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MAY 1986 £1.20

HAM RADIO TODAY

Review Of 6m Transceivers — The Yaesu FT690 and Icom IC505

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FRV8800	VHF converter	75.00
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FT203R-FNB3	2 mtr H/H 2.5W	189.00
FT203R-FNB4	2 mtr H/H 3.5W	195.00
FT209RH-FBA5	2 mtr H/H C/W empty b/case	220.00
FT209RH-FNB3	2 mtre handheld 3.7W	239.00
FT209RH-FNB4	2 mtr handheld 5W	245.00
FT2700R	V-UHF 25W transceiver	459.00
FT270R	VHF 25W transceiver	295.00
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PA4C	AC power unit for FRG9600	12.00
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SB2	Switch unit for YH1	13.50
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AT150	Matching automatic ATU for IC735	
BC35E	Desk-top charger for all nicads	59.00
BP3	Standard Nicad pack	26.00
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EX243	Curtis keyer unit for IC735/745	53.00
EX257	FM unit for ICR71	35.50
EX310	Speech synth. unit for 271 etc	39.00
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HS10/HS	Headset and boom MIC assy + switch	37.50
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IC-AT10	100W auto ATU	299.00
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IC120	1W 1296 MHZ mobile (40MHZ cov)	499.00
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IC271H	High power 100W version of IC271E	875.00
IC27E	25W 2 mtr FM mobile 9 memories	359.00
IC27H	45W version of IC27E	389.00
IC290D	25W version of IC290E	469.00
IC290E	10W multimode 2 mtr mobile	439.00
IC2E	2 mtr H/H thumbwheel 2W	185.00
IC2KL	1KW PEP linear auto band switching	1150.00
IC3200E	Dual band 25W t'ceiver	475.00
IC471E	UHF m/mode b/stn 32 mem	799.00
IC471H	75W version of IC471E	975.00
IC4E	70cm thumbwheel H/H 2W	239.00
IC505	3/10W 50MHZ SSB(FM) transceiver	329.00
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IC745E	All band SSB/AM/CW gen cov TX-RX 16 mem	875.00
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ICR71	All band short wave r'celver 32 mem	699.00
LC11/14	Leatherette case assy for IC02/4E	6.50
LC1/2/3	Leatherette case for IC2/4/E	4.99
PS15	External power supply 20A	139.00
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PS25	Internal PUS for IC751E	95.00
PS35	IC751 int. switch mode PSU	169.00
PS55	Matching power supply unit for IC735	165.00
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M'raker	10-12A PSU	10-12A 13.8V power supply	62.50

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RWC TOP 100

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ADONIS	AM503G	Base stn FM/SSB comp. mic	52.50
AKD	WA1	120-450MHZ wavemeter c/w ant.	24.95
ALINCO	ALM-203E	2 mtr H/H transceiver 3.5W	239.00
ALINCO	ALR-206E	2 mtr 25W mobile t'ceiver	295.00
ALINCO	EDH-25	DC/DC 12V converter	13.50
ALINCO	EMS-20	Speaker MIC for ALM203	18.50
ALINCO	ESC-3	Leatherette case and strap	14.50
AOI-MIC	DM300	600 OHM replacement microphone	6.50
AOI-MIC	DM301N	600 OHM replacement noise can. MIC	7.50
ARM-ANT	10FM-HW	10FM-portable 'HOT-WIRE' ant	7.99
ARM-ANT	TRAV-JIM	Travelling Jim portable 2 mtr ANT	7.99
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CRITON	LS88B	8.OHM replacement ext. loudspeaker	6.60
DAIWA	SA450M	2 way 2.5KW coax switch 0-900MHZ	17.50
FDK	FDK 725X	2 mtr 25W FM mobile transceiver	269.00
FDK	FDK 750XX	2 mtr multimode transceiver	389.00
GAMMA	2MTR S-JIM	Gamma twin slim Jim type ant.	9.50
GAMMA	3-5A PSU	3-5 AMP power supply unit	19.50
Hi-mound	HK703	Straight key	29.25
Hi-mound	HK704	Straight key	19.95
Hi-mound	HK706	Straight key	16.65
Hi-mound	HK707	Straight key	15.50
Hi-mound	HK808	Deluxe stralght key	49.95
Hi-mound	MK703	Squeeze key c/w base	28.95
Hi-mound	MK705	Squeeze key	25.65
Hi-mound	MK706	Squeeze key	23.50
HI-Q	HI-Q coil	2X coil/formers/insulators (pat-pend)	7.50
HOXIN	70N2DX	Dual band 6/8 + 3X 5/8 mobile	23.75
HOXIN	70N2M	144/432 dual band 1/2W+2x 5/8 mobile	20.95
HOXIN	70N2V	Dual b/base ant. 3'6" long	36.80
HOXIN	HS-358	430MHZ tripple 5/8 6.3dB	30.95
HOXIN	HS-770	144/432 duplexer 50W 30dB Isolation	19.55
HOXIN	HS-78F	2 mtr 7/8 fold over 4.5dB	16.95
HOXIN	HS-88F	2 mtr 8/8 fold over 5.2dB	19.96
HOXIN	SMC15SE	15 mtr 130W PEP mobile ant. 1.72M long	16.85
HOXIN	SMC20SE	20 mtr 100W PEP mobile ant. 1.72M long	21.50
ICS	AMT-2	AMTOR/RTTY/CW/ASCII terminal unit	245.00
ICS	RM-1	L-cost AMTOR/RTTY/CW/ASCII modem	69.00
Jaybeam	8XY-2M	2 mtre 8E crossed ant.	41.50
Jaybeam	LR1-2M	2 mtr omni-directional colinear	39.00
Jaybeam	LW10-2M	2 mtr 10 element YAGI	27.25
Jaybeam	MBM48	70cm 48E antenna	40.75
Jaybeam	Q4-2M	2 mtr 4 element quad	33.95

MuTek	BBBA 500u	20-500MHZ low noise wide band preamp	34.90
MuTeK	SLNA 144s	2 mtr low noise RF switched preamp	39.95
MuTeK	SLNA 145sb	Optimised preamplifier for for FT290R	39.00
MuTeK	TVVF50c	High performance 2M-6M transverter	189.90
RAYCOM	7.1MHZ TRAP	7.1 MHZ traps. c/w instructions	8.95
RCA	6146B	PA valve	12.85
REVCO	2044/5	Nest of dipoles w/band ant 26-500 MHZ	69.00
REVCO	Revcone	Wide band discone ant 30-500MHZ	29.95
RWC-ANT	2M HB9CV	2 mtr 2E directional beam antenna	6.99
RWC-ANT	70CM HB9CV	70cm 2E directional beam antenna	5.99
SUN-ANT	KG208 SE10	10 mtr loaded 1/4W tilt-over	12.50
SUN-ANT	KG309 SE2	5/8 mtr tilt-over ant.	13.50
SUN-ANT	SO239/CGM	Cast/chrome SO239/gutter mount assy.	4.75

RAYCOM MOD KITS

Raycom	757 modkit	FT757GX fast tuning mod kit	29.50
Raycom	FBX-RWC MOD	LC7136-7 10 mtr FM mod kit kit c/w Ins.	22.50
Raycom	LCL/DNT MOD	LCL/DNT 10FM mod klt	12.95

RAYCOM ANTENNAS

Raycom	1/1 G5RV	Full size G5RV m/band ant.	14.95
Raycom	1/2 G5RV	1/2 size G5RV m/band ant.	13.95
Raycom	1/4 wave 25	145MHZ 1/4 wave PL259 fitting	2.99
Raycom	1/4wave3/	145MHZ 1/4 s/steel whip 3/8 fitting	2.99
Raycom	3/8-mag	3/8 thread mag mount c/w cable PL259	9.25
Raycom	5/8 whip	145MHZ 5/8 spring type s/steel whip	3.75
Raycom	S0239-MAG	Magnetic mount SO239 c/w cable PL259	9.50
Raycom	Swivel-mag	Swivel base mag-base c/w cable PL259	9.25
Raycom	Trap-dipole	7.1MHZ trap dipole com. kit	29.95

RAYCOM RF POWER AMPS

Raycom	V15F-145	2mtr 15W FM amp.1-3W i/pt	62.50
Raycom	V35L-145	2mtr 35W linear amp.1-3W input	59.50
Raycom	V45F-145	2mtr 45W FM amp. 1-3W input	62.50
Raycom	V15L-145	2mtr 15W linear amp. 1-3W input	49.50

SPECIAL OFFERS

ARM-ANT	Multi P-6	Multi-polarization P/ant 140-800MHZ complete	36.00
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Kopek	AR1002	50kg loading 3-core auto-rotator	38.50
Raycom	100W d-load	100W coaxial dummy load 0-500MHZ	12.50
SUN-ANT	KG 208 SE2	7/8 2 mtr ant. tilt-over	14.50
SUN-ANT	SGM/239	SO239 type gutter-mount c/w cable/259	9.50

SCANNING RECEIVERS

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FRG9600/MK2-RW	60-950 All mode scanning RX	449.00
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REGENCY MX7000	25-550 & 800-1300MHZ scanner AM/FM	389.00
REVCO RS2000E/RWC	AM/FM scanner 60-179 & 380-520MHZ	259.00

TONNA — Full Range In Stock

TONNA	20089N	144MHZ 9 element port. antenna 'N'	27.95
TONNA	20199	144/435 9+19 element Oscar ant.	36.50
TONNA	20419	432MHZ 19 element	36.50
TONNA	20422	435MHZ 21 element ATV	31.25
TONNA	20624	1296 23 element ant.	27.95
TONNA	20809N	144MHZ 9 ele. fixed ant. 'N'	25.65
TONNA	20813N	144MHZ 13 ele. port. ant.	39.50
TONNA	20817N	144MHZ 17 ele. fixed ant. 'N'	47.83
TONNA	20818N	144MHZ 9 ele. crossed antenna 'N'	41.50

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HAM RADIO TODAY

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REGULAR COLUMNS

CONSTRUCTION

FEATURES

REVIEWS

SEE AND HEAR ICOM AT THE N.E.C.

This year at the N.E.C. Exhibition Thanet Electronics will be introducing the complete range of ICOM Amateur Radio Equipment. You will be able to try out and purchase accessories, receivers and transceivers in all popular frequency bands. The range and scope of these will enable you to appreciate the superb specifications and quality of ICOM equipment.

Stand D4

IC-735, The Complete HF Radio

The new ICOM IC-735 is ideal for mobile portable or base station operation. It has a general coverage receiver from 0.1MHz to 30MHz and transmits on all amateur bands from 160m to 10m. SSB, CW, AM and FM modes are included as standard. RTTY and Amtor are also possible. The IC-735 has a built-in receiver attenuator, pre-amp, noise blanker and RIT to enhance receiver performance. A 105dB dynamic range with pass band tuning and a sharp I.F. notch filter for superior reception. The twin VFO's and 12 memories can store mode and frequency. The HM12 scanning mic is supplied. Scanning functions include programmes scan, memory scan and frequency scan.
The IC-735 is one of the first H.F. transceivers to use a liquid crystal display which is easily visible under difficult conditions. Controls that require rare adjustment are placed behind the front panel hatch cover but are immediately accessible. Computer remote control is possible via the RS-232 jack. Output power can be adjusted from 10 to 100 watts with 100% duty cycle. A new line of accessories are available, including the AT150 electronic automatic antenna tuner and the PS55 AC power supply. The IC-735 is also compatible with most of ICOM's existing line of HF accessories. See the IC-735 at your authorised ICOM dealer or contact Thanet Electronics Limited.

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IC-505, 50MHz Transceiver

The IC-505 is a 50MHz band SSB, CW transceiver, and has already gained an excellent reputation worldwide. The dual VFO system has been developed using advanced computer and PLL technology. The IC-505 features 6 channel memories and can be used independent of emission modes, memory scan, program scan which searches only specified frequency band. LCD ensures clear visibility even in sunlight. The R.F. amplifier, a dual gate MOSFET features high gain and low noise characteristics. The IC-505 accepts a standard dry cell pack, rechargeable nicad battery pack (BP10) or 13.8v external power supply, 3 watts R.F. output, 0.5 watts low power, 10 watts at 13.8v. Accessory circuits include split frequency operation, noise blanker, squelch and CW break-in. Options include:- PS45 AC Power Supply.
All these features make the IC-505 a great transceiver for operation on the 50MHz band.

IC-R71E, General coverage receiver.

The ICOM IC-R71E 100KHz to 30MHz general coverage receiver features keyboard frequency entry and infra-red remote controller (optional) with 32 programmable memory channels, SSB, AM, RTTY, CW and optional FM. Twin VFO's scanning, selectable AGC, noise blanker, pass band tuning and a deep notch filter. With a direct entry keyboard frequencies can be selected by pushing the digit keys in sequence of frequency. The frequency is altered without changing the main tuning control.
Options include FM, voice synthesizer, RC-11 infra-red controller, CK70 DC adaptor for 12 volt operation, mobile mounting bracket, CW filters and a high stability crystal filter.

The ICOM Control System

If you have a BBC Micro (Model B) or Commodore 64 or 128, the ICOM control system can control up to four (or more) ICOM radios in the range: IC-751, 735, R71, R7000, 271, 471 and 1271 (and 745 with modification). The help menu shows the available functions. The system will be displayed at N.E.C. BCNU.

Stand D4

	H = HELP
F0	Frequency
F1	Select Mode
F2	Freq/Memory Scan
F3	Mode Scan
F4	VFO → Memory
F5	Memory Write
F6	Memory Clear
F7	Set 'SIG' Level
F8	Memory File Read
F9	Memory File Write

↔	Frequency Steps
↑ V	Up/Down (arrows)
M	Memory Channel
, .	Memory Up/Down
/	VFO/Memory
B	Bargraph Select
@	Occupancy On/Off
:	Scan Stop Off/On
S	Change Set
DEL	Speech (If fitted)
Q	Quit

LETTERS

A WELL ROASTED CHESTNUT?

Sir, What a pleasure it was to have been able to participate in the recent Auroral opening on 144MHz, 7/8th Feb. It was probably the most intense and most widespread event I remember since the event of November 1982. Sixteen countries were worked including OE, OK & SP with over 50 squares.

What a pity it was to have yet another good opening marred by what now appears to be an almost customary display of ill mannered operating by some newly licensed (and some not so newly licensed) G, GM and GW stations who persistently responded to specifically directional CQ DX calls. As the event intensified, I continually found myself fighting an impenetrable wall of mainland stations coming back to my "CQ DX Europe/ Scandanavia" calls on CW. I eventually had to move to the SSB segment of the band where I was able to begin to work some real DX after making very much more pointed directional calls, but even on SSB the situation was only a marginal improvement.

What on earth is the point gentlemen, during a really good event such as this, in trying persistently to establish a contact all over the top of what may be some exceptionally choice DX, in order to return an unwanted S9 signal report to what is essentially a "local" station within the context of that event? Why not save your report for a weaker phase or weaker event when it may actually be helpful or welcome? I find myself wondering (as usual) just how far I really could have worked on CW when, as in this instance, my SSB signals were S9 into SP and S7 into OK.

Our continental friends have a lesson for us here. It has been my experience that on the odd occasion that mainland stations can be persuaded not call, most continental stations are reasonably well behaved and will shut up (not to make too fine a point) until called by square or country, thus making the best of the event.

I realise that this problem is an old chestnut well roasted in the fires of time by now. Even in my limited time chasing DX on 144MHz I can see a steady decline in both operating standards and manners, particularly during openings. If we don't reverse this trend soon, it won't be worthwhile switching on the rig to come on the band. I also realise that GI is a new country for some mainland stations but we are always up here if you would only turn your beams. It is surprising how often east and south-east coast squares can be worked from Belfast with just a little enhancement in the band and just a little perseverence — of the proper kind. If you really need to work GI then GI4OMK and GI6ATZ are QRV most weekends for any tropo skeds, both are QRO & QTHR (SAE please). Failing that try GI4VIP/P May & September 144MHz contests when we will be delighted to make the contact (giving the WAB if you require) and I can guarantee a QSL card.

Meanwhile gentlemen, I look forward to a hard won tropo contact with you on a flat or slightly enhanced band, but when the next really good opening occurs with some real DX around, forgive me when I don't and won't take up your response to my CQ DX calls, giving you a very "cold shoulder".

Philip Murphy, GI4OMK,
Belfast

PS when we are fortunate enough to have a good opening I do try to remember to make the occasional call for QRP stations or those still needing GI but my enthusiasm to make such calls is usually inversely proportional to the QRM level.

CB OR NOT CB?

Sir, I was concerned to read a letter from an anonymous contributor (March '86 letters), who seems to be having some problems converting his/her Ham International CB to the 10m band.

The three crystal frequencies given by the contributor, will put the Concorde II into the following bands: 21.500MHz giving 28.36 to 28.80 MHz; 21.725MHz giving 28.81 to 29.25MHz; 21.950MHz giving 29.26 to 29.70MHz; These were specifically chosen in the original article, to give the rig the "top" end of ten going down over.

As regards the other article, (by Roger Alban), this operated on a somewhat different process of conversion and hence would naturally have different values for the crystal(s). I would recommend that the latter method is used rather than the process I suggested, as it is cheaper. However this method detailed by Roger Alban was not known to me in 1984.

The contributor mentions that the rig he/she has would "run at higher frequencies", I would be interested to hear what these are. I would additionally be interested to know whether the rig was fully tested prior to taking a soldering iron to it, eg were the Rx and Tx frequencies checked on a signal-generator/digital frequency meter. If the rig was not tested then it could be any number of things causing the problems but if the rig was known to be serviceable then that would at least give a basis to go onwards from.

If the contributor would care to write to me at the address shown I would be willing to provide what assistance I can by post.

Finally I'm not sure where the error came from but the callsign issued for my station is G4YNM (known as "YES,NO,MAYBE" in some quarters) and not G4UNM as given in the letter.

Basil Spencer, G4YNM,
125 Whitley Wood Lane,
Whitley Wood,
Reading.
RG2 8PW

HERTZ'S EXPERIMENTS

Sir, I read with interest the article in HRT February 1986 called 'The Marconi Story — The Early Years' by Louis Varney, G5RV.

With regard to the oscillators used by Hertz and others, at this time, the rods with end plates form a resonant circuit. The plates formed a tuning capacitor which could be moved together or apart to raise or lower the frequency of the 'electromagentic waves'.

Only when the transmitting equipment was adjusted to the resonant frequency of the nearby receiving loop could sparking be observed at the receiver spark gap.

The physical dimensions of the end plates and rods determine the operating frequency which produced wavelengths from 1.5cm to 13 metres.

Regrettably, Hertz had at that time no sensitive detector to receive the signal over a distance other than a few metres. I am sure that if he could have used a modern VHF receiver considerable receive ranges may have been achieved, though of course the note would not have been *T9*.

Hertz also used metal reflectors behind his transmitters and receiver loops and investigated horizontal and vertical polarisation of 'radio waves'. It seems almost impossible to believe that microwaves were being generated nearly 100 years ago and in closing may I thank G5RV for a most interesting topic.,

Pat Painting, G3OUC.

References: Electromagnetic Wave Telegraphy and Telephony (Flemming) and Magnetism and Electricity for Students H E Hadley (1919).

'ERE JOHN, WANT A WESSIE!

Sir, I recently read the interesting article by Chris Lorek, G4HCL, on converting Pye Westminsters which I found bright and enthusiastic (March, April '86 HRT). However, may I mention a few points for those wishing to carry out these conversions.

1. The availability of W15 FMB/D 25kHz multi channel sets is extremely limited and are about as rare as "rocking horse droppings".
2. A successful conversion without any component changes is unlikely as most of the FM sets are used in the 170MHz Tx and 168MHz Rx range. More 'L' or 'C' is required to resonate the inductors correctly on 145MHz.
3. Chris states that a modified set was measured at 0.35uV for 12dB sinad which was "possibly deaf". What is a good sensitivity for a Westminster then? Most that are in use will be no better than 0.5uV if you are lucky! In most cases 1uV is normal, far worse if converted or tuned without component changes.
4. In my opinion, the best option open for the prospective Westminster conversion is the use of LW15's. These are the ten channel System 3 radiophones and there are plenty around as System 3 is now finished. There is an abundance of these sets on the market at cheap prices, and they are more suitable as they are designed to operate on the 163-4MHz band (Tx is lower). All one has to do is remove the logic boards and rewire the standard Wessie boards and hey presto, you have a ten channel 2m radio for about £20-30.
5. Thanks for the interesting article Chris, but can you tell me where to buy W15FMD/B Westminsters at £15? I would like to buy some!

I hope that many new licensees will have a go at converting PMR sets as this is a wonderful way to learn about radio and a lot more enjoyment will be had operating a set that has been modified/tuned by its owner at a much cheaper price. With the imminent price increases of imported goods now is the time to have a go.

Ray Withers, G4KZH.

PS Re the FT290 DC socket. Thanks to G40HK for pointing out the difficulties some FT290 owners have experienced with the DC socket and the advice given (March '86 Letters). The DC socket is available for £1 post paid from me at 584 Hagley Road West, Oldbury, Warley B68 0BS. It is worthwhile replacing it as with continued use, the socket wears and the plug will start to feel loose.

Chris Lorek, G4HCL, replies:
I have seen plenty of W15FM sets at rallies throughout the country, a dealer near to me also has just taken delivery of 160 A band W15FMs for sale on the surplus market and often buys ex-professional radio equipment by the container load. They must get onto the market somewhere!

Secondly, sets operating on 170/160 MHz are A band sets and hence by reading the information provided in the article, you will see their tuning range is 148-174MHz. Due to the built in overlap by the manufacturer, you should have no problems in getting the sets to perform on 145MHz with no component changes.

I stated "typical sensitivity is 0.35uV for 12dB SINAD, possibly a little deaf by today's standards". The manufacturer specifies the receiver as 0.5uV maximum for 20dB quieting, hence I stand by my statement. If 1uV is normal, the set is clearly faulty. The average Japanese tin talking box nowadays is more sensitive than this, hence my comment of "possibly a little deaf by today's standards."

In large built up areas there have recently been LW15FMs disposed of I agree, but certainly a far larger quantity of W15FMs have been produced and will become available over the years. Being a standard FM Westminster with extra digital bits inside, it is no more suitable for conversion apart from the multi channel capability. The fact that it is aligned at a lower frequency has no significance. However, if readers can persuade the editor there is a demand, I would be willing to publish the mods in respect of linking out the logic boards.

If you came to the Cambridge Junk Sale Extravaganza, you could have bought some for £5. At other rallies I have also seen W15FMs go for similar prices and even sets such as Pye Olympics, a more modern rig, go for 50p at the Peterborough rally from Collins Communications. By the way, at Cambridge, Storno 55 chan synthesised ex radiophone sets went for £20 as well as Pye PF2UHs, W15Us, and PF1s by the crateful. Amateurs from as far away as Aberdeen left happy. In other words, seek and ye shall find!

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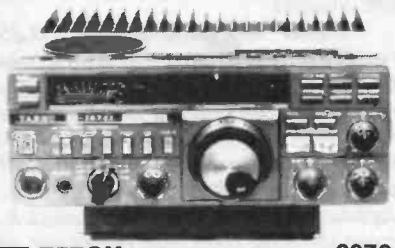

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KENPRO Iambic Electronic Keyer KP100	79.00
KENPRO Iambic Memory Keyer	169.00

Auto CW/RTTY

Tono 9100E	P.O.A.
Tono 9000E Reader/Sender	P.O.A.
Tono 550 Reader	P.O.A.
Tono 5000E	P.O.A.

VAT included. Add £1 carriage per item.

SWR/POWER METERS

WELZ SP200 1Kw	89.00
WELZ SP300 1Kw	129.00
WELZ SP400 150w	89.00
WELZ SP15M 200w	49.00
WELZ SP250 2Kw	65.00
TOYO TM1X 3.5 150MHz 120w	18.80
TOYO T430 145/430MHz thru line watt meter 120w	44.65
TOYO T435 145/435MHz thru line 200w	49.35

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RADIO TODAY

Fantastic Fun on Fone!

The long established and much enjoyed Verulam Club contest took place on 16th and 24th November. This time it had an extra sparkle — the prospect of prizes for the winners of the two sections and the bonus of a lucky dip prize for anyone entering a log.

The 160m section always attracts a large number of participants, mainly because throughout the year there are very few top band phone contests. This year, the winning station G2BBC, the Ariel Radio Group from Birmingham, clocked up 154 contacts. This being due to the operating skills of the G2BBC team G4FPH, G4YXM, G4JGV and G3NKC and in no small way to the full wave inverted vee dipole at 150'! The BBC team are regular participants and also regular winners of this section. The pleasing turnout on the night left us eagerly awaiting at least 50 logs, but as is normally the case this was not to be. Only 31 were actually forthcoming, but it was a slightly better than usual percentage return.

The timing of the 2m section, contrary to most people's belief, was deliberate, coming as it does one week before the RSGB 2m fixed contest. It provides an ideal opportunity for the keen types to get on the air to try out those new antenna systems and also test the propagation. The winning station G4MVR, Vaughan Reynolds, did extremely well to work 134 contacts under conditions that could only be described as 'flat'.

It was good to see the Wythall RC, Edgware DRS, Hesketh RC and Hull DARS entering logs in both sections. The Wythall RC must get a special mention, as they went portable in the 2m section with four operators and in the top band five manned the station, two of whom were class B licensees. Congratulations Wythall for entering 100% in the spirit of the contest. Hull DARS activated their two callsigns and involved eight of their members. The Jersey ARS deserve mention as well for sheer perseverance, as they were unfortunately not in too enviable a position under the conditions prevailing on the day. A lone mobile on the Isle of Arran, GM4XJF/M, stuck out the whole four hours during the 2m leg and even submitted his log.

Vaughan Reynolds receives his prize for winning the 2m section from Frank Claytonsmith.

The complete G2BBC team - can they be beaten next year?

It was pleasing to see that even though some participants had not worked vast numbers of stations, they still nevertheless saw fit to put in an entry. Without logs, after all, we would have no contest and for the Bromsgrove DARC it paid off as they were the winning entry in the lucky dip. The winners of the SWL sections of the contest were Mark Wardall who covered the 160m band and Norman Hembrey on 2m.

On 12th December, five Verulam members got down to the business of deciphering the entries and emerged at midnight with the following observations:

1. The standard of logkeeping was reasonable.
2. The number of people claiming sundry callsigns as being club stations as opposed to ordinary club members was quite high.
3. A number of people wrongly claimed an extra bonus of five points if the first station worked was a club station. This will be clarified in next year's rules.
4. Some people didn't realise that each complete contact was worth three points and bonus points were extra.
5. Club stations were only accepted as such if the call was registered as a valid club.
6. Contest exchanges will have to include the word 'member' next year for ordinary club members to distinguish them from club stations.

Finally, it remains for us at HRT to thank the Verulam ARC for organising such an enjoyable contest and providing the facilities for the presentation of the prizes. We are, of course, indebted to Amcomm Services for supplying the Heil equipment as prizes. And lastly, thank *you* for participating in the contest and sending in your logs. Hope to see you next time round.

Mark Wardall receiving his prize for winning the SWL section from Steve Ireland.

24 Hour Clock With Built in Radio

At last a portable rig is now on the market enabling you to give a time check to your friends or see when your next sched is due. The new 5 watt 2m handheld from Kenpro, called the KT220EE, has a built in LCD clock together with an on board CTCSS tone encoder system to allow you to page only your friends at the allotted time.

Programmable channel steps of 5kHz to 100kHz will allow the most discerning amateur to hop in and out of the allocated 25kHz channel steps and find the most hidden FM QSOs on 2m. Basic coverage on 144-148MHz is expandable for export models and its ten memories with four scanning modes seems very good value at £209. A JFET front end provides superb sensitivity with good blocking performance, built in electret microphone and DC jack socket are also standard features. The unit, similar to its 70cm counterpart has a DTMF access keypad. So for those 24 hour preprogrammable CTCSS encoded contacts on any 5kHz channel this is the watch (opps, sorry!) radio for you.

The winner of the SMC Polarphaser competition run in the February 1986 is Mr N Underwood of Salisbury. The correct answers were C F H J O Q.

Clacton Course

An RAE course will be starting on Thursday 10th April at the Clacton Adult Education and Youth Centre, Green Lodge, 180 Old Road, Clacton on Sea, Essex. The course is being run by Mr J. Harris, G3LWM, and will start at 7 pm. A morse class can also be arranged if there are enough people. For further details contact the Centre Principal on 0255 424151 or Mr Harris on 0255 432621 during office hours.

Leisurely Crawley Move

The following was printed in the Crawley ARC Feb '86 newsletter.

"...CARC approached the Crawley Leisure Centre with an offer we hoped they could not refuse, a communications room for use as emergency (Raynet) etc. The council were not impressed, local politics decree that we will not have any emergencies. However, for real folding money, the club could rent a room on a regular basis. We investigated the premises and were pleased with what we saw, it was ladies keep fit..."

The club will meet at the new venue from April and will probably meet in the bar/cafe area from 7.30 pm.

Interested In NOAA?

We have recently heard of a group that goes by the comprehensive title of the UK National Remote Sensing Centre (NRSC) Tiro-N Data Users Working Group. The aim of the group with the incredible name is to provide better links between UK users and NOAA in Washington and also improve the methods of providing info to users. To this end, they have appointed Peter Stein to represent the amateur interest.

Peter has been active in the amateur weather satellite field for some 15 years using a wide variety of equipment. He would welcome info from amateurs who have working stations so that an integrated picture of the amateur user can be obtained. He can be contacted at his home address: 32 Lusitania Road, Walton, Liverpool L4 6SX.

The group are trying to increase collaboration between the various 'data source groups' and data users in particular improving the archives and access systems. The UK user requirements and suggestions will be forwarded to NOAA for consideration and hopefully help the Columbus programme. The group has already helped in the setting up of the UK Weather-watch program.

Receive Software With All The Frills?

Technical Software have revised their RX 4 Multimode Receive program which can receive morse, RTTY, AMTOR and SSTV with only one key press to change modes. Furthermore, the software needs no hardware for Spectrum users (it connects direct to the ear socket) and a 'simple' interface for BBC B, CBM64 and Vic 20 users.

The morse receive part of the program includes a range of software filters as well as a wideband decoder capable of reading speeds of over 250 wpm (if you can find anyone who sends that fast!). It also has an autotracking facility to hold on to those fading signals.

RTTY and AMTOR are received with selectable unshift on space and normal/reverse polarity, and gives a visual display of frequency scales. RTTY has four baud rates and decodes any shift automatically. Apparently, AMTOR is capable of reading many commercial stations' TOR transmissions as well.

The SSTV sub program can display 8, 16 or 32 second frames and "good pictures are obtained even in the presence of some noise"! (How much QRM will it take? was a passing thought.) Picture storage can be overwritten and the grey scale of the picture adjusted.

The program costs £25 on tape, £27 on BBC B or CBM64 format disc. The interface, if required, is £5 as a kit or £20 ready built with all connections. Technical Software are based at Fron, Upper Llandwrog, Caernarfon, Gwynedd (phone 0286 881886).

Another improved version of an RTTY program for the 48k Spectrum has been announced by Binary Star Technology. The new software includes split screen (with full screen receive option), buffered keyboard and programmable message stores. It can even control automatically the PTT line on the rig.

The hardware comes complete and plugs onto the Spectrum edge connector and requires no external power supply. It is available as a kit for £14.95 with everything bar the connectors supplied or £19.95 built and tested. The software costs £7.95 on cassette or £9.95 on microdrive cartridge. Contact Binary Star Technology at 6 Waveney Terrace, Haverhill, Suffolk CB9 8DZ.

Did You Know

The Home Office has decided to allow licences for low power stations for special events — no not the amateur variety — more the carnival variety. They intend licensing 25 of these stations a year at present with the same conditions applying to content and advertising.

Lowe Life

Lowe Electronics have been rather busy recently supplying details of four new products which appeared on the editor's desk. *(How he ever found them amongst the used tea bags, I'll never know — GICKF).*

The first is the Trio TS440S HF transceiver which features 250W input power on all modes except AM (when it is 110W) and runs from 13.8V. All modes of operation are supplied as standard, with squelch on all of them. There are 100 memories, frequency search, direct entry of frequency via the keypad and a speech processor. This is all for £950 inc VAT, with a mains PSU costing £192.60. An optional computer interface will cost you an extra £125.

Next on the agenda is the TM2550E FM mobile rig. This is interesting for one reason in particular, in that it can be fitted with DCL (digital channel link), Trio's version of DCS (digital coded squelch). This enables the transceiver (when communicating with another DCL rig) to automatically change frequency from a crowded channel to an unused one — both rigs will QSY together. Other features of the TM2550E are its 45W output, 23 memory channels, memory and frequency scan facilities, and automatic selection of simplex or repeater shift according to band plan. The rig itself costs £399 inc VAT, and the DCL add-on is £26.78.

Another is the TR751E two metre multimode, which has two VFOs, ten memory channels, 25W output, 50Hz stepping on SSB and an analogue S/RF meter! Just in case you think an analogue meter immediately makes this rig low-tech, let us add that it can also do DCL, with a suitable add-on, and likewise voice synthesis. Prices of the rig and add-ons not known as we go to press.

Finally, there is the Japan Radio Company NRD525 general coverage receiver. This is a double superhet design with basic frequency range from 9.0 to 34MHz, but with optional internal converters it can cover 34 to 60, 114 to 174 and 423 to 465MHz. It can receiver upper or lower SSB, CW, AM, FM or RTTY (in the last mode, you can fit an optional demodulator/printer driver). It has direct entry of frequency via keyboard, 200 memories, two (two??) time clocks, remote switching of tape recorder (now that's why...) and many more bells and whistles, oops, we mean features. Prices not known at the time of going to press. Lowe Electronics Ltd, Chesterfield Road, Matlock, Derbyshire DE4 5LE, tel 0629 2817.

50MHz in Eire

With all the excitement that 50MHz has generated in Britain, it is good to know that amateurs in Eire may also have the opportunity of operating on this band. A recent Irish RTS newsletter reprinted a letter from the Dept. of Communications in Dublin announcing that a limited number of licensees will be allowed to operate temporarily on 50MHz as long as they are conducting "genuine, distinct experiments".

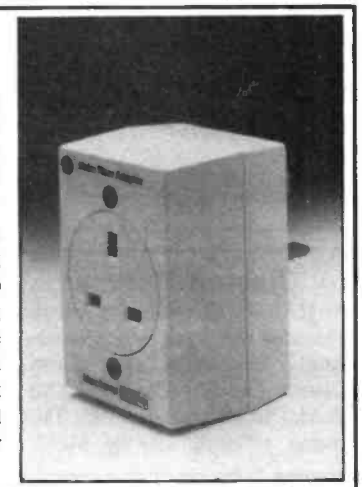
Applications will be considered from class A licensees and operation is restricted to the band 50.0 to 51.75 MHz with other limits on power, antennas etc. The experimenters (approximately 20, they imagine) must avoid causing interference with the Maghera transmitter and cable TV networks.

For further details, contact the IRTS, PO Box 462, Dublin 9 or the Department of Communications, Scotch House, Hawkins Street, Dublin 2.

New Welsh Society

A new club has recently been formed in the SW of Wales. Called the Pembrokeshire Radio Society, the group will cover all the normal activities of a club plus forming mini expeditions to some of the more remote areas in the region. The first of these mini expeditions will be early in the summer to one of the isolated islands off the Pembrokeshire coast for a weekend and be active on HF and VHF. Further details on the trips to come but if you want to get involved with the club, contact the Secretary, Paul Delaney, on 0348 840249.

The Plug With An Integral Filter



Have you ever spent hours trying to put together a simple mains filter in an attempt to stop mains borne interference getting in and out of your hifi or TV? Now Duraplug appear to have come up with a compact answer. The new plug in adaptor claims to be able to 'launder' electrical signals to plug in appliances. It comes in a white moulded flame retardent case and will cope with 3 amp or a 750 watt load. Priced at £17.90 it could be the answer to a lot of our prayers . . .

Uppington Tele-Radio

We would like to apologise to Uppington for printing an incorrect telephone number in the February and March issues. The correct number is 0272 557732.

Top Band Match For ATUs

A 160m kit is being marketed by Amateur Electronics/Holdings of Blackburn that will enable your KW Eeze ATU or other Z match ATUs to tune your antenna to top band. The kit includes switch, coil and full instructions for assembly and is, apparently, very simple to install. Furthermore, the manufacturers claim that it will match with good efficiency, impedances from 10 to 200 ohms and so should resonate 160m dipoles or wires from 50 to 200 feet long.

The price of the kit is £6.75 p) and is available from G3LLL at 45 Johnston Street, Blackburn, Lancs BB2 1EF (phone 0254 59595).

Rally Roundup

Lough Erne ARC are holding their fifth mobile rally on 13th April in the Killyherlin Hotel near Enniskillen. The rally will be opened by "a well known personality" and there will be all the usual stands plus more for the non amateur including a boat trip on the Lough. The doors open at 1pm and there is a talk in on S22 and SU8.

The first weekend in May certainly seems a busy time especially if your two main interests are Raynet and ATV. On Saturday 3rd May, there is a Raynet Symposium on the theme of Co-ordination and Communication. It is open to all amateurs and will cover general co-ordination for Raynet groups, going on to details with experts from the coastguard and mountain rescue.

The meeting is being held in the Avalanch Bar in the Strathspey Hotel, Aviemore Centre and will begin at 10am finishing after 4pm. Further details are available from GM3RFA on Fort William (0397) 3833, the Raynet Zone Representative for Scotland.

The following Sunday sees the regular BATC Television rally at the usual venue of the Crick Post Hotel just off junction 18 of the M1. This year the organisers have added a marquee to the usual rooms to provide more space for traders and demonstrations. For the more discerning members of the family, there is a fun castle, a licensed bar and a full lecture programme. There is of course ample parking and admission is free. The doors open at 10.30 am and all are welcome.

Special Events

A group of Cornish radio amateurs are organising a mini DXpedition with hoped for sponsorship using special event callsigns GB4IOS and GB8IOS. Thanks to the Duchy of Cornwall and the Nature Conservancy Council, they will be camping on the uninhabited island of Great Ganilly which dominates the easter isles of the Scilly group.

Clubs, businesses and individuals are being asked to donate money and prizes for a national raffle to provide funds for the RNLI. One of the first prizes to be offered was a free weekend with the only operating resident amateur on the islands. However, the group are aiming for a world-wide 'DX' expedition since the island is 110 feet ASL at its highest point.

The stations will be working as many bands as possible depending on what extra equipment is loaned/donated. They will certainly be on HF on 3.5, 7 and 14MHz plus 2m and 70cm, although their power may be limited by what they can carry in the small boat that must get them there.

If you would like to make a donation, buy a raffle ticket to the grand draw or arrange a sched, contact G4ZUI at Gwynsom Farm, Underlane, Carnkie, Wendron, Helston in Cornwall TR1 30EH.

Another special event this time tied in with an award is being organised by Wisbech DAREC. In celebration of St George, they will be operating GB0SGD, GB4SGD and GB6SGD most days between 20th April and 17th May.

The award is available to anyone who can supply verified info of contacts during this period. For the HF award, you will need to contact GB4SGD or GB0SGD plus eight English stations if you have a G prefix. Amateurs in Europe need only five English contacts and the rest of the world, three. On VHF, a contact with any of the three stations will suffice plus the above contacts with other English stations. These contacts must be simplex, not through repeaters.

Applications are of course welcome from SWLs on the same basis. The award costs £1.50 for all G applicants, six IRCs for Europe and eight IRCs or US$3 elsewhere. It is available from the award manager, G4KHF, 'Leon', Lutton Gowts, Long Sutton, Spalding, Lincs PE12 9LQ.

Hamnet Hull Phone Change

From 1st April, the Hamnet Hull amateur radio bulletin board phone number changes to 0482 46510. The baud rate is still 300, 8 bit word, no parity. The system hours are Mon-Fri 17.30-08.45 hours and 12.30-13.45 with weekends 17.30 Fri to 08.45 Mon. Public holidays have 24 hour operation.

The board is dedicated to radio amateurs although it is open to all users providing information associated with the hobby. There is a special callsign user log which to date has over 100 registered radio amateurs.

Silent Key

Bill Sparks, G8FBX, died on January 6th after a long illness. He was a keen SWL in his youth and was first licensed as G3DGJ. Having allowed it to lapse because of business commitments, he later became licensed as G8FBX. He will be remembered by a large number of fairly recent licensees whom he successfully tutored in the South Lancs and North Cheshire area. He also wrote for HRT and was a member of the RSGB and Raynet. He will be sadly missed by all those who were fortunate to know him.

Listening On...

Listening to international broadcasts on the SW and MW bands has had something of a revival recently with the arrival of a variety of general coverage receivers. This new bi-monthly column aims to explore everything to do with listening and offer the listener who thinks they've heard it all before, something more and very different.

Welcome to the first of a series of bi-monthly articles on what is happening on the "professional bands" — the international broadcast bands on short and medium wave. In these articles I hope to bring you news of new stations and programmes on the air which should be of interest to both programme listeners and DXers. Much of the information comes from my own listening, but it would be unfair not to admit that a lot of useful news about broadcast stations comes from some stations' "DX programmes". These vary from the extremely informative to the downright inaccurate and misleading, so you shouldn't always believe what you hear. Arguably the best four DX programmes in the world are these:

"Media Network" broadcast by Radio Netherlands in all their English programmes on Thursdays. This programme is presented by Jonathon Marks, an Englishman, and is probably the most up-to-date source of information about what is happening on the international broadcast radio scene. It is best heard in Britain in the 1130 and 1430 broadcasts, both on 5955kHz. (More about Radio Netherlands later).

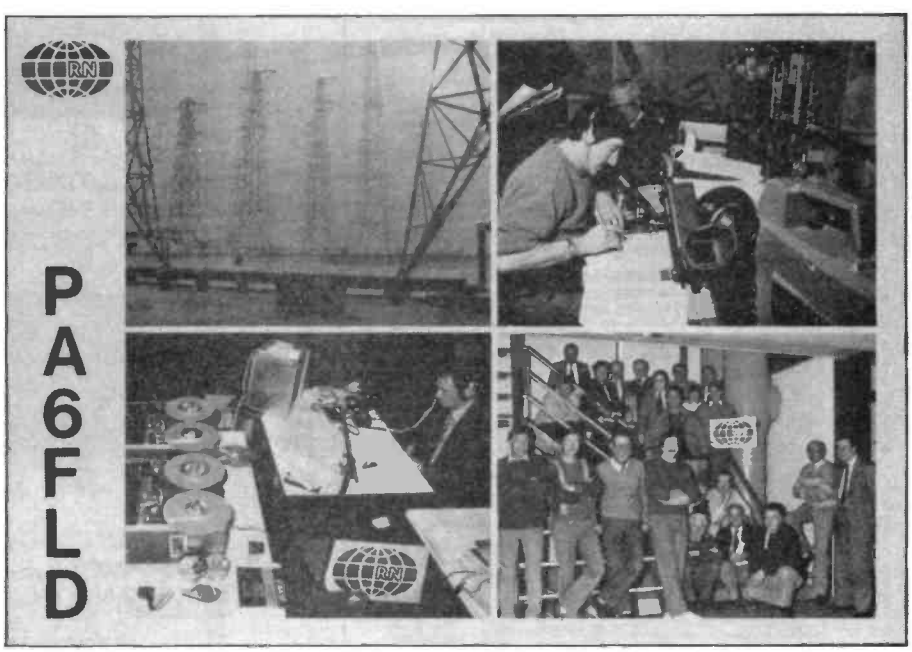
"Sweden Calling DXers", hosted by American George Wood, who holds an SM amateur radio licence, broadcast by Radio Sweden International on Wednesdays at 1100 on 9630kHz and at 1600, 2100 and 2300 all on 6065 and 1179kHz. This programme is a compilation of "DX tips" sent in by listeners and so is only as good as the contributors. In the past it has inclined to be rather inaccurate, though these days George Wood seems to weed out most of the more dubious loggings.

"The Two Bobs", although it sounds like a comedy programme, is an informative show on Swiss Radio International every Saturday at 0630, 1200 and 1700 on 12030, 9535, 6165 and 3985kHz. This programme caters more for beginners to the hobby, but usually has something of interest for anyone who likes playing around with radios.

Finally, Radio Australia offers "Talkback" at 0910 on Sundays on 9655kHz. This programme is perhaps the best for up-to-date news of broadcasting developments in the Pacific area, especially Australia itself, New Zealand and Papua New Guinea.

Dutch External Broadcasting

If you were active on 3.5, 7 or 14MHz SSB during the weekend of 16th-17th February last year, you may have heard or worked a station with an unusual callsign: PA6FLD from the Netherlands. The station was probably extremely strong, and the thought that they were running excessively high power probably ran through your mind. They weren't, they were using ordinary standard 100 watt amateur transceivers, but it was the antennas that were somewhat extraordinary. PA6FLD was, in fact, operating from Radio Netherlands' new transmitting site on the Flevo polder (FLD=Flevoland) and using vast sixteen element curtain array antennas, with gains of around 20dBd.



QSL card from amateur station PA6FLD, which broadcast from Radio Netherlands' new Flevoland transmitting site last year. The pictures show some of the 16 antenna towers, the PA6FLD operation, a live English broadcast over Radio Netherlands from the transmitting site, and the PA6FLD crew.

Radio Netherlands' modern studio complex, located in Holland's "radio city", Hilversum, near Amsterdam.

This amateur radio dream station was used on completion of the new transmitting site. It had been professionally tested and went on to daily operation, broadcasting Radio Netherlands' programmes in Dutch, English and other languages to a world-wide audience.

External radio broadcasting began at an early age in the Netherlands: entertainment programmes were broadcast on shortwave as early as 1927 under the callsign PCJ. Shortly after, a transmitter site at Huizen was inaugurated and in the 1950's a new station was built at Lopik, in the centre of the Netherlands. By the late '70s, though, it became obvious that a better site was needed if the Netherlands was to remain in the forefront of external broadcasting, despite relay stations constructed in the Netherlands Antilles off the coast of South America, and on the island of Madagascar.

The obvious place in the Netherlands, if not in most other countries, was to use reclaimed land, the so-called polders. Flevoland, in the former Zuyder Zee (now the IJsselmeer) was drained between 1950 and 1968. A futuristic town, Lelystad, was constructed with all possible amenities, hotels, conference facilities etc, and the newly formed land used mainly for agriculture. With huge areas of flat land available, it was also a suitable site for a shortwave transmitting station — perhaps the only suitable site in what is one of Europe's most densely populated countries. Flevoland is about four metres below sea level. The water table therefore is high and consequently the ground is soft. New techniques were developed to anchor the antenna towers safely which was a major consideration since the totally flat Flevoland is often exposed to strong gale force winds in the winter.

The antenna towers at the Flevo site, some of which are almost 400 feet high, are arranged in a star-shaped formation, giving coverage from 50° to 290° with electrical slewing of the curtain arrays by ± 30°. The difficult polar path to the west coast of North America is left to the Radio Netherlands relay station on Bonaire in the Netherlands Antilles.

The antennas are connected to new 500kW transmitters, capable of operating in any of the international shortwave bands, and which use Dynamic Amplitude Modulation (DAM). This is a power saving technique whereby the level of the carrier is adjusted, electronically, in step with the level of modulation. In other words, the peak carrier power of 500kW is only radiated during peaks of modulation; during quiet pieces of music, for example, the carrier power is reduced. With the high level of compression used by shortwave stations, I would not have thought this would have produced very much of a saving, as the level of modulation (and therefore the carrier with DAM) is kept artificially high by the compression. However, Radio Netherlands claims that savings of up to 25% can be achieved on energy costs by using DAM. This, along with other energy-saving techniques used at the Flevo site should raise their electricity bills by only 2.5 times, they claim, compared with the old Lopik site, despite the fact that the power output has increased five times.

The best time to listen to the new Flevo site is at 1130-1225 GMT, when Radio Netherlands broadcasts its first programme in English for Europe. Reception is excellent on 5955kHz. The programme is repeated, with some regional variations at 1430-1525, also on 5955kHz, and again at 1830-1925 on 6020kHz. Radio Netherlands has always had a problem putting a good signal into Britain during the evenings — the peak listening time — because the Netherlands are really too close to most parts of Britain for the 6MHz frequency used. Since moving to the new Flevo site and increased transmitter power considerably (they used to use an old 10 kilowatt transmitter for the 1830 broadcast) the situation has improved somewhat, but not as much as I think Radio Netherlands would have liked. During the winter especially, reception was still very poor, with many other broadcasters also crowding into the already over-populated 6MHz band. Reception was often better on higher frequencies intended for Africa and coming from the Madagascar relay station.

I have often wondered why Radio Netherlands does not use the 75m band (3.9MHz) for evening broadcasts to Europe, in common with other broadcasters such as Deutsche Welle in West Germany, Swiss Radio International and the BBC. Presumably the new transmitters, or antennas, do not cover this band: an oversight in my opinion, since it is far less crowded than the 6 or 7MHz bands as well as being propagationally

The first broadcasts from the Netherlands were as long ago as 1919: this is the original transmitter which used the callsign PCGG and which is now on show in the Posts Museum in the Hague.

more suitable in many cases. The old argument that few listeners had receivers covering this frequency range is no longer true. Most SW listeners who listen to the broadcast bands now have general coverage receivers covering 500kHz to 30MHz instead of the old "bandspread" sets covering just the 49, 41, 31, 25 and 19 metre bands.

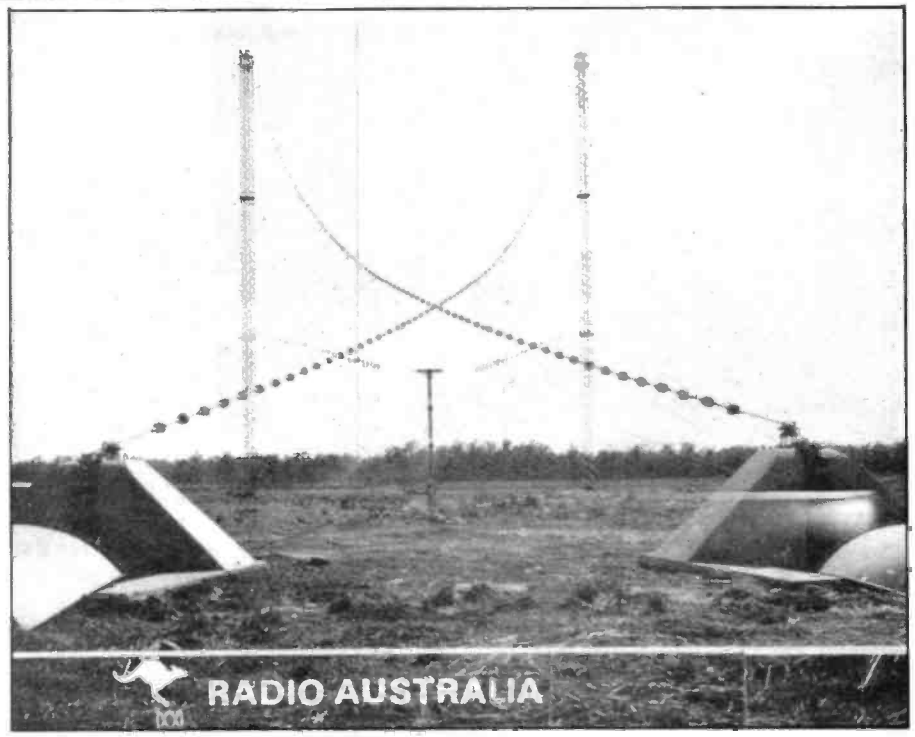
Several years ago, there was a plan known as the "Delta Project". This involved the Netherlands and Belgium co-operating in a station to broadcast programmes of joint Dutch and Flemish culture to Europe, using a high power long wave transmitter in the Netherlands and a high power medium wave transmitter in Belgium. As I understood it, the idea was that when not broadcasting "Delta Project" programmes the two transmitters could be used for the normal external programmes of Radio Netherlands and the Belgian Radio and Television, thus overcoming Radio Netherlands' old problem of putting a strong signal into Europe during the evening hours.

What happened to this grand plan, I do not know: Belgium certainly built a transmitter which is now on 1512kHz and used for home service programmes in Dutch/Flemish during the day and Dutch, English and Spanish in the evenings. It is extremely strong in southern England, but as far as I know there are no longer any plans to build a long wave transmitter in the Netherlands, although they still have an unused allocation on 173kHz (1734m).

Late last year, the Netherlands reorganised their home services, which used to be called "Hilversum 1", "Hilversum 2" etc into "Radio 1", "Radio 2" etc up to "Radio 5", with the news that Radio 3 (the Dutch equivalent of BBC Radio 1) would only be broadcast on VHF. The old Hilversum 3 had been on 675kHz as well as VHF. Perhaps Radio Netherlands had been hoping to use this MW transmitter for their external broadcasts? In any case, this will not now happen because there was apparently such an outcry from pop music fans who did not have VHF receivers, as well as people who listen on car radios covering only LW and MW, that the decision was over-ruled and Radio 3 remains broadcasting on 675kHz as well as VHF.

The News

A new service, if not a new station, is VOA Europe, which is presented in Washington and relayed by satellite to Europe, where it is made available to cable networks and independent local VHF stations. Apparently, this new idea in international broadcasting was not so successful. VOA Europe is now being broadcast additionally on the Voice of America's own 300kW medium wave transmitter in Munich on 1197kHz, at times when the transmitter is not broadcasting normal VOA programmes in East European languages. Reception generally in Britain is fair, though you may have difficulties hearing this one if you live in or near Bournemouth, Torbay, Cambridge or Eniskillen, as there are low power BBC Radio 3 relay stations on the same frequency in these towns. VOA Europe broadcasts its own news bulletins, for example at 1000 GMT, the rest of their programmes being mainly US rock and pop music.



A QSL card from Radio Australia illustrating one of their log periodic transmitting antennas.

A real DX station is Radio New Zealand. Always difficult to hear, it has been coming in relatively well recently around 1100 on 9600kHz, when the "Midnight news" is broadcast. This is a relay of New Zealand's home service — the station in fact identifies itself merely as "the National programme" rather than as Radio New Zealand. This station uses only 7.5kW carrier power, which may sound a lot to a radio amateur, but is positively QRP as far as broadcast stations are concerned, where 250kW or 500kW is the norm.

Staying in the Pacific area, Radio Australia is a lot easier to hear, especially now that they are once again beaming a frequency specifically to the United Kingdom. For some years reception was difficult as Radio Australia broadcast their programmes only to Asia and the Pacific, but a test frequency of 9655kHz beamed via the long path to the UK proved so successful that the station recently added it to its regular schedule, at 0700-1030. Radio Australia broadcasts world and Pacific news on the hour and Australian news on the half-hour, with a lot of good music in between.

According to reports on "Media Network" and "Sweden Calling DXers", at least two new commercial shortwave stations in the USA should be starting operations this year, perhaps by the time this is published. One is "World Harvest Radio International", yet another religious broadcasting station which will presumably be similar in format to the existing WINB, WYFR and KNLS. They expect to be allocated the callsign WHRI. The other station apparently already has a callsign allocated, NDXE, the first USA broadcast station with a callsign beginning with a letter other than W or K. Their plans are for a commercial music station with, eventually, shortwave broadcasts in stereo! Whether or not this plan ever gets off the ground, and the stereo system to be used, remains to be seen, as does the audibility of both of these stations. Another commercial shortwave station, WRNO in New Orleans, is only rarely heard in Europe and they have apparently been having some financial difficulties.

Newspaper reports have mentioned another unusual stereo radio station project, called "Stereo 531", presumably referring to the medium wave frequency of 531kHz. "Media Network" has reported that a ship is being fitted out in Honduras, of all places, but I am sceptical about whether we will ever hear this station here in Britain, especially after the much publicised demise of Laser 558.

That's all for this month. In the next edition, we'll look at Radio Sweden International's new 2 megawatt medium wave set-up, and bring you more broadcast station news. Good listening.

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RPCB 25 Tub	Front end IC251/211	84.90
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GFBA 144e	2m Mast head preamp	149.90
SBLA 144e	2m Mast head preamp	89.90
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LBPF 432u	Bandpass Filter	.40
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144-8T	8 Ele Long	31.26
144-14T	14 Ele	46.71
144-19T	19 Ele	55.88
144-6X	6 Ele Crossed	39.75
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70/3	3 Ele	30.12
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SP350	1.8-500MHz PWR/SWR	79.00
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DAIWA

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CN500	1.8-60 Mhz cross needle	21.64
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CN650	1.2-2.5 Ghz cross pointer. Up to 20W	143.75
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CNW518	3-30 Mhz 8 band hi power tuner	258.73

ICS

We now have in stock the full range of ICS RTTY/ASCII/AMTOR/CW products and the remarkable ALM-203E. This keypad operated handheld 2M transceiver has a host of features yet costs much the same as limited facility thumb-wheel units - just £209.00.

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TS940S	9 Band TX General Cov RX	1695.00
TS930S	General Cov RX	1395.00
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AT 230	All Band ATU/Power Meter	170.00
SP230	External Speaker Unit	51.00
TS530S	160m-10m Transceiver	779.00
TS430S	160m-10m Transceiver	750.00
PS430	Matching Power Supply	139.00
SP430	Matching Speaker	39.50
MB430	Mobile Mounting Bracket	13.56
FM430	FM Board for TS430	45.00
SP120	Base Station External Speaker	33.33
MC50	Dual Impedance Desk Microphone	39.56
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LF30A	Hi Low Pass Filter 1kW	27.70
TR7930	2M FM Mobile	365.00
TR9130	2M Multimode	544.00
TW4000A	2M/70cm moblie	580.00
TM201A	2M 25W mobile	296.00
TM401A	7cms FM 12W	350.00
TR2500	2M FM Synthesised Handheld	245.00
TR3500	70cm Handheld	270.00
TR2600	New 2M FM Synthesised Handheld	299.00
ST2	Base Stand	66.00
SC4	Soft Case	16.95
SMC25	Speaker Mike	19.78
PB25	Spare Battery Pack	32.20
MS1	Mobile Stand	38.41
R600	Gen. Cov. Receiver	323.00
R2000	Synthesiser 200KHz-30MHz Receiver	518.00
HS5	Deluxe Headphones	29.39
SP40	Mobile External Speaker	18.08
TH21E/41E	2M/70cm Mini-Handhelds	189.00/220.00
TM211E/411E	2M/70cm FM Mobiles	398.00/466.00
TS711/811E	2M/70cm base stations	770.00/895.00
TR3600	70CM Handheld	324.00

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MR750E	Multitorque, round controller	214.00
MR750PE	Round and preset controller	241.00
MR300E	High speed VHF rotator	214.00
MR75OU	Additional motor unit	71.74
MR300U	Additional motor unit	71.74
KS065	Deluxe bearing	30.30
KR500	Elevation rotator (not Daiwa)	156.40

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Tono 9000E	Reader/Sender	P.O.A.
Tono 550	Reader	P.O.A.
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HK702	Straight keyer marble base	34.44
HK703	Straight keyer	24.00
HK704	Straight keyer	17.00
HK705	Straight keyer	—
HK706	Staight keyer	—
HK708	Straight keyer	18.09
HK802	Straight solid brass	—
HK806	Straight keyer	39.95
MK704	Twin paddle keyer	17.18
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FT726R	2m Base Station	775.00
430/726	70cm Module for above	255.00
FRT7700RX	A.T.U.	49.85
MH1B8	Hand 600 8pin mic	15.70
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SB2	PTT Switch Box 290/790	13.80
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FF501DX	Low Pass filter	29.90

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FT270R	2m 25W F.M.	315.00
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LPM 144-25-160 2m, 25W in, 160W out, preamp	255.00
LPM 144-3-180 2m, 3W in, 180W out, preamp	295.00
LPM 144-10-180 2m, 10W in, 180W out, preamp	295.00
LP 144-3-50 2MN 50W out, preamp	125.00
LP 144-10-50 2M 10W in, preamp	125.00
LPM 432-1-50 70cm, 1W in, 50W out, preamp	235.00
LPOM 432-3-50 70cm In, 50W out, preamp	245.00
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L200	200W Dummy load	42.55
CT300	300W Dummy load	69.00
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HC200	10-80 HF Tuner	82.50
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Practicalities

There is a lot of talk these days about morse, whether it is now outdated what with the more sophisticated forms of communication. Another discussion revolves around the necessity for a morse test now that morse is being phased out in professional circles. Despite these and many more questions, the fact still remains that there is a morse test and this has to be passed before a class A licence can be obtained and one is let loose on the HF bands.

Ian Poole, G3YWZ, provides a variety of hints and tips that won't break the bank (as long as you have plenty of Letraset!).

Casting my mind back a few years to the time when I was practising hard to pass my test, I can remember two main ingredients I needed. The first one is a good dose of determination. I can remember having a couple of attempts at getting started and both failed within a couple of weeks. But it was different when a friend of mine received his licence — this provided the impetus I needed to keep going until I actually passed the morse test.

The second ingredient that is needed is practice. I found that at least fifteen minutes had to be spent *each* day practising in one way or another. This time could be spent practising in a variety of ways but initially I used a tape which a licensed friend prepared and this consisted of each letter of the alphabet sent three times. The idea behind this, which seemed to work in my case, was that it familiarised me with the sound of each letter. Having done this I found that tape recordings of both plain language and five or six letter groups were very useful. Of course these had to be recorded and changed every so often as one soon becomes very familiar with the letter coming next and the tape then loses its benefit.

In addition to these I found it very useful to listen on the bands and copy 'live' CW. I found that there was a lot of suitable morse being sent in the CW section of 80m at the weekend when many people were chatting in CW at reasonable speeds. Although it may be of interest to listen on the DX bands it is not so useful because the speeds are normally very high and the contents are normally only the 'rubber stamp' types where it is quite easy to guess what is coming next.

Having passed the morse test and received the licence I found that I had to go on CW in order to work DX because the transmitter which I had at the time was only AM and CW and there was not a lot to be worked on AM! This time spent on CW proved to be very useful and I have never regretted the fact that I had to use CW for the first year or so I spent on the air. However, people now say that CW is outdated and computer technology is taking over, but when the interference levels rise and conditions worsen a good CW operator will be able to cope far better than even some of the most complicated computerised equipment.

Now from practical ideas about learning CW to some more devoted towards station hardware.

Food For Thought

It is amazing to see what turns up at radio club junk sales or for that matter what can be found in any radio amateur's shack. I can remember buying a 'job lot' of aerial insulators at the local club junk sale several years ago. There was a goodly assortment, ceramic egg insulators, glass ribbed insulators and some others which have since been used several times in aerials and erected over the years. There were some ribbed stand-off insulators which stood idle as I had not found any uses for them. That was until I decided to use one of them as a base for a 2m quarter wave vertical.

The insulator shown in **Fig. 1** consisted of the basic insulator with a screw through the middle that was held in place by a wing nut. If this was used with an old car aerial cut to size it seemed the ideal 'misers' solution to my 2m aerial problem.

The main problem was that of connecting the aerial to the screw so that the centre conductor of

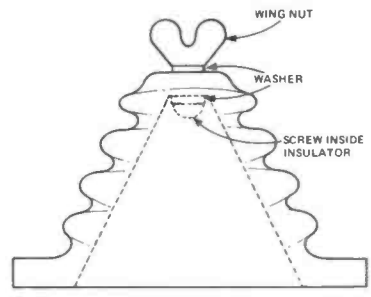


Fig. 1 The stand off insulator.

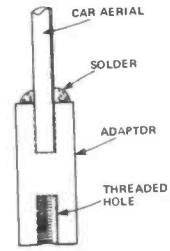
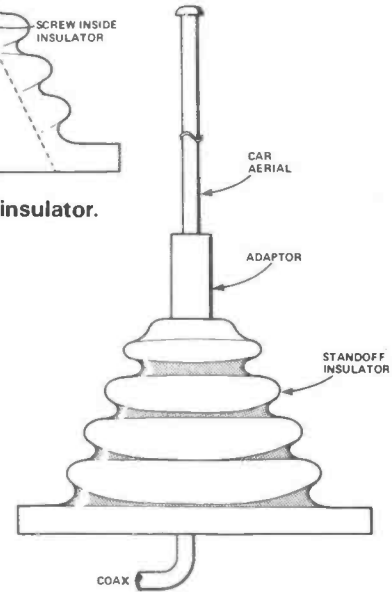


Fig. 2 An adaptor to join the car aerial to the insulator.

Fig. 3 The finished aerial.



the coax feeder could be connected to the vertical element inside the insulator. The solution came when a friend with a lathe turned up an adaptor out of brass into which the screw could be threaded at one end, and the aerial could be soldered at the other. The outer of the coax could then be taken to radials made up around the base of the aerial thereby finishing a cheap, yet robust, quarter wave vertical.

Although not everyone will have exactly the same insulators or parts of car aerials it does give some scope for other ideas and food for thought.

Finishing Front Panels

One aspect of homebrewed equipment which often spoils the finished appearance is the front panel. Previously in these pages I have mentioned the attributes of the wide range of pre-painted cases which are available and enable a professional finish to be given to a piece of equipment. It often happens that one ends up with a bare aluminium panel which does not look very attractive. I was interested to hear of a way of easily enhancing the looks of panels like this by giving them a 'grained' effect.

This can be done by rubbing the panel either with wire wool or a Brillo pad. If it is done carefully, ensuring that all the brushing is in exactly the same direction, it gives a pleasing finish. The lettering can then be applied using Letraset or another similar form of lettering system. The panel and the lettering can then be protected by covering it with clear fablon or the adhesive book covering which is available at most large stationers. The covering should be laid carefully onto the panel, starting at one side and ensuring that no creases or air bubbles form. The edge can be trimmed and the holes in the panel cleared so that the controls and indicators can be mounted onto it giving a reasonable finish for a minimum outlay of cost and effort.

Decorating The Shack

Many of us enjoy collecting QSL cards to a lesser or greater degree. After a while most of us will have accumulated a fair collection of cards, some which confirm prized contacts. It is only natural to want to pin these ones up around the shack to show them off. Unfortunately this can often damage them as pinning them up puts a hole in them, and then after a few months the pin may corrode slightly and leave another mark. Alternatively Blutack could be used, but again, this leaves a mark after a while.

Because of these problems I hit on the idea of mounting the QSL cards onto postcards or some other suitable card using photograph corners. Then the postcard itself can be pinned or stuck with Blutack to the wall leaving the QSL cards free from damage. As postcards and photo corners are often found around the home, or they can be bought from a local stationer. It is a simple, easy and cheap method of enabling QSL cards to be used to decorate the shack without spoiling them.

Get Onto HF Cheaply!

On HF, you can always match the rig to the pocket, if you know what you need and how to get it. Brian Kendal, G3GDU, explains the basic requirements and where to start getting on to HF cheaply.

I never cease to be amazed by the number of different reasons which I hear given by relatively new operators for not progressing from class B to class A licences. Of these, "I cannot afford a £1000 for an HF rig" and "I'll not be able to get planning permission for a tower and beam" are by far the most common. Both are based on misconceptions, for, as old timers will tell, it is far cheaper and easier to radiate a potent signal on HF than on VHF.

The acquisition or construction of equipment which will radiate a creditable signal on HF need not prove expensive and aerials other than those designed on the principles of Professor Yagi are quite capable of working DX. In these articles, however, we will only concern ourselves with equipment.

Misconceptions are quite understandable, for much of the advertising gives the impression that, without the plethora of facilities available today, operation is all but impossible. Consideration of equipment is, therefore, usually confined to discussion of ancillary features which, although perhaps useful, are certainly not essential. If, however, equal consideration is given for the minimum requirements for HF operation, the options immediately become wide open.

As it is necessary to learn morse code in order to gain a class A licence, why waste the effort spent! On CW it is possible to radiate a potent signal at minimum cost. Furthermore, many experienced operators say that this mode gives far more satisfaction and enjoyment than any other. If R/T operation is required, there are many older SSB transmitters available through the 'small ads' columns at very reasonable prices. Provided that it is restored to good working condition, the radiated signal will be indistinguishable from the most expensive modern transceiver.

Back To Basics

In order to contact other amateur stations, a transmitter and a receiver capable of operating on the desired mode of transmission are necessary. Whether these stand separately on the bench, are interconnected, or are combined within a single box cannot be determined by the distant station. He can only ascertain signal strength, stability, the quality of transmission in terms of the purity of CW tone or the speech characteristics of an R/T transmission and the ability of the person operating. Provided, therefore, that the station transmitter will radiate a signal of adequate strength and quality, it will meet all necessary requirements. Any further facilities available within the equipment are for convenience only.

For reception, the receiver must be capable of receiving the mode in use, have adequate sensitivity to receive weak signals and possess sufficient unwanted signal rejection to isolate the desired transmission. Again, any further facilities are for convenience only. How do these basic requirements relate to equipment?

The Transmitter

In the case of the transmitter, the first requirement is that it must radiate a stable signal. All modes of operation currently in use on the HF bands (except 10m FM) require the use of a beat frequency oscillator (BFO) for reception. In CW operation, a beat frequency between BFO and incoming signal of about 1kHz is normally considered optimum and a receiver bandwidth as narrow as 100Hz may be selected. Considering these factors, a short term transmitter frequency stability of better than 50Hz is necessary. Although the receiver bandwidth is wider for SSB, a similar stability is necessary in order to maintain constant speech characteristics.

The second requirement is that

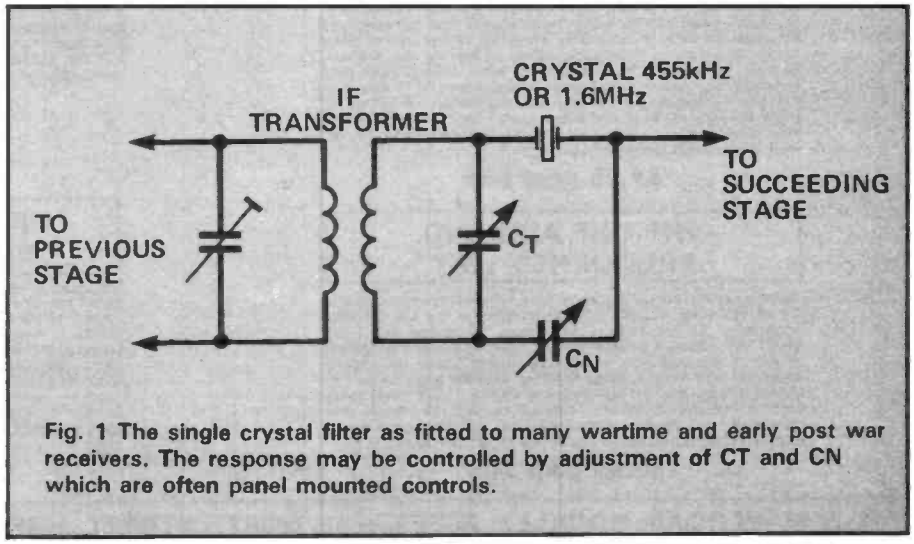


Fig. 1 The single crystal filter as fitted to many wartime and early post war receivers. The response may be controlled by adjustment of CT and CN which are often panel mounted controls.

"I THINK YOU'LL FND THE HUM IS COMING FROM THE BAND SCANNER--"

the signal should be of good quality. On CW this invariably means that the note should be a good T9. For SSB the speech quality should be reasonable, no residual carrier or unwanted sideband evident and any speech processing within reasonable limits.

Lastly, the transmitter should radiate a signal of adequate strength. Although QRP operation is a very interesting and highly skilled aspect of amateur radio, it may prove very frustrating for the beginner. Higher power must, therefore, be recommended, for 100 watts is quite easy to obtain and even 25 or 50 watts into a good aerial will still provide a very potent signal.

The Receiver

Obviously the first essential is that it should be capable of receiving the mode of transmission in use. For HF operation (except of course 10m FM) this means that the equipment must possess a BFO. This may seem self evident, but there are at least two models of government surplus "communications" receivers without one.

Secondly, the sensitivity of the receiver must be adequate to receive signals of strength equal to the atmospheric noise level. This varies very widely from one band to another. For example, at certain times of the year, background noise on 160 and 80 metres may be as high as 50-100 microvolts whilst, on 10m, noise levels are often only a small fraction of a microvolt. Most receivers, manufactured over the past 30 years, have a sensitivity better than 0.5uV and, in general, this is adequate for most HF operation. Wartime receivers usually had a sensitivity of around 2-3uV which is normally adequate for 20m and the lower frequency bands.

Thirdly, the receiver must exhibit sufficient unwanted channel rejection. This is a very complex subject; but, in simplest terms, there are four sources of unwanted signals: adjacent channel, second channel, cross modulation, and intermodulation products. The ability to reject unwanted adjacent channel signals (ie selectivity) is a measure of the quality of the intermediate frequency amplifier stages. The bandwidth of a receiver should be just sufficient to accept the signal radiated by the distant transmitter and reject all others. Of course in practice this is impossible, but modern developments in filter design have come very close to the ideal.

For CW operation a very narrow bandwidth is desirable (less than 0.5kHz) and in many older receivers this was obtained by a simple, single crystal filter. These may be adjusted to give an excellent response. Other receivers (known as double superhets) included a second, very low frequency, IF amplifier at which the required selectivity could be obtained.

For SSB operation, a bandwidth of about 2kHz is required with a sharp cutoff on either side. This is far more difficult to obtain. In general, satisfactory operation will only be obtained from mechanical or multiple crystal filters or some double superhet receivers.

Second channel interference is a characteristic of superhetrodyne receivers in which the equipment will respond to signals displaced by an amount equal to the intermediate frequency on the opposite side of signal to the local oscillator. This does not normally present a very serious problem for most receivers have adequate RF selectivity. It may become evident, however, in older receivers using a 455kHz IF when operating on 15m and higher.

Cross modulation is caused when extremely strong signals on another frequency drive one of the early stages of the receiver into non-linearity. This problem was most evident in the early solid state receivers. It may be considerably reduced by improving RF selectivity, decreasing RF gain, or inserting an attenuator between aerial and receiver.

Intermodulation products are the result of the mixing of fundamental and harmonic frequencies of any signals present within a receiver. These may originate internally (such as BFO, local oscillators, etc) or be introduced through the aerial circuit. These internal products are a measure of the quality of the circuit design and should be at a very low level. Those introduced when the aerial is connected can be minimised by good RF selectivity and a reduction of RF stage gain.

The Minimum Expense Station

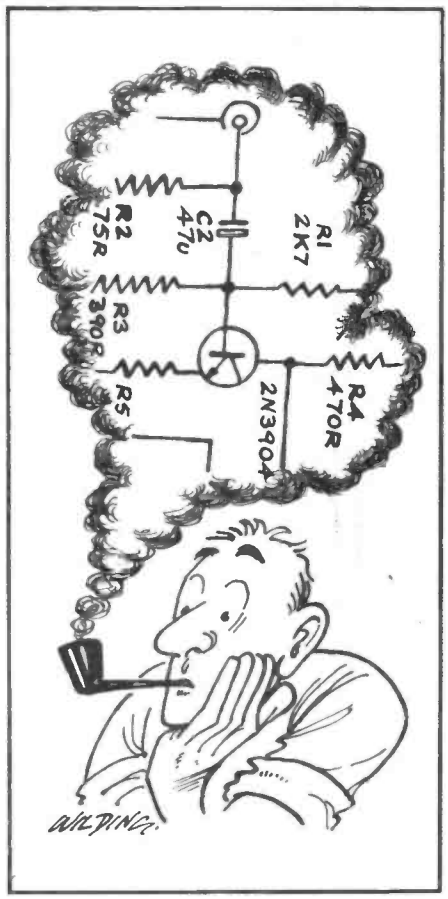
Having considered the minimum requirements for an effective amateur radio station, these must be converted into terms applicable to equipment, a major factor being the finance available.

The first consideration is which modes of transmission are required. If SSB operation is considered essential, then only equipment manufactured later than about 1960 is available. If only CW operation is anticipated, almost all equipment manufactured during or since the war will meet the requirement. These will almost invariably be separate receivers and transmitters. If a transceiver is required, only equipment manufactured after about 1965 can be considered.

Almost all equipment which may be considered under these criteria will use valves or, at the most, two or three transistors. Compared with modern solid state equipment, the circuitry is very simple. This, however, gives the considerable advantage that, should a fault develop, it may easily be repaired on the kitchen table using only simple test equipment and basic tools. Furthermore, with the assistance of a little modern technology, there is usually little difficulty in upgrading such receivers and transmitters to a performance never envisaged by the original designer.

Some amateurs may be deterred from purchasing older equipment by the thought that continual valve replacement will be necessary. Nothing could be further from the truth for, although valve life was often considered to be in the order of 1000 hours operation, in practice it is far more.

A while ago, the author removed from service a commercial transmitter which had been in 24 hour operation for over 20 years. The maintenance records indicated that the original PA valves had been in use throughout that period and closer examination showed that these valves (807s) still met their manufacturers specification. A few years ago, the BBC withdrew a broadcast transmitter after 40 years service. One valve, an ML4, had been in use thoughout that period. In the author's own experience, his KW Viceroy transmitter needed only two valve replacements in 16 years operation and his Drake 2B receiver only three in 24 years to maintain the original maker's specification.



Home-brewing

A further option is to consider building the station in whole or in part. This could prove by far the cheapest way of getting on the air, especially if full advantage is taken of radio club junk sales and rally bargain counters. The real secret here is to design the equipment around the available components rather than selecting a design and then trying to find components to fit.

Very often commercial, broadcast or ex-government units can be adapted for use in either transmitter or receiver. Even though the final appearance of the station may be like the proverbial "dog's dinner", there is no reason why it should not be capable of radiating a highly creditable signal. A combination almost invariably used in the early post war period was that of a commercial receiver in conjunction with a home built transmitter. The transmitter could be as simple as a single valve crystal oscillator, but if a three valve unit were constructed, VFO controlled, multi band operation was possible.

Quite recently, the author was asked to design a simple CW HF transmitter for Raynet use. In its final form, this was a two stage crystal controlled rig running about 10-15 watts input. On test, using only a 40' indoor aerial, in two weeks, 50 stations in 25 countries were worked on a single channel on 40m. There would appear to be no reason why a similar approach should not be possible today, especially as several firms now market kits for simple solid state transmitters. Even so, the older approach may prove more economic in terms of RF watts output per pound sterling.

When I have suggested this approach to younger amateurs, I have often been asked where suitable circuit information can be found. The answer is the same as for the components — junk sales and rallies. Very often old ARRL or RSGB handbooks and bundles of magazines from the 50's and 60's are available for a few coppers and these will provide all the information needed. A further advantage is that with valve technology, sections from different circuits can easily be combined to match the components available.

When the transmitter is complete, the lack of a brand name and the fact that it uses valves may cause some embarrassment. But you can always invent your own brand and announce to the world that you are using a "Mk2 Scrugg fully thermionic state equipment"! If, you do not wish to home brew, or you are not sure which equipment may be suitable for your requirements or cheque book, next month I shall be describing some of the older equipment which is available and which will enable you to get on the air for a cost between £20 and £200.

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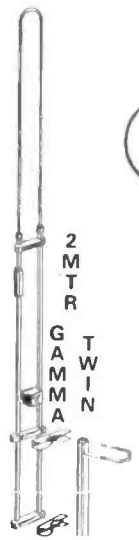

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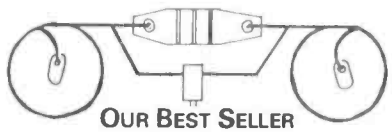

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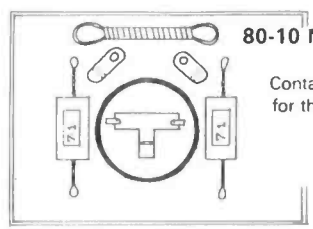

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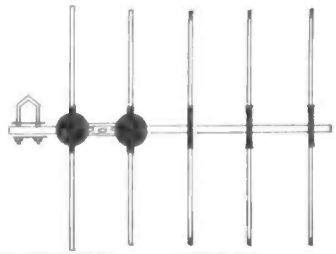

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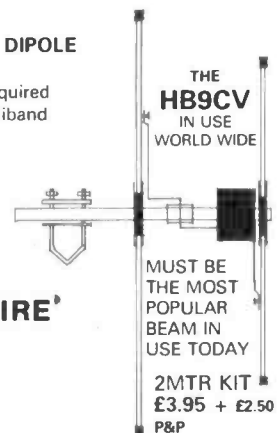

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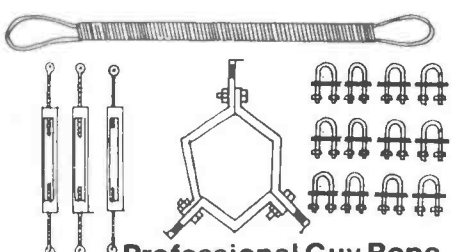

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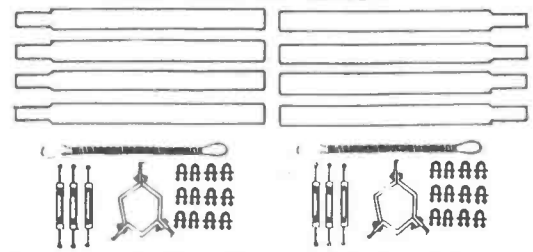

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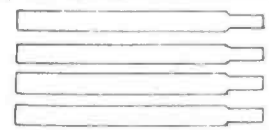

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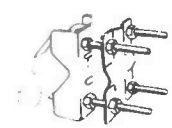

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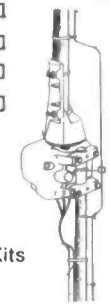

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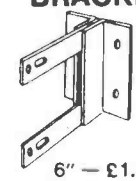

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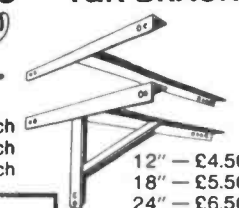

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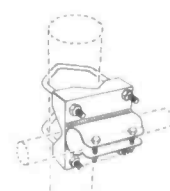

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RADIO Tomorrow

Your at-a-glance guide to what's happening around the clubs, on the air and in general radio-wise.

1 Apr Fylde ARS: *Building A Simple Receiver by G3AEP.*
Wolverhampton ARS: meeting.
Stevenage DARS: *Report by the Pilot of GIOOTO.*

2 Apr White Rose ARS: *Satellite Communications video.*
Three Counties ARC: *The Solar System.*
Fareham DARC: on the air natter night.
Cheshunt DARC: meeting.

3 Apr Horndean DARC: film show by G4BEQ.
Horsham ARC: *Mechanical TV by G3PVH.*
N Wakefield RC: *SSTV by G4FBA.*

4 Apr Ayr ARG: *Raynet by GM3ZDH.*
Amateur Radio and Computer Club: meets at the Crown, Bishops Waltham.
W Kent ARS: meeting.
Maidstone YMCA Sportscentre ARS: *Chassis Bashing by G3REM.*
Southend DRS: meets every Friday at 7.30 pm at the Rocheway Centre, Rochford.
Clifton ARS: meeting.
Coventry ARS: *All About VHF NFD.*
Maltby ARS: AGM at the Hellaby Community Hall.
Taunton DARC: meets every Friday at 7.30 pm in the Basement of the County Hall, The Crescent, Taunton.
Pontefract DARS: Ceilidh.
S Manchester RC: meets every Friday at the Salemore Community Centre, Norris Road, Sale at 8 pm.
Radio Society of Harrow: activity night.

5-6 Apr **RSGB National Convention at the NEC, Birmingham. See you there!**

6 Apr Mid Ulster ARC: meets at the Guide Hall, Castle Hill, Gilford at 3 pm.

7 Apr Borehamwood and Elstree ARC: quiz at the Wellington.
Basingstoke ARC: *Propagation by G3LTP.*
Worcester DARC: construction contest.
Braintree DARS: *Arrow equipment display.*
Todmorden DARS: *UK Atomic Energy Authority.*
Welwyn Hatfield ARC: meeting.
Felixstowe DARS: social.
Southdown ARS: *Linear Amplifiers and 50MHz by Ken Willis G8VR.*
Morecambe Bay ARS: morse class.

8 Apr Bromsgrove ARS: surplus sale by auction.
Worksop ARS: *Then and Now by G5UM.*
Wolverhampton ARS: meeting.
Keighley ARS: informal.
Bury RS: *Fibre Optic Transmissions by G4KLT.*
Verulam ARS: activity evening.
Chester DRS: *Power Supplies by G3EON.*
Westmorland RS: *A Pheasant talk by G4UWG.*

9 Apr Fareham DARC: *How to Predict Lift Conditions by G8VOI.*
Lothians RS: *DF Tune Up, Construction contest and Rig Check.*
Cheshunt DARC: natter night.
Stockport RS: meets at the Magnet Inn, Wellington Road North, Stockport.
Wirral DARC: *Skydiving at the Irby Cricket Club, Mill Hill Road, Irby.*

10 Apr Conwy Valley RC: GW3MZY.
Milton Keynes DARS: SWL activity night.
N Wakefield RC: on the air.
Southgate ARC: surplus equipment sale.
Edgware DRS: *Clandestine Radio by G3BA.*
Pontefract DARS: visit to British Telecom.
Preston ARS: *Weather Satellites by G3NKL at the Lonsdale Club, Fulwood Hall Lane, Fulwood at 7.45 pm.*

11 Apr Maidstone YMCA Sportscentre: *Contest Operating by G3ORP.*
Wimbledon DARS: *Electric Shock by G3ESH, G0CLK and St John's Ambulance*
Clifton ARS: meeting.
Maltby ARS: *Operating Techniques by G3BA.*
Dunstable Downs RC: *Spectrum Check Log Program by G3XJO.*
Radio Society of Harrow: *Inmarsat the International Maritime Satellite Organisation by Hans, LA1YQQ.*

14 Apr Atherstone ARC: *Clandestine Radio in the Japanese POW Camps on the Burma Siam Railway by G3BA.*
S Cheshire ARS: *AMSAT and OSCAR 10 at the new venue.*
Milton Keynes DARS: SWL competition and construction contest.
Southdown ARS: meeting
Morecambe Bay ARS: VHF film evening.

15 Apr Borehamwood and Elstree DARS: quiz.
Fylde ARS: informal with morse.
Wolverhampton ARS: meeting.
Midland ARS: *50 Years of Amateur Radio by G3BA.*
Dartford Heath DFC: pre-hunt meeting.
Chester DRS: *Oscillators by G3SEJ.*
Stevenage DARS: video and film evening.

16 Apr Three Counties ARC: *Direction Finding by G2FIX.*
Worcester DARC: informal.
Fareham DARC: on the air natter night.
Hastings ERC: junk auction.

Cheshunt DARC: chairmans lecture.
Brighton DARS: meeting
Stockport RS: natter night.

17 Apr N Wakefield RC: natter night.
Pontefract DARS: Raynet Group AGM.

18 Apr Ayr ARG: *The Other Mans Shack Video by GM3KJF.*
W Kent ARS: AGM.
Clifton ARS: meeting.
Winchester ARC: *Construction and Commissioning of Goonhilly Down by G3WPT.*
Coventry ARS: night on the air.
N Bristol ARC: bring and buy.
Radio Society of Harrow: activity night.

20 Apr Dartford Heath DFC: DF hunt.

21 Apr Todmorden DARS: informal chat night.
Welwyn Hatfield ARC: meeting.
Felixstowe DARS: ten pin bowling.
Plymouth ARC: meeting.
Morecambe Bay ARS: morse class.

22 Apr Bromsgrove ARS: meeting.
Worksop ARS: *Power Supplies by G8VHB*
Wolverhampton ARS: meeting.
Keighley ARS: visit to Menwith Hill Station, Harrogate.
Verulam ARC: *LF Antennas and Sunspot Minimum by John Heys, G3BDQ.*
Chester DRS: *Introduction to Microwaves by G3PFR.*

23 Apr Fareham DARC: *The Termitg by G4ITG.*
Lothians RS: *HF and VHF Operational night with GM4BYF.*
Cheshunt DARC: natter night.
Crawley ARC: *Antennas by G3TNO at the new venue, Crawley Leisure Centre.*
Stockport RS: meeting.
Wirral DARC: **on the air with GB2WDC.**

24 Apr Greater Peterborough ARC: RSGB video Space Shuttle.
Edgware DRS: informal.
Pontefract DARS: project evening.
Preston ARS: *The Ultra Secret.*

25 Apr Wimbledon DARS: *Propagation During Cycle 21 by G2FKZ.*
N Bristol ARC: Home brew competition.
Clifton ARS: meeting.
Coventry ARS: meeting.
Dunstable Downs RC: DF contest.
Radio Society of Harrow: *SSTV, RTTY, and Others by G6GCM.*

28 Apr Atherstone ARC: *AMTOR by G3WHO.*
Morecambe Bay ARS: junk sale.

29 Apr Wolverhampton ARS: meeting.
Keighley ARS: informal.
Chester DRS: *Your Questions Answered.*

30 Apr Three Counties ARC: AGM.
Fareham DARC: on the air natter night.
Cheshunt DARC: Brains Trust Q and A session.

1 May Horndean DARC: *CW With A Difference by G3JZU.*
N Wakefield RC: *Crime Prevention by Morley CPO.*
Horsham ARC: *Data Bases by G3IEE.*

2 May Ayr ARG: AGM.
Amateur Radio and Computer Club: meets at the Crown, Bishops Waltham.
W Kent ARS: constructors contest.
Southend DRS: meets every Friday at the Rocheway Centre, Rochford.
Coventry ARS: night on the air.
Taunton DARC: meets every Friday.
Dartford Heath DFC: AGM at the Scout House, Broomhill Road.
S Manchester RC: meets every Friday.
Radio Society of Harrow: activity night.

3-5 May **Porchester Community Association Arts and Crafts Exhibition with Fareham DARC running GB2HAM special event station.**

4 May **British Amateur Television Club rally at the Crick Post House Hotel J18 off M1 with more space for traders and demos in the Marquee outside. Lecture programme plus lots for all the family. Free admission and doors open at 10.30 am.**
Mid Ulster ARC: meeting at the Guide Hall, Castle Hill, Gilford at 3 pm.

5 May Borehamwood and Elstree ARC: meeting.
Basingstoke ARC: *Home Construction by G3CBU.*
Felixstowe DARS: *Fibre Optic TV by BT Research Labs.*
Todmorden DARS: chat night.
Dartmoor RC: mobile rally at the Town Hall, Princetown, Devon from 10 am to 3 pm for traders and followed by an auction of equipment. Further details phone Cliff on Tavistock 2318.

6 May Fylde ARS: equipment sale.
Dartford Heath DFC: pre-hunt meeting.
Dunstable Downs RC: visit to Milton Keynes TV.
Stevenage DARS: radio quiz.
Wolverhampton ARS: home built equipment competition.

7 May Fareham DARC: *24cm TV demonstration by G3VXM.*
Worksop ARS: visit to Bolsover club.
Brighton DARS: meeting

8 May Conwy Valley RC: fox hunt.
N Wakefield RC: visit to Leeds/Bradford Airport.
Southgate ARS: *A History of the Marconi Company.*
Edgware DRS: meeting.
Preston ARS: *Commercial Radio and Stereo Broadcasting by G6UOH.*

9 May Wimbledon DARS: inter club quiz vs Coulsdon ATS.
Radio Society of Harrow: *The Outgoing Chairman's Lecture.*

10 May **Radio Boot Fair at Whitfield near Dover opening at 10 am with an entrance fee of 20p with room for 30 pitches minimum. Anyone interested contact Ian, G3ROO, at Rosemount, Church Whitfield, Dover phone 0304 821588.**

11 May **Drayton Manor Rally.**
Dartford Heath DFC: DF hunt.

12 May Atherstone ARC: club night on the air.
Southdown ARS: meeting.
Milton Keynes DARS: *Long Range Communications Systems by USAF.*
Morecambe Bay ARS: *RSGB by G3XSN.*

13 May Bromsgrove ARS: AGM.
Keighley ARS: informal.
Bury RS: film show.
Chester DRS: *Computer Aided Design by GW8ICT.*
Delyn RC: meeting at 8 pm in the Daniel Owen Centre, Mold.
Wolverhampton ARS: *PEP The Whys and Wherefores.*

14 May White Rose ARS: AGM.
Three Counties ARC: *HM Coastguard.*
Fareham DARC: on the air natter night.
Lothians RS: *Raynet by GM3OWU.*
Stockport RS: meeting.
Wirral DARC: quiz night.

15 May N Wakefield RC: G4OOC.

16 May Ayr ARG: field day planning.
W Kent ARS: meeting.
Winchester ARC: *Satellites for TV by G3RDQ.*

17 May Milton Keynes DARS: *Long Range Aircraft. Communication by USAF, Upper*
Heyford.

18 May **Mid Ulster ARC: annual mobile rally at Parkanaur House, six miles from Dungannon on the main Ballygally Road, with the usual trade stands and bring and buy stall. Talk in on S22 if you get lost.**

19 May Braintree DARS: AGM.
Felixstowe DARS: social.
Todmorden DARS: chat night.

20 May Worksop ARS: *Clandestine Radio by G3BA.*
Chester DRS: Outside activity evening at Shepherds House, near Frodsham.
Fylde ARS: informal natter night.
Wolverhampton ARS: *SSB Transceiver Checks, Tests, and Power Measurements by G4WAS.*

21 May White Rose ARS: meet the new committee.
Fareham DARC: *SHF Measurements by Alan Dearlove.*
Hastings ERC: *Antennas.*
Brighton DARS: meeting.
Stockport RS: natter night.

22 May Greater Peterborough ARC: VHF NFD preparations.
N Wakefield RC: social at the Water Prince Floating Restaurant.
Edgware DRS: constructors contest.
Preston ARS: preparation for HF NFD.

23 May Dunstable Downs RC: Rig Doctor — check your equipment.

25 May **Plymouth mobile radio rally at Plymstock Comprehensive school, Plymstock, Plymouth, opens at 10 am until 5 pm with talk in on S22. Details from G0BNT on 0752 777777.**
Southdown ARS: raft race.
Wolverhampton ARS: 2m DF hunt.

26 May Atherstone ARC: DF hunt.

27 May Bromsgrove ARS: club night.
Keighley ARS: *Amateur Radio on a Shoestring by Rev. George Dobbs, G3RJV.*
Wirral DARC: *lecture by Gordon, G3LEQ.*
Chester DRS: *ATV by G4EZO.*
Delyn RC: meeting.
Wolverhampton ARS: your problems solved and night on the air.

28 May White Rose ARS: NFD briefing.
Three Counties ARC: junk sale.
Fareham DARC: on the air natter night.
Stockport RS: meeting.

30 May Ayr ARG: *Stargazing by Bill Williams.*
W Kent ARS: Meeting.
Maidstone YMCA Sportscentre ARS: AGM.
Wimbledon DARS: summer bazaar.

1 June **Southend DRS Amateur Radio and Electronics rally at the Rocheway Centre, Rochford, Essex. Trade stands bring and buy, refreshments, RTTY demo, family amusements. Talk in on S22.**
Mid Ulster ARC: meeting at the Guide Hall, Castle Hill, Gilford at 3 pm.

Will club secretaries please note that the deadline for the July segment of Radio Tomorrow (covering radio activities from 1st June to 1st August) is 26th April.

Contacts

Derwentside ARC	G1AAJ	0207 520477
Donegal ARC	E13BOB	074 57155
Droitwich DARC	G4HFP	0299 33818
Dudley ARC	John	0384 278300
Dunstable Downs RC	Phill Morris	0582 607623
East Kent ARS	Stuart	0227 68913
East Lancashire ARC	Stuart	0254 887385
Edgware DARS	John	Hatfield 64342
Exeter ARS	Roger Tipper	0392 68065
Fareham DARC	Alan	0329 288139
Farnborough DRS	Mr Taylor	0252 837581
Felixstowe DARS	G4YQC	0473 642595
Fylde ARS	PRO	0253 737680
Galashiels DARS	GM3DAR	0896 56027
G. Peterborough ARC	Frank	0733 231848
Halifax DARS	D. Moss	0422 202306
Harrow RS	Dave Atkins	0923 779942
Hastings ERC	Dave Shirley	0424 420608
Haverhill DARS	Rob Proctor	0787 281359
Havering DARC	G0BOI	04024 41532
Hornsea ARC	Norman	0262 73635
Horsham ARC	Pete Head	0403 64580
Inverness ARC	Brian	0463 242463
Keighley ARS	G1IGH	0274 496222
Kidderminster DARS	Tony	0562 751584
Kingston DARS	G3ODH	Epsom 26005
Lagan Valley ARS	Jim	0846 682474
Leighton Linslade RC	Pete Brazier	052 523 270
Lothians RS	Robin	0506 890177
Loughborough ARC	Philip	0509 412043
Loughton DARS	G6FWT	01-508 7190
Maidenhead DARC	John	0628 28463
Maidstone YMCA S/C ARS	G4AYD	0622 29462
Maltby ARS	Ian Abel	0709 814911
Medway ARTS	Tony	0634 578647
Midland ARS	G8BHE	021382 0086
Mid Sussex ARS	G1FRF	0791 82937
Mid Ulster ARC	Sam	0762 22855
Mid Warwickshire ARS	G4TIL	Southam 4765
Milton Keynes DARS	Dave	0908 501310
Morecambe Bay ARS	G3PER	Heysham 52659
N. Cornwall RS	J. West	0288 4916
N. Staffs ARS	G6MLI	0782 332657
N. Wakefield RC	Steve	0532 536633
Newbury DARS	G3VOW	0635 43048
Oswestry DARC	Brian	0691 831023
Plymouth ARC	G4SCA	0752 337980
Pontefract DARS	G0AAO	0977 43101
Preston ARS	George	0772 718175
Rhyl DARC	GW1AKT	Nantglyn 469
Salisbury RES	Neil	0980 22809
Shefford DRS	G4PSO	Hitchin 57946
S. Bristol ARS	Len Baker	0272 834282
S. Cheshire	Chris	07816 73185
S. Lakeland ARS	Dave	0229 54982
S. Manchester ARC	Dave Holland	061 973 1837
S. Tyneside ARS	G4XWR	S. Shields 543955
S. E. Kent (YMCA) ARC	John	0304 211638
Southdown ARS	P. Henly	0323 763123
Stevenage DARS	G4ISO	0462 892765
Stockton DARS	John Walker	0642 582578
Stowmarket DARS	M. Goodrum	0449 676288
St Helens DARC	A. Riley	051 430 9227
Swale ARC	B. Hancock	0795 873147
Telford DARS	Tom Crosbie	0952 597506
Three Counties ARC	Keith, G0BTU	0730 66489
Tiverton (SW) RC	Alan	0392 881569
Todmorden DARS	G1GZB	070 6817572
V White Horse ARS	Ian White	Abingdon 31559
Verulam ARC	Gerry	St Albans 52003
WACRAL	G4NPM	0795 873147
Wakefield DRS	G8PBE	0924 378727
Welland Valley ARS	J. Day	0858 32109
Welwyn Hatfield ARC	Dave	07073 26189
West Kent ARS	B. Guinnessy	0892 32877
Westmorland RS	G. Chapman	0539 28491
White Rose ARS	G4YEK	0423 884481
Willenhall ARS	G4LWI	0902 782036
Wimbledon DARS	G3DWW	01 540 2180
Winchester ARC	Gordon	0703 772191
Wirral ARS	Cedric	051 625 7311
Wirral DARC	Peter	051 677 7376
Wolverhampton ARS	Keith	0902 24870
Worcester DARC	D. Batchelor	0905 641733
Worksop ARS	G4ZUN	0909 486614
308 ARC (Surbiton)	Dave Davis	01 399 5487

Modifying the Keydaptor

D Anderson, G6YBC, offers a couple of mods to the Keydaptor (published in April 1985) which enabled you to use CW on your FM only VHF/UHF rig.

This modification was devised so as to enable the use of the more popular LM380N IC and to enable the Keydaptor to be run from the station PSU rather than batteries. **Fig. 1** shows how to reduce a typical 13.8V supply to 9V to suit the Keydaptor. It is not an original circuit I know, but useful and less painful than buying batteries.

Fig. 2 shows the modifications to the PCB tracks to suit the LM380N and **Fig. 3** how the LM380N is 'added' to the original circuit.

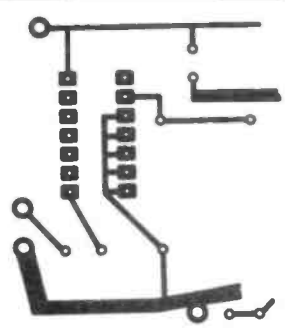


Fig. 2 The PCB should be cut as above if you want to use an LM380N for IC2.

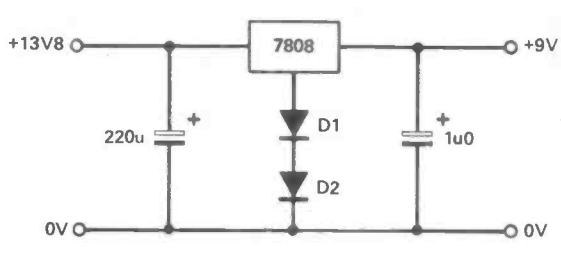


Fig. 1 The circuit used to reduce the 13.8V supply to the required 9V.

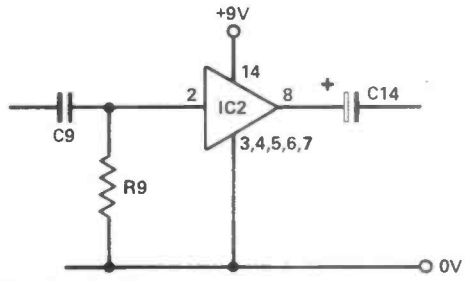


Fig. 3 The circuit diagram when using LM380N as IC2.

Working Oscar 10

The Advanced Satellite

part 3

Arthur Gee, G2UK, describes the transmitting side of an Oscar 10 station in this final part of the series.

Last month you will recall that we considered the requirements for receiving Oscar 10's signals; this month we will deal with the requirements for transmitting to its transponders. As we have seen, there are two transponders on Oscar 10: one functions in mode B and the other in mode L. The mode B transponder accepts 70cm uplink signals and retransmits them back to earth in the 2m satellite band. As mentioned in part 1, we shall confine ourselves to the mode B facility, as this is the channel used by most Oscar 10 operators. The L band facility is highly specialised for which one really has to have had some previous experience of microwave techniques. In dealing with the transmitting side of Oscar 10, there are so many ways in which the project can be tackled that you may find the advice of someone with Oscar experience helpful.

The Compromise Game

The first point to note is that you must decide whether to spend money on a high power transmitter and less on the aerial system, or a lower powered transmitter and a higher gain antenna. The latter offers a much narrower beam width, all be it a stronger signal, but the aerial system must be directed with greater accuracy toward the satellite. This may present problems such as keeping the antenna tracking accurately throughout the QSO, although not such a problem with Oscar 10, unlike the circular orbit satellites which pass out of range quicker. If we go for an antenna with less gain, and a wider beam width, our tracking problems are less critical but we need more power from the transmitter to get a reasonable signal into the satellite.

Unless you have a lot of experience in VHF work and have your own views on VHF aerial systems, your best bet is to go for something like the Tonna Oscar Special antenna mentioned last month. This has a 19 element Yagi array for the 70cm transmission, which gives reasonable gain and not too narrow a beam width. If you are an experienced VHF operator, you'll probably go for something bigger, say a helical or more than one Yagi in a phase matched array. You may well go for separate receiving array on 2m and transmitting array on 70cm, both arrays mounted on the same boom. However for the purposes of this article we'll confine our attention to the Tonna type of antenna.

The next point to note is that for our 70cm transmitting aerial system we need really good quality coaxial feeder. Losses are high enough at 70cm through all sorts of causes without adding aerial feeder losses to the system. Use the best coaxial cable you can get — the writer uses the H100 coax cable very successfully — and locate your aerial system as near to the transmitter as possible. Having sorted out our plans for our aerial system, let's now turn our attention to the transmitter itself.

No doubt the easiest way to solve the transmitter question — if money is of no consequence — is to get a unit such as the Ten-Tec 2510 satellite station. This unit has a tuneable 435MHz SSB/CW transmitter and a high dynamic range 2m — 10m receive converter. The transmitter unit gives 10W out and can be used to drive a 50 to 100 watt linear power amplifier. This should give plenty of RF when fed into an antenna with at least 12dB gain,

Possibly the quickest and easiest way of getting going on Oscar 10 is to purchase a unit like this Mode B Satellite Station by Ten-Tec. Expensive perhaps, but it will save you a lot of time and trouble.

giving very satisfactory results. Furthermore, both our transmitting and receiving needs are satisfied, as the 10m converter can be fed into the 10m band of the station SW receiver or the receiver section of a standard transceiver.

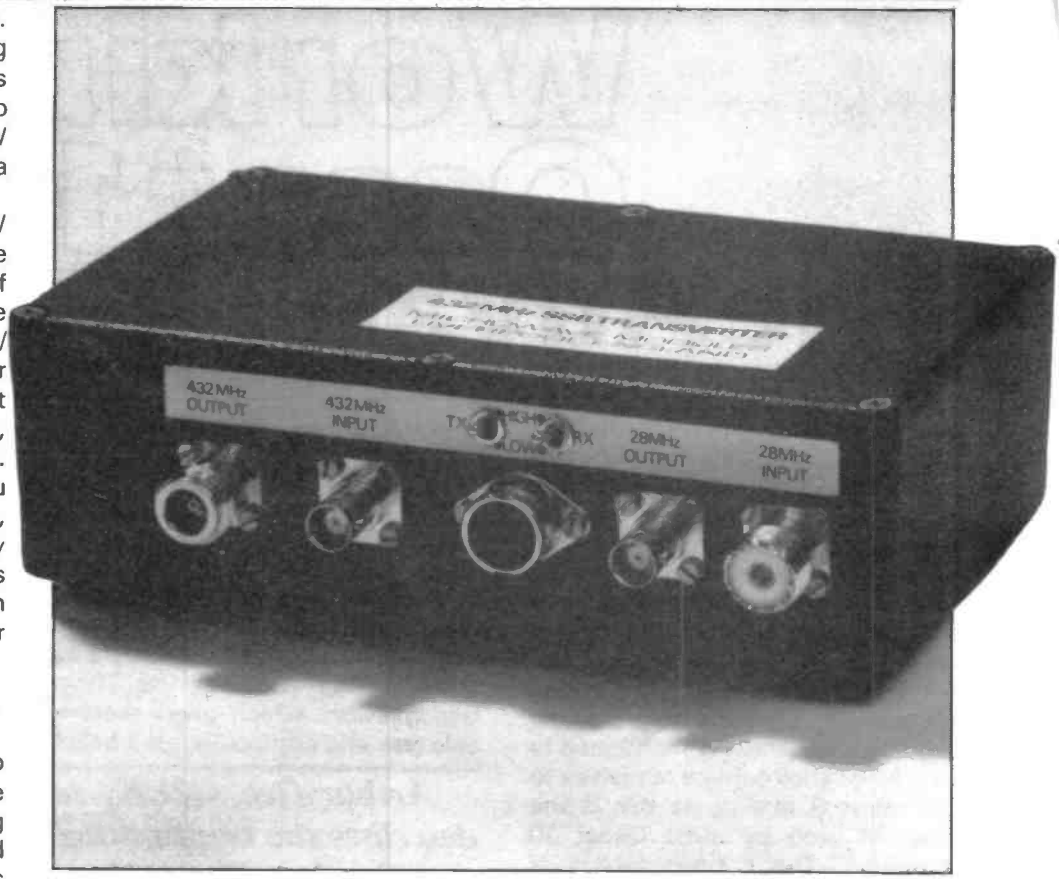
This unit is available through KW Communications Ltd, at a price between £300 and £400. It is of American origin with the usual price variations resulting from pound/dollar fluctuations. The 100W linear and its power supply will cost another £300. So here we are again, in another compromise situation. How best to spend our money. If you can afford it, go for the 100W linear, particularly if you are using a fairly simple antenna. If your aerial array is a bit more ambitious then you can get away with a 50 watt linear or even a 30 watt one.

An Economical Approach

Suppose however, we wish to approach the problem rather more economically, making use of existing equipment. With many standard amateur band transceivers, facilities are provided for taking off a low power signal from a pre-final amplifier stage. This will be in the region of a watt or two of RF which can be used to drive a multiplier unit to give a VHF signal suitable for further amplification.

For example the Yaesu FT 707, used by the writer, has rear panel connections which include a coax socket labelled "RF out". This is a "low level signal frequency output jack for use with a transverter" as the instruction manual describes it. The output is at 50 ohms impedance at a level of 220mV. If you have a similar facility on your transceiver, then read on. The transceiver is switched for the 28-30MHz band and from this low level signal output you can get enough RF to drive a 28 to 435 MHz transverter. This will give you sufficient 70cm RF to drive a 70cm linear amplifier.

The next item we need therefore is a 28 to 435MHz transverter. Microwave Modules can provide a suitable unit — their MMT 432/28-S transverter. The unit has two ranges, 432 — 434MHz and 434 — 436MHz, each for an IF of 28 — 30MHz, the required range being selected by means of two toggle switches on the front panel. The higher range is required for Oscar 10



working and has been specially provided for satellite communication. It requires an input drive of between 1 and 750mW to give a continuous 10W power output. A variable input attenuator must be added if the drive is outside the input range. The transverter has a receive side but this cannot be used for Oscar 10, it acts as merely a driver/multiplier unit for the final linear amplifier.

If you like looking around amongst surplus gear you may be able to find something you can press into use satisfactorily, for a far less financial outlay than the above suggestions. There are surplus handheld transmitter/receiver units which have an output on 70cm giving SSB facilities of sufficient power to drive an amplifier to a reasonable output. One such, used successfully by a friend of the writer's, is the IC402, which can still be found at times on the stalls at radio rallies or in surplus stores.

Again some 27MHz CB gear could be converted and adapted as a drive unit to drive a 28MHz to 432MHz transverter. Or if you are a dedicated home constructor you could build a 70cm transmitter from scratch. Certainly, a valve linear amplifier for 50 — 100 watts output could be made without running into too many difficulties. The usual amateur radio handbooks have circuits and constructional details for this type of equipment. Similarly, the linear amplifier can be made up by converting such equipment — if you're lucky!

One final problem which you will undoubtedly come across when you get to stage of testing out your completed Oscar 10 station, is that of 'birdies'. These are harmonics which crop up all over the place in the receiving section of the set-up. So you'll have to start playing around with a few bandpass filters in the leads connecting the various units. The writer was fairly lucky in this respect. All that was needed in his case was a 2m filter between the 2m receiving aerial array and the receiving converter and a 70cm one between the transverter and the linear amplifier. These reduced the 'birdies' to an acceptable level.

So you'll see, getting set-up for Oscar 10 is not just a matter of going out and buying the gear. Its quite a business getting it all sorted out. But once you've done it, you'll find it has all been well worth it! If you're one of those who likes challenges and experimenting, then have a go at getting going on Oscar 10.

100kHz And Down

Ever wondered what goes on below the LF regions of the radio spectrum? Communications is still possible with such low frequencies and they have some interesting advantages as Mike Bedford, G4AEE, reveals.

The purpose of this article is to investigate that portion of the radio spectrum little known to the radio amateur, namely the bottom 100kHz. The complete radio spectrum is illustrated in Fig. 1 with frequency, wavelength, ITU band designations and the positions of amateur and broadcast bands. The official band designations each represent a decade of frequency and the definition of band number 'n' is that it covers the range 0.3×10^n Hz to 3×10^n Hz. Of these 11 available bands, amateur allocations are mostly in band 4 with a slight overlap into a fifth and even when broadcast bands are considered, more than three decades at the bottom end of the radio spectrum is unrepresented. This unknown region, covering the ELF, VF and VLF bands plus the bottom of the LF band, exhibits unique properties making it suitable for various specialist purposes. Before going on to take a look at these areas of application, however, a few general comments are appropriate.

Although we have seen that the subject of this article is 3½ of the 11 ITU radio band designations, this statement could prove somewhat misleading. It should be borne in mind that these bands are frequency decades which means that each band has only a tenth of the frequency space of the next highest band. As a result of this, bandwidth is severely limited — the ELF band not even being able to accommodate a single SSB signal and even the VLF band only having a capacity of nine such signals.

Clearly it is only feasible to use CW modes on these bands except where very local coverage is intended (eg inductive and earth mode communications described later) thereby avoiding interference. Once we get into the LF band, however, this limitation is not as severe and of course the broadcast allocation contains several AM stations.

It will be noticed that the ELF, VF and part of the VLF bands cover what is often referred to as "audio frequencies". The use of the term audio frequency in this context has given rise to a misconception, namely that transmission at these frequencies could actually be heard. The human ear, of course, is only capable of detecting those vibrations in the air which we call sound, whereas radio waves are electromagnetic radiation to which the ear is not sensitive. The term audio frequency is taken to mean that range of frequencies in which the ear is sensitive to these vibrations. The division of frequency into audio and radio frequencies is therefore quite confusing as in the bands in question we are concerned with radio waves at audio frequencies!

Aerial Considerations

As we shall shortly see, there are many advantages of using very low frequency radio, however, the very long wavelengths involved represent a significant problem as far as aerials are concerned. To some radio amateurs a half wave dipole on top band is only just possible but the wavelength at even the top end of the VLF band is a factor of 100 greater. Half way down the VLF band at the 16kHz frequency used by the GBR standard frequency station, the wavelength is about 19km or 12 miles. As frequent travellers on the M1 will be aware, even the huge aerials actually used by this station at Rugby are small in terms of wavelengths. To go to the extreme case, a half wave dipole at the bottom end of the ELF band would reach from London to Cairo!

It goes without saying that aerials for these frequencies are by necessity very small electrically and accordingly very inefficient. To make up for this lack of efficiency, extremely high powers, measured in megawatts, are used. Nevertheless, every effort is made to obtain as great an aerial length as possible and some very novel means are used.

The following aerial types were considered for Project "Sanguine", (ref. 1) an ELF submarine communications system developed for the US

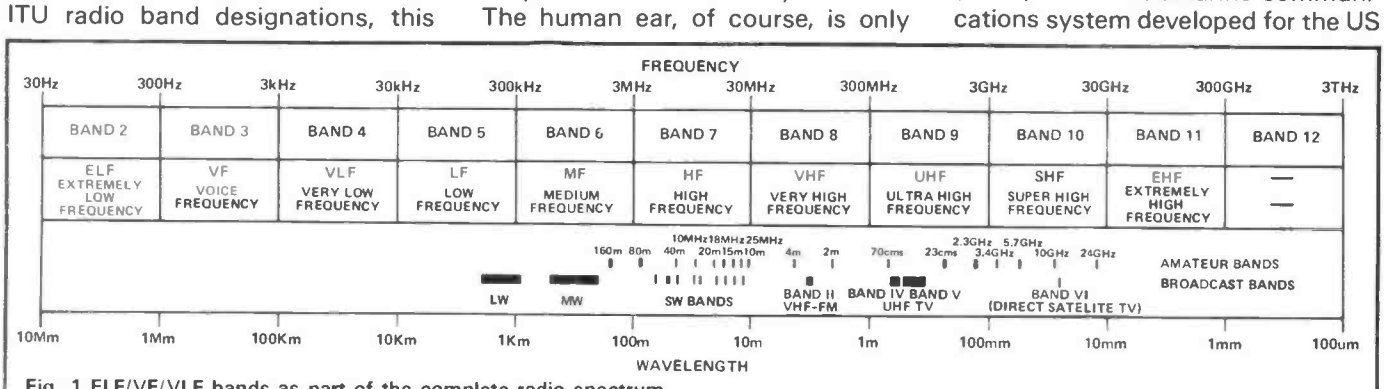


Fig. 1 ELF/VF/VLF bands as part of the complete radio spectrum.

Navy and indeed, a number of these aerial systems are used by other ELF, VF and VLF stations. In the following descriptions it should be borne in mind that the project in question called for a vertically polarised E-vector which can be achieved by either a vertical antenna or a loop in the vertical plane.

The dream of many a radio amateur is the legendary "sky hook" and in fact many of the Project Sanguine proposals realised such a support system for very long verticals. **Fig. 2(a), (b)** and **(c)** illustrates some of these proposals. At VLF, a long wire trailing from an aeroplane has been used with some success but suffered because a significant proportion of the radiator is horizontal and it is difficult to obtain a length of more than a few miles. The upgraded version of this system proposed for ELF was to suspend the wire from an earth satellite. Using such a support, a much greater length could be used and the gravity gradient would ensure that the majority of the length would be vertical. The disadvantages, however, were that a large proportion of the radiated signal would have to pass through the entire ionosphere and that the transmitter would have to be located in the satellite where existing technology would allow a power of only a few tenths of a watt.

The other form of sky hook proposed was an aerial anchored and fed at the bottom. The support in this case was to be a helicopter which would enable easy transport which could be established either on land or on a ship at sea. It was found, however, that to obtain the required length, wire of sufficient tensile strength to support its own weight would be too heavy to be lifted by even the largest military helicopters. As a result of this, lengths which would be feasible would have to be inductively loaded at the base which would have significantly reduced their efficiency. An alternative considered was to use a spiral top loading system, but since such a loading cap would require hundreds of miles of wire at a great height this was also considered impractical.

Before taking a look at some of the loop aerials proposed, including the type actually implemented, a radiation method not involving an ELF aerial at all will be mentioned. Although it didn't prove practical, this proposal was probably the most

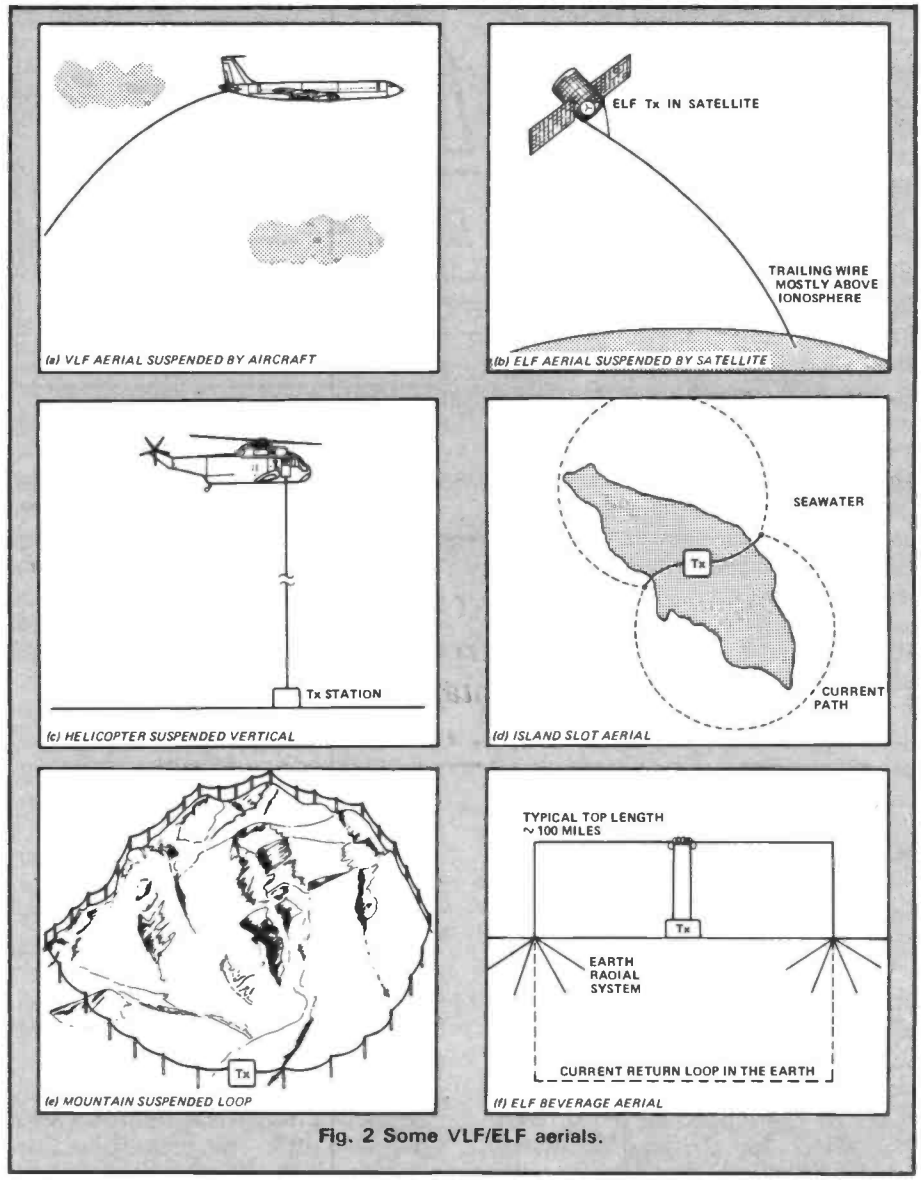


Fig. 2 Some VLF/ELF aerials.

innovative of all. It had been found that a non-linearity in the ionosphere causes a natural frequency mixing to take place when high power signals in the MF portion of the radio spectrum are present. Since this was first observed in the vicinity of the well known MW broadcast station, the phenomenon is called the Luxembourg Effect. The ELF radiating system proposed therefore involved transmitting two high power MW signals into the ionosphere, the frequency difference between these two signals being equal to the ELF frequency required. Unfortunately the degree of mixing which takes place is minimal making such a system of little practical value.

The various loop aerial possibilities are illustrated in **Fig. 2 (d), (e)** and **(f)**. The first such proposal was to use the conductive sea water surrounding an island or peninsular to act as the loop. Clearly it is possible to select an island of the appropriate dimensions or pick the feed point on the peninsular to achieve the required impedance at the operating frequency. The transmitter station is situated in the centre of the island and electrodes placed in the water at opposite sides of the island are fed by long feeders. Such a configuration was in fact tested using the eastern portion of Long Island, New York. Problems with this system were that a significant proportion of the current returned was via the earth beneath the feeder rather than round the island and also that the conductivity of the sea path could not be relied upon.

A second possibility which would achieve a truly vertical loop is to use a mountain or mountain range to support the wire. Unfortunately, unless the mountain happens to have a tunnel passing under its base,

it would not be possible to keep the return path in the same vertical plane as the upper portion of the loop. Since calculations showed that the area of the loop would be in the order of hundreds of square kilometres — dimensions larger than most mountains — this proposal was discarded.

The final proposal, the one actually implemented, is the beverage aerial. Although at frequencies in the HF band such aerials are only suitable for receiving, in the ELF spectrum, the ground penetration of the radio waves makes it suitable as a transmitting aerial. The beverage aerial is grounded at both ends and a return path deep in the earth causes it to appear as a huge vertically polarised loop. The first Project Sanguine aerial ran from Catawba, North Carolina 109 miles to a point near Algoma, Virginia, close to the Atlantic coast in an area of low ground conductivity. Interestingly, the effective area of such a loop (ie the depth of penetration) is affected not only by the ground conductivity but also increases as the frequency decreases as will be described in the section on subsurface communications.

Although these aerial considerations were for ELF, the same principles apply at VF and VLF and as the frequency increases the problems are not as severe. In fact many of the proposals which were discarded for Project Sanguine become quite feasible for the higher frequencies. An aerial type sometimes used at VLF is the valley span — stringing a long wire from mountains at opposite sides of a valley. A problem encountered here is the effect of the wind causing a stretching and hence de-tuning of a high Q aerial. This is overcome by constantly monitoring the aerial and making adjustments to the tuning.

Propagation

A full coverage of the mechanisms of ELF and VLF propagation is beyond the scope of this article as it would, by necessity be very mathematical. Most radio amateurs have generally been satisfied with a somewhat simplistic view of propagation modes and indeed the intention here is to provide just a basic description of the propagation characteristics.

As far as the ground wave is concerned, most radio amateurs would probably correctly predict a long range by comparing the ranges of say 10m and 160m ground waves and projecting towards VLF. Turning to the sky wave, propagation is achieved predominantly along the effective waveguide which is formed between the earth and the ionospheric D layer at these frequencies. This is a path of very low attenuation, offering worldwide communications with the further advantage that the path characteristics are accurately predictable.

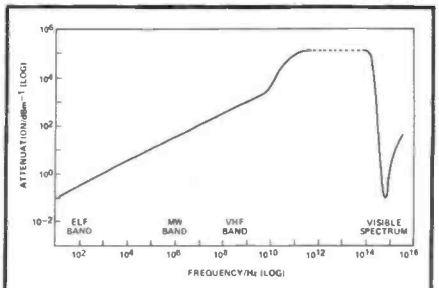


Fig. 3 The variation of attenuation of radio waves in sea water against frequency.

Unlike propagation at higher frequencies, the VLF/ELF propagation path is much less affected by time of day, season, sunspot cycle, climatic conditions and such like, making the signal very stable. Furthermore, at ELF and to a lesser extent at VF/VLF, there is also the possibility of propagation through conductive materials such as sea water and rock. This property of low frequency radio waves is the subject of the next section.

Subsurface Communications

Fig. 3 shows a graph of attenuation of electromagnetic radiation through seawater (ref 2). It will be noticed that, with the exception of a "window" at the high frequency end, the attenuation increases with frequency. This window in fact represents the visible part of the spectrum (ie light). So excluding the 'visible' spectrum for communications beyond line of sight, we are left with frequencies at the bottom end of the radio spectrum to be effective for communications purposes.

In effect, anything much higher than say 100Hz is virtually useless for effective subsurface communications. To give some idea of the amount of attenuation suffered by signals of "normal" frequencies in seawater, a 1MHz signal will be attenuated by 30dB/m. That is an S9 signal at the surface of the sea would be less than S1 at a depth of 1m and the effective power remaining from a 3kW transmitter after say 10' would be a mere 2uW! It doesn't take much imagination to see why frequencies in the range 30Hz — 75Hz were considered for the Project Sanguine system.

The combination of long distance waveguide propagation of ELF over the surface and its comparatively low attenuation below the surface of the sea means that it is now possible to communicate with submarines anywhere in the world at an operational depth of a few hundred metres. The systems used are one way, transmitting from a base station with very high power and aerial systems discussed earlier to a receiver onboard the submarine. The design of the receiving aerial is quite intricate due to potential noise generated by submarine machinery, surface potentials and water motion and bubbling. A typical aerial consists of a pair of exposed and widely separated electrodes trailed at some considerable distance behind the submarine.

Submarines do not constitute the only aspect of subsurface communication which have attracted interest. Mining, caving and communication between deep underground headquarters for use in case of nuclear attack are other examples of its use. The amount of signal attenuation is not only a function of frequency as described above but the conductivity of the media is also a major contributor. A term used in the area of subsurface communications is the "skin depth" a measure of how far signals will penetrate the earth or sea and is given by the following formula:

$$d = (2/\pi f \sigma \mu)^{1/2}$$

where f is the frequency, σ is the electrical conductivity of the media and μ is the magnetic permeability which can be taken to be a constant. Clearly, since rock is much less conductive than seawater (by a factor of 4 — 4,000 depending on the rock type), a higher frequency can be used and typically VF or low end VLF tends to be used. As a result of this the possibility of speech communications opens up, something which was out of the question for submarines at ELF.

Ten subscriptions to be won!

HAM RADIO TODAY

READERS SURVEY 1986

Its that time in the year again, dear reader, when we ask you directly what you want to see in Ham Radio Today. We, of course, have our own ideas for being more informative, more up to date, more entertainingly creative and offer more straightforward projects.

We've paid for the post, so all you have to do is fill it in, fold it up and stick it down. Oh yes and post it. What's more if you can get it to us by 16th May, we'll put your name into the prize draw bin from which we will draw ten free subscriptions to HRT.

If you have any comments of a general nature — not covered by our questions — put them in the space below so that we've been warned! Oh and don't forget to put your name and address in the space provided to enter the prize draw.

Are you sitting comfortably? Then turn the page and have a look at our custom designed, user friendly questionaire...

1. Do you hold a current radio transmission licence and which class?

- UK class A ☐ 1
- UK class B ☐ 2
- Non-UK licence ☐ 3
- No licence ☐ 4

2. If you hold a class B licence, do you intend to take the morse test to get a class A licence in the next year or so?

- Yes ☐ 1
- No ☐ 2

3. If you don't hold a licence, are you intending to take (or re-take) the RAE within the next year or so?

- Yes ☐ 1
- No ☐ 2

4. If you hold any sort of amateur radio licence, how long have you had one?

- Less than one year ☐ 1
- One to three years ☐ 2
- More than three years ☐ 3

5. a) Which bands do you transmit or listen on regularly (please tick all that apply)?

- 1.8MHz ☐ 1
- 3.5MHz ☐ 2
- 7MHz ☐ 3
- 10MHz ☐ 4
- 14MHz ☐ 5
- 21MHz ☐ 6
- 28MHz ☐ 7
- 50MHz ☐ 8
- 70MHz ☐ 9
- 144MHz ☐ 10
- 430MHz ☐ 11
- 1200MHz or higher ☐ 12
- Broadcast bands (SWL) ☐ 13

b) Which modes do you use regularly?

- AM ☐ 1
- SSB ☐ 2
- FM ☐ 3
- CW ☐ 4
- SSTV ☐ 5
- FSTV ☐ 6
- RTTY ☐ 7
- AMTOR ☐ 8
- TV-DX (broadcast or links) ☐ 9

6. What equipment do you own (please tick all that apply)?

- 'Base station' rig ☐ 1
- Mobile rig ☐ 2
- Handheld rig ☐ 3
- Communications receiver ☐ 4
- Roof-mounted antenna (house) ☐ 5
- Antenna mast ☐ 6

7. If you own a home computer, which make is it?

- BBC ☐ 1
- Commodore 64 ☐ 2
- Spectrum ☐ 3
- Amstrad 464/664/6128 ☐ 4
- Other (please write in below) ☐ 5

.....

b) Have you used a home computer in connection with your radio hobby?

- Yes ☐ 1
- No ☐ 2

c) If you don't own a home computer, do you think you will eventually buy one?

- Yes ☐ 1
- No ☐ 2

8. Which of the following best describes your attitude to radio as a hobby:

- You are very keen on radio, and it takes up all (or nearly all) of your spare time ☐ 1
- It's your major hobby, but you have other interests that take up your time as well ☐ 2
- It's one interest among several ☐ 3
- It's not really a hobby but an occasional interest ☐ 4

9. Do you exchange QSL cards regularly?

- No, don't bother ☐ 1
- Sometimes ☐ 2
- Whenever getting 'DX' ☐ 3

10. With antennas, do you:

- Buy ready made always ☐ 1
- Make some, buy some ☐ 2
- Always make your own ☐ 3

11. With your radio gear, do you:

- Buy built always ☐ 1
- Buy built rigs or receivers but make some 'gadgets' yourself ☐ 2
- Sometimes build rigs or receivers ☐ 3
- Always 'home brew' all your gear, except the inescapable minimum ☐ 4

12. Do you enter radio contests?

- No, never ☐ 1
- Sometimes ☐ 2
- Whenever you possibly can ☐ 3

13. Do you (or did you) use CB radio?

- No, never used it ☐ 1
- Yes, used it in the past ☐ 2
- Yes, still use it now ☐ 3

14. Do you go to radio rallies?

- No, never ☐ 1
- Yes, sometimes to local ones ☐ 2
- Yes, always to local ☐ 3
- Yes, all that I can get to ☐ 4

15. Do you think we cover the areas you are interested in properly? Please show by ticking the appropriate columns, which areas you think we should do more in, which we've got about right, and which we should do less in.

	More needed	About right	Less needed
Readers letters	☐ 1	☐ 2	☐ 3
New products and news	☐ 4	☐ 5	☐ 6
Club news	☐ 7	☐ 8	☐ 9
Major constructional projects	☐ 10	☐ 11	☐ 12
Small projects and gadgets	☐ 13	☐ 14	☐ 15
Conversions and mods	☐ 16	☐ 17	☐ 18
Equipment reviews	☐ 19	☐ 20	☐ 21
Computing in radio	☐ 22	☐ 23	☐ 24
HF operating	☐ 25	☐ 26	☐ 27
VHF/UHF operating	☐ 28	☐ 29	☐ 30
Satellites	☐ 31	☐ 32	☐ 33
SSTV/TV DX	☐ 34	☐ 35	☐ 36
Antenna designs and hints	☐ 37	☐ 38	☐ 39
'Travelogue' articles/DXpeditions	☐ 40	☐ 41	☐ 42
Historic radio articles	☐ 43	☐ 44	☐ 45

If there are any other areas you think we should cover, please write in below

.....

PERSONAL: It would help us to get the right sort of advertisements if you could give us some personal details; if you'd rather not given any part of this information, please don't but do return the questionaire. Non-completion of this section does not affect your chances in the draw for prizes.

16. What age range are you in?

Under 16	1
16-20	2
21-30	3
31-40	4
41-50	5
51-65	6
over 65	7

17. Are you:

Still at school/college/ university	1
Working	2
Retired	3
Not working for other reason	4

18. Please indicate your total annual NET income (ie after income tax, national insurance, pension contributions, etc) by ticking the appropriate box:

£11,690 or more	1
£9,350 to £11,680	2
£7,480 to £9,340	3
£5,980 to £7,470	4
£4,780 to £5,970	5
£4,770 or less	6

19. Are you still studying part time (for those not studying full time)

Yes	1
No	2

20. Are you married?

Yes	1
No	2

21. Do you have any children?

Yes	1
No	2

22. How much of the magazine do you normally read?

Read or look through nearly all	1
Read or look through some	2
Read or look through occasionally	3

23. a) How long do you keep your copies of the magazine?

One month or less	1
One to six months	2
More than six months but less than a year	3
A year or longer	4

b) Do you refer to back-issues?

Yes — quite often	1
Yes — when there's something I particularly want to re-read	2
No	3

24. Approximately how much do you spend per year on radio? (please include all costs, eg magazine subscriptions, QSL cards, equipment maintenance and repair, etc)

£100 or less	1
more than £100, up to £500	2
£500 to £2,000	3
£2,000 or more	4

25. Do you read the advertisements in the magazine? (excluding the 'Free Readers Ads')

Yes — read most of them	1
Yes — read some of them	2
Occasionally read the ads	3
Rarely/never read the ads	4

28. a) Have you ever bought anything after reading an advertisement in the magazine?

Yes — regularly buy from the magazine	1
Yes — have bought once or twice	2
No, never bought anything from ads	3

b) Have you bought *any* goods mail order in the last year or so (not just radio stuff)?

Yes	4
No	5

29. How do you get your copy of Ham Radio Today?

Buy it from a high-street newsagent but do not have a regular order	1
Have a regular order to collect your copy from a local newsagent	2
Have your copy delivered by newsagent	3
Subscription	4

30. For readers without subscriptions, do you ever have any trouble obtaining your copy of the magazine?

Yes, often have trouble	1
Yes, sometimes have trouble	2
No, rarely or never any trouble	3

31. How many people read your copy?

Just yourself	1
Yourself and one other	2
Yourself and several others	3

32 Do you belong to the RSGB?

Yes	1
No	2

If no, do you intend joining?

Yes	1
No	2

33 Do you belong to a radio club?

Yes	1
No	2

34 Do you prefer advertisements

In the front and back	1
Spread throughout	2

35. How often do you read the other radio magazines and how do you think they rate?

	How often do you read? Every Issue	Some Issues	Rarely/ Never	How do they rate? Good	Aver-age	Poor
Radio Communication	1	2	3	4	5	6
Practical Wireless	7	8	9	10	11	12
Amateur Radio	13	14	15	16	17	18
Radio and Electronics World	19	20	21	22	23	24
Short Wave Magazine	25	26	27	28	29	30

How would you rate 'Ham Radio Today' on these scales? 31 32 33

Finally, if you wish to enter the free draw for ten subscriptions, please write your name and address in here.

NAME.....

ADDRESS .....

.....

.....

THIRD FOLD

Postage will be paid by licensee

Do not affix postage stamps if posted in Gt Britain, Channel Isles, N Ireland or the Isle of Man

BUSINESS REPLY SERVICE
Licence No. WC3970

HRT READERS SURVEY
ASP LTD.
No 1 Golden Square,
LONDON
W1R 3AB

2

FIRST FOLD

SECOND FOLD

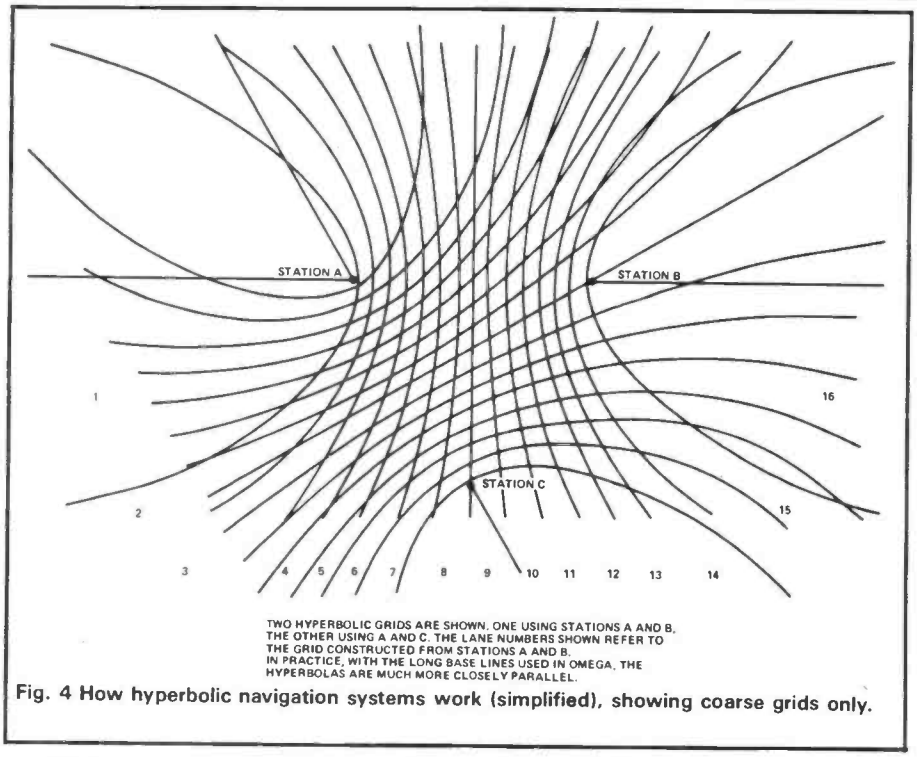


Fig. 4 How hyperbolic navigation systems work (simplified), showing coarse grids only.

Some types of rock seem to have an attenuation window well beyond the ELF/VLF bands but not in the visible band (most rock isn't transparent!). For example silica rock has such a window at 6.8MHz, a property which has attracted some interest in burying aerials in silica filled trenches as a mean of reducing noise levels (ref 3). Since the earth's surface is not made of pure silica, however, this doesn't provide a universal means of underground communication and we are once again left with VF/VLF. We will return to the subject of underground communications in the next section which approaches it from a slightly different angle.

Inductive And Earth Mode Communications

When we talk about radio waves, it is normally the electric wave which is implied, but of course, when an alternating current flows through an aerial, a magnetic field is also generated. Also referred to as the induction field, these magnetic waves are usually ignored since they are short lived in terms of range, decaying with the cube of distance compared to an inverse square relationship for the electric field.

The induction field is much more easily generated than true radio waves at these low frequencies simply as a result of aerial considerations and there are applications where an inherent short range is an advantage. This means of communications actually pre-dates the existence of radio as we know it and in all probability was the technique developed by Nathan B Stubblefield who some claim to have invented radio prior to the well publicised work of Marconi (ref 4).

One use of inductive communications, familiar to many, is the inductive loop hearing aid systems used in public auditoriums (ref 5). In this type of system, an audio signal is transmitted without the use of a carrier by means of a large loop encircling the building. The aerial is non tuned which means that it is able to transmit such a broadband signal which in effect occupies the entire VF band plus part of VLF. Very simple equipment, only an audio amplifier — is needed. It is because of the very localised nature of the field that these systems can be operated without the danger of interference between adjacent loops. A fairly uniform field exists within the loop and hearing aids switched to their "telephone" setting (primarily intended to sense the magnetic field generated by a telephone earpiece) act as receivers.

Another use of inductive communications, although not at ELF/VLF, has been the implementation of localised broadcast stations, for example within a university campus. A loop encircling the intended reception area is used as an aerial with the intention of ensuring that only a local magnetic field is propagated, hence avoiding interference within the band being used (eg LW broadcast band). In this instance of course, normal broadcast receivers would be used. The induction band is defined by the DTI as 0-185kHz and 280-315kHz and other uses included industrial control and paging.

Returning to the subject of subsurface communications, VLF induction has recently been in the news due to its application in the field of potholing. From the discussion of ELF/VLF aerial types, obviously, a transmitting aerial which could be carried down small cave passages would be an impossibility. On the other hand, a multi-turn loop of manageable dimensions would be effective for both the transmission and reception of magnetic waves in the VLF/ELF bands.

Like electric waves, the induction field will also propagate through solid rock if the frequency is low enough and since the depth of most caves (certainly in Britain) is rarely more than 400', the inherent short range of the signal is not a disadvantage. There is also a significant plus point to using magnetic waves, namely the very directional nature of the loop aerials which makes them suitable for direction finding and hence cave mapping. This use of magnetic wave communications made the recent historic link up between Gaping Gill and Ingleborough Cave possible, this being the subject of a current series of articles by the author in ETI. These articles also describe the construction of such a piece of equipment, the ETI Troglograph, (see ref 6 for details).

A closely related means of communication but on the fringe of radio is earth mode communications. Such a link is set up by transmitting a VLF signal into a pair of widely spaced ground electrodes, using a similar arrangement at the far end for reception (7). Some of the signal propagation is actually by an induction field as a result of current flowing between the electrodes in a large underground loop, but also ground conduction is a major contributor. It is worth noting that since earth mode transmitters also generate a magnetic field, it is possible to interact between the two different types of communication

REPEAT PERIOD = 10 SECONDS
BURST LENGTH (SECONDS)

STN	0.9	1.0	1.1	1.2	1.1	0.9	1.2	1.0	0.9	1.0
A	10.20	13.60	11.30						10.20	13.60
B		10.20	13.60	11.33						10.20
C			10.20	13.60	11.33					
D				10.20	13.60	11.33				
E					10.20	13.60	11.33			
F						10.20	13.60	11.33		
G	11.33						10.20	13.60	11.33	
H	13.60	11.33						10.20	13.60	11.33

0.2 SECONDS DEAD TIME

Table 1 Omega transmission format.

system. In fact, there are reports of generating an induction field by use of ground electrodes (where ground conductivity is suitable) and receiving this field by means of a loop aerial in a cave.

Navigation Systems

Although most users of the 160m amateur band will be familiar with the *Loran* navigation beacon at 1.9MHz, comparatively few will be aware of its principle of operation. The VLF/LF bands are much more suitable for navigation systems with *Loran-C* on 100kHz and *Omega* in the range 10kHz — 14kHz.

Omega is an example of a hyperbolic navigation system (8). A hyperbola is defined as a line joining all points with a constant difference in distance between two fixed points. Two radio stations transmitting carriers in phase, will have a hyperbola joining points of constant phase relationship between the two transmitters. **Fig. 4** makes this concept somewhat clearer. The hyperbolic lines represent points of zero phase difference between the two beacons, these lines are separated by a minimim distance (along the base line) of half a wavelength. The tracks between these hyperbolas are referred to as 'lanes'.

The receiver is able to accurately measure the phase difference between a pair of transmitters — which each transmit at certain intervals within an overall sequence — thus defining the position within a lane. Absolute lane number is unknown, so the equipment is initialised with a known starting lane number from which point the receiver counts lanes and formulates a readout of lane number plus position within the lane. Clearly, if two pairs of beacon stations are used, to hyperbolic grids are superimposed with the result that the absolute position can be determined from the appropriate charts.

The *Omega* system gives worldwide coverage using only eight stations located in Norway, Trinidad, Hawaii, North Dakota, Japan, New Zealand, La Reunion Island and Argentina — something which is only possible at VLF. What is more, the stability of the propagation path at VLF is vital when phase differences are being accurately measured. Those variations that do occur are predictable and correction charts are published.

The long wavelength at the 10.2kHz main frequency is also a significant advantage in that the lanes are eight miles wide. If the signal is lost for a significant length of time, the absolute position may not be regained, though with wider lanes the system becomes more resilient. Even at this frequency, however, a lane could be lost by an aircraft flying at 600 knots if the signal was lost for only 50 seconds.

For this reason a second *Omega* frequency of 13.6kHz is used, which when mixed with the 10.2kHz signal gives a beat frequency of 3.4kHz. This gives an extra grid of 24 mile lane spacing but with reduced

STATION	LOCATION	FREQUENCY	AUTHORITY
DCF77	Mainflingen, Germany	77.5	Physikallsch-Technische Bundesanstalt, Laboratorium 1-21, Federal Republic of German, Bundesallee 100, D33 Braunschweig.
GBR	Rugby, UK	16	National Physical Laboratory, Electrical Science Division, Teddington, Middlesex TW11 0LW
HBG	Prangins, Switzerland	75	Service Horaire HBG, Observatoire Cantonal, CH-2000 Neuchatel, Switzerland.
JG2AS	Sanwa Ibaraki, Japan	40	Frequency Standard Division, The Radio Research Laboratories, Ministry of Posts and Telecommunications, Koganei, Tokyo 184, Japan.
MSF	Rugby, UK	60	As for GBR.
OMA	Liblice, Czechoslovakia	50	Astronomicky Ustav CSAV, Budecska 6, 120 23 Praha 2, Vinohrady, Czechoslovakia.
RBU RTZ UQC3 UTR3	Moscow, USSR Irkutsk, USSR Chabarovsk, USSR Gorki, USSR	66 2/3 50 25 25	Comite d'Etat des Normes, Conseil des Ministre de l'URSS, Moscou 117049, USSR.
WWVL	Fort-Collins USA	60	Time and Frequency Services Group, Time and Frequency Division, National Bureau of Standards, Boulder, Colorado 80303, USA.

Table 2 Standard time signal stations below 100kHz. (1982, ref 10). Details of the time codes may be available from the addresses.

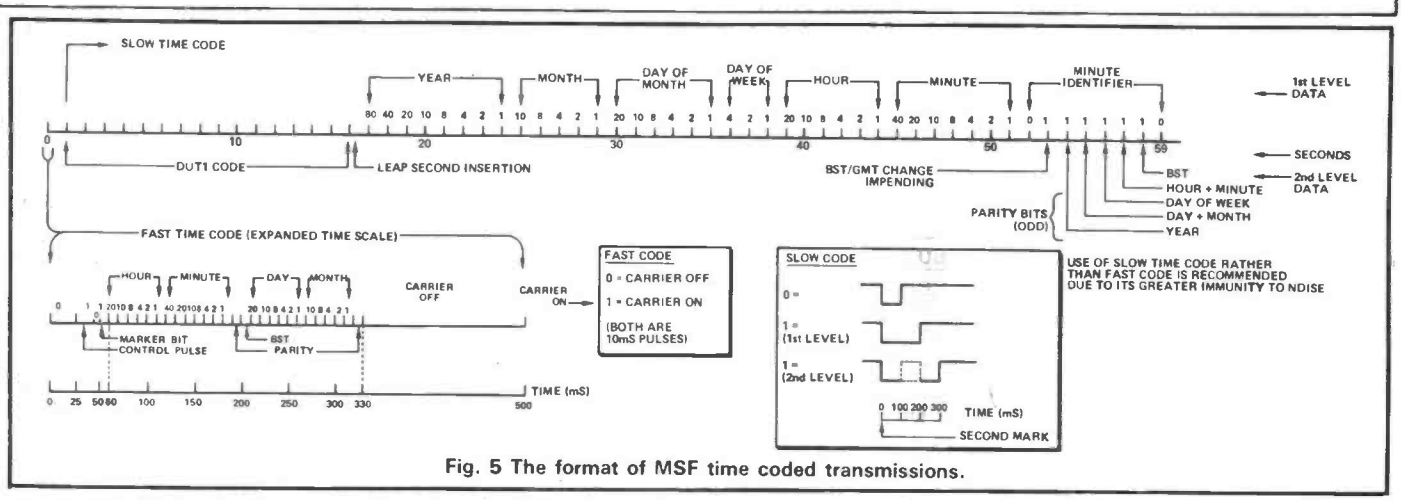


Fig. 5 The format of MSF time coded transmissions.

accuracy. Use of this second grid reduces the possibility of lane ambiguity after signal loss. A third frequency of 11.33kHz is also used, which provides a further beat frequency of 1.33kHz and an even coarser grid of 72 mile lane spacing. **Table 1** illustrates the sequence of transmission of the worldwide *Omega* network within their ten second frame. Finally, the system may be used by submarines just under the surface, an aspect which makes *Omega* unique among hyperbolic navigation networks.

Standard Time And Frequency Stations

Most readers will know of the international standard time and frequency service, particularly the HF ones like MSF on 2.5MHz, 5.0MHz or 10MHz or WWV on these frequencies plus 15MHz and 20MHz. These stations have their carrier frequencies accurately stabilised, typically to $\pm 2 \times 10^{-12}$, generated by a caesium beam frequency standard. They superimpose time signal information on the carriers, varying from simple second and minute pulses to digitally encoded data giving year, month, day, hour, minute and day of week information. This is transmitted to a very high degree of accuracy by use of atomic clocks (9).

The value of controlling the frequency, phase and time information to such a degree of accuracy is very much reduced if the propagation path is unstable. As a result, accurate information is only available from these HF stations in the small area covered by the ground wave. Obviously, the VLF band, with its stable propagation over long distances, is ideal and the band 19.95 — 20.05kHz is allocated exclusively to this service. Actually standard time and frequency stations are found throughout VLF and the bottom end of the LF band, as **Table 2** illustrates.

The two stations most easily received in Britain are the 16kHz GBR station and MSF on 60kHz. **Fig. 5** shows the format of the two types of encoded time information transmitted by MSF (11). Receivers designed to display this information having been published in the amateur radio and electronics press (12, 13). A design has also recently been published for a frequency reference using such a station (14). Although this design doesn't actually use a station below 100kHz the principles are the same. (In fact, it uses the Droitwitch 200kHz carrier which can be considered as a frequency standard though to a lesser accuracy than GBR or MSF).

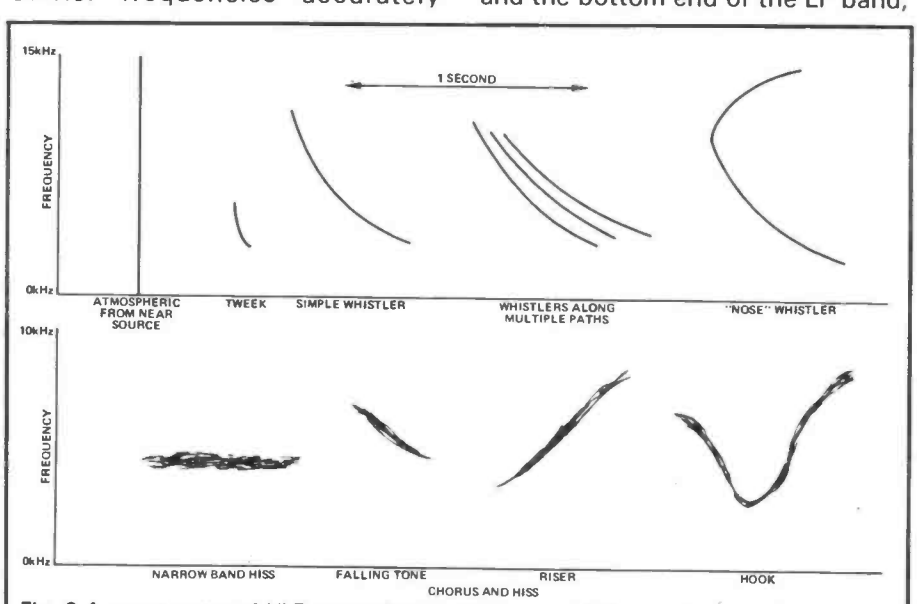


Fig. 6 A spectrogram of VLF atmospherics. The nose whistler can be reproduced under laboratory conditions.

Atmospheric Phenomena

One peculiarity of the portion of the radio spectrum below 10kHz is the existence of a whole range of natural atmospheric noises referred to by the high descriptive names of whistlers, tweeks, chorus and hiss. Radio enthusiasts have been amused by these noises for some time but they have also played an important role in the realm of particle physics research. In the early days of ELF/VF communications research, these atmospherics were also important in that they allowed research into propagation and receiving aerials even before the first transmitting aerial was built (15).

The first group of noises consists of tweeks and whistlers and have their origin in lightning discharge. VLF is by no means unique in exhibiting emission due to electric storms, lightning produces a wide range of noise from virtually DC to beyond light frequencies. What is unique about VLF/ELF is the way in

Components List for a VLF Up-converter

RESISTORS	
R1	100R
R2,R4	27k
R3	2k2
R5	3k3
R6	1kS
All 5%, ¼W.	
CAPACITORS	
C1,C4,C10	100n Cer
C2,C3	10n Cer
C5	120p Cer
C6	3.3-13p Trimmer
C7,C8	47p Cer
C9	1u, 10V Tant
C11	1n Cer
MISCELLANEOUS	
L1	100uH Choke
X1	HC18/U or HC25/U Min Fundamental Crystal
Q1	BF197 or BF224
IC1	SL1640
LED1	Standard Red LED
SW1	On/Off switch
B1	PP3 9V Battery
PCB and case.	

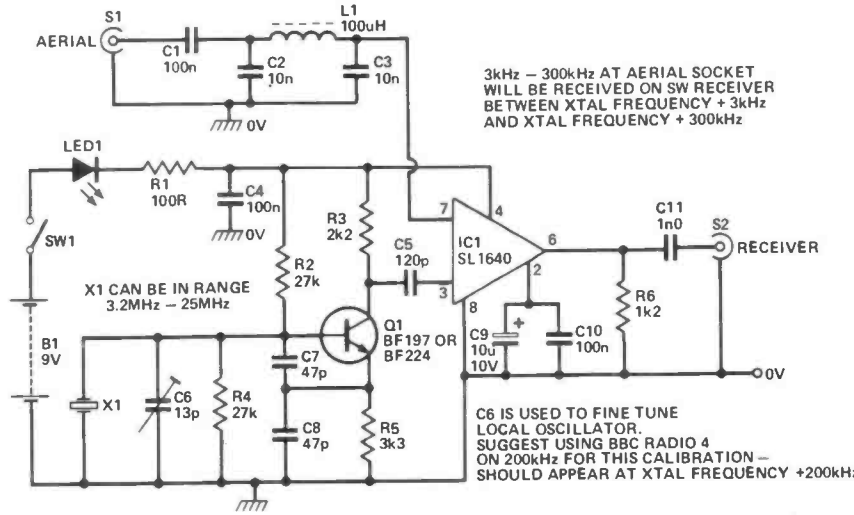


Fig. 7 Circuit diagram of a VLF up converter for listening to atmospheric noises.

which the ionosphere and magnetosphere affect this noise. Tweeks are about 20mS long, consist of a rapidly decreasing frequency finishing at about 1.6kHz and result from the noise being rapidly reflected backwards and forwards between the earth and the ionosphere.

Although the source of whistlers is the same, these emissions escape the ionosphere into the magnetosphere where they follow magnetic lines of force back towards earth in the opposite hemisphere. The paths taken by different frequencies are not of the same length, causing frequencies to be separated in time. Hence the characteristic falling note sound, lasting a second or so. Whistler can sometimes take multiple trips through the magnetosphere causing a whole sequence of such sounds often overlapping.

The second class of atmospherics includes hiss and chorus. These are not fully understood and two hypotheses exist to explain them. The ionised particles which stream between the sun and earth interact with the magnetic force lines in the magnetosphere. As they spiral around these force lines they emit radiation — in the same way as in a cyclotron — at the frequency equal to the gyrofrequency (in the order of tens or hundreds of hertz for electrons and below 1kHz for protons). The rising, falling or hook forms result from the Doppler effect.

The second hypothesis involves the amplification of noise in the ionosphere or magnetosphere by a travelling wave tube form of mechanism.

Practical Areas For The Radio Amateur

Of the various services in the VLF, VF and ELF bands, radio amateurs are licensed to receive only one — the standard time and frequency stations. An interesting project would be to use a home computer to decode the digital time information transmitted by these stations. This would have an advantage over dedicated hardware in that it can be made flexible enough to decode the varying types of code used by stations other than MSF. In fact the ETI project goes half way by using a microprocessor rather than dedicated TTL, but it is MSF specific by virtue of the EPROM based firmware.

As far as the RF side is concerned, **Fig. 7** is a circuit diagram of a receive converter for the frequency range 3-300kHz which is presented by permission of its designer R Lapthorne, G3XBM. This circuit is reproduced from an article in Radio Communications (16). Use of this converter will also permit reception of the various types of atmospheric emission described earlier. As long an aerial as possible should be used and generally night is the best time for reception of whistlers, chorus etc.

Turning to two way communication, we run into severe problems as there is no amateur frequencies anywhere close to the bands in question. Whereas the possibility of a VLF or LF amateur band (say in the range 10-100kHz) would be a very attractive proposition, this could only become a reality by international agreement and accordingly would be a long term venture. The situation below 9kHz on the other hand is quite different as the band is un-allocated internationally which means that nationai authorities may allocate this area at their discretion. In the USA, for example, no restriction at all is placed on the use of the first 9kHz of the radio spectrum.

This seems to suggest that there is a good case for making a request for some amateur use of these frequencies. Realistically, it would probably only be inductive or earth modes which would be practical due to aerial considerations, but then it is probably only these modes for which an allocation may be granted, if at all. Inductive licences are readily granted for hearing aid systems with an absolute minimum of technical requirements and a variant of this licence for use in cave communications was recently granted to the author. The most viable alternative would undoubtedly be to aim for a dispensation whereby individuals may apply for a special permit to augment their licence.

Unfortunately, the table of references has had to be held over until next month because lack of space.

The IC505 and FT690 6m Rigs Reviewed

Most 6m dedicated transceivers have been designed and sold for the US market. Chris Lorek, G4HCL, takes a look at two possible starters for six and assesses their worth whilst watching the British restrictions.

Thinking of setting up on 6m? Well, there are several ways to go about it. The cheapest is usually a transverter to convert an existing transceiver, either 10m or 2m, to cover the band. This can be a homebrew design, a kit design, such as with the G3WPO's featured in the February and March '86 issues, or with a commercial box such as the muTek 6m transverter reviewed in the April issue.

Although this approach gives you all the facilities of your present equipment, it has the disadvantage of tying it up for use on one band at a time. If transverting from your 2m rig, you often find you are constantly switching back and forth, which entails several plug and socket changes round the back, or the added expense of coaxial switches to do it for you. If only transverters had a 'straight-through' position like add-on linear amplifiers, I'm sure they would sell better!

The alternative is to dig deeper into your finances and use a dedicated set for the band, with the advantage of being able to keep it on all the time, possibly scanning around the beacons quietly to warn you of a lift, or monitoring the calling channel. Much arm twisting was carried out by the editor to obtain the FT690R and IC505 for review, as many amateurs also saw the advantages and initial dealer stocks ran out rather quickly! No doubt by now the situation will have changed somewhat with supplies back to normal.

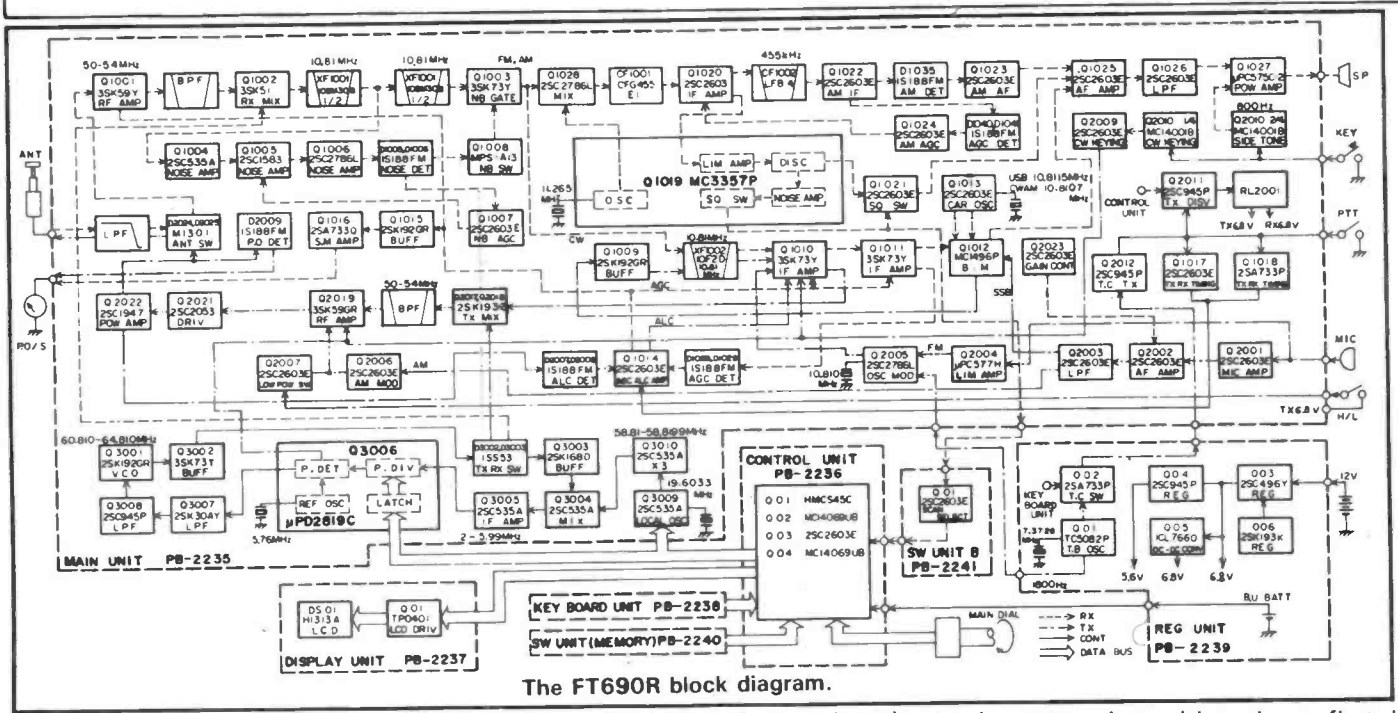
The Yaesu FT690R

Several years ago, Yaesu launched the FT290R, a 2m transportable multimode, and an overnight success. The FT790R for 70cm and the FT690R for 6m followed hot on the trail, with similar basic features. Even inspection of the FT290R and FT690R circuitry and PCB's show remarkable similarities.

The transceiver is multi-purpose; designed to be used portable, mobile, or as a base station. It measures 58mm high × 150mm wide × 195mm deep. It weighs 1.2kg plus the weight of whatever batteries you fit, and would not make your shoulder ache too much if you carried it around with the supplied shoulder strap. A protective case is available as an option to avoid damage from scratching if you intend to use it portable. Watch out for the telescopic whip; it's a quarter wave on 6m which is 1.5m in length, rather an unwieldy length.

A small internal speaker is fitted on the case top, with a 3.5mm jack socket provided on the side for an external speaker or earphone. Eight internal C cells provide power and a charging socket is provided for NiCad recharging. An external 13.8V supply may be plugged into a rear socket. Several amateurs have reportedly had problems with this socket on the FT290. It appears it has a tendency to apply 13.8V to the internal batteries occasionally so this may be worth checking with a dealer to investigate the latest situation. A lithium cell is internally fitted for memory backup with a quoted lifetime of about five years.

The rig operates on USB, CW, AM and FM, providing a power output of 2.5W (0.8W AM), switchable down to 0.5W. A main knob with soft 'click' steps provides tuning in 100Hz (USB/CW/AM) and 10kHz (FM) steps, again switchable by means of a front panel push button to 1kHz/20kHz steps. On receive, this main knob doubles as an RIT (receiver incremental tuning)



The FT690R block diagram.

control, tuning in 100Hz steps in all modes. The frequency readout is a five digit LCD display, which indicates to 100Hz.

Very Friendly Oscillators

There are two digital VFOs, as well as ten memory frequencies. Up/down push buttons on the microphone may be used to control the main VFO frequency or memory channel. Continuous frequency or channel scanning is accomplished by keeping your finger on the button for longer than ½ second. An internal busy/man/clear switch enables the auto scan to be stopped either on a busy or clear channel, as well as just continuing to scan whatever happens. A present priority channel, eg the calling or local net frequency, may be sampled every five seconds for activity by using the VFO and one memory channel, which also enables split Tx/Rx operation. On FM, +/– 1MHz Tx shift can be selected for repeater operation, but 'listen on input' requires a bit of knob-twisting.

The usual volume and squelch controls are fitted concentrically with the squelch operating on FM only. A small S meter marked with S1, 5, 9, and two divisions above S9, doubles as a relative power indicator on transmit. LEDs are fitted to show received signal ('busy' channel) and Tx mode. On the rear are fitted switches for high/low Tx power, noise blanker on/off, and meter/display illumination lamp on/off switch. The latter doubles as a battery check switch showing the battery voltage state on the front panel meter. A recessed SO239 socket is fitted for the external aerial connection. An external PTT socket is also fitted for a footswitch or similar.

A very comprehensive instruction manual is supplied, which apart from giving well-written operating details includes servicing and alignment information together with internal component placement photographs. A full parts list is also included.

The battery pack is internal to the transceiver, and requires removal of the lower case lid to fit or replace batteries. Although not as convenient as many portable rigs, this does give a good degree of mechanical security to the batteries; several portable rigs in the past have fallen down badly with broken plastic fixings designed to keep the battery pack in place. For mobile use, a matching mount is available as an optional extra.

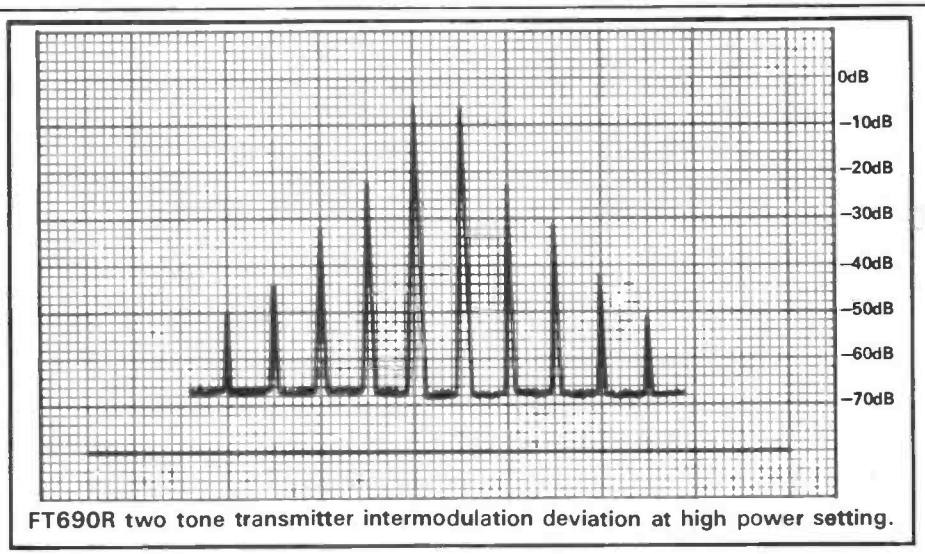
In Use

The transceiver was tested mainly in a base station environment, as this is all our present licence permits. However, a small amount of portable and mobile receive-only operation was done to test for suitability if this is allowed in the future.

After reading the instruction manual thoroughly, I managed to get the hang of frequency control using the memories; although at first I found the operating system not to be quite as logical or 'user friendly' as it could be. I found the memories to be fairly essential when tuning around the band, as QSY'ing between beacon frequencies and activity centres involved rather a lot of knob twisting and repeated pressing of the 'step' button.

I must say that the dual VFOs were found very useful in this respect with the present 500kHz band. If (or when?) we are allocated 50-52MHz I can imagine that local FM natter nets will become popular higher in frequency, and it would be logical for one VFO then to be kept in the SSB or CW section, and the other in the FM section. I found it a pity that QSY'ing from memory channels was not possible and involved more knob twisting. 1MHz up/down buttons would have been useful I feel, but then it is designed with compactness in mind, not to look like a portable mission control station with multitudes of knobs and switches.

The tuning rate on SSB was quite reasonable, although the 100Hz steps were in my opinion a little too coarse for correct resolution. This also makes it difficult to use for FSK RTTY or AMTOR operation. The clarifier does not help as it is a digital affair again with 100Hz steps rather than an analogue system. I must say though that I liked the soft 'click-steps', especially when carrying the rig around as this saved the dial being accidentially



FT690R two tone transmitter intermodulation deviation at high power setting.

knocked off frequency.

The tuning rate, as supplied on FM, was switchable in 10kHz or 20kHz steps, not conforming to European requirements of 25kHz channel spacing. Amateur Electronics UK have since told us that rigs supplied by Yaesu through authorised importers would be fitted with 12.5kHz and 25kHz steps. Activity already planned for 50.45 and 50.475 MHz in my locality in East Anglia would require dialling up the frequency on SSB, storing it in memory, then switching to FM and recalling that memory channel with this reviewed rig.

The set was linked to the 6m-20m mini beam on my tower and tested on-air with good audio reports received with no excessive 'spreading' of signal. Microphone gain on SSB was fixed at a level that required me to speak about 10cm from the mic. This seems reasonable and should not cause problems from extraneous noise pickup if used portable or mobile. Although I am not a CW addict, this facility was tested, with Tx keying performed by an external switch plugged into the side of the set. An 800Hz sidetone is emitted from the speaker, at a fixed volume level.

Received signal reports were nearly always less than those given, since most stations contacted were running between 10 and 25W output. Perhaps for base station use a linear amplifier would ensure reciprocity and less frustration when engaged in weak-signal communication. I found the S meter to be over generous; all reports I gave, therefore, were on what I thought they should be rather than what the S meter indicated. Examination of the circuit diagram and alignment section of the manual shows this is easily adjustable, if I owned the set I would be diving in with my trimming tool! Comparison of the readability of beacons when switching between the '690 and my normal station, an FT107M and FTV107 with 6m module, showed the receiver sensitivity to be comparable. When connecting the aerial to the '690, the receiver noise increased somewhat showing that the ultimate sensitivity to be limited by the band noise and not by the set.

No problems were encountered from blocking or adjacent frequency reception, although I must confess 6m is not the most crowded of bands at the moment, so laboratory simulation had to be resorted to for testing the effects of sitting on top of a hill in a contest in years to come (if allowed).

The AGC was set at a reasonable decay time on SSB and appeared to decay much faster on CW. Examination of the circuit diagram showed that an extra RC delay circuit is switched in when selecting USB — a nice touch. Unfortunately, FM could not be tested on-air as there was no-one to talk to on it! These are early days of course, so I'd better not comment too much on the provision of −/+ repeater shift and the toneburst facility except that they worked but the tone was set to 1800Hz, no doubt for the American market.

Mobile ignition noise on 50MHz is often far worse than on other bands, and plug leads form a lovely quarter wave. A noise blanker is fitted and performed reasonably but not marvellously, my Ford Escort with electronic ignition would need

FT690R Laboratory Results

All measured at 50.5MHz

Receiver

Sensitivity for 12dB SINAD

USB/CW	0.22
FM (3kHz dev)	0.18
AM (30% mod)	0.24

FM squelch opening sensitivity: **0.23uV** pd

Selectivity

	−3dB	−6dB	−60dB
USB/CW	2.1kHz	2.6kHz	8.4kHz

Third order intermodulation rejection

Measured as the ratio of two unwanted signals at 25kHz spacing to a single on-channel signal, both producing 12dB SINAD

USB/CW	71dB
AM/FM	69dB

Blocking

Measured as the increase in level over on-channel signal to degrade 12dB SINAD to 6dB SINAD, with 1MHz spacing

SSB/CW	+1MHz	102dB
	−1MHz	107dB
AM/FM	+1MHz	102dB
	−1MHz	107dB

Current consumption

Receive on SSB with volume at mid position: **69mA**

Extra current taken by dial lamp: **46mA**

S meter linearity

S1	0.225uV pd	−4.8dB
S5	0.30uV pd	−2.3dB
S9	0.39uV pd	0dB ref
S9+	1.19uV pd	+9.7dB
S9++	5.0mV pd	+82.2dB

Transmitter

Power output

Mode	High Power	Current Taken
USB	2.0W PEP	0.91A
CW	2.8W	1.03A
AM	0.5W	0.55A
FM	2.8W	1.03A

Mode	Low Power	Current Taken
USB	200mW PEP	390mA
CW	210mW	395mA
AM	82mW	240mA
FM	210mW	395mA

SSB two tone intermodulation distortion

Measured on high power

Order	dB relative to PEP
3rd	−22/−23
5th	−32/−31
7th	−44/−42
9th	−50/−51

Harmonic and spurii levels

Second harmonic: **−63dB**

Other harmonics and spurii: **all less than −70dB**

a little more suppression if mobile use was allowed. The small size of the set would make under-dash fitting quite easy in today's compact facias, although the frequency readout was a little small for this use. You can't have it both ways, I suppose.

Attempting to use the set portable is limited by the long quarter wave telescopic aerial, since there is no provision for fitting a helical to the top. Walking along the street, I imagine the average lifetime of this whip to be around a week before being broken, and I would not dare use it in a crowded rally! Perhaps an enterprising manufacturer will bring out a screw-on helical similar to those used on hand portable whips on 27MHz sets. Alternatively, I'm sure the enthusiastic portable operator could modify one.

Laboratory Tests

Examination of receiver sensitivity showed it to be adequate. I don't think there is a need for a permanently fitted receive pre-amplifier on the '690 as much as general opinions expressed on the FT290R, even though a similar receiver front end is used. Surprisingly, SSB/CW sensitivity was not as good as AM/FM. Then again, general band noise, TV timebases, ignition interference and so on would normally be the limiting factor here except when hilltop portable, where the low output power from the set would still make the receive sensitivity reciprocal.

Selectivity on both SSB and FM was of reasonable bandwidth for good readability and rejection of moderately strong unwanted signals, but the 'skirt' broadened out badly due to reciprocal mixing from side-band noise generated by the synthesizer. This seems to be a common failing in Japanese rigs full of bells and whistles. This would be unacceptable at HF but is probably tolerable on 6m, where very strong adjacent interference would be needed to cause problems.

Measurements of the S meter response confirmed my suspicions. In fact, there was only 4.8dB difference between S1 and S9 but with over 80dB difference between S9 and the top of the marked scale. The current consumption on both receive and transmit was very good indeed, and many hours of operation should be possible using internal batteries if you remember to switch the dial light off when not required.

The transmit two tone tests showed the set to be reasonably clean for a portable set, and few problems should be encountered using the set 'barefoot'. If you intend to use a linear amplifier beware that you don't exceed the recommended drive level of course, otherwise you will find your popularity on the band diminishing. The power output remained constant until 11.1V was reached, showing that the output was well regulated to allow for diminishing battery voltage.

Harmonic levels were reasonable and no other spurii were noted above −70dBc. The second harmonic could cause problems with adjacent broadcast band II reception. Although no worse in level than other rigs tested, I would still recommend a low pass filter fitted in the aerial line whenever possible.

Conclusion

A good all round transceiver capable of a variety of uses, reasonably small and versatile but the whip length makes future portable operation rather awkward. Use as a stand-alone home transceiver is a bit of a compromise, but the versatility of the rig must be borne in mind when considering this.

Many thanks to Mike Senior, G4EFO, who kindly loaned his FT690R at very short notice for this review. At the time of Chris writing the review, all FT690Rs had been sold by the authorised dealers, however, they *were expecting deliveries before the end of March.*

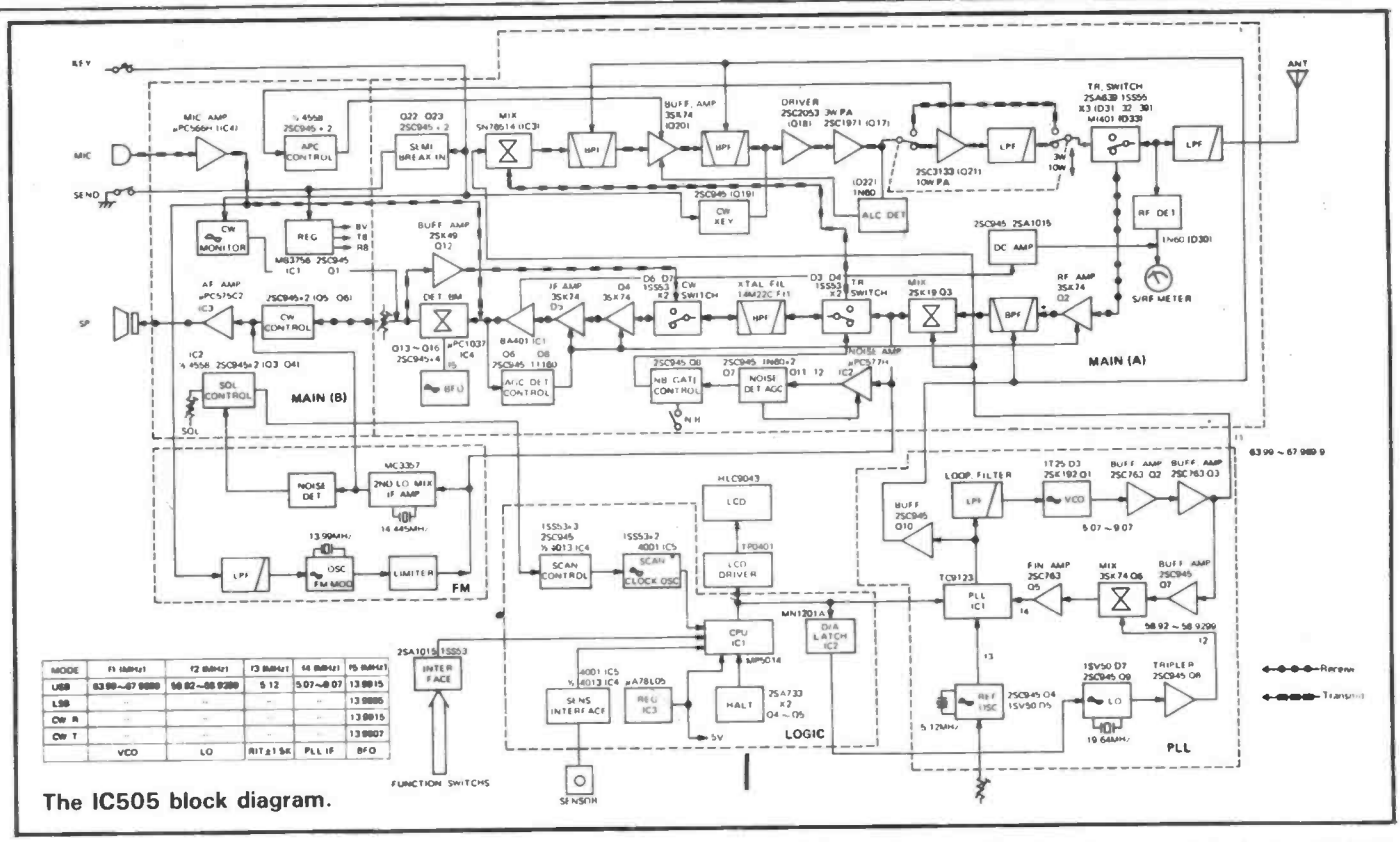
The Icom IC505

As with the FT690R, this is designed as a multi-purpose transceiver with portable operation catered for by an attached quarter wave telescopic aerial and shoulder strap. It operates on LSB, USB, CW, and FM with an optional module. Power output may be switched to 10W, 3W, or 0.5W, although 10W is not recommended by the manufacturer for battery operation.

A large tuning knob controls the operating frequency in 100Hz synthesized steps on SSB/CW, 10kHz steps on FM, with a switchable facility on the front panel giving 1kHz steps on all modes. Two digital VFOs are provided covering 50-54MHz, as well as six programmable memory channels and a programmable call channel facility, selected by front panel controls. Memory channels, together with the call channel if selected, may be scanned for activity, as well as the frequency range programmed between memory channels 1 and 2. Split frequency operation is possible between alternate VFOs, an equalising switch also being provided to match the two VFO frequencies. The main dial tunes at 5kHz per revolution on SSB (but see results later), and a 1MHz step button is fitted to get you to different parts of the frequency range quickly. The dial tunes continuously and a latching 'lock' button prohibits unintentional frequency shifts.

Frequency display is by a large LCD five digit display, with readout to 100Hz, ie when the squelch is raised, and transmit mode. Separate controls are provided for volume and squelch, the latter operating in all modes. A noise blanker can be switched on via a button on the front panel. This can operate on SSB and CW. A large S meter provides an indication from S1 through to S9, then in 20dB steps up to S9+60dB, doubling as a relative power meter on transmit and a switchable battery condition indicator. This together with the frequency display may be illuminated with an internal lamp when required. Front panel sockets are provided for an earphone/headphones, and CW key which can operate in a semi break-in mode with automatic Tx/Rx switching. Memory backup is achieved by four AA size dry cells inside the set with an estimated lifetime of one year. These may be replaced without loss of memory information.

The only rear panel switch selects 10W or 3W output power, and a recessed SO239 socket is also fitted on the back. The squelch knob doubles as a 0.5W power output switch. The set operates on nine C-size cells mounted in a plastic battery pack clipped into the side of the set, or a similar size NiCad pack available as an option. A small three pin power socket at the rear accepts 13.8V from an external source or a charging current from the optional NiCad charger. A set of dry batteries are provided with the rig on purchase, along with an instruction manual, full circuit diagram and PCB



The IC505 block diagram.

layouts. The equipment measures 76mm (H) × 230mm (W) × 188.5mm (D), and weighs 3.2kg including batteries.

In Use

On unpacking the carton, my initial thoughts were "Is this really a *portable* set?". It is a bit on the large side for this type of use as well as being fairly heavy, and I noted that the manual stated that a "heavy duty" shoulder strap was provided! Having said that, my comments on the FT690R as regards walk-along portable aerials apply equally to this set. Nevertheless it is certainly possible to carry it around but I would feel uncomfortable with it over my shoulder after a while.

Base station use is entirely a different matter, without reading the instruction manual first (doesn't that normally happen anyway?) I found the set very easy to operate. The memory operation was extremely easy to follow and the 1MHz step button would make QSYing around a larger frequency range very fast. The tuning step button was more often used though, because 5kHz per revolution of the large dial tended to be a little slow in getting from one place to another.

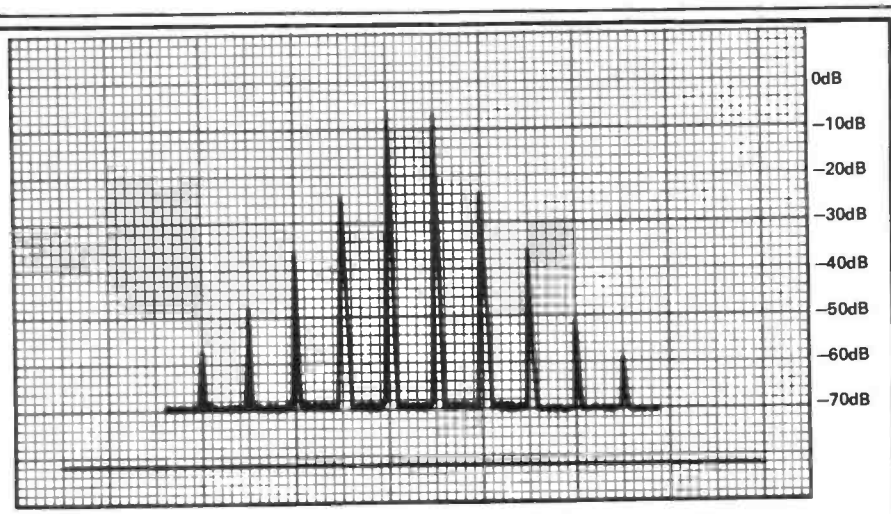
One problem encountered was that of a finite maximum tuning speed. If you rotate the dial slowly, sure enough you move around at 5kHz per revolution, but if you speed up the tuning using the finger hole provided, the synthesizer cannot keep up and the tuning rate is rather slower. This was a minor annoyance to me but may cause problems to a blind person counting the number of turns when QSYing off the calling channel.

The 'call channel' button was extremely useful giving instant access to 50.200 in my case. The main knob may be used to QSY from this and in fact any other memory frequency though this is not made clear in the manual — I found it only by accident. The squelch operation on SSB was extremely useful as well. Normally, I kept a listening watch on 50.200 or scanned a section of the band, the squelch raising and stopping the scan when a signal was found. This relieved the fatigue of listening to a constant hiss in the background when otherwise occupied in constructing or operating other bands when in the shack. One small problem was that it did take a reasonably strong station to open the squelch; those weak signals in the noise that could be brought up to full readability by rotation of the beam were lost.

The S meter appeared a little slow in lifting, weak but fully readable signals not registering a reading. The AGC seemed slow to come into operation, which meant that the volume required frequent alteration to permit readability. These two factors would suggest lack of overall gain, but the ultimate sensitivity appeared perfectly satisfactory. Again, the 100Hz steps were a slight annoyance, especially as the tuning dial perimeter had to be rotated about 2mm per step, I would have preferred more steps per revolution. The RIT control was a fully analogue device which was very useful as a fine tuning control on receive to interleaf between the 100Hz steps.

On transmit audio reports were again complementary using the supplied microphone with its built-in preamplifier. The 10W output gave good reciprocity to the power levels used by stations contacted, the majority copying me as well as I could copy them. Again no reports of 'spreading' were received and no problems were encountered from adjacent strong signals due to the generally low activity level at present.

Used mobile, the IC505 was still a touch on the large side but the noise blanker worked superbly in the car. I feel this is very important if SSB mobile operation is to be contemplated when or if allowed in the future. Noise levels from adjacent



IC505 two tone transmitter IMD test again at high power setting.

cars in a traffic jam can certainly mess you up even though you have suppressed yours to the best possible level, especially at this frequency band.

Examination of the block diagram shows that noise blanker signal muting is performed before the crystal filter. This is very good engineering practice, if it can be achieved, as the filter can stretch noise pulses to many times their original length, hence degrading readability much further. If the signal is blanked before the filter, the pulse lengths are relatively short and hence less information is lost.

In mobile reception, the main tuning knob was a little difficult to use when fine tuning because of vibration effects; it was too easy to place it on the brink of one of the tuning steps. An optional microphone with up/down buttons is available and this I feel would be useful here. The review set was not fitted with the optional FM unit so this could not be tested.

The aerial mounting is stood off from the side of the equipment, if space is at a premium for permanent installation either in the shack or mobile, this moulding could easily be removed by undoing four screws and desoldering and insulating the internal aerial connection wire. This would no doubt void any warranty though.

Laboratory Tests

The receiver sensitivity was found to be extremely good, but as found in practice there seemed to be a slight lack of overall gain; the AGC only beginning to act at an input signal level of 0.31uV pd. The S meter gave an indication only above this level, being AGC voltage derived. It gave a more reasonable, though rather non-linear, indication above this level.

The selectivity was very good, and little evidence of reciprocal mixing was evident. Apparently, the VCO tuning line is filtered more and hence the observed inability to keep up with fast tuning speeds. The multi-pole IF crystal filter fitted is hence used to its best effect. The intermodulation rejection was a little on the low side at 63dB, probably due to the gain distribution being a little on the wrong side. This has resulted in a very sensitive set and I would advise against fitting a preamp in line unless this is switchable and purely to overcome feeder loss. Blocking rejection from strong signals was good.

Harmonics and other spurii should not cause too many problems apart from the inevitable second harmonic in the middle of the broadcast band, and a low pass filter is advised as usual. The two tone spectrum was reasonable for a 10W solid state PA, you lower the output power by altering the drive level to the PA; this normally cleans up the signal further.

I was not too impressed by the current drawn, especially on receive at 182mA with no signal received, though this is within the declared specifications of the set. Operation on the internal batteries would cause them to drain quicker than I would have expected.

Conclusion

Quite a reasonable performer, especially for home and mobile use. Walk-around portable operation is possible if a bit on the difficult side with the bulk and battery drain. It is very easy to operate even with clumsy fingers and ergonomically well designed if a little on the large side by today's standards.

Many thanks to Thanet Electronics of Kent for holding on to their last 6m rig for our reviewer.

IC505 Laboratory Results

All measured at 50.5MHz

Receiver

Sensitivity for 12dB SINAD: **0.13uV pd for SSB/CW**

Squelch threshold level: **0.25uV pd for SSB/CW**

Selectivity

3dB	1.3kHz
6dB	2.3kHz
60dB	5.5kHz

Two signal intermodulation rejection: **63dB**
(measured as FT690R)

Blocking
(measured as FT690R)

+1MHz	108dB
−1MHz	110dB

S meter linearity

S1	0.48uV pd	−12.4dB
S2	0.61uV pd	−10.3dB
S3	0.78uV pd	−8.2dB
S4	0.91uV pd	−6.8dB
S5	1.03uV pd	−5.8dB
S6	1.12uV pd	−5.0dB
S7	1.26uV pd	-4.0dB
S8	1.69uV pd	-1.5dB
S9	2.0uV pd	0dB ref
+20dB	4.6uV pd	+7.2dB
+40dB	17.3uV pd	+11.5dB
+60dB	1.8mV pd	+40.4dB

Current consumption

Squelch closed	182mA
Squelch open, vol at mid point	205mA
Extra indicator light current	55mA

Transmitter

Power output

	PEP Power	Current Drawn
High	10.6W	1.76A
Mid	2.2W	690mA
Low	310mW	380mA

Harmonics and spurii

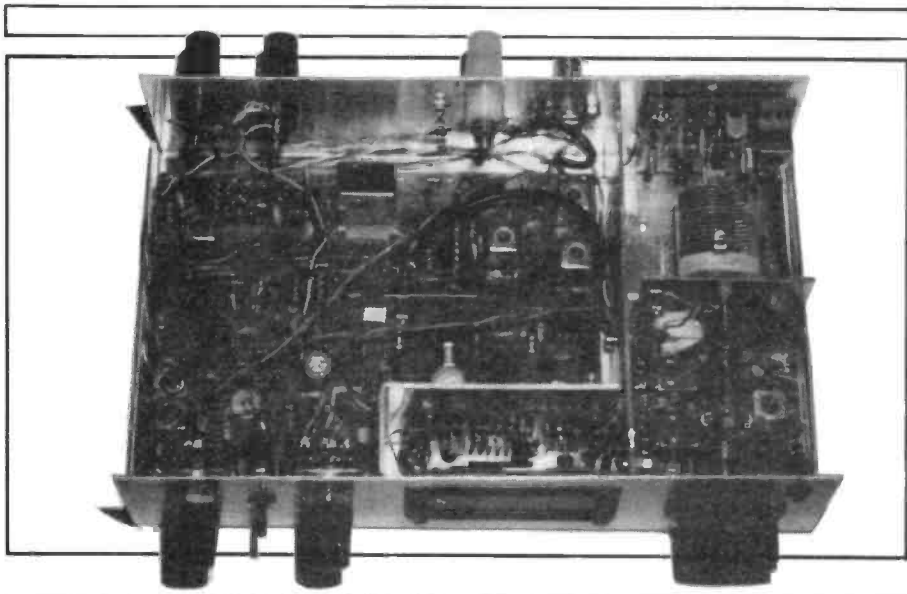
Second harmonic: **−57dBc**

All other harmonics and spurii: **less than −70dBc**

Two tone IMD distortion

Order	dB relative to PEP
3rd	−23/−23
5th	−36/−35
7th	−47/−50
9th	−56/−58

The Modula Receiver part 2



How to build this modular all band HF CW/SSB receiver by S Niewiadomski.

Construction

With the exception of the controls VR1, VR2, SW1 and VC1, sockets SK1-5 and the power-on LED, all components are mounted on one of five single-sided printed circuit boards, PCB1-PCB5. The etching patterns and component layouts for these PCBs are shown in **Figs. 7-16.** I have purposely not cramped the component and track spacing so that the PCBs can be reproduced easily using a Dale (etch resist) pen by anyone with a reasonably steady hand.

The first stage in producing one of the PCBs is to either photocopy the etching pattern or trace the hole positions onto a piece of transparent or translucent paper. *If the photocopying method is being used, check that the original dimensions are maintained on the copy, as many photocopiers produce distorted copies.* Cut a piece of single-sided copper-clad board to the correct size and stick the photocopy or tracing onto the board. Mark the position of each hole (including the 3mm fixing holes) onto the board with a centre punch and hammer. Then remove the paper and drill and deburr the 3mm fixing holes. Clean the board with a liquid abrasive cleaner such as 'Jif', rinse and dry it.

The track pattern can now be drawn carefully on the board, using the hole marks as a guide to the track positions. It can be seen that only the minimum amount of copper is removed on the boards, the unused area being used as an 'earth plane'. The earth plane helps the RF performance of the boards and has enabled single-sided boards to be used without any instability problems being encountered.

When all the tracks and the earth plane have been drawn, allow the etch resistant ink to dry for at least 15 minutes and then insert a piece of insulated wire through two of the fixing holes. Place the board in a bath of ferric chloride solution trackside-up so it is completely submerged and use the wire to agitate it until etching is complete. Finally, remove the board from the solution and clean off the resist ink with a suitable solvent.

Drill all the remaining holes in the board with a 1mm drill, then open out the holes shown on the component layouts to 1.5mm.

Mounting the components on each board should be done by starting at one corner of each board and working to the opposite corner mounting each component as it occurs. This method is to be preferred to mounting all the resistors first, then the capacitors, and so on, as by experience it results in less missed out components. Take the normal handling precautions with the JFETs and ensure that your soldering iron is earthed. On the prototype boards, all the dual-in-line ICs were fitted with sockets rather than soldering them directly to the PCBs, for easy fault finding.

Pinouts of the active components, shown in **Fig. 17**, help to orientate them on the boards. Terminal pins were used on the prototype boards for the inter-board connections. These allow connections to be soldered and unsoldered while the boards are fixed in the case, again aiding fault-finding. The only exception to these terminal pins is for the audio output from PCB4, where PL401 is fitted to the board so that the lid is not permanently attached to PCB4 by the wires to SK3.

Power distribution leads are run out separately to each PCB as twisted pairs from SK4 (+12V) and SK5 (OV).

Mechanical Details

A ready made case is used to house the receiver, thereby greatly simplifying the metalworking required. Drilling and cutting (for the frequency display module) details for the chassis are given in **Figs. 18 19** and **20.** SK1 on the prototype was a 50 ohm square-based BNC socket, but the constructor might choose to use a round BNC or SO239 socket. Any type of LED may be used for the POWER ON indicator, or it could be omitted altogether.

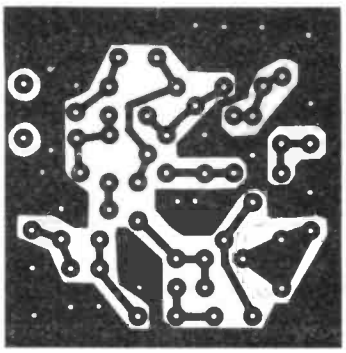
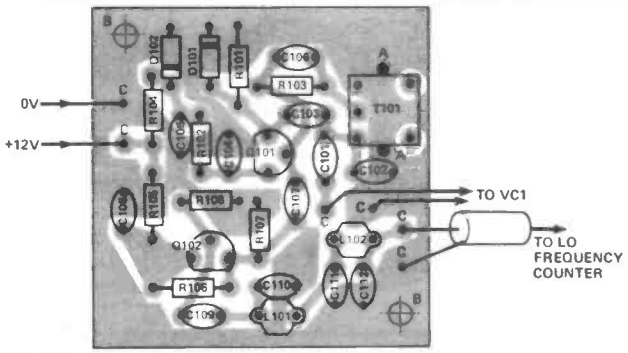


Fig. 7 The foil pattern of the VFO board (PCB 1).



DRILLING KEY:
● = 1mm DIA
A = 1.5mm DIA
B = 3mm DIA
C = TERMINAL PIN FITTED, HOLE LEFT AT 1mm

Fig. 8 The component overlay of the VFO board (PCB 1).

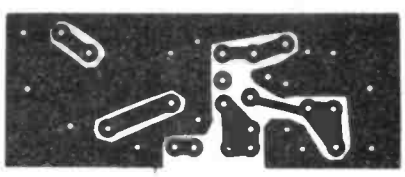
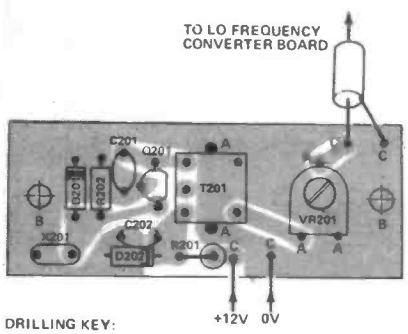


Fig. 9 Foil pattern of the 21MHz crystal oscillator board (PCB 2). Right: the component overlay for the board.



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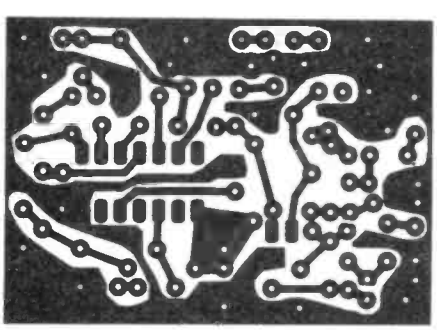
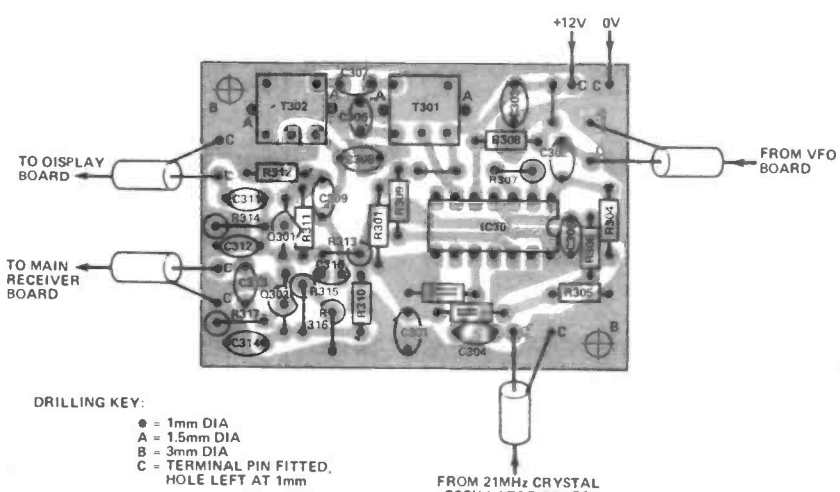


Fig. 11 The foil pattern of the local oscillator frequency converter board (PCB 3). With Fig. 12 the component overlay on the right.



DRILLING KEY:
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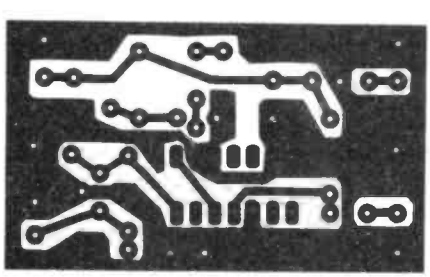
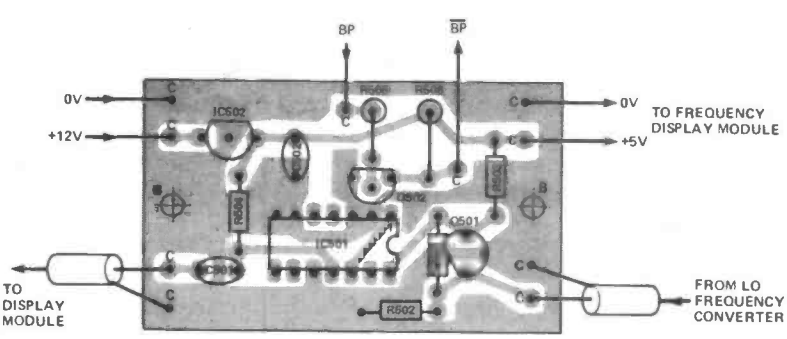
A = 1.5mm DIA
B = 3mm DIA
C = TERMINAL PIN FITTED, HOLE LEFT AT 1mm

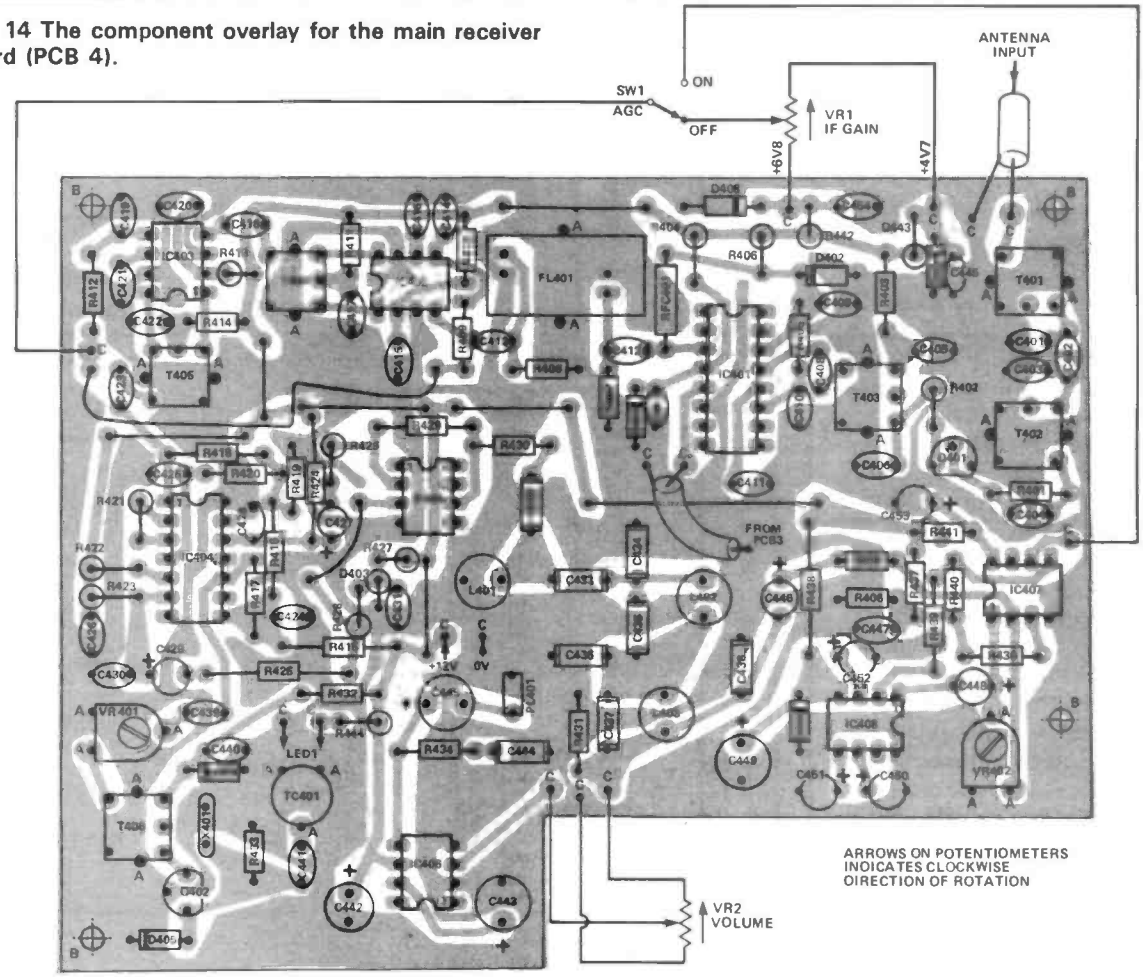


Figs. 15 and 16 The foil pattern and component overlay for the frequency display board (PCB 5).



DRILLING KEY:
● = 1mm DIA
B = 3mm DIA
C = TERMINAL PIN FITTED, HOLE LEFT AT 1mm

Fig. 14 The component overlay for the main receiver board (PCB 4).



DRILLING KEY:
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A = 1.5mm DIA
B = 3mm DIA
C = TERMINAL PIN FITTED, HOLE LEFT AT 1mm

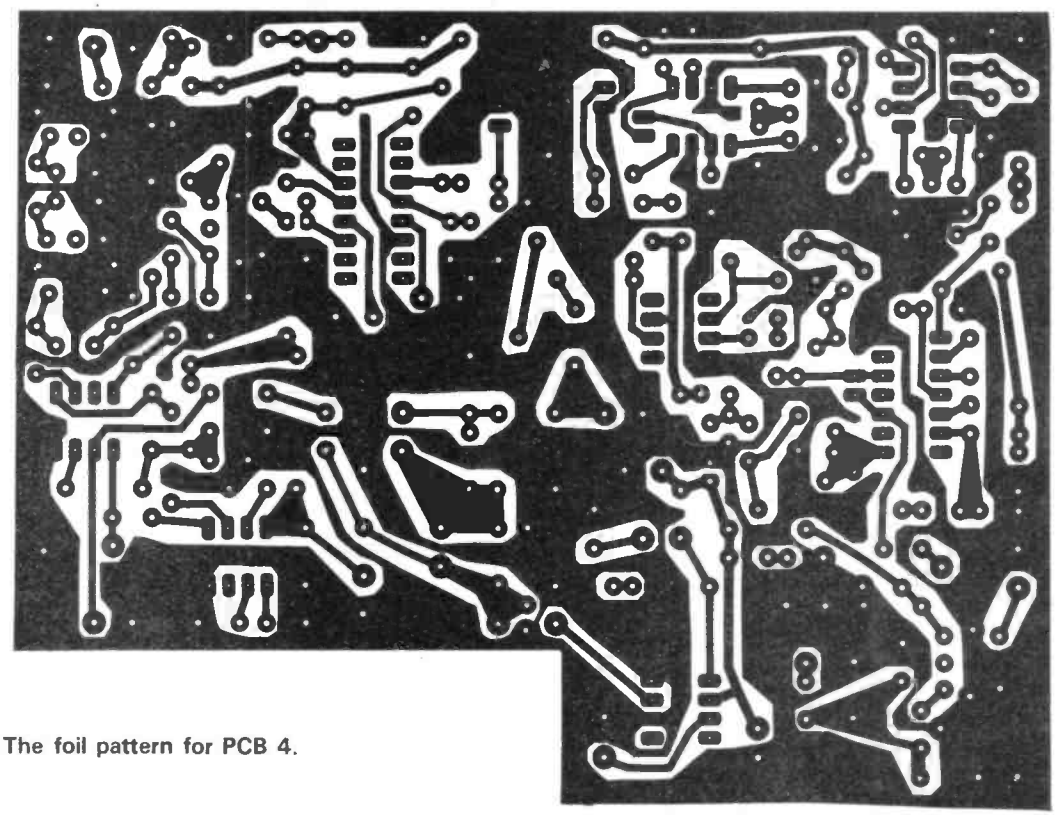

Fig. 13 The foil pattern for PCB 4.

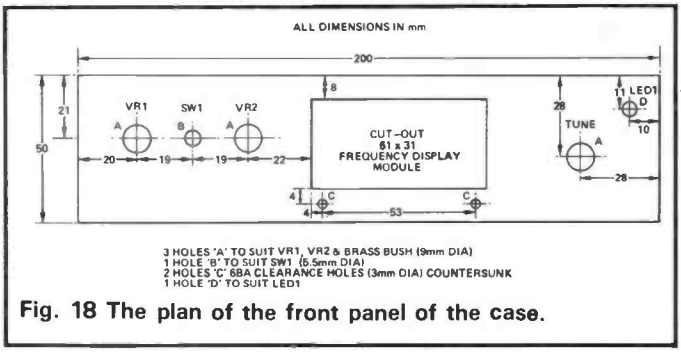

Fig. 18 The plan of the front panel of the case.

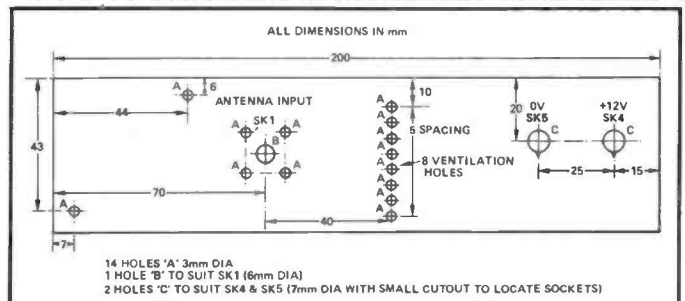

Fig. 19 The drilling details of the rear panel.

A total of 13 (eight in the rear panel and five in the bottom) ventilation holes are provided to allow the heat produced by IC401 to dissipate as this device runs rather warm.

Fig. 21 shows the dimensions for three aluminium brackets which act as supports and screens in the chassis. Again, it is better to bend and drill the brackets before drilling the fixing holes in the chassis bottom. Inaccuracies in the brackets can then be corrected without having to file oval holes in the chassis. The cut-outs in the lower edges of brackets B and C are to allow the receiver wiring to pass between the compartments formed and are not dimensionally critical.

When the chassis metalwork is finished and all the components have been shown to fit onto it correctly, the front panel can be rubbed-down and painted if required. Lettering can then be applied and finally a coat of clear lacquer sprayed on as protection.

Fig. 22 shows the positions of the major items which fit into the chassis. All the PCBs are held in the chassis by ½" long 6BA screws which are first fixed in the chassis

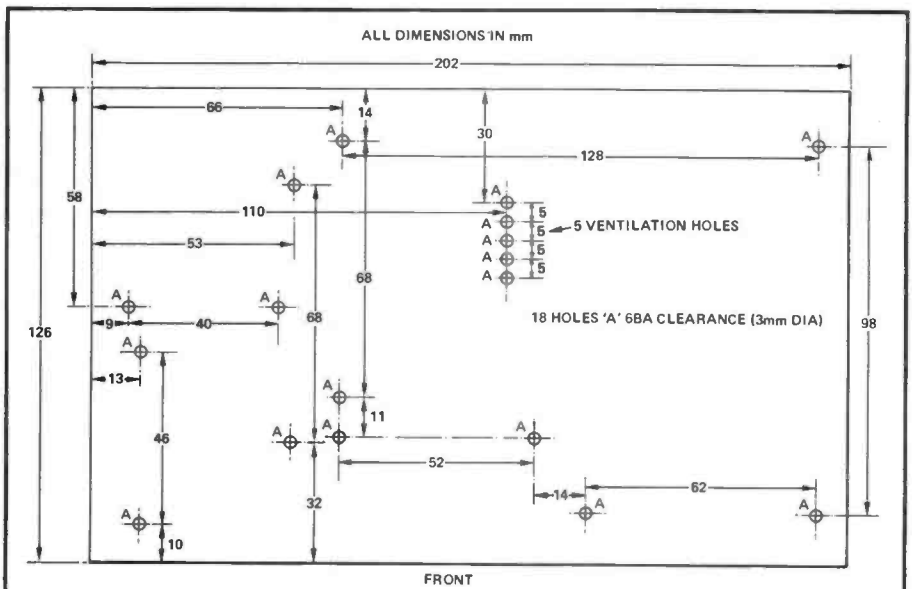

Fig. 20 The main chassis drilling details.

with 2 6BA nuts. The board is then fitted over the protruding part of the screw and further 6BA nuts used to fix the board.

A 48mm length of 6BA studding prevents the two 6:1 reduction drives from rotating by holding their upper flanges vertical and anchored to bracket A. Be careful to get the spacing between the drives correct, as they have to clear T201 on the crystal oscillator board. A brass bush is fitted to the front panel where the front reduction drive shaft passes through the panel. This gives support to the shaft and produces a smooth action when the tuning knob is rotated. Don't tighten the nut on the bush too tight, as this can twist the shaft due to slight misalignments between bracket A, the drives and the front panel and cause the turning action to be stiff.

Drilling details of the lid are shown in **Figs. 23** and **24**. These holes allow the loudspeaker, LS1, to be mounted inside the lid top using the four small aluminium brackets and the headphones socket, SK3, to be mounted on the left hand side (when viewed from the front) of the lid. Holes are provided to allow the sound output of the loudspeaker to escape without having to cut a large hole and fit a grill. Five more ventilation holes are drilled in the lid, vertically above the SL6440 to further improve heat convection from this device.

SK2 is made from a 3-way cable shell with two crimp ter-

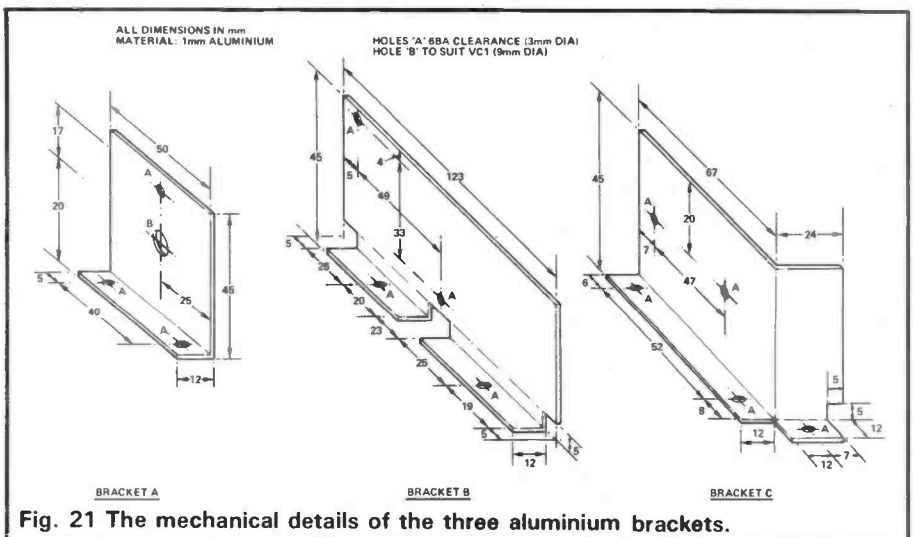

Fig. 21 The mechanical details of the three aluminium brackets.

minals inserted into the outer holes. This matches the 0.2" pin spacing of PL401 on PCB4.

Testing and Alignment

With a receiver such as this, it is best to test and align each board as it is fitted into the case rather than to assemble the whole receiver and then begin testing. This is because if a fault such as excessive supply current is detected, each board would have to be disconnected in turn until the fault clears. It is rather disheartening to have to take a receiver apart just after carefully assembling it.

The first step in the alignment procedure is to commission the VFO. Starting with a fully drilled but empty chassis, fit VC1 to bracket A and a knob to the shaft of VC1. Do not fit the slow motion drives yet. Now fit bracket A into the chassis with two 6BA screws and nuts. Fit the power supply sockets, SK4 and SK5, and the fully assembled VFO board PCB1. The orientation of PCB1 can be seen from Fig. 22. Wire the power supply connections from PCB1 to SK4 and SK5 using a pair of wires twisted together. Route this wiring in the rear corner of the chassis, allowing enough slack to pass through the cut-out in bracket B when it is fitted. Connect VC1 to PCB1.

Connect a stabilised 12V supply to SK4 and SK5 with a milliammeter of at least 400mA FSD in series with one connection. Switch on and check that the current taken is about 32mA. If it is greatly more than this, switch off and look for incorrect wiring or short circuits on PCB1. If the current taken is

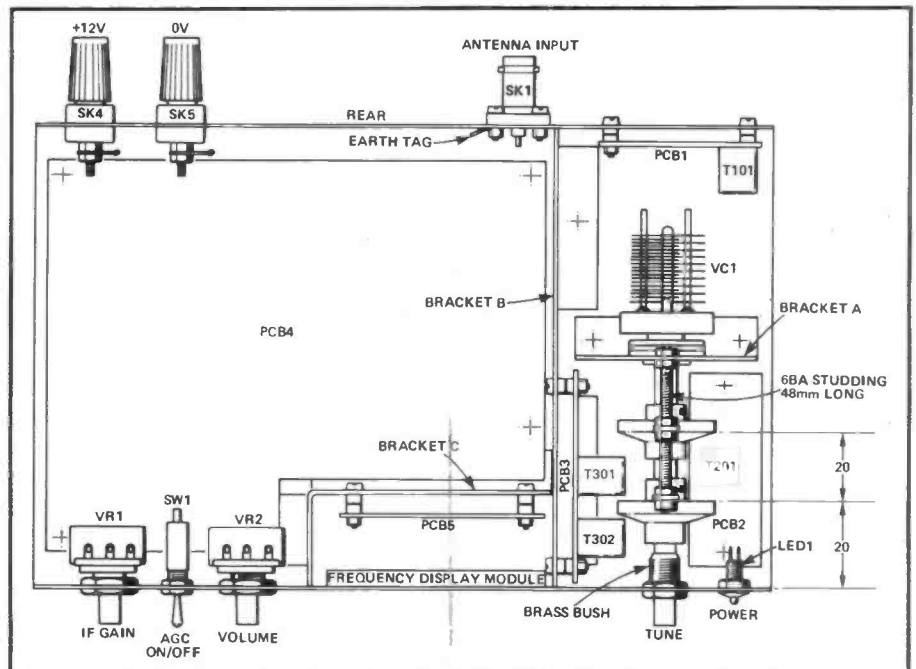

Fig. 22 A view from the top, showing the positions of the major items.

reasonable, check that the voltage across D102 is within 5% of 6.8V, then monitor the output at the 3.7-4.2MHz output pin with an oscilloscope, if available. The output should be a sine wave of approximately 300mV peak-to-peak.

Using a frequency counter or a general coverage receiver, measure the frequency of oscillation with the vanes of VC1 fully meshed. This frequency should be adjusted to be say 50kHz below 3.7MHz by rotating the core of T101 with a plastic alignment tool. Then rotate VC1 to minimum capacity and the frequency should be approximately 50kHz above 4.2MHz. If the overlap at the band edges is greater than 50kHz, it does not matter too much as the 36:1 reduction ratio will still give an acceptable fine tuning rate. As far as the VFO is concerned, that is all that needs to be done. If the receiver is only required to cover 14.0-14.35MHz, a restricted local oscillator injection frequency range of 24.7-25.05MHz can be obtained by adjusting the VFO to cover 3.7-4.05MHz. This is achieved by changing C101 to 390pF and C102 to 270pF.

Now fit the 21MHz crystal oscillator board, PCB2, into the chassis. Connect its power supply leads to SK4 and SK5. The current taken should now be approximately 18mA higher than before. Check that the voltage across D202 is within 5% of 6.8V. Monitor the output pin (the wiper of VR201) and rotate the core of T201 until oscillation is seen. Adjust the core of T201 to give the maximum output level. With the output at its

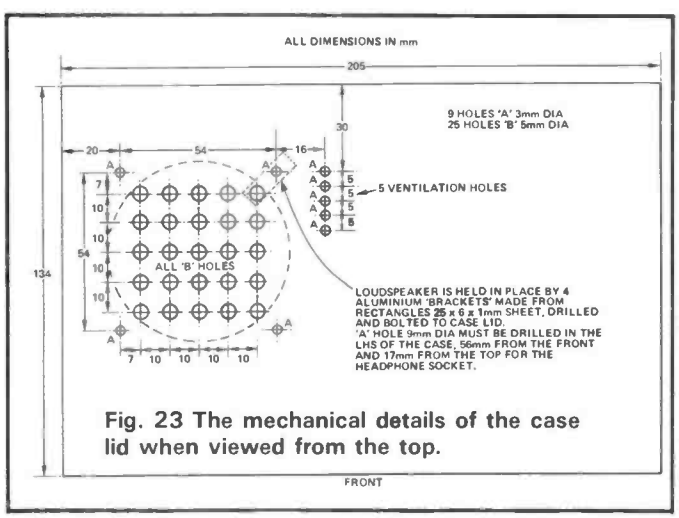

Fig. 23 The mechanical details of the case lid when viewed from the top.

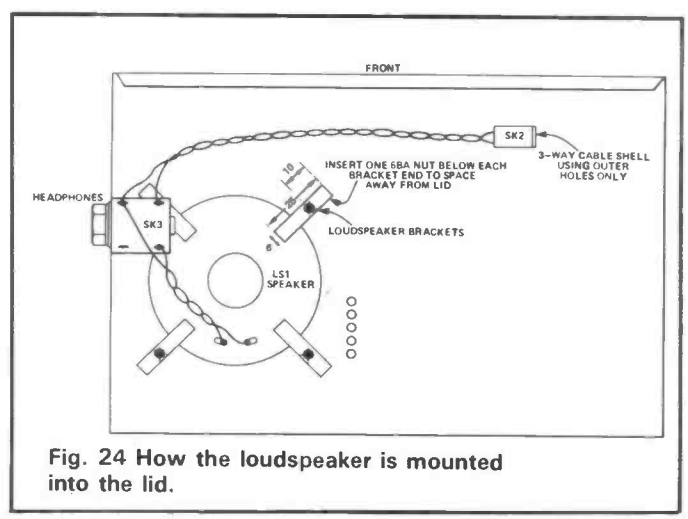

Fig. 24 How the loudspeaker is mounted into the lid.

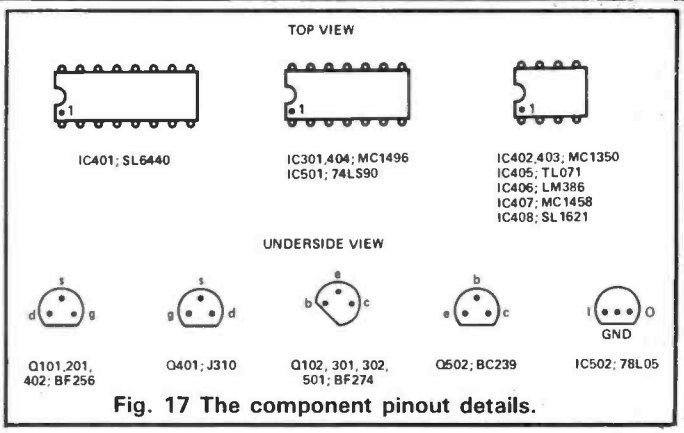

Fig. 17 The component pinout details.

maximum level (VR201 fully anticlockwise) an amplitude of approximately 6V peak-to-peak should be seen. Back off VR201 to about half way.

Fit the local oscillator frequency converter board, PCB3, to bracket B and mount the bracket in the chassis. Connect PCB3 power supply leads and the inputs from PCB1 and PCB2 using miniature coax such as RG174. The current taken should now be approximately 40mA higher. Monitor the AC voltage on IC301 pin 10 and adjust VR201 (on PCB2) to set this level to approximately 850mV peak-to-peak.

Set the VFO frequency to approximately 4MHz and monitor the output of one of the emitter follower stages (Q301 and Q302) on PCB3. Adjust the cores of T301 and T302 to give maximum output at 25MHz. The tuning of T301 and T302 is not too sharp, so that when maximum output at 25MHz has been obtained, the output should remain at almost constant amplitude as the VFO is tuned from 3.7-4.2MHz. When a satisfactory output from one emitter follower stage has been obtained, monitor the other one and check for similar results.

Doing The Display

Connect the power supply leads of the frequency display board, PCB5, to SK4 and SK5 but do not fit the board into the case or connect the frequency display module yet. The power supply current should now be about 20mA higher than before. Check that the output from IC503 is at 5V. Now fit PCB5 to bracket C and make the connections between PCB5 and the display module, being careful to connect the power leads correctly. It is a little awkward to get the connections between PCB5 and the display module the correct length, so keep trying bracket C and the module in their final positions as the connections are made until satisfactory lengths are obtained. Finally, connect the 24.7-25.2MHz output from PCB3 to PCB5 and mount bracket C and the display module in the chassis. The display module only consumes approximately 4mA supply current and so no drastic increase in the total consumption should be noticed.

As the VFO frequency is swung between 3.7 and 4.2MHz, the display module should display 14-14.5MHz. If a changing display is obtained, but not of the correct value check the connections on the edge connector of the module, as the wrong IF offset may have been programmed. When the correct readings are obtained the length of coax which connects PCB3 to the mixer on PCB4 can be soldered to PCB3 and routed through the middle cut-out in bracket B. To complete the connections which have to be made in the frequency converter compartment, fit LED1, solder a pair of wires to its terminals and route these also through the middle cut-out in bracket B. The slow motion drives and brass bush can now be fitted.

Testing Main Receiver PCB

The main receiver board, PCB4, can now be fitted and tested. Connect its power supply pins to SK4 and SK5; the aerial input to SK1; the controls VR1, VR2 and SW1; LED1; and the coax from PCB3. Set VR1 (IF Gain) and VR2 (Volume) to minimum gain position (fully anticlockwise); SW1 to AGC off; and VR401 (CIO Level), TC401 (CIO Frequency), and VR402 (AGC Threshold) midway. When switched on, the total supply current should now be approximately 320mA and LED1 should light. If it does not light, it is probably wired the wrong way round.

Check that the voltages across all the zener diodes (8 in all, on this board) are within 5% of their nominal values.

Inject a sine wave of approximately 100mV peak-to-peak at 14.25MHz into the antenna input and monitor T402 pin 6. Adjust the cores of T401 and T402 for maximum output of T402 pin 6. These adjustments are dependent on each other, so adjust each core in turn several times until the highest output possible is obtained. Now monitor T403 pin 4 (or IC401 pin 13) and adjust the core of T403 for maximum signal. The response of T401, T402 and T403 is sufficiently broad that only the adjustment at 14.25MHz needs to be carried out.

Check that the local oscillator input at IC401 pin 5 is approximately 800mV peak-to-peak. Monitor IC402 pin 4 and tune the receiver VFO until a signal at 10.7MHz is seen. Now move to IC403 pin 4 and rotate VR1 clockwise until a signal at 10.7MHz is again seen. Adjust the core of T404 to peak the signal. Very little gain is needed from IC402 to overload the input to IC403, so the 14.25MHz input signal can gradually be decreased as VR1 is rotated. T405 can now be peaked by monitoring IC404 pin 1, again adjusting the 14.25MHz input level and VR1 to avoid overloading the output of IC403.

The frequency and level of the output of the carrier insertion oscillator can now be set. Monitor

COMPONENTS LIST

PCB1

R101	100K
R102,105	100R
R103	150R
R104	270R
R106	22K
R107	10K
R108	220R

All resistors are 0.25W 5% carbon film type

C101	220p cer
C102	820p cer
C103	100p cer
C104,105,106,108	10n DISC cer
C107,109	4n7 cer
C110,112	330p cer
C111	470p cer
T101	KANK3337R (Toko)
L101,102	8u2 7BS (Toko)
D101	1N4148
D102	6V2 400mW zener
Q101	BF256
Q102	BF274

1mm (0.040") terminal pins

Toko products can be obtained from: Cirkit Holdings PLC (Tel. 0992 444111) or Bonex Ltd (Tel. 01-992 7748)

PCB2

R201	330R
R202	100K

All resistors are 0.25W 5% carbon film type

VR201	470R preset min. horiz.
C201	47p cer
C202	10n disc cer
T201	KXNK3767EK (Toko)
X201	21MHz crystal HC18U (Cirkit 45-21000)
D201	1N4148
D202	6V8 400mW zener
Q201	BF256

1mm (0.040") terminal pins

PCB3

R301	1K5
R302	820R
R303	56R
R304,314,317	220R
R305,306	1K
R307,310,313	100
R308,311,312,315,316	100R
R309	2K2

All resistors are 0.25W 5% carbon film type

C301,303,305,312,314	10n disc cer
C302	4n7 cer
C304	1000p cer
C306,308	33p cer
C307,309,310	12p cer
C311,313	100p cer
T301,302	KANK3335R (Toko)
Q301,302	BF274
IC301	MC1496

14 pin IC socket (if required)

1mm (0.040") terminal pins

PCB4

R401,403,406,410,411,413,414,421, 441	100R
R402	22R
R404,438	470R
R405,432	270R
R407,408	620R
R409,412	4K7
R415,443	1K2
R416	820R
R417,430,431,442	560R
R418,419,420,427,437	1K
R422,425,426,428,429,435,436	10K
R423,424	2K7
R433,439,440	100K
R434	10R
R444	1K5

All resistors are 0.25W 5% carbon film type

VR401	470 preset min. hori.
VR402	10K preset min. hori.
C401,403,406,441	22p cer
C402	3p3 cer
C404,405,407,409,410,415,416,417, 420,421,422,424,425,426,431,440, 447,454,455	10n disc cer
C408,411,412,413,418,423,428,430, 439	1000p cer
C414,419	4n7 cer
C427,429,446	1u 35V tantalum
C432,433	0u47 poly
C434	0u18 poly
C435	22n poly
C436	0u22 poly
C437	56n poly
C438	0u15
C442,443,445	100u 16V radial electro
C444	47n poly
C448,453	10u 16V tantalum
C449	470u 16V radial electro
C450,452	100u 10V tantalum
C451	47u 16V tantalum

TC4015-60p foil trimmer (Cirkit 06-60001)

X401	10.7015MHz HC18U crystal (Cirkit 45-10006)
T401,402,403	KANK3334R (Toko)
T404,405	KACKS3894A (Toko)
T406	KALSA4520A (Toko)
L401	220m 10RBH (Toko)
L402	27m 10RB (Toko)
L403	22m 10RB (Toko)
RFC401	470u axial RF choke (Cirkit 35-71474)
FL401	10M02DS 10.7MHz SSB filter (Cirkit 20-10022)
PL401	3 way (middle pin cut out) PCB plug (Cirkit 10-03010
D401,409	4v7 400mW zener
D402,403	6v2 400mW zener
D404,407,408	6v8 400mW zener
D405	1N4148
D406	9v1 400mW zener
Q401	J310 (Cirkit 59-02310)
Q402	BF256
IC401	SL6440
IC402,403	MC1350
IC404	MC1496
IC405	TL071 (Texas)
IC406	LM386
IC407	MC1458
IC408	SL1621

8 pin IC sockets 6 off (if required); 14 pin IC socket 1 off (if required); 16 pin IC socket 1 off (if required) and 1mm (0.040") terminal pins.

PCB5

R501	22K
R502	10K
R503	1K
R504	4K7
R505	100K
R506	47K

All resistors are 0.25W 5% carbon film type

C501,502	10n disc cer.
Q501	BF274
Q502	BC239
IC501	74LS90
IC502	78L05

14 pin IC socket (if required)

1mm (0.040") terminal pins

Miscellaneous Items

VC1	100p Jackson type C804
VR1	4K7 lin carbon pot
VR2	10K lin carbon pot
SW1	single pole min toggle
LED1	power on LED (any type, see text)
SK1	BNC 50 ohm or sim
SK2	3 way (middle pin cut out) cable shell Cirkit 10-03001) with 2 crimp terminals (Cirkit 10-03030)
SK3	1/4" mono headphone socket
SK4,5	4mm insul terminals, red and black

Case type SB3 (Electrovalue); stick on feet (4); frequency display module (Farnell 170-383); 8 ohm 2.5" dia loudspeaker; reduction drives 6:1 1/4" spindles type Electrovalue 4511 (2 off); brass bush 1/4" spindle (Maplin RX31J); small knobs (to suit VR1, 2); large knob 35mm skirt (to suit slow motion drive); 6BA screws, nuts, studding; miniature coax (eg RG174A), connecting wire and 1mm thick aluminium sheet for brackets.

the wiper of VR401 (or IC404 pin 10) and adjust the core of T406 until oscillation is seen and the amplitude is at a maximum. Measure the frequency and rotate TC401 until this is 10.7015MHz. Adjust VR401 until the level at IC404 pin 10 is approximately 850mV peak-to-peak.

An audio frequency sine wave should now be present at the output of IC405 whose frequency varies as the VFO is tuned. An idea of the response of the audio bandpass filter can be obtained by monitoring its output on an oscilloscope while tuning the VFO and measuring the frequency at the output of IC405. Little variation in the filter output should be evident for input frequencies between 300Hz and 3kHz, with rapid decrease in the output level outside this frequency range.

Now monitor IC406 pin 3 and ensure that adjustment of VR2 varies the level at this point. The loudspeaker can now be connected (by inserting SK3 into PL401) and the audio tone should be heard.

AGC operation can now be checked. The exact setting of the AGC Threshold control (VR402) should be obtained by listening tests but confirmation that this circuitry is operating correctly can be obtained at this stage. Monitor IC407 pin 1 and check that the output from the audio filter is attenuated by varying levels as VR402 is adjusted. Set VR402 to midway. Disconnect the 14.25MHz signal from the antenna input and monitor the DC voltage on IC408 pin 2. This should be close to 0V. Now measure the voltage on IC407 pin 7; this should be close to 5V. Reconnect the 14.25MHz input. The voltage at IC408 pin 2 should start to increase in sympathy with an increase in input level after a certain threshold point has been reached. This threshold should be adjustable by VR402. IC408 pin 2 should vary between 0V and 5V depending on the 14.25MHz input level and the setting of VR1. The corresponding variation at IC407 pin 7 should be 5 to 7V.

Now switch SW1 to the AGC on position and monitor the output of the audio filter. As the 14.25MHz input level is varied slowly, the audio level should remain constant. A voltmeter connected to the wiper of SW1 will show the changing IF gain control voltage which keeps the audio output constant as the RF input level is varied. If the RF input is suddenly removed, this control voltage will be seen to remain constant for approximately 1 second before rapidly falling to 5V to return the IF amplifier integrated circuits to full gain. This is the 'hang' facility which IC408 provides, holding the IF gain constant during inter-syllabic and inter-word breaks in transmission and then returning to high gain when a break is long enough to indicate a probable end of transmission.

This completes the testing of the receiver. It should now be capable of operating correctly and very efficiently on the 14MHz band.

In next month's issue we will describe the construction of matching converters for the MODULA for all amateur bands from 1.8-30MHz.

Free Readers' ADS!

WANTED

WANTED SMC ATU also rotator. Phone 0283 221870. Also Nato 2000 beam 28 or 27MHz. Phone 0283 221870.

WANTED Trio TR7010 or IC202 transceivers cash waiting. Ring Keith 01 290 5827 af 5.45pm.

WANTED by pensioner, cheap Arac 102 receiver. Mr W E Gates, 16 Highmill Drive, Scarborough, North Yorkshire YO12 6RN Tel (0723) 365093.

WANTED manual for Trio 9R 59DS Rx, original or photo copy. Ken Robinson 0908 75479.

WANTED NATO 2000 SMC ATO aerial suitable 0-30 MHz. Phone 0283 221870. For sale, Turner base mic T3B, offers. Yaseu FT7000 digital readout, perfect working order, £250. Phone 0283 221870.

WANTED 4CX250B HF base and chimney. Phone Corby 201697 after 7 pm.

WANTED Practical Wireless Radio Constructor 1960-1980, good price paid. J. Savage, 7 Weyhill Close, Swindon, Wilts. SN3 2NW.

WANTED late Trio TR7930 VHF transceiver, also Signal Communications Co. R532 airband receiver. Tel: Colchester 394336, Essex.

WANTED Yaesu FT 77 100 watts, also PSU, good condition, good price given. William McCann, 1 Ross Rd., Belfast 12, tel: 242663, N. Ireland.

CAN anyone help? I need my ham multmode 11 CB rig converting to 10m. Does anyone know where I can get it converted (preferably London, Home Counties). Write Dave, 27 Pragnell Road, London SE12 0LF or call 01-851 0723 anytime — thanks.

WANTED Pye Labgear Compac 8 HF SSB 2-9MHz rig. Phone, G3IAG, 0638 730373 or write 24 High Street, Cheveley, Newmarket, Suffolk CB8 9DQ.

WANTED Grundig Satellite 2000. Telephone Reading 580410 anytime.

XTALS glass encapsulated wanted, 3.5-3.6MHz HC6U holders. G3IPV, Haylett, Vancouver House, Kimberley Road, Bacton on Sea, Norfolk NR12 0EN.

WANTED multi valve table mains radio bluespot FM MW LW SW Nordmende etc, also FRG 7 or FR101S or JR5999 custom special, mint condition. Praze 831236 or Praze 831149.

WANTED for Vic 20. CW transceive software and interface. Other radio software wanted. Also wanted for VIC 20; 16K RAM cartridge, programmers, aid cartridge and other hardware/software. Reasonable prices only please. Phone 084 82 (Moniaive) 314 or send SU12, PO Box 8, Dumfries, Scotland.

WANTED for school radio society, AR88D or any similar HF rx, very cheap please (free if possible). Contact, GI10LK, 12 Grange Valley Green, Ballyclare, Co. Antrim, N. Ireland, phone Ballyclare (09603) 41511 evenings, ask for Jason.

DX302 general coverage receiver 0-30MHz AM/SSB/CW mains/battery, handbook, boxed, excellent condition, £135 ono or exchange Spectrum Plus computer. Mr Howard, 9 St. Catherines Road, Crawley RH10 3TA.

WANTED service manual for Heathkit oscilloscope model OS1, all exp paid. Ring Plant, 0278 423288.

YAESU FT-101ZD transceiver wanted with all bands. Prefer

FM fitted, must be excellent throughout, no modifications. Remote VFO considered also. Please call for a chat, if you are selling. Phone: Eddie, G0AQI, 01-445 0528 (North London) anytime.

WANTED FTV901R for FT1012D, must have 2 metre module. Phone 061 226 2316, Mr Ross, Manchester.

WANTED SSB adaptor for Grundig Satellit 2100 receiver. Please write or telephone 0642 559845.

WANTED FRA 7700 active antenna for Yaesu 7700 receiver, price reasonable. 0436 71181.

WANTED details and/or service manual for Telequipment oscilloscope S54A. Copy will do or will copy and return original with expenses. Alan Elcoate, 199 Rising Grove, Laindon, Essex, or phone Basilton 45573 after six.

WANTED Yaesu FT101 transceiver 160-10m AM/SSB/CW, must be in mint condition and in perfect working order, cash waiting. Write to Peter Burbeck, 70 Homefield Rise, Orpington, Kent BR6 0RW.

EDDYSTONE solid state HF communication receiver type 760 12V battery powered or similar. P/C in first instance please with details, condition, price, etc, to 121 Mays Lane, Stubbington, Hants. PO14 2ED.

WANTED advice how to modify Racal RA218 SSB adaptor to work with Racal RA17L receiver. N. Rowley, 11 Brewer Road, Bulkington, Nuneaton CV12 9RF, tel: 0203 491245.

WANTED Datong auto speech procesor, 4:1 and 1:1 balun preferable toriodal 2½" core type 1K + valve combined, SWRT power bridge up to 1K. For sale convertor MMATV, also Yaesu tranvertor 901R, perfect condition, 2m 70c and 50m. Board fitted professionally multimeter variance power from 1-20W, also new C5 fibre 2m COL NSVR U650, would part-ex for HF rig 16 757/707 77. Scarisbrick (Lancs.) 880345.

WANTED LAR HF omni-match 1.8 to 30 MHz. Phone 0253 721596 anytime, QTHR G4NAS.

WANTED antenna rotator up to £20. Tel: Fareham 286575, Hants. Wanted, 2-30MHz preamp, £5-£15. Morse key, £5-£15. Tel: Fareham 286575, Hants.

WANTED NATO 2000, good price paid, up to £80, hand held FM 27MHz CB, Belcom 28MHz mobile set. 0283 221870. For sale, FT7000 digital read out, also clock, £220. Phone 0283 221870.

EXCHANGE

EXCHANGE Leitz pradovit C2500 standard lens perfect condition ith remote control. Lost price £370. Wanted good communications receiver, FRG7 or similar. The best slide projector offered by pensioner recent B studying A anxious to listen. All frequencies G1NER 0943 466493.

EXCHANGE Yaesu FT707 plus FC707 ATU for BBC model B and disk drive and monitor. Dave (0706) 228342 after 6pm.

EXCHANGE Icom 4E synthesised 70cms hand held in mint condition with case and flexible ½ wave for six band HF TX/RX in any condition. Phone, G3TCO (Bristol) 0272 681068, QTHR.

EXCHANGE wanted. Yaesu FRV7700 model (A) for model (E), must be VGC, postage paid. 0634 404096 anytime.

EXCHANGE Racal RA1217 with all filters plus Yaesu FT107, for Yaesu FT757 or Trio TS430. George, GW4EVJ. Tel: 0792 843948.

EXCHANGE Dunlop golf clubs, two woods, eight irons, putter, bag, shoes, etc, for KR600RC or similar rotator or WHY. G3KEC, Looe 3651.

EXCHANGE Shibaden SV-610K reel reel video recorder with tape. Not sure if 100% working, do not have any means of testing. Camera or monitor for scanner Bearcat 220 F8 or any scanner considered. Abingdon 0235 33177 anytime.

EXCHANGE Microwave Modules MMA 144V pre amplifier as new for similar 70cm model or 28MHz Microwave Modules receive pre amplifier or SWL ATU or sell £20. Telephone: Cambridge 834263.

EXCHANGE HW8 QRP 80-15M RIT SWR counter output manual compute with broadband solid state linear 80-10M plus constant power supply for 2m multimode rig, mobile or base, all excellent condition with all documentation and GWO. G0AYZ, tel: Gosport 0705 589560.

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Hamming With Uncle Sam

Amateur radio exams in the USA has been revolutionised in the last few years. In the current jargon it has been deregulated privatised and liberalised.

The Radio Amateurs Exam and morse test have been sources of controversy in the UK for a good many years. However, in the United States, the exam system is very different as Martin Atherton, G3ZAY, reveals...

Until 1984 most tests were conducted by the Federal Communications Commission (FCC) at field offices across the country but successive 'Reaganomic' budget cuts meant that the amateur testing programme had to be dropped. Congressional legislation, sponsored by Senator Goldwater, K7YGA, enabled the administration to make use of volunteer assistants. The new arrangement is said to save the US taxpayer $400,000 per annum.

Today, all CW and theory tests (except novice) are conducted by teams of Volunteer Examiners (VEs). These are ordinary amateur operators working in their spare time under the supervision of one of a small number of national or regional organisations known as Volunteer Examiner Co-ordinators (VECs).

The VECs act as an interface between the FCC, as the licensing authority and the VEs. Their roles include recruitment and accreditation of VEs; provision of test papers and answer sheets; provision of official licence application forms; collection of completed answer sheets; forwarding of successful applicants documents to the FCC; and evaluation of new test questions. Organisations acting as VECs include the American Radio Relay League, the US equivalent of RSGB, as well as a number of other clubs and groups.

One of the most significant effects of the changes has been the enormous increase in the number of test opportunities. Nearly every local radio club, rally, and hamfest can now set up its own examination centre.

The Licensing Structure

The US has five grades of amateur radio licence: Novice, Technician, General, Advanced and Extra. All require competence at some level in both CW and radio theory. There is no equivalent to the UK Class B "no code" licence.

There are three levels of morse test at 5, 13, and 20 wpm and four levels of theory (at Novice, General, Advanced, & Extra). The pass requirements for each grade are shown in **Table 1**. This hierarchy of grades is designed as an "incentive licensing" structure with each higher grade allowing access to more of the radio spectrum.

Novice tests, both CW and theory, can be conducted by any amateur who need not necessarily be an accredited VE but holds a General class licence or higher, is over 18, and is unrelated to the candidate. Tests for the higher grades of licence must be conducted by accredited VEs with higher grade passes than the candidates they are examining. Three qualified VEs must officiate at every test session for Technician or higher licence grades. VEs may not have any significant business involvement with amateur radio.

Privileges For Passes

Novice licensees are restricted to medium power (200W) CW on parts of the 80, 40, 15 and 10m bands. Technicians have full amateur privileges above 50MHz plus novice privileges on HF. "Generals" have full amateur privileges with the exception of certain portions of the HF bands which are reserved for Advanced and Extra, or just Extra class licensees.

With CW being a requirement at every grade, it is perhaps surprising that the US Volunteer Examiners generally have considerable freedom to generate their own CW tests. Officially only a receiving test is required but some VEs insist on an additional transmitting test so that they can offer advice on correct keying technique. The receiving tests consist of five minutes of text at the end of which the candidates have

Table 1 The licence requirements for the USA.

Grade	CW Test	Theory Test(s)
Novice	5 wpm	Novice theory
Technician	5 wpm	Novice & General theory
General	13 wpm	Novice & General theory
Advanced	13 wpm	Novice, General, & Advanced theory
Extra	20 wpm	Novice, General, Advanced, & Extra theory

NB The Novice, General, Advanced, and Extra theory exams are known officially in the USA as Elements 2, 3, 4A, & 4B respectively. The CW tests at 5, 13, & 20 wpm are Elements 1A, 1B & 1C.

Rules and Regulations	7
Operating Procedures	1
Radio Wave Propagation	1
Amateur Radio Practice	3
Electrical Principles	3
Circuit Components	1
Practical Circuits	1
Signals and Emissions	1
Antennas and Feedlines	2

Table 2 The components of the US Novice Theory exam.

to show that they copied solidly for one minute. Alternatively, at the discretion of the examiner, candidates answer ten multiple choice or "fill in the blank" questions. In the latter case they have to get at least seven correct.

Some VEs use text from simulated QSOs to educate their candidates in CW operating practice. Others use random character groups to eliminate the "Blankety-Blank" method of guessing missing words.

Multiple Choice Theory

The biggest single difference between the US and UK theory exams is that whereas the actual City & Guild questions are supposed to be harder to obtain than plans to 10 Downing Street, all the US questions and answers are published quite openly. There was a brief phase when only the questions were available, but a number of VECs used the US Freedom of Information Act to force disclosure of the answers as well. Even the official wrong answers to each question, known in the exam trade as distractors are available!

VECs assemble test papers for their VEs by drawing questions from the official 'pool'. The FCC rules determine the number of questions to be included on each topic. As an example, the novice test consists of 20 questions made up as in **Table 2**.

The FCC view is that anyone who memorises enough questions to pass the exam will learn as much as candidates who adopt a more conventional approach to their studies. There are always ten times as many questions in the pool as are needed for a single exam so there may be some truth in this.

What certainly seems to have happened is that many radio classes now focus exclusively on topics and sub-topics known to be in the question pool. They cover less material because they omit anything which doesn't have an associated question in the pool. Why bother to study a particular aspect of propagation, for example, if it can be guaranteed never to come up?

This "Swiss cheese" approach to radio teaching certainly gets the exam results. A class of 197 students being taught a syllabus based exclusively on pool questions recently achieved a pass rate of 87% compared with a national average of 48%!

Clearly the size of the pool is critical as **Table 3** illustrates. The bigger the pool, the better if the memory factor is to be eliminated and students forced to cover the complete syllabus. The current ratio of pool questions to exam questions 10:1 seems to have become established simply because it was impossible to generate any more well constructed questions in the time available for implementation of the VE programme. From 1982 the FCC had been asking individuals and clubs to send in sets of questions and answers. Although many responded, the quality left a lot to be desired and a high proportion had to be discarded.

The pool questions are now reviewed on an annual basis with the help of the VECs but it is unclear how many new questions will be introduced in the short term. For the future it seems likely that separate question pools will be maintained by each VEC and the VEs themselves will select the questions for the tests they administer.

Cheap And Easy?

The VE system is very good news for exam candidates because by law the fees are only allowed to cover the examiners' expenses and may not exceed about $4 per candidate per session. Elements 1A and 2, the novice tests, must be administered free of charge. The others all count as part of one session and are covered by a single $4 fee! This applies even when tests are part of a hamfest or rally. Candidates cannot even be required to pay an admission fee.

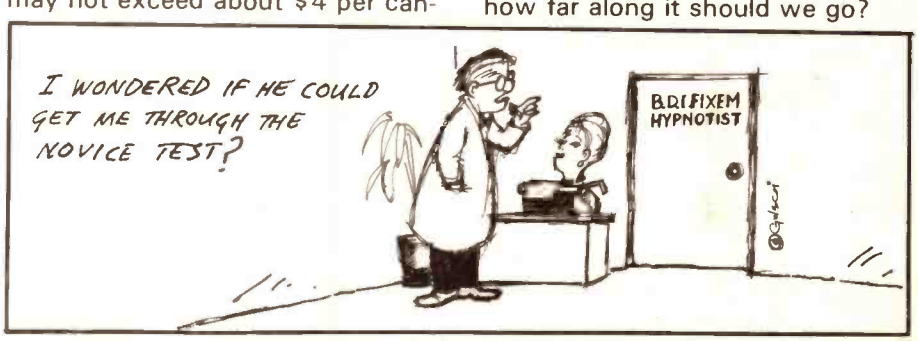
Table 3 The question pools.

Grade	Questions per Exam	Questions in Pool
Novice	20	200
General	50	500
Advanced	50	500
Extra	40	400

All tests are marked on the spot and successful candidates are given their pass certificates before they leave the examination centre. Pass marks are usually 75%, and those that fail cannot retake for 30 days unless they receive special permission from a VEC. But as the rules say that such permission can be granted "for any good reason" in practice it isn't too hard to get.

The US system has some definite advantage over the British: an enormous range of test locations and dates, instant results, and low cost. Yet, there must be doubts about the desirability of a programme which allows a novice on the air with 200W after a 20 question test administered by a single unsupervised amateur; a test that does not test CW sending ability and whose actual exam questions and answers are published in advance.

What is right for the USA is not necessarily the best choice for the UK. Perhaps with around half a million amateurs and seven different tests to be administered, they have chosen the only practical solution for them. The recent announcement that the RSGB is to take over morse testing is our first step down the American path. But how far along it should we go?



A Re-entrant Power Supply

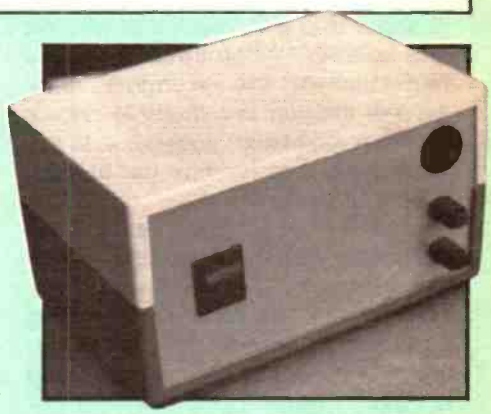
High powered linear amplifiers for boosting the power of mobile or portable rigs are becoming increasingly common. The recent HRT project for a 2m 80W linear amp (Jan, Feb '86) is a good example of this. But powering such an amplifier can be as difficult as building it in the first place. This power supply is specially designed for this application, and has many more advantages than a car battery brimfull of sulphuric acid. It is short circuit proof, very low ripple, and may be adapted for a wide range of power levels.

Do you have a linear amplifier for boosting the power of your 2m rig? You will need a power supply for it then and this design, by Andy Armstrong, G3YZW, is ideal for the purpose.

The Design

There must be almost as many power supply techniques as there are power supply engineers, but for this application most of them can be rejected as quite unsuitable (we'll let you decide whether we mean the power supplies or the engineers). For a start, all the switched mode designs would require tons screening and filtering to have any chance of being practical. This is a shame from the point of view of weight and efficiency, but solving all the problems with switch mode for amateur use would take a lot of time and a well equipped lab.

The actual configuration used owes its choice in part to the transformer I had available at the time, and in part to my wish to achieve a good overall efficiency. It is known as a re-entrant regulator which differs from the more conventional type of series regulator in that the emitter of the pass transistor is towards the unregulated input. This makes it unnecessary to have a large difference between input voltage and output voltage just to turn the



transistor on. It does, of course, require a transistor of the opposite sex from usual, which is marginally more expensive.

One drawback of the re-entrant regulator is that the power transistor requires a substantial amount of current to turn it on, and this is wasted as regards the load. The penalty in wasted current is paid to avoid one of wasted voltage. In the case of a 2N2955 running at near its maximum current, the current required to drive it may exceed 10% of the load current.

To overcome this, my design uses a darlington transistor as the series regulator element. This introduces more voltage drop, but still

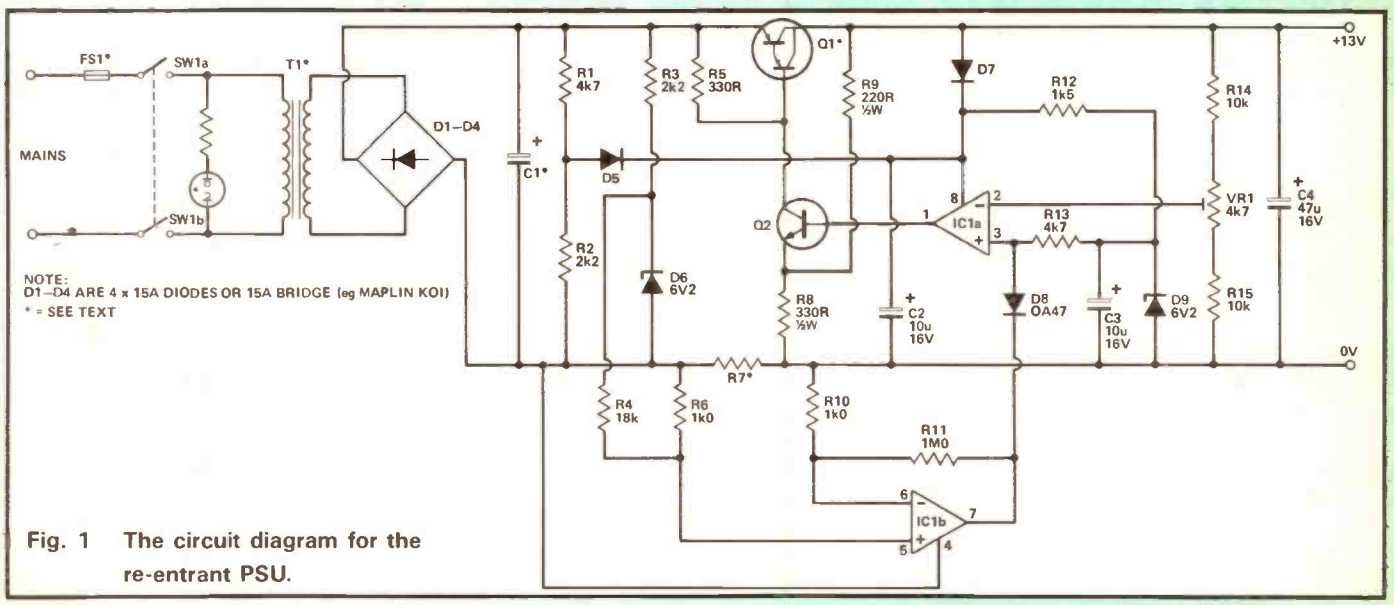


Fig. 1 The circuit diagram for the re-entrant PSU.

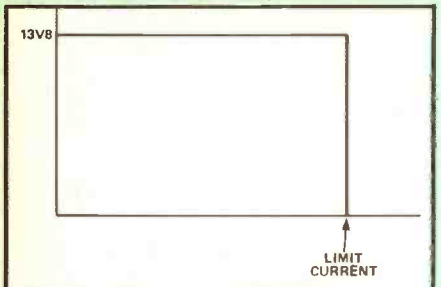


Fig. 2 **The current limiting characteristic.**

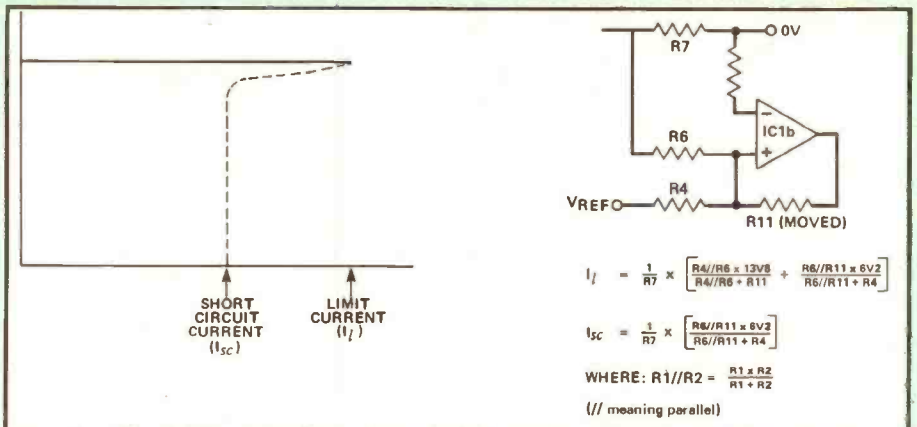


Fig. 3 The foldback limiting characteristic made using the adjacent circuit changes. The formulae will give the new values for R4, R6 and R11 if this characteristic is required.

much less than in a conventional series regulator. Those familiar with the law of the conservation of misery will now realise that this must cause a problem somewhere else!

How It Works

Examination of the circuit, in **Fig. 1,** shows that there is a unity gain stable op-amp, IC1A, driving a transistor — with voltage gain — which in turn drives the darlington device — also providing a voltage gain. In addition to the voltage gain, it also provides a much greater phase shift than a simple transistor. Because of this phase shift and gain, the circuit has a tendency to oscillate. The frequency at which it would like to oscillate will be determined in part by the characteristics of the op-amp, and partly by the series pass transistor. Accordingly precautions must be taken to stabilise it.

Two components in the circuit are responsible for keeping it on the straight and narrow: the presence of R9 provides some local negative feedback around Q1 and Q2; C4, if mounted close to Q1, will reduce the gain at high frequencies due to Q1's increasing collector impedance. This is adequate for most cases, but an RC feedback network may be added in parallel with R9 or between pins 1 and 2 of IC1 if there are any units which still insist on oscillating. (This is described more fully in the section on testing.)

The transformer output is rectified by D1 - D4 with C1 charged to a voltage above the aimed output voltage. Current flows to the output via Q1. The output voltage is potted down and compared with the voltage reference, given by D9. If the comparison voltage is less than the reference, then IC1A output goes more positive, switching on Q2 harder and hence turning on Q1 harder.

IC1B switches according to the voltage across R7, so that when excessive load current flows, the voltage drop across R7 is sufficient to drive the output of IC1B to (almost) 0V. This reduces the reference voltage received by IC1A to about 300mV. The output is thus regulated to about 600mV, at which voltage little current will flow. In practice, of course, the output stabilises at whatever voltage is required for the applied load to draw the maximum current allowed by the current limiter.

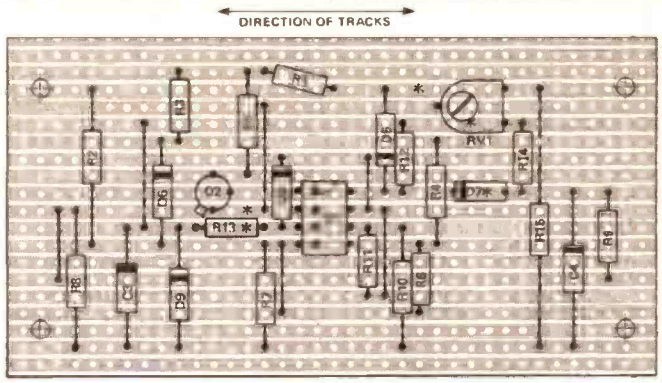
In greater detail, you will notice that the IC and the voltage reference are both powered from the output of the power supply. This is to minimise the ripple induced onto the output by the regulator circuitry. If they were powered from the unregulated supply, then some of the ripple would inevitably get through. Obviously, the power supply cannot start to provide any output until the reference and the op-amp receive some power, so a small amount of power is provided — by R1, R2 and D5 — from the unregulated side just to get things going. Once the output is at the regulated voltage, it is higher than the voltage at the junction of R1 and R2, so D7 starts to conduct and D5 is reverse biased. The only time it is needed, after start up, is to keep the op-amp running when the power supply is in the current limiting mode. The chosen op-amp has a very low current consumption, so R1 provides plenty of power.

The current limiter used is accurate and will give repeatable performance. The non-inverting input of IC1B is biased to 326mV above the input 0V supply by R4 and R6 potting down the reference voltage given by D6. When enough current flows for the output 0V to be 326mV above the input 0V, the circuit goes into current limiting. The op-amp gain is set by R10 and R11 to 1001, so that the current limiting characteristic is as shown in **Fig. 2.** If a short circuit is left on the output of the supply for very long, the power transistor will get extremely hot, because it has to dissipate all the power which would normally go to the load.

If there is a danger of a short circuit persisting, then a characteristic like that in **Fig. 3** may be provided. This reduces the dissipation of the power transistor under short circuit conditions, but makes it harder for the power supply to "climb out" of a momentary overload. To make it work in this manner, remove R11 and connect a resistor from pin 7 to pin 5 instead. Note that this alters the current limit threshold as well. The formulae shown in Fig. 3 gives a means of calculating what the levels are.

Component Choice

The op-amp must be able to work with its inputs at or close to its negative power supply voltage, and for the output to be able to pull down close to 0V. The LM358 fills these requirements admirably. However, the first thing to do is to choose the value of R7. This should be chosen to drop 326mV at about 15% above the maximum required running current of the power unit. This will mean that quite small overloads will operate the current limit and dissipation is limited. The series pass transistor must be of a type rated for a little over the maximum short



circuit current which may flow. Make some allowance for the fact that component tolerances may make the actual value higher than the calculated value.

There are two approaches to this transistor. I used a single TIP146 transistor, obtained from Farnell Electronics. Farnell are a professional component suppliers, but sometimes they accept small orders if approached in advance. The other approach is to wire up two separate transistors to get the correct configuration. Two possible configurations are workable, and are shown in **Fig. 4** and **Fig. 5**. I would recommend the second version, which can use an NPN power transistor. The transistor types shown here are suitable for a power supply rated at up to about 15A, enough for the linear amplifier mentioned earlier. My original design was intended to supply a maximum load current of about half this so the 10A transistor used was quite suitable. For a 15A power supply using a darlington transistor, the 2N6285 would be a good choice.

If a foldback limiting characteristic is needed then R11 should be connected to pin 5 and the formulae used to calculate the values of R4, R6 and R11.

Transformer Power

The choice of transformer is affected by the required output current, of course. I mentioned earlier that the transformer I had available influenced my choice of circuit configuration. This was because its output voltage, on load, was only a little higher than the required output voltage. By the same token, of course, most of the power from the transformer reaches the load under such conditions, and as little as possible is wasted in heating the power transistor.

In order to take advantage of the possibility of minimising the power dissipated, it is important to choose the correct voltage rating of transformer. The value and voltage rating of the smoothing capacitor is also important. Ideally, at full load current, the voltage on the electrolytic capacitor should sag to just above the minimum voltage which allows the regulator to work. Clearly, if the transformer sags marginally too much when using modest value of smoothing capacitor, then an increased value should reduce the sag enough to make it work.

In the rectification and smoothing part of the circuit, peak voltage on C1 under load is equal to the peak transformer voltage minus two diode drops. At a high load current, each diode may drop 0.9V, so the capacitor voltage is approximately $1.414 \times V_{rms} - 1.8$. This gives approximately 1/100th of a second for the voltage to sag due to the load current before it is charged up again. It sags by an amount given by the formula $I_L xt/C$.

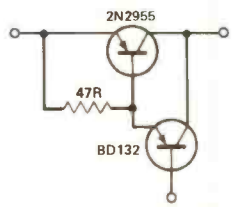


Fig. 4 One approach for the series pass transistor.

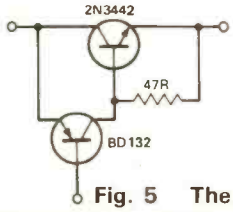


Fig. 5 The recommended approach for the transistor using a NPN power transistor.

For example, a 15V transformer would charge the capacitor to 21.2 − 1.8 = 19.4V peak on load. If the load current was 5A, and the capacitor value 15000uF, then the voltage would sag to 16V by the next mains cycle peak. If the output voltage of the power supply was 13.8V, then this would allow 2.2V drop across the series pass transistor. In fact, only about 1.5V should be required, so this leaves a slight safety margin to cope with component tolerances, dips in the mains, etc.

The voltage sag in this example is a reasonable figure, so it is clear that a 15A power supply would need a 47000uF smoothing capacitor. The peak voltage given above shows that at least a 25V rated component is required. The peak voltage is the on load voltage, though. The output voltage of the transformer is higher off load. The percentage higher is given by the transformer's regulation figure. Most large transformers have a good regulation, but if yours does not, it may be necessary to increase the voltage rating of C1 to avoid it having too many volts when the load on the power supply is light.

Current Rating

When a transformer is used with a smoothing capacitor load, a heavy current flows whilst the capacitor is being charged, and nothing for the rest of the time. It should come as no surprise that the maximum direct current drawn from the capacitor should not exceed ⅔ of the AC rating of the transformer. Otherwise, excessive sag and excessive temperature rise will result. Consequently, for a 15A power supply, a transformer rated at at least 22.5A would be needed. If a 15V type is to be used, its rating must be 337.5VA.

The largest 15V transformer I recall seeing in a catalogue was 120VA, so it might be necessary to connect three of these to separate bridge rectifiers, and connect the outputs of all the bridges in parallel. Do not be tempted to connect the transformer secondaries in parallel, as minor differences in transformer performance can cause heavy circulating currents to flow.

A possible supplier of a suitable

Components List

RESISTORS
(All 0.25W unless stated)

R1,13	4k7
R2,3	2k2
R4	18k
R5	330R
R6,10	1k
R7	*see text
R8	330R, 0.5W
R9	220R, 0.5W
R11	1M
R12	1k5
R14,15	10k
VR1	4k7

CAPACITORS

C1	15000uF for 5A supply 47000uF for 15A supply, 25V or greater
C2,3	10u,16V
C4	47u,16V

SEMICONDUCTORS

Q1	*see text
Q2	BC108, BC182, etc
D1-4	4 × 15A diodes or 15A bridge (eg Maplin K01)
D5,7	1N4148
D8	0A47
D6,9	6V2 400mW zener
IC1	LM358

MISCELLANEOUS

T1	13.5 - 15V transformer, suitable for power rating of supply
SW1	Mains rocker switch with neon
FS1	approx 1.3 * running current of transformer, slow blow
Heatsink	see text
Case and Veroboard	

transformer is ILP Electronics or you may be lucky and find an excellent high power transformer on the junk stand at a rally. If you do get an unusual transformer, remember that, with a large enough smoothing capacitor, a 13.5 or 14V transformer would be suitable. This voltage would also reduce the dissipation in the power transistor.

All this power means, of course, that a substantial heatsink is needed for the power transistor. If it is anticipated that maximum load current will be required for an extended period, then a heatsink rated at 0.5°C per watt would be a good idea. If, on the other hand, the maximum current is only required to cope with signal peaks on SSB, then a much smaller heatsink may be sufficient.

If the peak current is only required occasionally, a 'mixed' power supply may be possible. A lower current version of this supply may be built, with adequate capacity to supply the average power requirements of the equipment. This can be used to float charge a small (about 4AH) sealed lead acid battery, providing the peak current even though it could not actually run the equipment for very long. A set of six "Cyclon" cells would be most suitable for this job.

Several points should be noted here. First of all, the simple current limiting rather than the foldback type should be used on the power supply. Second, to protect the power supply and the battery, a relay should be connected to disconnect the battery from the output of the supply when the mains power is removed. A separate bridge rectifier on the output of T1 would be a good way to power this relay. The relay may disconnect the battery entirely, or leave it connected to the output terminals of the supply, so that the battery may be used on its own for short periods.

There is no current limiting on the lead acid battery, so it must be connected to the rest of the circuit via a fuse. If not, there could be a very real fire risk (have you seen what happens to a piece of insulated wire connected across a lead acid battery?).

This is not a totally 'pure' solution, and I have not tried it. However, my experience of using such batteries in other situations suggests that it will work well.

Construction

The control part of the circuit may be built on Veroboard or experienced constructors may wish to do their own, more compact, layout. The large components T1, D1-D4, C1, and Q1 are bolted to the case, or to a heatsink as appropriate, and should be wired up with thick wire once fixed in place. In particular, all 0V connections should be kept short and thick. Leave off the positive connection from the bridge rectifier to C1 to facilitate testing.

The power transistor (or transistors) should be mounted on the heatsink using insulating washers and heat transfer compound. The bridge rectifier should be mounted in good thermal contact with the metalwork of the case.

No particular case has been specified, because everyone's requirements are different. It is strongly recommended that, if the transmitting antenna is located anywhere near the power supply, the case should be entirely made of metal to provide RF screening. If RF were to be rectified in the input of the op-amp and send it haywire, the result might be an increased output voltage and a destroyed linear amplifier. For the same reason, in such circumstances it is a good idea to connect a 100nF disc capacitor directly across the output terminals.

Testing

With the supply wired up, connect a 100R high wattage resistor from the positive output of the bridge rectifier to the positive side of C1. This will limit the damage if anything is wrongly connected. Switch on, and check the voltage on C1 with an accurate meter.

If this voltage is between about 16 and 24 then proceed to measure to output voltage of the supply. By adjusting VR1 it should be possible to set it to 13.8V. If all is well so far, switch off and connect a wire in place of the 100R resistor. Repeat the checks. The voltage on C1 should be above 18V, and below 25V. Nothing should be getting hot!

If a suitable load resistor is available, it is a good idea to test the power supply at the kind of load and duty cycle it will experience in use. Keep on measuring the output voltage to make sure nothing untoward happens. Then add a little more load to test the current limit. Failing this, connect the linear amplifier and cautiously increase the power, while measuring the output voltage of the supply. If the test is carried out in this manner, the lid should be on the case to provide RF shielding. Be aware that some DVMs can lie in the presence of a high RF field!

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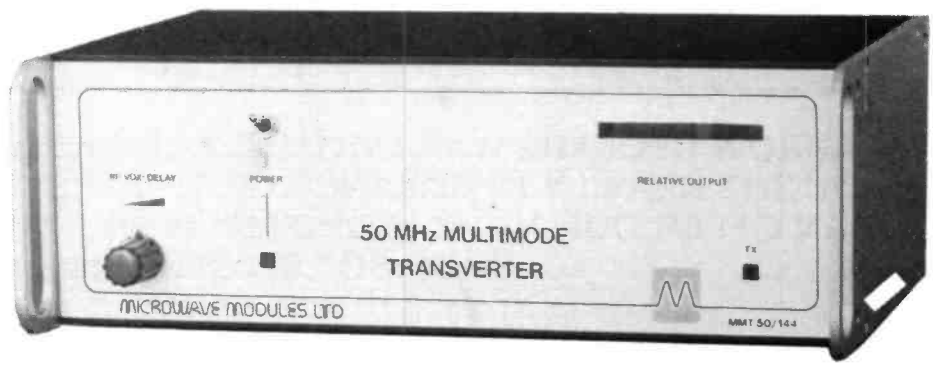

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		TOTAL inc. VAT	POST RATE
LINEAR AMPS			
MML28/100-S	10m 100W Linear, 10W input	129.95	C
MML144/30-LS	2m 30W Linear, 1 or 3W input	94.30	B
MML144/50-S	2m 50W Linear, 10W input	106.95	B
MML144/100-S	2m 100W Linear, 10W Input	149.95	C
MML144/100-HS	2m 100W Linear, 25W Input	159.85	C
MML144/100-LS	2m 100W Linear, 1 or 3W input	169.95	C
MML144/200-S	2m 200W Linear, 3, 10, 25W input	334.65	D
MML432/30-L	70cm 30W Linear, 1 or 3W input	169.05	C
MML432/50	70cm 50W Linear, 10W input	149.50	C
MML432/100	70cm 100W Linear, 10W input	334.65	D
TRANSVERTERS			
MMT144/28	2m Linear Transverter, 10W o/p	129.95	B
MMT144/28-R	2m Linear Transverter, 25W o/p	236.90	B
MMT432/28-S	70cm Linear Transverter	195.50	B
MMT1296/144-G	23cm Linear Transverter	258.75	D
MMX1268/144	1268MHz Transmit Up-Converter	195.50	D
MMT 50/144	6m Linear transverter 20W o/p	245.00	B
ATV			
MMC435/600	70cm ATV Converter, UHF output	35.65	A
MTV435	70cm ATV 20W Transmitter	197.80	B
MICROPROCESSOR			
MM2001	RTTY to TV Converter	189.00	B
MM4001-KB	RTTY Transceiver with keyboard	299.00	D
MMS1	The Morsetalker	115.00	B
MMS2	Advanced Morse Trainer	169.00	B
CONVERTERS			
MMC50/28	6m down to 10m Converter	35.65	A
MMC144/28	2m down to 10m Converter	35.65	A
MMC144/28-HP	2m High Performance Converter	47.90	A
MMC432/28-S	70cm down to 10m Converter	39.90	A
MMC432/144-S	70cm down to 2m Converter	39.90	A
MMK1296/144	23cm down to 2m Converter	129.95	B
MMK1691/137.5	1690MHz WX Satellite Converter	145.00	B
PRE AMPS			
MMG144V	2m RF Switched GaAsFET Preamp	37.90	A
MMG1296	23cm GaAsFET Preamplifier	75.00	A
MMG1691	1690MHz GaAsFET Preamp	129.95	B
OTHER PRODUCTS			
MMD1500P	1500MHz Divide by Ten Prescaler	119.60	A
MMR3/25	3dB 25 Watt Attenuator	19.95	A
MMR7/3	7 dB 3 Watt Attenuator	14.50	A
MMR15/10	15 dB 10 Watt Attenuator	14.50	A

Postage/Packing Charges:

A = 1.84 C = 4.60
B = 3.91 D = 5.98

DURING THIS YEAR OUR SALES TEAM WILL BE VISITING MOST OF THE MOBILE RALLIES. TO BE SURE THAT WE DO NOT MISS YOURS PLEASE RING MICK, G4EFO, ON 0403 730 767.

Access VISA WELCOME

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BROOKFIELD DRIVE, AINTREE, LIVERPOOL L9 7AN, ENGLAND
Telephone: 051-523 4011. Telex. 628608 MICRO G
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HOURS:
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9-12.30, 1-5.00
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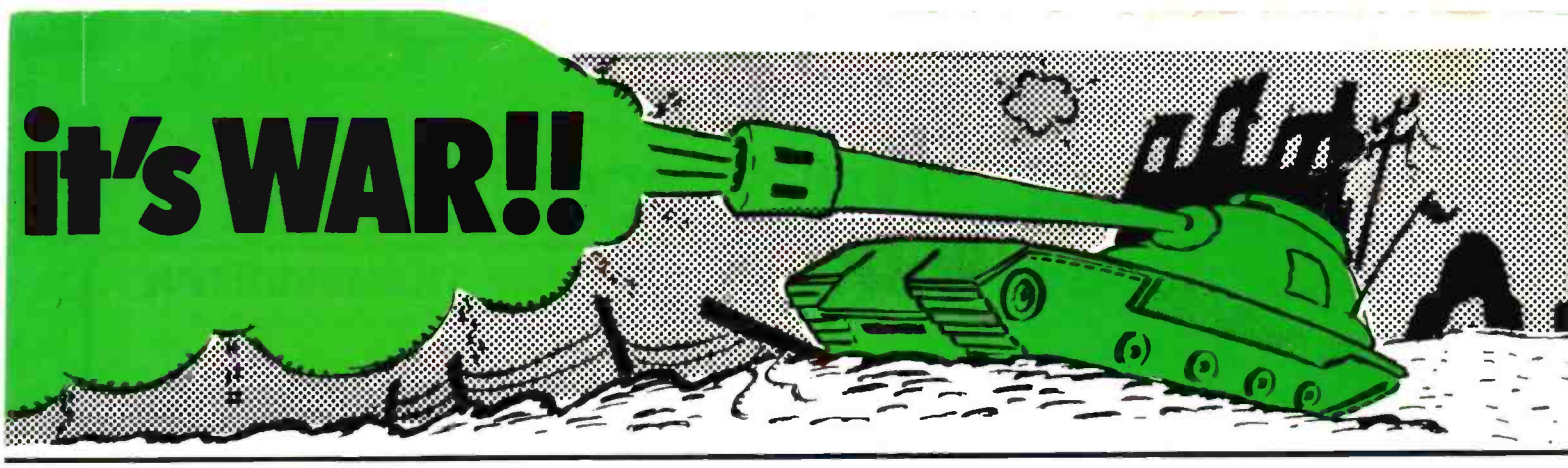

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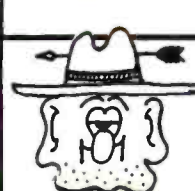
			CASH PRICE INC. VAT
FT290R	Yaesu's famous allmode portable	NOW	£339
FT730R	70cm FM 10W Mobile. (You can hardly buy a decent 70cm handheld for this)		£239
IC735	ICOM'S famous Mini HF masterpiece	ONLY	£839
FT690R	Cheapest ever buy for Six.		£249
FT726R	SATELLITE version (2M/70cm & Sat. board)	ONLY	£1159
FRG8800 +FRV8800	Gen. Coverage Communication Receiver INCL. FREE VHF CONVERTOR	ONLY	£575
ICOM 25 watt Allmode 2 metre Mobile (for less than the OLD Price)			£469
FRG9600	Allmode Scanner INCL. FREE Mains power unit		£419
FT2700RH	Dual Bander 2M & 70cm Full duplex.		£449

AND "UNDER OUR HAT" only for visitors to our NEC stand a VERY VERY special offer £???.00



ALL QUOTED PRICES ARE FOR CASH & CARRY AT N.E.C. and you can reserve your bargain in advance by telephone & collect at the show. Or if you prefer you can collect at any of our Branches or Agents. All NEC special prices are subject unsold WHILE STOCKS LAST. Prices, correct at press time, may vary up or down due to market conditions.

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