HRT

HAM RADIO TODAY

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ICOM IC-T21E
Reviewed

Who sells what in the UK? Our guide to finding that gear!

SSL reply on licensing problems!

Novice licence teaching now on disk!

G-TOR – the new HF data mode

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HAM RADIO TODAY

VOLUME 12 NO.6 JUNE 1994

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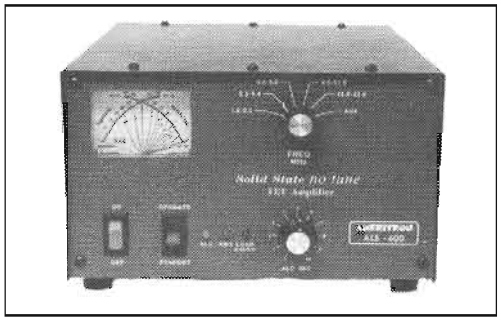

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NEWS AND VIEWS

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CQ de G8IYA Editorial

The summer 'rally season' is starting, where lots of us will be venturing forth in the hope of picking up a 'bargain'. But will we?

You've arrived at the rally entrance after the 100 mile journey to the venue. You've been sensible, and have a couple of amateur passengers with you to share the petrol costs, good planning that. There's a huge queue at the rally entrance, but after around 20 or 30 minutes you make it to the front. The man says "that'll be ten pounds, please". "What!" you reply. "That's right sir, it's £10 with your passengers including the £2.50 car parking charge, although entrance to the radio rally is free once you've paid to enter the grounds". Begrudgingly, you pay, after all you've travelled a long distance, and you didn't take the precaution of spending a few pence the weekend before in phoning the rally organiser to find out how much it'd cost you.

Once you're in, you try to find all the 'bargains'. But amongst the stacks of secondhand video games and 'untested' (faulty) PC compatible disk drives, the 'real' ham radio dealers have paid so much for their stand, plus their staff overtime costs, that they have to limit their lowest acceptable price for the piece of equipment you want, often to a figure higher than you'd be able to buy it from their shop.

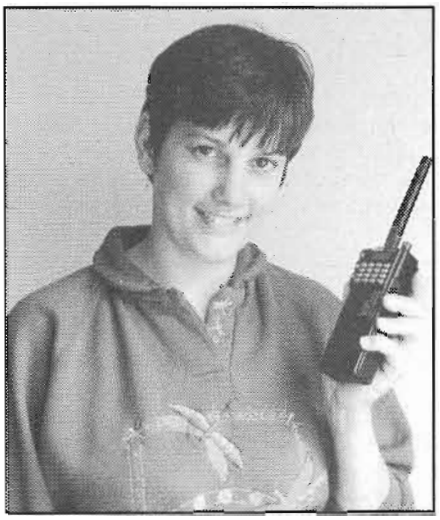
"Never mind" you think, "let's see what else there is around". "Ah, here's a stand selling surplus electronic gear, just like I see in the high street shops". There's a nice, boxed, multi-function radio remote control car that would be ideal for your nephew's birthday present. "It's half the price I've seen it in the shops for". So, you hand over your folding stuff, after checking it's all 'working'. "Certainly, Sir", the stall holder replies, "all brand new goods, excess stock that had to be cleared, their loss, your gain". "Can I try it out?" you ask. "Yes, certainly, just install your 10 AA cells in here, your PP3 and four D cells in here". "Have you got any batteries?". At these prices, I can't afford to keep them". "Oh, never mind, it's a bargain anyway".

You can probably guess the rest.

Let the Buyer Beware

At the risk of upsetting rally organisers, I'll say it here; Unless you can afford to 'write off' the money, don't buy anything from a rally (market) stall

Are we being ripped off at rallies?



unless you know, and have proof, that you can get your money and expenses back if you're sold something that doesn't do what the stall holder says it will. Make sure also that you know *who* you're buying from. If it isn't obvious, and the rally organiser doesn't display, or at least have available, details of who's exhibiting in what place in the venue they've charged you admission to, then demand your money and expenses back. If enough visitors do this, they might just get the message.

What to Look For

Common sense does unfortunately appears to be lacking with some people. If you see something at around a quarter of the price it would otherwise sell for, you'd think there's something fishy. Others think "What a bargain, here's my cash, I'll buy some for my friends as well, gimme, gimme, gimme". Fools rush where angels fear to tread. "But the 'surplus' goods are wrapped in plastic bags, neatly sealed, they must be OK" you think. How much are plastic freezer bags plus a bit of sticky tape down at your local supermarket?

If you're going 'rally hunting' for a rig, you'd do a lot worse than to take a look at the features 'Where To Buy Your Rig' (Jan 93 HRT) and 'Buying Secondhand Amateur Radio Equipment' (Aug 93 HRT), back copies are available if you haven't got these. There's also a 'Rally Hunting' article coming up soon, to be written by Dick G0BPS.

Surplus PMR Gear

In the surplus gear line, the 'best buy' bargains we at HRT have *consistently* found at rallies is surplus PMR gear. And that's *only* after following the instructions in HRT articles or the 'Surplus 2-Way PMR Conversion Handbook', which tell you to ***look*** at the riveted-on serial and/or model number of the set, to make sure you know ***what*** you're buying. This way, you know exactly what you're getting, and the price is usually well worth the expense for the components you get from the set alone, you also know exactly what you're letting yourself in for in getting it working on the amateur bands.

SSL Not To Blame

I recently offered SSL (Subscription Services Ltd.), a 'page worth' in HRT on the subject of amateur radio licensing, I'm very pleased they accepted this offer. You'll see in this issue that they've been having problems, but that they're trying hard to resolve them.

Original Pass Slips? – Chris Lorek Investigates

My Consultant Tech Ed, Chris Lorek, asked again for the latest written RA information detailing what is required to get one's amateur licence back with the original callsign once it had lapsed. He was sent RA Amateur Radio Information Sheet RA245, January 1994, ISBN 185569 669 8, which continues to state *exactly* what I published in the March 94 issue of HRT (prepared in Dec 93/Jan 94 and published on the 1st Friday in Feb 94), i.e., "an old Valuation Document showing the callsign" (quoted misspelling deliberate) plus "some proof that they are who they claim to be" is required. No need for original pass slips. But at the same time, both the RA and SSL verbally told Chris that SSL are instructed by the RA to ask for original pass slips. Following Chris's request to the RA for a definitive statement for publication (he was rather confused by now, as I'm sure you'll appreciate!), I'm pleased to report that the RA have given us this, you'll see it in this month's 'Radio Today'.

From this, it looks like SSL may not have been responsible for initiating the 'original pass slips' requirement, which makes sense because I'm sure it only makes more work for them! I think I'd better drop this subject now.....

LETTERS

Letter of the month

Dear HRT,

Whoever thinks the US VE system to an English licence is a short cut, had better take another look. It may cut the time you have to wait and the money you have to pay, but that is where it stops. In England you can miss 25 questions out of 55. In the US test 7 questions (or perhaps 8) out of 55.

To get to General Class there are three papers where you must score 70% in each. I missed 9 questions on the General Class exam, at the time I was taking the Tech Class (which I passed). I failed, had it been in England, I would have got a distinction.

In America if 90% of entrants failed, the FCC would say "study harder". If 90% failed in England they would say "make the test easier". That is why English education, which used to be the best in the world, has now taken a back seat to most of the world (yes, even third world countries).

I may seem a little hard, but when I, a secondary school person of the 50's, can give a GCE holder of today a run for their money and I have been out of school for 35 years. At one time I flew the Union Jack as proud as any Britain, now I count the days till I go home to America (at least a year).

To give fairness where fairness is due, I am presently studying electronics at Trafford College, the tuition is good, as was the tuition by my local club for the RAE. Where the system falls down is on how little you need to know to pass. Perhaps SSL is an example of what is wrong. Post Office Counters were doing a good job, so they gave it to someone else!

On a positive note, I like HRT, it is equally as good as CQ and other magazines I have read.

Dennis Barber, G0UFS/KB8GCF

Editorial comment;
Readers may be interested to note that recently published 'pass rates' in the US for US ham exams were noticeably lower than those reported for the UK RAE, Novice RAE, and the respective Morse tests. Of interest also is that UK amateurs sitting US ham exams have reportedly achieved an overall higher pass rate than those found in the US. Indeed we read that one UK candidate sitting the US General, Advanced, and Extra exams at a session earlier this year (attended by our very own HRT Tech Ed) achieved a 100% score in the written papers. Which goes to show the standard of UK amateurs and amateurs-to-be.

Dear HRT,

I placed an advert in a national 'supermart' newspaper that is always advertising secondhand CB radios at £100 upwards and amateur equipment at bargain prices. The advert read; "Vintage communicator kit circa 1906, consists of 2 bean tins and 10m of string, £20 no manual. Tel **** Alloa/ Kincardine."

I bet my amateur friends that this paper prints anything without thought. I had 16 calls. Four were amateurs.

John Redmond

Editorial comment;
Anyone want a homebrew QRP CW transmitter, crystal controlled, part built, will accept an FT-1000 as a 'straight swap', must be in good condition, will throw in a DIY long wire aerial for first caller. We got at least three calls two years ago.

Dear HRT,

Ref. your letters on complaints against SSL. Mine started last year and just to cut it short, I received no prior warning, just a red final demand. Someone had cancelled my standing order and never informed me, however that was finally sorted out. But again this year, I again received a final demand, no prior warning, telling me I had 14 days to renew my licence and that I was not allowed to use my equipment etc., etc. I phone SSL, they check, yes, everything is in order, "We will check". I phone back a couple of days later, another lady answers, again we go through the usual procedure, address postal code, "Yes sir, I can't understand, I'll get back to you". Finally, I phone my bank; "I'm sorry sir (after checking), we don't have any payment order to SSL, shall I phone for you and check with SSL?" A little while later the bank phones, says they spoke to SSL and that I was to send a cheque and ask for a new direct debit form (which I did last year after cancelling my old one). I sent a cheque and applied for a direct debit form. One week later I phone again; "Where's my licence? I sent the cheque you asked for on 10th Feb", "Oh," says the lady the other end, "We took the money from your bank on the 7th Feb, I'll look into this and send your cheque back with the licence". Great. A week later I get my 'A' licence. Hooray, we're all set. But wait a minute, something is wrong, the renewal date is 27/1/94. "Hell's bells, it's last years licence!". I had to phone them again. After all that expense, I find they (SSL) still had my direct debit form in their office, instead of my bank. I still haven't got my £15 cheque back, but I did get my correct licence today.

I think SSL should pack up and go home, they just don't seem to be able to get it together. Two years now my licence has cost me far more than it should, along with a great deal of inconvenience. This is just not good enough, the old system was good, never a single problem, and no threats of losing ones licence.

Tom Waters, G0GQJ/N8WHF

Dear HRT,

I purchased the March 94 issue of your magazine for the first time and I must congratulate you on the best book of its kind I have read for many years. I was very interested in your article on converting PMR equipment and received excellent service from your photocopy department.

I first sat the RAE in 1975 and failed....twice. In those days you had to write all the answers out and draw diagrams. I sat the exam again in December 1993. Imagine my joy when in the middle of March this year I received my pass certificate, this was about the same time that I read HRT 'Letters' column which introduced me to the spectre of SSL. "Dear me" I

£10 for the Letter of the Month

Do you have something constructive to say on the state of amateur radio today? Perhaps you'd like to put your viewpoint to the readers, get some discussion going, or give an answer to one of the issues raised? We'll pay £10 for the best letter we publish each month. So write in with your views, to Letters Column, The Editor, Ham Radio Today, ASP, Argus House, Boundary Way, Hemel Hempstead, Herts HP2 7ST, or fax your letter direct to the Editor's desk on 0703 263429. Please keep your letters short, we reserve the right to shorten them if needed for publication. Reader's views published here may not necessarily be those of the magazine.

thought, "will I ever get there? Will it be another 18 years?" I feel I should wait until matters improve and possibly try the Morse test while I wait. What would your readers suggest.

I'm retired now and so I cannot afford to nip out and buy a black box to plug into the airwaves. This leaves me interested in building or converting, HRT has been very helpful in this area and I look forward to many more of your pages.
Ian Hipkin, GM???

Editorial comment;
No, don't wait, get in there! We look forward to welcoming you on the bands with us, Ian!

Dear HRT,

I would just like to join the club that is unhappy with the way that SSL are handling the renewal of our licences. My licence ran out on the 18th December 1993 and was paid by direct debit from the bank. Knowing the trouble there has been at SSL, in which I have not been included till now, I did not query not receiving my validation document.

In February I received a letter from SSL and thought "Oh, they have decided to send the validation document", but when I opened it there was a red reminder that my licence had not been renewed and that I had 14 days in which to do this. I filled in the letter, enclosed a cheque and returned it to them on the same day. I checked with the bank and they said the direct debit was still there, waiting to be picked up. This was Tuesday, on the Saturday another letter from SSL, I said to my wife "That was quick, they have sent my licence back already". I opened the letter only to find my cheque etc. sent back, saying my licence had run out and that I would need to reapply. Bearing in mind the red notice said I had 14 days to renew, I immediately phoned SSL who said "Don't worry, a validation document has been issued to you and it's in the post". I have still not received this document but I have received another two letters, one asking for a cheque that I had returned to them more than a week before, another enclosing a new direct debit form, and both saying that my licence was in the post. At the date of writing this letter (6/3/94) the licence has still not been received, but SSL assure me that it is alright for me to use my radios.

Until now when I have heard fellow amateurs complaining, I have said that I have not had any bother, but that has changed with this renewal. From your article in the April edition of HRT, I see that the RA are investigating these problems, so I have decided to send them a copy of this letter hoping it will help with their enquiries. I suggest that all other amateurs who have suffered in this way do the same and hopefully something good might come out of it.
W. McGill, G0DXB

Dear HRT,

Before becoming a licensed radio amateur I have read your magazine and found it a great inspiration for passing my RAE. My problem is now, that my chosen area of interest is poorly catered for by British amateur radio.

My main interest lies in direction finding and the only source of information is the ARRL handbooks which contain many DF units for various frequencies. As I am sure many amateurs have come up against many obstacles when trying to copy American projects. I was lucky enough to come into contact with an amateur who has made an excellent DF unit for the two metre band, and gave me a lot of help in the construction of the said project.

I find it hard to believe that very few amateurs have knowledge of DF, this being as old as radio itself. Could you or other amateurs let me know if there are any DF clubs or people who have made DF projects for all frequencies, as I would like to learn more about this interesting section of our hobby.
George Kinder, G7PUT.

Editorial comment;
Several countries, such as the USA and Japan, are very 'hot' on direction finding. Indeed, '73' magazine (USA) and 'CQ' magazine (Japan) even have monthly features on these subjects, confirming the level of interest. Direction finding techniques and equipment is even a topic covered in the US ham exam structure. A look through the HRT 'Club News' will show that some UK clubs hold regular DF contests, maybe you could get in touch with these? DFing is a very pleasurable aspect of our hobby, maybe you could set up a local 'DF hunt' in your area to get some interest going? We'll be very pleased to help you publicize it.

Dear HRT,

Boot, bonnet, aerial, whilst our American cousins may listen to such words whilst viewing terraced houses against Buckingham Palace and say "Now aint that quaint", I see it as small minded. We think small, talk small and are small. People who find it hard to make a sentence, or read a children's book, say how the rest of the world has no class.

As far as antenna is concerned, I feel it is by G8IYA's description, the most descriptive of something that is used to pick up radio waves etc. Aerial on the other hand may have nothing to do with radio, you may have 'aerial photography', an aerial view in fact, most things which are aerial are not attached to the ground (or roof). Just the same as we may pack things in a trunk, but I put my foot in a boot.

A lot of snobbery is attached to words. Radio Hams, through talking to others and visiting hams in other countries, broaden their minds and give up on 'quaint' British words. Yes I am British, but sixteen years in the USA has shown me how stupid it is to get hung up on words, and to avoid snobbery like the plague.

So, I like many hams, have an antenna on my roof, I pack my gear in the trunk and the engine is under the hood, not because I must be different, but I feel a little silly saying aerial and bonnet.
Dennis Barber, G0UFS/KB8GCF

Icom IC-T21E Review

G4HCL goes cross band full duplex with a 2m handheld

The IC-T21E was first revealed 'in the flesh' to UK amateurs at this year's London Show. Here, a number of visitors were surprised to see that, although it was technically a single band 2m handheld, it could also receive on 70cm and even allow cross-band, full duplex, operation between the two bands. Is this a 'first'? It also has a useful CTCSS 'scan' facility, where if you've fitted the optional CTCSS board for alternative UK repeater access, the set can find out which tone is being used by the amateurs you're listening to on the repeater input. It does a lot more of course, let's take a look...

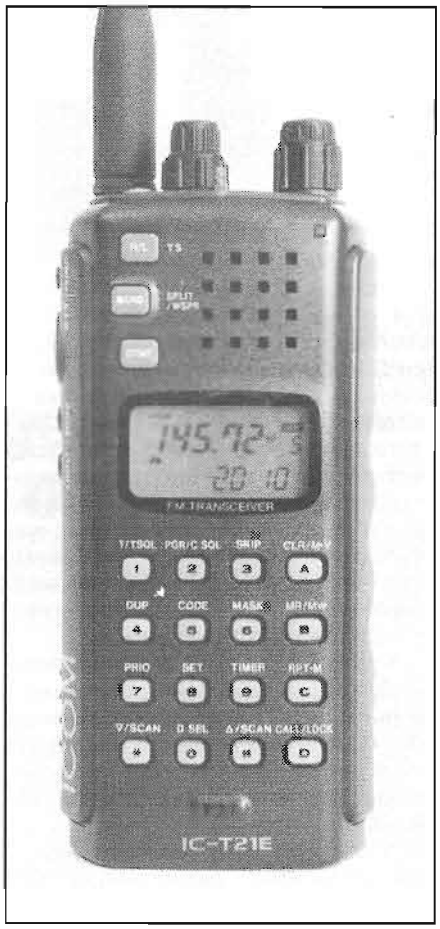
Physical Features

The size of the set is in keeping with many of today's tiny handhelds, and measures a compact 111mm (H) x 54mm (W) x 35.5mm (D), weighing 315g with the supplied BP-151 6V 800mAh battery pack which slides into the set itself. What's that – just 6V? Yes, with this the set's transmitter gives you around two and a half watts output, and if you plug in a 13.2V external supply it'll give you around six watts, if you're really stuck for voltage the set can even operate with a supply down to 4.0V, like four 'AA' cells down to their very last legs in an optional battery case.

For portability, the set's side panels are made of a 'soft feel' moulded Elastomer material which allows a good grip, and the keypad buttons as well as the LCD can be illuminated for easy nighttime use. The dual-band (2m/70cm) set-top aerial is one of the smallest I've seen on a handheld, it even uses a tiny SMA coax connector rather than the 'usual' but much larger BNC type to keep the size down.

Frequencies and Memories

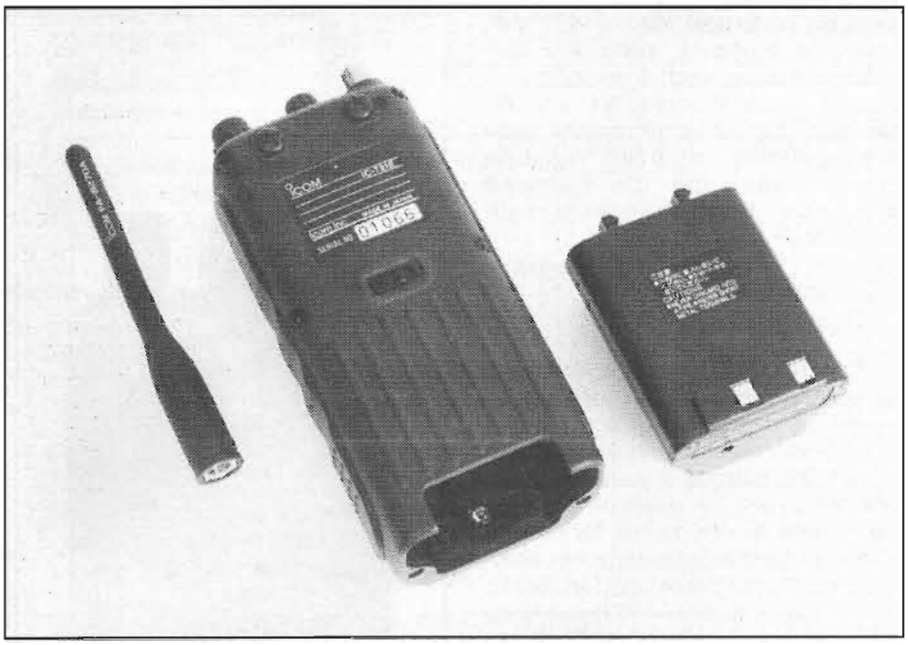
As well as covering the usual 144-146MHz range on both transmit and



receive, the set also has 70cm receive capability over 430-440MHz, which can be used simultaneously with the 2m transmitter in operation. For duplex use without feedback between the set's mic and speaker, you can either plug an earphone in, or enable Icom's 'Whisper' function which allows you to use the set like a telephone handset held next to your face, with lower RX/TX audio levels automatically switched in.

The set has 100 memory channels, plus a 'call' channel and a handy one-touch repeater memory, together with a number of scanning and searching modes to find those signals present on either band including further 'scan limit' memories. For example you can either scan or enable a 'priority watch' of the VFOs of each band, of both bands with the set alternating between each every second, between selected memory channels, or a combination of the above. A 'frequency skip' function lets the set automatically skip unwanted frequencies such as busy repeaters or beacons in 'VFO scan' mode, using up to 90 of the 'upper' memory channels for storage of unwanted frequencies. As well as this, up to 30 'memory select' channels may be filled with your most-used memory channel frequencies, for quicker selection and scanning.

The IC-T21E has built-in facilities for DTMF selective calling and paging – useful for 'special interest' groups of hams and especially for licensed husband/wife teams. CTCSS (subtone) encode and decode is available as an option. With this fitted, the 'CTCSS scan' facility on the set lets you listen on a repeater input with an automatic scan for the CTCSS tone used by an amateur transmitting into the repeater.



With the growing trend for UK 2m repeaters to be accessed by different CTCSS tones depending upon which geographical area you're in, this could be quite useful for country-wide travellers.

Power Savers

One of the biggest problems with small handhelds is that of battery life limitations. A small 'power-pack' like the IC- T21 could look odd with a relatively huge battery attached to it! The rig does, however, have a number of features to help this problem, including a variable rate battery economizer with on/off ratios of 1:1, 1:12, 1:40 and off. Together with high power transmit for getting your signal to those distant stations, you can select one of up to four 'low power' transmit power levels for local use, including an 'E Low' setting of around 15mW for use in real close quarters. There's even a selectable 'Auto repeater power control', which looks at the received signal strength every half a second, and adjusts your transmit power automatically for you! To keep your batteries going even longer, the receive 'busy' LED can be disabled, a transmit time-out can be selected (to save you 'waffling' for too long), and presettable power on/off timers together with an auto power-off (after either 20, 40, or 60 minutes of no switch operation) can be enabled. A small four- segment battery 'bar graph' shows you the battery pack voltage in use.

On The Air

After a nicad charge, using the supplied AC wall charger, I busied myself in having my first 'look around' on air with the set. I was very pleasantly surprised at the rig's good sensitivity with the small set-top aerial attached, even more surprised to be able to access my two semi-local 2m repeaters in locations around the house that I thought wouldn't 'make it'. The tiny aerial (one of the most important parts of any amateur station, remember) must certainly have been well designed – some I've found are hopelessly inefficient, just what you don't want with limited battery power! I had a number of pleasant contacts as a result on my daily walks to and from my house with the set in hand.

I hit my first snag when I tried to connect an external aerial – I needed an SMA aerial adaptor or plug to fit the set's tiny aerial socket. At the time of review, there wasn't an adaptor or lead available from Icom UK as an accessory (although I'm told there will be, being 'early days' as I write this). Fortunately, I 'had one I'd made earlier' for another purpose, and the set was quickly also pressed into mobile use, with journeys to and from the VHF Convention, London Show, and shorter trips around my locality. The set worked quite well, and there was enough audio from the small speaker for operation even at motorway speeds. A useful accessory I felt would be the optional remote

controlled HM- 75A speaker/microphone, with its various up/down switches to allow easier operation on the move.

Overall, the set worked quite well on air, both portable and mobile, it was comfortable to hold and use and relatively easy to operate. When connected to my rooftop 2m/70cm colinear at home, it naturally suffered occasionally from other strong signals on the band, which is probably to be expected. About the only thing I 'kicked myself' for in use was in trying to answer a call through my local 70cm repeater with the set. It had halted on this in 'scan' mode, and it took me a couple of unsuccessful calls to realise the set had naturally placed itself in cross-band full duplex mode – I was wondering why it was still receiving the 70cm repeater while I was holding down the PTT button!

Laboratory Tests

The accompanying table shows that the set worked reasonably well on both 2m and 70cm receive, although the 70cm image rejection was restricted, no doubt due to the 'secondary reception' aspect of this. The receiver on either band wasn't of course as good as a purpose-designed 2m or 70cm mobile or base rig, and this fact, a common limitation with most handhelds I test, should be borne in mind if you're thinking of using such a set in 'multi-purpose' mode in areas of high RF activity. The transmit power was well regulated, the peak deviation correctly set, and the transmit harmonics were extremely well suppressed.

Conclusions

The IC-T21E is a handy-sized rig, covering 2m on transceive with full receive capability on 70cm thrown in for good measure, together with the possibly unique feature of cross-band full duplex on a set of this type which could be very handy for remote transceiver control or emergency communication use. It was comfortable to hold and easy to use, and has a wide variety of search and scan modes to find those signals on the bands, the 'CTCSS Scan' with the CTCSS option board fitted could be quite useful for country-wide travellers. A similar model, the IC-T41E, is available for 70cm transceive, with 2m receive capability, which could be quite attractive for Novice use. The IC-T21E is currently priced at £329, with the optional UT-81 CTCSS unit at £32.

Our thanks go to Icom UK for the loan of the review transceiver.

LABORATORY RESULTS:

All measurements taken using fully charged BP-151 nicad, high power TX, otherwise stated.

RECEIVER;

Sensitivity;

Input level required to give 12dB SINAD;

144MHz;	0.15µV pd
145MHz;	0.14µV pd
146MHz;	0.15µV pd
430MHz;	0.22µV pd
435MHz;	0.20µV pd
440MHz;	0.20µV pd

Squelch Sensitivity;

	145MHz	*435MHz*
Threshold;	0.08µV pd (3.5dB SINAD)	0.10µV pd (3.5dB SINAD)
Maximum;	0.16µV pd (14dB SINAD)	0.34µV pd (23dB SINAD)

Adjacent Channel Selectivity;

Measured as increase in level of interfering signal, modulated with 400Hz at 1.5kHz deviation, above 12dB SINAD ref. level to cause 6dB degradation in 12dB on-channel signal;

	145MHz	*435MHz*
+12.5kHz;	22.5dB	13.5dB
-12.5kHz;	38.1dB	46.5dB
+25kHz;	59.7dB	56.8dB
-25kHz;	62.2dB	57.5dB

Blocking;

Increase over 12dB SINAD level of interfering signal modulated with 400Hz at 1.5kHz deviation to cause 6dB degradation in 12dB SINAD on-channel signal;

	145MHz	*435MHz*
+100kHz;	73.9dB	60.3dB
+1MHz;	88.6dB	61.0dB
+10MHz;	96.6dB	69.7dB

RECEIVER; *continued*

Intermodulation Rejection;

Increase over 12dB SINAD level of two interfering signals giving identical 12dB SINAD on-channel 3rd order intermodulation product;

	145MHz	*435MHz*
25/50kHz spacing;	64.5dB	52.3dB
50/100kHz spacing;	62.7dB	52.8dB

Maximum Audio Output;

Measured at 1kHz on the onset of clipping (10% distortion), 8 ohm load;

145MHz	*435MHz*
173mW RMS	166mW RMS

Image Rejection;

Increase in level of signal at first IF image frequency (- 61.70MHz), over level of on-channel signal, to give identical 12dB SINAD signal;

145MHz	*435MHz*
76.3dB	27.3dB

S-Meter Linearity

	145MHz Sig Level Rel. level		*435MHz* Sig level Rel. Level	
S1	squelch open		squelch open	
S3	0.43µV pd	-8.6dB	0.51µV pd	-6.8dB
S5	0.57µV pd	-6.2dB	0.64µV pd	-4.8dB
S7	0.79µV pd	-3.3dB	0.79µV pd	-3.0dB
S9	1.16µV pd	0dB ref	1.12µV pd	0dB ref
S9+	1.50µV pd	+2.2dB	1.60µV pd	+3.1dB
S9++	1.81µV pd	+3.9dB	2.12µV pd	+5.5dB

Current Consumption

	145MHz	*435MHz*
Standby, squelch closed;	36.5mA	51.0mA
Receive, mid volume;	127mA	139mA
Receive, max volume;	194mA	208mA

TRANSMITTER

TX Power and Current Consumption;

Freq.	*Power*	*6.00V Supply*	*13.2V Supply*
144MHz	High	2.49W/1.15A	6.32W/1.57A
	Low 3	2.49W/1.13A	4.44W/1.31A
	Low 2	1.19W/782mA	1.22W/787mA
	Low 1	980mW/724mA	980mW/731mA
	E Low	20mW/76mA	20mW/77mA
145MHz	High	2.49W/1.14A	6.37W/1.56A
	Low 3	2.49W/1.14A	4.44W/1.31A
	Low 2	1.19W/778mA	1.23W/780mA
	Low 1	980mW/720mA	1.00W/720mA
	E Low	20mW/76mA	20mW/77mA
146MHz	High	2.49W/1.13A	6.32W/1.54A
	Low 3	2.47W/1.11A	4.44W/1.30A
	Low 2	1.19W/772mA	1.23W/770mA
	Low 1	980mW/714mA	1.02W/720mA
	E Low	20mW/76mA	20mW/77mA

Harmonics;

2nd Harmonic;	-76dBc
3rd Harmonic;	-88dBc
4th Harmonic;	<-90dBc
5th Harmonic;	<-90dBc
6th Harmonic;	<-90dBc
7th Harmonic;	<-90dBc

Peak Deviation;

4.78kHz

Toneburst Deviation;

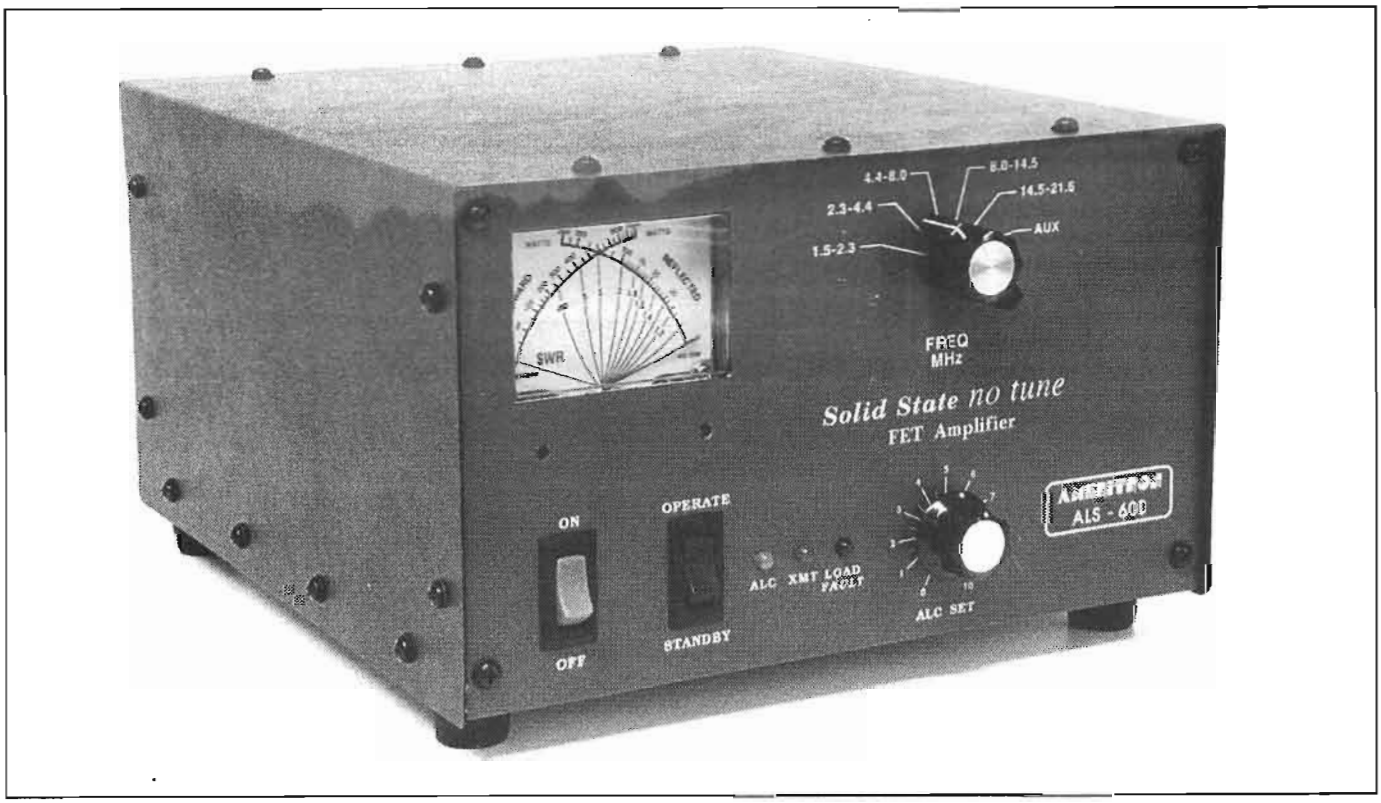
3.52kHz

Frequency Accuracy;

+180kHz

ALS-600X HF Linear Review

G4HCL increases his HF potential with a 600W solid state FET linear



If you mention a UK legal-limit HF amplifier, the vision that will spring to the mind of most amateurs is that of a big, heavy valve amplifier which hums away merrily in the shack, complete with plate and load controls that need to be repeatedly adjusted 'on air' each time you change frequency. That's *before* you can call that rare DX station you've just stumbled across who was giving his first 'CQ' of the day.

Wouldn't it be nice to instead just switch on, make sure the band switch is set correctly, and then transmit? Like you probably do with your current DX-chasing HF transceiver?

Solid State

This, of course, means running something without heaters that needs to warm up, something that's broadband with maybe just switched low pass filters for you to choose between. Like the Ameritron ALS-600X. Forget valves, this one's a solid state HF linear amplifier, using four MRF-150 RF TMOS FETs operating at 50V in a double-ended push-pull parallel output configuration. A front panel switch selects the frequency range, apart from that there's no other tuning or frequency selection needed, and no 'warm-up' time. Just switch on and transmit.

Coverage

The 'X' on the ALS-600X's model number means 'export', and this model covers the entire 1.5-30MHz range, yes that's 'top band' as well. Rated at 700W PEP or 500W CW output, it's powered from a matching 50V 25A PSU, each unit measuring around 150mm x 240mm x 305mm. You can quite happily sit the amplifier unit on your desktop, even on top of your HF rig with it weighing only around five and a half kg, and placing the (much heavier!) power supply on the floor next to or even underneath your shack table. The US ALS-600

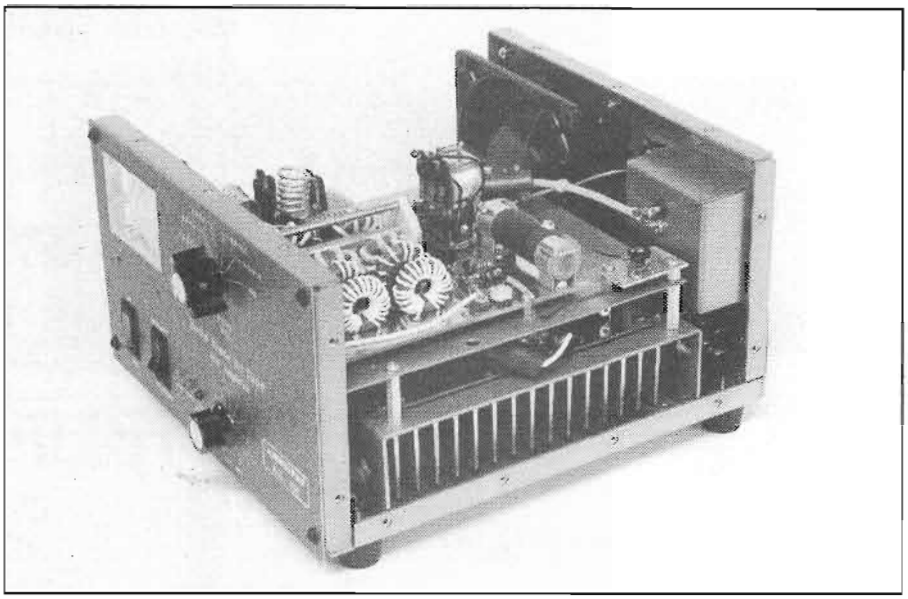
model is limited to a 22MHz upper frequency limit, amateurs over there can purchase a mod kit to extend this to 30MHz on production of their US licence.

On the Air

Connecting up and switching on was easy. A phono socket on the rear of the amplifier is used for the TX switching line from the driver transmitter, and an ALC socket provides negative-going DC voltage back to the rig for SSB drive power control, which can be set by a front-panel knob on the ALS-600X.

With this adjusted to give 400W output on the cross- needle meter on transmit in my station, the amplifier performed extremely well on air. My QSO partners could tell little and often no difference in the bandwidth or quality of my SSB signal with and without the amplifier switched in, apart from the resultant 'S-meter' increase! I found the amplifier a joy to use, even though I'd been 'brought up' on single and twin 3-500Z valve amplifiers which I've owned and used in my shack. The amplifier's blower was very quiet, indeed my shack computer's internal fan made more noise than the ALS-600X!

I found that I could always get in excess of 500W output with 100W drive, thus allowing for some feeder loss yet always managing the full legal limit when needed. I did however find that, running long contacts on HF data modes, the protective thermal trip on the amplifier cut in, which dropped my signal to drive power only. For example, I had to reduce to around 300W output to run PacTOR successfully on



LABORATORY RESULTS

SSB Linearity

Two-tone intermodulation products, measured as dB below PEP output level at 400W, 500W, and 600W PEP output;

		400W	500W	600W
3rd Order	+	25.5dB	24.2dB	18.9dB
	–	26.6dB	24.3dB	17.8dB
5th Order	+	44.4dB	31.4dB	27.0dB
	–	44.5dB	31.9dB	27.0dB
7th Order	+	44.3dB	45.3dB	30.6dB
	–	46.0dB	44.7dB	30.6dB
9th Order	+	51.5dB	45.0dB	43.8dB
	–	50.6dB	47.2dB	42.0dB
11th Order	+	54.0dB	58.0dB	44.1dB
	–	52.2dB	58.9dB	43.6dB
13th Order	+	54.9dB	54.9dB	46.5dB
	–	57.8dB	55.0dB	50.1dB

PEP Power Output

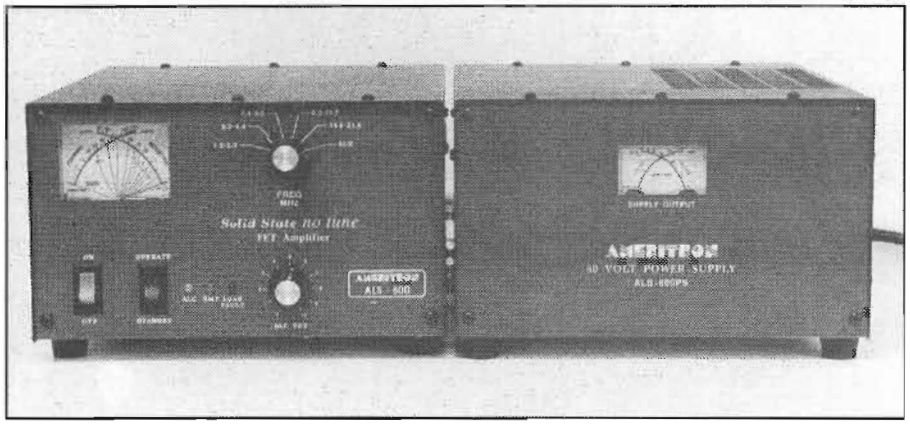
Measured 5 seconds after applying steady 100W PEP two-tone drive power

1.8MHz;	669W
3.5MHz;	555W
7.0MHz;	567W
10.1MHz;	802W
14.0MHz;	828W
18.1MHz;	802W
21.0MHz;	675W
24.9MHz;	898W
28.0MHz;	858W
29.0MHz;	834W

Harmonics

Measured at 500W carrier power output;

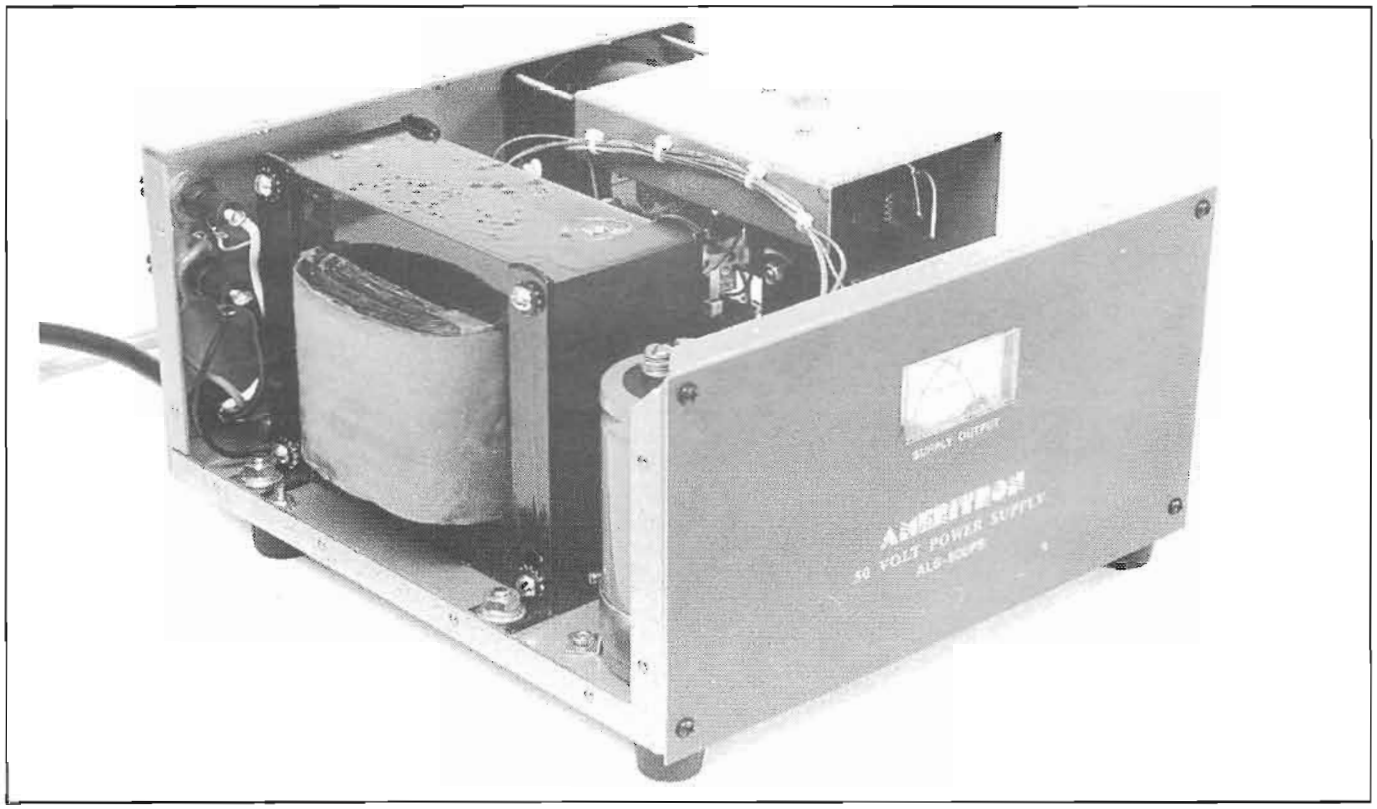
	2nd	3rd	4th	5th	6th	7th	8th	9th
1.8MHz	-48dBc	-59dBc	<-80dBc	-78dBc	<-80dBc	<-80dBc	<-80dBc	<-80dBc
3.5MHz	-53dBc	-52dBc	<-80dBc	-75dBc	<-80dBc	<-80dBc	<-80dBc	-75dBc
7.0MHz	-52dBc	-53dBc	<-80dBc	-79dBc	<-80dBc	<-80dBc	<-80dBc	<-80dBc
10.1MHz	-51dBc	-45dBc	<-80dBc	-75dBc	<-80dBc	<-80dBc	<-80dBc	<-80dBc
14.0MHz	-61dBc	-62dBc	<-80dBc	<-80dBc	<-80dBc	<-80dBc	<-80dBc	<-80dBc
18.1MHz	-62dBc	-62dBc	<-80dBc	<-80dBc	<-80dBc	<-80dBc	<-80dBc	<-80dBc
21.0MHz	-71dBc	-63dBc	<-80dBc	<-80dBc	<-80dBc	<-80dBc	<-80dBc	<-80dBc
24.9MHz	-69dBc	-67dBc	-78dBc	<-80dBc	<-80dBc	<-80dBc	<-80dBc	<-80dBc
28.0MHz	-70dBc	-63dBc	<-80dBc	<-80dBc	<-80dBc	<-80dBc	<-80dBc	<-80dBc
29.0MHz	-70dBc	-62dBc	<-80dBc	<-80dBc	<-80dBc	<-80dBc	<-80dBc	<-80dBc



amplifier with its noisy blower.

The ALS-600X, including 22-30MHz coverage and the matching ALS-600PS power supply ready-wired for 220-240V, is currently priced at £1575. Which isn't cheap. But the 'warm-up and tune-up' time with other amplifiers, that loses you the station that would have got you onto the DXCC Honour Roll, tends to put things a little more into perspective!

My thanks go to Waters and Stanton Electronics in Hockley for the loan of the review amplifier.

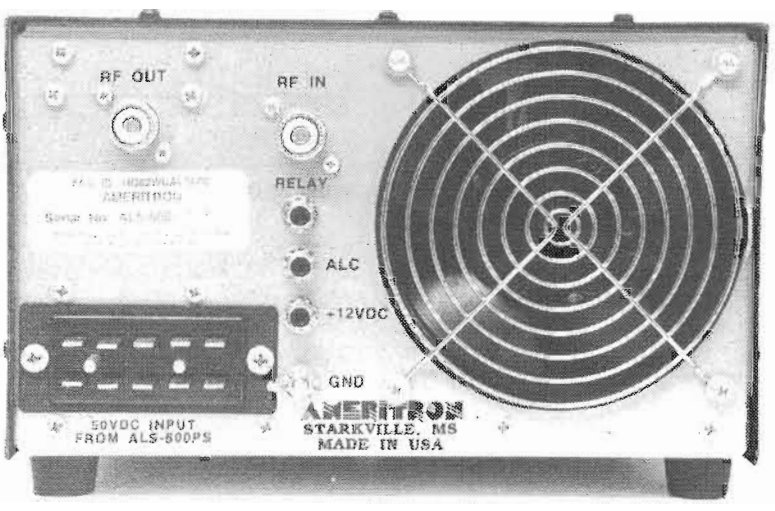


80m, RTTY users would need to reduce this further.

Conclusions

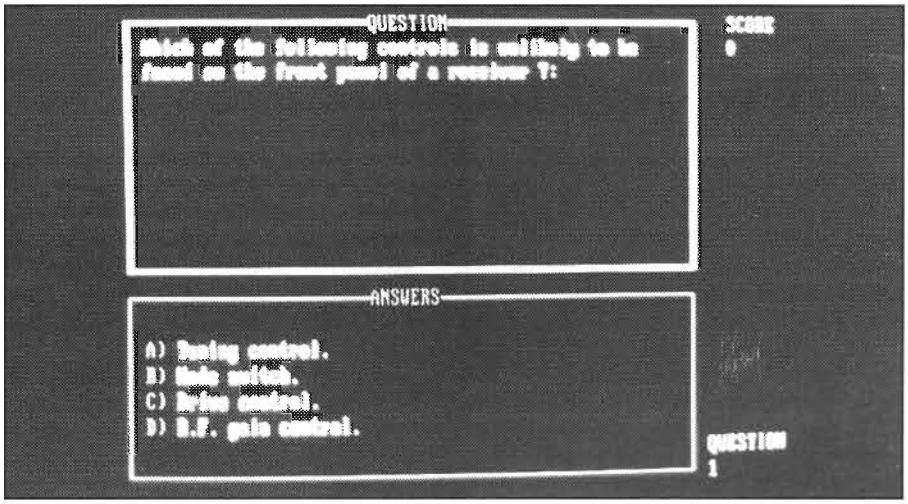
The accompanying lab results show that, at full UK legal limit, the ALS-600X gives a good technical performance in terms of signal 'cleanliness', both in respect of linearity and harmonic suppression.

The amplifier was a delight to use on air, no more frantic 'tweaking' back and forth of controls, or grabbing a premade 'look-up table' and adjusting knobs to suit before I could 'snag' that DX station coming through on the grey-line path as day breaks. Its very quiet operation also saved my nerves a bit, and I found myself normally always leaving it switched on, ready for instant operation when needed, unlike my valve



UK Novice Tutor – On Disk

The HRT Editorial Team take a look at a study aid for the UK Novice Licence



A recent addition to the Venus Electronics' PC shareware catalogue, which certainly caught our eye, was the "UK Novice Tutor", described as being written for the use of students undertaking the UK novice licence training course. This warranted a closer look, we thought!

First in the UK

PC based study aids and multiple choice exam programs are readily available for the US series of ham radio exams, but this is the first we'd seen that's written especially for the budding UK Novice licensee. Rather than being a tutorial (which it isn't) the program, which has been released onto the 'Public Domain' (i.e., no payment required to the author) is a simulated multiple-choice Novice exam, and has been written by John Butler GW0NFN with help from Mark Butler 2W1BPJ.

Originally written with the intention of it being distributed by the RSGB, which didn't materialize, this 'mock exam' attempts to simulate a typical Novice RAE, including no doubt any exam 'nerves', and comprises two modules of questions, the first containing 30 questions and the second containing 15 questions. Upon running the program, it comes up with simple but nicely done scrolling 'logos', and the student is asked to type in his or her name.

Each question is presented, with four possible answers marked A, B, C or D, the student tapping the appropriate letter on the computer keyboard to answer. The result, i.e., correct or not, is given to the student, and the correct answer must eventually be entered before the program continues onto the next question. Note that the program has only one set of simulated exam questions, i.e., it doesn't select random questions from a pre-programmed 'pool'. Upon completion, the score is then recorded on disk under the student's name for subsequent appraisal by the tutor.

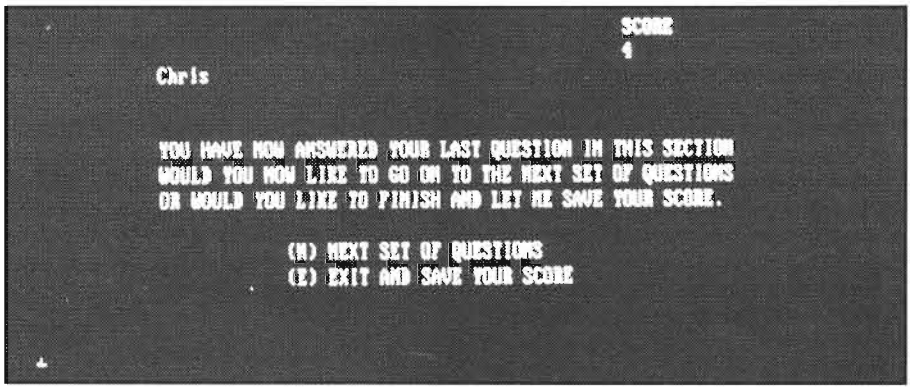
Updated Version

The version we tested, which is the current one, unfortunately suffered from a number of mistakes and ambiguities in the questions, although the program itself worked quite well. In chatting to John GW0NFN, he told us that he's updating these (the questions, incidentally, were *not* originated by him!), and that by the time this review appears in print, an updated version should be available. John also told us that he's hoping to release a 'shareware' version with a limited set of questions/answers to simulate a given exam (like the above), with an 'upgrade' to a larger question/answer set being available, the details for this being given on the disk.

Conclusions

The concept of this 'mock exam' is extremely good, youngsters in particular who otherwise wouldn't look forward to 'bookworm' type tests could, quite easily, even enjoy this Novice RAE 'puzzles game' on a PC (you know how many of them love computer games). The current version of the program (NOVICE.EXE, 14/11/93) suffers from some incorrect questions/answers, but we look forward to John's updated version, especially the one with an extended question pool.

Our copy came from Venus Electronics (Tel. 0252 837860 at £2.55 plus 95p p/p, disk No. AM247) who tell us they will always supply the latest version, and to whom our thanks go to for the supply of the review disk. Our thanks also go to John GW0NFN for his help in answering our queries, and of course for generously releasing the program into the public domain.



Libris Britannia CD-ROM Review

The HRT Editorial team look at what must be the largest quality shareware collection in the UK

Many readers are familiar with 'shareware', where computer software may be freely distributed and copied, for you to use on a 'try before you buy' basis, with an 'honour bound' payment to be made to the software author if you find you'd like to use the program after trying it out. This concept has many advantages, especially in that you can try a large number of programs to make sure you're happy with what you end up with, without possibly wasting a lot of money on a commercial program and then finding it doesn't do what you want. Yes, we at HRT have also had this happen in the past! But as an example of shareware software, our Tech Ed tried a number of Morse shareware programs to get his CW speed above 20wpm, finally settling on 'Supermorse V4.06' and sending the requested $20 (a bargain at the price, incidentally) to the US author for its use. That's how shareware works. A number of programs and information texts have also been released as 'public domain', i.e., they may be freely distributed and used at no charge, all you pay for is the disk and any copying charge.

As well as 'one to one' swapping of programs, a number of software libraries have set themselves up to distribute shareware, and in the UK the largest of these must be the Public Domain and Shareware Library (PDSL) – we've certainly been using their service for a number of years, and you'll have seen their name mentioned in these pages several times in the past. They hold a vast selection of general public domain and shareware software, including of course Ham Radio programs although they don't specialise in just this. With the 'CD-ROM Revolution', a while ago the PDSL recently went all the way and released most of their *entire library* on CD-ROM – a staggering 1.2Gb worth, which in the compressed format it's stored in just about fits into the 630Mb capacity of a single CD-ROM!

Fully Indexed

Their latest CD-ROM compilation is 'Libris Britannia Issue 3', and unlike many other 'collections' this CD-ROM comes with a bound 132 page book giving a complete index to the programs on disc, together with a description of the contents of each 'volume' (over 1000 of them!). A quick look in the book is all you'd need to see what's of interest to you on any particular subject.

To give you a 'taster' on what subjects are covered, the disc includes sections, in alphabetic order, on; Agriculture and Gardening, Artificial Intelligence, Astrology/Esoteric, Astronomy, Business Software, Specialist Applications, Combined Packages, Communications, Data, Database Systems, Desk Top Management, Desk Top Publishing, Education, Electronics, Engineering, Food, Games, Genealogy, Graphics, Ham Radio, Hobbies/Activities,

Home Finance, Household Applications, Literature, Mathematics, Medical/Health, Menuing Systems, Music and Sound, Printing Utilities, Programming, C/C++ Users Group (UK), Religion, Retail software Support, Scientific, Security, Special Needs, Spreadsheets/Calcs, Stock Market, Utilities, and Word Processing/Text Editing. Phew!

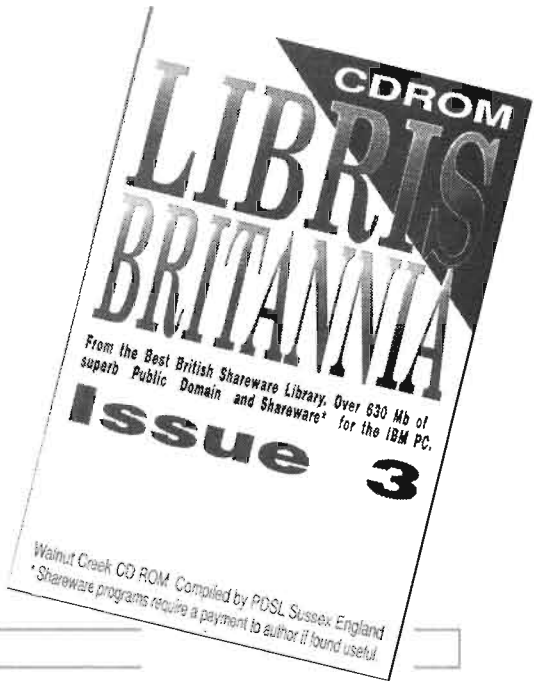
Something For Everyone

In the Ham Radio section there are the equivalent of 48 floppy disks-worth of compressed software, these all being the very latest versions, with subjects covering packet, satellites, aerials, Morse tuition, fax, SSTV, logbook programs, TX/RX control, DXing, even the complete CIS callbook-on-disk. But as you'll have read, it doesn't stop there. In the 'Electronics' section there's PCB design and circuit simulation programs, and the Engineering section will even help you calculate the wind loading and stresses on your tower. The language tutors can help you try your hand at QSOing in German, French, Spanish, even Russian and Japanese.

Of course, not all of us have 'one-track' Ham Radio-only minds, and there's plenty on the CD-ROM to keep most people going for many, many years. Think of the fun the kids will have with the hundreds of arcade games and educational programs included, there's even recipes and gardening information to keep your respective partner happy as well (and maybe even help justify the purchase of the CD-ROM in the first place!). We'll be using it over and over again.

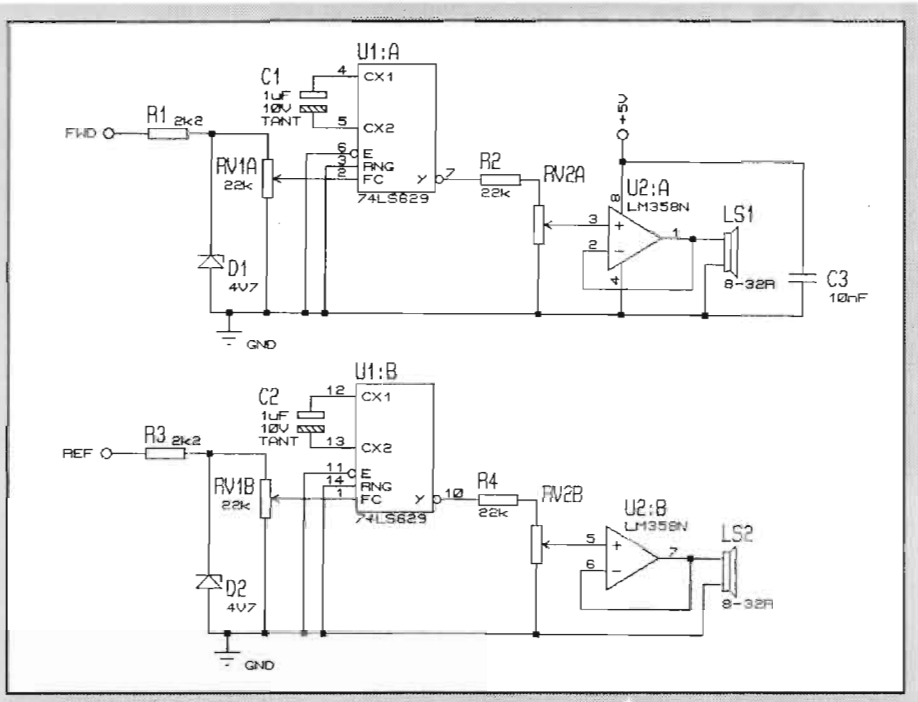
Conclusions

If you use a PC with a CD-ROM drive, for *anything*, you'll no doubt find this CD-ROM is worth every penny. We did, and if the last sentence fits your description, our wholehearted recommendation is, get it! Libris Britannia Issue 3 is currently priced at £49.00 inc UK p/p, and our thanks go to the PDSL (Tel. 0892 663298) for the provision of the review disc.

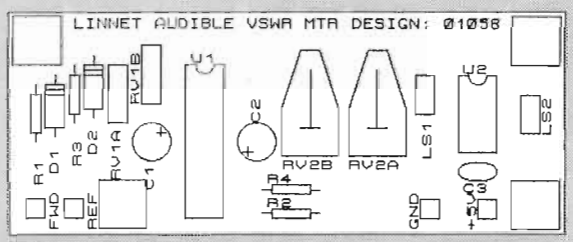


Project – Audible VSWR Meter

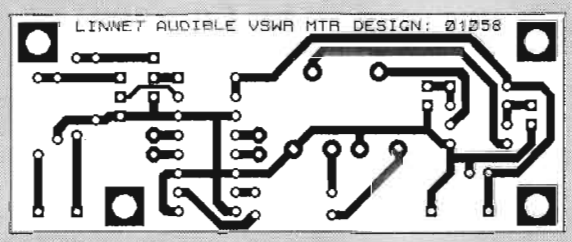
Ben Spencer G4YNM describes a VSWR meter which is also suitable for amateurs who suffer from impaired vision



Complete circuit diagram



Component layout



Solder side foil pattern

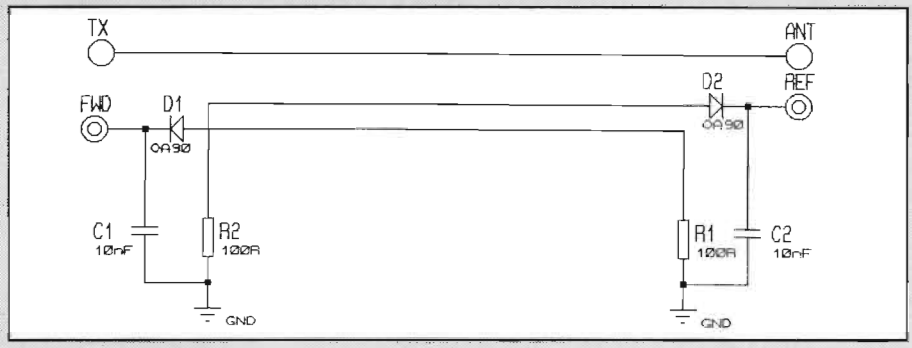
The HRT Audible VSWR Meter was specifically designed for amateurs who are blind or suffer from impaired vision. Instead of using moving coil meters to indicate forward and reflected voltages on the aerial system, it generates two audible tones whose frequencies are proportional to the respective voltages. The tones are fed to a pair of *stereo* headphones (the personal stereo ones are ideal), the left ear hears the forward voltage and the right ear hears the reflected voltage. Thus 'tuning up' a transmitter is simply a matter of tuning for maximum tone frequency on the left ear and minimum tone frequency on the right ear. Construction and testing are straightforward requiring no special skills or equipment, and there are no rare or hard-to-find components in the design.

Circuit Description

The complete circuit is shown in Fig.1. As the design comprises two identical circuits a description of only the 'forward' circuit will be given. Most passive VSWR meters are of the reflectometer type where sampling lines are loosely coupled to the conductor carrying the RF power. The induced RF voltages on the sampling lines are reflected by diodes and the resulting DC used to drive forward and reflected panel meters. The forward DC voltage is fed into the circuit at R1 and then via sensitivity control RV1A to the voltage controlled oscillator (VCO) U1:A. As the voltage on U1:2 increases, so does the output frequency at U1:7, this is fed via volume control RV2A to a simple buffer amplifier U2:A which drives the left headphone. Zener diode D1 limits the maximum input voltage, partly to protect U1:A but it also limits the upper VCO frequency to about 3kHz. Without any DC input the VCO runs at a low frequency (approximately 380Hz) to indicate to the user that the unit is operating correctly. Even a low power transmitter will cause the tone to change noticeably.

Construction

A single sided PCB has been designed for the HRT Audible VSWR meter, and the component layout, and foil pattern are shown in Fig. 2a and 2b, respectively. The assembled PCB is small enough to fit inside existing VSWR meters and can be battery operated if required, a *stereo* jack socket should be mounted on the front panel for the headphones to be plugged into whilst tuning up. Note the RV1B is a single component, a dual gang panel mount potentiometer, whereas RV2B are PCB mounting types. However for those who want a panel mounting volume control, details of a suitable part are given in the

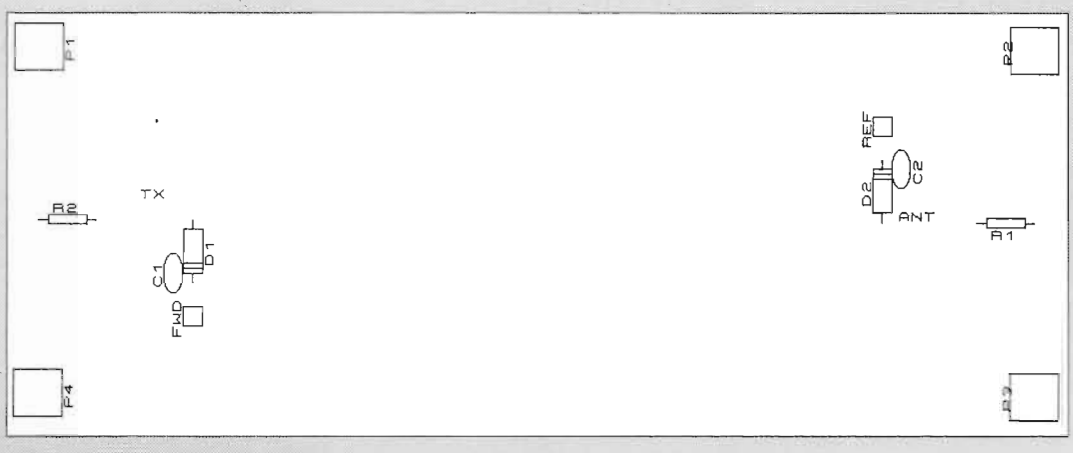


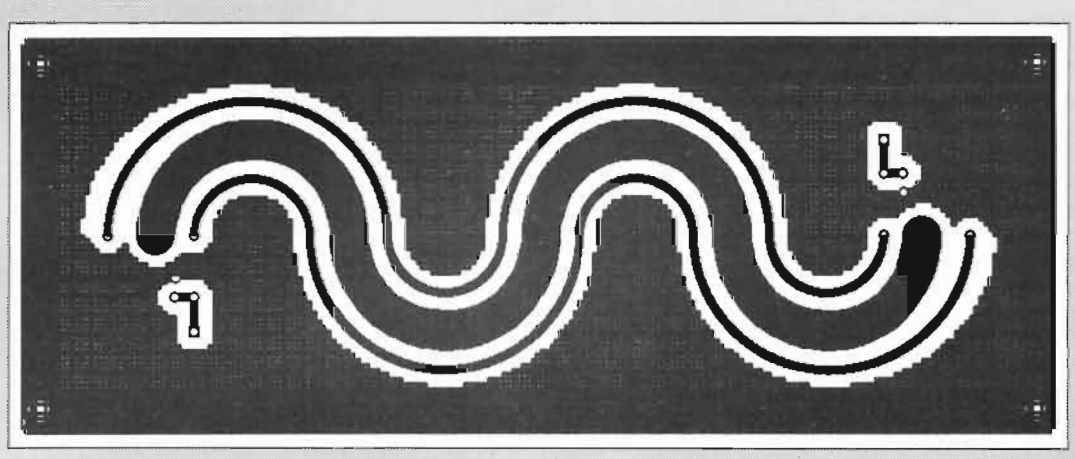
Sensor circuit diagram

tone should not change, in reality it probably will shift up in frequency slightly. If an ATU is adjusted, the two tones will then change according to how bad the mismatch is, the best match will be indicated by the forward (left) headphone tone frequency reaching a maximum and the reflected (right) headphone tone frequency a minimum.

The author will provide a 'help' service on queries concerning this project which are accompanied by a stamped addressed envelope, write to; Ben Spencer G4YNM, 100 Linslade Street, Swindon, Wiltshire SN2 2BN

Sensor component layout and PCB pattern





components listing.

Testing and Calibration

The HRT Audible VSWR Meter requires connecting to an external VSWR meter to obtain voltages for the forward and reflected levels. Connect up the circuit to a 5V supply, adjust the volume control(s) to an acceptable level, two identical low frequency tones should be heard through the headphones. Now connect up a low power transmitter via the external VSWR meter to a dummy load. When the transmitter is keyed up, the left headphone tone should move up in frequency quite dramatically, representing forward power. Whilst in theory there will be no reflected voltage and hence the right headphone

Components list;

Resistors;
All 0.25W 5% metal film unless otherwise stated.

R1, R3	2k2 (2 off)
R2, R4	22k (2 off)
RV1A, RV1B	22k Dual Gang panel mount potentiometer (1 off)
RV2A, RV2B	2k2 horizontal pre-set (2 off) or 1 4k7 Dual Gang panel mount potentiometer

Capacitors;

C1, C2	1µF 10V tantalum bead (2 off)
C3	10nF 10V sub-miniature plate ceramic (1 off)

Semiconductors;

D1, D2	4V7 zener diode (2 off)
U1	74LS629 Dual VCO (1 off)
U2	LM358N Dual op-amp or equivalent (1 off)

Miscellaneous;

LS1, LS2	8-32R stereo headphones (personal stereo type)
Stereo jack socket (1 off)	
Veropins (4 off)	
M3 mounting hardware	

Novice Notes

Ian Poole G3YWX explains what Image Rejection is all about

Image rejection is a particularly important aspect in a superhet radio. In good receivers it is rarely noticeable, but in the cheapest portable radios for broadcast AM reception it is a great problem. It is particularly noticeable at night when more stations are audible. Tuning around with no BFO switched on, howls and whistles can be heard which change pitch as the radio is tuned, and it is not always easy to tune the radio so that they cannot be heard.

What Is an Image?

To investigate how an image signal is received it is necessary to look briefly at the way in which a superhet radio works. Its operation is based around the fact that when two signals are mixed together in a non-linear circuit other signals at the sum and the difference of the frequencies of the original two will emerge. To put this differently if signals at frequencies f_1 and f_2 are fed into the mixer then frequencies of $f_1 + f_2$ and $f_1 - f_2$ will emerge. A simple example of a difference frequency being generated can be heard when musicians are tuning instruments. When the notes are reasonably close together a beat note is heard as the vibrations cancel and then reinforce one another. As the two notes become closer together so the frequency of the beat note is reduced.

In a superhet a variable frequency local oscillator is used as one of the two original frequencies. The other is the incoming signal from the aerial. These two signals are mixed together and the resultant signal passed through a fixed intermediate frequency (IF) filter.

To see how this operates take the example shown in the diagram where the IF stages operate at 500 kHz and the oscillator operates at 2000 kHz (2.0 MHz). For a signal to be produced at 500 kHz there must be an incoming signal at 1500 kHz, i.e., the difference frequency is 500 kHz.

Unfortunately incoming signals on a frequency of 2500 kHz will also produce a difference frequency signal of 500 kHz when they are mixed with the local oscillator. This is the origin of the image response of the receiver. From this it can be seen that the difference between the wanted signal and the image is twice the intermediate frequency.

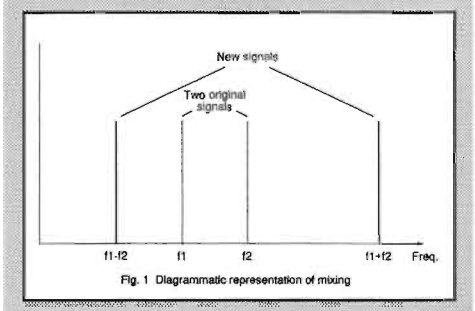


Fig. 1 Diagrammatic representation of mixing

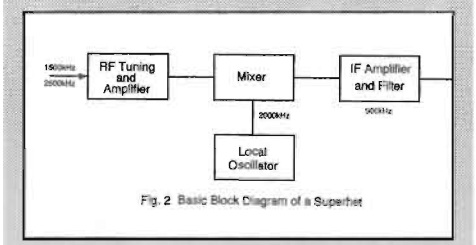


Fig. 2 Basic Block Diagram of a Superhet

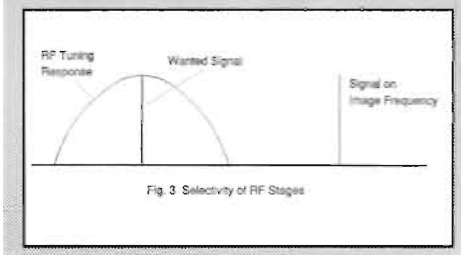


Fig. 3 Selectivity of RF Stages

Removing the Image

The image is removed by adding some selectivity into the radio frequency stages of the receiver before the mixer. This selectivity only needs to be sufficient to reject the image signal. It does not need to be nearly as sharp as the selectivity used in the IF which is used to reject stations on adjacent channels.

Once RF selectivity has been incorporated into the receiver it must be tuned along with the local oscillator so that both circuits are set up to receive signals on the same frequency. This is accomplished using a multi-section variable tuning capacitor. One section tunes the oscillator whilst the other one or ones are used for tuning the RF circuit or circuits.

Choice of IF

The choice of the intermediate frequency can have a large bearing on the image performance. It is found that for a given IF the image performance falls as the frequency rises. Take the figures given in the original example. The IF is 500 kHz, the wanted frequency is 1.5 MHz and the image frequency is 2.5 MHz. Here the image is at nearly twice the wanted frequency and the RF tuning should have little difficulty in rejecting signals on 2.5 MHz. As the frequency rises the performance degrades. Take the example of the receiver with the same IF covering up to 20 MHz. It will be found that the image is at 21 MHz. Now the percentage difference between the wanted and unwanted frequencies is quite small and the image rejection will be much worse.

To improve the situation a higher IF can be used because this will increase the difference between the wanted frequency and the image. Whilst most broadcast AM radios used 450 kHz as their IF to give the required selectivity in the IF to filter the stations on the medium and long waves, those which cover the VHF FM band from 88 to 108 MHz have a higher IF of 10.7 MHz. This enables them to reject any image signals because they will appear 21.4 MHz away from the wanted channel. Then because wideband FM is used and stations are spaced further apart the circuits can still give sufficient selectivity.

Nowadays many high performance communications receivers will have several stages of frequency conversion. Usually the first stage will convert the signal up in frequency to give a good image rejection performance. Later stages will convert the signal down to give sufficient IF filtering.

MuTek FT-736 Upgrade Review

Chris Lorek G4HCL tests a 'go-faster' mod for a very popular VHF/UHF base rig

The firm of muTek have a reputation of making 'good radios better' on 2m, and a 'muTek front end' was almost a standard fitment in the stations of serious VHF operators, especially contesters. MuTek's approach was usually to replace the entire front end and mixer sections of popular multimode transceivers, the resultant performance improvement gained in terms of sensitivity and far greater immunity to strong signal overload was very worth while.

The latest transceiver to benefit from the muTek treatment has been the popular FT-736R multimode VHF/UHF transceiver. Having used one of these for some time in my own station (before reluctantly having to sell it) I was very pleased to be given the opportunity to put a 'muTek-modified' set through its paces on air, side by side with a 'standard' FT-736R.

The Design

For the FT-736, mutek have designed replacement 2m and 70cm receiver front end and mixer circuitry, adding an 8 pole monolithic crystal filter and AGC amplifier common to both front ends (muTek say the latter can improve the selectivity of any other modules in the set also). Two filter bandwidth options are available, 'wide' (24kHz) to retain 9600 baud packet capability, for either terrestrial or satellite use, and 'narrow' (17.38kHz) where this isn't required. The 2m receive board contains muTek's 'usual' low noise dual gate MOSFET amplifier, band pass helical filter, diode ring mixer with high level local oscillator injection, and low noise IF amplifier. The 70cm receiver board is a new design, incorporating a very low noise MOSFET and helical filter, followed by downconversion to 47MHz where the signal is passed to the 2m board IF filtering and processing circuits.

As well as the two receiver boards, replacement transmitter PA boards are also fitted, these connecting to the set's existing 2m and 70cm 'block' PA modules. The PA boards replace the set's PIN diode switches with relays for lower insertion loss thus giving a better front end noise figure.

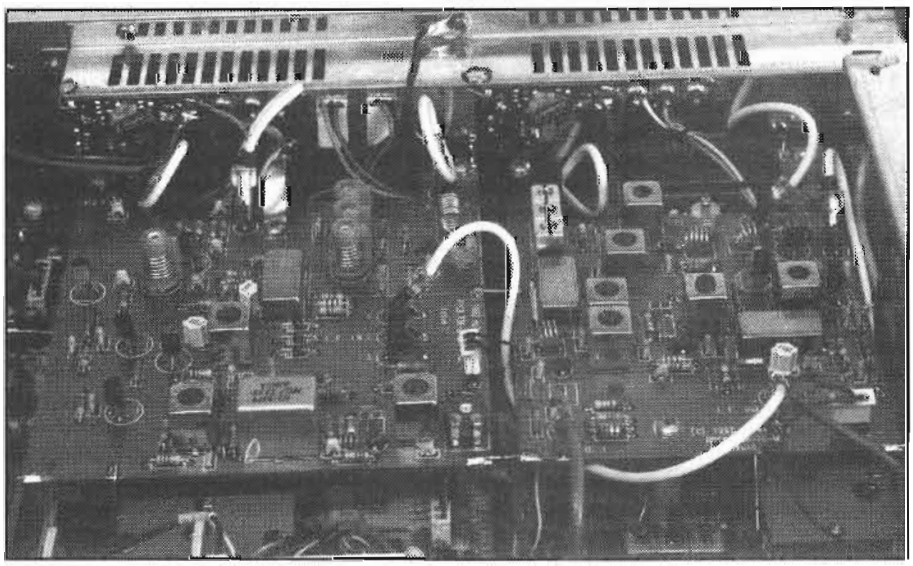
With four replacement boards to fit, do-it-yourself installation is not for the faint-hearted! Indeed, muTek advise the boards be professionally installed unless you're experienced in delicate soldering, although they add that no tuning is required after fitment.

On the Air

Fortunately, the sample on loan was ready-fitted with the replacement boards! So, on the air the sets went, one FT-736R above the other, connected to my VHF/UHF aerial systems (switched directional beam and vertical omnidirectional colinear on each band) via a pair of coax switches.

As I live in an area of rather high 'RF pollution', I was interested to see how muTek's upgrade improved matters. For example, whenever the RSGB news is read out on 144.525MHz, my two semi-local fire brigade transmitters just outside 2m, these radiating constant carriers separated by 100kHz, normally cause a complete 'wipeout' of the GB3SC repeater on 145.625MHz at my station due to intermodulation if I use an amateur receiver (my MX294 ex-PMR radio hardly suffers, incidentally). Unfortunately, I noticed no improvement here between the two sets on 2m FM, in fact the muTek modified set seemed a little worse in this respect, which I felt was a pity. There was some improvement on 70cm FM though, in this case the muTek modified set was a little better, for example in rejecting strong packet signals on 433.625 and 433.675MHz producing an unwanted signal on 433.575MHz. Tests on 70cm SSB though showed a significant improvement, with signals previously obliterated due to intermodulation coming though perfectly on the muTek-fitted version.

I spent some time testing the weak-signal performance, for example on Oscar 13 (a very good test of weak-signal 2m performance), as well as distant terrestrial 2m and 70cm stations and beacons. A handy aurora also manifested itself during the review period as well, which was quite handy! With my 'usual' masthead GAsFET preamps switched out, I found the muTek modified set to be fractionally *less* sensitive than the standard set on SSB on both bands. This was even more pronounced on FM, where weak but fully readable signals on a 'quiet'



The installed muTek 2m and 70cm receiver PCBs

band sometimes being unreadable on the modified set.

However, testing on SSB during crowded band conditions (well, at least with *one* strong station on the band plus one or two weaker ones 'thrown in' for good measure) and especially with my external preamps switched in, I very clearly noticed a signal handling improvement with the muTek- modified set on both 2m and 70cm. There certainly wasn't the apparent 'splatter' that I otherwise heard from an extremely strong local SSB station.

Conclusions

The muTek replacement Front End kit for the FT-736 does improve the set's close-in strong signal handling performance overall. On the sets I tested, however, the unmodified set was more sensitive than the separate modified one. MuTek tell me they have noted a considerable variation in sensitivity in sets before, and have suggested that a very sensitive FT-736 had been chosen for the comparison. Looking back to my review measurements of the FT-736 in the March 88 issue of HRT, this does seem to be the case, i.e., the 'standard' FT-736 tested here being rather more sensitive, on 2m at least, than the unit I'd tested a few years ago. Whichever way you look at it, in my opinion most serious weak-signal 2m/70cm operators would have a switchable masthead preamp fitted in any case, there's even a fitted 'Preamp' switch on the set for this very purpose. The muTek upgrade would then give you the very best of both worlds, no matter which end of the sensitivity scale your 'original' FT-736 may be!

My thanks go to South Midlands Communications Ltd. for the loan of the modified and unmodified transceivers for the review, and to muTek Ltd. for their comments following my technical measurements.

LABORATORY RESULTS:

All measurements taken at 144.500MHz and 432.500MHz, with the 24kHz bandwidth (i.e., wide) muTek filter option board used, unless stated.

Sensitivity

Input level in µV pd required to give 12dB SINAD;

	muTek		Standard	
	2m	70cm	2m	70cm
SSB	0.11µV	0.12µV	0.09µV	0.11µV
FM	0.20µV	0.22µV	0.13µV	0.13µV

SSB Selectivity

Measured as rejection of unmodulated single-signal carrier

	muTek		Standard	
	2m	70cm	2m	70cm
-3dB	1.9kHz	1.9kHz	2.0kHz	1.9kHz
-6dB	2.3kHz	2.3kHz	2.5kHz	2.3kHz
-20dB	2.9kHz	2.8kHz	2.9kHz	2.9kHz
-40dB	3.2kHz	3.1kHz	3.2kHz	3.2kHz
-60dB	4.4kHz	3.9kHz	4.4kHz	4.4kHz

Blocking;

Increase over 12dB SINAD level of interfering signal, constant carrier (SSB) or modulated with 400Hz at 1.5kHz deviation (FM) to cause 6dB degradation in 12dB SINAD on-channel signal at frequency offsets shown;

		muTek		Standard	
		2m	70cm	2m	70cm
SSB	10kHz	81.5dB	78.2dB	84.3dB	78.4dB
	20kHz	103.1dB	104.5dB	95.3dB	87.7dB
	100kHz	105.0dB	105.4dB	105.5dB	103.5dB
	1MHz	108.5dB	104.7dB	107.2dB	107.6dB
FM	100kHz	92.4dB	89.0dB	93.7dB	93.6dB
	1MHz	94.1dB	93.7dB	98.3dB	97.1dB
	10MHz	93.1dB	94.5dB	96.5dB	99.4dB

Intermodulation Rejection;

Increase over 12dB SINAD level of two interfering signals giving identical 12dB SINAD on-channel 3rd order intermodulation product;

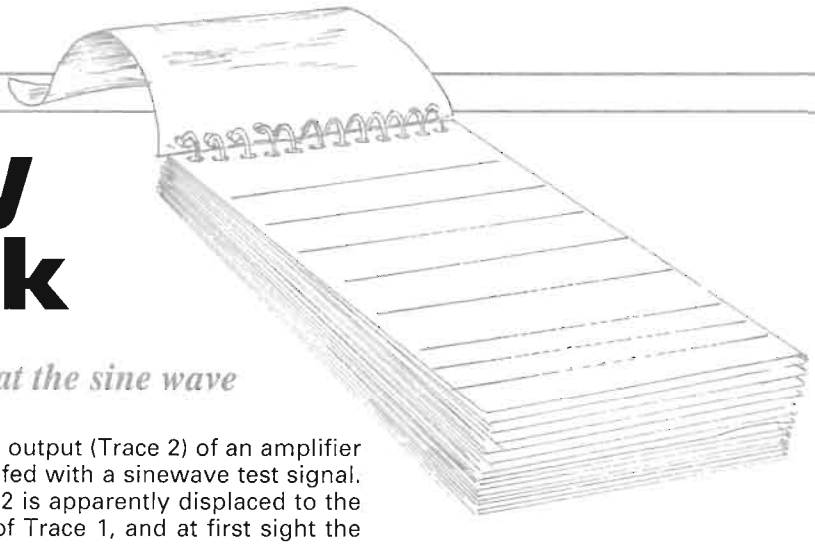
		muTek		Standard	
		2m	70cm	2m	70cm
SSB	10/20kHz	74.8dB	75.7dB	64.3dB	45.4dB
	25/50kHz	79.7dB	72.4dB	89.0dB	56.4dB
	50/100kHz	84.6dB	74.3dB	88.2dB	67.5dB
FM	25/50kHz	82.1dB	69.6dB	87.5dB	54.7dB
	50/100kHz	79.9dB	68.7dB	85.9dB	65.5dB

FM Adjacent Channel Selectivity

Measured as increase in level of interfering signal, modulated with 400Hz at 1.5kHz deviation, above 12dB SINAD ref. level to cause 6dB degradation in 12dB on-channel signal;

	muTek (Narrow option)		muTek (Wide option)		Standard	
	2m	70cm	2m	70cm	2m	70cm
FM(N);						
+12.5kHz	72.9dB	70.3dB	61.7dB	59.4dB	64.0dB	65.9dB
-12.5kHz	70.5dB	67.8dB	55.7dB	56.8dB	56.1dB	58.8dB
FM(W);						
+12.5kHz	43.4dB	44.3dB	0.4dB	0.5dB	2.3dB	4.1dB
-12.5KHz	38.9db	37.0dB	2.0dB	2.3dB	2.3dB	3.9dB
+25kHz	81.1dB	76.8dB	80.2dB	75.1dB	81.3dB	78.0dB
-25kHz	79.2dB	75.3dB	81.0dB	75.9dB	81.5dB	79.3dB

From My Notebook



Geoff Arnold G3GSR takes a look at the sine wave

Last month, talking about oscilloscopes, I mentioned a couple of ways in which an oscilloscope can be used to indicate the amount of phase shift occurring in a circuit.

You can go quite a long way in radio and electronics without ever having to come to a particularly deep understanding of the meaning and effect of phase shift in a circuit, or phase differences between two signals. There comes a time, however, when you will find it an advantage, or even essential, to get to grips with it all.

Incidentally, although phase-shift is often spoken of something thats definitely a bad thing, likely to cause instability or distortion, its sometimes a vital feature of a circuit. Oscillators, for example, wont function unless the feedback within or around them is applied in the correct phase – the feedback must be positive, or in-phase, to turn what is basically an amplifier into an oscillator.

Using Two Beams

In the conventional oscilloscope display, the spot is swept steadily across the cathode-ray tube screen from left to right, then returns rapidly to the left-hand side where it pauses before commencing the next sweep. Any voltage applied to the Y amplifier, and therefore to the Y plates of the tube during the sweep will deflect the spot up and down, and the waveform of that voltage will be traced out on the screen.

Because the spot sweeps from left to right, any feature of the waveform shown towards the right of the screen must have occurred after features to its left. This seems entirely logical and obvious. However, when using two beams for phase comparison measurements – monitoring at the input and output of an audio amplifier, for example – it is all too easy to become confused.

Let me explain with the aid of Fig. 1, which shows two racing cars heading along a track from left to right. Car 2 is ahead of Car 1, and is obviously in a winning position at this point. In phase terms, Car 2 is leading and Car 1 is lagging. In Fig. 2, we have two oscilloscope traces showing the input (Trace 1) and output (Trace 2) of an amplifier being fed with a sinewave test signal. Trace 2 is apparently displaced to the right of Trace 1, and at first sight the signal shown in Trace 2 might be thought to be leading in phase. In truth, though, exactly the opposite is happening.

Looking at the extreme left-hand end of the traces in Fig. 2, Trace 1 is crossing the zero-line and beginning to go positive but Trace 2 is still rising towards zero volts. The voltage being displayed on Trace 2 is behind – i.e., lagging – that on Trace 1. In other words, the amplifier under test is causing a delay to signals passing through it. Knowing the frequency of the sinewave being displayed, and measuring (or more correctly, estimating) the phase-difference between the two traces, we could calculate the actual delay. I shall come back to that later.

Vectors

The waveform, as traced out on the screen of an oscilloscope, is one way of depicting an alternating voltage (or any other alternating quantity for that matter). Another method is by the use of something called a vector diagram. The sinewave shows how the voltage is varying over a period of time, in the case of the traces of Fig. 2 over several complete cycles. A vector diagram, on the other hand, shows a snapshot of the voltage at just one instant.

A typical vector diagram is shown in Fig. 3. The voltage vector (the heavy arrow) starts from the 0 degrees mark at the right of the circle and rotates anti-clockwise. One complete revolution of the vector corresponds to one complete cycle of the sinewave. The choice of the zero-point and direction of rotation are simply mathematical conventions. I dont recall ever seeing an explanation of why they were chosen to be that way.

Alongside the vector diagram Ive also shown part of the corresponding sinewave diagram. You can actually draw an accurate sinewave using paper and pencil, with the aid of just a ruler and a protractor. In Fig. 3, the vector shows the state at 30 degrees into the cycle, at the moment when the voltage is one-third of its way towards the peak value.

Note that this is one-third of the way in time (or in terms of angle, since the vector rotates at a constant rate) but **not** in voltage. In a sinewave, the voltage rises very quickly at first, then gradually slows more and more until the moment when it reaches its peak value, whereupon it stops rising and begins to fall instead. If you visualise the vector arrow turning anti-clockwise, you will see that the **height** of the point of the arrow varies according to a similar pattern, increasing rapidly at first, then more slowly as it approaches the 90-degree point.

If you hark back to your school maths lessons, and the trigonometry, you may recall that the *sin* of an angle is defined as opposite divided by hypotenuse. In the vector diagram, the angle is the amount the vector has rotated from its starting point, and the opposite is the height of the point of the vector. The hypotenuse is the length of the vector arrow. With the aid of a set of trig tables, or the *sin* function on your calculator, you will find that at the instant shown in Fig. 3, where we are 30 degrees into the cycle, the voltage will have risen to *sin* 30 = 0.5 of its peak value. In other words, h is half the length of L.

So, our vector diagram tells us three things: what the peak (maximum) voltage of the sinewave is (the length of the vector L in Fig. 3); at what point in the cycle the snapshot was taken, and therefore whether the instantaneous value of the voltage is rising or falling (the size of the angle x); and what that instantaneous voltage is (the height h of the point of the arrow).

The vector diagram illustrates graphically why one complete cycle of a sinewave is said to occupy 360 degrees. It also explains the terms you will sometimes come across in descriptions of switched-mode power supply, and phase-controlled power regulators (lighting dimmers, for example) where the circuit is said to fire or conduct during certain quadrants. From 0 to 90 degrees is the first quadrant,

from 90 to 180 degrees the second quadrant, and so on.

Adding Vectors

When two sinewave signals are present in a circuit at the same time, and add together, the result often looks nothing at all like a sinewave. It is easy, though a little tedious, to draw the two waveforms on a single graph, to scale for both amplitude and phase, and then add them together graphically, point by point, to produce the combined waveform. Because each signal goes both positive and negative, this involves adding numbers of opposite sign (i.e., subtracting one from the other) over part of the cycle. It is educational to do this for, say, a fundamental and its third harmonic, and to see how the result begins to approach the form of a squarewave.

An alternative approach is to add the vectors, to produce a new one which is the vector sum (Fig. 4). A vector sum is exactly the same thing that you may have heard described as a parallelogram of forces during your school days, in either maths or physics. Vector addition will produce a new vector (V_R), proportional to the relative amplitudes and the phase difference of the individual vectors (V_1 and V_2).

So What?

All very interesting, you may be saying, but how is this relevant to the understanding of electrical and radio circuits at a practical level? The answer to that is: very relevant indeed. The idea of vector addition is helpful in understanding the properties of any circuit which incorporates a reactive element – whether it be C and R, L and R or L and C.

Beginning with a simple example, the first of these – the CR circuit – is encountered over and over again in audio and radio engineering as a means of coupling the output of one amplifying stage to the input of a second without upsetting the DC operating conditions of either of them.

When looking at the series CR circuit from a DC point of view, we use the familiar idea of a time-constant to describe its operation. At the moment of switching on the DC input, the capacitor is totally discharged. We are taught that a capacitor is an open circuit where DC is concerned, totally isolating one part of the circuit from another (leakage current apart). But at the moment of switch-on, the voltage applied to the capacitor changes almost instantaneously from zero to the full supply voltage. That DC open-circuit definition of a capacity holds good only when the applied voltage is steady.

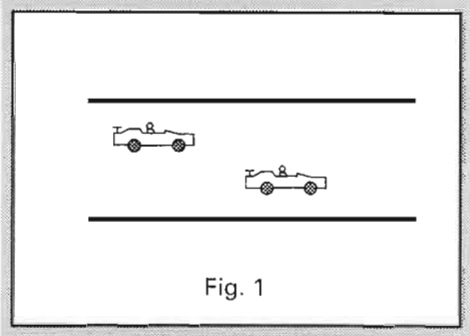


Fig. 1

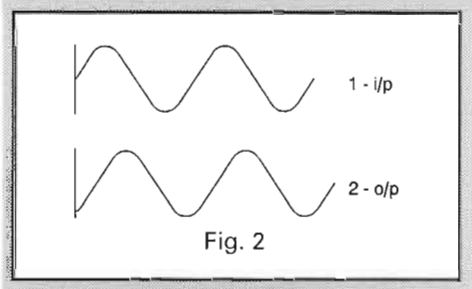


Fig. 2

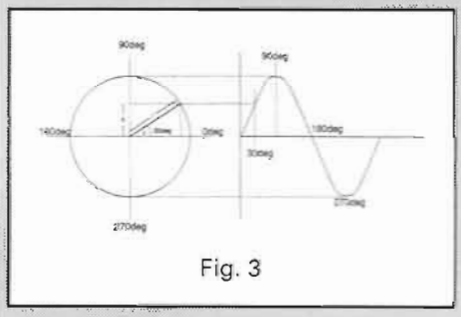


Fig. 3

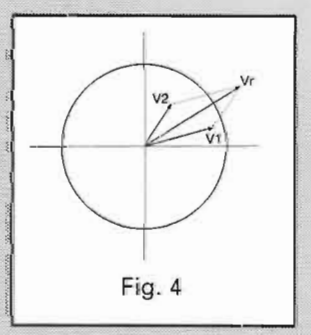


Fig. 4

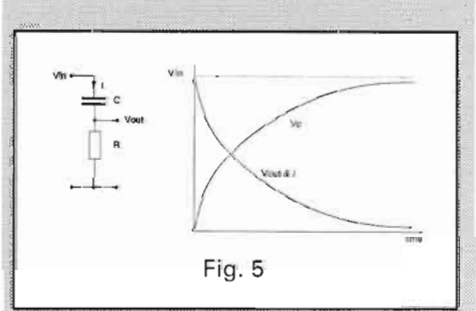


Fig. 5

At switch-on, the capacitor to all intents and purposes looks like a short-circuit, rather than an open-circuit, and a large current will flow to begin charging up the capacitor. That current will be limited initially by the series resistor, but will then fall as the capacitor charges and the reverse voltage across it due to that charge is effectively subtracted from the applied voltage. The voltage across the capacitor increases according to an exponential law, and the charging current falls according the same law. Although in theory the voltage on the capacitor will never quite reach the supply voltage, in practice it comes so close that the residual charging current can be considered to reach zero.

The output from the circuit (Fig. 5) is taken across the resistor, and when the current through that resistor has effectively fallen to zero (capacitor fully charged), the output voltage will be zero also. The output is DC-isolated from the input. Looked at another way, there is a voltage across the capacitor when fully charged which is equal and opposite in polarity to V_{in}. That voltage is subtracted from V_{in}, leaving zero voltage across the resistor.

So the effect of this circuit is that the voltage transition from zero to V_{in} at switch-on is passed to the output, after which the voltage V_{out} decays to zero again. The rate at which it decays depends on the values of the resistor and capacitor; when multiplied together these give the time-constant. The actual relationship is $t = CR$, where t is in seconds, C in farads and R in ohms. More usefully, you can take C in microfarads and R in megohms, since making one unit a million times smaller cancels out the effect of making the other a million times larger.

You may already have seen a problem in all this. As the capacitor never actually finishes charging, just where and when does point t come on the waveform. Under another of those mathematical conventions, tied to the value of e, the base of natural logarithms, t is defined to be the time which the voltage across the capacitor takes to reach 63.2% of its final figure.

Suggestions Please

I've had one or two ideas from readers on topics that I might tackle in future Notebooks, but I'd welcome some more, so what about it?

Your suggestions, please, to Geoff Arnold, 9 Wetherby Close, Broadstone, Dorset BH18 8JB. I look forward to hearing from you.

QRP Corner

Dick Pascoe G0BPS goes milliwatting with an 80m transistor transmitter for readers to build

I am often accused, unjustly I hope, of ignoring the VHF aspect of our hobby. QRP activity is not solely the precept of the HF man. One of the most popular VHF rigs of all time must be the FT290R (FT790R) series, almost every operator I know of has owned one at one time or another.

One difficulty of these rigs is that the early FT290Rs were considered quite 'deaf'. A change of aerial changeover relay helped, and a change of the front-end 3SK88 to a BF981 assisted. But a popular way to improve these radios was the addition of a muTek preamplifier. If you have one of these transceivers, and are unsure whether this is fitted, or if you are considering buying one of these, it is very easy to check.

Open the case by sliding the button over to gain access to the battery compartment. To one side, by the aerial input, will be seen a very small PCB with two switches on it. If fitted, the muTek board is slotted into the space next to this. If you have an open space, you don't have a muTek. It is almost impossible to miss the board, as it takes up almost all of the spare space.

Even without this 'extra', it is possible to work some DX without any supplementary power. 2.5W can be successful, especially at this time of year during late May and June when Sporadic E enlivens the band. For those who have never experienced this, it can best be described as *WOW!* I have been operating and working into the near continent from the south coast, and had a CQ call answered by Malta. Yes, with 3W to a 19 element aerial. The band remained open for about two minutes, and then closed.

Six metres can be even better. The openings last even longer, sometimes for hours! Wonderful fun can be had on what are normally flat bands when the E strikes.

What Constitutes Home Brew?

One subject that is creating heated discussion at this time is the perennial question "What constitutes home brew?". Some comments have been made that the whole of the 'end product' should be designed, and made, by the constructor, including the PCB. Some would be happy to purchase a PCB and find the remaining components. Some love building 'ugly style' where no PCB is used at all.

This would, of course, exclude kits such as the well- known Heathkits and many others. Most operators having built one of these would be proud to call it "home made". After all, in most cases it would have been made in the home! Would the use of Veroboard exclude the unit too?

I suggested that anything actually constructed in the home would qualify, note that word "constructed". This includes anything that the builder decides to make. After all, the house builder buys ready-made bricks.

If we exclude commercially-made kits such as Heathkit, should we not also require that, to qualify, the builder must design an original circuit? Or perhaps they should also design and build their own transistors to qualify?

As with many other arguments of this type, there is no cut and dried answer. We have agreed to disagree in our argument. Unless of course you have an answer? What would *you* define as home brew? Which, if any of the above is the right answer for you?

GX3CMH/P

Readers will be familiar with the annual gathering of the Yeovil Club's QRP Convention, and just to prove that they are not willing to sit back on their laurels they are getting involved in milliwatting.

I have heard of their celebration of the 40th anniversary of the first sky wave radio contact using a transistor transmitter. Many of the members of the Yeovil Club are dedicated QRP enthusiasts and enjoy that aspect of the hobby. Their Convention is a testament to this enthusiasm. Back in 1954 the first contact was made using a transistor based transmitter.

To celebrate this anniversary in 1994 the members of the Yeovil club decided to set up a station using a similar single transistor transmitter. Using this transmitter on 3.560MHz, they managed to contact 18 other stations with best DX being up into GI4LSH at a distance of over 260 miles. Not bad for a power output measured at just 12mW, Yes, that's just twelve milliwatts!

To encourage you to give this a try, I offer the following for your delight, can any reader better this 260 miles? It has the absolute minimum of components and originates in Hawaii. From Jeff NH6IL it looks very simple and should work with almost any PNP transistor to give a few milliwatts out. Try it and let me know how you get on, the components suggested are for the eighty metre band. Components include 80m crystal, L = 21 turns on a T50/2, C = 750pF.

For those who have not tried milliwatting, here's your chance. I would suggest in the first instance, to avoid being disheartened too much, that a 'schedule' be set up with a friend. Start the contact with higher power (say 1W) and then bring in the milliwatt rig.

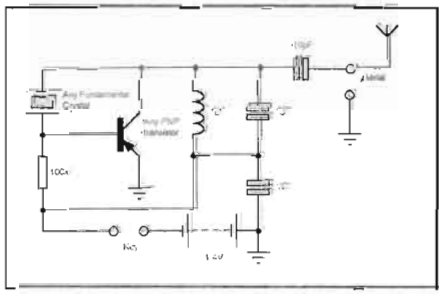
Calling CQ will almost certainly prove to be a dismal failure except in the rarest case. Tail-ending is a good way to get a contact too. Listen to a QSO, and at the end of their contact call the loudest station. Hopefully they will hear you and you will have your first milliwatt contact.

Like many other aspects of our hobby, it is not easy. A good aerial will help plus a good receiver. Above all, this is *fun*, and that's what it is all about. You never know, you may get hooked, like Randy AA2U who delights in breaking pile-ups to work DX with high power levels of over 500mW. He rarely uses more than one watt these days.

Components

One of the 'bugbears' of home construction is finding suitable components. Trying to find a air-spaced variable capacitor at a reasonable price has become almost impossible, they seem to have vanished from the face of the Earth. Those favourite circuits that we love to build will all have to be changed to include a different way of tuning. Yes, I know that lots of people use varicap diodes, but the associated problems with these are an enigma.

The issue of what to have in the junk box is also a problem. Gone are the days of builders stripping radios to find a source of components. Most parts are available, but what should the beginner buy to start the junk box? (a



contradiction in terms if ever there was!).

The obvious to 'start with' is one of those assorted bags of components that are often found at rallies. These will normally contain a selection of capacitors that can be used in most instances. Resistors may be more difficult to find but some bags are usually hidden somewhere. A small selection of ferrite beads are useful for RF chokes, and a few small reels of different coloured wire will be very useful. Make sure that the wire you buy is multi strand though, the single stranded breaks very easily.

The difficulty arises when looking at transistors. I would suggest a selection of simple pairs, PNP & NPN such as the BC182 & BC212 with switching transistors such as the ZTX751. Simple diodes such as the 1N4148 will prove beneficial as well as a few high powered ones. Buy something like the Maplin or Cirkit catalogues. They have a huge amount of information buried in them on various components, they sometimes also have a few example circuits to try.

Individual home brewers will each have their own favourites, but after looking at a few circuits the constructor will soon get a list of what to look for.

As mentioned, one of the most difficult to find are the air spaced variable capacitors, grab these if you see them making sure that they have the normal 6.3mm shafts, 50pF, 100pF and 350pF are useful values. These will normally cost in the region of about £1.50 each for used examples, their new cost is between £7 and £15 each.

WARC Band Frequencies

There is a little problem at the time of writing about the WARC QRP frequencies. 10.106MHz has been in use for some time, but many operators are finding problems with this.

The following have been suggested to the G-QRP club and I offer them for your comments. The ones suggested are 10.106MHz, 18.096MHz & 24.906MHz (for spot CW frequencies of course, as on 10MHz and 24MHz CW is the preferred mode). I have also been requested to offer 18.160MHz as the SSB centre of activity. What are your ideas on these?

I have also heard that a member has been finding difficulty with his Ten Tec Scout 555. The complaints include stiff tuning, consumption of 4.5A at the 5 watt level, and audio output being difficult. Value for money is not good was the comment.

At variance to this, another amateur who also has a Scout raves about it. I wonder if the bad one is the "Friday afternoon" rig, much as we used to get the Friday car that kept falling to bits? I must say that the Scout that I tested proved to be very good in most aspects. There were a few things I didn't like, but they were not a problem. My only immediate modification would be to put the drive control onto a pot on the rear panel. Fitting a trim tool through a hole in the base of the rig was not my idea of fun.

My final comment this month is about the last word in the previous paragraph. I have noticed so much being said about our hobby lately. Many amateurs seem to take everything so seriously that the smile seems to have vanished from the shack. I just love to have fun on the bands. This of course does not mean that my idea of fun hurts anyone, perhaps enjoyment would be a better word. It is after all a hobby and this is for our enjoyment. If we can show others that we do have both fun and enjoyment without all those serious faces we may get a few more to join us.

Well, that's it for now, news views to me via HRT Editorial, GB7RMS or to Seaview House, Crete Road East, Folkestone CT18 7EG. 72/73 de Dick.

Packet Radio -Roundup-

Chris Lorek G4HCL with details on the new 'G-TOR' mode for HF data communications

At this year's London Show, G4NQO gave a very interesting lecture, complete with overhead projector display of a 'live' PC packet screen and a video presentation of 'both ends', of the *LONNY* London to New York packet 'wormhole'. You'll have read about this in this column in the past, and the lecture hall was literally filled to capacity, with standing room only! It certainly proves the growing interest in this 'niche' of our hobby.

G-TOR

A fax from my friend Phil Anderson W0XI gave details on Kantronics' very interesting new data mode, G-TOR. Needless to say, several calls and faxes between the two of us followed! Phil tells us;

"On New Year's Day, W0XI and WK5M transmitted a 9,718 byte file from Kansas to WA4EGT in California on 20m in 5 minutes, 20 seconds. The mode was G-TOR. Immediately thereafter, the file was transmitted again, this time using Pactor. It took 20 minutes, 15 seconds. Throughout the month of January these tests were repeated with over one million bytes transferred error-free. The average character/second rate for G-TOR was 23.7 and for Pactor 8.64.

G-TOR, short for Golay-TOR, is an innovation of Kantronics Co., Inc. It's a new HF digital communications mode for the amateur service. The error correction coding outlined in MIL-STD-188-141A forms the basis for G-TOR. In order to keep costs low yet take advantage of concepts prescribed in the standards, G-TOR makes use of existing multimode TNC hardware but establishes a completely new hybrid-ARQ system in firmware.

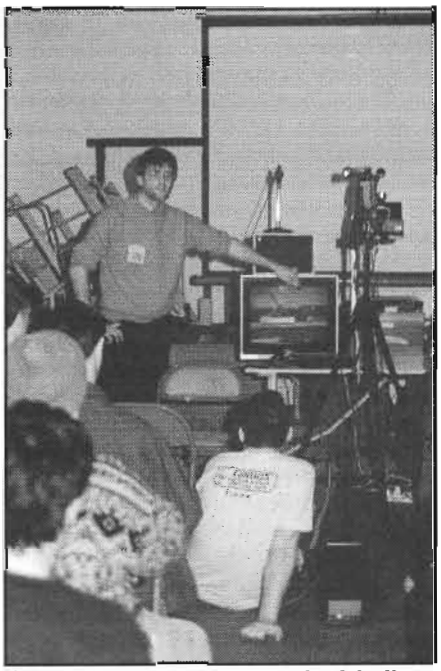
The benefits of these innovations are exceptional; dramatically increased throughput. Apparent reduction in the effects of interference and multipath. Low cost. The key features of G-TOR are typical; extended Golay forward error correction coding. Full frame data interleaving. On-demand Huffman data compression with run-length encoding. Link- quality based baud rate, 300, 200, or 100. 2.4 second hybird- ARQ cycle. Fuzzy acknowledgements. Reduced overhead within data frames. Standard FSK tone pairs (mark and space).

Background research

It occurred to us after porting Pactor into the KAM that this protocol did not go far enough. It did not incorporate any of the potential strengths prescribed by MIL-STD-188-141A. In addition, we knew that commercial and military systems use forward error correction (FEC) and data interleaving. So, we decided to evaluate the potential of using FEC coding with interleaving to decrease data file transfer throughput with existing multi-mode TNCs such as the KAM and KAM Plus.

We collected signatures of HF error patterns by sending Pactor idle characters through a DSP-based HF simulator. The simulator was programmed for various types of channels and conditions. In particular, we gathered error signatures using the good, moderate, poor, and flutter fading channels prescribed by the CCIR as recommended simulator test channels.

We then exclusive-ORed the error patterns with random data files on a PC and tested various coding schemes. Random data files were Golay encoded, interleaved, and mutilated by the error signature. The process was then reversed; each file was de-interleaved, decoded, and the data displayed. We were encouraged with the results, so we moved on to the remaining major design tasks: designing a robust hybrid-ARQ protocol and determining whether or not the TNC could handle the necessary computing task!



G4NQO lectures to a packed hall on LONNY, the London-New York Packet Wormhole.

A protocol evolved over time that met the challenge. We coded and ported it into the KAM Plus and conducted real-time tests using the HF simulator.

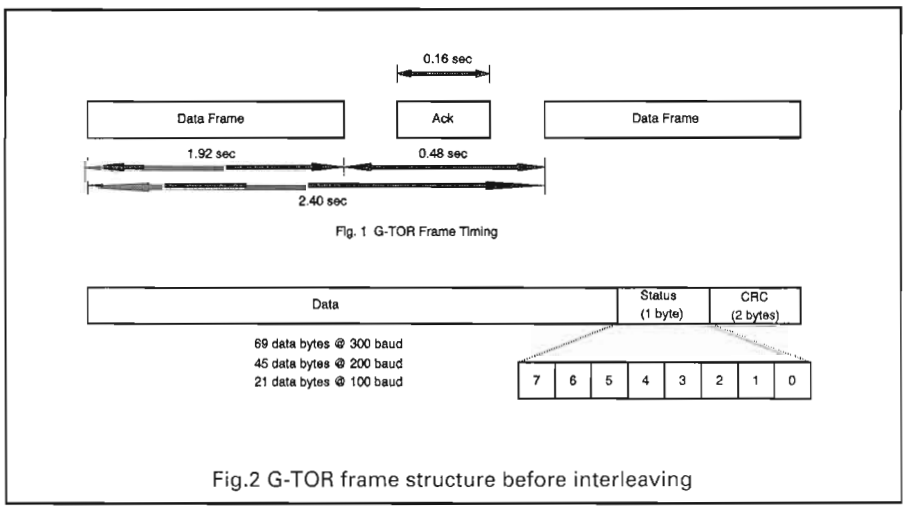


Fig. 1 G-TOR Frame Timing

Fig.2 G-TOR frame structure before interleaving

Minor adjustments were made and we began on-the-air tests. G-TOR performed even better than our simulator predicted. Through a combination of coding and interleaving, G-TOR 'hung in there' even when interference appeared and signals were weak but readable.

G-TOR frame structure and Hybrid-ARQ cycle

G-TOR operates as a synchronous hybrid-ARQ mode, see Figure 1. Regardless of transmission rate, the cycle duration is always 2.4 seconds, data frames are 1.92 seconds long, and the acknowledgements take 0.16 seconds. At 300 baud, each data frame contains 69 bytes of data, one control byte, and a two-byte CRC. Frame makeup is noted in Figure 2.

To establish a link, the master station transmits the callsign of the intended receiver and the information receiving station (IRS) synchronizes to it. Once in step, the IRS sends < link established > to its terminal and sends an acknowledgment to the master. Transmission of data can then begin. Sufficient time is left between data frame and acknowledgment transmissions for propagation between stations over an HF path. The IRS changes its acknowledgment frame into a full-length data frame to effect a change in direction in information flow. Once the other station acknowledges this action, changeover is complete. Link quality, denoted by a set number of consecutive good or bad frames, determines link speed.

The effective performance of stations, while communicating over adverse HF channels, relies on the combined use of forward error correction, interleaving, and redundancy. These tools for improvement are incorporated in G-TOR within the firmware of the KAM Plus (or KAM with Enhancement Board). We adopted an extended version of the (24, 12, 3) Golay code for G-TOR. The generator polynomial is;

$$g(x) = x^{11} + x^9 + x^7 + x^6 + x^5 + 1.$$

Procedures for data formation, transmission, reception, and data recovery are outlined below. Prior to transmission, 300 baud frames are divided into 48 12-bit words and matched with 48 error correction words of 12 bits each. The entire 72 byte data frame is then interleaved bit by bit, resulting in 12 bins of 48 bits, and transmitted. Upon reception by the IRS, the reverse process is carried out. The frame is synchronized, de-interleaved, decoded, and checked for proper CRC. If the frame is found to be in error, the IRS will request that the matching parity frame be sent. Upon receipt, the parity frame is used in combination with the data frame in an attempt to recover the original data bits. If unsuccessful, the ARQ cycle begins again. The dispersement of noise-burst errors via interleaving combined with the power of the Golay code to correct 3 bits in every 24 usually results in the recovery of error-free frames.

On the air testing

During the month of January over a million bytes were transferred error-free from Lawrence, Kansas to Laguna Niguel, California. During these tests, TRACE was set ON at each station, enabling the display of acknowledgment bytes and data frames including control bytes. This allowed us to view and count data and acknowledgment frames received with and without the aid of forward error correction and interleaving.

The results were somewhat surprising! While Pactor often dropped in transmission speed from 200 to 100 baud, G-TOR nearly always kept on crunching frames at 300 baud! Enough frames are corrected to keep the system running at 300 baud, regardless of manmade interference and mild multipath conditions. Transfer duration for the entire test file varied from 12 to 27 minutes for Pactor but only 5.5 to 7.5 minutes for all but one G-TOR transfer. G-TOR simply maintained its highest pace better than Pactor, resulting in a substantial increase in average throughput.

Operation of G-TOR is much like AMTOR. Establish a link by typing <GTOR callsign> and <return> at the cmd:prompt. Enter standby to copy CQs or to receive a link request by typing <GTOR> and <return>. Tune to a G-TOR CQ call as you would in AMTOR. G-TOR uses the AMTOR FEC mode for calling CQ and as its broadcast mode. Change the direction of information flow using the directives <control-CT> and <control-CE>.

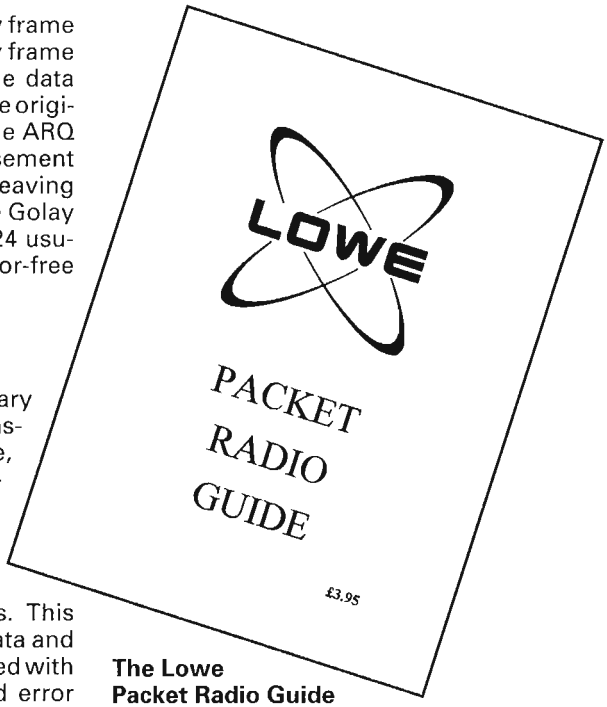
Conclusion

G-TOR features include Golay forward error correction coding, full-frame interleaving, on-the-fly Huffman data compression with run-length encoding, fuzzy acknowledgments, a long hybrid-ARQ cycle, and a link-quality based transmission rate. Combined, these techniques result in a very robust, interference-resistant mode for HF digital communications for the amateur radio service. Throughput exceeds other existing all-mode TNC modes by better than two-to-one.

G-TOR will be standard in the KAM Plus and the enhancement board for the KAM (predecessor of the KAM Plus). G-TOR will not be available for KAMs without the enhancement board since the EPROM space is too small, firmware EPROM updates will be available for the KAM Plus and KAM with enhancement board."

G-TOR is a trademark of Kantronics Co., Inc., 1202 E 23rd Street, Lawrence, KS 66046, USA, who hold the copyright, and Phil tells me that the mode is being made available under licence to other manufacturers.

A press release that followed some time later from the UK Kantronics Distributors, who are Lowe Electronics, indicates that, by the time this appears in print, new models of the KAM-Plus will have G-TOR fitted as standard, and upgrade EPROMs will be available for existing owners of the KAM-Plus and the KAM with fitted Enhancement board (these models being necessary for G-TOR to function). You can get further details from Lowe Electronics on 0629 580800.



The Lowe Packet Radio Guide

CTRL-Z, End Of Message

A new beginner's packet guide is now available, written by Steve Jelly G6URJ. Entitled the Lowe Packet Radio Guide, it's a 67 page A5 sized book, and is available through Lowe Electronic's outlets at £3.95.

That's all I have room for this month I'm afraid. Please do keep in touch with what your local group are up to, either by post via HRT Editorial, or packet to G4HCL @ GB7XJZ.

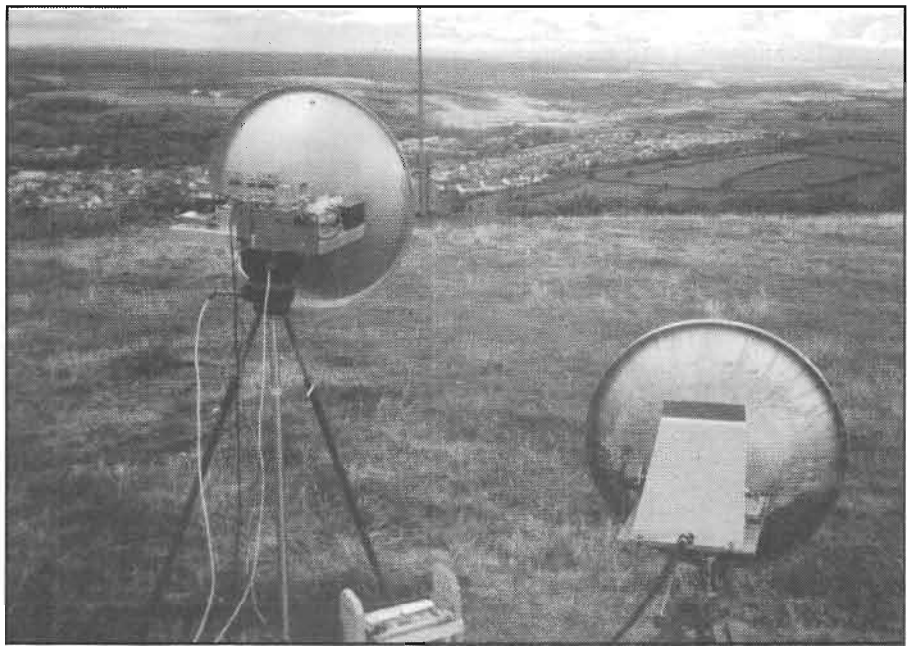
VHF/UHF Message

Geoff Brown GJ4ICD hopes for higher power for UK hams on 6m

February started off with lots of auroras. Neil G0JHC (Lancs) reported that he had worked over 100 stations via aurora on 50MHz during the weekend of the 5/6th, OZ's, LA's etc. but alas no new squares.

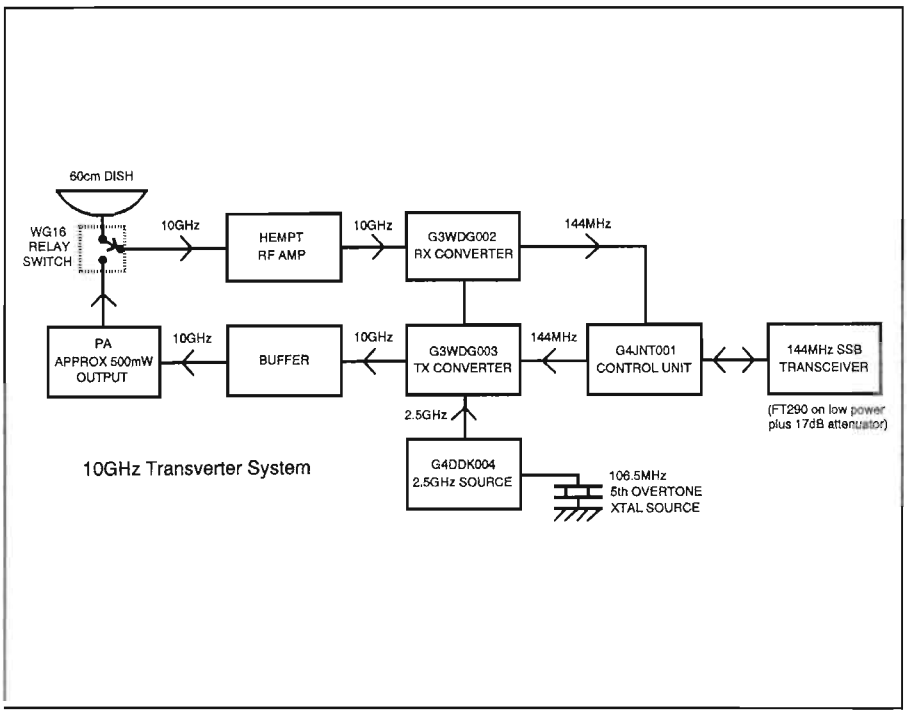
Depression after depression rolled in from the Atlantic bringing no sign of an anticyclone or good tropo, but we live in anticipation, or precipitation (whichever!). Which brings me to another goody. You may remember a few months ago that I spoke of weather satellites, well there is a very good program floating around at the moment called JVFAX v6. If you have a PC and are interested in the weather then try JVFAX, it's free and if you send me a formatted 1.4Mb disk plus an IRC (*not* UK stamp) and suitable return mailer, then I'll send you the latest copy.

It must be nearly five months since the last high pressure system sat slap bang on top of the UK for several days, just what *is* happening to our weather system? This time last year saw a few nice openings on the bands, but so far this year, nothing. So much so that having been bored myself I've even turned to doing DXCC on 80m for a laugh, and I must admit it does help with a GJ callsign, but I do miss VHF!



G6XM's microwave station on Dartmoor

10GHz block diagram



More on 10GHz

Back to our friend Bill G6XM, and the giggle-hertz bands this month. Bill reckons that you can purchase "The White Box" which is easily modified for 10GHz wideband use at most rallies, prices vary from £40 to £100. They only require a milliwatt at 144MHz to drive them, and produce about 100 milliwatts on 10GHz.

Bill has now disposed of the wide band 10GHz equipment and gone onto the "WDG" and DDK4 modules (info available from the RSGB Microwave Committee). Good results have been obtained on sideband, with DX being worked over 400km, mostly on CW. From Devon, Bill has contacted G3LQR in Norfolk, G3PHO/P in Yorkshire, G4FUF in Essex plus others in Shropshire, together with lots of stations around 100km distant. Shown here is a block diagram of 'The new state of the art 10GHz station'.

A nice idea for a QSL!

As I was running short of QSLs, I had decided to have a new batch printed. Last year, VHF Dxer Bob WA6BYA from California visited the RSGB VHF Convention and showed off his beautiful full colour QSL. The qsl was designed around the many

countries that Bob had worked on 50MHz with an overprint of '50MHz' on the front. So I placed all the DXCC cards on my living room floor and photographed them, Chris G4BUE (Adur Printers) then went to work and came up with my own DXCC 50MHz version. What about a two metre DXCC card? Anybody got 100 Countries on that band yet?

The VHF Convention

This year the RSGB's VHF Convention was a little earlier than usual, but at least it did not coincide with any of the VHF contests as in previous years, just a big HF contest instead!

Our journey up to Sandown Park on the Sunday was through a few small blizzards of snow, and judging by the number of people attending, VHF/UHF is still alive despite poor band conditions. Visitors from abroad were present which shows that the UK still has something to offer! For the first time ever vast numbers of the industry standard Bird 43 power meter were available, even P.E.P. types. Prices varied from £145 to £165, a little high I thought, elements for the meters were also available at around £25 which is half the new price.

I spoke to the VHF Chairman, Peter G3UBX, who advised me that the RA are now discussing the requested power increase on 50MHz. You may recall, that, initially last year Peter requested that I supply him with a good argument for an increase in power for 50MHz. This I did, and now an application for an increase in power to 400W is on the table! More news as soon as I get it. At the President's address it was all packet, packet, and more packet! The usual faces seemed to carry off the VHF trophies, including this year the Editorial team of 'Six News' (the journal of the UKSMG). Well done to those concerned. The only new VHF 'goody' spotted was the Kenwood TS60, a 50MHz version of the TS50, and it does look good. I'm told it only weighs 3kg and produces 90W out! More on that one in a later issue after I've had a play with one.

Jordan, latest news

Well, May (as you read this) is the month when it all happens. As I am writing the column in March I wonder what is going to happen out in the Middle East, things are certainly a little hostile from time to time. All being well, Neil G0JHC and I will be leaving on the 28th (Sat), and with one stop in Berlin we should arrive at around 1730 in Amman.

We should have the aerials up by Sunday lunchtime, and our first transmission will be on the VHF net on 14.345MHz and the call will be JY7SIX to say we are now QRV. From then on we will add the other aerials for HF and 144MHz. Yes, we *will* be active on 144MHz, but no skeds for EME or MS will be taken, we are just hoping for 'ES' on 144MHz into Europe.

Last month I mentioned that the UKSMG were having a collection to buy radio equipment for the Royal Jordanian Amateur Radio Society. This situation has now changed, as the RJARS have now ordered their own equipment and may well be on the air before we arrive. So the few coppers that have been collected will now be used towards the high cost of excess baggage (£11 per kilo!). We have the air tickets, the visas, and the hotel awaits our arrival, we will be monitoring 14.345MHz and 28.885MHz from time to time, so keep a look out and good DX to you all.

Finally, through the medium of this column the UKSMG would like to thank H.M. King Hussein JY1 for his generous permission to allow this first 6 metre DXpedition to go ahead. The group would also like to thank Colonel Ali Shukri JY3AK, and Mohammad Balbisi JY4MB for all their help with the licenses.

Beacon News

7Q7SIX (Malawi) on 50.003MHz is at long last operational. It has taken the guys in Malawi nearly a year to obtain the licence, thanks go to Mike G3JVL for another 50MHz beacon on the air.

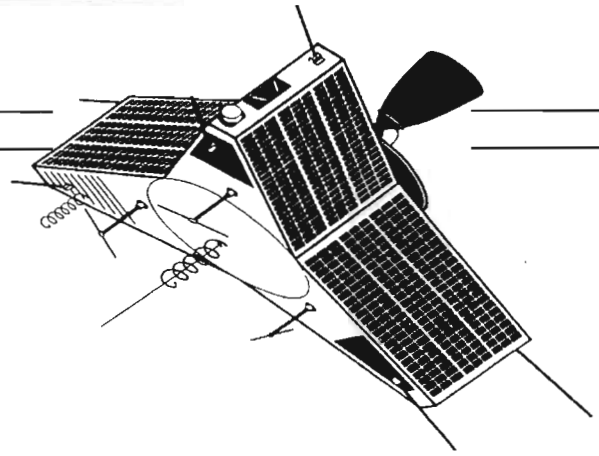
Mal Z23JO wrote regarding Z21SIX, but unfortunately I cannot decipher a word in his letter, and therefore do not understand his problem with the beacon. He states that "the callsign is OK but the ..... is up the spout". I presume he means the grid locator is wrong, and so we have sent the circuit down to Zimbabwe to help out. At least we know that Z21SIX is on the air, luckily the keyer is programmed via a diode matrix and not an EPROM otherwise Mal would have real problems trying to get his hands on an EPROM blower in the middle of Zimbabwe!

Over and Out

That's it for another month, I think we should all keep our fingers crossed for some VHF/UHF DX. Still, you might *just* get that JY contact and I may not! More news on the DXpedition next month when I return. News, views and photos please to Geoff Brown, GJ4ICD, TV Shop, Belmont Rd, St Helier, Jersey, Channel Islands or Phone/Fax 0534 77067.

DXCC type QSL card

Satellite Rendezvous



Richard Limebear G3RWL with this month's collation of AMSAT-UK news

The AMSAT-UK team were at the London Show on 12/13th March. Thanks go to all those who came along to the stand to say 'hello', and a bigger thanks to those who also managed to help by joining AMSAT-UK, and/or buying or donating something!

SAREX STS-60 a Success

The first Shuttle Amateur Radio Experiment (SAREX) flight of 1994 can be considered a resounding success. The STS-60, Space Shuttle Discovery, mission concluded on February 11th with a perfect touchdown at the Kennedy Space Centre. During the mission, nearly 4000 packet connections were made with the SAREX station on Discovery. Several voice contacts were also made, mainly late in the mission, with several schools, one of which was in Russia.

SAREX was officially activated on February 4th in a successful voice contact with the University of Surrey amateur radio station operated by G0SYX. Unfortunately the Shuttle crew were unsuccessful in their attempts to communicate with MIR using SAREX, but a contact was made using commercial satellites.

Those of you who heard or worked STS-60 and wish to receive a QSL card need to send your signal report and an SASE or an envelope and IRCs to: *STS-60 QSL, Education Activities Division, ARRL, 225 Main St, Newington, CT 06111.*

RS-15 Launch

According to reliable sources close to the project, as this is being prepared a launch date for RS-15 has still not been firmed up, and the official presentation to the Russian Space Agency was delayed until 20-Mar-94. The accompanying table gives some data pertaining to the transponder carried on RS-15 and its orbital characteristics.

RS-15 Data
Uplink: 145.857 -145.897 MHz
Downlink: 29.351 -29.397 MHz
Beacon 29.398 MHz.....P = 0.4/1.2 W
Beacon 29.353 MHz.....P = 0.4/1.2 W
Aerial.....1/4 wavelength
Height.....2,300 km
Inclination.....67 degrees

MicroSats

AO-16 has resumed its Experimenter's Day schedule on Wednesdays. The power output is reduced on the 70cm transmitter and the S-Band transmitter is turned on. The power output from the S-Band transmitter is not variable so power management is controlled by varying the output of the 70cm transmitter. Experimenter's Days managed by AMSAT-NA have been held on Wednesdays since the days of AMSAT-OSCARs 6 and 7 when Wednesday was 'battery recharge day.'

Recently the *DOVE* Command Team began using the text message frame to transmit the callsigns of everyone who has sent a DOVE reception report to PY2BJO. Because of the limited length of that frame, about 15 calls will be sent at a time and the message will be changed about every 3 or 4 days. This is the DOVE Command Team's way of thanking everyone who has sent in reports (several hundred at present). Special DOVE QSL cards will also be mailed to those who have reported. They are particularly interested in hearing about the equipment used and the quality of the signals and would also like to hear about the use of DOVE signals or data in education. Actual telemetry is not needed at this time.

Please send reports to: Dr. Junior Torres De Castro (PY2BJO), 119 Rua Macaubal, Sao Palo, Brazil 01256-150

Spot Launch

KO-25 opened its BBS service on 1st Feb. *KAIST* wish to thank everyone for their cooperation in keeping their transmitters off the KO-25 uplinks so that they could complete their experiments. KO-25 operates in normal mode, 9600 baud FSK using the usual set-up for any of the 9600 baud OSCARS, e.g., KO-23, UO-22.

After the **IO-26** software crash on the 7th December, ITAMSAT decided to delay the reloading of code in order to improve the on-board software and further analyze the Whole Orbit Data dumps so that they might better understand the satellite motion and operation. If any specific set of telemetry channels (up to 6) are needed by anyone for study purposes, please post a message to I2KBD on IO-26 to arrange a specific WOD survey. On the 6th January the final version of the code was validated and the BBS was reopened to all the users. The integrated housekeeping software now has WOD capabilities and weekly data dumps will be taken without affecting the BBS operations. You use IO-26 in the same way as AO-16/19; i.e., use PB/PG software at 1200 bps with a PSK modem; the BBS call sign is ITMSAT-11 for receiving broadcasts and ITMSAT-12 for uploads.

PoSAT has been up and running but seems to have gone away for a while. A note on the BBS seemed to imply that the 'amateur experiment' would end soon but no are details available. PoSAT has two uplink frequencies: 145.925 & 145.975 MHz. The downlink frequency was 435.275 MHz. PoSat also has a talkthrough capability and on 24th February this mode was turned on for a single pass as a demonstration to a technical exhibition in the Azores.

Oscar 10

It's still operational in Mode-B. Despite good signals from the transponder, there are very few stations using it. It's currently available when in view but *please do not* attempt to use it if you hear the beacon or the transponder signals FMing. The downlink signals are quite strong from AO-10 but there are complaints that no users are taking advantage of it.

The AMSAT-UK stand at this year's London Show

Dr. Jeff Ward G0/K8KA

Congratulations go to Jeff Ward, G0/K8KA, who recently earned his PhD. Jeff has been instrumental in the design of not only OSCAR satellite hardware, but also the ground station software that is used for PacSat communications.

AMSAT-UK News

The Secretary informs me that the Phase-3D fund has just passed the £20,000 mark (this doesn't count the £32,000 we have already sent to Amsat-DL).

Now a date for your diary:

The 1994 AMSAT Colloquium will be held on the 28th to the 31st of July, 1994. Further details are available from Amsat-UK.

For further information about Amsat-UK contact: AMSAT-UK, c/o Ron Broadbent,G3AAJ, 94 Herongate Rd, London, E12 5EQ. Big SAE gets membership info. SWL's are welcome. All new joiners get the USAT-P tracking program on 5.25in disk.

KEPLERS

SAT:	OSCAR 10	UoSat 2	AO-13	PACSAT
EPOC:	94051.71420822	94044.54899300	94048.56858325	94045.75388848
INCL:	27.2097	97.7907	57.8103	98.6038
RAAN:	340.7072	65.0254	267.6554	133.2765
ECCN:	0.6035253	0.0011279	0.7205099	0.0010934
ARGP:	156.2883	310.7761	335.0990	188.0238
MA:	250.5966	49.2455	2.8997	172.0765
MM:	2.05880368	14.69144313	2.09722235	14.29879034
DECY:	3.95E-06	3.63E-06	-2.077E-05	7.6E-07
REVN:	5241	53215	1200	21210

SAT:	DO-17	WO-18	LO-19	FO-20
EPOC:	94045.23034447	94045.76328214	94045.74960276	94046.42832899
INCL:	98.6058	98.6054	98.6048	99.0216
RAAN:	133.0443	133.5798	133.7927	221.3367
ECCN:	0.0010965	0.0011505	0.0011921	0.0539917
ARGP:	189.4352	188.3662	187.6862	255.4010
MA:	170.6623	171.7330	172.4137	98.6634
MM:	14.30017107	14.29993172	14.30087334	12.83223845
DECY:	7.1E-07	5.9E-07	6.4E-07	-1.4E-07
REVN:	15389	13555	7112	2022

SAT:	AO-21	UO-22	KO-23	KO-25
EPOC:	94053.96716387	94046.13690949	94046.40390865	94045.75293537
INCL:	82.9410	98.4466	66.0810	98.5674
RAAN:	227.2228	123.0432	174.9628	121.3071
ECCN:	0.0036055	0.0007219	0.0009874	0.0011406
ARGP:	43.1176	301.1937	317.5713	172.0390
MA:	317.3312	58.8542	42.4539	188.0975
MM:	13.74533568	14.36890610	12.86284764	14.28033386
DECY:	4.6E-07	1.13E-06	-3.7E-07	5.3E-07
REVN:	15389	13555	7112	2022

SAT:	IO-26	AO-27	PO-28	RS-10/11
EPOC:	94042.21058899	94046.21545311	94045.75585944	94055.06025169
INCL:	98.6649	98.6626	98.6608	82.9205
RAAN:	119.2441	123.1936	122.7699	52.4578
ECCN:	0.0008529	0.0008062	0.0009759	0.0011680
ARGP:	216.1988	202.2052	191.0097	343.2236
MA:	143.8612	157.8775	169.0872	16.9116
MM:	14.27708814	14.27607193	14.28003980	13.72331626
DECY:	5.3E-07	5.8E-07	87.2E-07	3.1E-07
REVN:	1971	2028	2022	33439

SAT:	RS-12/13	Mir
EPOC:	94044.66379265	94055.06448148
INCL:	82.9220	51.6191
RAAN:	103.0678	33.6824
ECCN:	0.0030946	0.0004797
ARGP:	91.8517	356.7110
MA:	268.6203	3.4543
MM:	13.74034946	15.60444091
DECY:	4.3E-07	1.7777E-04
REVN:	15168	45840