

HAM

AN ARGUS SPECIALIST PUBLICATION

November '83

Morgan

RADIO

90p

TODAY

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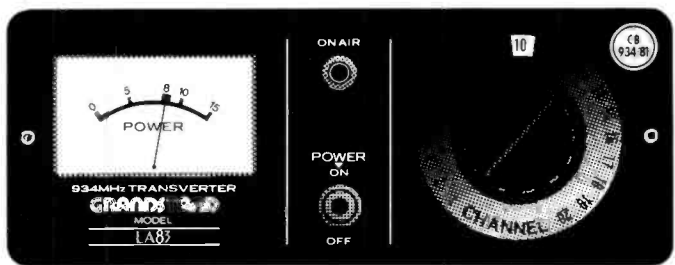
PLUS

- Reading a Smith chart
 - Reviewing the Mizuho SB2X
 - Constructing the Omega QRP PA
 - Amateur radio in South America.
- By G5RV, Organising special event stations

SPECIAL REVIEW:

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Suggested Retail Price £399.95 including VAT (Kit comes complete with Bluebird 27MHz Transceiver).

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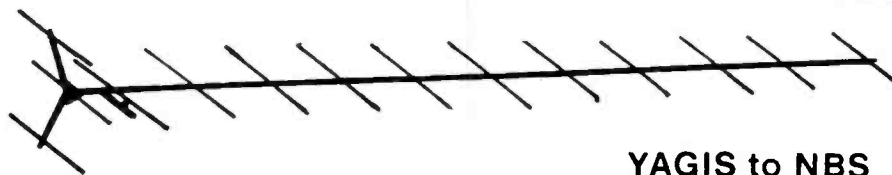
PRODUCTS BY

BEEWARE
LIMITED



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Ripon Way, Ripon Road, Harrogate, North Yorks., HG1 2AU. Telephone 0423 501151/6 Telex 57953 Adam G.

MET ANTENNAS



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WHAT IS N.B.S.?

In 1976 the U.S. National Bureau of Standards published a report under the authorship of Peter P. Vezibicke detailing some nine man-years of work undertaken in the optimisation of Yagi design.

Investigation took place on the NBS antenna ranges at Sterling, Virginia and Table Mountain, Colorado into the inter-relationship between director and reflector lengths, spacing and diameters as well as the effect of the metal supporting boom in order to achieve maximum possible forward gain.

MET yagis have been designed and engineered within the strict specifications of the NBS report.

★
N.B.S. Standard

★
Gain Optimised

★
P.T.F.E. Insulated Gamma

★
User Adjustable Matching

★
N Socket Termination

★
Easy Assembly

★
Made in U.K.

★

CODE	MODEL	LENGTH	GAIN	COST (inc. VAT)
70 cms				
432/19T	19 Ele	2.2 m	14.2 dBd	£33.90
432/17X	17 Ele crossed	2.2 m	13.4 dBd	£46.83
432/17T	17 Ele long	2.9 m	15 dBd	£37.33
2 M				
144/7T	7 Ele	1.6 m	10 dBd	£19.99
144/8T	8 Ele long	2.45 m	11 dBd	£31.26
144/14T	14 Ele	4.5 m	13 dBd	£44.49
144/19T	19 Ele	6.57 m	14.2 dBd	£53.22
144/6X	6 Ele crossed	2.5 m	10.2 dBd	£37.86
144/12X	12 Ele crossed	4.57 m	12.2 dBd	£54.95
4 M				U.K. P&P on all above is £2.95
70/3	3 Ele	1.7 m	7.1 dBd	£28.69
70/5	5 Ele	3.45 m	9.2 dBd	£43.56
				U.K. P&P on above is £5.49
				144 GP 2 m (Ground Plane) £14.41 + P&P £1.30

please telephone for details



Tel: 0304 853021

Enquiries from Overseas dealers welcome

METALFAYRE 12 Kingsdown Road,
St. Margarets-at-Cliffe. DOVER. CT15 6AZ

HAM RADIO TODAY

CONTENTS

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Advertisement Manager
David Gadsden G4NXV
Classified Sales
Julie Bates

Managing Editor
Ron Harris
Managing Director
T.J. Connell

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REGULAR COLUMNS

LETTERS	4
NEWCOMERS' FORUM	25
RADIO TOMORROW	28
PRACTICALITIES	41
METREWAVE	50

CONSTRUCTION

PROJECT OMEGA. QRP PA AND TX/RX SWITCHING	13
<i>We're almost on the air with Part 5</i>	
AUTO ANTENNA SWITCH FOR THE FT102	60
<i>Got an FT102? Change antennas as you change bands - automatically and in comfort</i>	

FEATURES

LICENCE CONDITIONS AND THE RAE	6
<i>D Ffestin Jones, GW3SSY, takes an informative but sideways look</i>	
SECRETS OF THE SMITH CHART	21
<i>Here is the key to designing your own power amplifier and antenna systems</i>	
THIS IS SPECIAL EVENT STATION... ..	43
<i>The A-Z of special event station operation</i>	
AMATEUR RADIO IN SOUTH AMERICA	58
<i>Licensed in Uruguay as CX5RV, Louis Varney reveals radio South American style</i>	

REVIEWS

2m PREAMPS UNDER SCRUTINY	32
<i>Want to buy a preamp? Read this comprehensive and though provoking review first!</i>	
MIZUHO SB-2X	54
<i>Value for money 2m SSB/CW transceiver put through its paces</i>	
NEXT MONTH IN HAM RADIO TODAY	53
Emporium Guide	63
Classified	65

LETTERS

DRESSLER D200S REVIEW

Frank, A few comments on your publication of the review of the D200S.

1. It would have been nice to point out to people that there is a choice of building a similar amp for much less money (*VHF Communications* No. 2 1978).

2. The price of a new valve is quoted at £160+ which in the same issue of your magazine (page 9) it is advertised for £69.50 + VAT and (page 39) for £71.50 + VAT.

3. I would be interested to see an article by G3OSS on how he performs reviews and tests like this as I understand that he is blind.

If he does all the measurements himself then I am sure other blind amateurs would be interested in his adaptations of power meters etc. for blind use. If he does not perform the tests himself why doesn't he give credit to the nameless people who do the reviews that he appends his name to.

Congratulations on a good magazine and keep up the standard of the RF-type home brew articles. What was the outcome of G3TLB's exploits on 23cm?

Nick Foot G8MCQ

1. *The homebrew versus blackbox argument is an interesting one, but it doesn't belong in a review.*

2. *The price of £160+ is the price for a new, guaranteed specification Eimac valve from the appointed importer. Although we have no reason to suspect that there is anything wrong with the sources you mention, there are a lot of below-standard 4CX-series valves on the market.*

3. *Angus plans and writes all the reviews himself. He does however, rely on colleagues to read the meters etc. on his test equipment. From time to time he does mention them in his articles, albeit not in this one. —Ed.*

QRA PROGRAM

Sir, Congratulations on the publishing of the QRA prog for the ZX81 (Sept 83)

from the RAIBC. It is an excellent program which worked (more or less) first time, which is more than can be said for computer progs published in other magazines (due to poor proof reading).

Slight help is needed due to poor printing:

LINE 90 LET Z(1,1)=43

LINE 2390 GOSUB 2870

So after four years of typing in other peoples progs from radio and computing magazines this is the first one that has gone off well, without having to write to the originator for corrections. This applies to the commoner newstand issues of such magazines (no names!).

Dr A G H Heaney

Dear Sir

I have bought your magazine since its first issue (in Dec 82) and must encourage you to keep up the good work.

However, like everyone, I have a complaint, though you will be pleased to hear it is not about HRT.

After reading an article in the April 83 issue of your magazine by Cyril Young (G8KHH) titled 'This is RAYNET', I decided to make enquiries about joining, despite not yet being licenced (I am in that long wait between RAE results and receiving my ticket). I wrote to the R.S.G.B. who, with their normal efficiency, wrote back very quickly sending me an address to write to. I have since written to this address twice and, despite enclosing a stamped addressed envelope each time, have received no reply.

So, 'This is Raynet', a service which lives could depend on. Do they want volunteers or not?

73's

S.M. Richards

PIRATE?

Sir, I have just read about SWL, Michael John Craven, being fined for installing an Icom 720A with the Tx side disabled. If the facts as reported by you are correct, Mr. Craven has my sympathy as I am of the opinion that he has been wrongly convicted.

To obtain a conviction under Section 1(1) of the Wireless Telegraphy Act 1949, the prosecution must prove three things

1. That he installed the apparatus
2. That he installed it for 'Wireless Telegraphy'
3. That he was not in possession of a Licence to do so

In the particular matter, the whole case rests on the definition of 'Wireless Telegraphy'. This is defined in Section 19(1) of the Act and effectively means the sending or receiving of radio signals using frequencies under 3×10^6 MHz. However, although the Act does not appear to have been amended, an Order in Council was made some 17 or 18 years ago the effect of which was that Licences were no longer required for the reception of Radio signals other than TV Signals for which Licences are still required. It is my opinion, therefore, that 'Wireless Telegraphy' is now only the sending of radio signals. As such, Mr. Craven could not possibly be found guilty of an offence under Section 1(1) of the Act if his Transceiver was only capable of reception. It is also interesting to note that Section 14(3) of the 1949 Act was amended by the 1967 Act, Section 11(3), the effect of which is that Magistrates no longer have the power to order the forfeiture of Receiving apparatus.

I feel there must be more to this case than meets the eye as it is my opinion that the Radio Regulatory Department, who have to approve all prosecutions, would not normally instigate a prosecution in these circumstances.
Douglas Taylor

Dear Sir

re: *The Wireless Telegraphy Act 1949*

I refer to your brief article in the August issue of your magazine concerning the short wave listener who was unfortunately prosecuted under the above Act.

What concerns me is a possible "hidden" implication for a majority of Class A Amateurs not just Class B operators.

A majority of HF equipment sold by dealers states that it is limited to

transmissions within the Amateur band but with a lot of equipment it is possible to transmit just outside the bands as the design of the equipment is not so precise for transmissions to be stopped at the extreme edges. I believe some equipment can transmit up to 200 KHZ either side of the band edges. Whilst very few, if any, amateurs would even bother to transmit outside the amateur bands it does technically mean that the amateur has equipment for which he has no licence. As it is illegal to instal any form of transmitting equipment without the appropriate licence it means that the majority of amateurs in theory could be deemed to be committing an offence because of the capability of their equipment taking them beyond the terms of their licence.

Clearly the law, of necessity, has to be very precise and it is know that despite what we hear and read in the press a lot of discretion is exercised by the powers that be in prosecuting many offences.

If this particular shortwave listener has been prosecuted simply because he had equipment installed albeit not capable of transmission at that point in time then it would be appreciated if the Home Office could give some reassurance that they accept there are one of two design limitations in the majority of HF equipment to the effect that although they predominantly limit themselves to the amateur frequencies it would be possible to transmit out of band.

I have no objection if you wish to publish this particular letter.

Yours faithfully,

**Richard H. Langdon
G4RHL**

Frank, Your feature 'Radio Today' in the August 'H.R.T.', containing the item 'S.W.L. Fined' has certainly got me thinking — particularly the reference to 'B' Licensees owning h.f. equipment in anticipation of an eventual 'A' ticket. I was under the impression that where a 'B' Licensee operated h.f. gear of his own under the supervision of an "A" Licensee, used the appropriate station identification and entered the relevant details in that station's log, that all was well, even under the revised W.T.A., but now I am not so sure. I wonder also if the Home Office has an answer for the following:

(a) What is the position where vintage h.f. transmitters form part of a collection of wartime military radio equipment, where this is owned by a 'B' Licensee or by an unlicensed individual? No doubt

some sort of exemption would be available, if required, for the owners of large private collections open to the public (e.g. Blandford, Warnham), but what of the many no doubt B-Licensed or unlicensed personnel now taking an interest in 'real' radio — which includes, e.g. T1154, TCS, ART13, W.S.12/18/19/52, etc.? Much of the attraction of this equipment, for many people, no doubt lies in its appearance, nostalgia and/or rarity value, rather than in its operation, although personally I find the latter aspect equally interesting.

(b) From time to time, I have assisted some recently licensed G4's in troubleshooting their valve h.f. transceivers. This usually requires that the rigs concerned are delivered to and kept at my home QTH for as long as is necessary to effect the necessary repairs, which may be for a few hours or a few weeks, and invariably includes a test run at full power *into a dummy load*. What happens now if the man from the Home Office walks in in the middle of this activity?

Incidentally, how was the S.W.L. in your article 'caught' with his IC-720? (Assuming, of course, that he was not actually transmitting with it?) By someone with a grudge against him perhaps, or by official 'snooping' in dealers' sales records, or what?

I have no objection to the Wireless Telegraphy Act being strengthened to deal with radio piracy, illegal CB operation and so on, certainly this was long overdue. Similarly, I do not object to the principle of taking a code test to gain a Class A License — maybe even I shall succeed in doing this eventually! I wonder if, however, it will be possible, through your good offices, to extract some sort of official response to the above, especially paragraph (a), which can then be made generally available through the medium of your excellent publication.

Neil Clyne, G8LIU

Sir, I have just read your article concerning the SWL (page 7 August 83 *Ham Radio Today*) fined for the installation of a transceiver under the WT Acts 1949, and would like to raise the following points:

1. If the station is used solely for 'listening' purposes how was the equipment discovered?
2. The SWL states that the transceiver was disabled by the dealer local to him. If this is the case could you please explain how the "Welz" power meter, shown in

the photograph, is used in the receive mode and also the matching Icom ATU. This unit is, unless I am mistaken, an automatic unit and needs RF to tune it to the transceiver and antenna.

Perhaps our friend was told that because the mike socket was taped up, the rig could not transmit.

Lastly, I would if you could advise me, and possibly a good many others, as to the legality of a G8, G6 or G1 using a HF transceiver with transverter on the VHF Bands, or indeed of obtaining say a surplus piece of P.M.R. equipment which until converted is capable of being used on frequencies other than those which are covered by our licences.

S. G. R. Van Kassel

Let he who is without sin cast the first stone. —Ed.

RADIO YESTERDAY

Sir, I have read with considerable interest Mr Dean's letter in the September issue of *HRT*.

The three letter callsign era was before my time, however I do have a copy the *Gamages Directory of Experimental Wireless Stations* which was published in March 1914.

From this list Mr Dean's callsign is given as DXN and that of L McMichael as MXA. I feel sure that those given in his letter are 'slip of the pen'; he is quite right in recalling of Mr Perrier PFX.

The full entries in the list are as following:

DXN — Frank L W Dean, 71 Washington Road, Worcester Park, Surrey. TX 10 watts Accum, wavelength 200M, range 8 miles, RX 100-4000m Auto jigger.

DXN — Col. Dennis, Woolwich Arsenal. TX ¼kW 450m.

MXA — L McMichael, 18 Stonton Road, Forrest Hill, London 18. TX 150 watts, 275m, range 40 miles, 6 inch coil. RX up to 10,000m, range 1,500 miles.

PFX — S Perrier, Silverdale, Cargreen Road, South Norwood, London SE. TX 150 watts (AC mains) 200-300 and 400m, range 20 miles, RX 250 miles. Mr Dean's callsign G2DB is no longer listed, but he must be of about the same age as W K Alford who was TXK in 1912. As G2DX he is still regularly on 80m.

G R Jessop G6JP

*Please address correspondence to:
Ham Radio Today,
145 Charing Cross Road,
LONDON WC2 0EE*

Licence conditions and the RAE

The following pages contain extracts from the licence regulations. They are not the full regulations and reference must be made to the regulations to gain a full understanding. CAPITAL letters are used to stress important words and cartoons to aid as a memory aid. Page references are from "How To Become A Radio Amateur" published by the Secretary of State for the Home Department.

You **DON'T** need to hold a class "B" licence to obtain a class "A" licence. You can have a class "A" right away providing you have passed the morse test. But you must apply within 12 months of passing your morse test." Morse test taken during twelve months immediately preceding the date of application". Page 4 & 1.

Qualifications:—
Class "B"

British subject
no longer a requirement

Have passed the Radio Amateurs Exam

Over 14 years of age

Paid the licence fee

For a Class "A" licence you have to pass a Morse test as well

MORSE TEST

Words in 3 minutes
figures in 1½ minutes

PLAIN language 36 words
10 groups of 5 figures

Speed 12wpm

Receiving and sending

Maximum errors	Corrections	Uncorrected errors
Words 4	4	0
Figures 2	2	0

INTERPRETATION

Page 10(16)

Secretary of State:—
Messages/Signals:—
Standard Frequency:—
United Kingdom:—
Telegraphy:—

Secretary of State for the home department
Include television and facsimile
See Page 10 16(1)(iv)(v)
Great Britain, Northern Ireland, Isle of Man and Channel Islands
The word also means Telephony

Suffixes:— Page 9... 1(b) (c) (d)
Page 5... Subclauses are shown below

You are the **LICENSEE**

1 (a) (i)

ADDRESS

MAIN address
(Correspondance address)

SUFFIX
None

TEMPORARY PREMISES

Hotel

Hamlyn's Holiday Camp

(Fixed places)

"Mobile Home"

Static
Not to exceed 4 consecutive weeks 1(a) (ii)

TEMPORARY LOCATION

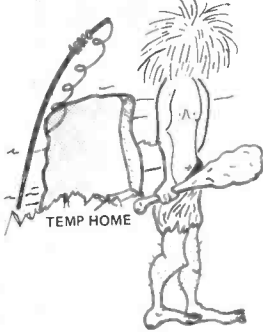
Caravan

Movable

SUFFIX /P

ALTERNATIVE PREMISES

When exceeding 4 consecutive weeks 1 (a) (iii)



7 days notice in writing of postal address, and in writing when you have left

To: GENERAL MANAGER OF THE POST OFFICE TELEPHONE AREA IN WHICH YOU WILL STAY
Channel Islands

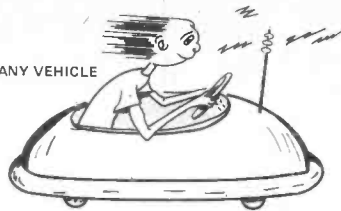
DIRECTOR OF THE COMMUNICATIONS BOARD OF THE APPROPRIATE BALIWICK

SUFFIX None



SUFFIX /M

IN ANY VEHICLE

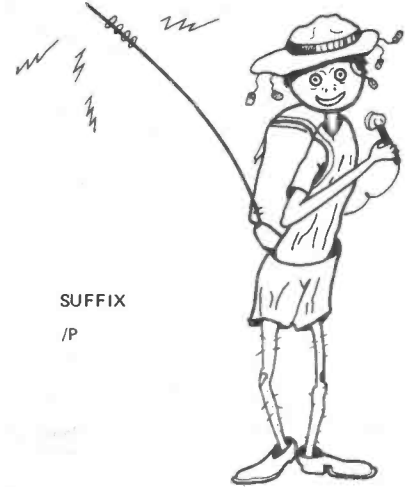


OR

VESSEL 1 (a) (iv)
(inland waters only)



NOT ON SEA, OR WITHIN ANY ESTUARY, DOCK OR HARBOUR

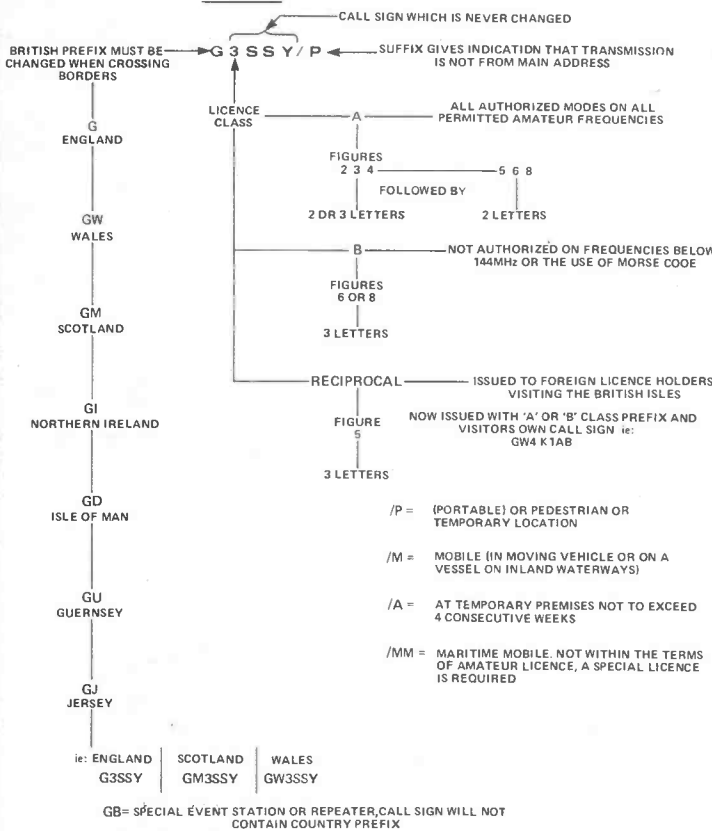


SUFFIX /P

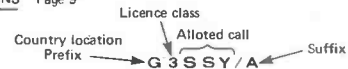
AS A PEDESTRIAN 1 (a) (v)

CHANGE OF ADDRESS – Notify SECRETARY OF STATE FOR THE HOME DEPT. PROMPTLY of change of correspondence address (MAIN ADDRESS).

CALL SIGNS

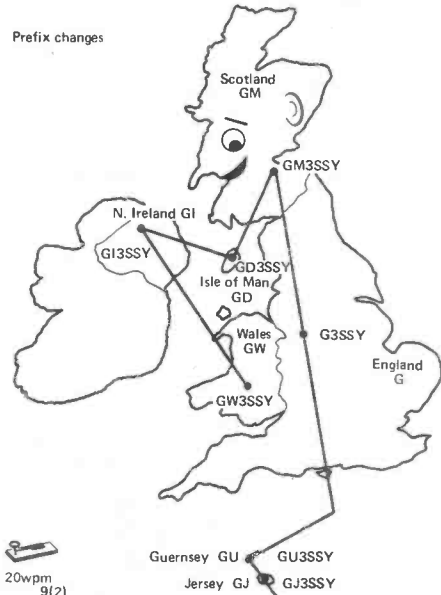


CALL SIGNS Page 9



Suffixes 9 1 (b) (c) (d) see also previous references on ADDRESS Prefix changes as you pass through each UK country. 9 1 (a)

Prefix changes



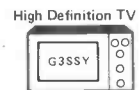
SENDING

Not greater than 20wpm 9(2)

Call sign letters may be pronounced by well known words—NOT FACETIOUS OR OBJECTIONABLE. 9(3)

Send at BEGINNING and END of each period whenever frequency is changed If period is over 15 MINUTES, at beginning of every 15 MINUTES. 9(2)

At TEMPORARY PREMISES or LOCATION address must be sent at beginning and end or every 15 minutes. 9(4)



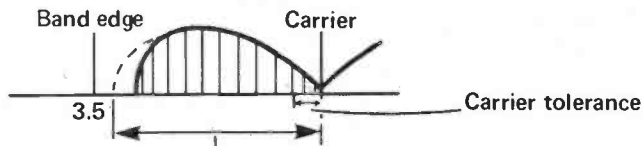
Centre of Video Channel 9(5)

6 1(1)(d)(v)
11 (16)(3)

No secret code or cypher
The use for BUSINESS, ADVERTISEMENT, PROPAGANDA. Sending news or messages OF or on BEHALF OF or for the BENEFIT OF or information of any SOCIAL, POLITICAL, RELIGIOUS, or COMMERCIAL ORGANISATION.

ACCURACY Page 39 4 (a) (b)

Sufficient accuracy to verify that emissions are within authorized bands



Modulation bandwidth added to carrier tolerance

Your TX should have satisfactory frequency stabilisation and you must provide equipment capable of verifying that the transmitter is operating with emissions within authorised frequency bands.

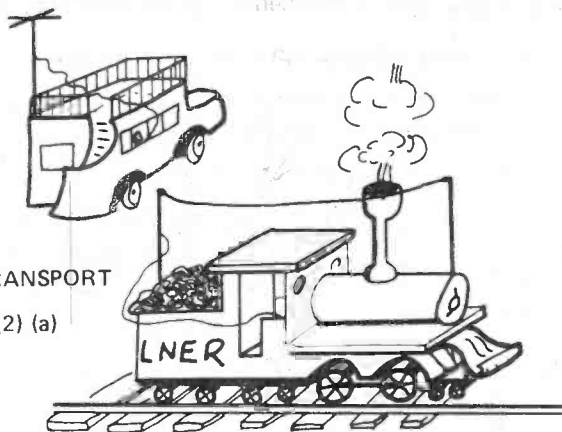
For a CRYSTAL CONTROLLED TX suitable equipment is an absorption device to check that the desired harmonic of the crystal frequency has been selected;

For NON-CRYSTAL CONTROLLED TX a heterodyne wavemeter based on a crystal oscillator is necessary.

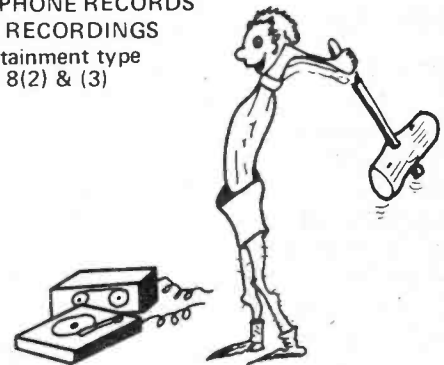
In practice, amateurs often use a separate receiver with a reasonably accurate frequency scale and a crystal controlled oscillator to obtain the functions of a heterodyne wavemeter. Up to 4 MHz, it is probably adequate to use a single 100kHz crystal; above this frequency an additional 500kHz or, better, 1MHz crystal should be used in conjunction.

PUBLIC TRANSPORT

Page 6(2) (a)



NO GRAMOPHONE RECORDS
OR TAPE RECORDINGS
of entertainment type
Page 8(2) & (3)

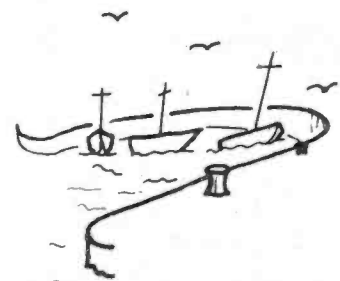


NOT TO BE USED FROM AIRCRAFT



OR IN ANY DOCK OR HARBOUR
OR SEA OR ESTUARY

PAGE 5 1(1) (iv)



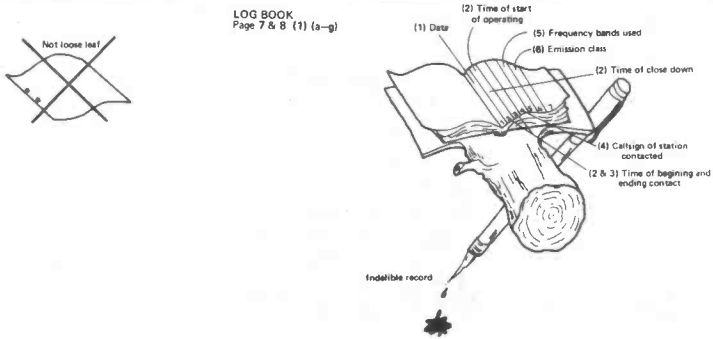
GENERAL CONDITIONS (see relevent section for details)

- Page 5 1(1)(b) Use as self training in communication by wireless telegraphy.
(i) Messages in plain language
- Page 6 " (ii) Facsimile
(iii) RTTY — INTERNATIONAL TELEGRAPH CODE 2 (5-Unit start-stop-)
Speeds 45.5 or 50 Baud. Page 7 1(2)(e)
(iv) Visual images
(v) Related messages to the above
Use on behalf of: —
BRITISH RED CROSS SOCIETY
ST JOHN AMBULANCE BRIGADE
EMERGENCY COUNTY PLANNING OFFICER
ANY UK POLICE FORCE

(YOU SEND ON THEIR BEHALF, THEY DO NOT USE YOUR STATION)
- Page 6 1(1)(d)
&
Page 10 16(iv)
Page 6 1(2)(c) Receiving transmissions in the STANDARD FREQUENCY SERVICE.

OPERATED ONLY BY YOU (THE LICENSEE)
By another person who holds a CURRENT LICENCE or AMATEUR RADIO CERTIFICATE issued by the SECRETARY OF STATE FOR THE HOME DEPT. IN YOUR PRESCENCE and under your **DIRECT SUPERVISION**
- Page 7 4(1) DESIGNED, CONSTRUCTED, MAINTAINED and USED so as not to cause UNDUE INTERFERENCE with ANY wireless telegraphy.
5 No UNAUTHORISED person to operate or have ACCESS
- Page 8 7 The receiver used to be capable of reception of the FREQUENCIES and MODES in use.
8(1) Recorded messages can only be transmitted to the ORIGINATING station the call sign of that station being OMITTED from the transmission.
8(2) SINUSOIDAL TONE or TONES within the AUDIO frequency either CONSTANT or STEADILY changing in FREQUENCY.
- Page 9 9(2) CALL SIGN in morse to be sent NOT GREATER than 20 wpm at the beginning and end of transmission. Whenever frequency is changed. At commencement of each succeeding 15 minutes.
9(3) Telephony — 'well known words used' (See SUGGESTED PHONETIC ALPHABET)

Also to be shown: —
CQ and test calls
Address of: —
Temporary premises
Alternative premises
Location of: —
Temporary location



The diagram shows a log book page with several annotations: (1) Data, (2) Time of start of operating, (3) Time of beginning and ending contact, (4) Callsign of station contacted, (5) Frequency bands used, (6) Emission class, (7) Time of close down. A crossed-out leaf is labeled 'Not loose leaf'. A pen is shown writing on the page, with the text 'Indelible record' written below it.

Mobile/Pedestrian — Make entries as soon as practicable after end of journey showing DATE, GEOGRAPHICAL AREA of operation TIME of BEGINNING and END of journey. A separate log book may be kept.

Page 8 6(2) When other person operates station they must: — Sign your log with FULL NAME and enter his CALL SIGN or AMATEUR RADIO CERTIFICATE number.

NON-INTERFERENCE

Page 7 4(1)(2) KEY CLICKS must be ELIMINATED
AVOID OVERMODULATION
RADIATED ENERGY within NARROWEST POSSIBLE FREQUENCY BANDS.
HARMONICS, SPURIOUS EMISSIONS shall be SUPPRESSED to such a level they cause no UNDUE INTERFERENCE with any wireless telegraphy.
Tests for the above made from TIME to TIME:

PRIVATE PROPERTY

Page 12 (j) CONSENT necessary before entering PRIVATE OR PUBLIC PROPERTY

THE SCHEDULE

Important points to note from the schedule are:

	Carrier power to antenna	PEP to antenna	
1.85-2 MHz 70.025-70.5	9dBW 16dBW	15dBW 22dBW	No RTTY Only band in which a government official may demand you to cease using immediately. Only available till further notice.

NOTES

1.81-2MHz & 3.5-3.8MHz Only shared bands; certain frequencies to be avoided by amateurs.

10.1-10.15 70.025-70.5 & all bands above 430 MHz Used on a secondary basis on condition that they shall not cause interference to other services.

BANDS

3.5-29.7MHz		
144-146 MHz	20dBW	26dBW
432-440 MHz		

NOTES

430-432 MHz Power must not exceed 10dBW Effective Radiated Power (ERP) Not available within area bounded by 53°NO2°E, 55°NO2°E, 53°NO3°W and 55°NO3°W.
High definition TV allowed.

432-440 MHz Facsimile allowed: bandwidth not greater than 6kHz. These bands may be used by non amateur stations in the event of natural disasters to meet the needs of international emergency communication in the disaster area in accordance with regulations of the Radio Regulatory Department.

7.0, 14.0, 21, 28, 144 Amateur satellite may be used in these bands limited on
1260-1270 MHz Earth to Space
5650-5670 MHz Earth to Space
5830-5850 MHz Space to Earth

Data transmissions allowed from 144 MHz.

Class B licence starts at 144 MHz. RTTY is allowed.

Knowledge of power limitations on 1000 MHz for RAE has been discontinued.

POWER The dBW is a ratio expressed logarithmically, with 0 dBW set as 1W. The power doubles for every increase of 3 dBW, so 3 dBW = 2W, 6 dBW = 4W, etc. An increase of 1 dBW is equivalent to multiplying by 1.26. Multiplying 1.26 by itself repeatedly, as many 1.26s as there are dBW, will give the power in watts; eg 20 dBW = 1.26 x 1.26 x . . . x 1.26 (20 1.26s) = 10.1W (100W is the correct answer).

NOTE

20 dBW = 100W
9 dBW = 8W
15 dBW = 32W

The Decibel is not a measure of anything, it is a ratio of one power (or voltage, or current) to another. The formulae are:-

$$10 \text{ Log } \frac{P_2}{P_1} = \text{For a positive dB} \quad 20 \text{ Log } \frac{V_2}{V_1} \text{ or } \frac{I_2}{I_1} = \text{For a positive dB}$$

For a negative dB change the 1 & 2 around.

Another way to work out what the actual power out, is to enter the dBW on top of the line and divide it by the number at the front of the equation. This will give you the "power" of ten:-

$$26 \text{ dBW} = \frac{26}{10} = 2.6 \text{ this is the power of } 10 = 10^{2.6} = 398.107 \text{ Watts. Try working out } 9 \text{ dBW (ans} = 7.943\text{W)}$$

Examples of current amateur emissions: see pages 3,4,5 of insert for full list.

- A1A Telegraphy by on-off keying, without the use of a modulating audio frequency.
- A2A As above but on-off keying of a modulated frequency.
- A3E Telephony double sideband, known commonly as AM.
- J3E Telephony single sideband suppressed carrier.
- F2A Telegraphy by on-off keying of a frequency modulated audio frequency, or on-off keying of a frequency modulated emission.
- F3E Telephony commonly known as FM.

Bandwidths.

Bandwidths will now be shown using the initial letter of the band in place of the decimal point and "Prefix letter of Power of ten" used in place of Hz eg:

0.001-999Hz	H	50H
1.000-999kHz	K	200K
1000-999MHz	M	28M
1.000-999GHz	G	450G

Decimal point: 3.5MHz/3M5

A receiver which has a bandwidth of 2.5kHz will be . . . 2k5

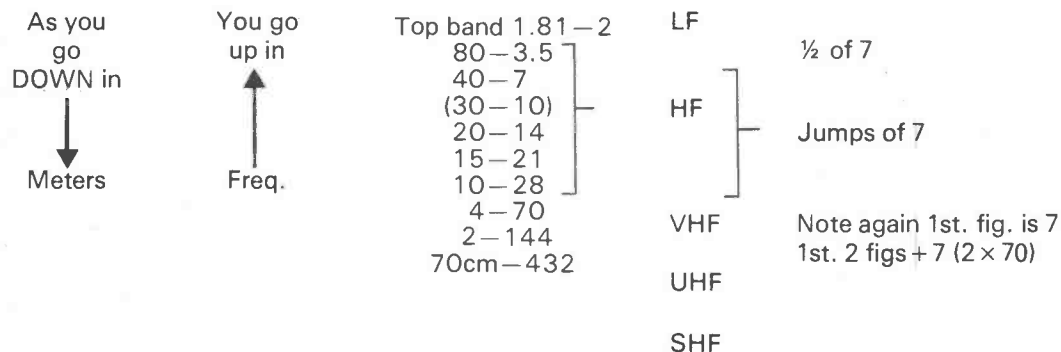
This system is also used to give values of some components in circuits especially resistors.

- 3k3 = 3.3k or 3300Ω
- 3R3 = 3.3Ω
- 3M3 = 3.3MΩ or 3,300,000Ω

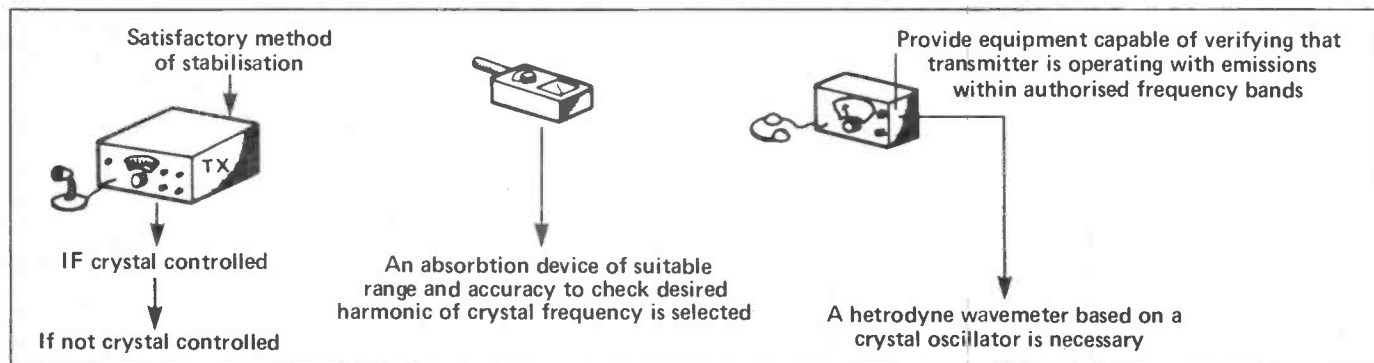
INTERNATIONAL REQUIREMENT

OBSERVE and COMPLY with the relevant provisions of the TELECOMMUNICATION CONVENTION

An easy way to try and remember the relationships between amateur bands is shown below:



FREQUENCY CONTROL AND MEASUREMENT Page 7 (3) Page 39 (3)(a)b



LICENCE-SENDING does NOT allow:-

- Page 10 (16) (iii) Remarks about business affairs
- 12 (h) Sending misleading messages
- 6 (d) Messages other than initial calls (CQ) shall not be broadcasted to amateur stations in general.
- 7 1(2)(f) No message which is GROSSLY OFFENSIVE or of an INDECENT or OBSCENE character shall be sent

YOUR NAME PUBLISHED

Page 12 (k)

If you don't want it published notify Secretary of State for the Home Department within ONE MONTH of issue.

INSPECTION

Page 9 (10)

STATION, LOG, and LICENCE, available at all REASONABLE TIMES.

CLOSE DOWN

Page 9 (11)

At ANY TIME on DEMAND by a person acting under the AUTHORITY of the SECRETARY OF STATE FOR THE HOME DP.

RENEWAL

Page 9&10 (12)

IN FORCE for 1 YEAR from date of issue

Pay secretary of state ON or BEFORE anniversary in ADVANCE.

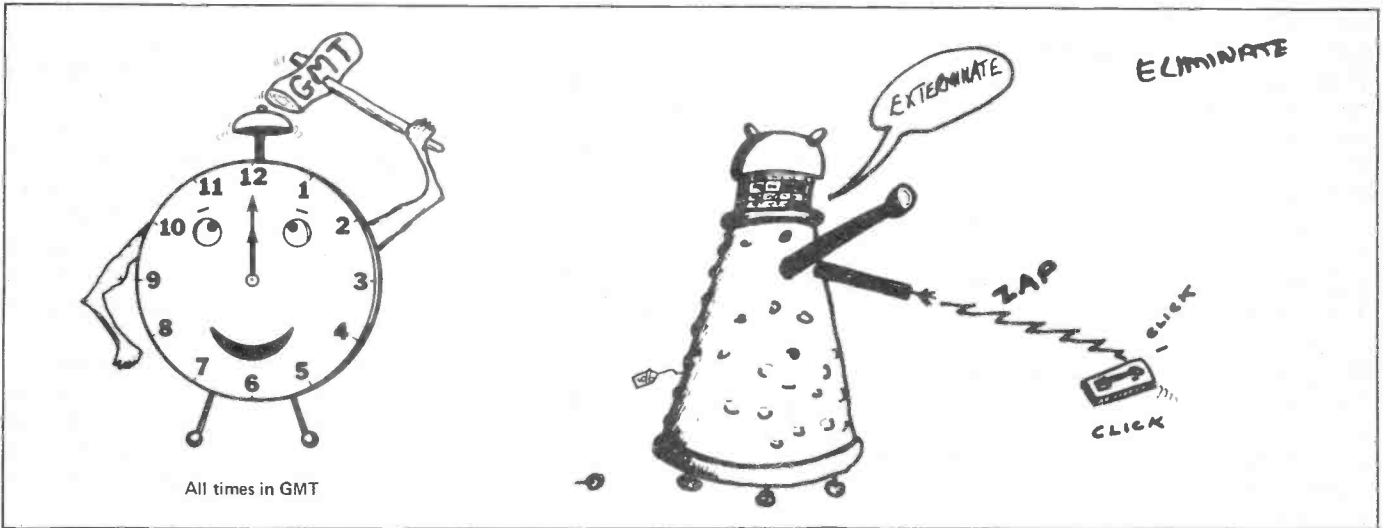
Secretary of state may at ANY TIME REVOKE THE LICENCE

NOT TRANSFERABLE

Return licence when revoked or expired.

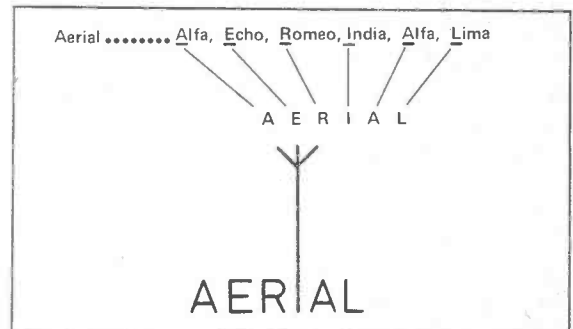
(13)

(4)

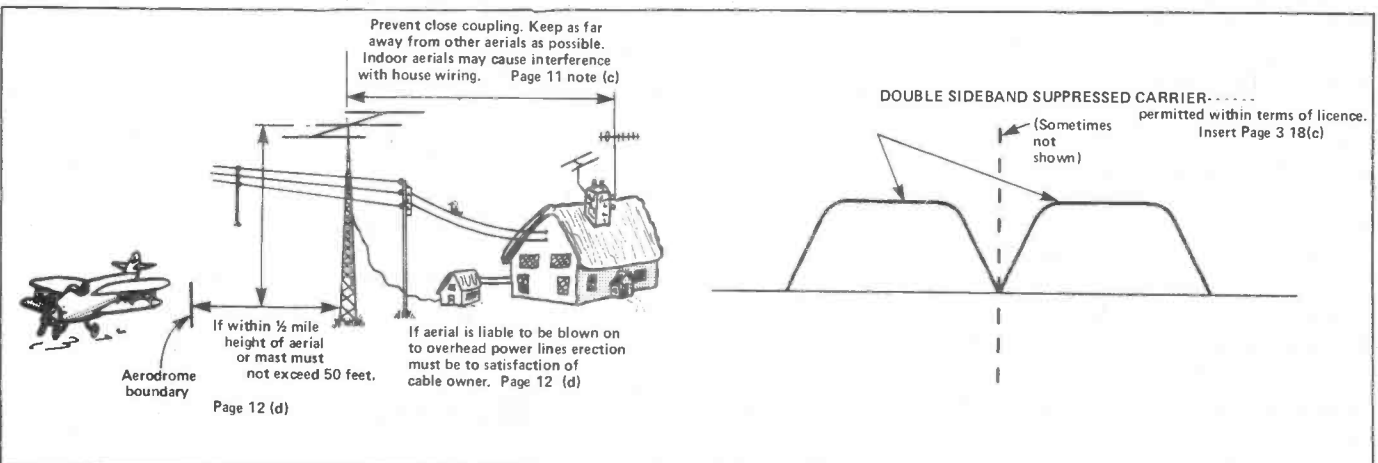


SUGGESTED PHONETIC ALPHABET

- | | | |
|------------|-------------|------------|
| A. Alfa | J. Juliett | S. Sierra |
| B. Bravo | K. Kilo | T. Tango |
| C. Charlie | L. Lima | U. Uniform |
| D. Delta | M. Mike | V. Victor |
| E. Echo | N. November | W. Whiskey |
| F. Foxtrot | O. Oscar | X. X-Ray |
| G. Golf | P. Papa | Y. Yankee |
| H. Hotel | Q. Quebec | Z. Zulu |
| I. India | R. Romeo | |



You will be asked at least one question in the exam to test your knowledge of the above code: —



ALL MODE TRANSCEIVER Project

CIFPU

Before commencing description of these units, there are a couple of modifications required to the CIFPU unit published in the July issue. These are a result of component tolerance problems resulting in insufficient drive to the PA on all units. Also, some afterthoughts have occurred to us which are worth incorporating.

Mod 1

To guarantee the drive level, T6 requires changing to a different type of transformer. This should now be a Toko KALS4520A (as already used in the CIFPU unit). Also, C46 should be changed from 39p to 1n. A consequence of this mod is that the ambient level of RF around the CIFPU PCB is much higher when in TX mode. Therefore you may find that the existing sidetone level adjust circuit has no effect, and that the level is too high. A modification to overcome this will be published, but is included with the kits and PCBs available from WPO communications.

Mod 2

As noted in the Corrections page of the September issue (p. 50), the source resistors R15 and R19 plus C15 and C17, are not required. Connecting the sources of Q4 and 5 directly to the top foil will result in better AGC performance. On original PCBs, small wire off-cuts can be used to strap the hot ends of the resistors to the foil. Later PCBs will have these components removed.

Mod 3

Again, as noted on p. 50 September, the noise performance can be improved. An easier way to do this mod is to remove R1 and wind about 12 turns of 0.20mm enamelled copper wire round the body, soldering at both ends, and then replace R1.

PROJECT



Part 4

*This month the QRP PA,
TX/RX switching and logic
sequencing unit.*

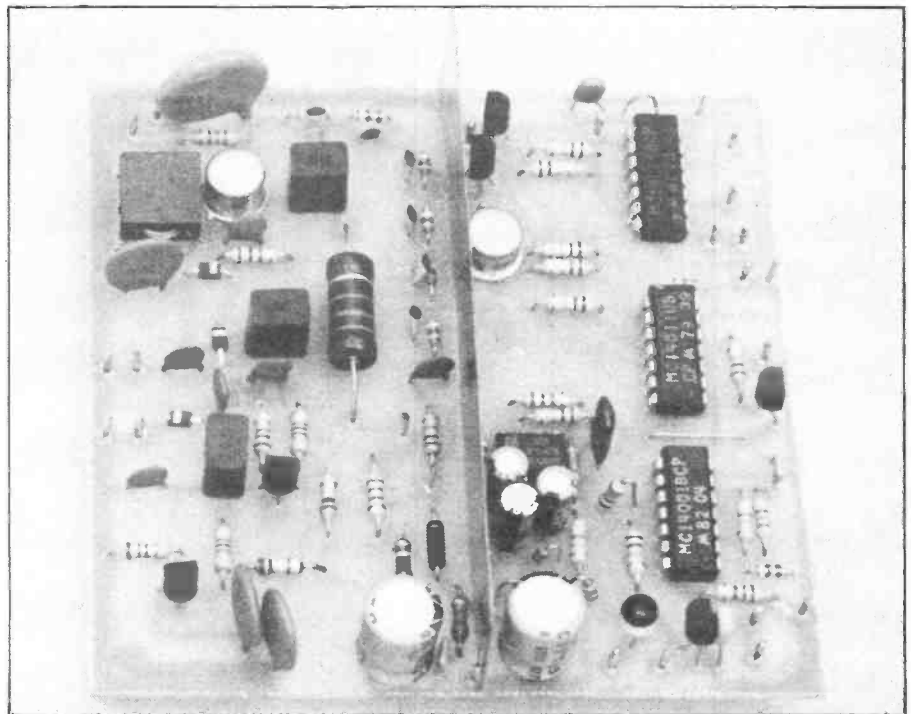
*By Frank Ogden, G4JST
and Tony Bailey, G3WPO.*

The next issue of PCBs for kits will have the above mods incorporated.

The TX/RX antenna switch

At first glance the circuit of the solid state aerial changeover switch (Fig. 1) may seem a bit complex for an apparently simple task but operation is straight forward. At the outset, it should be said that the whole unit could be usefully replaced with a high quality aerial relay except for the fact that full high speed CW break-in (listening between dots at up to 50wpm) requires relay operation of a few milliseconds at most. If you are not concerned with CW break-in then a mechanical option should be considered. This would however require major circuit changes. Either way there is no noticeable performance penalty involved in using the solid state switch. The receive side of the switch will handle signals up to +20dBm (100mW) without apparent intermod problems while the transmit section will stand off up to

The completed TX/RX antenna switch.



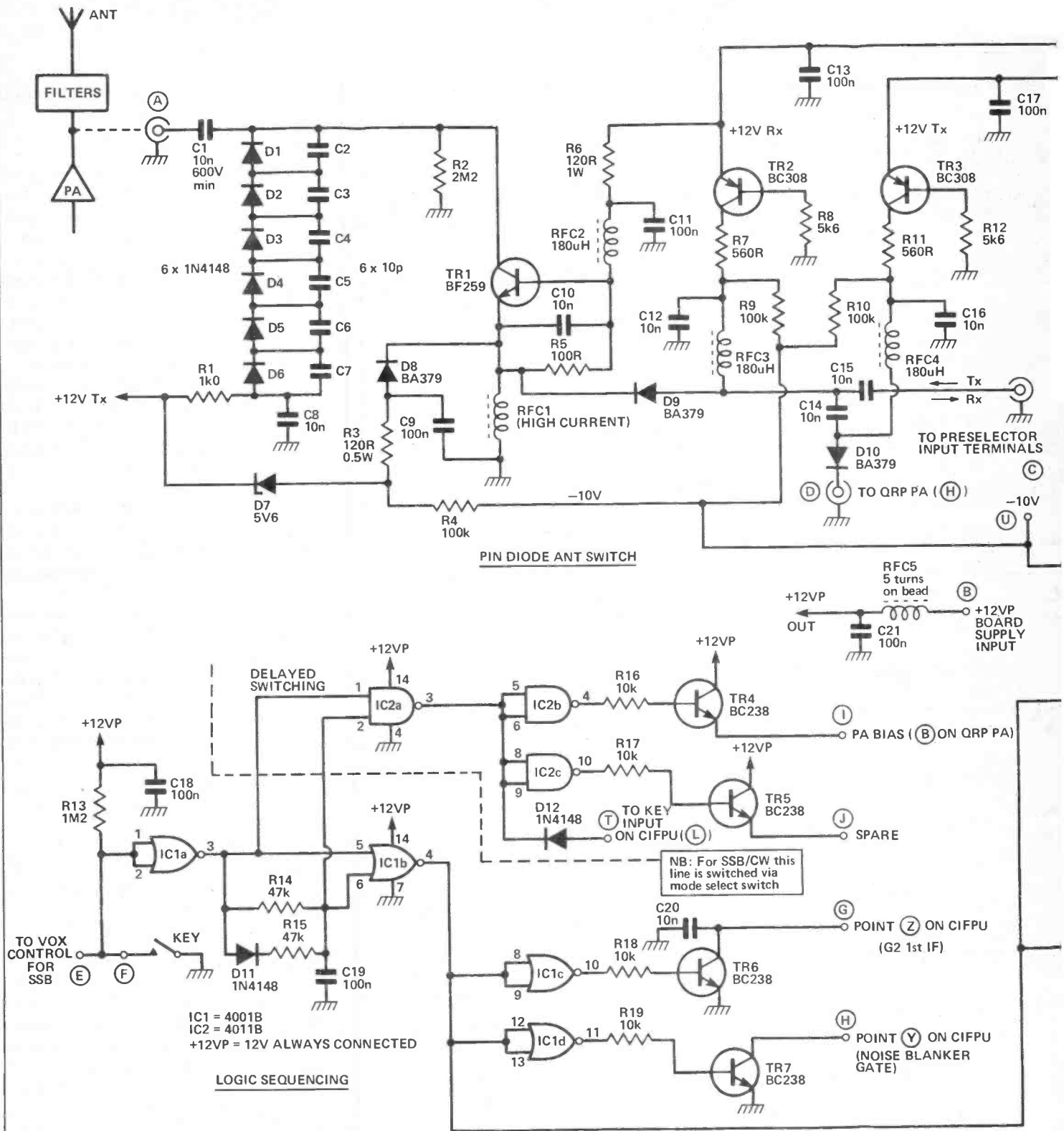
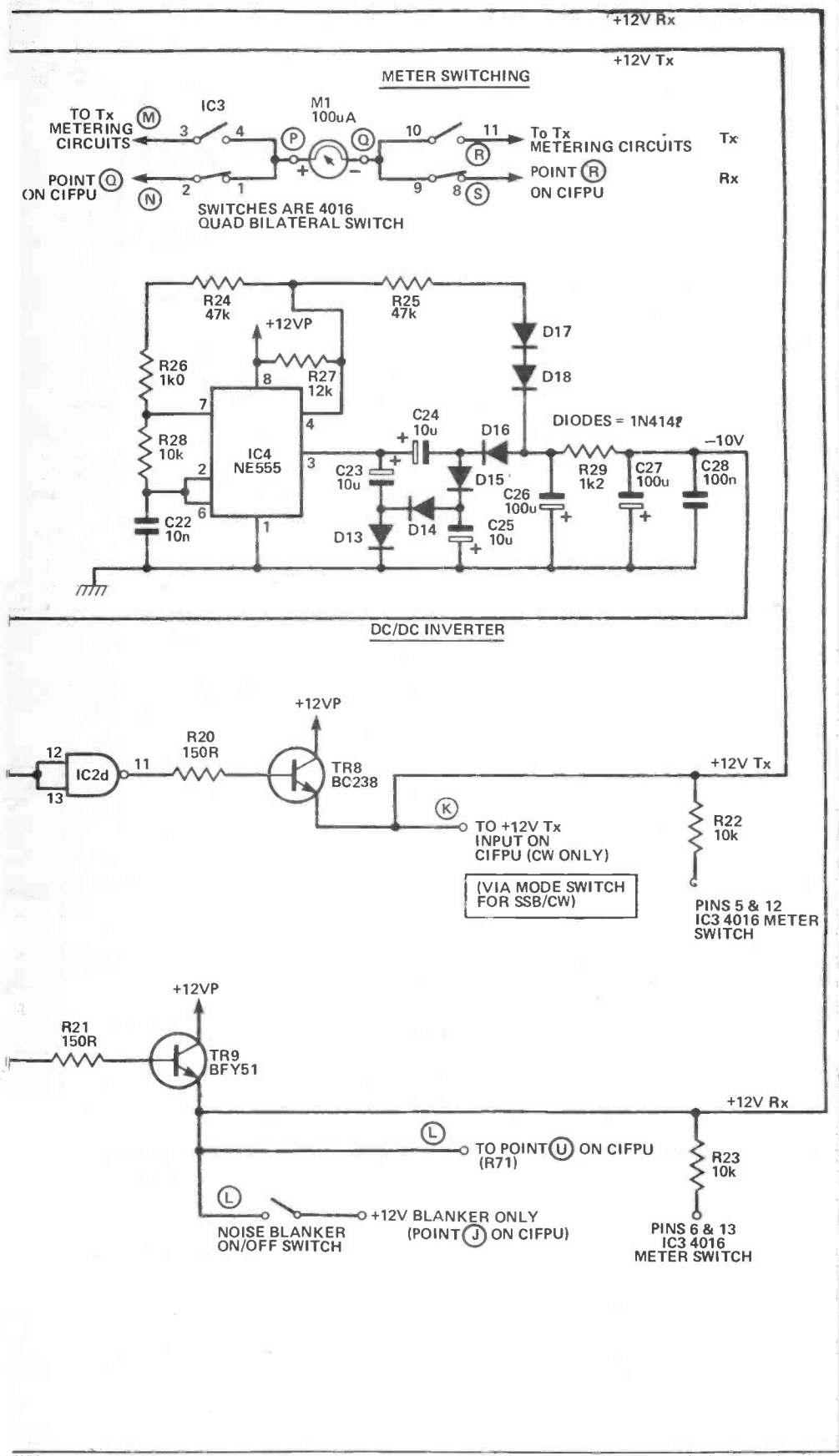


Fig. 1 The TX/RX antenna switch circuit.



250W of TX RF in the transmit path with more than 70dB of isolation in the receiver, typically 80dB from 14MHz and below. This is better than most mechanical relays when operated at HF.

Transmit path. The first thing to understand about the SSS is that it isolates the PA stage from the receiver but does not switch HF power directly. The path from the TX PA through the aerial filters to the aerial socket is hardwired, thus the PA stage is connected to the aerial regardless of Omega being in transmit or receive.

In transmit, Tr1, a BF259 high voltage small signal transistor is open circuit with the base tied to the emitter via C10 and R5. PIN diode D8 conducts tying the emitter (and hence the base) of Tr1 to RF ground. It acts simply as a reverse biased diode in transmit. Diodes D1 to D6 and their RF potential dividers C2 to C7 rectify the transmit RF signal to keep Tr1 biased to a DC level just 10V more than the peak to peak RF voltage. Any forward conduction of Tr1's collector base junction during the RF cycle spells instant death for the transistor. The diode chain prevents this occurring. Note that Tr1 develops around +200V on the collector during transmit.

A small DC to DC generator provides around -10V of reverse bias for PIN diode D9 (and the other PIN diodes in their off state) adding further isolation to the receive path. In transmit, the other remaining function of the SSS is to connect the input of the PA strip to the output of the pre-selector. D10 connects point C, the pre-selector, terminal to point D, the PA strip terminal. Tr2 and Tr3 simply provide DC switching.

Receive Path

The TX PA stage, which connects continuously with the aerial, has the bias removed from the output transistors. This effectively puts the port into a high impedance state. Note though that the DC supply to the output transistors is not removed. If the supply were removed completely there would be a massive increase in output capacitance due to the varactor effect. This would de-tune the output filters and load the receive signal path.

Tr1, the high voltage transistor is massively saturated by heavy base current though R6. The minority

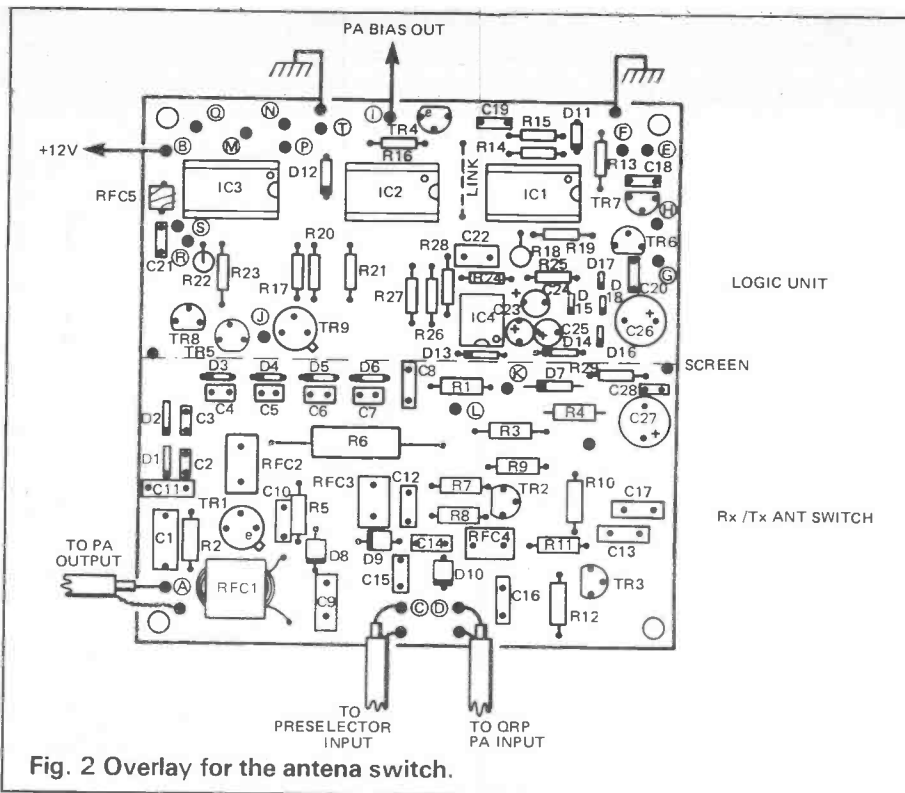


Fig. 2 Overlay for the antenna switch.

carriers created in the device provide an almost 'metallic' contact from collector to emitter. The alternative would have been to use a high voltage PIN diode at a cost of some several pounds. As it is, the BF259 does the job equally well and only costs a few pence.

D9 turns on connecting the receive signal at the emitter of Tr1 with the input to the preselector. D10 now isolates the PA strip input from the receive path. Strictly speaking the DC to DC generator is not necessary for basic operation but its inclusion does, we feel, extend further the performance of the solid state switch. Overall, the losses of the SSS amount to just a fraction of a dB.

The Logic sequencing unit

In order to achieve full break-in operation on CW using an antenna switching unit such as just described, it is necessary to have additional circuitry which will change the transceiver from receive to transmit mode, and back again as the key is made and released. This has to take place at keying speeds, with no clicks or thumps being generated.

As you would soon discover, any attempt to switch the voltages involved between Tx and Rx in a simple fashion will generate an assortment of clicks and thumps, making operation impossible. Some form of sequencing is required which will perform the following operations in the listed order:

- a) Mute the receiver.

- b) Change the antenna from receive to transmit.
- c) Switch on the Tx carrier oscillator.
- d) Apply bias to the PA, and therefore radiate RF.
- e) Remove bias from the pa.
- f) Switch off Tx carrier oscillator.
- g) Change antenna from Transmit to receive.
- h) Activate receiver.

In the case of this system, the first three and the last three operations take place virtually simultaneously, and it then becomes a matter of delaying the application of the PA bias for a suitable time, dictated by how long it takes the Tx carrier oscillator to stabilise after switch on. A slightly longer delay after releasing the key before the receiver is activated is required to ensure no RF is present when the antenna is reconnected to the receiver.

All this is performed by the Logic Sequencing unit. Although it looks complicated, it is in fact fairly simple, the heart of the unit being the delay circuit comprising IC1a/b and IC2a. The rest of the circuit is simply to isolate the various switching voltages from each other. The "delayed" outputs from IC2b and IC2c have been selected so that the PA bias is applied about 1ms after the key is depressed, or 1mS after the receiver has been muted and the antenna switch changed.

On release of the key, the PA bias is removed, and about 2-3 milliseconds later the rest of the circuitry is returned to receive, via the outputs

controlled by IC1b.

The receiver muting is achieved by activating the noise blanker gate (via output H) and reducing the gain of the first I.F. via output G. If needed, muting can be even further enhanced by applying output G to the second I.F. as well.

It is necessary to switch off the noise blanker amplifier chain during transmit, so the blanker on/off switch must be connected via the output from T9.

Metering. The S Meter is also required to perform the functions of a transmit monitor, so a 4016 CMOS Quad Bilateral switch is used to change the meter inputs between transmit and receive at keying speeds. The selection of the meters' monitoring function on Tx is made via a separate rotary switch.

CONSTRUCTION

Logic antenna switch unit. Both of the circuits described are built on the same single sided PCB, with a screen separating them.

The construction is not difficult, and the whole board can be built in one go, starting with the insertion of the connection pins. Take note of the following:

- a) All three of the CMOS IC's are held in sockets — avoid handling the pins if you can, although modern 'B' type CMOS is not as notoriously static sensitive as the earlier type.
- b) C1 must be a high voltage type as specified.
- c) As usual, keep all the leads as short as possible, especially round the RF switching unit.
- d) RFC1 requires 35cm of .25mm wire to wind. RFC5 needs 18cm of the same wire.

Testing

It is important that the operation of this unit is checked before connecting it to the PA and firing up the rig. If it isn't working properly you may lose the SBL1 mixer in the CIFPU unit rapidly! Double check all the component positions and orientations before proceeding.

- a) Connect + 12V and an earth to the PCB. Check that the current consumption is around 130mA or so.
- b) Check that approx -9-12V is present at point U. If too high or low, a slight change to the value of R7 will put it right.
- c) Check that points I, J, K do not have a positive voltage on them. Then that

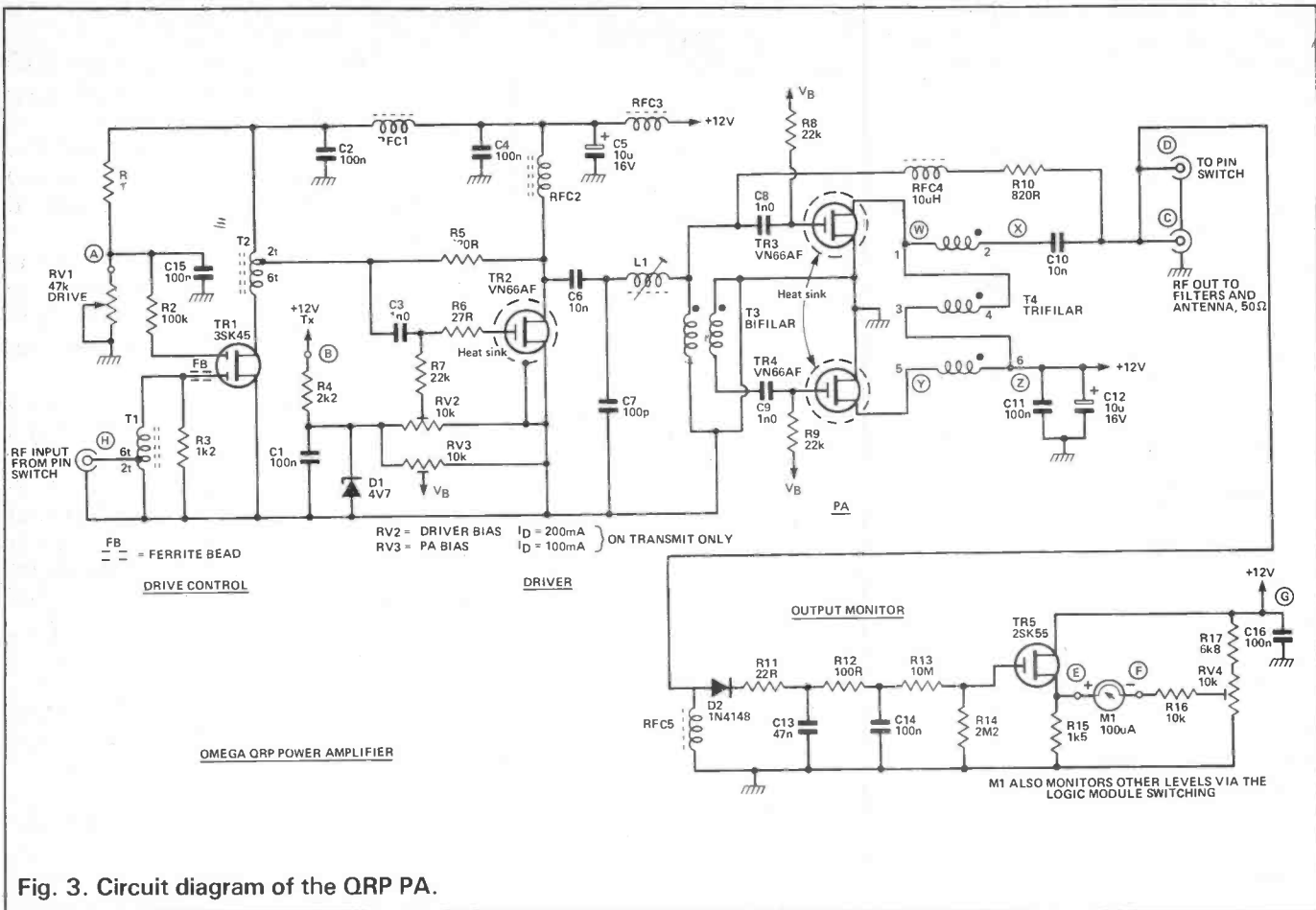


Fig. 3. Circuit diagram of the QRP PA.

point L has approx. the supply voltage on it, the case of T1 is virtually at 0V, the junction of D9 and C15 is at about 0.8V, and the junction of C14 and D10 is at negative potential.

d) Now earth point F — the current consumption should about halve. Make the following checks:

- i) Points I, J and K go to near supply potential, and the case of TR1 has about 8V present.
- ii) Junction of C14/D10 is at about +10V, and that of D9/C15 is now negative.
- iii) With an ohmmeter check that points G and H are at low resistance. Removing the short from point F should increase this resistance. Check also that pin 8 of IC2 is low on TX and high on receive.

This should ensure that the unit is functioning correctly. If things are not as they should be (the voltages may vary a little but the magnitudes and polarities should agree) then a step by step check through the logic is required. Look for gates that don't invert as they should do, and diodes that are inserted the wrong way round.

If you have dual beam scope, you should be able to see the delay

present between pins 3 of IC2a and pin 4 of IC1b, while keying point F.

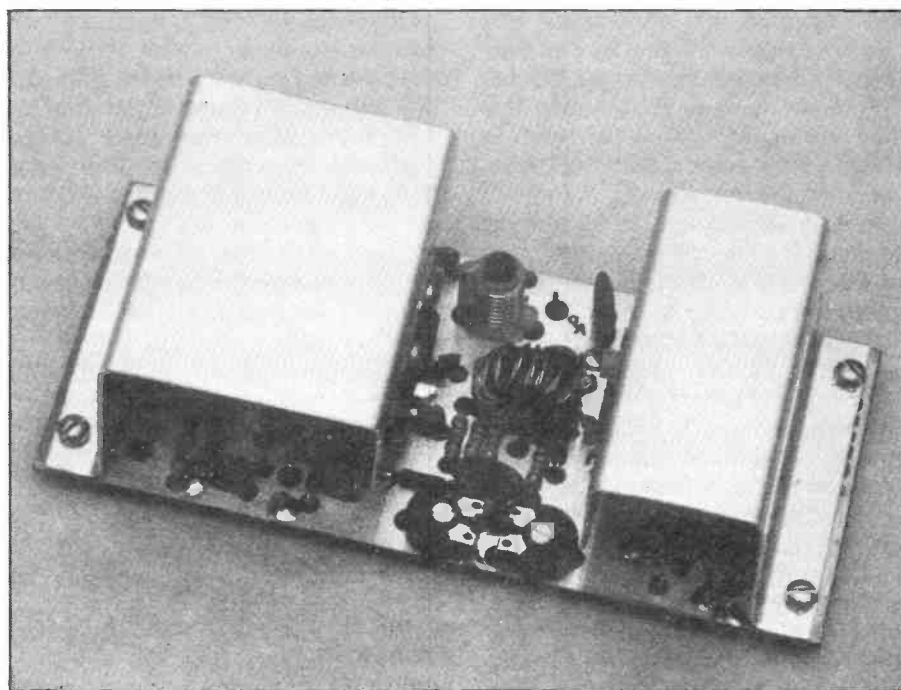
THE QRP PA

This unit is built on one double sided PCB. Construction should be in

the following order.

1. Insert and solder all nine PCB connection pins.
2. Insert and solder all fixed resistors, earthing to the top foil where required.

The PA board with heat sinks in position.



3. Insert and solder RV2, 3 and 4, with one leg of each soldered to the top foil where shown.

4. Insert and solder all capacitors keeping the leads as short as possible. Observe polarity of electrolytics.

5. Insert and solder D1 and D2 observing polarity.

6. Insert and solder L1 (cut off the square protruding lugs first), and RFC1, 2, 3 and 5. These latter each require 18cm of wire for winding.

7. Taking care that the orientation agrees with the diagram (one edge of the case is chamfered) insert and solder TR2, 3 and 4. These devices are static sensitive — push the leads through a small piece of kitchen foil or wrap wire round them to short the leads before handling them. The top of each tab needs to be 25mm above the PCB top surface. Solder the source lead of each to the top foil first, before soldering the other leads.

8. Insert and solder TR1 with a small ferrite bead on the G1 lead. The device should be pushed as close as possible to the PCB. Earth the source lead to the top foil.

TRANSFORMERS

Wind and insert the transformers as follows:

T1. Note that one turn on these balun cores is defined as the wire passing down one hole and back through the other. Take 13cm 0.25mm wire and wind six turns through the core. Strip one end to near the core. Take another length 5cm long, strip one end, twist to the other stripped end already on the core, and solder. Wind a further two turns on the core, leaving the last bit of wire put through longer than the other so you know which end is which. Strip the ends, with the longer end being the earthy end.

T2. Wound exactly as T1 but the longer wire is the C2 end.

T3. Bifilar transmission line transformer. Take two lengths of 0.4mm dia wire 30cm long. Twist each end loosely together. Then clamp one end in a vice, and the other in a hand twist drill. Now twist the winding until you have about eight to ten turns per inch. Remove from the clamps and wind 12 turns round the core, taking great care not to strip any insulation off. Reduce the lead lengths to 15mm, untwist the free ends, and strip about 5mm of insulation off each wire. Establish with a multimeter which lead is which (and that they

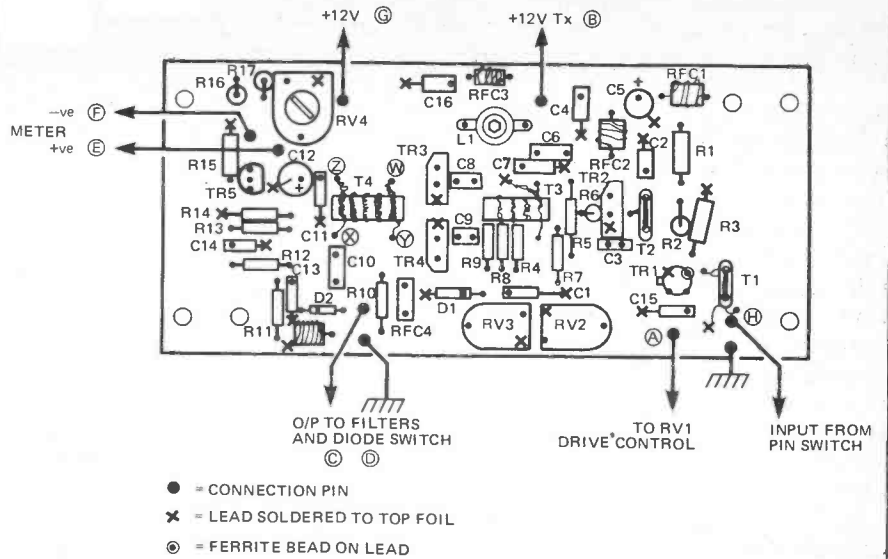


Fig. 4 Overlay for the QRP PA.

don't have a DC short between them), and connect the beginning of one winding with the end of the other. The pair then becomes the earthed lead, and the other two go the PCB either way round.

T4. This is a Trifilar winding which is fairly easy to get right if you follow these instructions. One of the authors makes no apologies for getting it wrong at least twice (*and it wasn't me—G4JST No Frank, you only got the drawing wrong!—G3UPO*) It helps if you can get hold of three different coloured wires, but this is not easy.

Take three lengths of 0.4mm dia enamelled copper wire, each 30cm long. Repeat the winding exercise already gone through with T3, checking for interwinding shorts and wind 12 turns onto the core — the direction of winding is vital to agree with the drawings — start by holding the core in your left hand and thread one free end of the wire triplet through from the front, so that about 30mm protrudes from the back. Then continue the 12 turns so that the winding is moving to the right of you.

Reduce the free ends to 25mm in length, unravel them and strip about 7mm of insulation off each. Now,

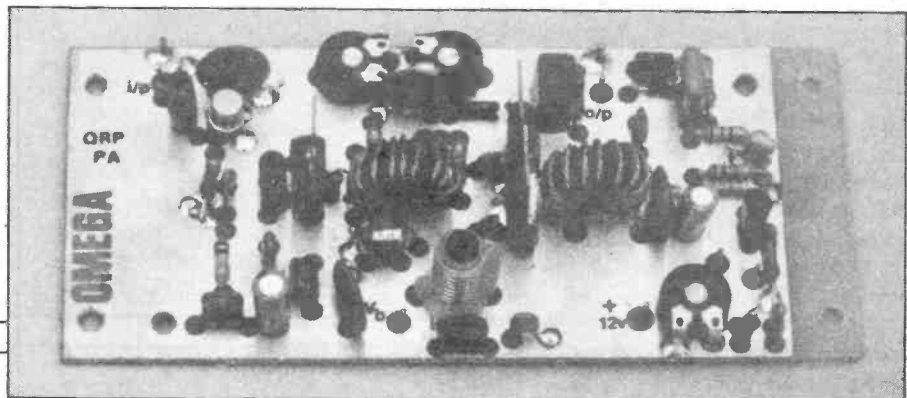
again establish which ends of the windings are which, and arrange them as in Fig. A (1, 3 and 5 are beginnings and 2, 4 and 6 are ends). Then connect the appropriate ends loosely as shown, Fig. B. Check that you have DC continuity between lead 2 and 5.

Rearrange the leads so that they are as in Fig. C. Then carefully push the leads through the appropriate holes in the PCB (the wires may look at bit tangled underneath but don't worry). You will probably need to strip a bit more insulation off underneath the board before soldering into place. If you think you have gone wrong at some point, then start again.

You should now have all components in place, and the heatsinks may be constructed. Note that that for the output transistor pair is not earthed — the PCB top surface is cleared around the flange, whereas the driver heatsink is earthed. Both require insulating washers between the transistor tabs and the sinks.

The sinks are made from 20swg aluminium sheet as shown in the drawings. The mounting holes are marked through onto the flanges after bending to get the correct positioning. When mounting the sinks, it is essen-

The completed (but naked!) QRP PA board.



tial that you use NYLON 6BA bolts, otherwise there will be a DC short between the tabs and the sinks (these bolts are supplied with the kits), as well as the insulating washers. Heat-sink compound is required between all mating surfaces.

Testing the PA

To test out the PA, it will be necessary to use the CIFPU as the drive source. Proceed as follows.

1. Connect up the CIFPU/VFO etc for normal operation but do not connect point U. Don't apply any power yet. Connect points Y and Z to earth and +12V to the +12V TX connection. Connect the preselector output to the CIFPU and the INPUT to the preselector to the INPUT of the PA, using miniature coaxial cable.
2. Connect the drive control, RV1 to the PA as shown, so that the earthy end is at anticlockwise travel. Set

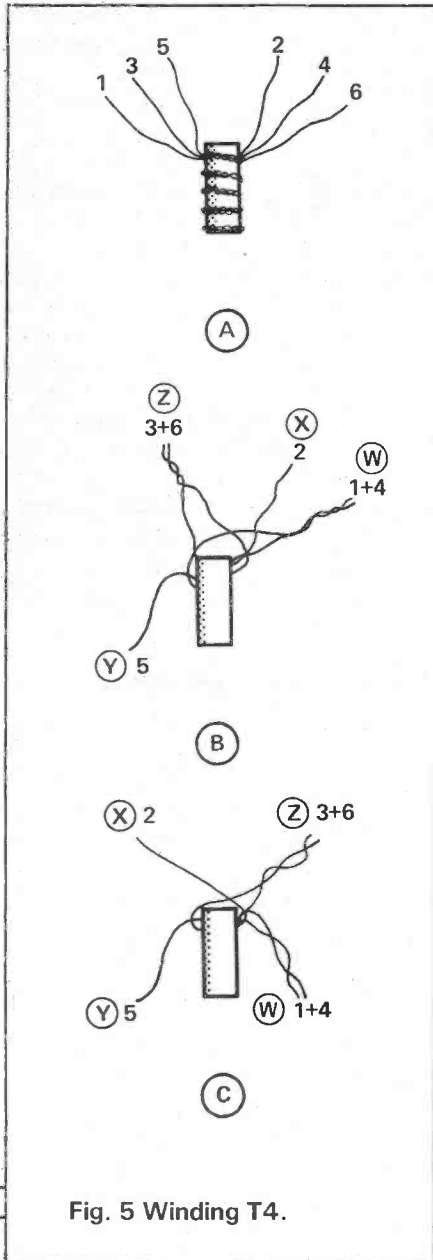


Fig. 5 Winding T4.

RV2, 3 and 4 fully anticlockwise. Connect +12V to the PA and to the bias input (marked +12V TX on the PA layout). Connect a 50 ohm dummy load to the output of the PA, together with a power meter or SWR bridge to monitor the output.

4. Apply +12V to the PA ONLY, while monitoring the input current. Adjust RV2 so that the current increases by 200mA (thus setting the driver standing current to 200mA), and then adjust RV3 for an additional 100mA. The increase in current as these are adjusted should be smooth with no sudden jumps.

If there are sudden jumps the PA is almost certainly unstable and the fault will have to be found. Remove the dummy load. The PA should not take any additional current or give any output. If it does, then it is almost certain that T4 is wrongly connected. 5. Now connect +12V to the CIFPU unit etc, and wind RV1 (DRIVE) fully clockwise. Keying point L on the CIFPU should result in output from the PA. With the VFO on 29MHz, adjust the core (use the correct tool) of L1 on the PA for maximum output.

You should now find that the output power is reasonably constant across the 10 bands, with about four watts available from a 12V supply (this assumes the mods to T4 have already been made as detailed earlier). The drive control should vary the output power down to virtually zero watts. Total current consumption of units connected at this stage will be in excess of 1 amp. (PA board around 700mA at max output).

If you get very little power, check the transformer windings on the PA (especially T4!). A clue to the problem will be whether the PA is taking any current. If it is but there is little output, then the problem is in the PA. If no current is being taken (other than the standing current) then no drive is reaching the unit. Checking with a scope or diode probe should reveal where the problem lies.

Monitor meter

To set this up, connect the 100uA meter as shown, and apply power. Adjust RV4 so that the meter reads about 90% of FSD at 29MHz with full power output. Under normal operating conditions, the drive control can be set flat out for CW, but for SSB, the drive needs to be adjusted so that the meter reading just backs off a little from maximum. More details

when the SSB unit is published. An additional unit will be published for monitoring the actual output power.

Connecting up

Once you have correct output power, you can then interface the PA and CIFPU with the Logic Sequencing Unit. Later on in the series we will give a complete wiring diagram for the whole unit, but there is sufficient information here to connect it all together. At this stage the units will very likely be spread around the bench. This doesn't matter as long as you keep the connections between the Antenna switch and the PA as short as possible, and use coaxial cable where needed. Have all diecast box lids in place where required.

The output of the PA has two coaxial connections made to it — one

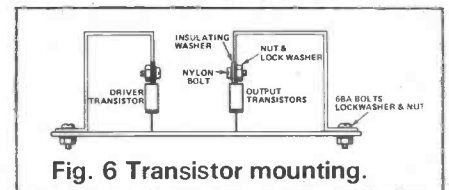


Fig. 6 Transistor mounting.

to the switching unit and the other to the output filters (next month).

Connection between the CIFPU keying input (L) and the switching unit (T) should be made with screened audio cable.

Important

PLEASE NOTE that the TX should not be put on the air until the output filters are in place (unless you make a temporary one for a particular band) as harmonics will be present from the PA (see next month's article).

However, a check on the break-in (QSK) operation can be made using an aerial with the drive backed right off to see that everything is OK. Keying at speeds up to 50wpm should be clean, with no clicks and thumps as the rig changes between RX and TX. The AGC Decay control on the CIFPU will normally be set around the "fast" end, but it can be adjusted to a setting which suits the strength of the incoming signal.

One of the problems occurs when the incoming signal is at the same strength as the sidetone — it then becomes difficult to hear what you are sending (if you need to). Under these conditions you should advance the AGC decay so that the receiver takes longer to return to full sensitivity.

KITS

Kits of parts for these modules are obtainable from WPO Communications as follows:

QRP PA: Price £21.00 inc VAT and post. All components are included except the heatsink material. PCB only £3.00 inc.

ANTENNA SWITCH/LOGIC: Price £15.45 inc. All components are included except the tinfoil screen. PCB only £2.50 inc.

Both kits include wire and drilled PCB.

Also available: 100uA meter as recommended to suit the front panel. Price £8.00 inc.

QRP PA — Component Listing

R1,2	100K
R3	1k2
R4	2k2
R5,10	820R
R6	27R
R7,8,9	22k
R11	22R
R12	100R
R13	10M
R14	2M2
R15	1k5
R16	10k
R17	6k8

All resistors 5% carbon film 0.25W.

RV1	ALPS 47k lin pot
RV2,3,4	10k 10mm dia preset
C1,2,4,11,14,15,16	100n ceramic disc
C3,8,9	1n ceramic disc
C5,12	10u 16V electrolytic
C6,10	10n ceramic disc
C7	100p ceramic
C13	47n mylar
D1	4V7 Zener diode 400mW
D2	1N4148
TR1	3SK45

TR2,3,4	VN66AF
TR5	2SK55
RFC1,2,3,5	10 turns 0.25mm en Cu wire on ferrite bead.
RFC4	TOKO type 7BA or BS 10uH
T1	8 turns, tapped 2 turns from earthy end. 0.25mm en Cu wire on Fair-Rite balun core type 28-43002402
T2	8 turns, tapped 2 turns from C2 end. As T1
T3	12 turn Bifilar Transmission line transformer. Wound using 0.40mm en Cu wire on Fair-Rite Core type 59-61001101 (see text).
T4	12 turn Trifilar Transmission line transformer. Wire and core as T4 (see text).
L1	TOKO type 301KN-0800
M1	100uA Type ML52 (also used as S-Meter)

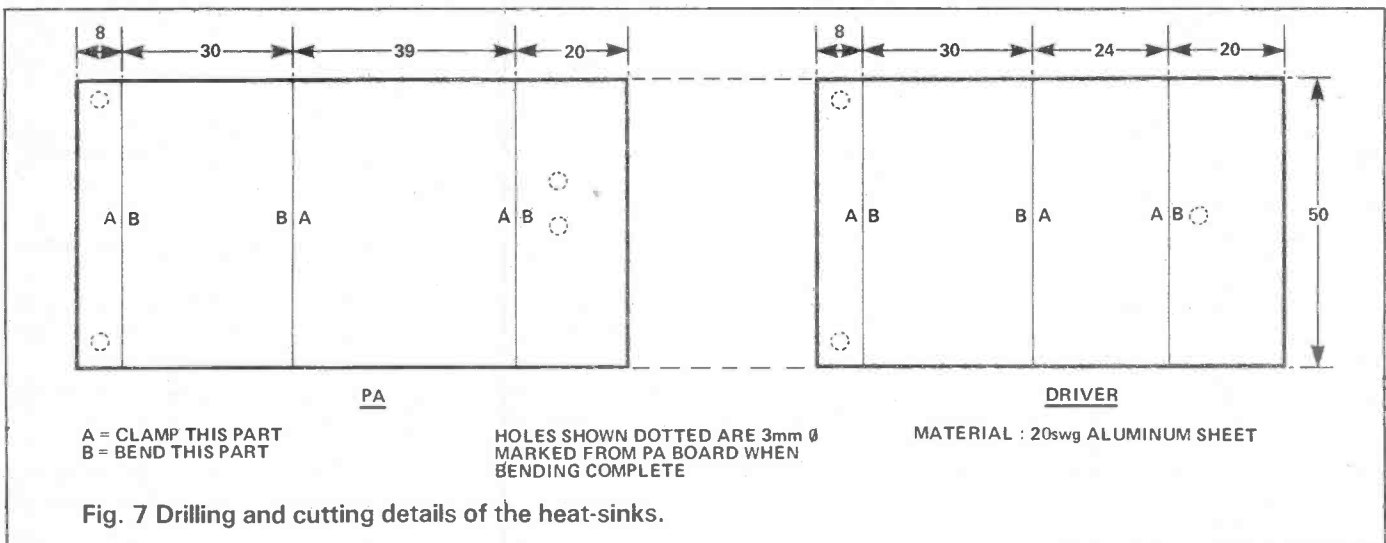
Also required:
9 x 1mm PCB connection pins.
20 swg aluminium sheet (for heat-sinks).
3 x Nylon 6BA bolts (6mm long) and nuts (metal or nylon).
1 Miniature Ferrite Bead.

Component Listing — Logic and antenna switch

R1,26	1k0
R2	2M2
R3	120R 0.5 watt
R4,9,10	100k
R5	100R
R6	120R 1 watt
R7,11	560R
R8,12	5k6
R13	1M2
R14,15,24,25	47k
R16,17,	

18,19,22,23	10k
R21, R22	150R
R27	12k
R28	10k
R29	1k2
All resistors 0.25W carbon film 5% except where specified.	
C1	10n 600V min ceramic disc
C2-7	10p ceramic disc
C8,10,12,14,15,16,20	10n ceramic disc
C9,11,13,17	100n ceramic disc
C18,19,21,28	100n monolithic ceramic
C22	10n mylar
C23,24,25	10uF 16V Radial electro
C26,27	100uF 16V radial electro
D1-6,11-18	1N4148
D7	5V6 zener diode
D8,9,10	BA379 pin diode
TR1	BF259
TR2,3	BC308 or 309
TR4,5,6,7,8	BC238 or 239
TR9	BFY51
IC1	4001B
IC2	4011B
IC3	4016B
IC4	NE 555
RFC1	10t 0.25mm en Cu wire wound on 10mm block toroid.
RFC2,3,4	TOKO type 7BA or BS 180uH
RFC5	10 turns 0.25mm en Cu wire on ferrite bead.

Also required:
Tinfoil or D.S. PCB screen 95 x 20mm.
3 x 14 pin DIL I.C. sockets.
25 x 1mm PCB connection pins.



The secrets of the Smith chart

by
Alec Jones,
GM8HGD

If you look through the normal run of electronics text books, such as those produced by the RSGB, you will see some weird and wonderful formulae to calculate the component values for interstage couplings and the input and output networks of HF and VHF power transistors. If you are a lover of mathematics, they have a strange beauty, and

design value which could be, but need not be 50 ohms is taken as unity, and all values drawn on the chart are divided by the design value). The point on the horizontal diameter at the centre of the big circle is taken as the unity value. Thus one chart can be used for all ranges of impedance without cramping of scale. The diameter line is the nor-

Dreamed of designing your own power amplifiers, aerial systems? Then read on...

they can be translated into forms which whizz round the innards of computers and are regurgitated into long lists of numbers for idiot use. Such a list is the Motorola Application Note, AN-267, Matching Network Designs with Computer Solutions, by Frank Davis. It is a crib to give component values for four commonly-used networks.

But the normal design laboratory doesn't do things that way. They prefer to use a graphical method, which is of sufficient accuracy. This is a **Smith Chart**. It is a system invented in the 1930s by a man called Smith (surprise!). It is so new that 20 years ago, when I was in college, they didn't even mention it — like some other things now common. It is a circular graph derived from the lines of force as seen in waveguides. It works as easily as finding your way on the London Tube network.

The making of a Smith chart

The Smith chart is, in fact, just a formalisation of the phasor diagrams that are used to represent resistive and reactive impedances. This is possible to do provided that you consider only series or parallel impedances at the same time.

How is the chart constructed? Take a circle, and draw across it a horizontal diameter. On the right hand side, draw a tangent normal (90°) to this diameter. This line is for constructional purposes only. The chart is normalised (that is, a

malised resistance axis (R/Z_0). Circles are then constructed along the diameter with radius $1/(1 + R/Z_0)$, as in Fig. 1. All these circles form lines of constant resistance.

Now construct arcs of circles with their centres lying on the tangent to the diameter. The radius of these arcs are $1/(+jX/Z_0)$ and $1/(-jX/Z_0)$. These form a family of lines of constant reactance, Fig. 2.

Put the two together, and the Smith Chart is formed. I include a complete Smith Chart as part of this article (Fig. 3). Blank charts are available from Chartwell, reference numbers 7510 and 7513. As you will see, there are peripheral scales on the complete chart. There are various forms of peripheral scales available. The ones we will consider later in this article are marked as electrical length in wavelengths, and phase angle of the voltage reflection coefficient. For the moment, we will ignore them. Others before me have had a go at explaining the Smith Chart elsewhere. I am trying to keep things as simple as possible, so if you want to know more, look up the info. You could do worse than look up Phillip H. Smith's "Electronic Applications of the Smith Chart", published by McGraw-Hill, price £29+, which is my source book.

As an engineer, for me, mathematics are a tool, just as much as a soldering iron. The Smith

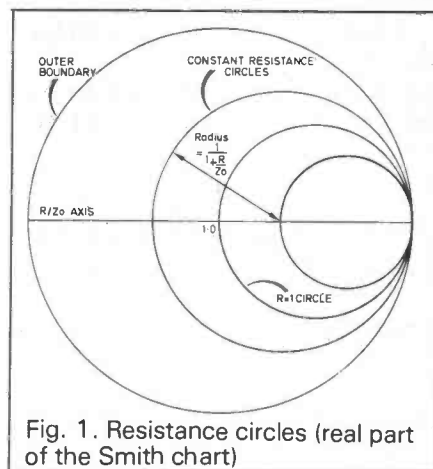


Fig. 1. Resistance circles (real part of the Smith chart)

Chart is another tool, and the purpose of this article is to help you to find ways of using this tool, in the first case to help you to roll your own power amplifiers, and secondly, using the outer scales, to design an aerial. With this as a basis, you can follow by teaching yourself the other uses.

Three types of ohms

There are three types of ohms. There are ohms resistive, which come from a pure resistor. There

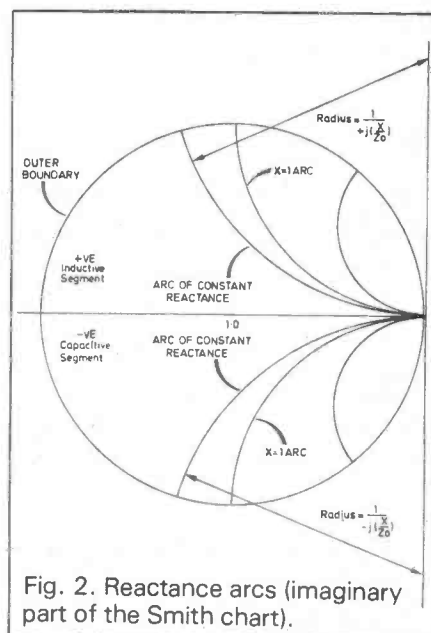


Fig. 2. Reactance arcs (imaginary part of the Smith chart).

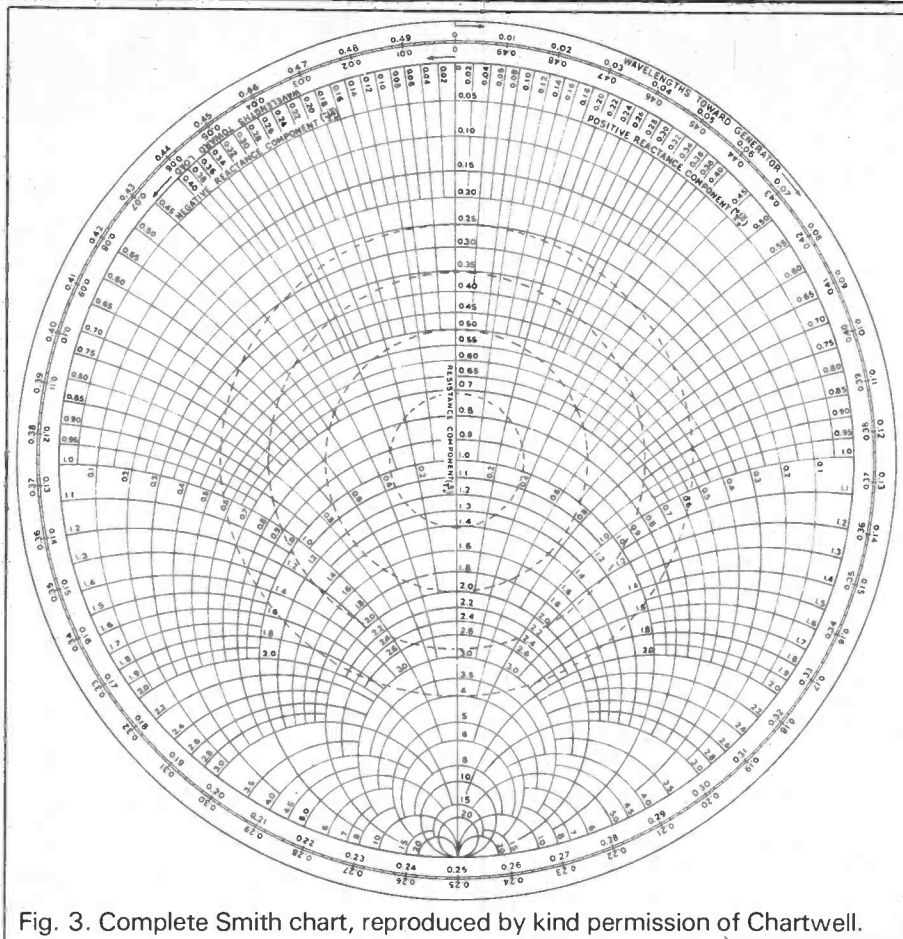


Fig. 3. Complete Smith chart, reproduced by kind permission of Chartwell.

are ohms inductive, the impedance (reactance) to AC of a coil, and these are taken as positive values as the j operator takes them through 90 deg clockwise.

Let's move round the Smith Chart, shown in simplified form in Fig. 4. Start at the right hand side of the chart. A point is marked OC for open circuit. This represents a point of infinite impedance (resistance and reactance). At the opposite side of this chart is a point marked SC for short circuit, where there is zero resistance and reactance. If we start from SC , there are three main routes we can take to reach OC . First, we can add pure resistance. This takes us along the diameter line of pure resistance until, eventually, if enough resistance is added, we reach OC . Alternatively, we can add series inductance which takes us along the circumference of the circle in a clockwise direction until eventually we reach OC . Thirdly, we could add capacitive reactance which goes anticlockwise along the perimeter to reach, eventually, OC .

Take a slightly more practical case. Assume a value of $\frac{1}{2}$ ohm resistive. We want to make that up

to 1 ohm resistive. We could just add $\frac{1}{2}$ ohm in series to go straight along the resistive line to our objective. But let's be sneaky. Let us add 1 ohm of inductive reactance (coil) in series. This takes us from point A in Fig. 4 around the circle of constant resistance 0.5 until it cuts the reactive arc 1 at point B . Now add series resistance of $\frac{1}{2}$ ohm. This takes us down the line of constant reactance 1 to point C . We now want to go in an anticlockwise direction. This means capacitive reactance. So add 1 ohm in capacitive reactance in series. We

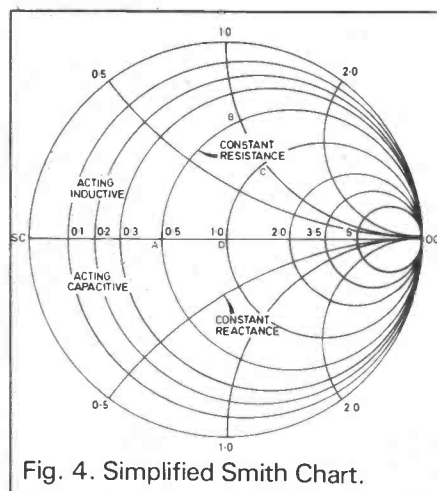


Fig. 4. Simplified Smith Chart.

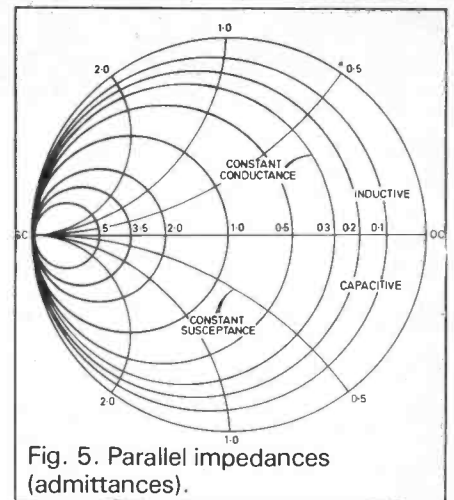


Fig. 5. Parallel impedances (admittances).

now travel along the line of constant resistance 1 from the point $+1$ reactive by a distance of -1 reactive, which brings us to $1 + j0$, the point D . We have now produced a NETWORK to match $\frac{1}{2}$ ohm to 1 ohm. In doing so, we have learned to move round the Smith Chart.

The problem with this is that the chart only works as it stands for series components. In practice, we need parallel components to get away from the dissipative resistances. Sneaky to the end, we just turn the chart through 180° and look at it the other way up. We now call the scales MHOs conductive and susceptive. The mho (or Siemens) is an inverse ohm. We now have a chart which works for parallel impedance, or more properly admittances, Fig. 5. So:

where

$$Z = R \pm jX \text{ Impedance}$$

$$Y = G \mp jB \text{ Admittance (note reversal of + and - signs)}$$

$$G = R/(R^2 + X^2) = 1/R \text{ when } X=0$$

$$B = X/(R^2 + X^2) = 1/X \text{ when } R=0$$

For a resistance and coil, $Y = G - jB$; for a resistance and capacitor $Y = G + jB$, which is why the $+$ and $-$ signs are reversed above.

Most matching networks are designed for a pre-determined value of Q , the magnification factor. For VHF power amplifiers, this will be about 10. As you will know, the value of Q affects the bandwidth of the amplifier. It is necessary to draw lines of constant Q on the chart. Draw a line perpendicular to the main diameter going through the unity resistance point. (Fig. 6) Measure the length from the perimeter to the line of pure

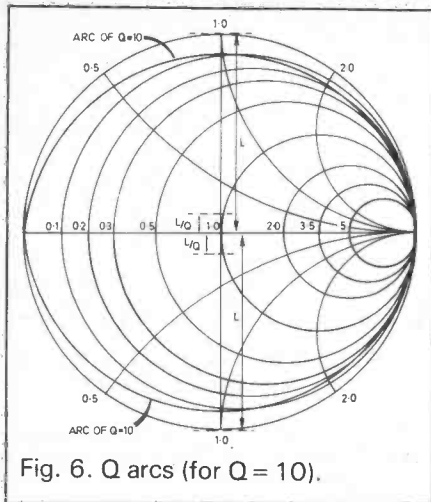


Fig. 6. Q arcs (for Q = 10).

resistance (L). Using compasses, draw the arc passing through the SC and OC points with the compasses' point on the vertical line at distance L/Q from the pure resistance line in both the inductive and capacitive halves of the chart. These two arcs form the lines of constant Q.

In practical terms, the input and output impedances are of the order of 1 to 10 ohms for transistors used in VHF and UHF power amplifiers. The usual cable impedance to which we want to match the amplifier is 50 ohms. The range over which the chart can easily be read is 0.025 to 20 ohms. So a normalising value is chosen so that all values can be resolved. In the case of transistor amplifiers, normalise to 10 ohms absolute is 1 ohm on the chart. In the aerial case shown later, a value of 200 ohms is used, or it could have been 180, or whatever is needed. With 10 ohms, all values we encounter in the design of matching networks for transistor amplifiers are easily resolved. Normalising is done purely to make the range of values to handle.

Now we shall take a practical example to see how to make our way round the Smith Chart. If you look in the RSGB Radio Data Reference Book, 4th Ed., 1977, you will see on page 69 the calculations for a 25W PA using a Mullard BLY89A. Take the input network for this, fed from a 50 ohm source. The transistor has in input impedance of $1.7 + j1.4$ ohms. We normalise at 10 ohms is 1, so the input impedance of the transistor becomes $0.17 + j0.14$. The matching network whose component values we are going to find is

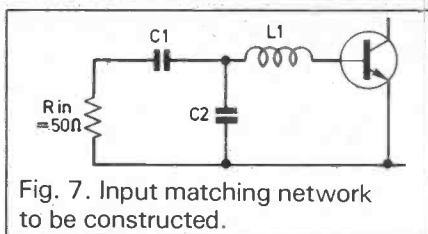


Fig. 7. Input matching network to be constructed.

shown in Fig. 7. The simplified Smith Chart where the values are plotted is given in Fig. 8. The "Q" value of the amplifier in this example is 10 (Fig. 8A).

Take the point 0.17 on the resistive axis, and travel round the line of constant resistance until we cross the inductive line +0.14 (Fig. 8B). This gives us the start point for our calculations. The first component is a series inductance L, so we continue in the same direction clockwise until we reach the

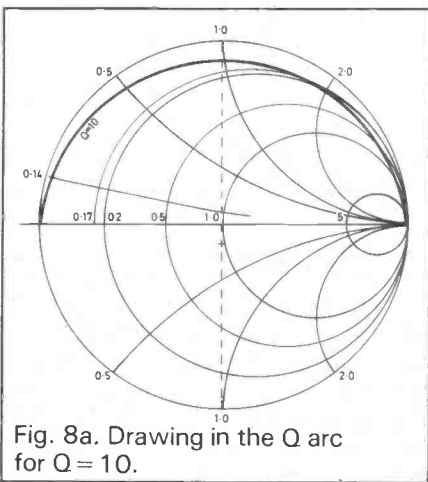


Fig. 8a. Drawing in the Q arc for Q = 10.

Q = 10 arc (Fig. 8C). It does this at $X_L = 1.7$. We started at $X = 0.14$, so the value of the inductor is $1.7 - 0.14 = 1.56$ ohms.

The next component is a parallel capacitor, so we change to the admittance form by turning over the graph paper. I used an overlay system as recommended in

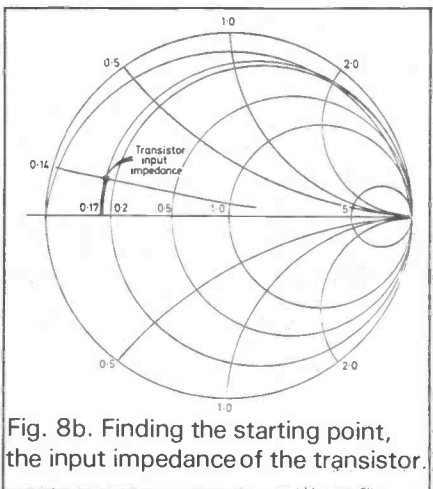


Fig. 8b. Finding the starting point, the input impedance of the transistor.

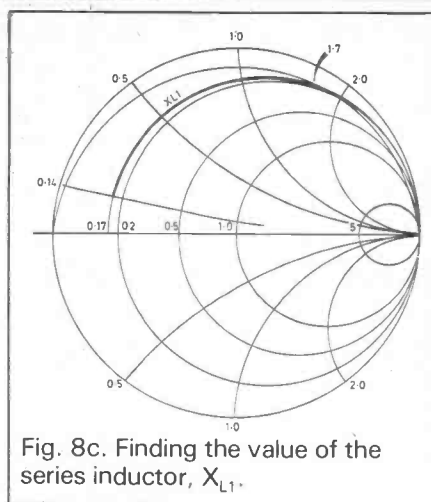


Fig. 8c. Finding the value of the series inductor, X_{L1} .

Phillip Smith's book. One American article on the Smith Chart used graph paper with double markings, but this does not seem to be available in this country. Later on, we shall see there is a simpler method of using one sheet of graph paper to convert from impedance to admittance. However, we know the final destination is reached after a series capacitor at a constant

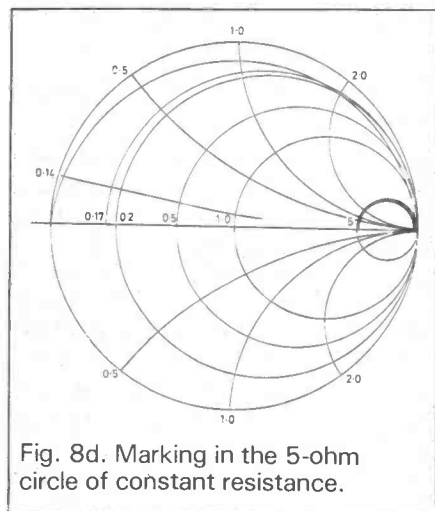


Fig. 8d. Marking in the 5-ohm circle of constant resistance.

resistance of 5 ohms. Hence before we mark in the parallel component, we mark the circle of constant resistance 5, Fig. 8D.

Looking through the overlay, Fig. 8E, we now see the equivalent line of constant conductance. Take the line of constant susceptance which passes through the point X_L and continue this down until it cuts the circle of constant conductance. We can see from the chart that this line equivalent to C in parallel runs from 0.575 mho to 0.085 mho, so the capacitance will have a susceptance of 0.49 mho.

Reverting to the impedance mode, we see that the line equivalent to C in parallel cuts the

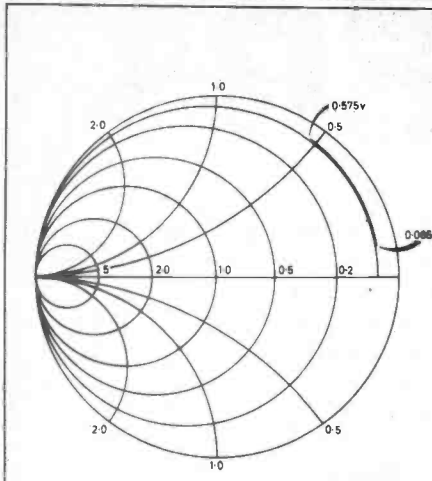


Fig. 8e. Admittance overlay.

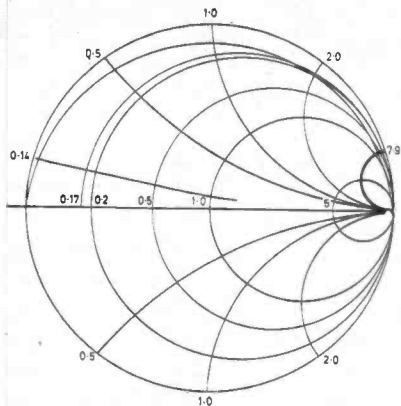


Fig. 8f. Calculating the value of the series capacitor, C1.

line of constant resistance 5 at 7.9, as near as can be judged. The series capacitor runs anticlockwise along this line of constant resistance until it crosses the line of pure resistance, so it is of length 7.9 ohms. The parallel capacitor has a length already determined of 0.49 mho, which is $1/0.49$ ohms = 2.04 ohms.

Allowing for the normalisation,

we find the absolute values of the inductance is 15.6 ohms, the parallel capacitor is 20.4 ohms, and the series capacitor is 79 ohms. This compares with the calculated values in the book of 15.6, 20.3, and 78 ohms respectively. Not bad for a graph.

Next month we shall be going on to look at the use of the Smith chart for aerial matching.



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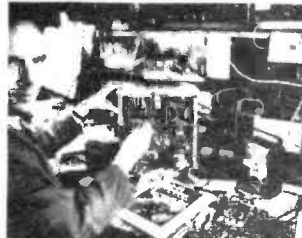
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NEWCOMERS FORUM

By Tony Bailey G3WPO

I mentioned Sporadic-E last month and the DX that can be worked via this mode. Another 'DX-getting' mode is that obtained by auroral reflection.

If you haven't yet heard an aurora in full swing then you are missing something. It's not something you can mistake for any other propagation mode because of the characteristic sound that Aurora puts on the signals. CW takes on a familiar 'raspy' note, that sounds as if the other station's transmitter has gone haywire. So much so that the 'T' part of the RST report (representing the tone quality of the CW note) is abandoned, and an A (for Auroral) substituted instead. A typical report would be 57A.

On SSB, signals are rather disconcerting to copy as they are extremely rough — so much so that I always start clearing my throat when listening to them! It is generally agreed that CW is the better mode under these conditions, and you will certainly work the best DX using it. This isn't a case of CW for the sake of it — auroral SSB is difficult to copy at weak signal levels.

QSOs during aurora are usually short — just signal reports, QTH locators and maybe names, so that as many contacts as possible can be made while the aurora lasts.

Mechanism

Auroral reflection cannot occur until there is something to reflect the radio signals in the first place. The cause of the event is the release of large amounts of energy from the Sun in the form of a solar flare. The immediate result of this is often a sudden fade-out (Dellinger fade) on the HF bands, causing a sudden loss of communication. This does not always mean that an Aurora will follow, but if the fade-out is followed by a magnetic storm, an aurora is almost certain. Eventually, this radiation from the Sun will cause the formation of an auroral curtain (which may not be visible), and conditions are set for some good DX.

Another indicator is the state of the 3.5 and 7MHz bands. Weak and 'watery' signals are often a sign that things are going to happen.

Once the ionisation curtain has been formed radio signals will be reflected off it at 2m, or even at 70cm. Because the curtain is continually moving and changing, VHF signals will have a form of distortion caused by the path length changing when they arrive at the receiving station — so much so that Doppler shift can be as much as 2kHz at 2 metres. Hence the peculiar sound which aurora produce.

Beam headings

One of the first things you will notice is that the beam heading for maximum signal strength is not the same as for a normal contact. You will often find yourself working others to the West of you when you are beaming NE. Also, unlike other propagation modes, an aurora does not cause polarisation changes, so horizontal polarisation is the best choice.

Signals will peak from somewhere between North and East, at the start of the event, usually going further North as the Aurora progresses (depending on the magnitude of the Aurora the direction may not change much). The best place to start is at 45 degrees, then 'peak up' on the wanted stations, checking every so often that you have the optimum heading.

The beacon sub-band is one of the best places to listen and it will give you some idea of the extent of the event. If you can hear a number of beacons spread over Scandinavia and Germany, then the aurora should be a good one.

Predicting aurora

Besides the fade-out warnings already mentioned, you may find there is a 'warning system' in your locality. Many amateurs have an arrangement whereby a chain of telephone contacts is set up. When one person learns of

an Aurora (or Sporadic-E) then he sets the chain in motion. (This is why large numbers of stations suddenly appear out of thin air!)

Rings

The chain should actually be a 'ring' of contacts, with everyone knowing the structure of the ring. The first person to hear an opening telephones his immediate neighbours in the ring, then each of these telephones the next person. Providing everyone answers (phone the next person in the ring if not) then eventually someone will get two calls and the ring is complete.

Timings

Once an aurora has taken place, there is often a repeat event, or repeats, at approximately 27 day intervals, if the activity on the Sun that caused the first event persists (the rotational period of the Sun is 27 days). You can therefore keep an 'auroral calendar' which will remind you to look for a repeat event.

Aurora normally occur during the afternoon, late evening, and after midnight. You may get activity at all three times on the same day, with fade-outs in between, or only one. It is worth noting that those that occur after midnight often mean there will be a much larger event the next day, so be prepared. Certainly, if there is an afternoon or evening event which then stops, don't leave the shack. Keep monitoring, as it is all likely to start happening again in as little as half an hour!

The peak auroral seasons of the year occur at around the equinoxes. Also, there is a peak about two years after Sunspot maximum

The distance of stations contacted/heard under auroral conditions is variable but about 1300km is normal, with a maximum of about 2000km under exceptional circumstances.

Enjoy the next aurora!

Beacons

This list may prove useful as a reference to pin to the shack wall. If you know of any others, please let me know.

Frequency	Callsign	Location
144.130	ZS6DN	Pretoria, South Africa
144.138	LX0LX	DJ31B
144.139	5B4CY	QU12B
144.145	ZB2VHF	XW64G
144.157	EA3URE	AA12C
144.800	OH8VHF	MZ79H
144.810	IS0A	EA08A
144.825	I0A	GB12D
144.830	9H1VHF	HV03F
144.840	IT9G	GY67C
144.850	DL0UB	GM47B
144.855	LA5VHF	JD25E
144.860	LA1VHF	ET13C
144.870	LA2VHF	FX43G
144.875	SK2VHF	JY69H
144.885	OY6VHF	WW76D
144.890	LA4VHF	CU47A
144.895	FX0THF	AL46H
144.897	EA3VHF	BB41C
144.900	OH6VHF	KW59F
144.910	DL0PR	EO54C
144.915	GB3CTC	XK76D
144.920	SK7VHF	GP38C
144.925	GB3VHF	AL52J
144.930	OZ7IGY	GP23C
144.945	GB3GI	XO41J
144.945	SP3VHG	HL08J
144.950	SK1VHF	JR41D
144.960	SK4MPI	HU46D
144.965	GB3LER	ZU65F
144.975	GB3ANG	YQ35C
144.975	DL0SG	GJ77E
144.980	SP2VHC	JO33E
144.985	ON4VHF	CK23E
432.810	GB3WHA	AL71D
432.855	LA4UHF	JD25E
432.855	SK3UHF	IW40B
432.860	LA1UHF	FT50A
432.865	OZ2UHF	EP83H
432.870	FX4UHF	ZD52C
432.880	LA3UHF	DS80B
432.885	OY6UHF	WW76D
432.890	GB3SUT	ZM31B

432.890	LA4UHF	CT47C
432.900	OH3UHF	LV39J
432.910	GB3EM	ZN32B
432.925	SK6UHF	GR61A
432.930	OZ7IGY	GP23C
432.960	SK4UHF	HT55J
432.975	SK5UHF	IU78D
432.983	OZ2ALS	EP79C
432.984	HB9F	DG40C

Another plea on behalf of AMSAT-UK

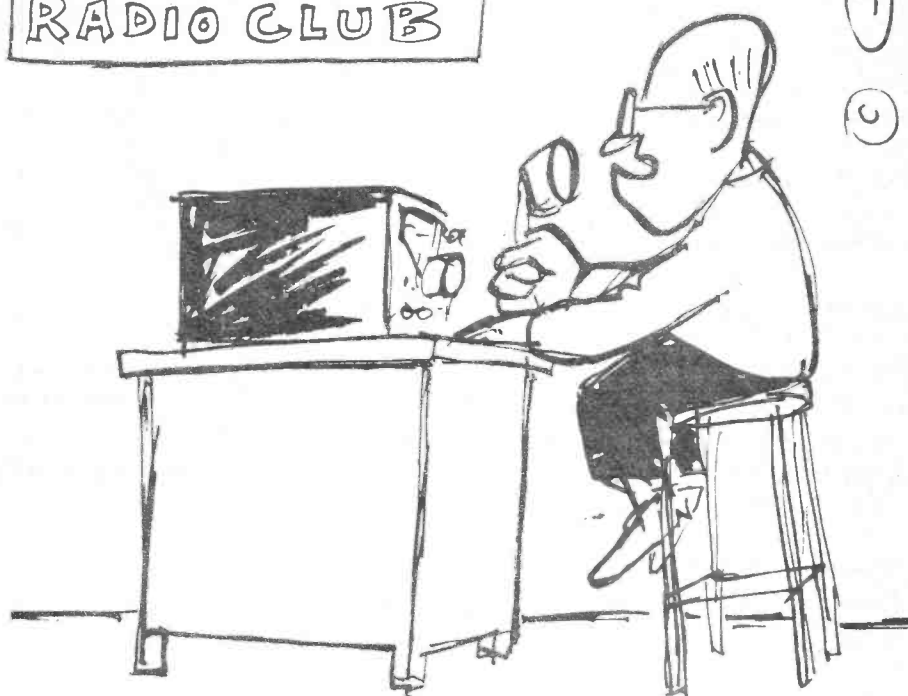
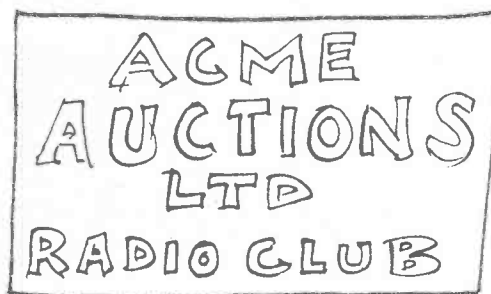
Now that UOSAT, and Phase-3 satellites are active, *please do not use* the frequency spectrum above 145.800MHz for FM contacts. 145.825 is slap on one beacon frequency for a start, and there are a lot of people out there collecting data from it. There is now little excuse for using the satellite allocation for other purposes — there is an awful lot of 2 metres available for straightforward chatting on other modes.

You will probably know that the Phase III satellite *Oscar 10* is up and has been in action. There was

some damage due to a slight accident with the propulsion stage of the rocket, but it doesn't seem to have caused too much aggro. If you want more info on this and UOSAT, then the man to contact is Ron Broadbent, G3AAJ, 94 Herongate Road, Wanstead Park, London E12 5EQ. An SAE *must* be enclosed. Initially you will receive an application form for membership plus other info. AMSAT-UK depends on donations and lots of voluntary help for all its good work. The minimum donation is £6.00 per year, but Ron will smile 'broadbently' if he receives more.

Oscar News is the newsletter of AMSAT-UK — this has progressed from a few sheets of duplicated paper, to a very professional 36-page printed A5 booklet. It contains lots of info, and is worth the £6.00 a year alone. There are also a number of nets, on both HF and VHF, where you can hear the latest info and get your questions answered by the experts.

As time progresses, satellites are likely to play an increasingly important role in our hobby — now is the time to get in on the act.



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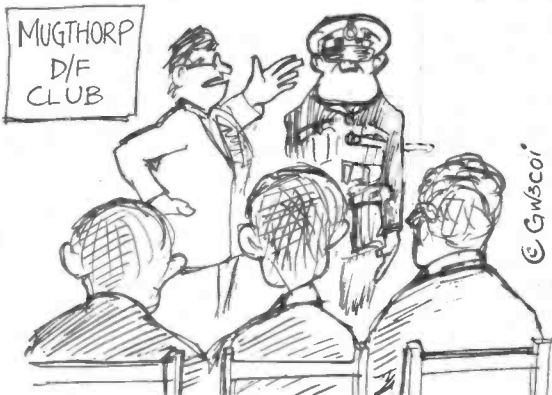
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 Please allow 21 days for delivery

Radio Tomorrow

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

- | | | | |
|----------|--|-----------|---|
| 6-8 Oct | 12th ARRA Amateur Radio and Electronics Exhibition, at Exhibition Centre, Doncaster Racecourse, Leger Way, Doncaster. | 14 Oct | Spalding & DARS: <i>Computers and Amateur Radio</i> by Terry Roberts. |
| 7 Oct | Maltby ARS: <i>Telephone Systems</i> . | 15 Oct | Midlands VHF Convention at BT Training School, Stone, Staffs. Lectures, bring and buy. Free parking. Talk-in S22. Admission £1 on the door, evening buffet tickets £4 (in advance only). |
| 8 Oct | Audiojumble: junk sale of audio and radio equipment at St. James' Hall, Gloucester Terrace, London W2 (nearest tube Lancaster Gate). Admission 90p. Proceeds to St. John Ambulance. | 15-16 Oct | Jamboree-on-the-air. |
| 8-14 Oct | GB2MOD at <i>Mod of the Clyde Valley</i> (Gaelic Festival) on HF and 2m CW/SSB. Special QSL. | 15-16 Oct | EI/GI Convention, Ballymascanlon. |
| 9 Oct | 21-28MHz Phone Contest (rules in May <i>Radcom</i>). Cambridge University WS: informal meeting. Wirral & DARC: DF hunt. | 16 Oct | 21MHz CW Contest (rules in May <i>Radcom</i>). 1296MHz Cumulative Contest (rules in July <i>Radcom</i>). |
| 10 Oct- | | 17 Oct | Cambridge University WS: informal meeting. Braintree & DARS: visit by RSGB Regional Representative Tony Howe G3PLF. Leighton Linlade RC: <i>AMSAT</i> by Richard Limebear G3RWL. |
| 5 Dec | <i>Taurids</i> meteor shower (max 1 Nov). Milton Keynes & DARS: AGM. Thornton Cleveleys ARS: photos and videos of club activities. | | <i>Plymouth RC: Air Sea Rescue</i> by G3XLU. Stourbridge & DARS: <i>Meteor Scatter Propagation at VHF</i> by Dave Powis G4HUP. Swale ARC: <i>HF Amplifiers</i> by G4AXD. Thornton Cleveleys ARS: AGM and Pie & Pea supper. |
| 11 Oct | Bury RS: construction competition. | 18 Oct | Biggin Hill ARC: Amateur Radio Satellites. Fylde ARS: discussion on programme for March '84 onwards. Mid-Warwickshire ARS: <i>Safety</i> by Norman Read G8CXL. Stevenage & DARS: talk on batteries by Eveready. Wakefield & DRS: Pie & Pea supper. |
| 12 Oct | Cheshunt & DARC: <i>Writing for Amateur Radio</i> by Tony G4FAI. Fareham RC: <i>S-meters and PL259s</i> by G4JCC and G6BBS. Farnborough & DARC: construction contest. Hastings E & RC: visit to TVS, Maidstone. Nene Valley RC: <i>Aylesbury Vale Repeater Group</i> by G3MEH. South Essex ARS: construction contest. Three Counties ARC: <i>HF Contest Work</i> . Wirral & DARC: <i>Computers in Amateur Radio</i> by Paul Collister G4DLY. | 19 Oct | Deadline for January <i>Radio Tomorrow</i> . Cheshunt & DARC: natter night. Fareham RC: natter night/on air. Hastings E & RC: junk auction. South Essex ARS: <i>DXpedition to Andorra</i> by G4FUF (including video). Wirral & DARC: drinking and waffling at the Victoria Lodge, Tranmere. |
| 13 Oct | Edgware & DRS: <i>Simple Transmitters</i> by Gerald Stancey G3MCK; also discussion on a novice licence. | 20 Oct | Chichester & DARC: junk sale. Greater Peterborough ARC: <i>Homebrew Transceivers</i> by G4LOC. |
| | | 21 Oct | Maltby ARS: <i>RTTY</i> by G30ZN. Medway AR & TS: social evening, 'at home' to Gravesend ARS. |
| | | 23 Oct | Cambridge University WS: informal meeting. |
| | | 24 Oct | Thornton Cleveleys ARS: natter night. |
| | | 26 Oct | Cheshunt & DARC: <i>Satellite Receiving Installations</i> by David Woollard (Rediffusion). Fareham RC: <i>Shack Layouts</i> — open forum. Farnborough & DARC: surplus equipment sale. Nene Valley RC: natter night and sale of parts by Garex Ltd. |



"So a welcome to Chief Insp. Findern who will talk about missing persons . . ."

	South Essex ARS: <i>Standing Waves</i> by G3BHF (follow-up to earlier lecture).		10 Nov	Edgware & DRS: <i>Amateur TV</i> by J. Betts G4HMG.
	Three Counties ARC: knock-out games night.		11 Nov	Farnborough & DARC: AGM.
	Wirral & DARC: inter-club quiz night. Return match with Chester ARC.			Maltby ARS: project night.
28-29 Oct	Leicester Amateur Radio Show, Granby Halls, Leicester		12-13 Nov	Spalding & DARS: Construction Contest — G2BQC memorial trophy.
30 Oct	Cambridge University WS: informal meeting.		14 Nov	Second 1.8MHz Contest.
31 Oct	Plymouth RC: activity/on air night; construction competition.		15 Nov	Milton Keynes & DARS: bring-and-buy junk sale.
				Plymouth RC: video/slide show (RSGB).
				Biggin Hill ARC: <i>BBC Radio News</i> .
1 Nov	Aylesbury Vale RS: <i>Semiconductors & Transistors</i> by G8AYM.			Fylde ARS: informal meeting.
	Chichester & DARC: meeting.			Mid-Warwickshire ARS: <i>Mobile Interference Suppression</i> by Roy Metcalf G8XDL.
	Fylde ARS: <i>Nucleonics</i> by John Ball G4DPI.		16 Nov	Stevenage & DARS: talk on navigational satellites.
	Mid-Warwickshire ARS: natter night.			Wakefield & DRS: film show.
	Stevenage & DARS: <i>Slow Scan TV</i> by G4BWU.			Cheshunt & DARC: natter night.
	Wakefield & DRS: on air/natter night.		17 Nov	Fareham RC: natter night/on air.
2 Nov	Cheshunt & DARC: natter night.			Wirral & DARC: drinking and waffling at The Primrose, Liscard.
	Edgware & DRS: visit to British Aerospace Club at Hatfield, plus <i>UOSAT</i> by Martin Sweeting G3YJO.		18 Nov	Chichester & DARC: <i>Sporadic-E and DXTV</i> by Ron Ham.
	Fareham RC: natter night/on air.			Medway AR&TS: <i>A Return to Real Amateur Radio</i> by P J Poole G4EVY.
	Wirral & DARC: drinking and waffling at The Harp, Lower Neston.		21 Nov	Braintree & DARS: junk sale.
4 Nov	Maltby ARS: <i>Amateur Photography</i> .			Leighton Linlade RC: meeting
	Medway AR&TS: video evening (of radio interest).			Stourbridge & DARS: main meeting: annual surplus sale.
5 Nov	North Devon Radio Rally at Bradworthy Memorial Hall (near Holsworthy); 10.30am-5pm, bring and buy, talk-in S22.		22 Nov	Cheshunt & DARC: quiz (away) against Harlow RS in Mark Hall Barn, Harlow.
5-6 Nov	144MHz CW Contest (rules in August <i>Radcom</i>).		23 Nov	Cheshunt & DARC: AGM.
6 Nov	Worked-all-Britain (WAB) LF CW Contest (rules in April <i>Radcom</i>).			Fareham RC: <i>SSTV</i> by G8VOI.
	Cambridge University WS: informal meeting.			Farnborough & DARC: Chairman's evening.
	Braintree & DARS: construction contest.			Nene Valley RC: <i>Why do Radio Communications Work?</i> by G8TTF.
	Leighton Linlade RC: meeting.		24 Nov	Three Counties ARC: <i>Hospital Radio</i> .
	Stourbridge & DARS: informal meeting.			Edgware & DRS: informal meeting.
9 Nov	Cheshunt & DARC: quiz — at home against Harlow RS.		25 Nov	Greater Peterborough ARC: junk sale/quiz/natter evening.
	Fareham RC: <i>QRP Operation</i> by G3CCB.		28 Nov	Maltby ARS: <i>Music Synthesis</i> .
	Nene Valley RC: <i>Wheatstones Greatest Invention?</i> by G40DI.		29 Nov	Peterborough RC: DF contest.
	Three Counties ARC: judging of <i>Build Your Own Equipment</i> competition.		30 Nov	Aylesbury Vale RS: <i>Buying Second-hand Equipment</i> by G30SS.
				Wakefield & DRS: <i>Alignment of Equipment</i> .
				Cheshunt & DARC: natter night.
				Fareham RC: natter night/on air.

Contacts

Audiojumble	Ed Lord	01-837 7811
Bath & DARS	(Mike Mason	Bath 311046
	Trevor Whitehead	Bath 319050
Brixton College RAE course	M.C. Parnell	01-737 2323
Bury RS	Brian Tyldsley	Burnley 24254
Cheshunt & DARC	Roger Frisby	Hoddesdon 464795
Fareham RC	Brian Davey	Fareham 234904
Hastings E&RC	Tony Masters	Hastings 51659
Hendon College RAE course	Chris Holford	01-202 3811 extn. 7
Leicester Amateur Radio Show	Frank Elliott	Leicester 553293
Maltby ARS	Ian Abel	Rotherham 814911
Melton Mowbray College RAE course	K.G. Melton	Melton Mowbray 68810
Mid-Warwickshire ARS	Carol Finnis	Southam 4765
Sarah Robinson School RAE course	Steve Webb	Crawley 25742
Spalding & DARS	Ian Buffham	Spalding 3845
Stevenage & DARS	Cliff Barber	Baldock 893736
St. Hugh's School morse class		Grantham 3141
Swale ARC	Brian Hancock	Minster 873147
Telford AR Rally Group	M.I. Vincent	Telford 55416
Thornton Cleveleys ARS	Janet Atkinson	Blackpool 826451
Three Counties ARC	Mrs. C.J. Baker	Bordon 3395
Thetherras School RAE course	Bob Lawrence	Wadebridge 3649
WACRAL	Brian Hancock	Minster 873147
Wirral & DARC	Gerry Scott	051-630 1393

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SMCGP432X	Colinear 70cm 3 x 1/4 wave	6.8dB 5.6'	£29.90 £2.50
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SMCZH86	6M HB9CV 2 Driven elements		£19.95 £2.50
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SMC7BF	Element 144MHz 7/8 wave	4.5dB	£13.80 £2.00
SMC7B8	Element 144MHz 7/8 wave	4.5dB	£13.80 £2.00
SMC8BF	Element 144MHz 8/8 wave	5.2dB	£18.80 £2.00
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SMC3S8	Element 432MHz 3 x 5/8	6.3dB	£16.85 £1.80
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155BA	5Ee Yagi 15 metres 24.5'LE 12.0'B		£236.90 £5.90
203BA	5Ee Yagi 20 metres 35.0'LE 16.0'B		£178.25 £4.90
204BA	5Ee Yagi 20 metres 36.5'LE 16.0'B		£286.35 £7.30
205BA	5Ee Yagi 20 metres 38.0'LE 16.0'B		£396.75 £9.40
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DB10/15A	3 Ee Yagi 10-15M 23.0'LE 13.0'B		£196.95 £4.80
TH3JNR	3 Ee Yagi 10-15-20M 24.2'LE 12.0'B		£202.40 £3.50
TH2MK3	2 Ee Yagi 10-15-20M 27.3'LE 14.0'B		£169.05 £3.50
TH3MK3	3 Ee Yagi 10-15-20M 27.0'LE 14.0'B		£274.85 £5.30
TH5DXX	"Thunderbird" 5 Ee 31.0'LE 18.0'B		£419.75 £6.70
TH6DXX	"Thunderbird" 6 Ee 31.1'LE 24.0'B		£396.75 £8.50
TH7DXX	"Thunderbird" 7 Ee 31.0'LE 20'TR		£351.75 £8.75
HYQUAD	2 Ee Quad 10, 15, 20M 13.5' TR 8.0'B		£364.20 £6.00
18TD	Dipole Tape 10, 15, 20, 40, 80M 132		£121.90 £2.80

JAYBEAM			
VR3	Vertical 10-15-20M. DC Short 6 lb 13.5'H		£46.00 £2.50
TB3	3 Ee Yagi 10-15-20M 14.6' TR 14.1'B		£189.75 £5.40

MINI BEAM			
C1	Vertical Miniature 10-15-20M 8lb 11.5'H		£59.00 £2.50
H01	"Mini" Quad beam 10-15-20M 11.0'LE 4.5'B		£139.00 £4.00

G4MH MINI BEAM			
Mini Beam 10-15-20M			£82.50 £4.00
SMC TRAPPED DIPOLE 10-80M 119' Potted Traps			
SMCTD/HP	14SWG H/D c.w. traps 1000W PEP		£43.41 £2.50
SMCTD/P	Portable c.w./Terylene 75' coax		£59.80 £2.50
SMCHPT	High Power 7MHz 1000W Per pair		£15.52 £1.80

SMC-HS ANTENNA			
SMCHFSV	Vertical 10, 15, 20, 40, 80M 15.7'		£54.80 £2.50
SMCHFSR	Radial kit loaded 6.5'-7.3'		£34.90 £2.50
SMCHFSVNB	Vertical 10-18-24M 1000W PEP 16.0'H		£51.35 £2.50

ANTENNA ROTATORS

RDL3			
Beil	5 Core Light Duty		£40.25
S05	5 Core Light Duty		£40.25
AR30	Offset		£56.35
KP250	Beil	6 Core Lighter Duty	£54.91
9502B	Offset	3 Core Lighter Duty	£56.92
AR22	Beil	4 Core Medium Duty	£67.85
9508	Offset	3 Core Medium Duty	£80.21
AR40	Beil	5 Core Medium Duty	£90.85
BT1	Beil	5 Core 4 Preset Medium	£91.43
KR400	Beil	6 Core Medium matches K8500	£97.75
KR500	Thro	6 Core Elevation	£112.12
AR50	Beil	5 Position Medium	£113.85
KR400RC	Beil	6 Core Medium Duty	£114.94
CD45	Beil	8 Core Heavy Duty	£136.85
KR600RC	Beil	8 Core Heavy Duty	£163.30
HAM IV	Beil	8 Core Heavy Duty	£258.75
KR200RC	Beil	8 Core Heavier Duty	£314.52
T2X	Beil	8 Core Very Heavy Duty	£327.75
H300	Beil	8 Core Digital Readout	£493.35

Control Cable			
RC4W	4 Way 28p/mtr	Carriage	£1.80
RC5W	5 Way 33p/mtr	Carriage	£1.80
RC6W	6 Way 51p/mtr	Carriage	£1.80
RC8W	8 Way 55p/mtr	Carriage	£1.80
9523	Support Bearing		
9502		£15.81	Carriage £2.50
KC038	Lower Mast Clamp		
KR400/600		£12.07	Carriage £2.50

Prices including VAT and carriage, but accessories are extra unless sent with rotators.

STATION ACCESSORIES

HANSEN			
FS710H	1.8-80MHz 15/150/1500W Pep		£89.70 P&P FOC
FS710V	50-150MHz 15/150W Pep		£88.70 FOC
FS50HP	1.8-80MHz 20/200/2000W Pep		£88.70 FOC
FS50VP	50-150MHz 20/200/2000W Pep		£88.70 FOC
FS500H	1.8-80MHz 20/200/2000W Pep		£69.75 FOC
FS500V	50-150MHz 20/200W Pep		£69.75 FOC
FS300H	1.8-80MHz 20/200/1000		£46.40 FOC
FS300V	50-150MHz 20/200W		£46.40 FOC
FS200	1.8-150MHz 20/200W Pep		£50.60 FOC
FS001M	1.8-30MHz 20/200W Pep		£51.35 FOC
FS601MH	1.8-30MHz 200/2000W Pep		£51.35 FOC
FS800M	50-150MHz 20/200W Pep		£51.35 FOC
FS600M	430-440MHz 5/20W Pep		£51.35 FOC
FS210	1.8-150MHz 20/200W Auto SWR		£55.20 FOC
FS301M	2-30MHz 20/200W		£36.65 FOC
FS301MH	2-30MHz 200/2000W		£36.65 FOC
FS302M	50-150MHz 20/200W		£36.65 FOC
FS711H	2-30MHz 20/200W Head		£36.60 FOC
FS711V	50-150MHz 20/200W Head		£36.60 FOC
FS711U	430-440MHz 5/20W Head		£36.60 FOC
HB1	FS711H Coupler		£23.75 FOC
VB1	FS711V Coupler		£23.75 FOC
UB1	FS711U Coupler		£23.75 FOC
FS5E	3.5-150MHz 20/200/1000W HF		£37.20 FOC
FS5S	1.8-150MHz 20/200/1000W HF		£37.95 FOC
FS7	145&(432MHz) 5/20/200 144		£41.00 FOC
SWR3E	3.5-150MHz 20/200/1000W HF		£25.00 FOC
SWR3S	3.5-150MHz F/S Meter ant.		£28.46 FOC
SWR508	3.5-150MHz Twin Meter		£26.45 FOC
FS20D	3-150MHz 5/20W		£37.95 FOC
FS800	1.8-150MHz 6/30/150W		£115.00 FOC
JD			
JD110	1.5-150MHz 10/100W		£13.80 FOC
MIRAGE			
MP2	50-150MHz 50/500/1500W Pep		£100.00 FOC

MORSE KEYS			
BKU1	Squeeze Key		£30.30 £1.20
HK703	Straight Key		£25.70 £1.20
HK704	Straight Key		£17.65 £1.20
HK706	Straight Key		£14.60 £1.00
HK707	Straight Key		£13.75 £1.00
HK710	Straight Key		£36.40 £1.75
HK808	Straight Key		£45.60 £1.75
HK711	Key Mounting		£29.50 £1.50
BK100	Mechanical Bug		£22.25 £1.75
MK701	Single Lever Paddle		£25.25 £1.60
MK702	Single Lever Paddle		£26.45 £1.60
MK703	Squeeze Key		£25.95 £1.75
MK705	Squeeze Key		£22.60 £1.75
MK706	Squeeze Key		£19.50 £1.75
IKP60	lambic		£9.95 FOC
SR1	Straight Key		£12.65 FOC

MORSE EQUIPMENT			
KP100	Squeeze CMOS 230 /13.8V		£69.00 £2.00
KP200	Memory 4096 Multi Ch Mem Back Up 230 /13.8V		£155.25 £2.50

Datong			
D70	Morse Tutor		£56.35 FOC

MICROWAVE MODULES - RTTY EQUIPMENT			
MM2001	RTTY to Demod. /Converter		£189.00 FOC
MM4001	RTTY Transceiver		£219.00 FOC
MM4001	IKB RTTY Transceiver c/w Keyboard		£299.00 FOC
MMS1			

2m preamps under scrutiny

Putting in a preamp, though, always degrades the RF intermodulation performance, and so the design of the preamplifier has to be a compromise between an improved overall noise figure and an amount of gain which is not so high as to cause bad RFIM

relay and the first RF stage, you will probably see a moderate improvement, but there are two snags to this. You will probably have a permanent grossly excessive gain and, therefore, strong signals on the band will start spreading more, and ruin

equivalent to a $0.1\mu\text{V}$ RF input level. If the disturbing signals were both raised by just over 10dB to 1mV, then the equivalent RF input level of the same IM product would be increased to at least $1.1\mu\text{V}$ (ie. +21dB), and perhaps to as high as $4\mu\text{V}$ (ie. +32dB). An RFIM product at $0.1\mu\text{V}$ is not too disturbing, although it might be a slight nuisance if you are trying to receive a very weak station, but a $4\mu\text{V}$ product is going to be near the S9 level which, frankly, will be extremely annoying, and yet the disturbing signals have only gone up by just over 10dB. Supposing you just have one SSB signal at 15kHz off channel which is developing slight spreading. The chap then throws in his linear, and the signal goes up by 10dB. His transmitted IM products shoot up if he is using a nasty linear, but whether his linear is good or bad, your receiver will be generating at least a 20dB inferior IM ratio. If you have a rig such as an IC251E, or FT221, and you have fitted a Mutek board in it, then your front end will be almost bomb proof, since the IM products even at highish levels are very low. But supposing your rig has a bad RFIM performance? When the other station puts in his clean linear and goes up 10dB, you'll go bananas, as you won't be able to hear that elusive HB9 any more! If you have provided the facility for bypassing your internal added preamp, you might be able to suffer the situation, for the intermod. products will drop by at least 20dB when you take out the preamp, whereas you might only lose 3dB, or so, of input sensitivity. There is another snag, though, in putting the preamp inside the rig. You are not overcoming the loss of the input SO239 socket, the input circuitry to the relay which may include lossy filters, the loss of the relay itself, followed by more loss in the circuit to the internal preamp. On a very good rig, such as one with a Mutek front end, the input

There are, unfortunately, many rather deaf rigs around. These can usually be improved greatly as far as input sensitivity is concerned, by the addition of an RF preamplifier, either in the rig or external to it.

problems. This compromise between preamp noise figure and gain is quite difficult to make, and in any particular installation the first rule to observe when adding a preamp is to use the minimum amount of gain required for the preamp just to overcome the input noise of the main receiver.

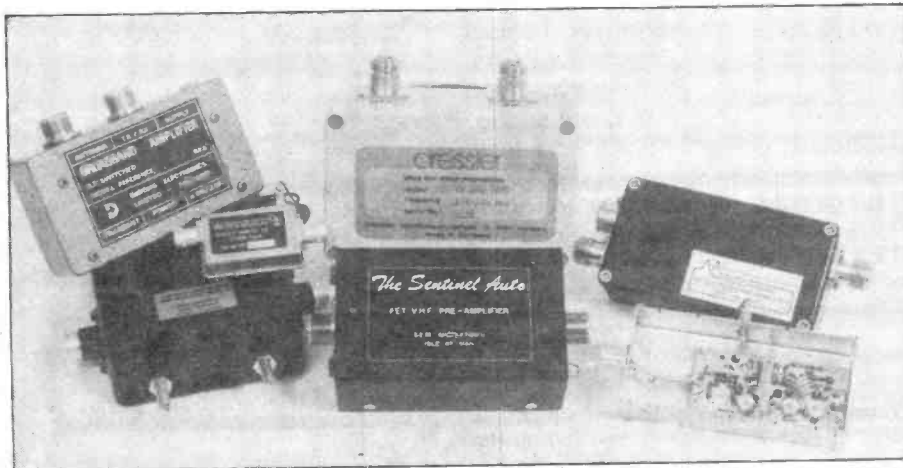
Intermodulation

Before looking more closely at the seven preamps reviewed in this article, let's have a look at all these compromises in great detail, and the different ways in which a preamp can be used. If you put the preamp inside the rig between the aerial changeover

your reception of weak signals. Remember that for every dB of additional gain before the front end, the intermod. product ratios will be degraded by at least 2dB. In some cases, if the RFIM performance of the receiver is poor because there are contributions from both the mixer and other stages you will find that above a certain quite moderate level, intermod. products may actually go up by 3 or more dB for every dB increase in the input RF level of the strong station.

Let's have an example of this by considering a rig that has two strong signals, each of $300\mu\text{V}$. Let's say that the 3rd order product would be

A pride of preamplifiers!



loss may be as low as 0.3dB or so, but I have measured some well known Japanese black boxes with over 4dB loss in the same route, which explains why the average noise figure of these black boxes is as bad as 7dB or so. So it is much better to put the preamp outside the rig, but this may involve marked losses in the two relays required to bypass the preamp on transmit, unless you use good quality ones. The main loss, of course, will be the relay on the aerial side of the preamp, so use the best one you can afford in this position. A good relay will only lose perhaps 0.05dB on 2m. If your rig has a large loss on the input circuit, and has the legendary 7dB noise figure, and the preamp/relay combination has a 1.2dB noise figure, then you will need around 16dB gain if you want to see almost all of the noise figure improvement given by the preamp. This will degrade your RFIM performance by a colossal 35dB or so on the average rig, which is dreadful. It is vital, therefore, to be able to switch your preamp in and out so that you can choose which is best in any circumstance. You may, of course, buy a preamp which has automatic RF sensing, in which case you will not need to incorporate wiring to the rig which changes the relays over, etc. But you may have a very long and lossy lead to your aerial. It is not unusual to have a loss of 3dB or so, in the coax lead, especially if you have rummaged around your junk boxes for various bits of coax, and have connected them up with umpteen SO239/PL259 back-to-backs to make the lead long enough. (I assisted one young amateur only last week who had done just this, and what was even worse, used plugs designed for CB use, which were very lossy on 145MHz!) The answer to this problem on receive is to put the preamp at the masthead. Now you've got an overall cable and receiver input loss of 10dB, ie. the cable loss plus the input noise figure. You'll need at least 18dB to overcome these losses almost completely.

Noisy neighbours

Fortunately, or unfortunately, whichever way you look at it, the actual band noise on 2m is equivalent to a noise figure of at least 3dB, and sometimes a lot higher, particularly if you've got 10 neighbours, who all have thermostats on the go which are out of sync with one another. I reckon



Wood and Douglas PA4

that you won't gain much by improving your overall system noise figure to better than 2.5dB or so, unless you really are working in the middle of the night, and trying to receive a very weak station, with no other amateurs close to your frequency, with no local interference, and you are not pointing at the Crab nebula! Joking apart, you'll only need a significantly better noise figure for meteor scatter, moonbounce or satellite reception. I have a 1dB noise figure early SSB Products preamp at my masthead, and 1dB cable loss into a Microwave Modules 2m transverter which has a measured noise figure of 2.1dB, and I can notice only the minutest difference to the readability of the weakest signals when I switch on my masthead preamp. For this reason you will probably only need (in the example mentioned) 15dB gain. If your black box is a little better, and you are using UR67, or even better, H100 cable, then a 12sB gain might be sufficient, and even 10dB gain will give you a marked improvement. Don't forget that the lower the gain, the less will be the deterioration in overall RFIM performance.

Unfortunately, we've not yet finished with the discussion of problems encountered when adding preamps. Its bandwidth can be very important indeed in some locations, and out-of-band signals may be a dreadful nuisance if they are strong, since they may generate IM products within the 2m band. This is highly dependent on the performance of the main rig. If you live out in the country, and you do not have any police transmitters lurking around in the band 146MHz to 150MHz, nor any strong signals below 144MHz, then you won't have to worry. Living in Finchley, I am surrounded by police FM transmitters just above 2m, and a

bad rig is soon shown up by intermod. products appearing on various FM channels. This can be most annoying, some rigs being virtually perfect, whilst others are diabolical. If the preamp has an overall flat bandwidth of tens of MHz around 2m, then you may be in a lot of trouble. One that starts falling in gain at the band edges fairly rapidly, but also preserves its noise figure reasonably across the 2m band is going to be a lot better. You will need to weigh up, therefore, the bandwidth, gain and noise figure, as well as the preamp's own IM performance, before you make your final choice. Most preamps are much better than the rigs which they feed, so the preamp RFIM performance is only going to be a fairly important factor if the main rig is bomb proof.

Transmitter power

Another important consideration is the relationship between overall receive performance, and the power used on transmit taken at masthead. Most stations run at least 10W PEP output, which will be, say, 5 to 8W at the aerial. If you are running a barefoot low power rig which is providing only a watt or two at the masthead, then you will not need a masthead preamp, unless you want to work other low power stations, or your rig is in desperate need of a deaf aid (you'd be surprised just how many rigs need this). If you are running anywhere from 50W to 400W at the masthead, then the likelihood is that you will be running more power than many other people, so you will need a good sensitive receiving system to pick them up if they are weak. Perhaps the chap the other end has a very deaf receiver, and if so, then you'll probably be all right! Sometimes a very good system sensitivity can be a boon, even if you have low power. Suppose you

are beaming in West, and a juicy DX station is off the side of your beam, and is just audible within your preamp in, but not audible with it out. You can turn your beam onto him, and up he comes. When you have nailed him you will probably be able to take the preamp out. This facility can be very important in contest operating. If you are running 400W at the masthead, it becomes vital to use the best coax you can afford, not just to reduce the required output power of the linear, and thus reduce its intermod., but to decrease the loss between a masthead preamp and the receiver. This allows you to use a lower gain preamp. However, the loss of the coax will, of course, be cutting down the output level of a preamp, and thus reduce the system RFIM. There is just one final point which is worthwhile mentioning, this being the hold-on time of an RF sensed preamp, whether it is built into a linear, or on its own. You will go mad on SSB if it is clanking on and off between every word, and you will also be introducing annoying interruptions on transmit, with the beginnings of some words disappearing into thin air! On FM, though, a rapid return to receive is important, if you get just a very short, snappy comment from the other end. It is ideal, therefore, to have a system which is switchable between an almost instantaneous return for FM, and a hold-time of at least 1 second, and perhaps 2 seconds, for SSB. I do not know of any RF sensed pre-amp which has a remotely controllable sensing time, but there are linear amp/preamp combinations which can be switched to FM or SSB sensing, which is most useful.

Preamp tuning

Most of the preamps were at least quite well aligned. The SEM *Sentinel*, however, was so badly aligned as to be almost ridiculous, and the Moulding was peaked above 146MHz. A few words about alignment might be useful here, since many users do tend to have a twiddle now and then. My first advice to you is never to attempt any alignment unless you have a very good reason to believe that the manufacturer has got it wrong, or that the shop who sold it to you, or the person you bought it from secondhand has 'been at it'. Alignment is, in fact, quite difficult, and is often wrong unless it is done with appropriate test equipment. To



SEM Sentinel Auto

do it in just a minute or two after the box has been opened is almost impossible, unless you have an immaculate noise source which chops on and off at least a few times every second. If you don't have such test equipment, and if you really must make adjustments, here are one or two suggestions. The ear is much more sensitive to minute changes in noise figure on FM than on CW or SSB. Furthermore, it is much easier to adjust the input circuits on an extremely weak signal. Since band noise is quite high, you should first put a high quality 20dB aerial attenuator in line as close to the preamp as possible. It is absolutely vital that this attenuator should be of the same rated impedance as that of your coax and aerial. This will reduce the band noise to well below any audibility, and also allow you to receive stations that are suitably weak. The reason why FM is to be preferred, is that on a very weak signal the rate of change of noise figure is perhaps 1/3 to 1/2 that of the apparent signal-to-noise ratio change. At around the 10dB SINAD ratio point you will get at least a 1dB improvement in ratio for every 1/2dB of noise figure improvement, provided you have effectively removed band noise. On the other hand, overall gain is better adjusted by using the 'S' meter on your rig when you have tuned to a signal which is about half scale. Many rigs have 'S' meters which vary rapidly in level with only small RF level changes on FM. If you look at the preamp circuit you will usually see trimmers on the input and output circuits. The output trimmer should normally be adjusted for maximum gain in the centre of the band, as a kick off. The input trimmer, however, will

normally adjust for minimum noise figure at a position well away from the maximum gain point, and this is what is meant by 'noise matching' rather than 'gain optimising' an input. You may have to go backwards and forwards between input and output trimming, adjusting input for best signal-to-noise ratio, and output for best gain. Using this method, you should be able to get within half a dB or so of optimum performance, unless you have cloth ears! This method will only work properly, though, with the attenuator in the input circuit, for without it you will probably end up by adjusting for maximum gain, and you would also find the input trimmer to be much flatter in adjustment, as the null would be incredibly difficult to hear with all the band noise present. Matching the input for optimum gain normally results in the input impedance being lowered, and when this is near 50 ohms you should have the best power match. Best noise figure though, and thus best noise match, occurs when the input has a somewhat higher impedance, and at this point the internal noise has dropped more than the signal level has. The signal level has dropped at this point because of negative feedback which exists within any transistor. Neutralisation, incidentally, when added in a circuit, can bring optimum gain and noise match positions rather closer together, but correct neutralisation in a preamp is very difficult to achieve without appropriate test equipment. While writing this article, Myles Capstick, G4RCE, tried adjusting one or two of my preamps by ear, and then checked them on a Hewlett Packard noise figure and gain measurement system.

He almost always got to within 0.5dB, but we always managed to make a slight improvement with the HP system. Don't forget that you might not need all the gain that you can get, so you might make a useful improvement, if you can spare some gain, by loosening the output tuned circuit coupling, this also usefully increasing the Q of the output, which helps to keep out signals outside the band.

Noise figure and gain

We measured most of the preamps initially with a manual analogue system, including a Rohde and Schwarz *SKTU* noise figure source/meter, Andrew's *FSJ4* connecting cable, a 3dB pad, a very accurate 50 ohm screened input termination, with a Microwave Modules transverter down to an Icom *IC740* HF rig with the audio feeding a Bruel and Kjaer true RMS audio volt meter. The precise attenuation of the input lead, 3dB pad and adaptors was measured using a Marconi *2019* signal generator and a Racal RF power meter. We found that we got more accurate results by setting the noise-off level using the 50 ohm input termination, rather than turning the 'off' switch on the noise source, although there was only a minute difference. We increased the level of noise until the audio output noise power increased by 3dB within the

pass band 300Hz to 3kHz. We restricted the pass band to avoid any possibility of interference being created from noise, etc., coming from the *IC740* outside this passband from circuits after the SSB filter.

Hewlett Packard very kindly loaned me, for a short period, their complete new noise figure measurement system, worth around £8,000! We found to our great pleasure that preamps measured on both the R and S and HP systems gave readings within 0.1dB of each other which surprised me considerably, although we did not attempt to measure the very best preamps with the R and S system. The HP system employs a noise source which includes a noise diode and source impedance extremely accurately matched to 50 ohms from quite low frequencies up to many GHz. The noise head is designed to give out a level of 15.2dB excess noise over that which would be generated from a resistive source of 50 ohms, taking into account the temperature, etc. Noise is generated immediately upon a 28V DC source being switched through to the noise head. The measurement system switches this 28V on and off many times a second. The meter looks at the on and off noise values of the head when it is directly connected to the measurement system's input socket, which again is very carefully controlled at 50 ohms. The internal microprocessors were previously calibrated to

expect a certain value of on to off noise, the calibration procedure being simple for the operator, but extremely complex for the microprocessor! Not only is the input noise figure of the measurement system calculated on calibration, but the frequency band over which the measurement is to be made can be pre-set on the instrument, together with the lower and upper limits of frequency at which measurements are to be taken. When you are calibrating, you must include all the adaptors, or those with equivalent loss, that you are going to use in the measurement loop, so that you are measuring only the device under test, and not the additional attenuation of a heap of adaptors! On placing the device in the loop, you can then get an immediate readout of noise figure and gain around the frequency of measurement. There are three very serious snags, though, with using the HP gear, which absolutely must be taken into account: since the machine without ancillary mixers, etc. measures from 10-1,500MHz and with a bandwidth of around 4MHz, the internal local oscillator must be capable of avoiding image problems, and so the IF within the instrument is way above 1500MHz, and the yig oscillator is above this. These microwave oscillators are notoriously wibbly-wobbly, and the Hewlett Packard spec is fairly wide on the tuned-in input frequency, therefore. This in effect means that you must not accept the indicated tuned frequency as precise, especially at UHF, let alone microwave, unless you are measuring a wide bandwidth preamplifier. To get over this problem, you have to ascertain, by experimental means, the centre of the input passband of the measurement equipment. In fact, we never found the HP to be significantly out on VHF, although by 1296MHz it was quite a long way out. A more serious problem is that of the measurement bandwidth, for it measures the average noise figure over a 4MHz bandwidth, as well as the total power gain over the same bandwidth. The only way of getting around this problem is to recalibrate with a much narrower filter immediately before the HP. For this, we used in many of our experiments, our Boonton tuneable preamplifier type *230A*, which has a 700kHz equivalent noise power bandwidth. I also had to use a 20dB attenuator immediately after it to get rid of some gain! By calibrating with

Wood and Douglas 144PA3 Miniature preamplifier



this in circuit, the equipment completely excludes the contribution of noise from the Boonton, the attenuator, and the input stage of the HP. Only on one amplifier did it make a significant difference, one of my own having a very narrow bandwidth.

I measured around 30 pieces of equipment, and only on 3 or 4 did I notice a significant change in noise figure, the improvement being between 0.2 and 0.4dB. Gain, however, quite frequently showed up as being significantly lower than expected, and so I could not trust the measurement on equipment having 3dB points tighter than around 5MHz or so, and so we decided to make all gain measurements with another set-up. Although the HP accuracy is quoted by them as being within 0.1dB, with all other things right, I must emphasise most strongly that the HP figures should be regarded as having an accuracy of + or - at least 0.2dB, despite the fact that my colleagues and I were extremely careful. I must here acknowledge the help of Hewlett Packard, and many other friends professionally involved in noise figure measurement.

Gain

After many discussions with colleagues, we felt the best way to measure gain was to use a Marconi 2019 generator as a source, connected

Dressler VV200 GaAs



via screened attenuators and Andrew's coax to the input of the preamp, with an attenuator right at the preamp as well, followed by the output feeding through a Marconi UHF attenuator, feeding through an attenuator again into an HP 8558B spectrum analyser. All these attenuators were used to preserve an accurate 50 ohms throughout the measurement system, and to reduce any mismatching resulting from transformer action of lengths of 50 ohm coax with preamp input and output impedances. The attenuator before the analyser is used to load the line more accurately, thus allowing the Marconi variable attenuator to be accurate. We measured gain at a reasonable level of just over 100 μ V into the preamplifier, having set the analyser on the 1dB per vertical division position. The through loss was measured by observing the level on the analyser, whereas gain was measured at various frequencies by inserting attenuation on the attenuator, to bring the level to the same point on the screen as it had been on calibration. We measured the frequencies at which gain dropped by 3, 10 and 20dB, and the gain at 144, 145 and 146MHz.

Two-tone IM tests

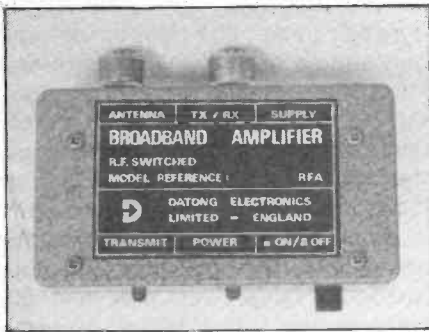
We used two Marconi 2019 signal generators with frequencies 200kHz

apart in the middle of the band for this test, with both generators operating at the same output level feeding a high quality hybrid transformer. The output port of this was connected to the input of each preamplifier. The output fed straight into the HP spectrum analyser, allowing us to read off the IM products from the screen. We determined the input level of the tones required to give both 60dB and 30dB 3rd order products, the ratio being the IM product level to the level of either of the two tones. An intercept point was derived from these two measurements. Sometimes the ratios were not quite linear and this is due to either distortion being slightly too high at lower levels, or IM increasing very rapidly as a clipping point was reached. We show in the charts both input and output approximate intercept points, bearing in mind the measured gain.

Laboratory test results

I thought it would be helpful to discuss how each product fared, one parameter at a time, and then in the conclusions section make some recommendations for various situations. I must admit that having done all these tests I feel that I have learned quite a lot about preamps!

Let's have a look first at noise figure, perhaps the parameter which will be of most interest, although oddly enough, one of the least important, within reason, if you have the preamp at the masthead. By far the worst in the survey, and the worst that I have ever measured on 2m, even including the once ubiquitous 6CW4 Nuvistor of about 20 years vintage, was the SEM *Sentinel*. A 5dB noise figure, with such a low gain is, frankly, a fat lot of use. We decided to attempt to improve the alignment, and noted a ferrite cored inductance, which when tweaked greatly affected gain. We tried removing it completely, and in passing, for a few seconds, noted a moderately respectable noise figure before the contraption went into oscillation. After this attempt at alignment, we put it back again, and after much tweaking improved the noise figure to 2.1dB, and the gain shot up to around 19dB. However, in this condition the preamp tended to be unstable if we even looked at it, let alone change the input load slightly. It was virtually impossible to achieve a stable, respectable performance



Datong RFA

across the entire band. Please note that the specification, as published in current advertisements, has been a claim of 1dB noise figure and 20dB gain. We are surprised that SEM claim such a gain from a BF981, let alone a noise figure of 1dB from their circuit.

The Chris Moulding preamp gave a useful noise figure, but was so asymmetrical in gain performance that I must infer that it had been poorly aligned.

The Datong RFA is an absolutely fascinating product, as it employs the proved negative feedback technique also used by Packer Communications and Mutek. The original principle was written up in VHF Communications. Packer, I believe, was the first to make available a commercial product. In this design the output is, in fact, placed in series effectively with the input source, by using a minute transformer with several windings on it. Datong uses a single transistor, and with 50 ohm output loading achieves a useful noise figure over an extremely broad range of frequencies. The review sample was RF sensed with a small bypass relay, which switched over with an input from a transceiver of only 15mW, but the hold-on time was too short. The two Wood and Douglas preamps were better for noise figure, and the Microwave Modules better still. This preamp was also RF sensed, but most surprisingly required 2.5W to pull it to the straight-through mode. In my opinion, therefore, it is only suitable for FM installations with a minimum power of 3W or so reaching it, or in SSB installations where at least 25W peaks pass through. The hold-time from transmit is very short, which would be annoying. By far the best noise figure was measured on the Dressler VV200 GaAs, at 1dB. This preamp is certainly excellent for almost all applications, as far as the noise figure is concerned, but see comments later on RFIM. We have, incidentally, recently measured an

SSB Products model (GaAsFET) at an amazing 0.5dB!

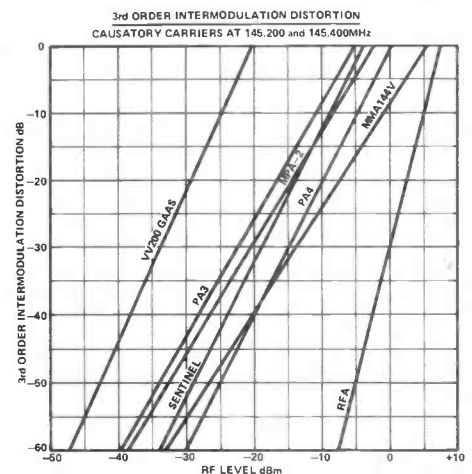
The Wood and Douglas PA3 had the highest gain, which, however, I feel is excessive, unless you have an incredibly long, lossy aerial cable. The Wood and Douglas PA4 also had a very high gain, but an internal attenuator of three resistors is provided for in the circuit, and you can change the values to fit your requirement. The Dressler had around 18dB gain and considering it is designed to go at masthead on an installation that would probably be a fairly good one, I feel the gain to be rather excessive. The Microwave Modules MMA144V had just about the right sort of gain for a medium quality system, having a few dB cable loss interconnected with an average noisy black box, taking everything into consideration. The Chris Moulding's gain was incredibly asymmetric across the band, having an extremely low gain at the bottom end, and nearly 2½ times the gain at the top end. The Datong, on 2m, had a very low gain of 9dB, but this is very useful, as any more gain would cause problems to broadband receivers, for which it was particularly designed. It will almost certainly hot up a *Bearcat*, without excessively degrading the already poor RFIM. This little unit is so adaptable, and I prefer to regard its RF sensing as a protection device in case you inadvertently stuff RF through it! The SEM *Sentinel* gain was originally just under 4dB more than its noise figure, when measured at band centre. I suppose it could make a marginal improvement to some deaf black boxes, especially the *Liner 2*.

Bandwidth

The narrowest bandwidth of any of the preamps was in the Dressler. Note the response shown in the table. It will reduce, but by no means eliminate, interference from police transmitters HF of the band, and it could significantly improve the rejection of some annoying strong interference from various strange transmissions below 142MHz. The bandwidth of the Moulding preamp is very sharp indeed, peak gain on the review sample being set at just over 146MHz. If the equipment were properly aligned it would obviously have a very sharp bandwidth indeed which could actually be useful. We did not attempt re-alignment, since the

box was sealed. The manufacturer will obviously have to take more care in alignment, for the review sample had a response which was ridiculous. The Wood and Douglas preamps had a reasonably controlled bandwidth of around 6MHz for 3dB points, the response falling reasonably outside this. The Microwave Modules is much wider than I like to see, the 3dB bandwidth covering 25MHz. The 20dB bandwidth is very wide indeed at 83MHz, although the PMR band around 165MHz is quite usefully attenuated. The SEM *Sentinel* had a 3dB bandwidth of 43MHz which is absurdly wide in the context of being claimed as a 2m band preamplifier. The Datong is a very special case, as it is marketed as a very broadband amplifier, having useful gain down to 1MHz. Depending on how you look at this, the LF response is either grossly too extended, or useful. My opinion is that a very steep cut should be built in below 20MHz or so, allowing it to be used for frequencies above this, but keeping out all the very strong lower frequency shortwave signals, and more importantly, medium wave. If you are using an ATU, then this will help a lot, but be careful about attempting to hot up a cheap receiver over most of its coverage, for you may have trouble. You will probably be all right using it on most VHF systems with aerials such as multi element log beams of disconses as these reject lower frequencies anyway. Note that the gain is most useful up to well above the specified 200MHz.

It is in the performance field of radio frequency intermodulation that we saw the biggest differences in the preamps, which we found one of the biggest led downs. The Dressler would give a 1µV product from two 21mV ones on the band, and so matters could be very serious if there



are any very high power stations around. Someone running 400W PEP into a high gain antenna pointing across you from several miles away could cause you serious aggro if the Dressler was switched on, even if you had a bomb proof receiving system following it. The calculated intercept point at -22dBm (22mV PD on 50ohms) is easily the worst in the survey, and Dressler will have to improve on it. We should look at both the input levels required for -60dB 3rd order products, and the calculated intercept point which we derived from at least two levels. Looking at all these measurements, the Wood and Douglas PA3, and the Moulding were not particularly good either, although appreciably better than the Dressler. Of the remainder, the SEM *Sentinel*, the Microwave Modules and the Wood and Douglas PA4 were good, with the Datong outstanding. The fascinating point about the Datong is that its onset of IM is remarkably sudden, IPs at lower levels being almost immeasurable, which is absolutely fascinating, and due to the negative feedback circuit employed. Incidentally, the intercept point will apparently be different depending upon how you estimate it, and there is a great danger in getting the wrong apparent point with only one reading. We drew graphs from two or more points to see a reasonable point, but of course this is always an imaginary one, as you cannot actually get a real 0dB figure.

All the preamps in combination with a rig having a bad RFIM performance will not contribute a marked degradation in RFIM, other than that given by the gain of a preamp, but the better your rig is, or the higher the loss between the preamp and the rig, the more important becomes the performance of the preamp.

Overall conclusions

As a double check on the effect of noise figure and gain we interposed each preamp in turn between a Marconi 2019 signal source, delivering 1kHz modulation at 4kHz deviation with attenuators on the output, and the IC251E with Mutek front end, as reviewed in the last issue. Give or take a small fraction of a dB, the noted improvement (or degradation) was as expected, with the exception that the Datong gave a significant lack of

degradation which required much investigation, for we expected around 0.75dB degradation. Please note that the 251E front end is already extremely good, and all the preamps would probably make at least a marginal improvement to the average black box with its usual 6 or 7dB noise figure. Returning to the Datong, as the input impedance follows in the same direction as that of the load on the output, and the lcom rig has a very high input impedance, the Datong preamp input would be at a significantly higher impedance, than with the output loaded with 50 ohms. It seems clear that the Datong noise matches slightly better with a 75 ohm, (or higher) output load. What is more important is that the Datong

performance may vary considerably depending on the length of line between its output and the effective input of the preamp circuit of the main rig. Making the line longer or shorter might make a dramatic difference to the Datong's input impedance, and so it's worth trying a few different coax leads of different lengths. If you are using the Datong over a wide frequency range, you may find the performance to be better in some frequency bands than others, for the same reason. A half-wavelength at a particular frequency, or a multiple, will reflect the same impedance both ends, whereas a ¼-wave will give the maximum effective transformation ratio.

Taking all measurements into

Table 1: Lab tests & data

1. Gain

Preamp	Gain at 144 MHz (dB)	Gain at 145 MHz (dB)	Gain at 146 MHz (dB)
Dressler VV200 GaAs	17.5	18.0	17.0
Chris Moulding MPA-2	6.5	12.5	16.5
Mic. Modules MMA144V	15.0	15.0	15.0
Wood & Douglas PA3	22.0	23.5	25.0
Wood & Douglas PA4	18.5	19.0	19.0
SEM <i>Sentinel Auto</i>	8.2	8.9	9.2

2. Noise figure

	Noise figure at 144 MHz (dB)	Noise figure at 145 MHz (dB)	Noise figure at 146 MHz (dB)
Dressler VV200 GaAs	1.1	1.0	0.8
Chris Moulding MPA-2	2.5	2.4	2.3
Mic. Modules MMA144V	1.4	1.4	1.4
Wood & Douglas PA3	1.8	1.8	1.9
Wood & Douglas PA4	1.9	1.9	2.0
SEM <i>Sentinel Auto</i>	5.4	5.0	5.3

3: Datong RFA measurements

Frequency (MHz)	Gain (dB)	Noise figure (dB)
10	8.8	5.0
20	8.7	4.2
30	8.7	1.8
40	8.7	1.8
50	8.7	1.9
60	8.7	1.9
70	8.7	2.1
80	8.8	2.2
90	8.9	2.3
100	8.9	2.2
110	9.0	2.2
120	9.1	2.2
130	9.2	2.2
145	9.1	2.6
160	9.1	2.5
170	8.9	2.6
180	8.7	2.7
190	8.8	3.0
200	8.5	3.0

consideration, the Dressler can only be recommended quite strongly if you have no high power stations within quite a large radius, although in a tropo opening you could have trouble. The *Sentinel* was such a poor performer, judging by the review sample, that I would not consider it. I contacted Mr Crapper of SEM but unfortunately it took nearly a week to receive a phone call as he had been unavailable. He kindly supplied a second sample received just after this article had been submitted to the Editor, we could only briefly test the second sample which gave a gain of 18dB +/- 0.5dB across the band, and judging by FM and SSB

SINAD tests into the *IC 251E*/Mutek the noise figure at mid band was around 2dB, degrading to 3dB at band edges. Quite clearly it had been far better set up, and the reader will have to draw his own conclusions in the circumstances. The Chris Moulding preamp had such a poor response characteristic, that there might be a chance that another one which you might buy could be equally off tune. The Datong preamp, whilst being extremely good as a wide band model, is for specialist applications, and it should certainly hot up a general coverage receiver, and may also be worthwhile on 2m if you have already

chosen it for its amazing merits. The Wood and Douglas *PA3* has in my opinion a rather excessive gain which could degrade the system IM performance too much, so two preamps come out the leaders in overall performance, the Wood and Douglas *PA4*, and the Microwave Modules RF sensed model.

Let's consider the merits of the final two alternatives. Both Wood and Douglas preamps are available in kit form, or as completed circuit boards, at an extremely reasonable price. You'll have to at least make up your own box for them, and the *PA4* receives a very strong recommendation for its outstanding performance, particularly at the price. There is an RF sensed version of the *PA4* which you may need. The *PA4* was within its specification on all points, and will obviously do quite a lot for an average rig.

If you want a complete, ready to go, preamp with RF sensing, then I very strongly recommend the Microwave Modules, which has the second best noise figure, a good but not excessive gain, very good RFIM performance, but a little too wide a bandwidth. It is expensive, though, but good products supplied ready to go, cost more of course, and so I recommend it strongly for normal uses, but it has got too much gain for use in esoteric installations with a low loss cable, and a rig with a reasonable front end noise figure.

The Microwave Modules pre-amp would be suitable for special use in excellent systems if you put a pad of three resistors in the output circuit before the relay of, say, 3 or 4 dB, which will improve the system RFIM performance by around 7dB, which could be useful. Just before going to press, and after discussing all our measurements with Microwave Modules, we received a letter from them informing us that by the time this is in print, the *MMA 144V* will have a switchable RF VOX hold time from 0 for FM to 1 second for SSB, the later being variable with a preset pot. I welcome this greatly and it will make their preamp an even better buy. I would like to thank all the manufacturers/dealers who have loaned the equipment for review, and the many who have been most helpful on the telephone.

I would also like to thank Wood & Douglas for generously donating their review samples to RAIBC. ©Angus McKenzie Laboratories Ltd. 1983.

4. Bandwidth

	-3dB bandwidth (MHz)	-10dB bandwidth (MHz)	-20dB bandwidth (MHz)
Dressler <i>VV200</i> GaAs	5.5	13.0	28.8
Chris Moulding <i>MPA-2</i>	7.1	13.9	21.4
Mic. Modules <i>MMA 144V</i>	24.7	38.7	82.9
Datong <i>RFA</i>	232	360	574
SEM <i>Sentinel Auto</i>	42.9	57.8	111.6
Wood & Douglas <i>PA3</i>	5.6	15.2	28.9
Wood & Douglas <i>PA4</i>	6.4	16.4	36.6

5. Third order intercept

	RF level at input for:		Input/output for	
	-30dB 3rd order intermod. (dBm)	-60dB 3rd order intermod. (dBm)	0db 3rd order intercept (dBm)	
Dressler <i>VV200</i> GaAs	-33.7	-47.2	-20.0/	-2.0
Chris Moulding <i>MPA-2</i>	-20.2	-38.7	-1.8/	+10.7
Mic. Modules <i>MMA 144V</i>	-13.7	-33.2	+5.8/	+20.8
Datong <i>RFA</i>	-0.2	-7.7	+7.0/	+16.1
SEM <i>Sentinel Auto</i>	-18.7	-34.2	-3.5/	+5.4
Wood & Douglas <i>PA3</i>	-22.2	-39.7	-4.5/	+19.0
Wood & Douglas <i>PA4</i>	-14.7	-30.2	+0.5/	+19.0

6. Sensitivity

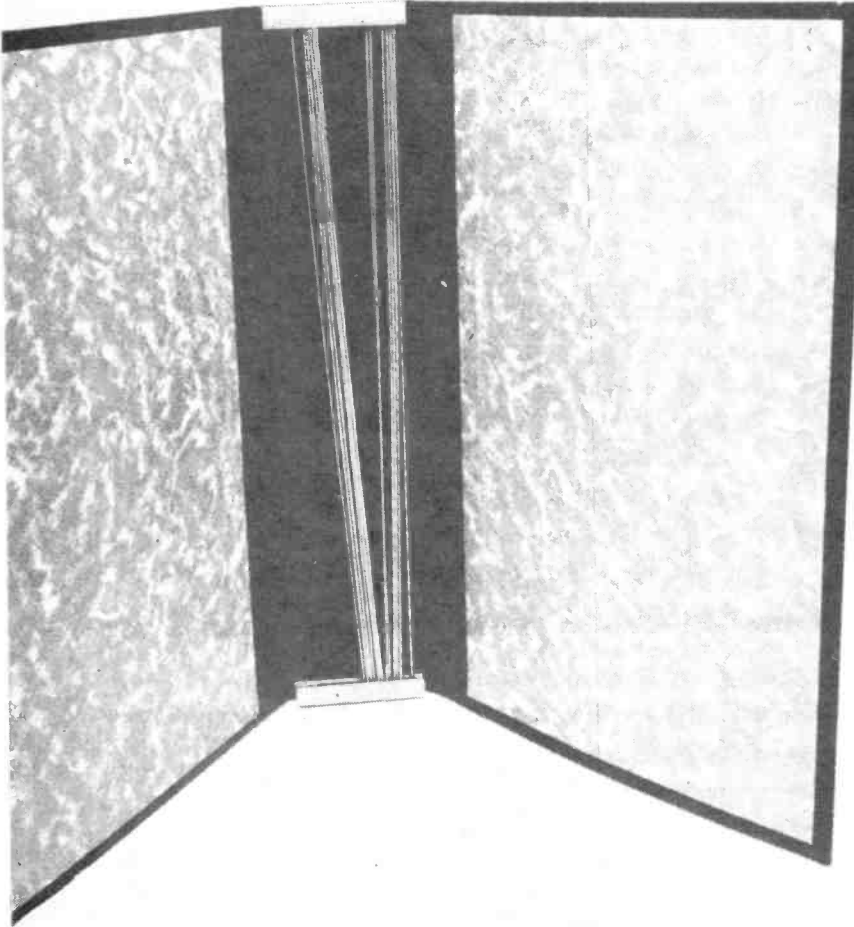
Sensitivity of Icom *IC251E*/Mutek front end when used with preamp (RF level in dBm for 12dB SINAD on FM)

Dressler <i>VV200</i> GaAs	-128.5
Chris Moulding <i>MPA-2</i>	-126.4
Mic. Modules <i>MMA 144V</i>	-128.0
Datong <i>RFA</i>	-127.1
Wood & Douglas <i>PA3</i>	-127.5
Wood & Douglas <i>PA4</i>	-127.6
SEM <i>Sentinel Auto</i>	-126.2

7. Price

	Price (£ including VAT)
Dressler <i>VV200</i> GaAs	75.00
Chris Moulding <i>MPA-2</i>	33.50
Mic. Modules <i>MMA 144V</i>	34.90
Datong <i>RFA</i>	33.92
SEM <i>Sentinel Auto</i>	28.00
Wood & Douglas <i>PA3</i>	6.95 (kit)
	8.10 (board)
Wood & Douglas <i>PA4</i>	7.95 (kit)
	10.95 (board)

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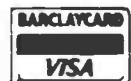
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Practicalities

One type of component which is often avoided throughout the whole field of electronics if possible is the inductor or coil. They are not available off the shelf as easily as capacitors and resistors and therefore they usually have to be wound for each individual use, which adds to the cost of a unit if it is being manufactured commercially. However, amateur radio,

Hints and tips for home constructors

By Ian Poole G3YWX

being what it is, lends itself very well to the use of coils, chokes and the like. So this month I thought I would concentrate on inductors and give a few tips on how to overcome some of the problems encountered when making them.

Inductance of a Single Layer coil.

I can remember seeing some excellent circuits published in various magazines which were spoilt by the fact that the winding details for the coils were omitted and only the inductance or the part number of the commercially made component given. Of course matters were usually made worse by the fact that the item in question was either no longer available or it was not available in this country. This meant starting from scratch with the coil. This can be very time consuming, just guessing at the winding details, as I discovered some years back. In addition to this it is always very helpful to have a good starting point for a coil when you are developing a circuit. As the inductance depends on many factors it is possible to generate very complex formulae. I have seen formulae as long as one's arm to determine the exact inductance of a coil. However, whether one will have access to all the figures for all the variables is another matter. In addition, I wonder how accurate the

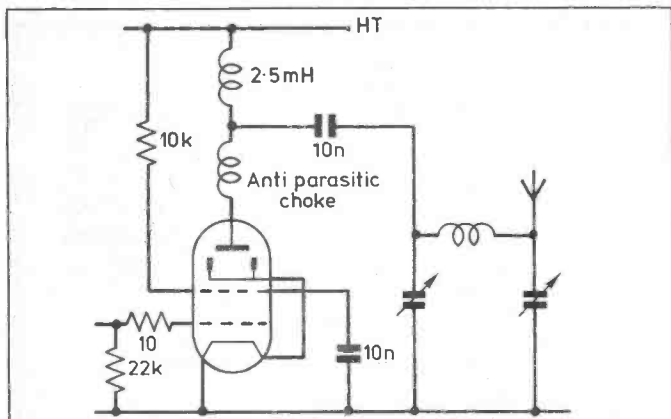


Fig. 1. Circuit diagram of a typical valve power amplifier showing use of anti parasitic choke

end result will be in any case? There are three formulae which I have come across which do give a very good starting point when designing a coil, and they are accurate to the degree one really needs, because the

inductance can easily be trimmed by using either ferrite or brass cores to adjust the inductance. In any case some method of trimming the inductance would probably be needed even if the exact inductance was known, because the other circuit components and leads will alter the overall effective inductance. The formulae here have been given in a form which should be the most useful for the constructor:

$$N = 10 \sqrt{\frac{L}{D}} \text{ if winding length is twice diameter}$$

$$N = 7.6 \sqrt{\frac{L}{D}} \text{ if winding length equals diameter}$$

$$N = 6.2 \sqrt{\frac{L}{D}} \text{ if winding length is half diameter}$$

where N is the number of turns; L is the inductance in microhenries; and D is the diameter of the coil in inches.

As mentioned earlier these formulae will give a good starting point from which to work and the value of the inductance can be changed using cores. If a ferrite core is used this will give an increase in inductance to about twice its original value, while a brass core will reduce the value to about three quarters of its original value.

RF chokes

Very often one requires a small RF choke for suppressing oscillations in a power amplifier, or for protecting the input of an audio amplifier from RF pick-up or for some other use where a small amount of inductance is required. There are two easy ways of constructing small chokes, both of which I have seen used in commercially made equipment. I have found the first of these used mainly in power amplifiers where a very small amount of inductance is required, as shown in Fig. 1. To reduce the susceptibility of the amplifier to parasitic oscillations. The choke is easily made by taking a fairly high value resistor, preferably above 100k but less will suffice, and winding five or six turns of enamelled copper wire using the resistor as a coil former. Normally a small wattage resistor (say 1/2 watt) is perfectly satisfactory as it will be large enough to accommodate the winding without taking up too much space. For some of the higher power amplifiers, a larger resistor will be more suitable. If the turns are fairly wide spaced then tinned copper wire can be used. The other advantage of using the resistor as a former is that it provides a readily available method of providing the choke with mechanical strength whilst not detracting from its performance. Using the formula given above for a winding length of twice the diameter, the inductance turns out to be 0.06uH, which would not normally be enough to alter the

basic operation of an HF amplifier but is enough to stop any 'funnies' when used in the correct place.

The other method of constructing small chokes is to use ferrite beads. These are normally used in lower power applications such as the return path of a 2 metre RF amplifier as shown in Fig. 2, or for

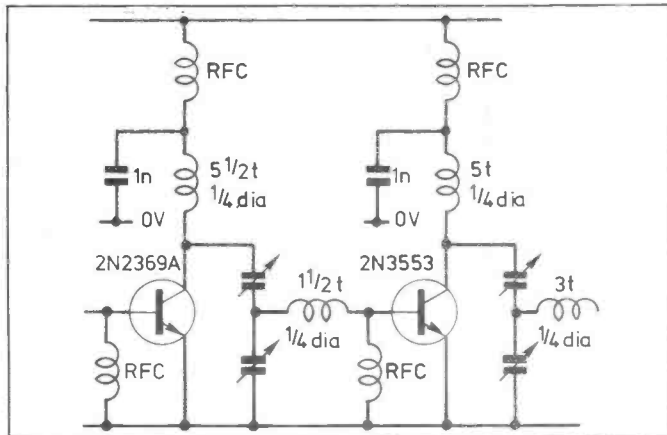


Fig. 2. Part of 2m transmitter showing use of ferrite bead chokes
N.B. all chokes labelled RFC are wound on ferrite beads as described

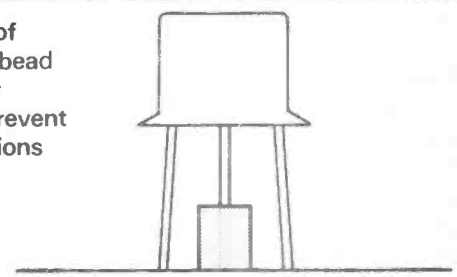
protecting the input of an audio amplifier from RF. The chokes are very easily made up by winding three turns (normally) of enamelled copper wire on a ferrite bead as shown in Fig. 3. The type of bead which is probably most often used is the FX1115, but most other types available from component stockists will



Fig. 3. Diagram showing construction of ferrite bead choke

perform just as well, because the specification required for most applications is not tight. The inductance of these chokes is not only increased by the fact that they have a ferrite core but the fact that the core is toroidal. Because of this it is not possible to use the formulae. I have just given to calculate the inductance. These beads can also be used to supply a small amount of inductance to suppress parasitic oscillations in circuits such as that shown in Fig. 4. The bead can simply be slipped over the gate lead which overcomes the problem of adding extra components onto an otherwise untouched board. I have in fact used this method in a VHF FM tuner which I built, and it very successfully suppressed the unwanted oscillation.

Fig. 4. Method of placing a ferrite bead over a transistor or FET lead to prevent parasitic oscillations



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Kits available so far:

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Preselector	£11.00 (Aug HRT) (Pair pcb's)
Notch Filter	£11.20 (Aug HRT) £2.60)
VFO Unit	£64.00 (Oct HRT) (Pair pcb's £7.90) plus crystals @ 5.00 ea or £40 set of 10 (10.7MHz IF)
VFO Drive Kit	£5.80
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Rx only SSB Adaptor	£6.20 (Oct HRT)
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Watch these ads for the rest of the modules. Each kit is available just after publication of the relevant issue.

We have a mailing list for all actual or potential builders (ask to be put on if you are interested). This will carry latest info/mods, plus quick notification of any errors in the articles. Once the QRP PA is published, we shall also be starting an Omega Net on HF.

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Isn't it amazing how whenever you hear a GB special event callsign there's always a pile up of people dying to make contact? Do you really enjoy queuing up to hear about the special event or is it just the QSL card that you want to collect? Well, whatever your reason,

had to pay the cost of an annual licence fee for the privilege. But since then everything has changed and they are now issued via the Radio Society of Great Britain at no cost to the licensee. The processing of applications by the RSGB was supposed to be an experiment

callsign. The gentleman I spoke to at the RSGB said that they had never, to their knowledge, issued a callsign to a non-licensed person! The class of licence issued must be the same as that of the applicant ie, a G2, G3 or G4 licensee can have a GB2 or GB4 callsign enabling the HF bands to be used whereas a G6 or G8 amateur can only have a GB8 special event callsign with all the usual class B frequency restrictions. The moral of this is that if you, as organiser, hold a class B licence and want to play HF, you enlist the help of a friendly class A licensee to be the applicant and supervise the station.

By Sharon R. Metcalfe, G6LCC

you may be wondering how 'special' special event callsigns are, who can get them and for what events, what is it like to operate the station and how do you forward the QSL cards you write? I'll attempt to answer these but you'll have to forgive me if I keep harping back to GB4HHC (Haywards Heath College in Sussex) which is the only special event station of which I have had experience.

Up until 1977, special event callsigns were issued directly by the Home Office and the licensee

during Silver Jubilee Year, but proved so much more convenient all round that it stuck.

From 1978 to mid-July 1983, 2110 special event callsigns had been issued. This may or may not seem many to you but, to put it in a more comprehensible form, 60 were issued in the six week period from 1st June to mid-July this year and applications were still pouring in.

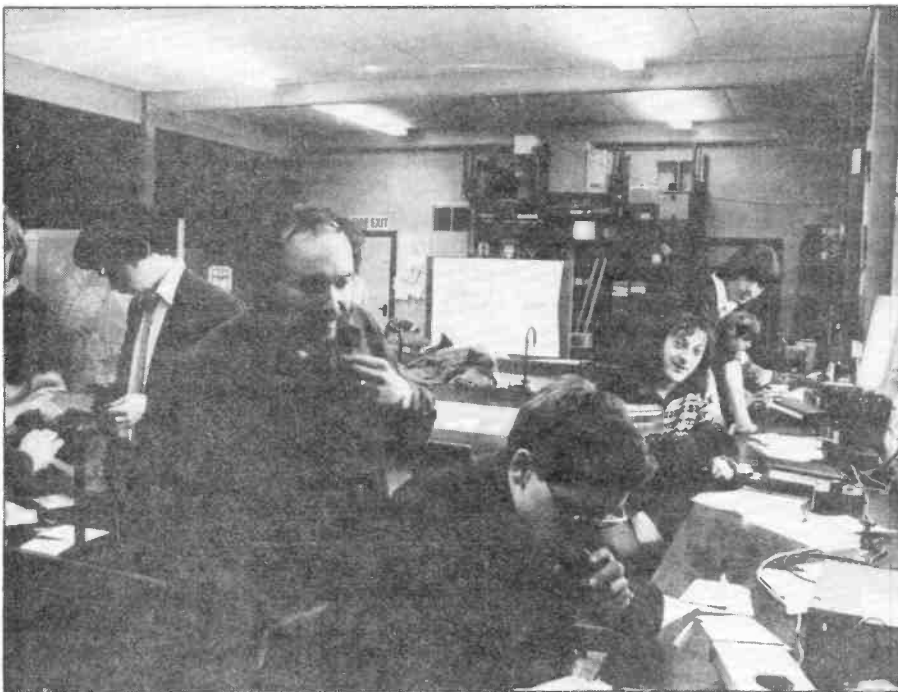
Any licensed British radio amateur (not just RSGB members) may apply for a special event

Whys and wherefores

Indeed you may wonder why special event callsigns are issued. I would say that it is to promote amateur radio to a wider range of people ie, it is just one huge publicity campaign! With that in mind, the events for which these callsigns can be issued can be examined.

If specifically requested, the RSGB's computer will happily churn out a list of recently issued callsigns and interesting reading it makes! The events range widely from school fetes, college rag weeks and village days to anniversaries and centenaries of famous people and even to the celebration of the Royal birth last year by GB2RB. However, the most well-known events are likely to be talk-in stations to mobile rallies and stations operated by local radio clubs or scout and guide companies. The possible events for which callsigns are wanted are limitless and no reasonable request is rejected by the RSGB. In fact over the last year only a couple of applications have been turned down as not suitable (remember the publicity you are supposed to attract for amateur radio?), most probably because the

The happy band at GB4HHC Special Event Station



applicant was not really connected with the event. For example, when applying for GB4HHC the callsign is issued to Richard G3TDL who, as husband of one of the teachers at the College, is the nearest friendly class A licensee willing to be responsible for a 24 hour station (he even enjoys operating throughout the night!). The idea of GB4HHC as part of Haywards Heath College Festival Week was conceived by my husband Pete G8DCZ, who teaches Electronics there, to promote interest in amateur radio amongst the students there (all sixth formers) and to give those already licensed the experience of operating a special event station. It also has the useful sideline of sponsorship for the number of contacts made which gets the Electronics Dept. a little extra money to gradually equip a permanent radio station there (any donations gratefully received!).

We were lucky getting GB4HHC with the College's name as its phonetics but what callsigns are issued? Some GB callsigns eg, GB2RN (HMS Belfast) are permanent stations and will not be available to the general public. These are all listed in the current callbook which can be consulted to avoid duplication. Most GB3 callsigns are those belonging to repeaters and beacons nowadays but in the past they have been issued for special events and, where these events are held annually, they will continue to be issued at present. So the normal callsigns available to new applicants are GB2 and GB4 followed by two or three letters or GB8 followed by three letters.

On the application form it is necessary to state what phonetics will be used for the station and it is more usual to choose a callsign whose phonetics describe the event of its location and to use these rather than the internationally recognised ones eg, the Sussex Mobile Rally applies for GB2SMR and uses its name rather than Sierra Mie Romeo. Although it is still necessary to keep within the terms of an ordinary license and use no 'offensive language', the choice of phonetics is almost limitless. A quick telephone call to the RSGB's Membership Services Dept. will en-



sure that your idea is sound before sending in the application form. Indeed when telephoning to ask for an application form two years ago, the callsign GB4HHC was reserved for us pending written application. As I said before, no reasonable request is turned down by the RSGB but it is as well to have alternative callsigns up your sleeve in case the one you want has been issued to some other event.

Once an event has got its callsign, the RSGB tries to ensure that the callsign is kept specially for that event for approximately 18 months after its last use. This enables annual events to keep their call signs and should cause less confusion than if different events took over the same letters, especially with QSL cards sent to the event. (Biennial events are at risk here.) It is this continuity that allows GB3 special event callsigns to exist for, if they lapse now, they will not be renewed under the present policy of keeping GB3s for repeaters and beacons.

Although the keeping of a callsign works in theory, it can sometimes go wrong. Often it would go unnoticed by most amateurs but there was one recent 'hiccup' when the the Boys Brigade Centenary took over GB2BBC, having applied for it two years previously. During the intervening time, the British Broadcasting Corporation in London had applied for all the possible GB-BBC callsigns to

celebrate 50 years of their external services ie, converting all their normal club stations G-BBC into special event callsigns. The confusion seems to have arisen because G2BBC is not held by them but they were granted GB2BBC to use for the month ending at midnight on 31st December 1982 (although they did not use it after Boxing Day in practice). At midnight the same callsign GB2BBC was taken over by the Boys Brigade in a station operating from Devil's Dyke, Sussex. Since amateurs in Surrey and Sussex were able to receive both GB2BBC stations, there was considerable confusion and the Boys Brigade had to deal with a spate of enquiries asking why the British Broadcasting Corporation had suddenly re-opened its special event station. It must have been even more confusing to foreigners listening from Europe who would not have grasped the significance of the different phonetics. Also by mid-July no QSL cards had been received by the British Broadcasting Corporation for GB2BBC although their other special event callsigns had received plenty. I pity the QSL Bureau's sub-manager who will obviously have to check them by date to ensure that they reach their correct destination. Unfortunately for him, both GB2BBC stations were in operation on consecutive weekends in July this year and both were operating from Motspur Park, London!

So you've thought of an event to promote amateur radio to a wider range of people, how do you

get your callsign? In the first instance you will have to telephone or write to the RSGB's Membership Services Dept. and ask for an application form for *each* callsign you require. I stress this point because GB4HHC this year was also supposed to have GB8HHC to be supervised by my husband at times during Festival Week when GB4HHC was inoperative ie, when there was no Class A licensee to supervise it. When telephoning for an application form, GB4HHC was already on the computer from the previous year but GB8HHC managed to get overlooked. Only one application form was sent to us by the RSGB and, although the Class B callsign was written in, the error was not spotted until there was too little time to re-apply. We received profuse apologies from the RSGB and the slip didn't spoil things too much as GB4HHC operated for just 24 hours as it had done the previous year.

Doing the paperwork

The form sent to you requires the name of the event and details of its nature to check that you have a valid reason for wanting the callsign. You will have to state your choices of callsign with their proposed phonetics, the location of the station, the starting and finishing times of operation, whether or not you require the RSGB's QSL service (you do not need to be a member) and the licensed amateur responsible for the station. The location will either be a postal address or, for those of you going on a DXpedition, the location in terms of its distance and bearing from the nearest town and its National Grid Reference. (Please note that permission from the owner of the land/site must be obtained before setting up a field station.) Unfortunately, the need for details of the fixed location rules out the possibility of mobile operation, which is a great shame as members of our holiday on a narrowboat rather fancied the idea of operating a special event call sign while cruising along! However, it does not rule out the possibility of having the station at one location for a while and then changing the site providing each station has its own application form with clearly defined start/finish times with no

overlapping. As the note at the foot of the application form states:

"Special event callsigns are issued for a maximum of 28 days to cover 1 event at one particular specified location." However, the RSGB still requires definite start/finish times.

As the covering letter received with the application form states:

"Your co-operation . . . in forwarding it (the application form) to HQ at least four weeks prior to your event is essential to ensure the smooth running of this service." The form is sent back to the RSGB's Membership Services Dept. who vet the event as being a suitable one. The form is forwarded by them to the Home Office 28 days before the commencing date, hence the need to apply in plenty of time. The Home Office checks the validity of the licensee responsible for the station and issues a 'Letter of Authority' which acts as the special licence. This letter is sent to the name and address requested on the application form and need not be that of the supervising licensee or the address of the station. The Letter of Authority must be available at the special event station.

Preparing for the day

When applying for the special event callsign, you can ask the RSGB to send you a 'publicity package'. They will then send you a tube containing posters, information leaflets and RSGB application forms which can all be displayed at the station. Other useful display items which you may wish to provide include locator maps of Great Britain and Europe and a world map. If you are trying to recruit new amateurs it may also be useful to have a copy of the RAE manual to show the knowledge required to pass the exam and possibly past copies of *Ham Radio Today* containing sample RAE questions. (You could even use the questions as a quiz or make up some extra ones yourself.) Sponsorship based on eg, the number of contacts or the furthest contact, or a competition to guess what these will be can all help to raise money for your event (subject to the Lottery and Gaming rules governing the event of which your station is a part). After all, such diversions do help to keep

people interested in what the radio station is doing.

Displaying information about the contacts made in such a form that it can be updated throughout the event is another important part of a successful station. Visual displays are especially important to non-amateurs eg, children who can see updating taking place and can be encouraged to call back later and see how the contacts are progressing. For this I suggest that you enlist the help of some computer freaks and get them to program eg, a map of Great Britain or the world placing dots at locations/countries where contacts have been made. If you are going to have microcomputers in the station room, please remember that they can be horrible sources of RFI so keep them to the far end of the room well away from the rigs.

Equipping your station

To help your operators, I would suggest that at each rig there is a card stating useful information such as the QRA, height above sea level, power of that rig and the aerial being used.

As with any amateur station, contacts need to be logged in a non-looseleaf book ie, standard logbooks (if you can afford them) or ruled out exercise books. The most sensible arrangement seems to be that each rig being used has a logbook with plenty of space for comments and a space for the operator to sign the log at the end of his/her stint. (As well as being a legal requirement, the signature can be useful in sorting out any queries when you can't decipher the scrawl!). Under the terms of a special callsign, the station may operate on all bands simultaneously, so the more different bands/modes you have available eg, RTTY and ATV, the better the impact (and the fun!).

Unless you are operating from a permanently equipped club station, you will need to do some scrounging of equipment. Start asking local amateurs (to save on petrol) well in advance and earmark a couple of possible rigs on each band. (It's amazing how equipment doesn't always materialise or blows up in your face during the event.) Where possible it is a good idea for operators to lend their rigs (and



Frank, G4JST, operating his HF station at GB4HHC

always invite lenders to come and operate) for you can be more certain of the rigs arriving and you have a resident repairer if a minor fault develops. Also you won't feel so guilty if the whole thing goes up in a plume of smoke, as the owner will be able to see that there was no maltreatment of his precious rig. Remember that whatever rigs you want, you will always have duplicates on some bands and no rigs for others however good your planning!

So much for the easy part, but rigs on their own won't help you transmit. Has your room got enough power points for all the rigs you want? You will also need a good toolkit (especially soldering irons and screwdrivers), power supplies, cables, connectors and plugs, aerials and multi-meters; most of which you can borrow from other amateurs. (Remember the 'law': you will always need more than you first expect.) I suggest that on items which cannot be named easily eg, plugs and connectors, you use a colour code for the equipment lent by each amateur, using bands of coloured insulating tape. This greatly aids the dismantling of the station and the return of equipment to its owner.

Aerials need masts or towers and you will have to negotiate for portable ones in most cases. If you are stuck, it may well be worth contacting a local club or your local RAYNET group which may have a small pump up mast for hillside use. (Our thanks to Robin G3ZYE for the use of one such mast for GB4HHC.)

It would seem that the more pump up masts you have, dismantling is much quicker (very useful when the enthusiasm for the station dies with the last contact).

On the subject of scrounging equipment, it is a good idea to contact your local 'emporium'. Our one at Handcross has always proved very helpful and is prepared to lend any secondhand equipment it happens to have in stock at the time.

The final preparations will take place just a few days beforehand and consist of assembling the equipment and checking its operation. The same regulations about non-interference with police, fire, ambulance and airports etc, apply to special event stations in the same way as to ordinary licences. It's at this point that you find the 70cm sideband rig has no microphone or the HF rig has not got enough connecting cable for its aerial. If several rigs are in one room, be sure to plan the room so that the rigs are not so close together as to make it difficult to hear your contact over the surrounding noise. (You could try a row of alternate CW and phone HF rigs.) This year's GB4HHC fell down on planning because the 2m FM and 2m SSB rigs were alongside each other with their feeders close together and their aerials connected to the same mast. It meant that there was interference between them and only one of the rigs could operate at a time, leaving one disgruntled, redundant operator — usually me! Efficient filters, additional to those in the rigs, may pro-

vide some reduction of this effect but you can't beat careful siting ie, distance. Have a word with your local radio club, they'll have had a lot of experience with this during field days.

So much for the equipment but you will also need QSL cards of a standard format and a size not exceeding 140mm by 90mm to help the QSL bureau to handle the cards efficiently and without damage. The problem with this is how many do you have printed? Well, as a guide, with six rigs in operation for 24 hours, 299 contacts were made by GB4HHC. This may not seem a vast number but special event call signs are not really meant for fast, contest-type working. Your contacts always want to know about the event and it's no fun for anyone if you're not prepared to natter. You will also have to allow for wastage when cards are filled out incorrectly (especially by operators who are staying awake for 24 hours!). So you will probably want to order double the number of cards that you first think of!

A few additional hints

The 'greetings message' ruling can be made use of under a special event call sign. It allows an unlicensed visitor to the station to talk to a licensed amateur in Great Britain (which is far more fun than just listening). The only provisos are that a licensee makes the contact and does all the operating of the rig itself and that the non-licensed person may only talk for one over lasting no more than two minutes with each contact. This is a super way to involve everyone in amateur radio and can be used to great advantage eg, letting the college students themselves explain what the event is in aid of (it does get very boring repeating your little speech about the purpose of the station). People may also be more willing to come back later in the day to see how the number of contacts and their distances are progressing if they have become actively involved with the station rather than just looking at your displays.

If you are going to operate a special event station, you want everyone but everyone to know, so publicity is the next important thing to organise. To advertise to other

amateurs you can have your event listed in the radio magazines if you have planned several months ahead or, by telephoning the RSGB a couple of weeks in advance, you can get it broadcast on GB2RS, the Society's news service. Your own QSOs in which you are arranging for the loan of equipment from local amateurs and a letter to your local radio club will also promote interest. However, it is probably non-amateurs (or would-be-amateurs) who you are aiming at mainly. Here the local press are often willing to print a column explaining the event, possible with a picture of people clambering up roofs to erect aerials in preparation for it. Our BBC local radio station in Brighton has always been very interested in GB4HHC, transmitting a live programme from the college two years ago and recording an interview during the station's operation this year (and asking for the final number of contacts as an update item).

The importance of publicity cannot be stressed enough for, although as an operator you may have fun chatting away all day, the purpose of a special event station is to promote amateur radio, especially to those not converted! So you need as many people as possible to drop in and see the station in operation and under the 'greetings message' ruling it should be even easier to persuade them to come.

If all this sounds like a lot of organisation, well let me tell you that it is! There are no shortcuts to making the event really 'special' but a lot can be done to ease the problem if the organiser can delegate to some reliable people. Different people can take responsibility for the erecting of the equipment, its dismantling, QSL cards, logbooks, refreshments for the operators and publicity. Remember that the more people that the delegate has in his team, the better for publicity in general and the less lugging of aerials he'll have to do!

On the day

So the day has arrived (not without a hitch I daresay). As organiser you have hopefully got the honour of making the first contact calling tentatively "CQ, CQ from GB-***" (you'll soon get used to the callsign) on your favourite

band/mode. On the other hand this may well be one of only a handful of contacts which you, as organiser, will be able to make, for your main job will be wandering around to keep everyone happy. You are responsible for the legal side eg, filling in logbooks correctly and checking that the operators sign the log with their name and callsign at the end of a stint, and ensuring that for a Class A special event callsign there is always a Class A licensee present (even if the licensee who holds the 'letter of authority' cannot be there all the time). You will be explaining about the station to visitors, the Press, and will probably be interviewed if your local radio station comes. What will you be left with if your local RAYNET is called out on an operation? You can certainly expect to lose half your operators and what about their rigs and the pump up mast you borrowed? I hope that you have discussed this possibility in advance for you must always be prepared for the unexpected!

Even if you are only planning HF contacts from the station, you will find it extremely useful to have a VHF portable or low power rig with a vertical aerial at your disposal (using your own callsign if preferred). This will enable you to get local coverage eg, to talk-in visiting operators or to keep in touch with the foraging party going to the chip shop or pub for refreshments.

To liven up the dead hours of the early morning you can always

try repairing rigs, supping the beer brought in during the evening, filling in QSL cards and trying out different bands/modes to those you are familiar with. This is an ideal opportunity for a Class B licensee to learn about HF operation and to become inspired to learn Morse (I'm still planning to when I get the time!).

And after . . .

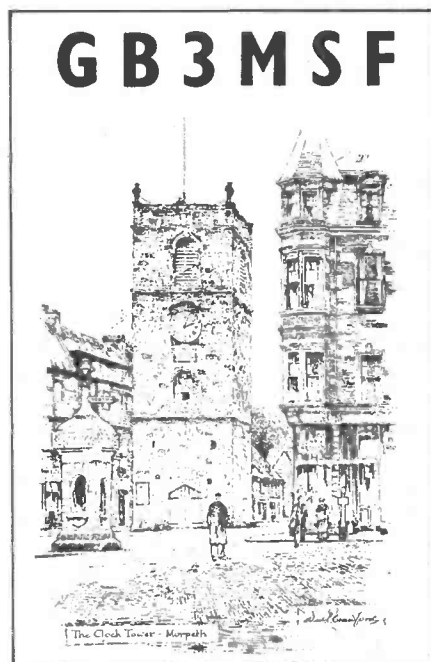
And so at the end of your successful and enjoyable special event station comes the time of dismantling it all. Isn't it funny how everyone disappears and you alone get left to let down the pump up mast and remove its aerials (not a delicate operation for one person as you try not to get hit round the head with the aerial crashing down towards you).

When every rig etc, is packed away and returned to its owner, you'll be left with the logbooks and the QSL cards. The first of these items you will have to keep whereas the second you will want to get rid of as quickly as possible and await the returning goodies to use for next year's display and publicity. (Hopefully you are hooked and there will be one next year.)

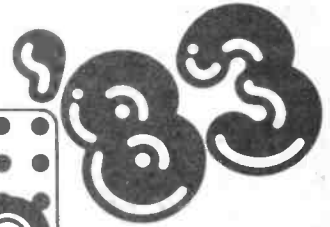
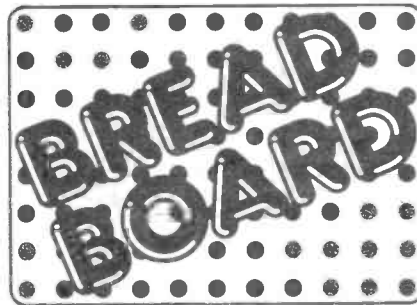
The QSL cards can either be sent direct or via the RSGB's bureau. For friends of the operators and members of local radio clubs or RAYNET groups it is often much appreciated if the cards are passed on through local contacts as it is far quicker than if they go via the bureau. However, posting QSL cards directly is a costly business and is to be avoided where at all possible. After all, the contact could always send you a stamped, self-addressed envelope.

To receive QSL cards sent to you via the bureau you will need to send the sub-manager responsible for GB stations plenty of strong envelopes stamped with more than the normal letter rate to allow for the great number of cards you hope to get.

With the dispatch of the last QSL card the organiser's job is done. It really is nice to bask in the glory of a successful special event station commemorated by a report and photographs in the local Press and by the receipt of a fat bundle of QSL cards (so my husband keeps telling me!).



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*see next page

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Signature

Metre wave

Try to imagine a 2m band devoid of repeaters, and occupied by a few hundred fixed stations plus no more than a scattering of mobiles all with horizontally polarized halo antennas,

hands of technically well versed groups like the Pye one), or were to be administered inefficiently (equally unlikely: this is via the RSGB VHF Committee to the MPT exactly as the beacons are,

the common one internationally for the benefit of VHF users travelling in countries other than their own?

The chances were indeed favourable. Earlier in that same year of 1972 when the 'PI experiment took place, an international conference of the radio societies of Europe and adjoining territories had been held in Holland. It represented about 250,000 licensed amateurs. During its deliberations it naturally gave its attention to as many aspects of ham radio as it could, but it turned special concentration on the 'how and why' of repeaters. It started a revolution in metre-wave operating.

For one thing, the planning of the metre-waves geographically was on its way out after many useful years of service. Planning by mode was on its way in. Thanks to the delegates of that Netherlands conference those dozen-plus years ago, and to their 'technical bods' who did the behind-the-scenes calculations, the framework established then came out right first time. And in the particular context of repeater operation the suggestions and recommendations made then are what we have today — and they have worked very well.

They envisaged dividing up the 2MHz available on the 2m band into, broadly, 'DX at the bottom, and local working (including repeater working) at the top'. At 70cm a slightly modified version of this arrangement was recommended in order to take care of a flourishing amateur television community at the top end of 'Seventy'

Ensuing experience showed the need to shape minor mods into these overall concepts, but — again in the particular context of repeater operation — the arrival of 'channelisation' assisted the emergence of bands planned by mode, as we have them today.

The self-help ethic

It was one thing to propose

The 'why' and 'how' of repeaters By Jack Hum G5UM

fed for the most part with a few watts of amplitude modulated phone. Imagine also single sideband as being "far too difficult", an exotic, almost esoteric mode practised by so few that a special contest had to be arranged for them (their calling frequency was 145.41MHz!). Imagine 'Two' band-planned geographically and not by mode as it is today.

This was the condition of the 144-146MHz allocation less than a dozen years ago in the United Kingdom.

Then an event occurred that was to change the face of metre-wave ham radio in Britain in so dramatic a manner that only the most prescient could have envisaged it. Perhaps a few did. It may well be described if only cursorily by the following extract from a G5UM diary entry for one Saturday in June of 1972:

"Today was the day of the demonstration of the new GB3PI 2m repeater. G3USB, G3GGK and I cruised around the city of Cambridge talking to others through it. Then 'USB took me out to Balsham. I operated en route to G3SXX, one of the young engineers behind the '3PI project, and ended the trip convinced of its value".

One amplified these observations in an extended comment in *Radcom* a little while later which described how 'sold' one was for the repeater concept but adding:

"... we would rapidly become unsold again if this aid to communication were to become abused by inane use (not likely from the generality of commonsensical VHF folk) or were to function unreliably (not likely in the

and the Society pays the £3 licence, just as it does for the beacons)".

From the modest experimental beginning has developed the chain of almost 150 repeater stations which today cover most of the populated areas of the British Isles in the 433MHz and 145MHz segments of the metre-wave spectrum.

Meanwhile, in other places . . .

Although in 1972 the repeater concept was a newcomer to the British ham radio scene it was slightly less new to metre-wave aficionados in other countries. The Americans had commissioned several examples. Nearer to home the German repeater chain of some fifty stations excited great interest in the UK during a VHF propagation lift when some of them could be heard back in Britain — their output ends at any rate, and more rarely their vehicle-borne input ends. At that time, in an understandable attempt to keep input well away from output, the German chain used 1.6MHz separation of transmit from receive. The input would be around, say, 144.2MHz and output around 145.8MHz.

It is a commentary on the rapidly developing techniques of the time that the GB3PI experiment aimed to reduce this gap to the 600kHz separation of input from output which is today's norm.

Establishing standards

But how and when did 600kHz spacing become that norm? And what were the chances of establishing it as

recommendations for repeater frequency allocations; it was quite another to ask "Who will implement these proposals?". The delegates to that international conference a dozen years ago probably harboured no doubts on this score. Being practising radio hams themselves they were aware of the pent-up demand for repeaters that already existed in Europe's amateur radio fraternity, a demand fostered by what enthusiasts had read of existing schemes like the German one and highly successful experiments like the GB3PI one.

This enthusiasm for the repeater concept caused the biggest collective effort in designing and building ever to occur in the amateur metre-wave communication field. Here at last, was the feeling of many hundreds, we have something that will free the VHF man from the 'line of sight' tyranny which had dogged him for so long — and at the same time had dissuaded many others from trying their hands in this part of the spectrum. ("Oh, you never get very far and you can't work any DX".)

At last you would be able to talk around corners on Two. At last, if a repeater station were to be established in your district, you would have the chance to talk to people a hundred miles away with only modest power levels at each end. Admittedly, through-repeater contacts would not be 'real QSOs' but proxy ones, yet still worth having.

No wonder the Holland IARU Conference decisions were followed

very soon by the formation of many repeater groups in districts throughout the United Kingdom, all of them bursting with enthusiasm to design, build and commission repeater transmitter-receivers locally, in a remarkable demonstration of the self-help ethic which has always been prominent in amateur radio history. Here was another slice — and a very sizeable slice — of history in the making.

Not everything was plain sailing. Although there was much pro-repeater feeling among the fraternity there was still a lot of *contra*. In the Autumn of 1972 for example, a vote of two to one against repeaters was registered by the Scottish VHF Convention of that year. And elsewhere the 'Why' of repeaters (see our title-line) was challenged by many others. For nobody in these islands at that time had had any experience of what repeaters could do. Hearsay gave rise to the belief, sincerely held by many, that through-repeater operation did not represent true amateur radio communication as it had been known until then.

Gradually the misgivings were allayed as the GB3PI experiment, planned to run for a year, continued on its remarkable way into 1973, monitored not only by its protagonists but by the VHF Committee of the national society (by early 1973 the subject of Repeaters was permanently on its agenda). This Committee reported back to the RSGB's Council in such enthusiastic terms about the success of the GB3PI experiment that

the decision was taken to persuade the Licensing Authority to allow its continuance.

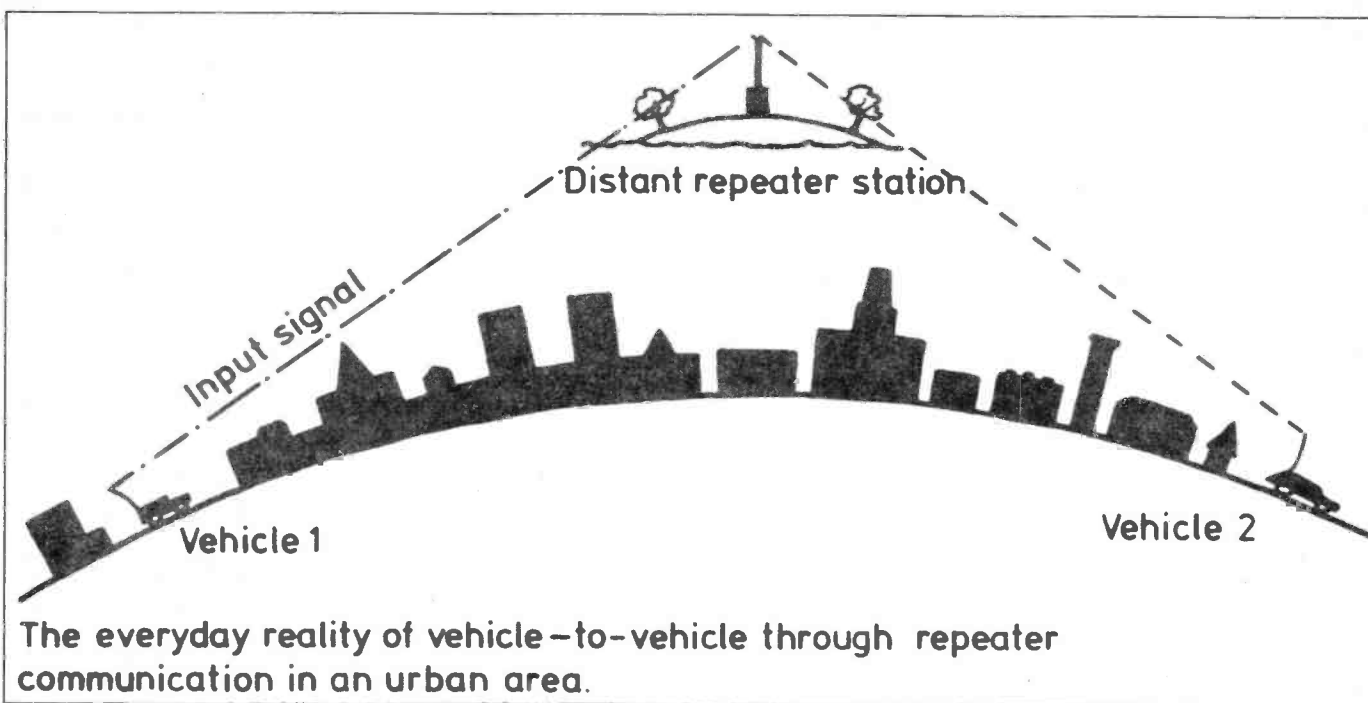
As 1974 dawned three significant events in the repeater context were, first, the implementation of the new 'by modes' bandplan with repeater allocations printed plain for all to see, secondly the commissioning of GB3BC, the first unit to serve a heavily populated region (South Wales), and thirdly some evidence that not all repeaters need necessarily be 2m ones: a South Midlands group was formed to explore the potential of 70cm. (In a report of the National VHF Convention of that year the comment was made that "... the real need now is for repeater schemes on 70cm".)

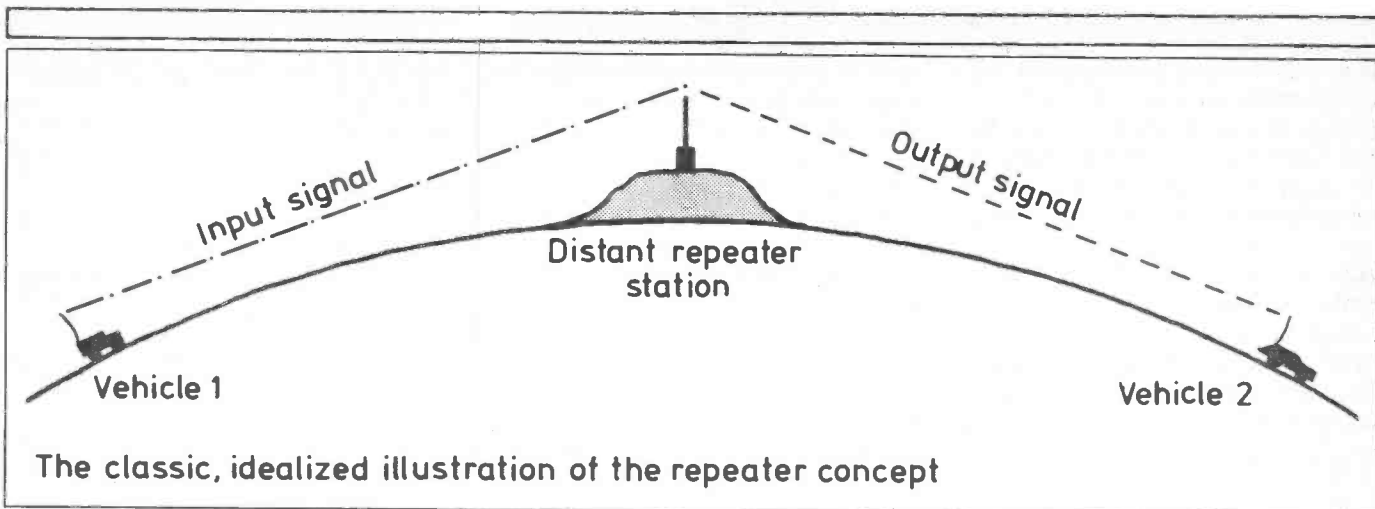
Around this time, too, there was a temporary hiccup: the Licensing Authority felt compelled to complain about the large number of applications for repeaters which it was by now receiving. Thankfully it was persuaded that a repeater service, properly controlled, was a good thing.

Control of the repeaters

This question of control of a proliferating repeater chain was a very real one. It was essential that repeater stations would be established in those places where they would provide the greatest good for the greatest number, and not solely because "... a repeater would be a rather nice thing to have ... let's see if we can build one and get it working".

The four firm repeater proposals





which had come forward at that time precisely met the requirement for 'the greatest good': GB3BC already served the heavily populated areas either side of the Bristol Channel (hence BC), GB3MH in the Malvern Hills was planned to provide an extension of service from Bristol up the traffic flowline to the West Midlands; another would serve the south coast conurbation around Southampton and Portsmouth, and a fourth was planned for London. Truly the GB3PI experiment was gathering its converts!

Because the licences for all repeater stations would be paid for by the national society and because all applications would be vetted by its VHF Committee before they were submitted to the licensing authority, adequate control of the repeater chain was exercised right at the start and has continued very effectively to this day. Logical development of the chain followed, phase by phase. Anarchy was avoided.

For example, one of the decisions taken before the end of 1974 was to limit the repeater spectrum to the frequency area R0 (145.0MHz) to R7 (145.775MHz), thus leaving 145.8MHz (technically within the European repeater orbit) to be preserved in the UK as a widely used net and Raynet frequency (then) and as a satellite frequency (later). Much thought was turned also on which repeaters should go where if co-channel interference was to be minimized. (It could not be prevented: tropo lift conditions and so on would ensure that at times inevitably more than one repeater output signal would be heard on a given channel).

Next band up

"But if the available space for repeaters on 'Two' is filling up why don't we try 70cm? There's more room

on the next band up."

This is what the more forward-looking repeater groups were saying by now. Perhaps few of them could have forecast then that within a few years there would be more 70cm repeaters in the UK than 2m ones, and that the even-numbered channels would fill up so quickly on 70cm that it would be imperative to allocate the odd-numbered ones. Yet that is how the 433-435 MHz area has developed. And it all began in 1974 when three schemes

were put forward to place repeaters in that 'next band up'.

And who would be the clientele for all these repeaters when they came on stream? Quite obviously, the mobile operators; their operational ranges would be hugely extended with a repeater's aid. There were thousands of them waiting for just such an opportunity. Their numbers happen to be known precisely: nearly 3,500 Class A and over 1,500 Class B held the separate mobile transmitting licence

Table 1 the repeater channels on 2m

Channel No	FM repeater input at	Repeater output at
R0	145.000MHz	145.600MHz
R1	145.025MHz	145.625MHz
R2	145.050MHz	145.650MHz
R3	145.075MHz	145.675MHz
R4	145.100MHz	145.700MHz
R5	145.125MHz	145.725MHz
R6	145.150MHz	145.750MHz
R7	145.175MHz	145.775MHz

Note: At 2m inputs are *low* and outputs *high*.

Table 2 the repeater channels on 70cm

Channel No	FM repeater input at	Repeater output at
RB0	434.600MHz	433.000MHz
RB1	434.625MHz	433.025MHz
RB2	434.650MHz	433.050MHz
RB3	434.675MHz	433.075MHz
RB4	434.700MHz	433.100MHz
RB5	434.725MHz	433.125MHz
RB6	434.750MHz	433.150MHz
RB7	434.775MHz	433.175MHz
RB8	434.800MHz	433.200MHz*
RB9	434.825MHz	433.225MHz
RB10	434.850MHz	433.250MHz
RB11	434.875MHz	433.275MHz
RB12	434.900MHz	433.300MHz**
RB13	434.925MHz	433.325MHz
RB14	434.950MHz	433.350MHz
RB15	434.975MHz	433.375MHz

* At present widely used for simplex: not yet allocated to repeaters.

** Designated for use by RTTY repeaters.

which was then compulsory, before it was integrated into the main licence.

Five thousand licensed mobiles, then, were watching the progress of the proposed repeater chain with intense interest. This progress would not go unnoticed, either, by the 15,000 Class A and 4,000 Class B home-based operators. That it how it is today, except that the number of licensees has virtually doubled in the succeeding eight years, bringing a resulting vast increase in the potential 'audience'.

Attending to the hardware

As the Seventies progressed the amount of repeater organisational work which was being generated compelled the RSGB's VHF Committee to hive off a separate Repeater Working Group to handle it. Out in the field a huge programme got under way among local groups to build the equipment that would be needed when their applications for local repeaters were granted. The transmitter-receiver, though, was but one unit of the many likely to be required. Others included complex filters to separate outputs from inputs, and the logic circuitry to identify each particular unit in morse.

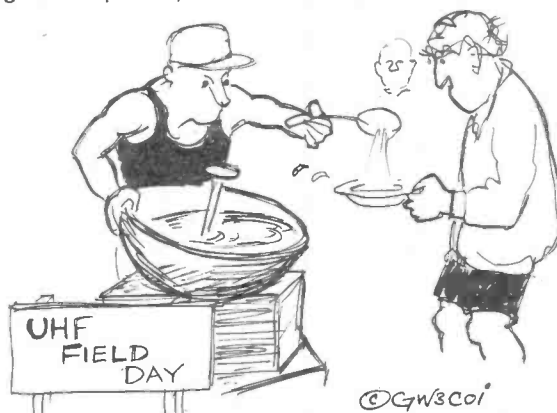
Another essential was an indestructible power supply unit, the whole of the machinery so designed and constructed that it would meet the licensing authority's requirement for a reliable service 24 hours a day for 365 days a year.

A tall order? Not for groups with that self-help ethic already touched upon above. And its financing? No problem for groups with three-figure memberships — and there were plenty of these, brought to birth by the enthusiasm which the repeater concept had engendered among metre-wave people.

As the Seventies drew to a close and the Eighties opened, Britain's

repeater chain totalled something like 150 units, the majority of them by now in the 70cm band. Coming forward were even more sophisticated projects for 1.3GHz transponders, and others for television and for data, all demonstrating their sponsors' ability to handle contemporary communications techniques — and often to be ahead of them.

But what of the bread-and-butter, day-to-day use of this highly developed, almost nation-wide repeater network which today few marvel at but thousands accept as simply being there when wanted? That is something to be mulled over in the next instalment.



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Mizuho SB-2X review

Regular readers of *Ham Radio Today* will have seen in the May issue a review of the Mizuho *MX-2* written by Frank Ogden, who concluded his review by saying that, although he liked the *MX-2* he would have preferred it to have been in a larger case and with extra crystals to cover a wider frequency range, including the beacon band. Well, in fact, such a rig exists, and it forms the subject of this article.

It's not strictly true to say that the *SB-2X* is an improved version of the *MX-2*, since both are derived from the Mizuho *SB-2M*, which was in production a few years ago and is still available on the second-hand market. The *SB-2M* was the same size as the *SB-2X*, ie. somewhere between the sizes of the *TR2300* and the *FT290*, and covered the frequency range 144.2 to 144.4MHz, producing one watt of SSB or CW output. The tuning system used was not a synthesiser, but a variable crystal oscillator (VXO), which is simply a crystal oscillator whose frequency is varied over a small range by a tuned circuit connected in series with the crystal. The advantages of this system for VHF use are that the stability obtained is better than all but the very best free-running VFOs, and the circuitry is much simpler (and hence cheaper) than either a VFO or a synthesiser. The disadvantage is that the tuning range is limited, since a crystal can only be pulled by a small amount, of the order of 10kHz, before the stability and crystal output become unacceptably low. For VHF this can be overcome to a certain extent by running the oscillator at a low frequency and multiplying up, but the tuning range is

still only about 50-100kHz in practice, and so it is necessary to use several crystals to cover even the SSB section of two metres. In the *SB-2M*, four crystals were used, covering 144.2 to 144.4MHz in 50kHz segments.

As mentioned above, the *SB-2M* produced two descendants, the *MX-2* and the *SB-2X*. The *MX-2* is essentially a miniaturised version of the *SB-2M*, still tuning in 50kHz segments but with only two crystals, and a reduced output of 200mW. The *SB-2X*, on the other hand, is an improved version of the *SB-2M*. Whilst it is the same size, the tuning range has been quadrupled by increasing the tuning segments to 200kHz each, so the coverage is now 144.0 - 144.6MHz and 144.8 - 145MHz in four ranges. In addition, a slow motion drive is now fitted, which makes tuning much easier. The tuning dial now has a pilot light, fitted with a ten-second timer; press a button on the front panel and the light comes on for about ten seconds and then goes out again! In addition, the *SB-2X* now has a noise blanker, RIT and a built-in mains operated nicad charger.

Circuit description

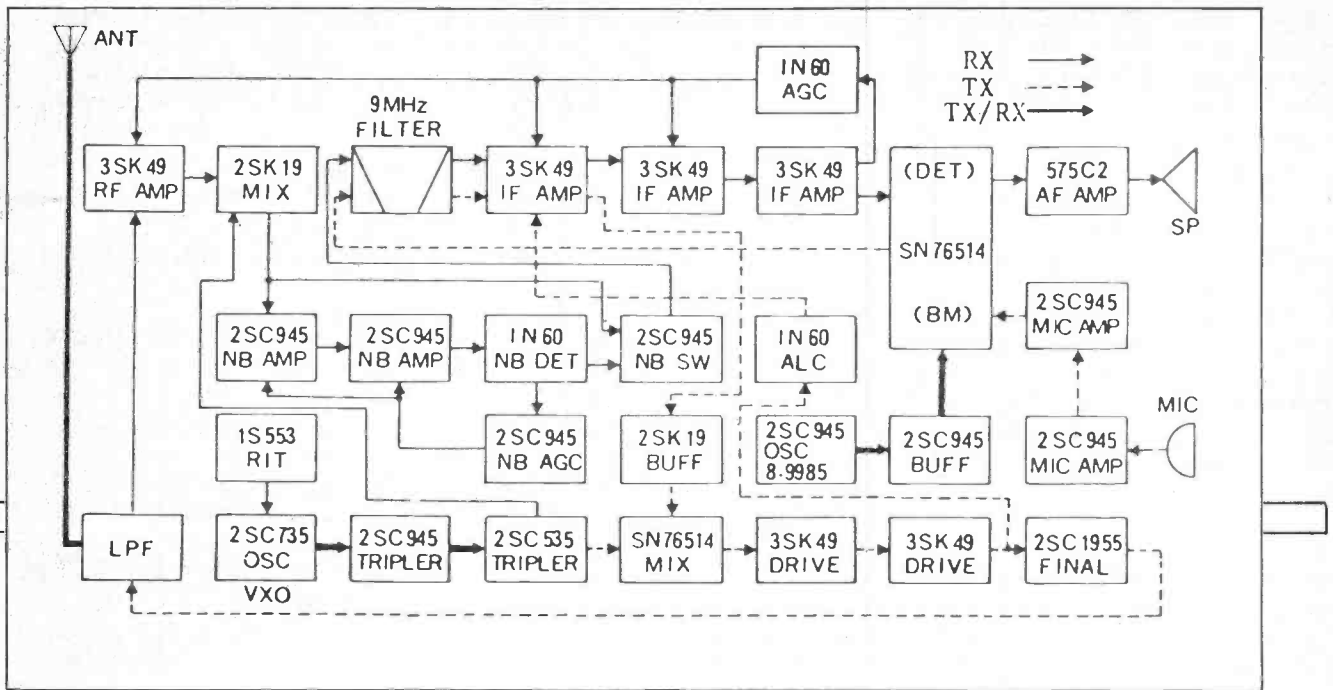
A block diagram of the *MX-2* is shown in Fig. 1. On receive, the signal is amplified by a dual-gate MOSFET RF amplifier, and is then converted to the IF of 9 MHz by a junction FET mixer (why a junction FET?). It then passes through the SSB filter and is amplified by three IF stages using dual-gate MOSFETs before being fed



to the product detector, an SN76514 dual balanced mixer. From here the demodulated audio is fed to an IC AF amplifier and then to the loudspeaker. AGC is derived from the output of the third IF stage; it also operates the S-meter.

On transmit, the signal from the microphone is amplified by a two stage mic amp and then fed to the balanced modulator, the same double balanced mixer as is used for the receive product detector. The output of the balanced modulator passes through the SSB filter, the first receive IF amplifier and a junction FET source follower before being fed to the transmit mixer, another SN76514. Following this are two stages of amplification using dual-gate MOSFETs and then the bipolar PA. ALC is derived from the base circuit of the PA and fed back to control the IF amplifier.

In the VXO local oscillator circuit, one of four 15MHz crystals is pulled in frequency by a tuned circuit connected in series with its earthy end. RIT is provided by a varicap diode



connected in parallel with the main tuning capacitor. The output from the oscillator is passed through two frequency triplers to produce the 135 MHz local oscillator signal for the receive and transmit mixers. The noise blanker operates on the IF signal at the output of the receive mixer. The signal is first amplified by two bipolar stages, and then rectified to produce a fluctuating DC signal which is fed to the base circuits of two further transistors, one of which contains a CR network to reduce the rise time. These two stages control the biasing of the two ends of a diode connected in series with the signal path. For slowly changing signals the two transistors will turn on and off at about the same rate, keeping the bias on both ends of the diode in step so that the diode remains on. Fast rising pulses, such as ignition noise, will turn on one transistor faster than the other due to the presence of the CR network, and this will cause the diode to be biased off momentarily, preventing the interfering pulse from reaching the SSB filter. At least that's the theory.

For CW transmit operation the mic amp is switched off and a DC voltage is applied to the AF input port of the balanced modulator, thus unbalancing it and introducing carrier. A trimmer capacitor in series with the carrier crystal is also removed, moving the frequency HF into the passband of the SSB filter. Keying is carried out in the source lead of the second transmit buffer.

Construction

The *SB-2X* is housed in a metal case measuring $120 \times 56 \times 188$ mm. Like that of the *TR2200*, this case forms a removable sleeve secured by two 'popper' type plastic clips on the rear panel. This arrangement makes for quick and easy access to the internal circuitry, but Mizuho have tried to squeeze rather a lot into the available space with the result that the case is quite a tight fit and slightly tricky to refit once removed. The front panel carries, nearly centrally, the main tuning knob, 28mm in diameter, which operates a green on black tuning scale via a slow motion drive. This scale is marked in 10kHz divisions, and can be back illuminated by a pilot light operated by a push button and ten second timer. To the right of the tuning knob are the volume and RIT controls, the push button for the pilot light and LEDs to indicate that the RIT and noise blanker are in use. These LEDs, incidentally, are rather bright, and the values of their series resistors could be increased with advantage since, as will be mentioned later, one of the bad points of the *SB-2X* is its rather high power consumption.

To the left of the tuning dial are the crystal selector switch and a small 'edgeways' meter, which indicates signal strength on receive and RF volts out on transmit. As is usual for a rig of this type, it simply indicates received signal voltage, with the result that the

S-unit scale on it is somewhat meaningless and should be ignored! I was also surprised to find that no provision had been made for checking the state of the batteries; obviously a modification is called for here. To the left of the meter and crystal switch are the mic socket (standard Japanese 4-pin), a slide switch for switching on the RIT, and a telescopic whip antenna. This is removable in the manner of that on the *TR2300* since, as the handbook says, an "optional helical rubber duckie antenna is available" (sic).

On the rear panel are mounted the external power connector, a standard transistor radio type with, I am glad to say, the live side connected to the centre pin (unlike the *FT290*), the key jack, which is a standard 3.5 mm jack socket, and a 1mm socket for the control of a linear. This latter is a useful feature, although as wired it provides volts on transmit and no volts on receive; not only is this incompatible with the Microwave Modules range of linears, which require an earth on transmit, but it also means that this socket cannot be used as an external PTT connection, for example for a foot switch, which, as will be explained later, is more or less essential for CW operation with this rig. Next to the key jack are two miniature slide switches, one to switch on the noise blanker (a rather inconvenient place to put it), and the other to select SSB or CW operation. The rear panel layout is completed by a two pin socket for the

mains connection to the built-in NiCad charger, and an SO239 socket for an external aerial, this being recessed rather a long way into the panel and hence making it difficult to tighten the plug up fully.

Inside the case most of the circuitry is mounted on two large PCBs and the construction is generally uncluttered, which, coupled with the simplicity of the circuit, should make for easy servicing. Connections to the boards are, for the most part, made by wire wrap pins (some of which, however, are soldered). All component positions are clearly marked on the component sides of the boards. The standard of construction is generally good, although, having said that, I did find two dry joints which prevented the rig from operating when first received.

The *SB-2X* comes complete with a good range of accessories, and in fact the only item which might be needed and is not supplied is a set of NiCads; however, this is normal practice with a rig of this type. I'm not sure, though, whether I feel it to be entirely honest to describe the carrying case as being made of leather — it is, in fact, made of the usual canvas-reinforced plastic! This case, incidentally, has the useful feature that it can be removed and refitted without having to remove the carrying strap from the rig. One further point about accessories; Mizuho supply a mounting clip for the rather large hand mic provided with the *SB-2X*, and the manual instructs that this "should be fixed to the side of the set using the screws and washers supplied". Unfortunately, inspection of the metal case reveals that no provision has been made for this, since no mounting holes have been provided, and if the clip were mounted using the long self-tapping screws supplied it would be impossible to return the set to its case until the protruding ends of these screws had been filed off inside! Furthermore, the plastic carrying case makes no provision for the mic clip, and it would be necessary to cut a large hole in it to allow the clip through. In the event, I decided not to bother with the clip as the plastic case has a large pocket in which the mic can conveniently be stowed.

Handbook

Mention was made earlier of the handbook; however, this is probably

rather a misnomer, since it consists of just three photocopied A4 sheets! However, it does seem to contain all the information required for the operation and maintenance of the set, even down to instructions on how to adjust the VXO 'tracking' (calibration linearity would probably be a better term), and although there are many examples of 'Japanese English' the meaning is usually clear. My main complaint concerns the quality of the printing (or should I say photocopying) of the circuit diagram. This has obviously been photoreduced from a much larger copy, and although the diagram itself is just about legible, most of the component references, which are in very small lettering, are not. A phone call to the suppliers, Lowe Electronics, produced a copy which was both larger (A3) and clearer, but even here some of the smaller print was difficult to read. There is obviously some room for improvement in this area!

In operation

I used the *SB-2X* in a variety of situations, both portable and base station, over a period of some weeks in order to get the feel of it. Not surprisingly, the plus and minus points are similar to those Frank found for the *MX-2*. One obvious criticism is the battery consumption — it seems amazing that it could not have been reduced below 95mA on receive, when you consider that far more complex synthesised rigs can keep it down to about 35mA. That said, it represents far less of a problem than with the *MX-2*, since the *SB-2X* uses standard AA size NiCads, which should give about 3½ hours operation with a fully charged set, assuming a transmit to receive time ratio of 1:3. Looking at the circuit one can see various factors contributing towards this consumption, such as the low value of the LED dropping resistors, and the use of several individual zener diode stabilisers in different parts of the circuit, rather than one centralised IC regulator. Fortunately, unlike the *MX-2*, the *SB-2X* is designed with NiCads in mind, and the supply voltage is a convenient 12 volts, making the use of an external power supply easy.

The overall performance of the *SB-2X* is good, and the speech quality, both on receive and transmit, was generally liked. The receiver was

reasonably good in terms of signal to noise ratio, but was rather lacking in overall gain. Although weak signals were not lost in the noise it was necessary to turn the volume up rather a long way to hear them, and quite strong signals, approaching S9, in fact, were needed before the AGC (and hence the S meter) began to operate. The addition of a preamp remedied this without having any significant effect on the actual signal to noise performance. It did, however, greatly improve the action of the noise blanker, which had previously seemed to be fairly useless; obviously the level of signal supplied to it had not been sufficient for it to operate effectively. The S meter calibration was, as might be expected, totally meaningless since, as mentioned above, it took about an S8 signal to even move the pointer off the zero stop! Even with a preamp it is fairly meaningless, since it is linear in terms of signal voltage whereas its scale is linear in terms of S units, which are proportional to the logarithm of voltage! It would be far less misleading if manufacturers of this type of equipment followed the example of the Trio *TR2300* and simply marked the meter with a 0 to 10 scale with no reference to S units.

The stability of the VXO, whilst adequate, was not brilliant. It probably met the manufacturer's specification for drift of "within 200 Hz in any 30 minutes after initial warm up", but in practice this meant that it was nearly always necessary to retune by a small amount at the end of each transmission. Whilst this sort of stability would not be adequate for HF, it is probably OK for the less crowded conditions on two meters. The drift is probably due to the fact that the VXO crystals are being pulled by rather larger amount than is generally recommended, and since it is the *SB-2X* that is drifting, the temptation to correct it by using the RIT rather than the main tuning should be resisted!

On transmit, the performance of the *SB-2X* was generally satisfactory. Despite the low power, it was rare for a station that could be heard, however weakly, not to be worked. Whilst not being able to equal Frank's "washing-up DX" record, I did receive a report of 5 by 9+ from a station 16 miles distant under similar conditions (yes, I was washing up too!), and since my QTH in north Brighton is surrounded by hills on all sides I was quite pleased about

Amateur radio in South America

I have spent many years living abroad in many parts of the world and have held amateur radio licences in many countries. In others, I have obtained permission to operate as a 'guest operator'. In all, operation from 55 countries has been experienced since 1927

Massive electrical storms

In tropical and sub-tropical countries, the problem of atmospheric (QRN) is, of course, much greater than we are accustomed to in Europe. The lower frequency bands, 1.8, 3.5, 7 and

When you are listening on the HF bands and hearing signals from 'rare' DX stations, have you ever wondered what it is like to operate from one of these countries?

when my first call 2ARV was issued in England, superseded by G5RV in 1928. Since my retirement in 1976, my wife and I spend six months each year in England and six months in Uruguay, where my call is CX5RV.

Some of the more 'rare' calls held have been; VP4RV (Trinidad), VP5RV (Jamaica), VP6RV (Barbados), VP7RV (Bahamas), PJ5AA (Aruba), PJ5CA (Curacao), PX1RV (Andorra), EP2RV (Iran), FOORV (Tahiti), YJ8RV (New Hebrides), VK9LV (Papua New Guinea), TU4AJ (Ivory Coast) and PY1ZAR (Brazil).

Although there are several hundred licensed amateurs in Uruguay, many of them are relatively inactive and others obtain licences to enable the family, living in Montevideo or one of the other towns, to communicate with their *estancia* (cattle ranch) in the country. This is done on SSB, normally in the 7MHz band and often with scant observance of the 'gentlemen's agreement' to leave the lower 50kHz of that band clear for CW operation. This, together with the intrusion of several broadcasting stations in the band, right down to as low as 7012kHz, makes amateur operation, especially for DX contacts at night, extremely difficult at times.

even 14MHz are sometimes virtually unworkable because of very heavy crashing QRN which can reach peaks of S9 plus on the S-meter. Violent thunderstorms are much more frequent in these latitudes than they are in Europe. One of the consequences of such storms is the occurrence of much more frequent and prolonged electrical power cuts so if, when you are in QSO with a CX station, he suddenly disappears do not think that he has left you 'high and dry' — it may well be due to one of these power cuts, or *apagones* as they are called in Spanish.

What is 'DX'? It is generally accepted that by 'DX' we mean stations located at least 1,000 km distant from our QTH. However, this is a purely arbitrary figure and is influenced by the 'rarity' of the called or calling station. Thus, here in Uruguay (a relatively small country) stations in remote parts of Brazil and Argentina and in other South American countries are DX in distance. However, because PY and LU are so easy to work on all bands from 3.5 to 28 MHz, we are inclined to consider them as being locals. Certain areas of the world are particularly difficult to work from Uruguay and are only heard at very rare intervals. The distant islands of the South Pacific can on-



ly be heard very occasionally during the year on 14, 21 and 28MHz and only for about an hour or so in our early morning, around 0630-0800 CX time (0930-1100 GMT). Australia and New Zealand are also heard only infrequently, usually during this period but sometimes also in our early evening. However, on the relatively rare occasions when propagation conditions between Oceania and Uruguay are particularly good, VKs and ZLs can produce signals up to S7 or S8 on the 14 to 28MHz bands. At this stage, it is opportune to state that I am a 'dyed in the wool' CW man and only use SSB on very rare occasions. However, all that has been said above applies equally to phone operation. Without doubt, the most consistently strong DX signals here are those from USA and Japan which, given reasonably good conditions on these three bands, can be heard and worked during day and night time for many more hours than other parts of the world. Not unnaturally, when operating in a country far from home, one tends to try hard for QSOs with the homeland and neighbouring countries. This fact motivated the analysis of a typical six month's period of operation from Uruguay



By Louis Varney G5RV/CX5RV.

and Fig. 1 shows, in graphics form, the number of European QSOs per month made over this period on the three main DX bands. It should be borne in mind that, although preference was given to answering European calls when the bands were open to Europe, many QSOs were also made with other areas of the world when propagation conditions permitted. Daily average operating time over the six month period analysed was approximately two hours. Since CX5RV is only active during the Spring, Summer and part of the Autumn months here in the Southern Hemisphere, it is not possible to give first-hand experience of DX conditions during the late Autumn to early Spring period. Nevertheless, DX conditions here follow the same trend during that period as they do in Europe.

Operating conditions

What is it like to operate from Uruguay? It is 2000 hours CX time (2300 GMT) on a February evening and in the cloudless night sky the myriads of stars seem to shine with greater brilliance than they do in the Northern Hemisphere. Off the far end of my G5RV antenna the Southern Cross is in its station and a quick listen on the 14 and 21MHz bands shows both to be lively. A short 'CQ DX' call on either 14 or 21MHz CW brings a shoal of calls from USA stations — many anxious to work their first CX. Signals from many States are strong, mostly around RST579 to 599, background noise is low and the only problem is to pick out one from the crowd for a quick QSO. Generally, the callers are well behaved and await their turn and

QSOs proceed at the rate of one every two minutes! No time for chatting. Most are excellent CW operators and about 20 to 25wpm is normal speed. QSY to 7MHz at about 2130 local time (0030 GMT) brings calls from PY and LU with 599 signals while, QRN and QRM permitting, East Coast to Mid-West USA can be worked. In the very early morning hours, from about 0100 to 0330 CX time, European stations can be worked but signals are usually rather weak. DX QSOs on 3.5 MHz are even more difficult and, at most times of the year, QRN is very strong. However, at least one Uruguayan amateur, Julio CX6CW, has made DXCC on CW on both the 7 and 3.5MHz bands. When propagation conditions are unusually good on the 14 and 21MHz bands for Europe and the Far East (Siberia and Japan especially), strong signals from these areas sometimes have quite audible round-the-world echo on them when both the long and short paths are open simultaneously.

And on VHF . . .

The 2 metre band is used for both fixed and mobile operation by a number of CX amateurs who live in, or relatively near to, the main towns along the coast. Four 2 metre repeaters exist; one in Montevideo, another in Piriapolis 65km to the East, a third at Nueva Helvecia 115km to the West of Montevideo on the River Plate. The fourth is at Minas 60km to the North of Piriapolis. The Nueva Helvecia repeater also provides a 2 metre link to Buenos Aires across the River Plate, some 110km distant. However, for those amateurs who live on *estancias* well into the interior or in remote towns, the scope for VHF operation is very limited.

Even after 55 years of operating, it still seems like a miracle to hear signals that have travelled 6,000 miles from the UK, perhaps from a fellow amateur in one's home town, spelling out a message of friendship engendered by the common interest in our great and fascinating hobby.

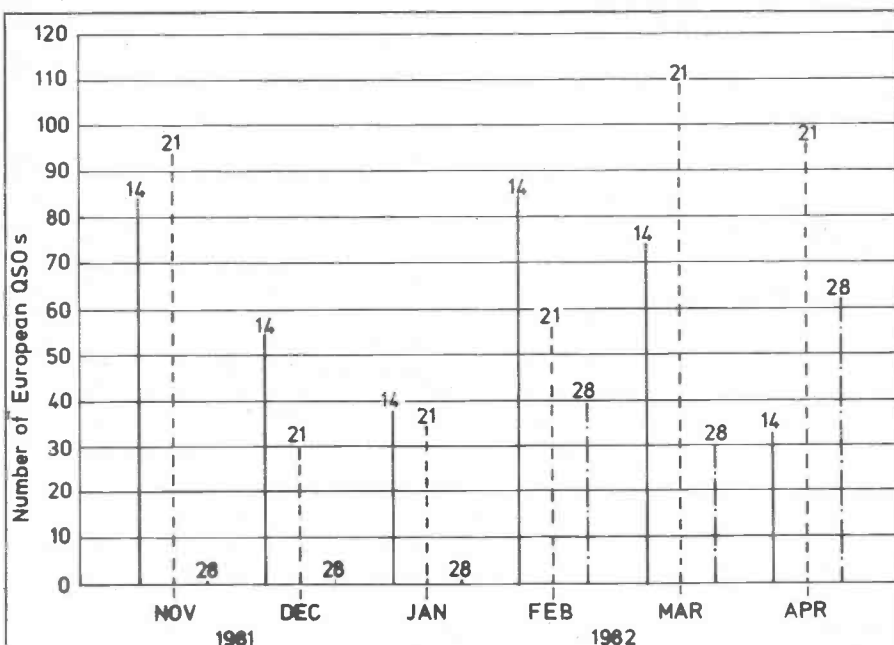


Fig. 1. European QSOs made on 14, 21 and 28MHz (CW) by CX5RV during November to April 1982 inclusive

Auto antenna switch for the FT102

By A.J. Oakley 5Z4DJ

All connections to the circuitry of the transceiver are made via existing plugs and sockets, and the new PCB can be removed at a later date without leaving any trace. The author fitted a

Circuit Description

1) **Principle:** One wafer of the BAND switch, together with the '+0.5' button, causes +8 volts to be

This modification enables the correct antenna to be automatically connected to the transceiver when changing bands, and is controlled by the BAND switch on the front panel. The whole system consists of a single PCB for mounting inside the transceiver, and an outboard relay box.

15 pin 'D' socket on the rear panel of the transceiver to allow simple inter-connection of the relay box, and this, of course, cannot be removed without leaving a hole in the back. However, for those that may be worried about resale value, it is possible to pass the inter-connecting multi-core cable through an existing hole in the rear panel, and terminate it in a cable-mounted socket.

Many other modern transceivers use a similar type of "logic" switching operated from the BAND switch, and these may be modified.

applied to one of 13 wires in a cable running between these switches, the 'Counter Unit' and the 'Local Unit', as the various bands and sub-bands are selected. This cable is terminated in 13 pin plugs which mate with 13 pin sockets on the appropriate PCB, the whole cable being 'series connected' between the boards. By introducing the new 'Relay Driver Unit' PCB in series with this cable, the logic signalling voltage may be tapped off for further processing.

2) **Relay Driver pcb:** The current available from the 8 volt logic is not

sufficient to drive the antenna change-over relays direct, and anyway the 8 volts used is unusual for relays of the type required. An Octal Darlington driver IC is used for the 8 lower bands, and a transistor is used for the 9th band. The input to this transistor is fed via a simple 4 input OR diode gate so that it responds to any of the 4 Ten Meter sub-bands. The 12 volts to drive the relays is taken from the 12 volt supply provided in the FT102 for such purposes.

3) **External Relay Box:** The original used 5 relays, distributed as follows:

- (i) 10, 15, 20 meters Tri-band beam
- (ii) 40, 80 meters Trap dipole
- (iii) 160 meters Loaded vertical
- (iv) 17, 30 meters Trap dipole
- (v) 12 meters Wire dipole

However, any combination of aerials may be used, and more (or less) relays fitted to suit the operator, but remember that you may wish to add extra aerials later and that each aerial requires one relay.

(Note that 5Z4 amateurs not yet allowed to operate on the 'new' bands, nor on top band).

Construction

1) **FT102 modification:** First fit the 15 pin 'D' socket on the rear panel. This is positioned horizontally, close under the RCA Jack Board on the right, looking at the back of the set. Mark out the outline of the hole for the socket, and the two mounting holes, before starting work. Remove the top cover of the transceiver (6 screws) and un-plug the loudspeaker leads. Remove the IF unit pcb. (6 screws, 13 multipin plugs and 4 coax plugs) Carefully re-position all the wires inside the rear panel in the vicinity of the new socket. There is plenty of slack, and they may be held clear by the use of self adhesive PVC tape. Place a postcard sized piece of card (an old QSL card) against the inside of the rear panel, and on top of the

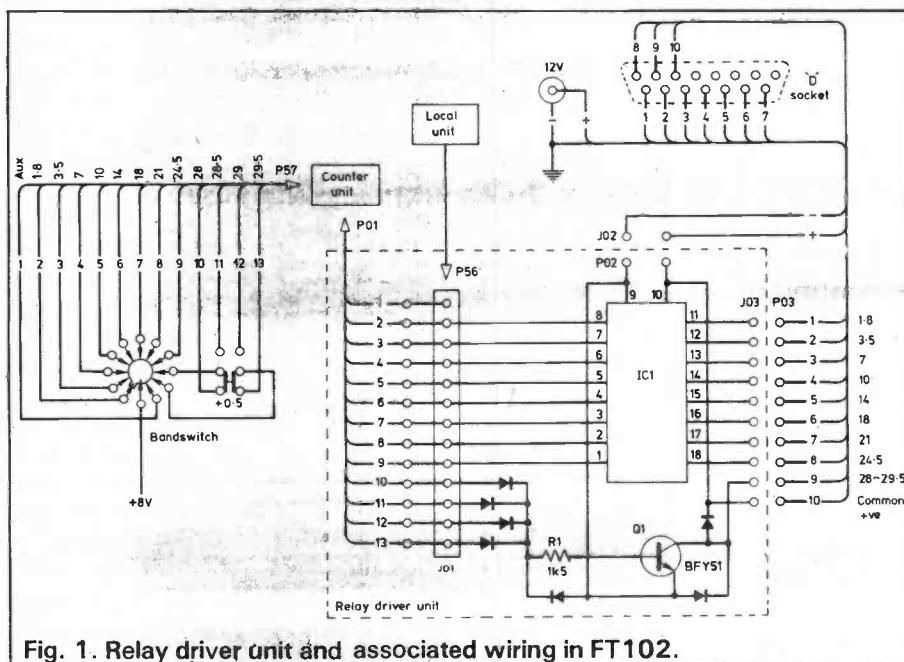


Fig. 1. Relay driver unit and associated wiring in FT102.

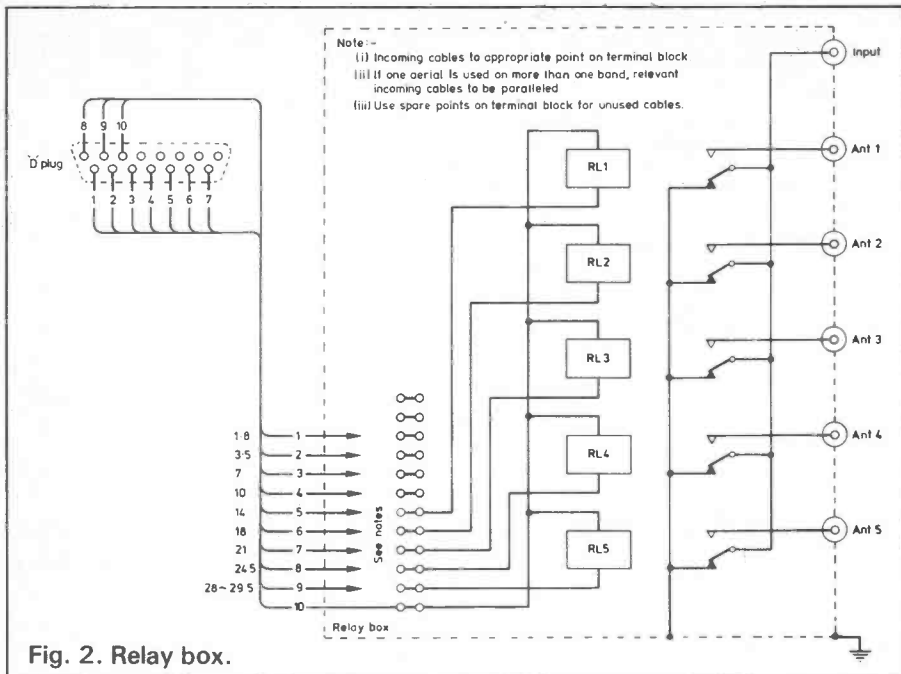


Fig. 2. Relay box.

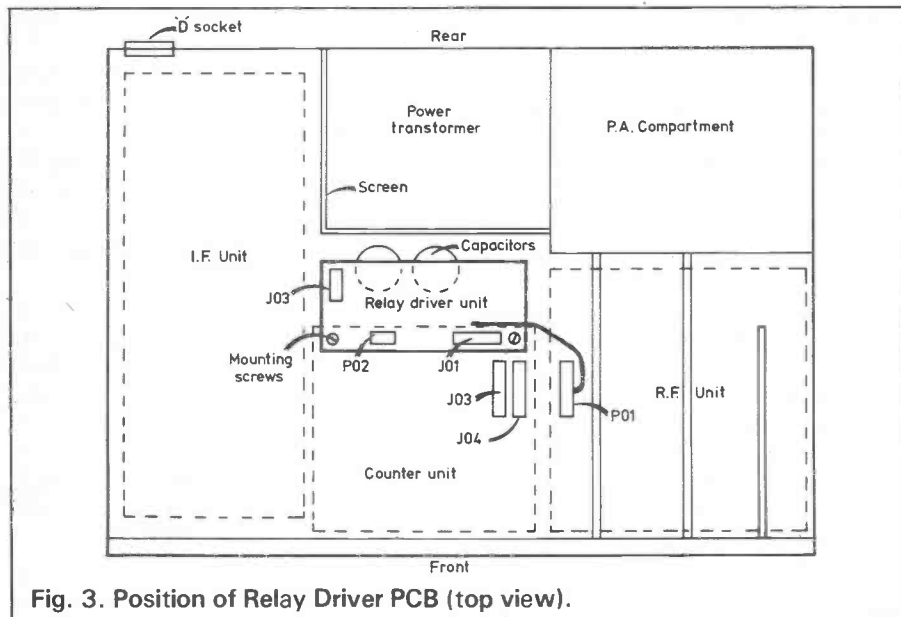


Fig. 3. Position of Relay Driver PCB (top view).

chassis. Bend up both edges, to make a shallow tray, and tape it securely to the rear panel and the inside of the side panel. This is to catch all the swarf and

filings, so ensuring that no gaps are left around the edges.

Now cut the holes in the rear panel. The metal is not very thick, and

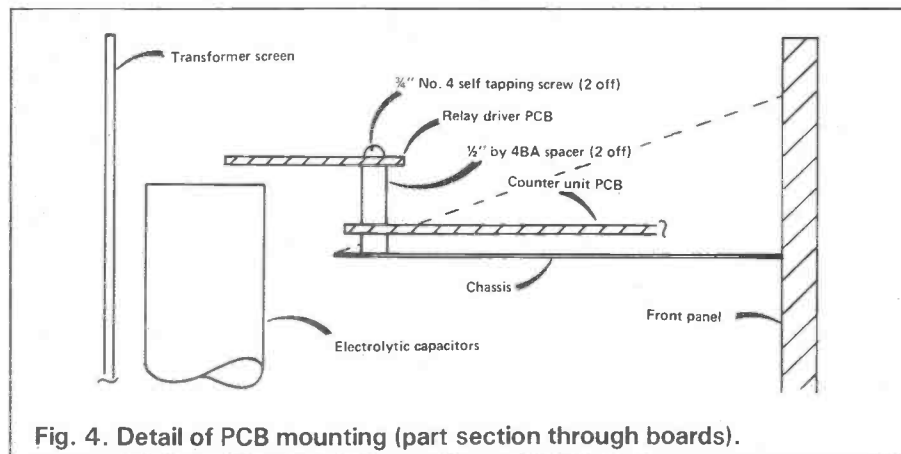


Fig. 4. Detail of PCB mounting (part section through boards).

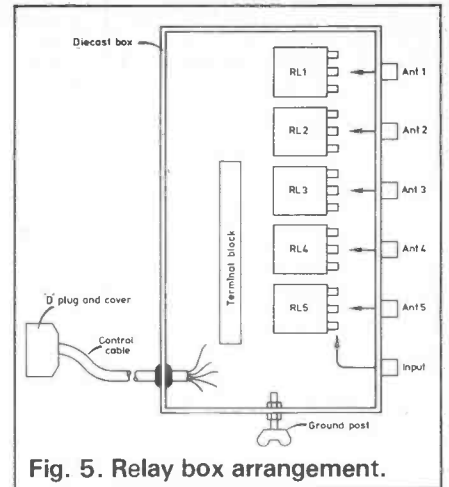


Fig. 5. Relay box arrangement.

works easily with drills and files, though the right chassis punch would make life very easy. Be careful not to puncture the card tray you have just fitted, and any tears or punctures should be immediately patched with a small piece of sticky tape. When satisfied with your handiwork, remove all burrs, and carefully remove the card tray without spilling any of its contents. (If you have not been able to contain all the filings, remove the bottom cover of the transceiver (8 screws), and blow them clear from between the local unit PCB and the chassis, and brush the whole set clean)

Wire up pins 1 to 10 (inclusive) of the socket before mounting it, using 300mm lengths of wire. (Colour-coded wires are essential here). Fit the socket, using two 4BA nuts and bolts. Next make up a pair of wires about 300mm long, and solder one to the centre tag of the 12V phono socket on the rear panel, and the other to the adjacent ground tag. Bunch all the cables together, either by lacing or

Bandswitch position	Pin No.														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1-8	1	0	0	0	0	0	0	0	0	C	X	X	X	X	X
3-5	0	1	0	0	0	0	0	0	0	C	X	X	X	X	X
7	0	0	1	0	0	0	0	0	0	C	X	X	X	X	X
10	0	0	0	1	0	0	0	0	0	C	X	X	X	X	X
14	0	0	0	0	1	0	0	0	0	C	X	X	X	X	X
18	0	0	0	0	0	1	0	0	0	C	X	X	X	X	X
21	0	0	0	0	0	0	1	0	0	C	X	X	X	X	X
24.5	0	0	0	0	0	0	0	1	0	C	X	X	X	X	X
28	0	0	0	0	0	0	0	0	1	C	X	X	X	X	X
28.5	0	0	0	0	0	0	0	0	0	1	C	X	X	X	X
29	0	0	0	0	0	0	0	0	0	1	C	X	X	X	X
29.5	0	0	0	0	0	0	0	0	0	1	C	X	X	X	X
Aux	0	0	0	0	0	0	0	0	0	C	X	X	X	X	X

Notes :-

- (i) Logic level measured between C (pin 10) and any other pin.
- (ii) Logic 0 < 0.5 volts
- (iii) Logic 1 > 10 volts
- (iv) X pins are not used
- (v) Current drive from logic 1, 200mA maximum

Table 1 Truth table for 15pin 'D' socket on rear panel.

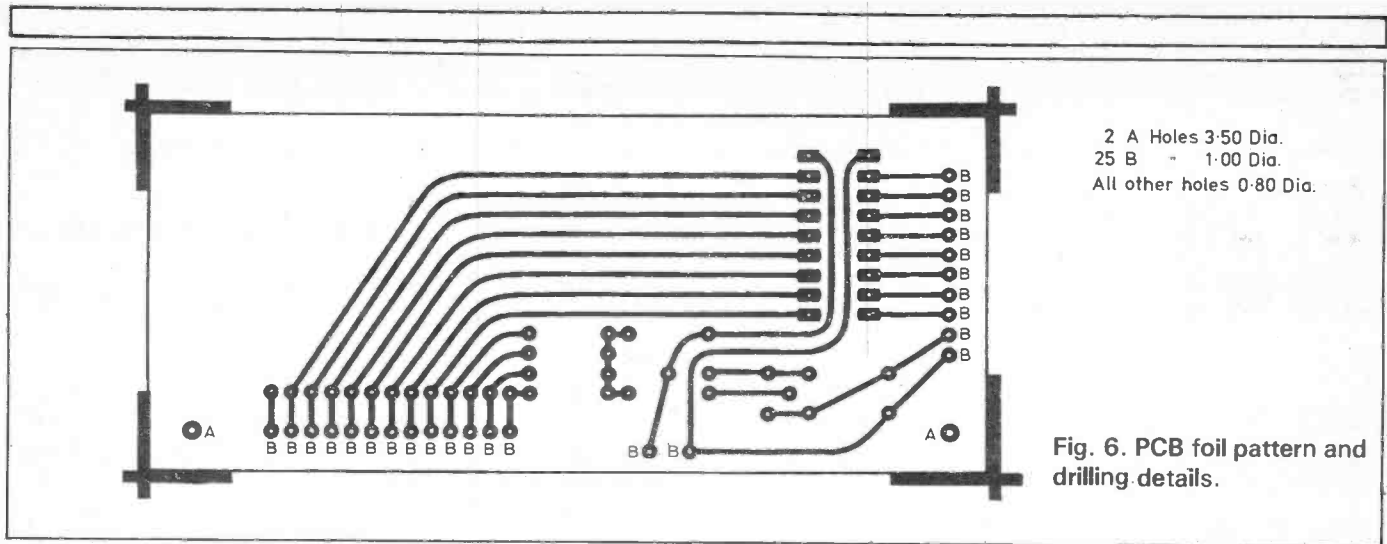


Fig. 6. PCB foil pattern and drilling details.

with small tie-wraps, and lead them towards the rear of the counter unit PCB.

Remove the temporary fastenings on the other cables around the rear panel, and replace them in their original positions. Replace the IF Unit PCB, securing all six screws, and replacing all the plugs. (If you get confused, each plug is marked with its number, and the illustration on page 45 of the Instruction Manual shows where they go).

Before continuing, have a last look round to make sure that no wires are trapped (or melted with your soldering iron!) and that all plugs are firmly in their correct place.

Make the new PCB using any of the usual techniques (sorry, but they are *not* available from the author). Fit all components, and solder up, being careful not to make any unwanted solder bridges. Remove the two mounting screws for the Counter Unit PCB nearest the rear of the set, and mount the new PCB (using two 3/4 inch long No. 6 self tapping screws and 1/2" long 4BA spacing pillars) above and to the rear of the Counter Unit PCB. These screws pass through the lower PCB into the original holes in the chassis.

Put the 10 pin connector onto the 10 wires from the D socket, and the 2 pin connector onto the two wires from the 12V phono socket, trimming the wires to a convenient length (not too short, or they will tend to be pulled off). Unplug P56 from J03 on the Counter Unit PCB, and plug P56 into J01 on the new board. Plug P01 from the new board into J03 on the Counter Unit PCB. Plug the other two connectors into the new PCB.

Take a final look round before replacing the top cover, and check out that all is well. The truth table for the 15

pin D socket is shown in **Table 1**, and the voltage should be at least 11 volts when a 100Ω resistor is connected between any 'active' pin and common. Replace the top cover (6 screws) and place the transceiver on the air to check that you haven't inadvertently disturbed something.

2) **Relay Box:** Mark out and drill the holes for the 6 coax sockets along one side of the box, avoiding any internal webs. Also drill holes for the control cable and ground post. Mark out and drill the holes for the 5 relays, so that the solder tags on the relay ends are about 30mm from their respective coax socket. Mount the 12 way terminal block in the bottom of the box, and drill holes for mounting the completed box if necessary.

Mount all components securely. Wire up the coils of the relays first, using colour-coded flex cable for identification. Next wire up the RF circuits, using 16 swg tinned copper wire. Do not omit the grounding wire on the Normally Closed contacts, as this is a useful feature that not only grounds all unused aerials, but grounds ALL aerials when the transceiver is switched off.

Make up the necessary length of interconnecting cable with a 15 pin D plug at one end. Pass the other end through a grommet in the hole drilled in the side of the box, and make off the ends for connection into the terminal block. One or more wires from this cable may be connected in parallel to operate any one relay, depending on the band selected, so that a relay may be activated on more than one band. Changes to the selection used may be made at any time by re-positioning the wires on the terminal block.

Finally, make a note of your arrangement, and sellotape it to the inside of the lid before closing the box.

The ground post on the Relay Box should be connected to the station earth.

Use

To make use of this new facility, a piece of coax is connected between the AERIAL socket on the transceiver and the INPUT socket on the relay box. Each of your aerials is then connected to its appropriate socket on the relay box. Now, as you change from band to band, using the BAND switch on the FT102, the relay box will select the correct aerial for you. However, don't forget to re-tune your transceiver PA stage!

The author has the relay box mounted on the shack wall, close to where the aerial feeders enter the shack. However, there is no reason why the relay box couldn't be made watertight, and mounted on top of a mast, so that the whole aerial system is fed with only one feeder. However, each relay draws about 100mA, and the suggested multicore cable is rather fine (0.055mm²) for long runs, having a resistance of about 1 ohm per 10 ft. Because two wires are used for each relay (supply and return), the effective resistance is 2 ohms per 10 ft. The relays will operate satisfactorily down to 10 volts, and this limits the total acceptable line resistance to 20 ohms maximum, or say 100 ft of cable. For longer cable runs a heavier cable is needed. A 12 core, 0.22mm² cable is a standard product, and this would allow cable runs of up to 350 ft, or the next size up (0.5mm²) would allow cable runs of up to 800 ft, surely enough for the most extensive aerial farm!

Due to lack of space, the PCB overlay and components list have been held over until next month.

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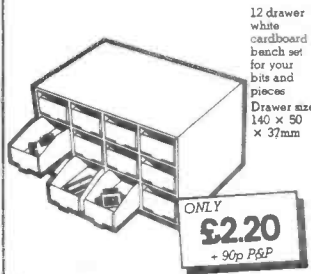
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Beeware	IFC
B.N.R&E.S.	57
Booth Holdings	57
Greatch Electronics Ltd.	57
Holdings photo Audio	24
Leicester A.M. Radio Show	OBC
M.E.T. Antenna's	IFC
P.M. Components	IBC
S.M.C.	30,31
Wood & Douglas	24
W.P.O. Communications	42
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