration.

Most copies had bad print of part of the text on page 16. It should read 'so as to create a two turn centre tapped winding'

G3WPO asks us to point out that PCBs, sent out with recent kits, have been suitably modified.

As an observation about the operation of the Project Omega CIFPU board, the source resistors, R15 and R19, are not needed. Superior AGC performance results by connecting the source leads of Q4 and Q5 directly to the PCB groundplane. C15 and C17 are then superfluous. The noise performance can be improved even further by connecting a 470nH choke in parallel with R1, the parasitic stopper on the input to Q1.

There are some mistakes on the voltage table on page 17. We are trying to draw up a corrected table but this is not ready at the time of writing.

Project Omega (August)

The notch filter PCB layout was an early issue and did not take account of C73, a padding capacitor although this unit was shown on the circuit diagram. The 5p value unit connects directly across the variable capacitor.

VHF To HF Transverter (August)

The components list (page 10) requires the following additions and corrections: C33, 27p; C34, C35, 22p; C50, C51, 18p.

The bottom of the components list: 301-KN-0800 not 301-KU-0800.

G3WPO asks us to point out that oscillator components for all three bands are provided.

PCB overlay(page 12) shows diode D1 the wrong way around. The end marked 'k' should be the anode.

At the top of circuit diagram (page 13) the legend should indicate that a 63MHz crystal is to be used for 18MHz coverage, not 64MHz.

Top of page 14, end of first para: the emitter of TR2 is soldered to the top foil, not TR1.

Halfway down the same column: the para beginning' Both TR5 and TR6 have...' should read 'TR5 has...' ie not TR6 as well.

A microwave test source for 24cm

By Andy Emmerson G8PTH

Our amateur radio hobby is officially tolerated by HM Government in the belief that it fosters a process of self training in wireless telegraphy. Despite this, a lot of 'cheque book' amateurism goes on these days and I am no exception: if there is a kit available I will probably buy it, possibly even a Japanese black box if it is chep enough. Kits and ready made items take the guesswork out of wireless, but of course they leave much less scope for self training.

Sooner or later, however, the keen radio enthusiast comes to the stage where no commercial device is available and it's all down to a bit of real homebrew construction. That's what is described here. Mind you this is no half kilowatt amplifer or 500 channel scanning receiver, but a simple test generator, just right for cutting your teeth on. Not too much theory but a chance to learn up construction and tuning techniques.

A bit of building never did anyone harm, I thought, when Jean F2XO passed me a simple looking photocopy. Here was a construction project for a simple 24cm test generator, just right for testing receivers at 3am when you can't really expect to find any signals on the air. Only four transistors, a few coils, couldn't be easier . . . probably knock it up within an hour. Well, life is not like that, is it? To be honest, I had never previously built any project for the 1200MHz band and this little exercise turned out to be a good object lesson in self training. In the process I learned (a) how little information there is to be found in books on the nuts and bolts of making things actually work at UHF, and (b) how lucky it is to have friends who can impart this vital information. So if you have a need for a test generator at 23 or 24cm (you can fiddle with the dimensions if you dare) this might be just the project for you. On the other hand, once you have read the article, you might not think so . . .

24cm FM amateur TV

Down to business. The original design for this test generator is by Jaques Pochet, F6BQP. Jacques is one of the gang of two dozen-plus people who are active in France on 24cm FM-ATV, a mode which is rapidly catching on here and in Germany. With the pressure on 70cm, it seems natural to get up on 24cm and it is the way the ATV repeaters will go in this country. Until we get those repeaters and as we have no beacons in the TV portion of the band a test generator is essential for any further home construction activities. This little gadget pokes out a healthy signal on 1255MHz, adequate for our purposes.

The circuit is quite conventional (**Fig.1**): a crystal oscillator

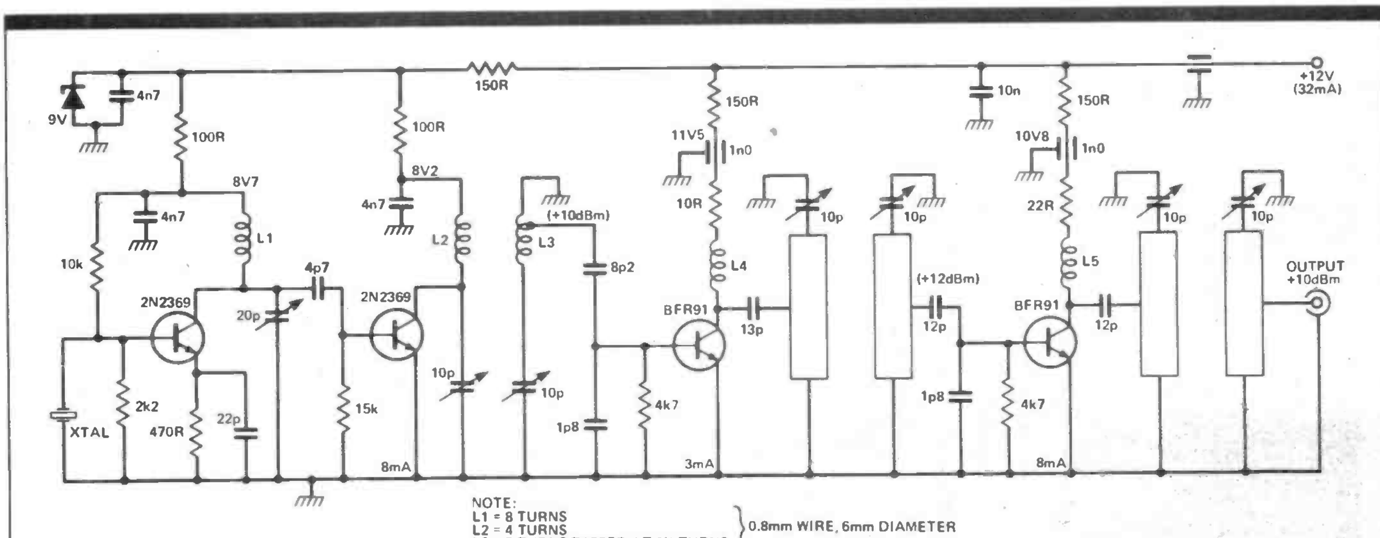
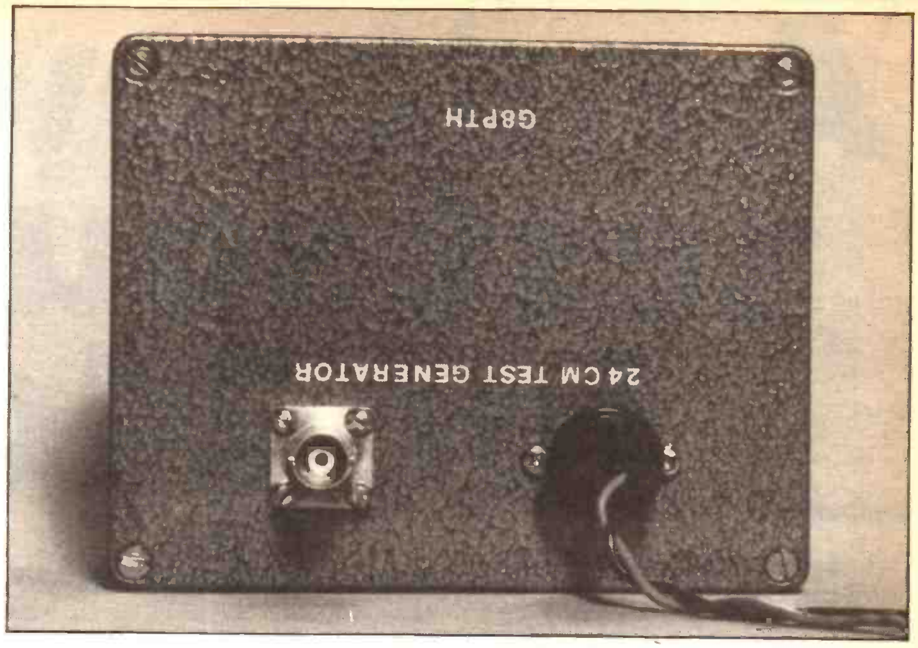


Fig. 1 Circuit diagram.

operating at 69.722MHz is amplified and the third harmonic (209.18MHz) selected. This is coupled out at L3 to drive a BFR91. This is doubled and tuned with a couple of parallel lines in a screened compartment. A second BFR91 is concealed in a hole in the screen and the third harmonic (1255.08MHz) is tuned in the second pair of lines, from which the output is taken to the test generator's output socket. The unit is supplied with 12 volts, with zener stabilisation for the early stages.



Construction

Most constructors will wish to 'lose' the unit in a diecast box, but to avoid any problems of detuning it is best to build a primary screening of printed circuit board (or tinplate) around the generator. Usually these articles include a warning saying that you must adhere to all the dimensions, used the specified components and use normal high quality construction techniques. I thought I could ignore all this . . . well, suffice to say I wasted my time the first time round. Rally bargain ceramic or plastic trimmers just don't work at around a Gigahertz, so you must use the proper Johansen or Airtronic *gigatrim* types, but if you look at microwave 'junk' PCBs in the boxes *under* the stands at rallies you can strike gold at a lower cost. I picked up a 900MHz preamp for £2.50 — it was loaded with the things. NB: most rally dealers don't understand microwaves, thankfully, so they put the mystery gear in old boxes under the stand . . .

OK, we start constructing. The first stages are built on a PCB (see **Fig. 2**) and you *can* use plastic trimmers on this board. The coils are wound with 21swg silvered copper wire from the Scientific Wire Co. (PO Box 30, London E4). Thinner wire did not work (insufficient Q). Screens of PCB or tinplate one inch high should be built all round the boards, and don't forget to bond all surfaces to together with pieces if wire or copper foil to ensure everything is at RF and DC ground potential. The crystal comes from Quartslab (PO Box 19, Erith, Kent) — it will be made to order and will take about three weeks. You should file a notch where the first BFR91 is fitted in the PCB, together with a smaller notch on the other side of the screen in the main board (for the collector to poke up).

This main board is not etched but cut to size. The lines are cut from copper, brass or nickel-silver shim or from tinplate: their thickness is not critical but their width and height above the groundplane are. By using the correct trimmer you will ensure that these lines lie parallel to the groundplane (and thus at the right impedance). Power for both BFR91s is brought up through the groundplane by feedthrough capacitors; the 150 ohm resistors (with sleeved wires) run below the boards. Output connector is a BNC (*Subclic* SMB or N if you prefer).

Alignment

Construction will probably take you about four hours, from start to finish. (Painting the diecast box, lettering it neatly with dry transfers and making it look smart is extra). Tuning up is something else, though, and this is where the self training comes in. The method to be described works, though if you are looking for an inspired explanation you will be disappointed.

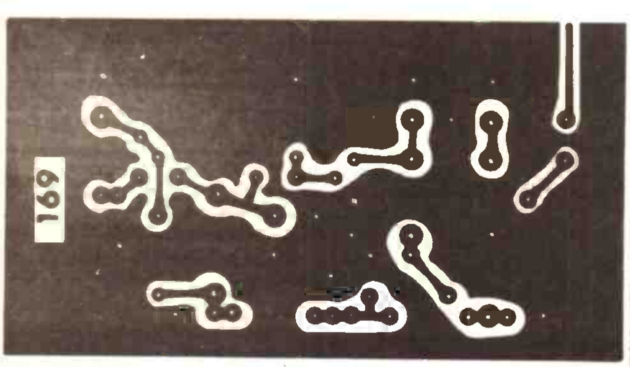
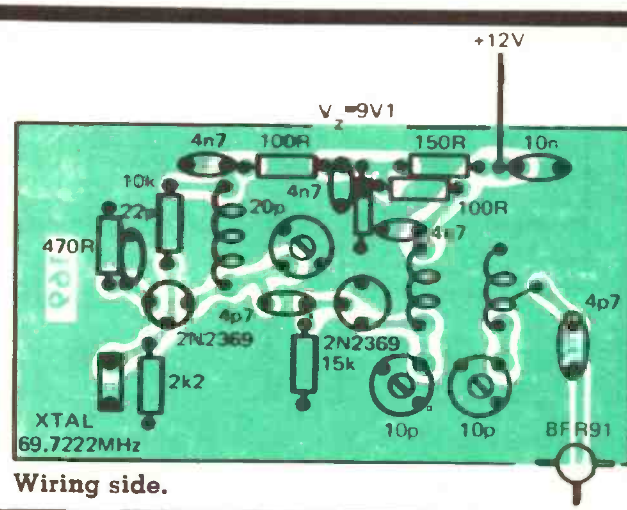


Fig. 2 PCB track side.



Wiring side.

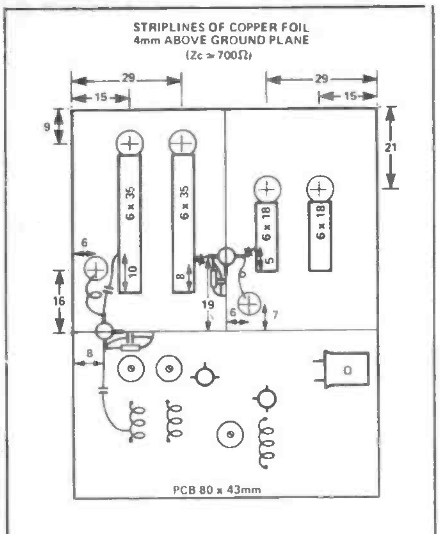
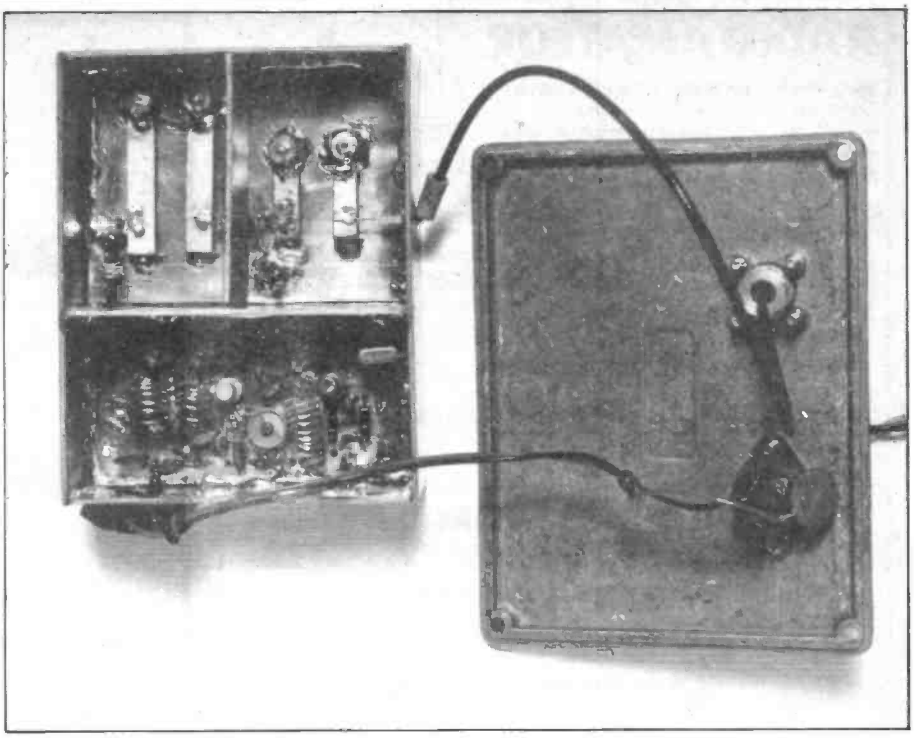


Fig. 3 Main board.

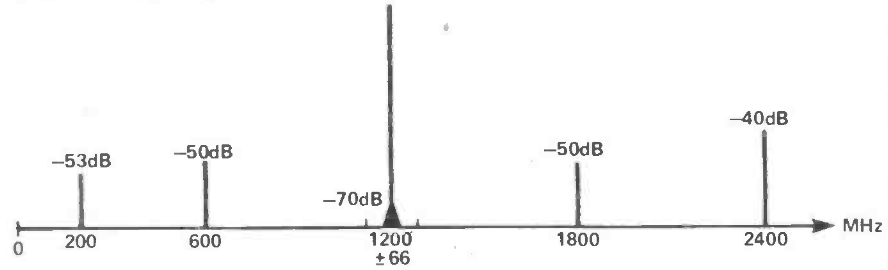


Test gear required: multimeter, frequency counter and absorbtion wavemeter covering up to 1300MHz. If you don't have these you're going to be in trouble and I cannot honestly kid you that you don't really need them. Borrow them perhaps from your local club, or buy your best microwave friend a superb meal/round of drinks/year's subscription to *Ham Radio Today* as a bribe to taking on your problems.

First check the PCBs for solder splashes (but I don't need to tell you the 'wally' checks everybody is supposed to do first — and doesn't bother to do). Now ensure that the crystal oscillator is working, with the counter. Adjust the 20p trimmer if necessary but remember that after a few twiddles these plastic trimmers lose their stiffness and can no longer be relied upon. Disconnect one end of the 150R resistor in the first BFR91 collector circuit and connect the multimeter on milliamps range in series. Tune both 10p variable capacitors to draw maximum current. Use the counter to check that the frequency here is 210MHz. Adjust the trimmer on the end of the first line, and monitor with the counter for a 418MHz signal close to the line.

Introduce the multimeter into the collector circuit of the second BFR91 in the same fashion. Trim the second line's capacitor so that the transistor draws maximum current. Now you can tune the trimmers on the two final lines for maximum signal at 1255MHz, but it won't be as easy as that. In fact the adjustments are interactive and you will find yourself monitoring TR4 collector current, absorbed power and frequency along the lines. I run a small loop as a probe around all the coils and lines to monitor that the right harmonic is being selected — it is easy to get a rock crushing output on 627MHz but this is not really what we want. Also the exact spot whre you tap into and out of the lines with those tiny 12p capacitors is critical; if nothing wants to work try moving one of them 1mm in either direction. After about three hours you should hit on the right combination by accident and boy — what a feeling of elation, probably how Marconi felt when he got his first set working. Joking apart, it may be a bit of a struggle but it has got to be worth it. You will have a vital piece of test equipment which you cannot buy for any price in the shops, and what's more you made it yourself and you know how you got it to work.

Fig. 4 Output spectrum.



No wallies please, we're British

Just as an afterthought, let's return to that concept of self training. At our local antique market I bought a book today. It was written by F J Camm and is all about becoming a radio amateur. It dates from 1945 and includes the following information to prospective amateurs: "Applicants must satisfy the Postmaster General as to their qualification to conduct experiments of scientific value or public utility. If scientific investigation is intended they should be certified as competent investigators by a Government Department or some recognised scientific body. Authority to use wireless sending apparatus, even with an artificial aerial (dummy load) can be granted only if the nature of the proposed experiments and other circumstances warrant that course." No wonder they had no wallies on the air in those days! ●

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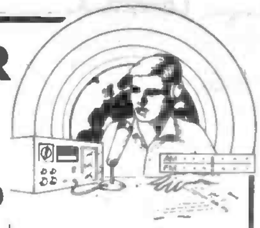

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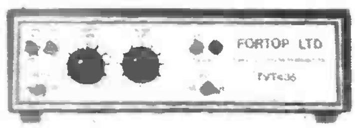

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REVIEW: Dressler *D200S* high power 2m amplifier

By Angus McKenzie MBE,C.Eng,FIERE, G30SS

There have been very few commercially made 2m band valve linears that have been reasonably available in Europe, the only ones that I can immediately think of are, in order of succession, a Belcom one using the antique 829 valve, the German Fischer *F200* which could be supplied either with a 4CX250B, or R (the latter having a higher power rating). These were succeeded by the Nag, which incorporated a 4CX350, or alternatively, the Tempo *6M2* from the US which glided along gracefully at well above a kilowatt, but at a huge importation cost. Now we have the German Dressler imported by Harvey Lexton, who kindly supplied the review sample. The Dressler is by a considerable margin the easiest of these valve linears to drive, by far the easiest to service, and probably the simplest to use.

Facilities

This linear is housed in a very handsome cabinet, having a thick and well plated chassis and is generally very well constructed and robust. The UK model is provided with a mains transformer suitable for 240V AC. This replaces earlier Dresslers sent to the UK with only 220V transformers, which caused much overheating and bad troubles. The mains input socket is a normal IEC one. The input to the linear is on a 50 ohm BNC socket, whereas the output is on a 50 ohm 'N' type. A switch on the back permits the input drive to feed straight through to the grid circuitry of the 4CX350A Eimac valve, or via a passive capacitive variable attenuator which can cope with drive levels from around 2W to well over 15W for full output. The coaxial relays are of very high quality which bypass the input to the output directly when the amplifier is not in use, or on standby. The input attenuator on the low gain input is varied by a trimming tool, via a hole in the back panel. Two RCA type phono sockets, as used in many audio amplifiers, are provided for PTT connections, one causing the linear to go to the transmit mode when the line is shorted to the screen, whilst the other socket requires between 5 and 15V DC to transmit. By having these two alternatives, a very wide range of equipment can be immediately used with Dressler, and this is extremely convenient. As if this is not enough, there is an RF sensing circuit which requires just over 0.5W on the input to activate it, a variable hold-on time being controlled by a potentiometer on the panel (almost instantaneous fall back up to 1.5 seconds variation).

Across the front panel are the anode tuning control, and further knobs for off / standby / operate / operate with mast head pre-amp on, output loading, left hand meter switch for measuring HT volts, grid 1 current, grid 2 current and output power, whilst the right hand meter is always on anode current (FSD at 0.5 amp). Finally, a switch selects SSB or FM operation, the standing currents being set respectively at 100mA and below 10mA for those two modes.

The very heavy duty mains transformer is of a highly efficient design and is situated towards the back of the right hand side of the equipment. Air intake holes are provided underneath the transformer, air being sucked in by quite a large and very smooth running fan in the centre of the linear, which blows the air straight through the valve area and out through a hole in the side panel on the left cheek. This hole is amply protected with a mesh internal cover. Under normal operation at intermediate power levels on SSB this air outflow was just slightly warm, but when the linear was working hard at, say, 500W PEP one cannot hold ones hand near the outflow for more than a few seconds without severely feeling the pinch! This is one of my very few criticisms, and I feel that the air flow should be at least 50% higher as valves are so very expensive.

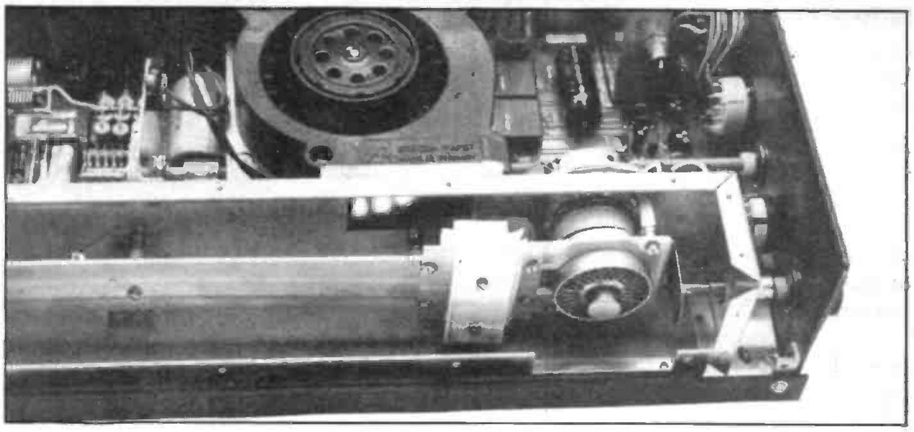
When the pre-amplifier mode is selected, 15V DC is put onto the centre pin of the antenna feed socket for activating a Dressler masthead pre-amplifier. SSB Products models also work well with this facility, the 15V being withdrawn immediately on the linear swtiching to TX, either by VOX sensing or by PTT.

There could be a problem here in the use of the mast head pre-amp if RF sensing is being used, particularly if you are using a fairly low level input to achieve full output power. There is insufficient gain in the RF sensing circuit for the Dressler to change to the TX mode at the slightest sniff of RF, and so low power could go sailing up to the masthead at around half a watt and perhaps do some damage. To obviate this, a Dressler accessory switching unit, their *VV-Interface*, can be used in the coaxial feed to the antenna instead of using the 15V from the Dressler rig. This interface box requires connection from the main rig's PTT line, or voltage on TX line, 13V DC input, high power RF in and out on 'N' sockets, and a PTT line from the box to the Dressler. This allows the mast head pre-amp to be used when the linear is switched off and when you want to use just the exciter. When the Dressler is in circuit and switched on, its switching to TX is delayed for a few milliseconds to give the masthead pre-amp adequate time to change over. All this circuitry worked extremely well and is strongly recommended, as it is all too easy to make a mistake and blow up an expensive GaAsFET, so inaccessible at the masthead!

Extremely good protection is provided against 'wally' problems. First of all, when switching the rig to standby the 'ready for operation' light is held off for 80 seconds, by which time the valve is well and truly ready for giving of its best. In the operate position everything is normal, whilst when switched to the preamp position 15V is put onto the antenna line on RX. Three LEDs show the operational state, a green one indicating that the linear is ready to operate, a red one showing the linear is on TX, and a flashing red one indicating that the safety cutout circuits are in operation because of excessive heat, too high a current is being drawn, or something that is clearly not right that is being monitored by the protection circuits.

Instructions and operation

The instruction book is very badly translated from German to English and this is totally ridiculous since only about 2 hours work would have been required for a knowledgeable British amateur to have re-written it. There are many points about the instructions that are either over optimistic or not optimum, and I feel a few examples might be of interest: On SSB, the rig is claimed to have a good intermodulation performance at up to 700/750W PEP output. It also infers that it can give short bursts at up to 1kW with degraded IM performance. I feel these specifications are ludicrous, for whilst you might get the amount of power stated, you will finish off the valve remarkably quickly. What really matters is the performance of the equipment within



Air from the fan goes through the anode fins and a chimney (not shown)

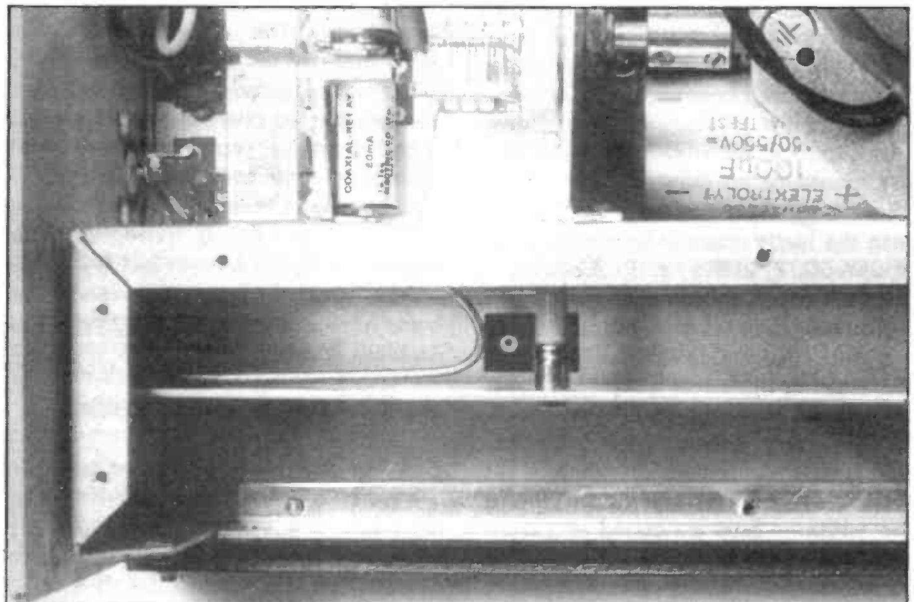
the licence regulations established in the UK, allowing for a small loss in the coax feed to the antenna of up to a dB or so. The instructions state that the low gain input should always be used, together with the attenuation facility, unless very high output powers are required, ie up to 1kW. I totally disagree with this, since the whole idea of the Dressler is to develop a really good clean signal at high level. If you drive your exciter black box, or transverter, at 10W or so to get 500W output PEP, thus giving 400W (26dBW) at the antenna, you will be working your driver flat out with relatively high IM products. I have been using for almost all the subjective tests a Microwave Modules transverter, cut down to only just above 1W drive, feeding into the high gain input straight onto the grid circuitry of the *350A* for maximum power transfer. By operating the transverter at such a low level, IM products are at very low levels indeed into the linear, which therefore works at its best. I would, therefore, strongly advise Dressler owners to do likewise, and if necessary fit a control into their main driver rig to cut its power right down and operate the driver PA more linearly.

There is insufficient detail in the instruction book concerning the linear's electronic circuitry, which is a pity since space precludes discussing this in too much detail here. The instructions claim that the valve is not covered by the Dressler warranty but by Eimac's own one. Clearly Dressler is not conversant with British law, for the purchaser has his main claim, when things go wrong, on the dealer who sold the rig to him. If it can be shown that in the opinion of the Trading Standards Organisation Dressler's instructions and specifications could lead to the valve being overrun, and thus its life greatly shortened, there could be a claim on the dealer, My own advice is to use the linear at not more than 550W PEP under all circumstances, and keep normal output down to around 400W PEP on SSB. On FM, you cannot run more than 100W at the antenna, and so if you have a 3dB cable loss, then you might run the Dressler at 200W quite safely on FM, but I would not advise much more. If you are using a compressor or clipper, then you will have to remember that the average width of the transmission may increase and so I suggest keeping the PEP down to around 400W. When using the compressor, you will be increasing the duty cycle very appreciably, and it is under these circumstances that the blower proves to be insufficient, blowing out very hot air indeed.

In tuning up I found it best to get an approximate tune position at a low level for maximum gain, and then go up to a power level above that which you would want to use, and tune up as rapidly as possible for maximum 'smoke'. I suggest that whilst doing this you watch anode current very carefully, and avoid transmitting carrier for more than five seconds in 15 seconds. If this is done for an output carrier of 550W for example, you will then find the rig to be very linear indeed at lower levels, although it may not be operating at maximum gain. Such gain, if attempted, often leads to insufficient loading.

Subjective comments

When I first received this linear, several weeks before writing this review, I ran it at about 300W PEP output for some considerable time, driving it with around 5W PEP from my Microwave Modules transverter into its low gain input. RF sensing was used initially, and the attack was not always sufficiently positive, suggesting inadequate RF sensing sensitivity. This was later confirmed in the laboratory. I, therefore, connected up the PTT line in the normal way and this worked admirably. I received in general very good reports indeed on the quality of the transmission, other than from locals who complained that it was just slightly wide, although no worse than my normal transmissions with the Fischer linear at the same power level, which is reasonable, and itself far better than any transistor linear that I have used or tested. Having got to know the beast, I decided to change my style of assessment, and run the Microwave Modules transverter at the lowest level possible, and use the high gain input on the Dressler. At the same power level as before, at 300W PEP, there were unanimous comments, even from locals, that the transmissions were extremely narrow, other than from one amateur who had a rig with a diabolically bad front end, from memory, a *Liner 2*! At this power level the fan coped excellently, and the air never became too hot from the exhaust port. I then altered the drive from the transverter so as to set up the linear to give between 500 and 550W PEP into the antenna coax, equivalent to +26dBW at the radiator of my 17 element Tonna. The rig ran decidedly hotter, but was still just tolerable after a long over. The air cooled down quite rapidly during a reception period, which is a gained after much fiddling.


Output coupling loop – very close to anode line

reasonable sign. Reports were generally again very favourable indeed, as far as bandwidth is concerned, from all but the very closest stations, ie. stations receiving my transmissions at more than '30dB over 9' or so. Local stations receiving me very strongly said that it was not bad for the signal strength, and that it was tolerable, but perhaps that it should have been slightly better. When compression and clipping were also used, spreading became decidedly worse, and approached that of the average 100W transistor linear being driven correctly at 5W input. Accuracy of tuning at this stage was found to be critical, and a slight maladjustment made spreading worse, but no improvement could be Approximately 0.4A seemed to be the limit for reasonable output performance. At maximum output and with clipping the exhaust air temperature was alarmingly high, and continued to be hot for a minute or so after the beginning of the reception period, and it is this that makes me feel that the fan is slightly inadequate. Even so, I much enjoyed being given remarkably good reports from EI, GI, GM, and GW on an almost flat band!

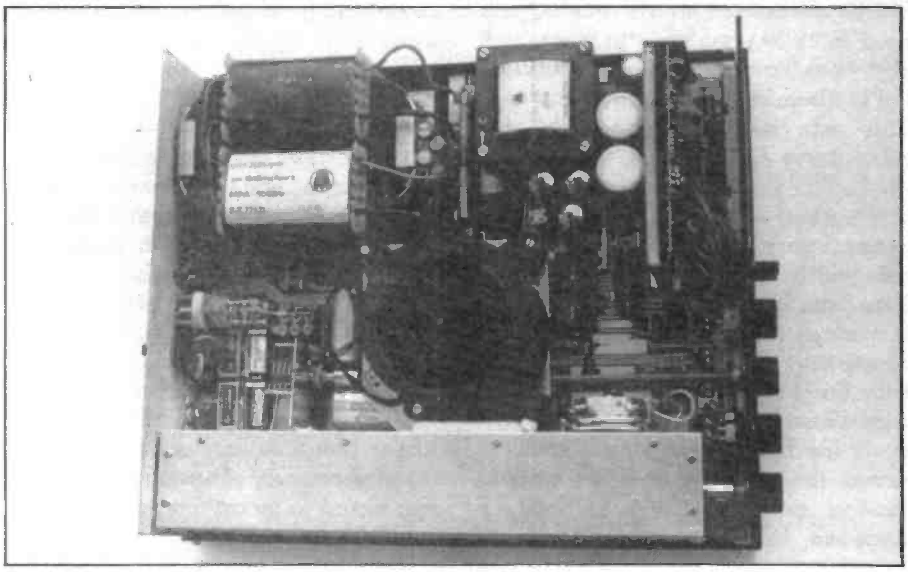
Fault

After around 12 hours of use over a fortnight of operating, mainly at weekends, the linear suddenly developed a fault in that no more than 40W output could be reached. I was totally perplexed since indications were very strange on the metering, the DC conditions were completely normal, this suggesting that it was an RF output problem. On opening up the linear (taking off the top lid is very simple — only 4 screws to be unscrewed) the whole of the inside is revealed. We opened up the anode cavity, thus revealing a half wave line, one end of which is very solidly earthed to the back chassis, whilst the other end is firmly connected to the anode ring clamp via a very high voltage capacitor element. The secondary pick-up loop is connected at one end to the printed circuit board, whilst the other end feeds through the cavity wall onto the output loading capacitor, which is tweaked by a long insulated rod running from the back of the linear to the front panel. The loop was actually touching the anode line, which seemed very odd indeed, and on releasing this contact, where there had been some arcing, normal operation was restored. We positioned the loop with a gap of around 2mm from the anode line, and it is clear that it had been set so close to the line at the factory that the slightest temperature increase eventually caused contact, and Dressler should take a little bit more trouble in assembly here. In any case, I have more than a hunch that the coupling loop is not quite good enough at loading the anode line, for the indications of two tone intermodulation tests seem to suggest that heavier loading would give improved results.

I also tried the Dressler with an *IC251* multi-mode rig, having a Mutek front end. The combination worked excellently and again comments were very favourable provided the output power was held to below 500W PEP.

Finally, whilst looking at the subjective performance, I should comment that not only was the linear superb ergonomically in every way, but that the fan noise was so much quieter than most other heavy duty fans that I have encountered on big linears. The Dressler's size (320 × 110 × 390mm) should make it very easy to fit into an installation, and even its weight is not too bad at just over 8kg. Perhaps the omission of an ALC line for interconnection with many external rigs is unfortunate, but it should be easy to fit one in for yourself as there is plenty of room inside for small modifications. Incidentally, the anode tuning control was excessively stiff, the capacitor actually tuning the anode ring against earth within the cavity most effectively.

Laboratory tests



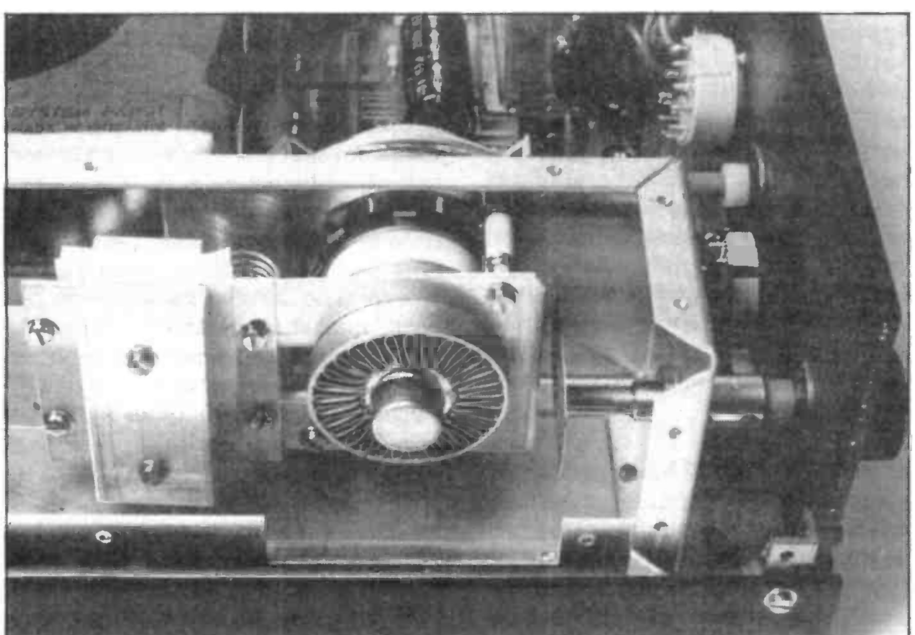
It is most important to develop very clean signals when testing valve linears, as they are so much cleaner normally than transistor ones, and you want to make sure that any distortion noted is from within the product being tested, rather than from the source. We first checked the Dressler with a single tone input of 100mW, with the Dressler input switch on the high gain position. The output was peaked up for maximum gain and the accompanying table shows the output powers reached. Checks were made at various levels up to 500W maximum, the output powers being noted both on the PEP meter and on the Racal. The 4CX350A valve current was noted under all conditions, as were grid 1 and grid 2 readings.

We checked the input VSWR on both the high and low gain positions, and this was none too good, generally being between 2:1 and 2.5:1.

Half power bandwidth will be seen to be approximately 1.7MHz wide for 3dB reduction of power, so re-tuning is recommended for QSYs of more than 300kHz or so. We tuned up for 350W output at 145MHz and adjusted the tuning and loading controls for maximum power and minimum harmonic distortion. We were unable to reduce the second harmonic of 290MHz to below −42dB, 3rd harmonic being −52dB. This is already pointing to insufficient loading, incidentally (but see later). The only time that we saw any grid 2 current was at the 500W level which produced 1mA screen current, and we would have thought that slightly more screen grid current would have flowed here if loading had been optimum, but we could not make any improvement by altering the capacitors own length. I was impressed with the fairly small HT voltage drop of only 100V, ie 5%, at 0.4A drain.

Standing currents were (as I would have expected) set for optimum results for the valve fitted. It is worth mentioning here that no grid current is permissable in the 4CX350A, which is a valve designed primarily for linear SSB service. We checked on this linearity, having carefully loaded the valve as best we could at a high output level and found it to be remarkably linear down to extremely low levels, for apart from the slight compression at the high end, linearity was within the errors of our test equipment. This is part of the reason why signal quality reports were so favourable, as compared with similar ones received recently when I was checking some transistor linears.

We also checked the amplifier on FM and found, as expected, the efficiency to be better, but gain was lower, and of course the valve was very non-linear, apparently working in class B.


Anode mounting assembly

Intermodulation tests

For the intermodulation tests we chose to run two tones 100kHz apart through the system. We regularly checked the intermod. of the drive source by switching the linear to stand-by and checking our analyser, and the worst source IM figures are shown in the table as taken at a 1W PEP drive level. Needless to say, source IM was always very substantially below the Dressler IM. An examination of all the 2-tone tests show the Dressler to be really excellent at all levels up to 190W, very good at 340W, and tolerable at 500W PEP, although we noted that the high order IM products failed to go down fast enough with increasing order at this very high power level. Even at the 340W level they should have been reducing faster. We are, therefore, convinced that the output secondary loop is not as good as it could be and results would have been even better with a more satisfactory loading. I have no doubt that amateurs who know what they are doing will be able to re-adjust or modify this loop to get better linearity, the Eimac valve specifications suggesting that the figures should be around 8dB better for 3rd order at the high levels, and that high orders should be reducing much more quickly.

One absolutely fascinating pointer to a good design is whether the IM products are symmetrical about the two input tones or not. We are pleased to report that the symmetry was excellent up to 350W, and surprisingly reasonable at 500W PEP, showing good earth routing etc.

Since we had had a slight reservation about the RF sensing threshold, we checked it quite carefully and found that it varied from just over 0.5 to 0.9W. I would have preferred to see this rather more sensitive, particularly for applications when low power drivers might be used, and RF sensing becómes essential. The through loss on receive measured very well at less than 0.5dB. The internal power meter was a little optimistic, indicating around 10% too high, but perhaps German watts are that much louder! Quite frequently, when tuning up, we exceeded 0.4A for a short while, and the box protested mildly with its intermittant red light showing it to be gasping for breath, and when this happened we always allowed it to cool off for a while. We had no problems at all in measurement, apart from the odd occasion when we switched from stand-by to off by mistake, which resulted in a curse, followed by an 80 second wait for the 'ready' light to come on every time this happened, this being accompanied by rather impatient foot tapping! Better to save the valve than the leather on our shoes, though!

Table 1. Laboratory test results

Frequency of input signal for single tone tests: 144.45 MHz unless otherwise stated.
Frequencies for two tone tests: 144.35 MHz and 144.45 MHz

Measurement	Result	Notes
Output power for the following inputs (SSB position) 0.01/0.1/1.0/2.0/W	4.5/46/350/500	'HI' gain input used 'HI' gain input used
Anode current at 500W o/p -SSB position (mA)	380	
HT volts — no load (kV)	2.1	
HT volts — 500W o/p	2.0	
Grid 1/Grid 2 current -SSB (mA)	0/1	
Output power for 2W input —FM position (W)	330	'HI' gain position used
Anode current at above output (mA)	240	
Grid 1/Grid 2 current —FM (mA)	0/0	
Standing anode current FM/SSB (mA)	< 10/100	
Intermodulation distortion of two tone source at 1W PEP level (dBc)	3rd order: −55 >3rd order: < −70	
Intermod at 100W PEP output 3rd/5th/7th/9th/ >9th order (dBc)	−32/−55 /−64/−68 /< −70	
As above but for 190W PEP output	−28/ −48/ /62/−70 /< −70	
Intermod at 340W PEP output (dBc) 3rd/5th/7th/9th/11th/13th/ 15th/17th order	−25/−33/−48/ −52/−58/−60/ −60/−65	
As above but for 500W PEP output	−23/−38/−46/ −50/−60	
Through loss on RX (dB)	0.3	
RF sensing switching level 'LO'/'HI' gain (mW)	560/890	
Delay between switching back to RX	Adjustable between 0 and 1.5 secs.	
−3dB Bandwidth (MHz)	1.7	
Harmonic output — 350W o/p 2nd/3rd/4th/5th/6th (dBc)	−42/−52/−50/ −55/−50	

Conclusions

I highly recommend this linear to those who appreciate the fun that can be had from running high power, although there are many provisos. If you have previously been running no more than 10W and you suddenly step up to 400W, you must expect much hammering on your front door for a while, abusive phone calls, and a check by the Home Office as a result of many complaints being handed in at the local Post Office. If you can survive all this, or live in a house miles away from anywhere, you can then begin to enjoy the Dressler for a longer period.

If you are a dab hand at fiddling, then you should be able to improve, or re-adjust both the input and output matching. I would have preferred, also, a slightly higher HT voltage for SSB linearity improvement. The variable input attenuator will be a real boon to those who like to fiddle, and now that Dressler have greatly improved reliability since their company was taken over by new management comparatively recently, it seems fair to suggest that the rather unfortunate name that the company had acquired originally should now be well and truly forgotten. Perhaps you ought to take out an insurance policy on the price of a new valve, though, which is now well over £160 in the UK, although you should be able to get it rather cheaper in the US if you look around.

I am slightly concerned that perhaps one or two components are being stretched a bit, for example the mains transformer is rated at 630VA. It seems logical that Dressler will bring out a new model eventually, perhaps with a larger fan, but in the meantime this present model is certainly the best bet commercially.

I have very much enjoyed using this machine and am now trying to justify its purchase, which perhaps is the best praise that I could give it. ●

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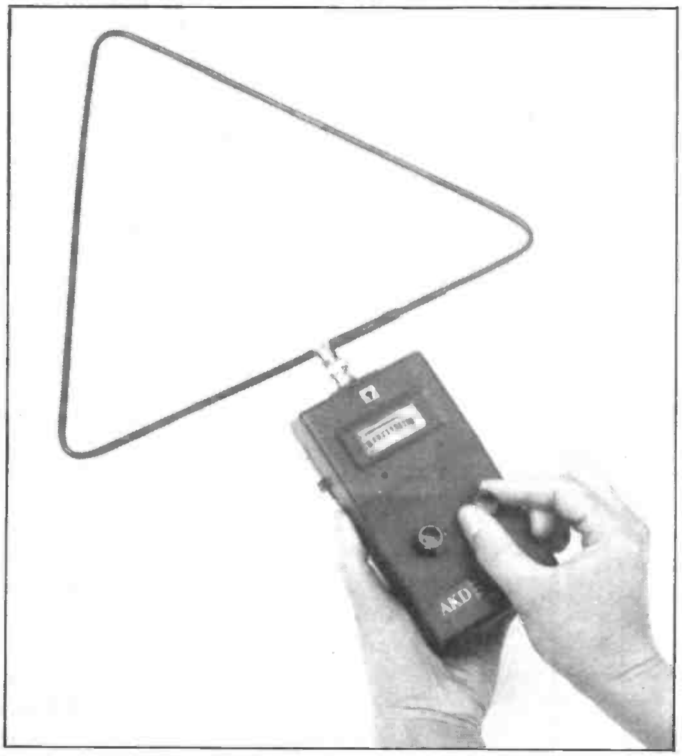
The aerial supplied is for use at ranges of up to 50 metres (with transmissions of 2 watts ERP) although any standard directional aerial may be used for greater distances.

Later units will be cover other frequencies. The *PDF 11-M* is available at £59.95 from the distributors: Telecomms, 189 London Road, North End, Portsmouth. Tel Porstmouth (0705) 660036/662145



Sidetone/VOX module

This CW sidetone/VOX module is designed to provide CW or MCW facilities on SSB-only or FM-only rigs. The module produces a tone to modulate the transmitter, and provides a semi-break-in facility. The unit can also be used as a morse practice oscillator.

As soon as the key is pressed the transceiver is switched to transmit, and it stays on until one second after the last morse character.

It is built in a small ABS case with a standard ¼" jack socket for the morse key and a trailing lead to connect to the transceiver's microphone socket. A small piezo-ceramic transducer provides the audible sidetone.

The module is a spin-off from the development of the *CM1000* HF transceiver.

The price of the CW sidetone/ VOX module is £7.00, plus 50p postage and packing, from Chris Moulding Radio Services, 276 Hulton Lane, Bolton, Lancs BL3 4LE. Tel Bolton (0204) 651348.

Catalogue: Bi-Pak Semiconductors

This latest components catalogue from Bi-Pak is now available, and costs 75p plus 25p postage. Bi-Pak Semiconductors, The Maltings, 63a High Street, Ware, Herts SG12 9AD.

HF balun

A new HF balun transformer has been introduced by LCS Designs of Maidstone. Properly installed, LCS says it will aid both the transmitting amateur and the short wave listener to achieve peak performance on all balanced antennas, reduce the possibility of causing TV interference and prevent manmade noise being picked up on the coax cable braid.

The manufacturer's specification is: impedance 50 ohms nominal; VSWR better than 1.2:1 into 50 ohms; power capability 30dBW (1kW) into 50 ohms, 26dBW (400W) into 2:1 VSWR; usable frequency range 3-50MHz (1.8-60MHz with reduced performance); balance within 5% across frequency range.

The balun is an encapsulated block with an SO239 socket for the coaxial feed, and brass studding for the aerial connection. The manufacturer recommends that the balun is supported rather than letting it take the strain of the cable.

The price is £8.75 plus 75p postage and packing, from LCS Designs, 29 Pickering Street, Maidstone, Kent.

Cheaper SSTV

A slow-scan TV system, currently undergoing field tests in prototype, will bring slow-scan television within reach of more amateur pockets. Designed by Davtrend Limited, it will be introduced in late summer with the launch of the *SST-1000* slow-scan receiver, which will cost less than £200.

The receiver will be able to accommodate a transmitter PCB to upgrade the transceiver for two-way work. This board will be introduced at a later date to coincide with the launch of the full transceiver system, the *SST-2000*.

The standard specification will be used, ie. 128 by 128 discrete picture elements each encoded into 16 grey shades, producing one frame every 8.5 seconds.

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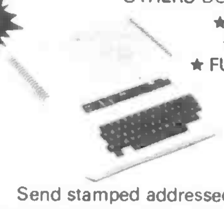

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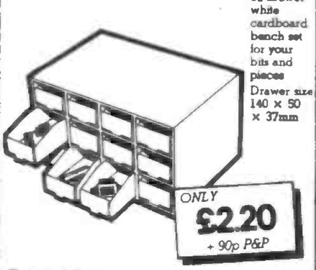

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