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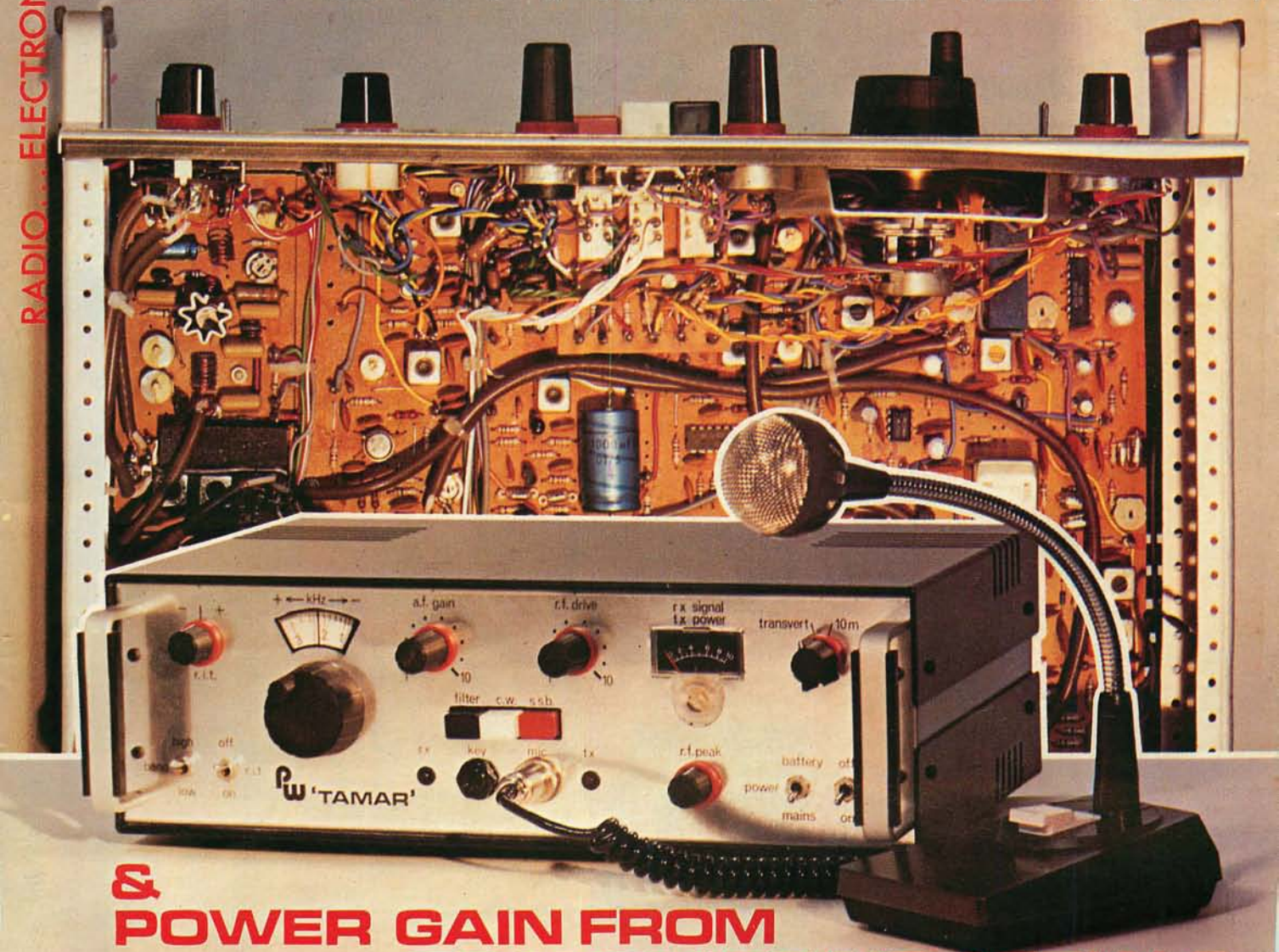

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AUGUST 1980
VOLUME 56
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While we will always try to assist readers in difficulties with a *Practical Wireless* project, we cannot offer advice on modifications to our designs, nor on commercial radio, TV or electronic equipment. Please address your letters to the Editor, *Practical Wireless,* at the above address, giving a clear description of the problem and enclosing a stamped self-addressed envelope. Only one project per letter please.

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Our September issue will be published about 1 August
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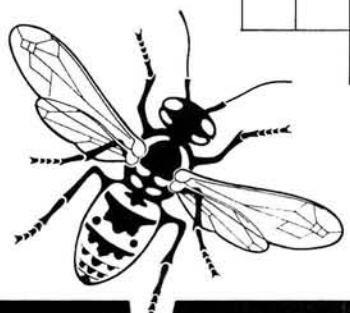

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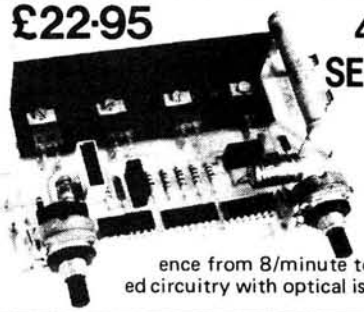

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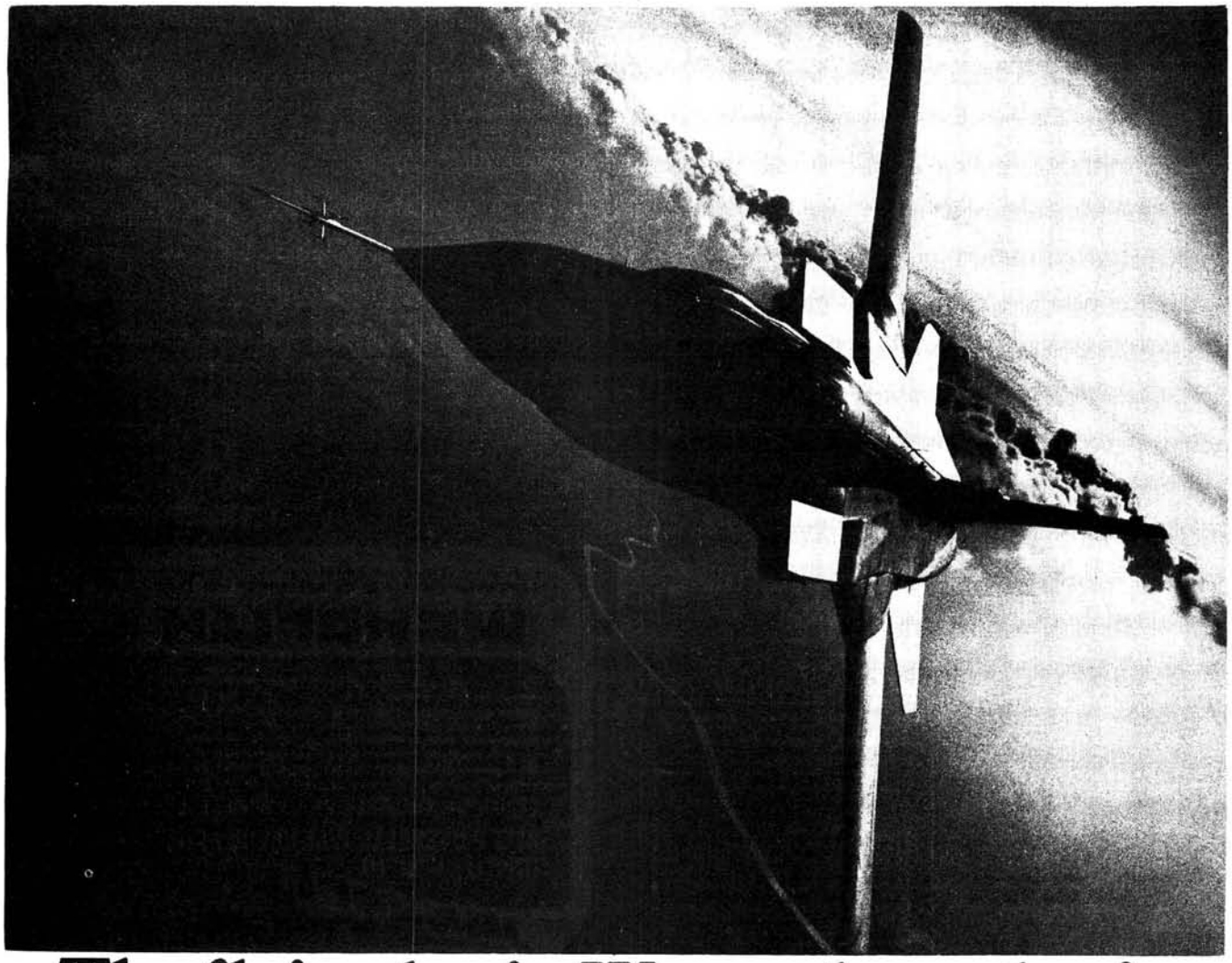

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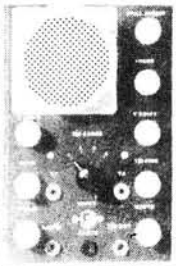

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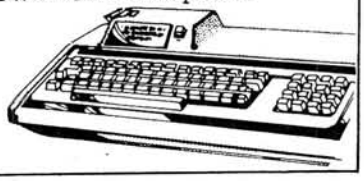

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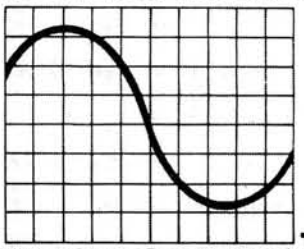

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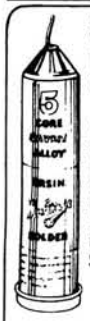

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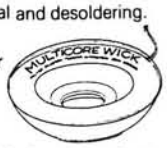

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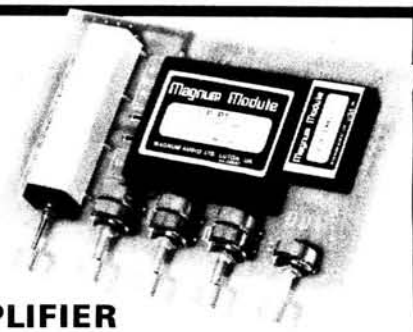

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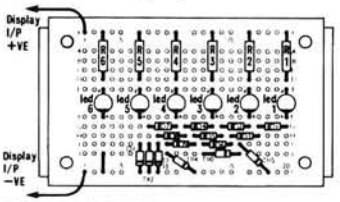

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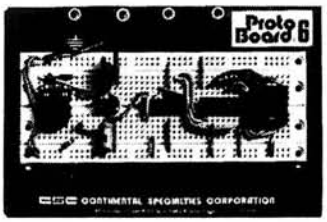

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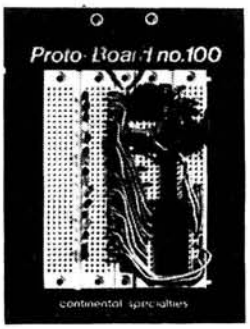

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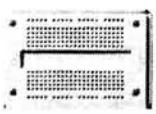

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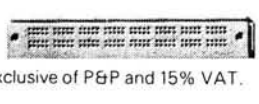

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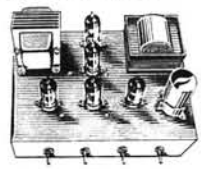

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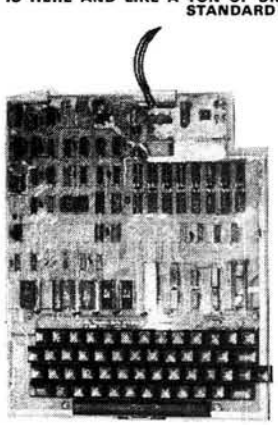

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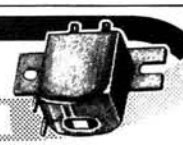

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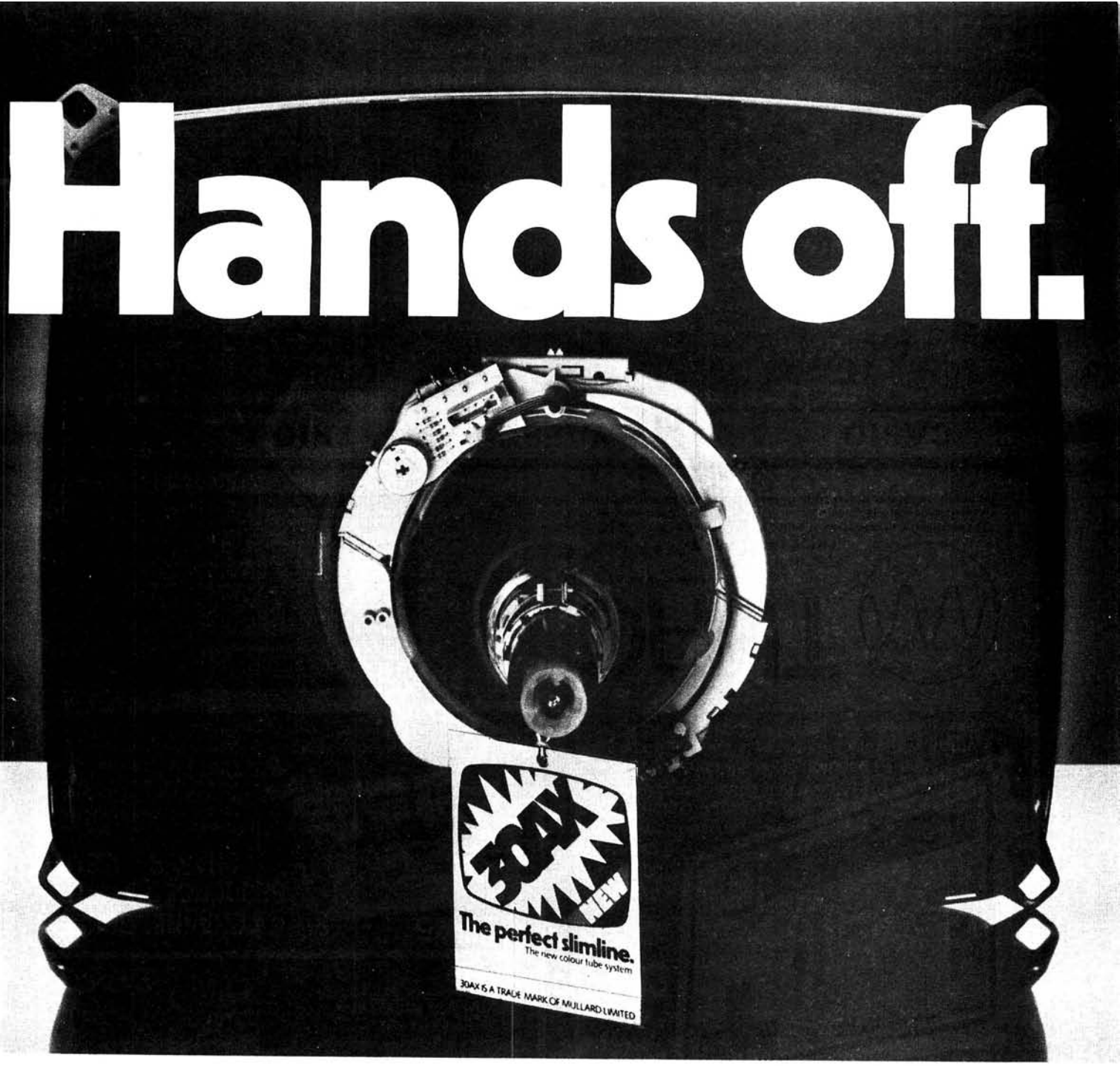

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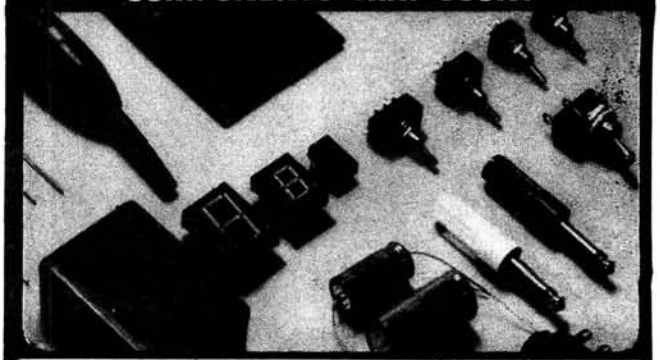

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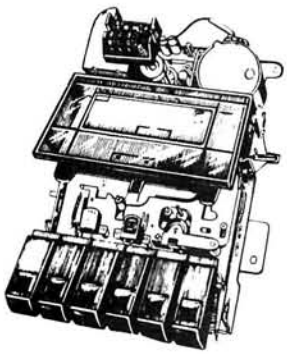

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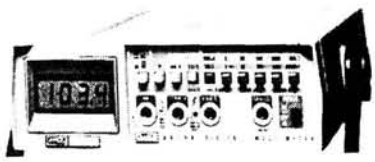

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The 8010A is a general purpose, bench/portable digital multimeter with more functions and features than ever offered for such a low price. Its companion, the 8012A, has identical characteristics except that it has two additional low resistance ranges, 2Ω and 20Ω to replace the 8010A's 10 ampere current range.

The 8010A and 8012A feature:
10 voltage ranges from 200mv-1000v dc, 200mv-75v ac.
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6 resistance ranges from 200Ω-20mΩ – the 8012A has two additional resistance ranges 2Ω and 20Ω.
10 current ranges from 200μA-2A AC/DC – the 8010A has two additional current ranges 10A AC and 10A DC.

8010A **£159** 8012A **£199**

Carriage and Insurance £3.

The 8010A is also available with two rechargeable Nicad size C batteries installed in option –01 a+ **£179.00.**

TMK500 MULTITESTER 30,000 OPV

A sturdy and reliable instrument. Has internal buzzer. AC volts: 0 to 2.5, 10, 25, 100, 250, 500, 1000.
DC volts: 0 to 0.25, 1, 2.5, 10, 25, 100, 250, 1000. DC current: 0 to 50 ua, 5 ma, 50 ma, 12 amp.
Resistance: 0 to 6K, 6 meg, 60 meg.
Decibels: –20 to +56 db.
Short test: Internal buzzer.
Size: 160x110x55 mm.

£20.50 P&P 75p

CHROME DIOXDE CASSETTES

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You've seen the reviews... you've heard the excitement... now make the kit!

This is the ZX80. 'Personal Computer World' gave it 5 stars for 'excellent value.' Benchmark tests say it's faster than all previous personal computers. And the response from kit enthusiasts has been tremendous.

To help you appreciate its value, the price is shown above with and without VAT. This is so you can compare the ZX80 with competitive kits that don't appear with inclusive prices.

'Excellent value' indeed!

For just £79.95 (*including* VAT and p&p) you get everything you need to build a personal computer at home... PCB, with IC sockets for all ICs; case; leads for direct connection to a cassette recorder and television (black and white or colour); *everything*!

Yet the ZX80 really is a complete, powerful, full-facility computer, matching or surpassing other personal computers at several times the price.

The ZX80 is programmed in BASIC, and you can use it to do quite literally anything from playing chess to managing a business.

The ZX80 is pleasantly straightforward to assemble, using a fine-tipped soldering iron. It immediately proves what a good job you've done: connect it to your TV... link it to an appropriate power source *... and you're ready to go.

Your ZX80 kit contains...
- Printed circuit board, with IC sockets for all ICs.
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- Leads and plugs for connection to domestic TV and cassette recorder. (Programs can be SAVEd and LOADed on to a portable cassette recorder.)
- FREE course in BASIC programming and user manual.

Optional extras
- Mains adaptor of 600 mA at 9 V DC nominal unregulated (available separately – see coupon).
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*Use a 600 mA at 9 V DC nominal unregulated mains adaptor. Available from Sinclair if desired (see coupon).

The unique and valuable components of the Sinclair ZX80.

The Sinclair ZX80 is not just another personal computer. Quite apart from its exceptionally low price, the ZX80 has two uniquely advanced components: the Sinclair BASIC interpreter; and the Sinclair teach-yourself BASIC manual.

The unique Sinclair BASIC interpreter offers remarkable programming advantages:
- **Unique 'one-touch' key word entry: the ZX80 eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry.**
- Unique syntax check. Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately. This prevents entry of long and complicated programs with faults only discovered when you try to run them.
- Excellent string-handling capability – takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison). The ZX80 also has string input-to request a line of text when necessary. Strings do *not* need to be dimensioned.
- Up to 26 single dimension arrays.
- FOR/NEXT loops nested up to 26.
- Variable names of any length.
- BASIC language also handles full Boolean arithmetic, conditional expressions, etc.
- Exceptionally powerful edit facilities, allows modification of existing program lines.
- Randomise function, useful for games and secret codes, as well as more serious applications.
- Timer under program control.
- PEEK and POKE enable entry of machine code instructions, USR causes jump to a user's machine language sub-routine.
- High-resolution graphics with 22 standard graphic symbols.
- All characters printable in reverse under program control.
- Lines of unlimited length.

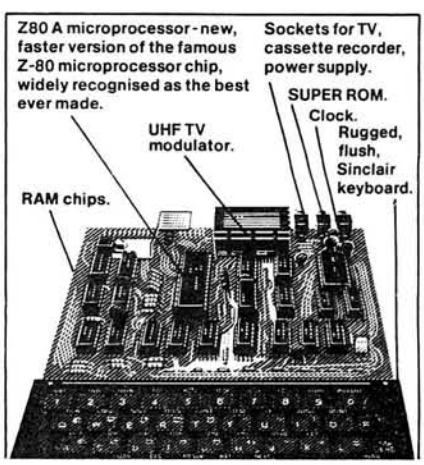
Fewer chips, compact design, volume production – more power per pound!

The ZX80 owes its remarkable low price to its remarkable design: the whole system is packed on to fewer, newer, more powerful and advanced LSI chips. A single SUPER ROM, for instance, contains the BASIC interpreter, the character set, operating system, and monitor. And the ZX80's 1K byte RAM is roughly equivalent to 4K bytes in a conventional computer – typically storing 100 lines of BASIC. (Key words occupy only a single byte.)

The display shows 32 characters by 24 lines.

And Benchmark tests show that the ZX80 is faster than all other personal computers.

No other personal computer offers this unique combination of high capability and low price.



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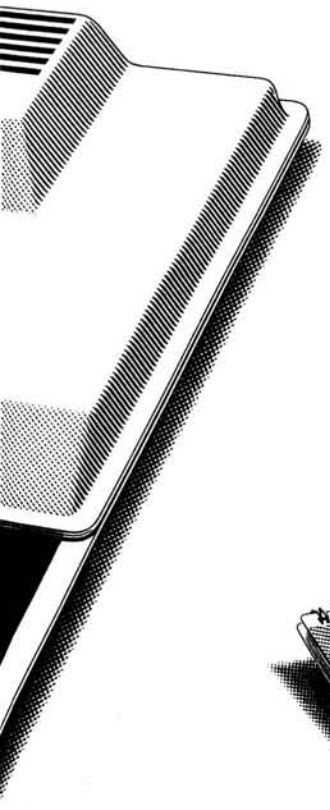
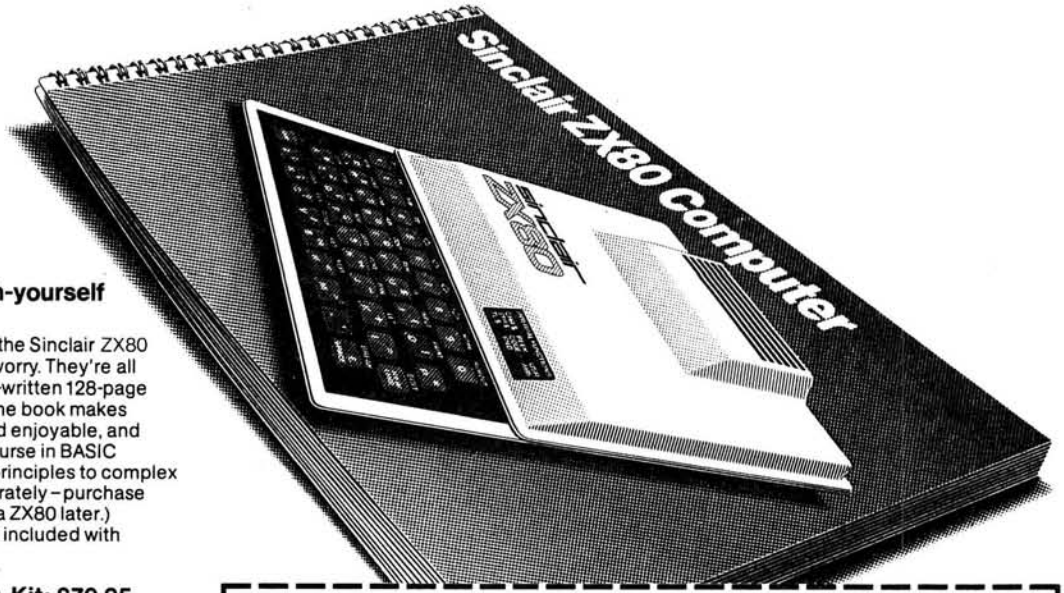


ZX80 software – now available!

See the advertisements in Personal Computer World (June) and Electronics Today International (July).

New dedicated software – developed independently of Science of Cambridge – reflects the enormous interest in the ZX80. More software available soon – from leading consultancies and software houses.



The Sinclair teach-yourself BASIC manual.

If the specifications of the Sinclair ZX80 mean little to you – don't worry. They're all explained in the specially-written 128-page book *free* with every kit! The book makes learning easy, exciting and enjoyable, and represents a complete course in BASIC programming – from first principles to complex programs. (Available separately – purchase price refunded if you buy a ZX80 later.) A hardware manual is also included with every kit.

The Sinclair ZX80. Kit: £79.95. Assembled: £99.95. Complete!

The ZX80 kit costs a mere £79.95. Can't wait to have a ZX80 up and running? No problem! It's also available, ready assembled, for only £99.95.

Demand for the ZX80 is very high: use the coupon to order today for the earliest possible delivery. All orders will be despatched in strict rotation. We'll acknowledge each order by return, and tell you exactly when your ZX80 will be delivered. If you choose not to wait, you can cancel your order immediately, and your money will be refunded at once. Again, of course, you may return your ZX80 as received within 14 days for a full refund. We want you to be satisfied beyond all doubt – and we have no doubt that you will be.

sinclair ZX80

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	Ready-assembled Sinclair ZX80 Personal Computer(s). Price includes ZX80 BASIC manual, excludes mains adaptor.	£99.95	
	Mains Adaptor(s) (600 mA at 9 V DC nominal unregulated).	8.95	
	Memory Expansion Board(s) (each one takes up to 3K bytes).	12.00	
	RAM Memory chips – standard 1K bytes capacity.	16.00	
	Sinclair ZX80 Manual(s) (manual free with every ZX80 kit or ready-made computer).	5.00	
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*EASY TO BUILD *5 PUSH BUTTON TUNING *MODERN STYLING DESIGN *ALL NEW UNUSED COMPONENTS *6 WATT OUTPUT *READY ETCHED & PUNCHED P.C.B. *INCORPORATES SUPPRESSION CIRCUITS

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The P.E. Traveller features pre-set tuning with five push button options, black illuminated tuning scale, with matching rotary control knobs, one, combining on/off volume and tone-control, the other for manual tuning, each set on wood simulated fascia.
The P.E. Traveller has a 6 watts output, negative ground and incorporates an integrated circuit output stage, a Mullard IF module LP1181 ceramic filter type, pre-aligned and assembled and a Bird pre-aligned push button tuning unit.
The P.E. Traveller fits easily in or under dashboards.
Complete with instructions.

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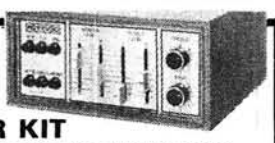
NEW 12+12 AMPLIFIER KIT

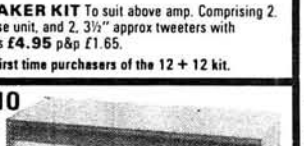


An opportunity to build your own 12 watts per channel stereo amplifier with up-to-the-minute features. To complete you just supply screws, connecting wire and solder. Features include din input sockets for ceramic cartridge, microphone, tape or tuner. Outputs—tape, speakers and headphones. By the press of a button it transforms into a 24 watt mono disco amplifier with twin deck mixing. The kit incorporates a Mullard LP1183 pre-amp module, plus 2 power amplifier assembly kits. Also featured 4 slider level controls, rotary bass and treble controls and 6 push button switches. Silver finish fascia panel with matching knobs. Easy to assemble teak simulate cabinet and ready made metal work. For further information instructions are available price 50p. Free
Size 9¼" x 8¾" x 4" approx. with kit **£13.95**
NOTE: for use with 4 to 8 ohms speakers. p&p £2.55

TWO WAY SPEAKER KIT To suit above amp. Comprising 2. 8" approx Phillips base unit, and 2, 3½" approx tweeters with 2 crossover capacitors **£4.95** p&p £1.65.
Available only to first time purchasers of the 12 + 12 kit.

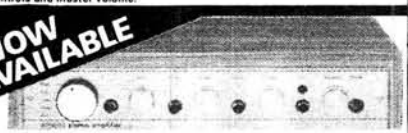
50 WATT MONO DISCO AMP £30.60

p&p £3.20



Size approx 13¾" x 5¼" x 6¾"
50 watts rms. 100 watts peak output. Big features include two disc inputs, both for ceramic cartridges, tape input and microphone input. Level mixing controls fitted with integral push-pull switches. Independent bass and treble controls and master volume.

NOW AVAILABLE



30 + 30 WATT STEREO AMPLIFIER

Viscount IV unit in teak simulate cabinet Silver finish rotary controls and pushbuttons with matching fascia, red mains indicator and stereo jack socket Functions switch for mic magnetic and crystal pickups, tape tuner and auxiliary Rear panel features fuse holder. DIN speaker and input socket 30 + 30 watts RMS 60 + 60 watts peak for use with 4 to 8 ohm speakers.
Size 14¾" x 3" x 10" approx.
BUILT AND READY TO PLAY p&p £3.30 **£32.90**

Mullard AUDIO MODULES IN BARGAIN PACKS

ACCESSORIES ARE ONLY AVAILABLE TO THOSE CUSTOMERS WHEN BUYING OUR BARGAIN PACKS

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1 PACK 1 2 x LP1173 10w RMS output power audio amp modules, + 1 LP1182/2 Stereo pre amp for ceramic and auxiliary input
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2 PACK 2 2 x LP1173 10w RMS output power audio amp modules + 1 LP1184/2 Stereo pre amp for magnetic, ceramic and auxiliary inputs.
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ACCESSORIES Suitable mains power supply parts, consisting of mains transformer, bridge rectifier, smoothing capacitor and set of rotary stereo controls for treble, bass, volume and balance. **£3.00** plus p&p £1.60

Two Way Speaker Kit Comprising of two 8" x 5" approx. 4 ohm bass and two 3½" 15 ohm mid-range tweeter with two cross-over capacitors.
Per stereo pair plus p&p £1.70 **£4.05**

RTVC

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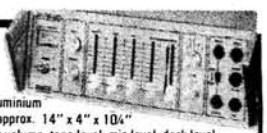
£76.00 p&p £4.00 100 WATT MONO DISCO AMP



Brushed aluminium fascia and rotary controls. Size approx. 14" x 4" x 10¼"
Five vertical slide controls, master volume, tape level, mic level, deck level, PLUS INTER DECK FADER for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre fade level control (PFL) lets YOU hear next disc before fading it in. VU meter monitors output level. Output 100 watts RMS 200 watts peak.

EMI SPEAKER BARGAIN

Stereo pair 350 kit System consists of 13" x 8" approx woofer with rolled surround. 3½" Goodman tweeter crossover components and circuit diagram Frequency response 20 Hz to 20 KHz Power handling 15 watts RMS 20 watts max
8 ohm impedance
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Per stereo pair
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BSR P200 £25.50

Belt drive chassis turntable unit semi-automatic, cueing device. p&p £3.00
Shure M75 6 Magnetic Cartridge to suit. **£7.95**

BSR Manual single play record deck with auto return and cueing lever. fitted with stereo ceramic cartridge 2 speeds with 45 r p m spindle adaptor ideally suited for home or disco use
OUR PRICE **£12.25** p&p £2.75

PHILLIPS RECORD PLAYER DECK GC037

HiFi record player deck, belt drive complete with GP401 magnetic cartridge—LIMITED STOCK. **£27.50** complete.
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EDITORIAL OFFICES
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Telephone: Poole 71191

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Nice to be Back...

I KNOW that our usual practice of putting out each issue of *Practical Wireless* during the month before the cover date confuses some readers, but I think that we shall be causing even more consternation this year, because there won't be an issue dated July. Add to this the fact that the June issue actually appeared in June, and I think that everyone will be confused, including ourselves!

All of this was not done by design, of course, but was the result of two separate and unrelated industrial disputes affecting production of *Practical Wireless,* and of many other magazines as well. Now that things are returning to normal, I'd like to apologise to all our readers, and to our advertisers, for the late publication of our June issue, and for the non-appearance of July. Apologies are also due to all the newsagents who handle *PW* each month, and who've had to face daily enquiries from frustrated readers as to when the next issue was likely to appear.

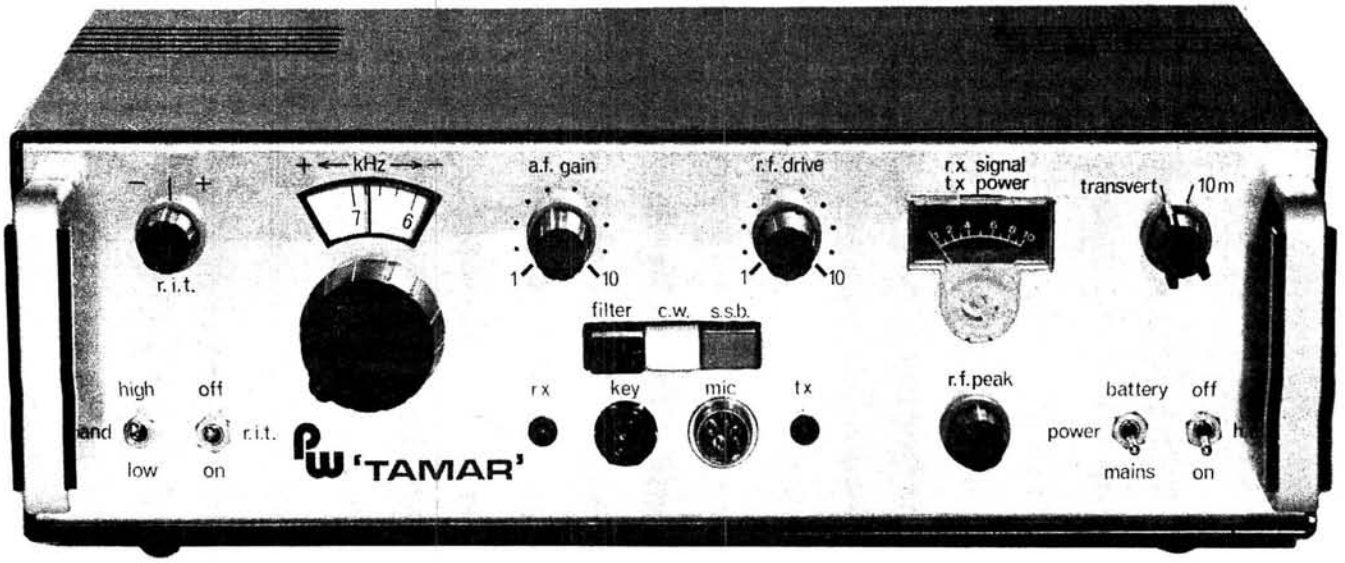
An unfortunate side-effect of our recent problems is that we're probably going to have to re-schedule some of the features which we had planned for our autumn issues. I hope that those readers who talked to us about forthcoming projects at the RSGB Exhibition at Alexandra Palace in May will bear with us for a month or two if their particular interest is delayed.

It was great to meet so many of our readers at Ally Pally, and to find out what they want to see in *PW.* Watching the visitors to the show, it was pretty obvious that there is no shortage of young recruits to the hobby of amateur radio, though there weren't too many YLs among them. On the Monday following the show, the May 1980 Radio Amateurs' Examination was due to take place, and there were several entrants dashing around the stands looking for last-minute aids to revision! Quite a few of them bought copies of the reprint of our series *So You Want to Pass the RAE?,* still acknowledged to be about the most easily understood text on the subject. If you're working towards the December exam, why not send for a copy (85p including post and packing) to IPC Magazines Ltd., Post Sales Department, Lavington House, 25 Lavington Street, London SE1 0PF.

Out of Thin Air, our guide to aerials and propagation, now seems to have sold out in most newsagents. If you haven't been able to get your copy, these too are available from Post Sales, price £1.50 including post and packing to UK addresses, or £1.80 by surface mail overseas. *Out of Thin Air* is a collection of articles that have appeared in *PW* over the past three years, plus two new, previously unpublished items. Oh yes, before I forget, cheques and postal orders payable to IPC Magazines Ltd., please, and with your name and address on the back.

Well, that's finished the commercial! Now to business. As I said, its nice to be back.

Geoff Arnold



PW 'TAMAR' Part 1

28 MHz TRANSVERTER DRIVER

R. S. HEWES FSERT G3TDR

Readers who intend to operate the *PW* Tamar should be in possession of the appropriate licence issued by the Home Office to those who have passed the City and Guilds Radio Amateurs' Examination. Details may be obtained from: The Home Office, Radio Regulatory Department, Amateur Licensing Section, Waterloo Bridge House, Waterloo Road, London SE1 8UA.

The design of this transceiver originated in 1976 principally as a prime mover for transverters requiring receive and transmit frequencies of 28 to 30MHz. The transceiver output of 2 watts p.e.p. is sufficient to drive both valve and transistor linear power amplifiers for 10 metre band operation. This design operates from a.c. mains or from a 12 volt car battery, using a built in, transformer-less, d.c.-to-d.c. invertor for mobile operation. A dual voltage stabiliser is also included in the internal p.s.u.

In the basic design it was decided to dispense, as far as possible, with air dielectric tuning capacitors, with their mechanical mounting problems and substitute varicap diodes for tuning the receiver, v.f.o. and pre-mixer outputs. As varicap diodes become varactors in the true sense of being frequency multipliers even when low r.f. power is applied across them, a miniature, twin-gang air dielectric tuning capacitor is used to tune the transmitter mixer and class A amplifier stages.

Full frequency coverage of the 10 metre band is obtained in two 1MHz segments, i.e., 28–29MHz and 29–30MHz. The power stage of the transmitter section, which employs a 2N4427 transistor designed for linear class B s.s.b. and c.w. operation, is pre-tuned to cover 28–30MHz with minimum power loss at the band edges. Readily available, consumer type semiconductors and integrated circuits are used in receiver, exciter, v.f.o., pre-mixer and crystal oscillators. The well-known and versatile MC1496 i.c. is used in the balanced modulator, pre-mixer, product detector and transmit mixer stages.

The transceiver design is based on the single conversion superhet principle using an i.f. of 9MHz. The frequencies of the v.f.o. and the b.c.o. (band control oscillator), to operate the pre-mixer and tune the pre-mixer output frequency, are chosen to minimise the generation of unwanted spurious frequencies. This principle considerably reduces the chance of "birdies" on receive and the emission of in-band and out-of-band spurious transmissions. A block diagram of the complete transceiver is shown in Fig. 1 and the full transceiver specification is also shown. The receiver section is dealt with first in some detail and the circuit diagram is shown in Figs. 2 and 3.

The R.F. Amplifier

Signals are routed to the aerial tuned circuit, L2, via the transmit/receive relay and the coupling winding L1. Tuning is accomplished by D1, a BB104, in conjunction with padding capacitor C4.

The amplifier stage gain is limited by a tapping on L2 tuned winding to feed gate 1 of Tr1, a 40822 dual-gate MOSFET. Amplified signals appearing at the drain of Tr1 due to RFC1 are routed to tuned circuit L3 via C10. Coil L3 is tuned by D2 in conjunction with C11, padding capacitors C4 and C11 being necessary to restrict the tuned frequency range of L2 and L3 to 28–30MHz.

Resistors R3 and R9 provide the necessary d.c. return path for the "top" diode in each varicap as C4 and C11 block this path through the tuned inductors. Trimmers VC3 and VC4, in conjunction with the dust cores in L2 and L3, preset the frequency coverage. The d.c. control voltage for the varicap diodes is applied via R4 and R10 with C3 and C13 providing additional shunt capacity across L2 and L3.

The Mixer

Signals transferred from L3 to L4 are routed to gate 1 of the dual-gate MOSFET mixer Tr3, a 40823. The impedance of L4 is very low at the i.f. of 9MHz, thus giving considerable rejection to signals present at or near the i.f. The local oscillator voltage from the pre-mixer output (19–21MHz), is applied to gate 2 of the mixer. This local oscillator input mixes with the r.f. signals in Tr3, the resultant difference signal being present across T1 primary which is resonated by C16. The i.f. signal is coupled to T2 secondary, tuned by C20, via link windings and C19 to CF1 via C83, switching diode D10 and C82.

The S.S.B. Filter

This filter, CF1, employs six crystals which give 6dB and 60dB bandwidths of 2·4kHz and 4·6kHz, respectively, and a shape factor of 1·9 to 1. The stop band attenuation is 70dB and the passband ripple a maximum of 1dB with an insertion loss of 3dB maximum. The filter has equal input and output impedances of 500Ω and may be used in a bi-lateral mode, thus providing the necessary selectivity characteristics for optimum attenuation of unwanted adjacent channel signals. Resistors R78 and R81 provide the required termination for the filter, in parallel with the associated source and load impedances.

Delayed A.G.C. Amplifier

The i.f. signals present across R81, are routed via C24 and C84 to the base of transistor Tr4, a BF240, the delayed a.g.c. i.f. amplifier. The stage gain is designed to overcome the insertion loss of the filter and to provide a signal level sufficient to drive the delayed a.g.c. diode, D7, a 1N60 and d.c. amplifier Tr2, a BC239. Transistor Tr2 is non-conductive with signal levels of less than 500μV.

★ specification

GENERAL

Frequency range:	28–30MHz
Modulation:	A1 (c.w.), A3J (s.s.b.)
Supply:	14V nominal, 240V a.c. via mains p.s.u.
Current consumption:	400mA maximum
Dimensions:	345 x 200 x 110mm
Weight:	Approximately 1·5kg

TRANSMITTER

Output power:	2W p.e.p.
Output impedance:	50Ω
Spurious radiation:	Better than −40dB relative to 2W p.e.p.
Variable frequency oscillator:	Mixer type
Dynamic audio compression range:	50dB change in input for 3dB change in output

RECEIVER

Intermediate frequency:	9MHz
Sensitivity for 1μV input:	26B signal-to-noise (s.s.b.) 36dB signal-to-noise (c.w.)
Selectivity:	±2·4kHz (−6dB) ±4·6kHz (−60dB)
Shape factor:	1·9
Audio output power:	2W into 8Ω at 1kHz
Total harmonic distortion:	10 per cent at 2W output
Input impedance:	50Ω
Automatic gain control characteristic for 3dB change in output:	100dB change in input (s.s.b.) 110dB change in input (c.w.)

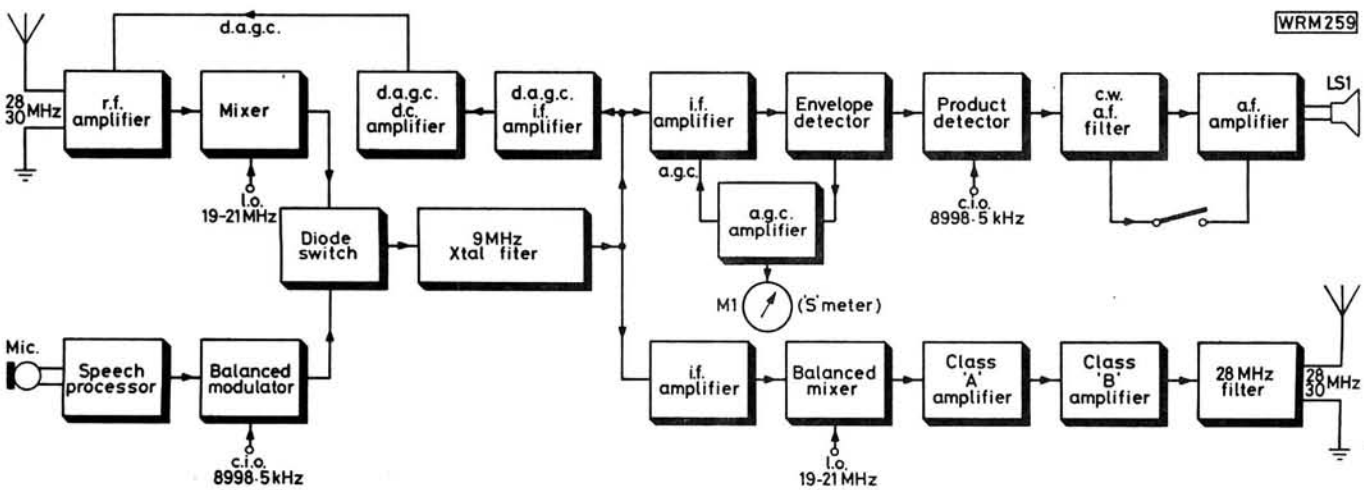
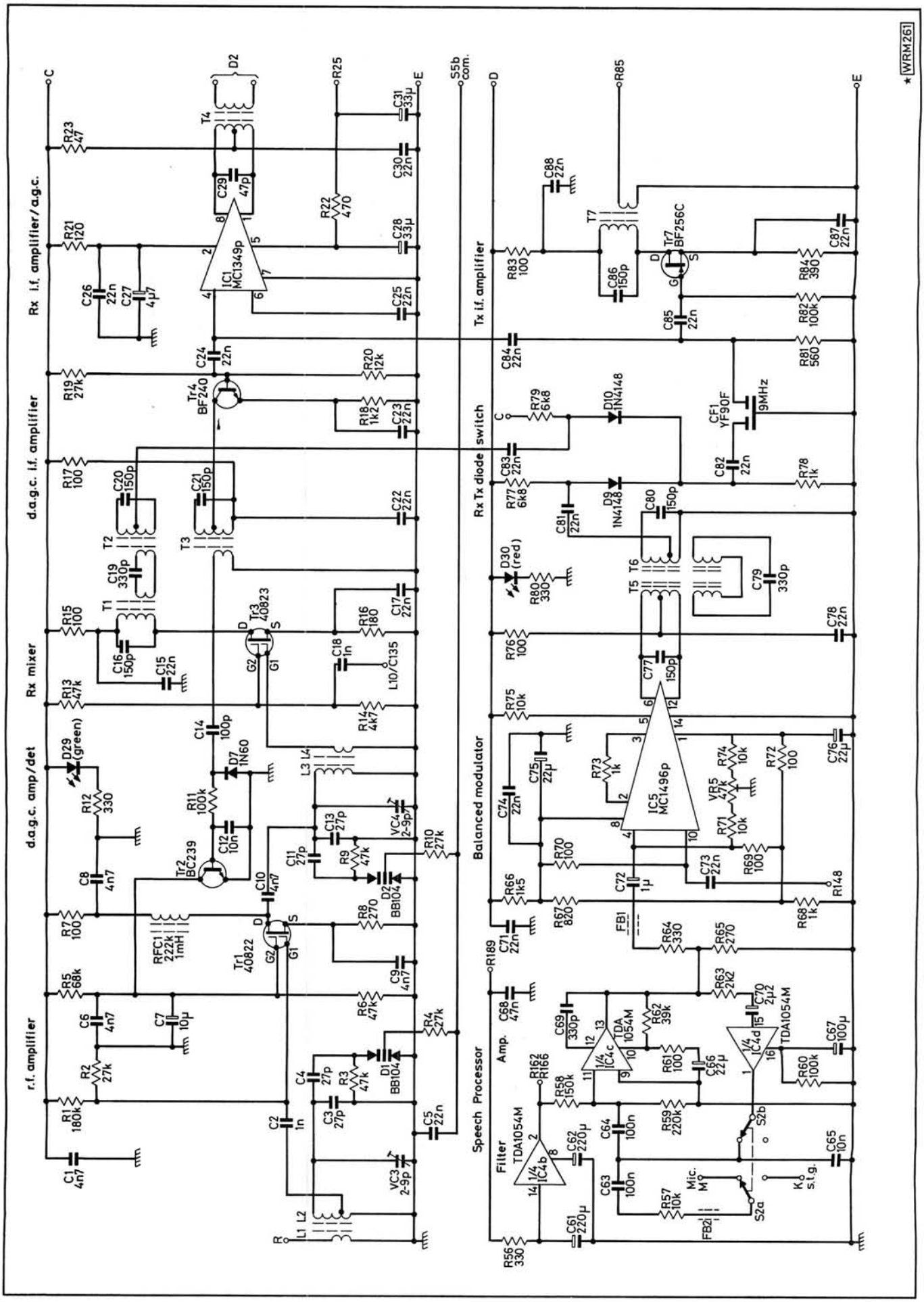
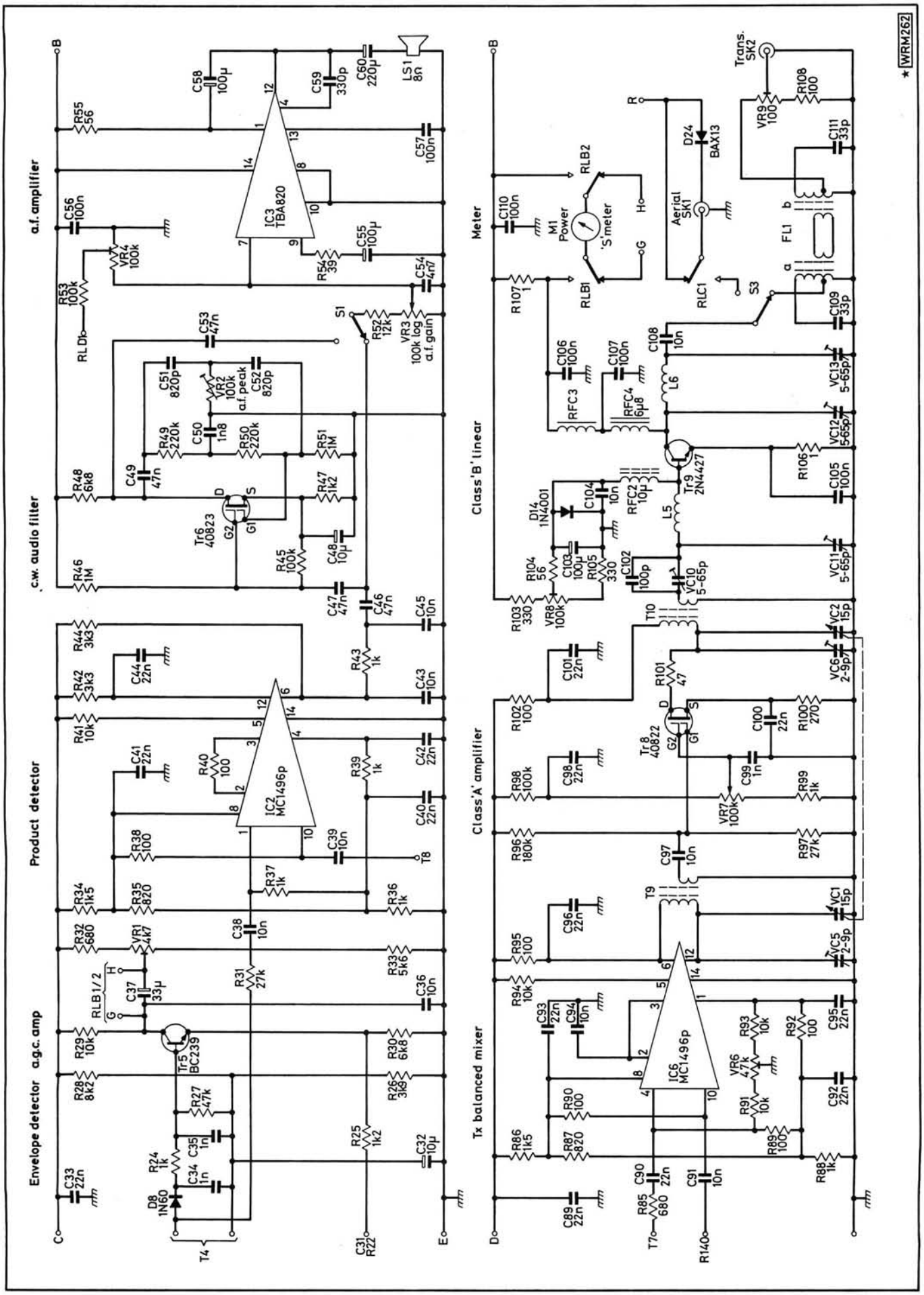


Fig. 1: The block diagram of the complete transceiver





★ components

Resistors

¼W 5% carbon

1Ω	3	R106,107,176
10Ω	1	R190
39Ω	1	R54
47Ω	4	R23,101,188,189
56Ω	3	R55,104,164
100Ω	26	R7,15,17,38,40,61,69,70, 72,76,83,89,90,92,95, 102,108,125,126,128, 131,137,159,173,174, 175
120Ω	1	R21
150Ω	1	R177
180Ω	1	R16
220Ω	3	R111,119,170
270Ω	4	R8,65,100,136
330Ω	7	R12,56,64,80,103,105, 120
390Ω	1	R84
470Ω	1	R22
560Ω	4	R81,148,172,180
680Ω	3	R32,85,121
820Ω	4	R35,67,87,123
1kΩ	17	R24,36,37,39,43,68,73, 78,88,99,124,147,151, 158,178,179,181
1·2kΩ	5	R18,25,47,140,154
1·5kΩ	4	R34,66,86,122
1·8kΩ	2	R168,169
2·2kΩ	2	R63,143
2·7kΩ	1	R165
3·3kΩ	3	R42,44,182
3·9kΩ	1	R26
4·7kΩ	5	R14,113,114,166,171
5·6kΩ	3	R33,160,161
6·8kΩ	6	R30,48,77,79,115,116
8·2kΩ	5	R28,144,149,150,155
10kΩ	12	R29,41,57,71,74,75,91, 93,94,97,127,129,130
12kΩ	5	R20,52,145,156,163
15kΩ	1	R183
22kΩ	3	R110,117,162
27kΩ	13	R2,4,10,19,31,97,109, 132,133,138,139,146, 157
33kΩ	2	R142,152
39kΩ	1	R62
47kΩ	10	R3,6,9,13,27,134,184, 185,186,187
68kΩ	2	R5,135
100kΩ	10	R11,45,53,60,82,98,112, 118,141,153
150kΩ	1	R58
180kΩ	2	R1,96
220kΩ	4	R49,50,59,167
1MΩ	2	R46,51

Capacitors

Ceramic

6·8pF	1	C135
22pF	1	C130
27pF	4	C3,4,11,13
33pF	3	C109,111,151
100pF	7	C14,102,114,129,134, 139,149
330pF	4	C19,59,69,79
1nF	6	C2,18,34,35,99,146
4·7nF	6	C1,6,8,9,10,54
10nF	34	C12,36,38,39,43,45,65, 91,94,97,104,108, 112,119,120,122, 123,124,125,126, 127,128,131,132, 133,136,143,144, 145,150,152,153, 154,155
22nF	38	C5,15,17,22,23,24,25,26, 30,33,40,41,42,44,71, 73,74,78,81,82,83,84, 85,87,88,89,90,92,93, 95,96,98,100,101,118, 121,140,142
47nF	6	C46,47,49,53,68,174
100nF	14	C56,57,63,64,105,106, 107,110,157,158,161, 162,165,166

Polycarbonate

220nF	2	C159,160

Polystyrene

47pF	1	C29
100pF	2	C147,148
150pF	7	C16,20,21,77,80,86,141
200pF	2	C137,138
270pF	1	C115
680pF	2	C116,117
820pF	2	C51,52
1·8nF	1	C50
3·3nF	1	C113

Electrolytic 25V

1µF	2	C72,170
2·2µF	1	C70
4·7µF	1	C27
10µF	4	C7,32,48,156
22µF	3	C66,75,76
33µF	3	C28,31,37
100µF	4	C55,58,67,103
220µF	4	C60,61,62,169
470µF	3	C167,168,172
1000µF	1	C171
3300µF	1	C173
4700µF	2	C163,164

Solid Film Trimmers

2–9pF	7	VC3,4,5,6,7,8,9
5–65pF	7	VC10,11,12,13,14,15,16

Variable Twin Gang

2–15pF	1	VC1,2

Potentiometers (rotary)

4·7kΩ (lin.)	1	VR10
100kΩ (lin.)	1	VR7
100kΩ (log)	1	VR3
100kΩ special (see text)	1	VR14

Potentiometers (lin. preset)

100Ω	2	VR8,9
1kΩ	1	VR13
4·7kΩ	1	VR1
47kΩ	3	VR5,6,11
100kΩ	3	VR2,4,12

Relays

2 pole c/o	2	RLA, RLB
1 pole c/o (reed)	1	RLC
1 pole normally off (reed)	1	RLD

Switches

Push-button 1 pole, 2-way	1	S1
Push-button 2 x 2 pole 2-way	1	S2
Min. toggle s.p.d.t.	2	S3,4
Min. toggle d.p.d.t.	3	S5,6,7

Inductors (all Toko coils)

TKXN5-2225ON	4	L1,2; FL1a,b
KXNS-K4172EK	4	L3,4; T9,10
154AES-7A6661EA	3	T1,3,5
154AES-7A6662EA	3	T2,6,7
154PC-6602EK	1	T4
154PE-7A6663AO	1	T8
MKAN-K4174HM	1	L7
KXN-K4173AO	1	T13
KXNS-K4613BM	1	T11
KXNS-K4612BM	1	T12
113KN-2K1026HM	2	L9,10
144HY-471K	3	RFC7,8,9
187LY-102K	1	RFC1
187LY-272K	1	RFC5

Crystals (wire ended)

8998·5kHz	1	X1
15666kHz	1	X2
16666kHz	1	X3

Semiconductors

Integrated circuits

MC1349P	1	IC1
MC1496P	4	IC2,5,6,7
MC7400	1	IC8
TBA820	1	IC3
TDA1054M	1	IC4

Transistors

BC238	1	Tr22
BC239	2	Tr2,5
BC338	2	Tr17,21
BD675	3	Tr18,19,20
BF240	1	Tr4
BF241	2	Tr13,15
BF256C	2	Tr7,11
BF451	2	Tr14,16
2N4427	1	Tr9
40822	2	Tr1,8
40823	4	Tr3,6,10,12

Diodes

BAX13	1	D24
BB104	5	D1,2,4,5,6
BZX83C4V7	1	D25
BZX83C6V2	1	D28
BZX83C11	1	D27
MVAM115	1	D3
MZD15C	1	D26
1N60	2	D7,8
1N4001	10	D14,15,16,17,18, 19,20,21,22,23
1N4148	5	D9,10,11,12,13
Green l.e.d.	1	D29
Red l.e.d.	1	D30

Miscellaneous

Mains transformer T14, 0–20V 1A secondary (1); F1–1A surge-proof fuse and holder (1); F2–315mA surge-proof fuse and holder (1); CF1-Yakumo Tusin YF90F or similar (1); printed circuit boards (6) (see text); 8Ω loudspeaker (1); 200μA meter (1); instrument wire; cabinet; nuts, bolts and screws; knobs.

The Delayed A.G.C. System

When the signal level to the receiver input is greater than 500μV, amplified i.f. signals appearing across T3 are routed to D7 via C14. Diode D7 rectifies the signal; the resultant d.c. is filtered by R11 and C12 and applied to Tr2 base causing Tr2 to be driven into conduction. As R5 provides a very high value collector load for Tr2, gate 2 voltage on Tr1 is progressively driven almost to zero with respect to chassis with increasing input signal level. The r.f. gain is simultaneously reduced to a factor of 1. This form of delayed a.g.c. prevents blocking of the mixer, hence there is no deterioration in cross and intermodulation characteristics of the receiver due to high level signals. Capacitor C7 provides a low impedance path to ground for recovered audio signals present on gate 2. This delayed a.g.c. provides an additional 40dB of receiver control and dispenses with the need for a manual r.f. gain control.

Main I.F. Amplifier And Primary A.G.C.

The i.f. signals are routed to the input, pin 4 of IC1, an MC1349, via C84, with C25 bypassing pin 6 of IC1 at i.f. The device IC1 is an integrated circuit, high gain, linear i.f. amplifier with a gain of approximately 66dB at 9MHz and with a built-in forward a.g.c. facility. The amplified signals appear at T4 which is resonated at 9MHz by C29. Transformer T4 has a 1 : 1 turns ratio allowing the a.g.c. detector diode, D8, a 1N60, to operate in a high im-

pedance configuration for driving the emitter follower a.g.c. amplifier, Tr5, a BC239. An external transistor is needed because IC1 requires 100–200μA of a.g.c. drive current for maximum gain reduction, i.e., approximately 66dB, which is more than can be provided by D8 alone. The amplified a.g.c. current appears as increased d.c. volts progressively reducing the gain of IC1, across R30.

The a.g.c. line is filtered by R25 and C31 which, with R22 and C28 sets the time constant for s.s.b. and c.w. signals and is applied to pin 5 of IC1. Resistors R26 and R28 set the bias conditions for Tr5.

The "S" Meter

The voltage drive for M1, the "S" meter on receive, is provided by R29 in the collector of Tr5. A "set zero" facility is provided by a voltage differential network, R32, VR1 and R33. The meter will read zero when the slider of VR1 is set for 9V d.c. and requires 200μA for full-scale deflection. Capacitor C37 provides sufficient damping of the meter movement preventing "needle bounce", M1 being connected in circuit by the relay RLB.

Product Detector

Advantage is taken of the very low signal input, approximately 10μV for 10dB signal-to-noise ratio at IC2, an MC1496, when used in the product detector configuration. The i.f. signals are routed to IC2 via R31 and C38, providing a 27 : 1 stepdown of voltage appearing at T4. Even under weak signal conditions, sufficient level will appear at IC2 input for correct operation whilst its low input impedance will not be reflected back across T4 secondary. The s.s.b. and c.w. signals at pin 1 and carrier insertion at pin 10 are mixed in IC2, the resultant product appearing at pin 6. Carrier and signal filtering is provided by C43, R43 and C45 with the audio signal then routed to S1 via C46.

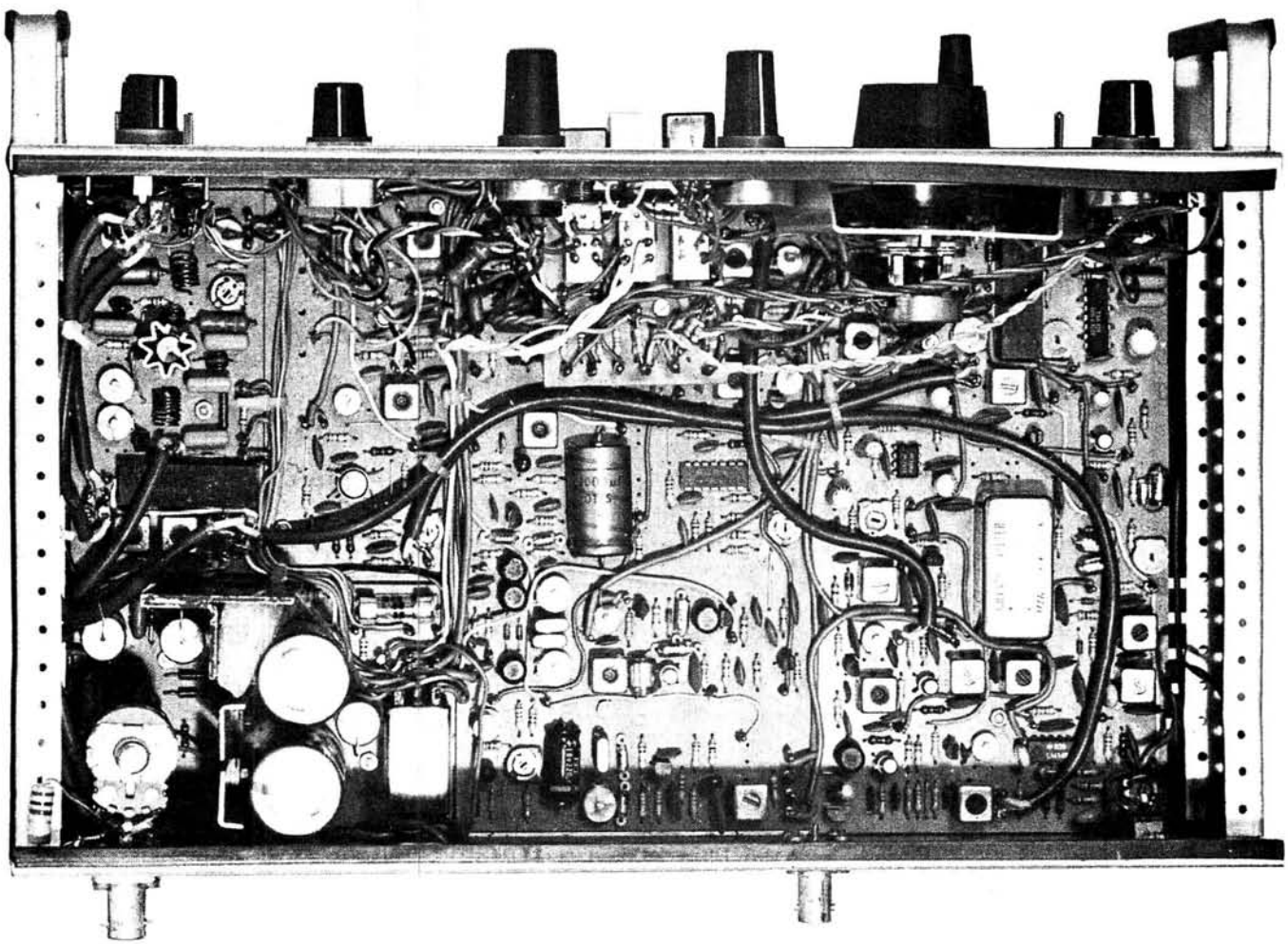
The C.W. Filter

The frequency selective audio amplifier, Tr6, can be switched into the audio line by S1 to improve the reception of weak c.w. signals under crowded band conditions. The circuit uses a dual-gate MOSFET and has a twin "T" CR filter circuit in its output. The network provides regenerative feedback to its input *circuit at* an audio frequency determined by C50, C51, C52 and VR2. The amplifier is selective at approximately 1kHz with a rapid fall-off in output either side of this frequency, VR2 allowing ±10 per cent variation in the peak frequency response.

Audio Frequency Amplifier

The audio amplifier, IC3, employs a TBA820 integrated circuit which delivers 2 watts output for 10 per cent distortion to the 8Ω loudspeaker, the output being arranged for a d.c. grounded speaker connection. The amplifier sensitivity is governed by R54 and C55 which controls the negative feedback; C59 limiting the upper frequency response and C60 the lower frequency response.

In Part 2 we will deal with the remaining circuit description and constructional notes.



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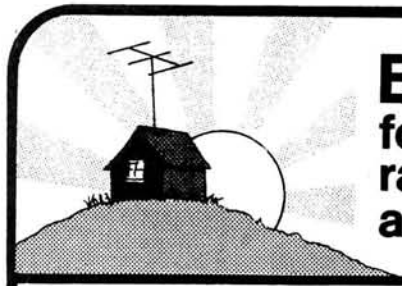

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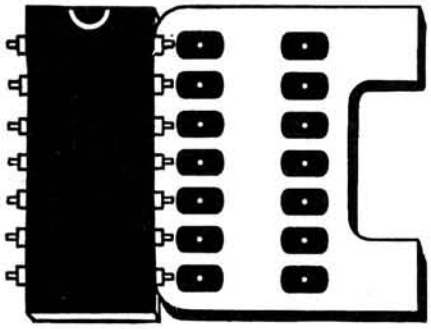


OF THE MONTH

Brian DANCE M.Sc

The Integrated Photomatrix IPL1500A1

Electronic light-activated switches have many applications including burglar alarms, automatic-door opening circuits, daylight level switches for controlling lighting, light-coupled circuit isolators, and so on. This device is a miniature light-activated switch whose output voltages switch rapidly as the intensity of the light falling onto the device varies. The light level at which the switching occurs can be varied over a range of at least 1000:1 by a suitable choice of two external components.

The output from the device can be used to directly drive CMOS logic circuits or a miniature reed relay, while the output may be amplified by a single transistor so that it can control a heavy-duty relay.

Operation

The internal circuit of the IPL1500A1 is shown in Fig. 1 together with the basic external circuit. The block marked "A" in this diagram is a pulse generator network which produces a sawtooth waveform and is connected to the sampling amplifier "B" with its associated photodiode. The values of the components R1 and C1 determine the threshold light level at which switching will occur.

The negative-going ramp part of the sawtooth waveform, from block A, has a duration of approximately 0·28 × C1 × R1 seconds (where R1 is expressed in megohms and C1 in microfarads). This period is known as the "integration time"; during this time the sampling amplifier output is kept at a fixed level and the photodiode operates in the light integrating mode, sensing the total amount of light received during this period.

The positive-going slope has a duration of about 0·01 × C1 seconds (where C1 is expressed in microfarads), and is known as the "resetting time". At the start of this period the sampling amplifier takes up a potential which is dependent on the product of the light intensity and the integration time. The photodiode potential is reset to a fixed value at the commencement of the next integration period.

Block "C" of Fig. 1 consists of a trigger circuit operated by the sampling amplifier output together with a push-pull output buffer stage. The output of the sampling amplifier "B" is applied to the input of the trigger circuit. As the triggering voltages are fixed for a given supply voltage, the product of the light intensity and the integration time is fixed for both trigger levels, so the illumination level required for switching to occur is proportional to the reciprocal of the integration time.

Light-activated switching can occur only at the start of the resetting period and not at any other point in the pulse cycle. A delay in switching of up to two integration periods plus one resetting period can therefore occur.

The whole of the internal circuit, including the silicon planar photodiode, is fabricated onto a single monolithic silicon chip which is encapsulated in a 4-lead TO18 miniature metal package with a glass window at one end to admit the light. The connections are shown in Fig. 2.

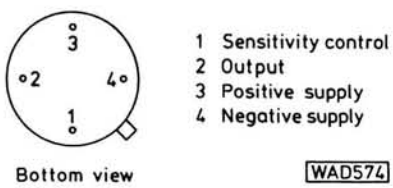


Fig. 2: Pin connections

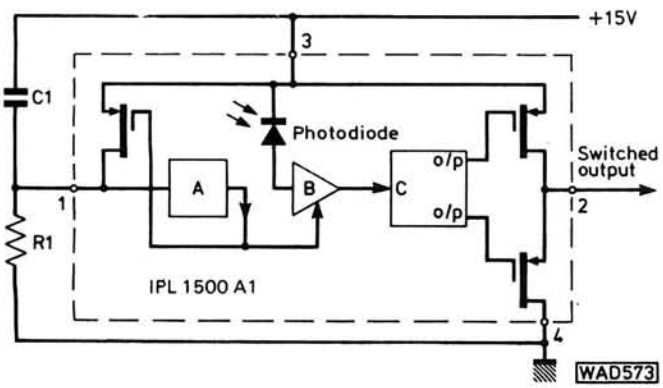


Fig. 1: The internal circuit of the IPL1500A1

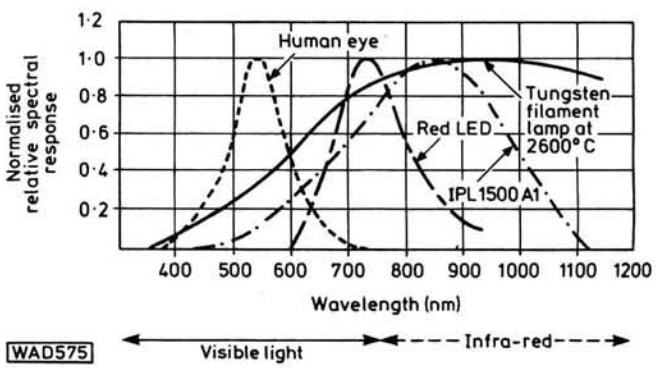


Fig. 3: The spectral sensitivity of the IPL1500A1

Sensitivity

The spectral sensitivity of the IPL1500A1 is shown in Fig. 3, together with the sensitivity of the typical human eye.

It can be seen that the device is sensitive mainly in the red and the infra-red regions of the spectrum, but has some sensitivity to light of all colours.

The light emitted by a typical red l.e.d. and by a tungsten filament bulb at 2600°C are also shown. It can be seen that the IPL1500A1 is very sensitive to the radiation from a red l.e.d. and to that from the tungsten bulb. Indeed, the spectral sensitivity of the device is mainly determined by the energy band gap of the silicon employed in its integrated photodiode.

The greater the value of the time constant C1 × R1 in Fig. 1, the lower the threshold light level at which the device switches. However, these component values must be chosen within the recommended limits. The value of R1 should be between 220kΩ and 10MΩ, whilst the value of C1 should be between 47pF and 330nF. In addition, the time constant C1 × R1 should be within the range 4·7μs to 33ms.

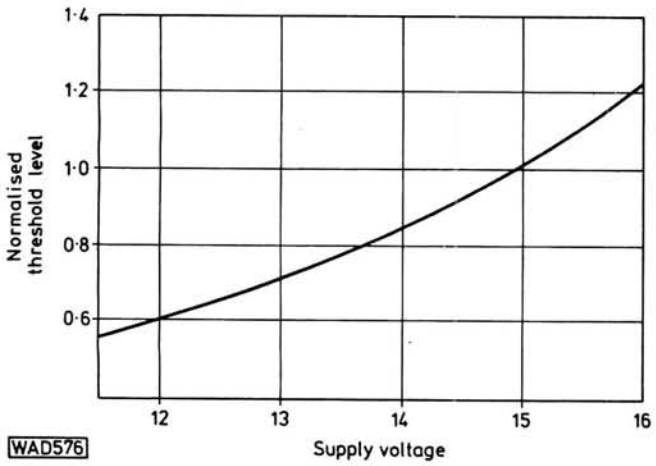


Fig. 4: Variation of switching threshold level with supply voltage

As shown in Fig. 4, there is some variation of the switching threshold level with the supply voltage. The minimum supply potential for satisfactory operation is 12V, whilst the absolute maximum supply potential is 20V. In practice, it is wise to regard 18V as the maximum supply so as to allow a margin of safety, since the device can be damaged by a supply of over 20V, even though it may be applied only for a very short time. The supply current required is typically 1·1mA when no current is being taken from the output pin.

Reed Relay Switch

A simple circuit for switching a reed relay according to the light intensity is shown in Fig. 5. A variable resistor has been included in this circuit to allow the sensitivity to be set. The value of C1 should be chosen so that the sensitivity to the type of light used is within the required range. When light of the correct intensity falls on the device, the reed relay closes.

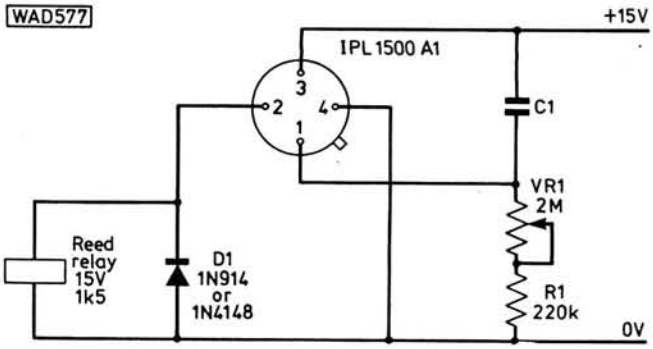


Fig. 5: A simple reed relay switching circuit

The IPL1500A1 cannot supply enough current to operate a large relay, but is able to control a miniature reed relay designed to operate at about 15V and which has a coil resistance of around 1500Ω. The device can supply at least 16mA when its output is in the high voltage state, so it can directly control relays having a coil resistance down to 1000Ω.

A diode is required in the circuit of Fig. 5 to bypass short transient voltage peaks which are developed when the current ceases to flow through the relay coil. If such transients are not bypassed to ground, they could damage the IPL1500A1 device, since it is possible for these voltages to become very high for a short time. Almost any small silicon diode can be employed across the relay, but it must be connected with the polarity shown so as to bypass the negative transient peaks.

Large Relay

The circuit of Fig. 6 shows how the output current from an IPL1500A1 device can be amplified by a *npn* transistor (such as the 2N3053), so as to control a relatively heavy-duty 12V relay requiring, perhaps, 100mA of coil current. Such a heavy-duty relay can switch typically 10A at 240V a.c. and can thus control a load of 2·4kW.

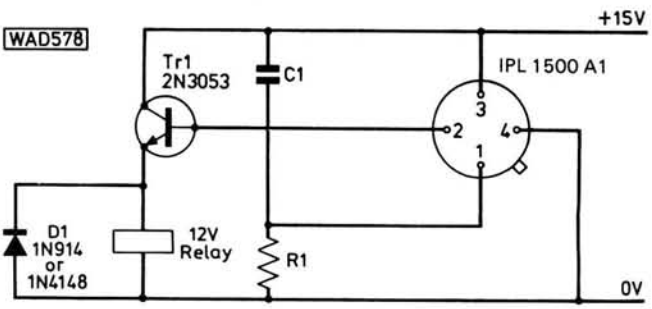


Fig. 6: The switching circuit for a heavy-duty relay

Hysteresis

The light level at which the device is switched, so that its output voltage is high, is slightly greater than that at which the output returns to the low state when the level of illumination falls again. This effect is known as "hysteresis"

and is very useful because the small difference in switching levels in each direction help to prevent repeated switching from one state to the other each time there is a very minor variation in the intensity of illumination.

The in-built hysteresis is typically 1 per cent. This means that the illumination level has to fall to about 1 per cent less than the level required for switching to the high voltage state before the circuit returns to the low voltage state. However, for some purposes it is desirable to have a higher level of hysteresis in the circuit. This may be accomplished by the use of a feedback resistor, R_f, as shown in Fig. 7.

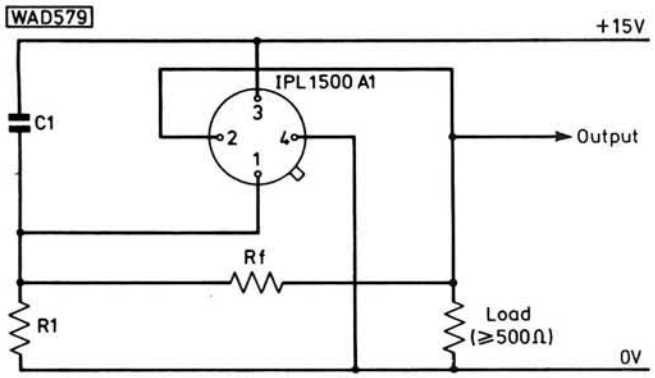


Fig. 7: Circuit for increasing the hysteresis level

The value of the feedback resistor for a given level of hysteresis varies with the component values. If C1 is 1nF, R1 is 1MΩ and the load is 22kΩ, the values of R_f for various hysteresis levels are shown in Table 1. The output from the circuit of Fig. 7 can be used to switch a relay or to operate the input to a CMOS circuit.

Table 1. The percentage hysteresis produced by various values of R_f

R_f (megohms)	1·5	2·2	3·3	4·7	10
Percentage Hysteresis Required	57	43	29	23	9

Relay With Hysteresis

The circuit of Fig. 8 shows how the IPL1500A1 device may be used to drive an output transistor stage which controls a heavy-duty relay (with a coil resistance of not less than 100Ω), with additional hysteresis provided by the feedback resistor R_f.

Conclusion

It is recommended that R1 should have a value of about 1MΩ for all light levels except the highest. For such high light levels, C1 can be set to 47pF and R1 chosen from the range 220kΩ to 1MΩ.

As the peak response is at a wavelength of around 800nm (just into the infra-red region), as shown in Fig. 3, the relative sensitivity is much greater to red light than to daylight or to blue light. As an indication of the sensitivity one may expect, a typical 1·2W tungsten filament

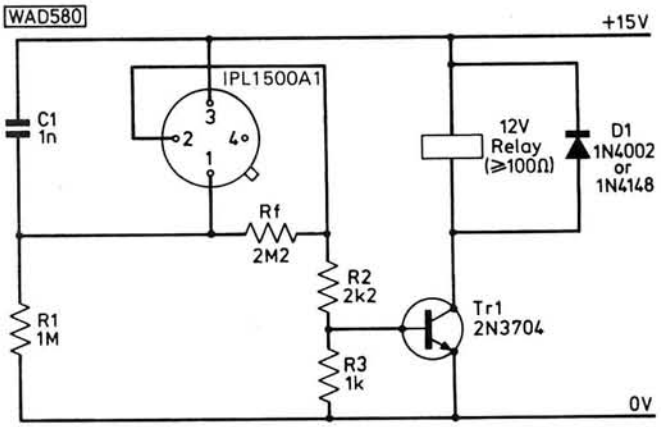


Fig. 8: A complete heavy-duty switching circuit

bulb produces a level of about 1·2mW/cm² at a distance of 10cm and the threshold levels at which switching occurs can be adjusted over a typical range of 10μW/cm² to 10mW/cm². A red l.e.d. may produce rather less than half the level of illumination produced by a 1·2W tungsten filament bulb, but nevertheless, can easily operate the light activated switch provided that the distance between the light source and the switch is reasonably small.

Availability

The IPL1500A1 light-activated switch is available from Arrow Electronics Ltd., Leader House, Coptfold Road, Brentwood, Essex CM14 4BN. ●

ENGLISH IN EUROPE

Charles MOLLOY G8BUS

Holidaymakers and others travelling abroad often wish they could pick up programmes in English, either from their car radio or domestic-type portable. It is not just a search for entertainment. There is a desire to keep in touch with world events, and if possible to obtain weather and traffic reports covering the new locality. Surprisingly, there are quite a number of English broadcasts on the long, medium and v.h.f. bands in Western Europe and the Mediterranean area, and this article is an attempt to bring together known information about them. All times quoted are GMT and allowance should be made for local time, including summer time, where applicable.

BBC

The BBC domestic programmes can be picked up in Belgium, Holland and Northern France during the day, and further afield after dark. Listen on the long waves on 200kHz (1500m) for Radio 4. Listen on the medium waves for Radio 1 on 1053kHz (285m) and 1089kHz (275m), and for Radio 2 on 693kHz (433m) and 909kHz (330m).

The BBC World Service, which is in English, is broadcast to Western and Northern Europe during the day, and to Central and Southern Europe after dark, from transmitters at Crowborough in Sussex and Orfordness on the Suffolk coast. The principal frequency is 648kHz (463m) using 500kW, but the World Service is also carried at times on 810kHz (370m) and 1296kHz (231m), and during the night on 200kHz on the long waves. Details of World Service programmes are contained in *London Calling* which is available from the BBC, Box 76, Bush House, London WC2B 4PH, the annual subscription being £4 for 12 issues for those living in Europe and £6 for outside Europe.

AMERICAN FORCES NETWORK

On the air 24 hours a day, AFN is located in West Germany. The main transmitter at Frankfurt is on 873kHz (343m), with a power of 150kW. There is also a medium-power chain on 1107kHz (271m), led by a 40kW transmitter at Munich, and there are two low-power chains on 1143kHz (263m) and 1485kHz (202m). There should be no difficulty hearing AFN on the medium waves in any part of West Germany, but in addition there are ten v.h.f. stations on 87·85MHz, including one in Berlin which is also served by 1107kHz on the medium waves.

AFN is on 100·9MHz v.h.f. in Brussels 24 hours a day with a relay of AFN in Frankfurt.

BRITISH FORCES BROADCASTING SERVICE

The BFBS has a day and night service in West Germany on v.h.f. from Bonn on 99·8MHz, Hameln 99·3, Werl 87·8, Herford 95·4, Langenburg 96·5, Visselhoud 97·6, and Berlin 98·75. There are two stations in Holland at Maastricht on 101·2 and Hoensbroek 101·7MHz.

AUSTRIA

Blue Danube Radio broadcasts on 102·2MHz v.h.f. in Vienna for foreign residents. The schedule is 0600–0800, 1100–1300 and 1700–1830. In addition news, weather and traffic reports in English are to be found daily on 585kHz (513m) in Vienna and 520kHz (577m) from Innsbruck/Linz/Liezen.

WEST GERMANY

Deutschlandfunk 1269kHz (236m) has a daily programme in English from 1840 to 1930 weekdays and 1800 to 1830 Sundays. If you want the latest on the DX front, listen on a Tuesday to Alan Thompson's *DX Circle*.

The Voice of America (VOA) operates a high-power transmitter at Munich on 1197kHz (250m). Listen for English programming between 0300–0400, 0430–0500, 0600–0700 and 1700–1730.

LUXEMBURG

Radio Luxemburg, which puts out 1200kW on 1440kHz (208m) is audible over a large part of Europe as well as in the UK. Its English programme starts at 1900 and continues well into the night. There is also a

The front cover of BBC leaflet 1043

programme in English on 92·5 v.h.f. from 1300–1630, and on 97MHz from midnight to 0200.

DENMARK

The 3rd programme on 1062kHz (282m), together with 15 v.h.f. channels across the country, has news in English for tourists at 0715 during the summer.

SWEDEN

The English part of the international service of Radio Sweden is on 1179kHz (254m) daily at 1600 with repeats at 1830 and 2300. *Sweden Calling DXers* is included in the Tuesday transmission.

FINLAND

Radio Finland uses its long wave outlet at Lahti on 254kHz (1181m), plus m.w. transmitters at Helsinki on 558kHz (538m) and Turku 963kHz (311m), daily at 2030 to carry the English section of the overseas service.

ICELAND

If you are in Reykjavik you will be able to listen all day (and night) to the nearby American base at Keflavik on 1485kHz (202m).

FRANCE

During July and August, news in English at 0900 and 1600 can be heard on 164kHz (1829m) on the long waves.

SPAIN

Radio Gibraltar is on 1458kHz (206m) from 0655 to 2300 daily. Radio Costa del Sol in Marbella has an English/German programme on 87·6MHz v.h.f. The British Forces Broadcasting Service transmits on 93·5MHz v.h.f. 24 hours a day.

MOROCCO

Sebaa Aioun on 702kHz (427m) broadcasts in English from 0900 to 1200 daily. It has been heard in southern Spain and should be audible in the Canaries and Madeira.

ALGERIA

Radio Algiers is on the air daily in English from 2000 to 2030 on 254kHz (1181m) long waves. It can be heard in the UK after dark and should be audible all over the Mediterranean.

CANARY ISLANDS

Radio Atlantico Las Palmas transmits daily in Swedish/German/English from 0900–1000 and 1800–2000 on 1215kHz (247m).

MADEIRA

A programme for tourists can be heard on 1485kHz (202m) between 0815 and 0915 and again from 1800 to 1900.

MALTA

Listen for Radio Mediterran on 1557kHz (193m) between 1835 and 1850 daily.

ITALY

Rome 846kHz (355m) and Milan 900kHz (333m) have news in English on the hour between 2300 and 0500. Naples 1368kHz (219m) has a programme for NATO personnel at weekends. AFRTS (US Forces) 0500 to 2300 daily on v.h.f. 106MHz from Aviano, Geta, Livorno, M. Virgine, Naples, Rimini, Sigonella, Veronna and on 107MHz from San Vito and on 108MHz from Vicenza.

GREECE

The National Programme 729kHz (412m), plus 17 v.h.f. outlets, has news on a Saturday at 0530 and weather reports daily at 0430. The Night Programme starting at 2300 on 666kHz (450m) is in English and other languages.

Yened (Greek Armed Forces) has news in English on weekdays at 1225 and 1925. The main transmitter is on 981kHz (306m) in Athens, with relays at Ioannina 765kHz (392m), Larrissa 945kHz (317m), Iraklion 954kHz (314m), Orestias 1080kHz (278m), Thessaloniki 1179kHz (254m), Florina 1278kHz (235m), Tripolis 1314kHz (228m), Pyrgos 1485kHz (202m) and Kavalla and Kozani on 1602kHz (187m).

US Forces (AFRTS) at Athens and Iraklion are on 1584kHz (189m) and Kato Souli 1485kHz (202m) with a 24-hour schedule. The Voice of America transmits from Kavalla in NE Greece on 792kHz (379m) at 1930, also from Rhodes on 1260kHz (238m) from 0400 to 0600 and again at 1630.

VATICAN

Religious programmes for English-speaking listeners can be heard on 1530kHz (196m) at 1445 and 2030. Audible as far as the UK after dark.

CYPRUS

BBC Eastern Mediterranean Relay on Cyprus carries the World Service for reception in the Middle East on 693kHz (433m) and 1323 (227m), from 0300 to 2315 daily. Good signal in East Africa on 693kHz.

BULGARIA

Radio Varna (Bapna) on 774kHz (388m) has programmes for holiday makers from 0600 to 1200, with English news at 0605, 0905 and 1155.

ROMANIA

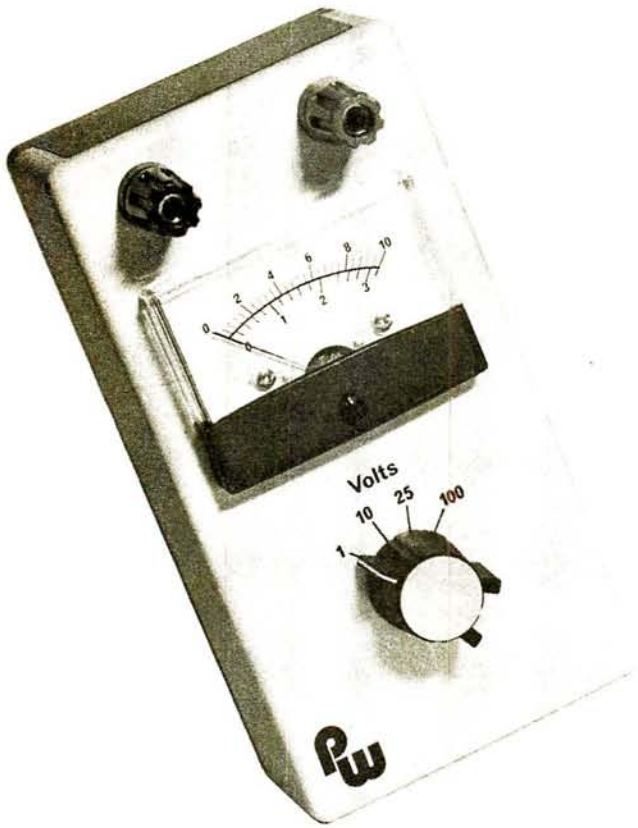
Programmes for tourists on 756kHz (397m) daily at 2230.

ACKNOWLEDGEMENTS

Thanks are due to the *World Radio and TV Handbook* (1980 edition), to Gemini Coaches of Lee-on-Solent, to the BBC Engineering Dept Information Sheet 1043, and to Fred Pilkington G3IAG who sent me recordings, made in the Costa del Sol of the two stations in Gibraltar, of Radio Costa del Sol and of the Voice of Morocco.

LOW COST HIGH-IMPEDANCE VOLTMETER

J. P. MACAULEY



Probably the most common measuring instrument to be found in the hands of the electronic experimenter is the multimeter. If the writer's experience is anything to go by this instrument is most usually used for measuring voltages on transistorised equipment.

Although the sensitivity of the multimeter is adequate when measuring the potentials at low impedance points in such equipment it is very seldom accurate for measuring the base emitter voltage of a transistor, especially if this happens to be carrying a low collector current. Furthermore it would also be an advantage, especially in development work, to monitor two voltages simultaneously. The price of two multimeters is prohibitive but the voltmeter described here can be built quite cheaply and has the advantage of a high impedance on the low voltage ranges.

The circuit of the complete voltmeter is shown in Fig. 1.

Voltage Follower

The op. amp. is connected as a unity gain voltage follower (Fig. 2) giving an output of the same magnitude and phase as the input. The advantage of this circuit is that the input impedance is very high.

The input voltage is applied to the non-inverting input of the 741 producing a voltage at the output equal to this input voltage. As a result the current flowing through the meter will be the same as if the op. amp. were not there and the meter can be calibrated to read directly in volts.

To avoid damage due to inadvertent overloading of the input, and the consequent possibility of damage to the meter, a protection circuit employing Tr1 is used.

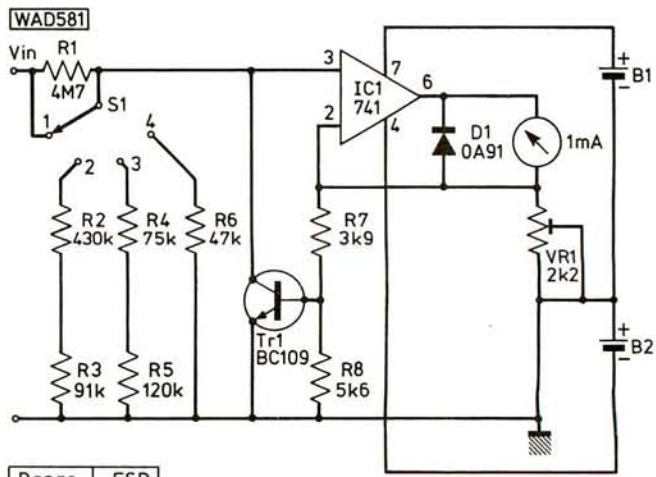
The voltage at the non-inverting input is sampled by the potential divider R7 and R8 the junction of which is connected to the base of Tr1. If an overload occurs this transistor turns on reducing the voltage at the input thus protecting the meter. Reverse polarity input protection is provided by a germanium diode D1, which limits the applied voltage to 0·2V.

Although the current consumption of the unit is typically less than 1mA an on-off switch should be included, although with such a small current drain, the batteries employed will have a long life.

Construction

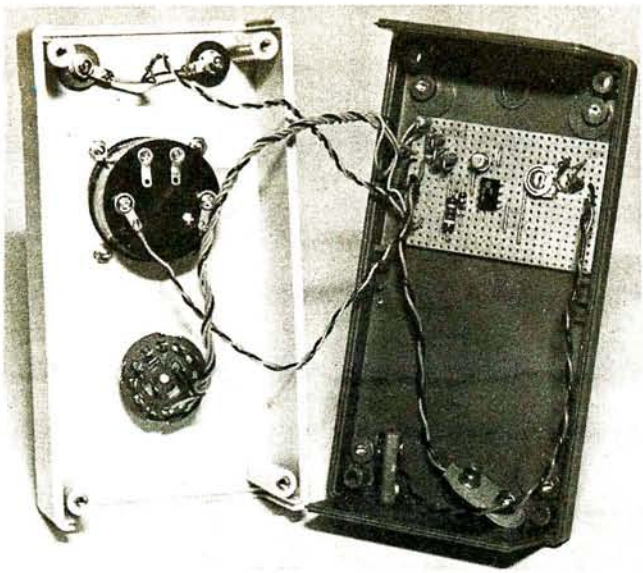
The construction commences with the wiring of the Veroboard panel shown in Fig. 3. Little comment is required about this, just ensure that the semiconductors are correctly inserted and that no solder bridges have formed across the tracks.

Although the housing for the equipment can be made by the constructor to suit his own circumstances, most will opt for a ready-made box; the prototype was built into a plastics Verobox.



Range	FSD
1	1V
2	10V
3	25V
4	100V

Fig. 1: Complete circuit diagram of the high impedance voltmeter. A d.p.d.t. switch should be inserted to switch off the batteries when not in use



The voltmeter showing internal layout of the Veroboard and front panel controls

Final assembly consists of mounting the sockets, meter and board into the case. The board is mounted with 4BA screws, spaced by nuts to ensure that the underside doesn't short-out to the case if a metal housing is used. The interwiring is the next step and, when this has been completed, the meter can be set up.

Setting Up

Before connecting the batteries adjust VR1 for maximum resistance and measure the voltage of B1 with your multimeter. Connect the batteries, the meter should register zero. On some meters a slight indication may be visible. This is due to the offset voltage at the output and can be nulled out by the meter movement adjustment screw.

Connect a length of wire from the positive socket to the positive terminal of B1. Switch to the 25V range and adjust VR1 until the reading is the same as that obtained from the multimeter.

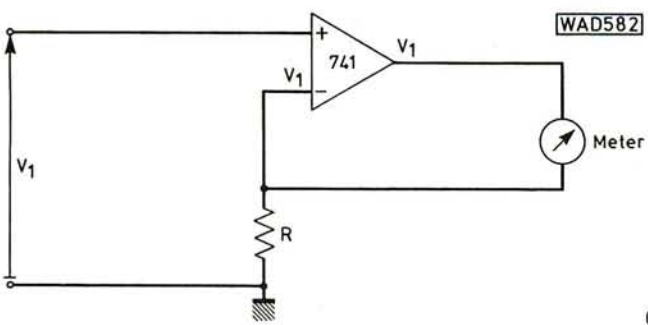


Fig. 2: The unity gain voltage follower circuit ▲

★ components

Resistors
¼W 2%

3·9kΩ	1	R7
5·6kΩ	1	R8
47kΩ	1	R6
75kΩ	1	R4
91kΩ	1	R3
120kΩ	1	R5
430kΩ	1	R2
4·7MΩ	1	R1

Potentiometers
Min. horizontal preset

2·2kΩ	1	VR1

Semiconductors
Diodes

OA91	1	D1

Transistors

BC109	1	Tr1

Integrated Circuits

741	1	IC1

Miscellaneous
Meter 1mA f.s.d. (1); Veroboard 0·1 inch pitch 16 tracks x 25 holes; 3p4w rotary switch (1); d.p.d.t. switch; 4mm insulated terminals (1 red, 1 black); Case 152 x 102 x 51mm; Knob; Battery connectors (2).

The meter is then functional, accuracy being mainly determined by the tolerance of the resistors R1–R6. Using standard tolerance components, i.e. 5%, the accuracy is within ±5%. For general purpose work this is often sufficient, if not the accuracy can be improved by using 1 or 2% resistors giving an accuracy of ±1 or 2% respectively.

Input impedance is high on all ranges, 4·7MΩ in fact, except on the 1V range where the voltage is fed directly into the non-inverting input. Even taking into account the shunting effect of Tr1 the loading on this range is about 10MΩ. ●

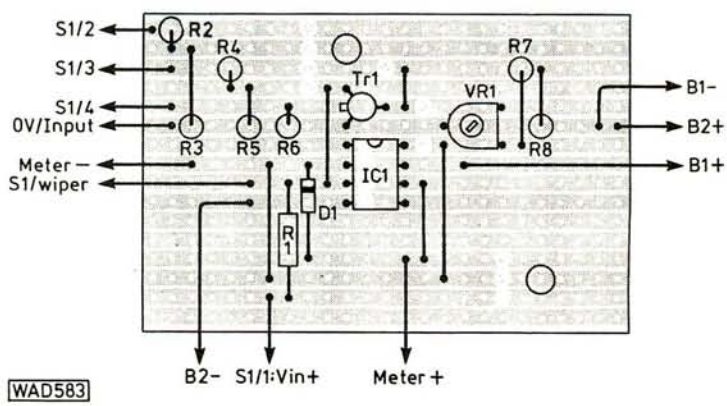


Fig. 3: Layout of the components on the Veroboard ▶

RADIO SPECIAL PRODUCT REPORT

STANDARD

C7800 70cm UHF FM TRANSCEIVER

Seventy centimetres seems to have had an upsurge of interest in recent months, particularly in areas where there is a good repeater with a wide coverage. The Standard C7800 u.h.f. transceiver was therefore looked at with great interest.

The initial impressions of the rig are ones of a Rolls-Royce class of equipment—well built and designed with a solid look and excellent styling. Nothing looks cheap and nasty and all the external parts were well finished and fitted neatly together. The rear panel is a black anodised aluminium casting which acts as the heatsink for the output transistors as well as carrying various sockets and the aerial input SO239 u.h.f. socket.

As with most transceivers intended for mobile use as well as base station use the C7800 can be slid into a special mounting rack which allows it to be adjusted in the car. A chromed bar is also provided to act as a front tilt leg to angle the rig when used in the shack.

Appearance

The front panel is particularly pleasing in appearance and is not unduly cluttered with controls. A large smoked window covers the green digital frequency display as well as the various indicator l.e.d.s and the very useful l.e.d. power and signal strength meter. The keyboard under the display window is the main means of driving the rig. This keyboard controls the microprocessor and gives access to the five memories, scanning modes, and instant SU20 calling channel selection.

The actual frequency selection can be performed in two ways. A large round knob on the front panel allows the frequency to be changed up or down in either 25kHz or 50kHz steps. The step size is selected on the rear panel. The hand-held microphone also carries a rocker switch which allows the frequency to be changed up or down remotely. Operating this switch gives an initial shift of one step followed a short while later by a continuous shift of frequency until the switch is released. The frequency selected is shown on the display with the first two digits removed.

The volume control also doubles as the push-on-push-off power switch and the squelch control is also the push-button control for the repeater access tone generator.

Concentric inner switch levers are fitted to the squelch and volume controls and control the repeater shifting and the transmitter output power.

The front panel is sloped to allow easy use of the controls and this also gives the rig its stylish lines.

Inside the C7800 lives up to its outer appearance. The main printed circuit boards are well made and all internal components are fitted neatly giving the set a professional look and obviously contributing to its potential reliability and stability.

Access to the works is by the simple removal of the top and bottom panels and can be accomplished in a matter of seconds. The instruction manual gives very complete step-by-step instructions for obtaining access to any part of the set as well as full alignment instructions.

In Use

The rig was given a very thorough air-test over a period of some four months, both mobile and fixed, and after a few preliminary problems gave a very good account of itself.

At the start of the tests the C7800 was used as a mobile rig fitted into the reviewer's Maxi. The power take-off was from the feed provided for a car radio and so is switched off when the ignition key is removed. The aerial used was a colinear from the SMC range of gutter mounted mobile aerials with the mount on the drivers side at the rear of the gutter.

The first few days were very disappointing with dismal failure every time an attempt was made to access the nearest repeater shown in the RSGB handbooks. A few enquiries locally brought to light the fact that the Wimborne

FM . . . SSB . . . CW
ICOM does it again!

ICOM IC-260E

WITH FULL 7 DIGIT READOUT AND GUARANTEED FINALS

Enjoy VHF mobile at its best. Sideband FM or CW, the ICOM IC260E does it all. The ICOM IC260E contains all the features a mobile operator would want in a compact 2 metre mobile package with FM, SSB, CW operation. Features customers ask for most, including:

- ☐ 3 memories built in (quick access to your favourite frequencies)
- ☐ Memory scan – automatically stops on an active frequency programmed in the memories
- ☐ Programmable band scan – scan the whole band or any portion of it you desire (adjustable scanning speed)
- ☐ Squelch on SSB the 260E will automatically and silently scan the SSB portion of the band seeking out the SSB activity on 2
- ☐ 600 KHz repeater offset built in. Easy repeater operation on the FM portion of the band.
- ☐ Variable repeater split with the 2 built in VFOs it's possible to work the odd splits plus accommodate future repeater band changes
- ☐ Multimode operation – USB, LSB, CW and FM, great for getting into OSCAR plus enjoying SSB rag chewing as well as repeater operation.
- ☐ With optional 240/12V supply, the 260E makes a flexible functional base for SSB/OSCAR/FM operation.

The RF amplifier and first mixer circuits using FETs and other circuits provide excellent Cross Modulation and intermodulation characteristics. The IC260E has excellent sensitivity demanded especially for mobile operation, high stability, and with crystal filters having high shape factors, exceptional selectivity.

The transmitter uses a balanced mixer in a single conversion system a bandpass filter and a high performance low-pass filter. This system provides distortion free signals with a minimum spurious radiation level.

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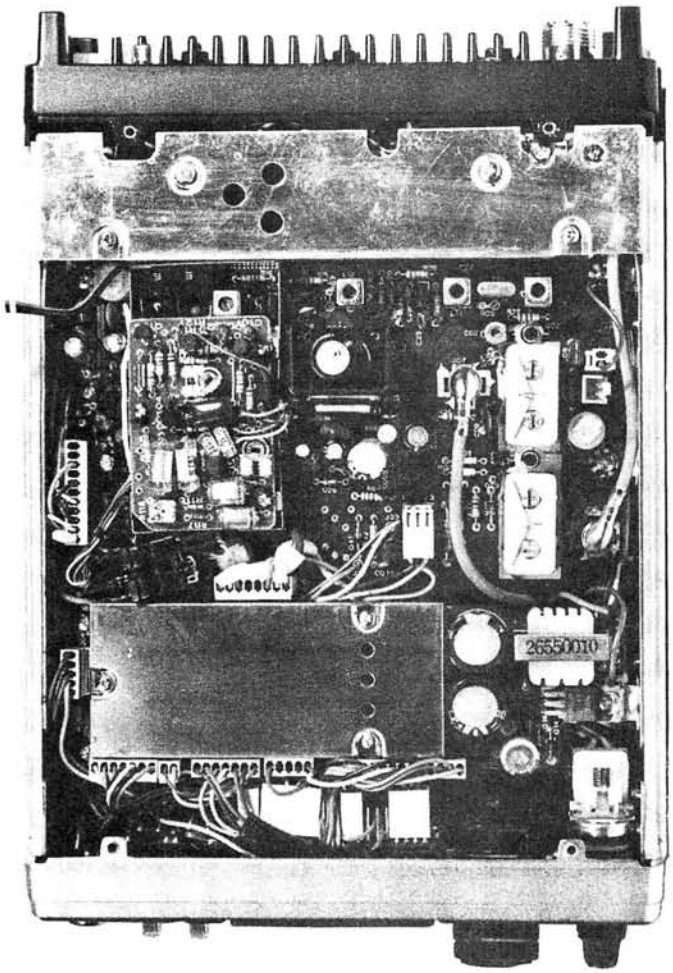


Interior view of the Standard C7800 with the bottom cover removed. The substantial heatsink is at the top

★ specifications

RECEIVER	
Sensitivity:	−6dB (20dB QS); −8dB (12dB SINAD)
1st i.f.:	21·4MHz
2nd i.f.:	455kHz
Bandwidth:	±7·5kHz
Selectivity:	Better than 60dB
Audio output:	2W (10% distortion)
Loudspeaker:	8Ω
TRANSMITTER	
Power (r.f.):	10W (1W low power)
Load impedance:	50Ω
Modulation:	F3
Deviation:	5kHz
Spurious emissions:	60dB
Response (a.f.):	300 to 3000Hz
Microphone:	600Ω
GENERAL	
Frequency band:	430MHz to 440MHz
Channel spacing:	25kHz or 50kHz
Memories:	5
Scanning:	Under microprocessor control
Repeater shift:	+1·6MHz up to 434·75MHz −7·6MHz above 435·00MHz
Power:	13·8V at 4·5A maximum on high power
Dimensions	168 x 58 x 240mm
Weight:	3·0kg

repeater did not exist except in the repeater books! Hope rose and attempts were then made to access the next repeater, GB3SD at Weymouth some 30 to 40 miles away. The repeater could be heard very strongly but all attempts to access it failed. By now it was becoming apparent that there was something amiss with either the rig or the operator. Success was achieved through GB3CB while in the Birmingham area but shortly afterwards, while working GB3LT at Luton, the reports on the audio quality from the Standard were not very complimentary. It would seem that the rig was transmitting way off frequency. This was confirmed when GB3SD was at last accessed and quite by chance a regular user of SD (G8TGE) who also runs a C7800 was listening and was able to pinpoint the trouble.

The C7800 has a phase locked loop system to set the frequency and when the repeater mode is selected another crystal is brought into use for transmit only to give the required 1·6MHz shift. It seems that the crystals were inserted by the importers but, by oversight, not trimmed to give exactly 1·6MHz shift. This put the rig outside the pass band of SD when deviated and the repeater failed to recognise the input. Adjustment proved very simple once the correct trimmer capacitor had been located. Here the instruction manual proved both very helpful and at the same time devious. The location of the trimmers was clearly shown but they were all incorrectly labelled. G8TGE had been through this exercise and was able to pinpoint the correct trimmer. Five minutes later the Standard was set up correctly and since then reports from the many contacts made through SD have been very complimentary on the quality of both signal and audio from the C7800.

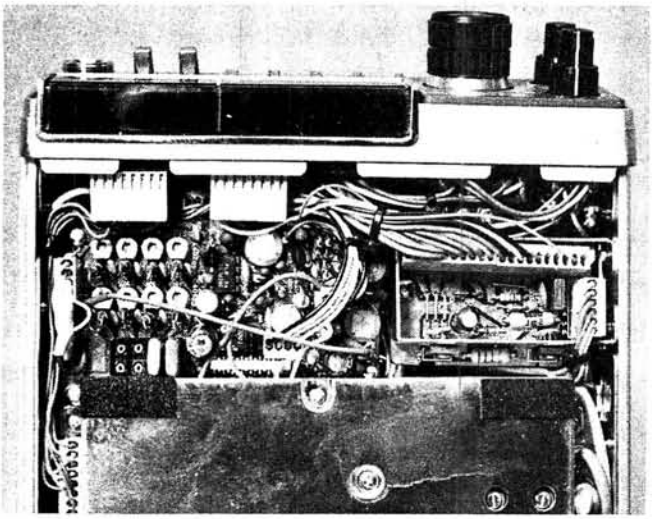
Microprocessor

The microprocessor control of the C7800 seems to be very effective once the controls have been mastered. The main keyboard has eight push-buttons controlling the scanning, memories, selection of the MHz band and SU20 calling channel selection. There are five memories each of which can be accessed from the keyboard or scanned at two speeds for either busy or vacant situations. Setting up the memories is straightforward, after selecting one of the memories the frequency desired to be entered is set up using the frequency selection knob or the microphone rocker switch. When the display indicates the desired frequency the MEMORY ENTER button is pushed and the frequency shown on the display is stored in the memory.

A simple memory back-up supply is fitted to retain the memory when the main power switch is turned off. However this back-up is only operative as long as the rig is still connected to a 12 volt supply. If the supply is removed the memories are erased and the rig must be re-programed the next time the rig is switched on. This is a nuisance but can be overcome by connecting a separate small 9 volt battery to the accessory socket on the rear heatsink. A remote keyboard can also be connected through this socket if desired.

Pushing the CALL button selects SU20 as the simplex calling channel. This can only be overridden by pushing the cancel button which then restores the frequency to that selected before the CALL button was pushed.

Unfortunately there is no reverse repeater facility, which is surprising since there is a spare button on the keyboard and



The p.l.l. crystals can be seen on the left with the two sets of trimmer capacitors immediately above them. It was necessary to trim the p.l.l. crystal to net the rig onto frequency for repeater operation. One of the crystals gives a 7·6MHz downshift for Continental operation

this could have been used simply to provide instant selection of the repeater input frequency using the appropriate crystal in the p.l.l. system.

It is possible, of course, to use one of the memories to store the repeater input frequency as long as you do not object to losing one of the memory channels.

All the controls fall easily to hand with the exception of the Tone button for repeater access. This is the control farthest away from the driver in a right-hand drive car and in some models the only suitable mounting position could give a long stretch to press the button. Fortunately this only needs to be done to bring the repeater up initially so this is only a minor criticism.

The display is clear and easily read in all conditions while the repeater mode is indicated by white l.e.d.s alongside the frequency display. For certain conditions the transmitter is automatically locked out and this is indicated by a red l.e.d. The power and signal strength meter is a multicolour l.e.d. display and is most effective when operating mobile. It is much simpler to notice that two red l.e.d.s are lit rather than try to read a continuously wavering meter needle, and this is a form of indicator that must surely catch on for transceivers.

The C7800 fits neatly under the dash of the reviewer's Maxi

The hand-held microphone was comfortable to use but it proved very easy to accidentally operate the frequency change rocker, thus losing the channel being worked.

The transmitter and receiver seem to be very well matched in terms of performance. When the repeater comes in on receive at above about S5 then the transmitter will put a good signal into the repeater. When the S meter indicates say S1 then the repeater is not accessible.

Towards the end of the tests a 5 amp 13·8 volt stabilised power supply was constructed along with *a scaled* down version of the 12-element ZL Special beam aerial described in *Out of Thin Air*. These were used to run the Standard as a fixed station working into SD over a distance of some 40 miles. The results have been outstanding with the reports of the Standard's signal showing it to be performing exceptionally well. The r.f. power output was measured at 13W on high power and 0·9W on the low power setting.

On test the Standard C7800 transceiver performed really well and was a pleasure to operate. As a fixed station it is compact and all controls fall easily to hand and even on high power it does not require too large a power supply. As a mobile unit it is very good offering the amateur enthusiast a versatile 70 centimetre rig at a reasonable cost.

Thanks must go to the regular users of GB3SD for the reports on the signals from the Standard as well as four months of interesting and well-ordered QSOs over quite incredible distances.

Price

The Standard C7800 costs £275 inc. VAT.

The Standard C7800 was loaned by Lee Electronics, 400 Edgware Road, London W2. Tel: 01-723 5521 and we would like to thank them for their co-operation.

NEWS... NEWS... NEWS...

Club News

The Brighton and District Radio Society meet every other Wednesday at 47 Cromwell Road, Hove, Sussex at 1945. They produce a newsletter bi-monthly and on July 16 the club is to visit Ron Ham's collection at the Chalk Pits Museum, Amberley. Further details of this club are available from the Secretary, John Trimmer G4JDM, 7 Dale Crescent, Patcham, Brighton, Sussex.

Whitleigh Methodist Church, Budshead Road, Whitleigh, Plymouth, is the meeting place of the Plymouth Radio Club. Meetings start at around 1930hrs on alternate Mondays and club activities include talks, activity nights and other interesting things. Contact: John Butcher, Secretary, on Plymouth 338417 for further details.

Down on the south coast of Wales the Swansea Amateur Radio Society meets every other Thursday evening at 2000hrs in the Technicians' Common Room, 2nd Floor of College House, Swansea University. Hon Secretary is Roger Williams GW4HSH, QTHR, who will be glad to let you have details of club activities.

Ambit Have Moved

Ambit International have asked us to advise our readers that they have moved to new premises, their new address is: *200 North Service Road, Brentwood, Essex CM14 4SG. Tel: (0277) 230909.*

New Catalogue

Livingston Hire Limited, Europe's number one electronic instrument rental company, have just published their latest catalogue, copies of which are available, free of charge, from their London offices.

In 1979, Livingston Hire invested over £1.2 million on new equipment, and their 1980 catalogue reflects this. Details are given of instruments in over 130 test and measurement categories, comprising a total inventory of almost 4000 items including nearly 100 new instrument types.

The 1980 catalogue is available from: *Livingston Hire Limited, Shirley House, 27 Camden Road, London NW1 9NR. Tel: 01-267 3262 or 5411.*

2m Multi-mode

Due in from Japan any day now is the latest mouth-watering multi-mode 2m mobile rig from Yaesu. Called the FT-280, it has two v.f.o.s, four memories, usual repeater shifts with auto-toneburst, and output power of 10W.

Stepping and scanning can be controlled from the microphone, with selectable steps of 10Hz/100Hz/1kHz on s.s.b./c.w. and 1kHz/12·5 or 25kHz/100kHz on f.m. Both memory-and band-scan modes are available, with pause or stop on an occupied channel, plus monitoring of a priority channel. Digital clarifier with shift displayed, l.e.d. "S" meter, semi break-in and sidetone on c.w., plus a special "Satellite" mode, complete the range of fascinating features.

Price is expected to be around £350 including VAT. For further details contact *Amateur Radio Exchange, 2 Northfield Road, Ealing, London W13 9SY. Tel: 01-579 5311.*

New Company

Derrick Taylor, the former sales director of Coutant Electronics, has left and formed his own company to market a wide variety of power supplies from all over the world.

In setting up his own concern, he decided to specialise in a very wide range of state-of-the-art power supplies with outputs from 2V up to 100kV.

Although most of the range are OEM products, the company will supply these direct to hobbyists at trade prices.

The new company is: *Powerline Electronics Ltd., 208 Elgar Road, Reading, Berks. RG2 0DD. Tel: (0734) 868567; Telex: 847073.*

Rooftop Terminals

"Satellite Communications into the Eighties," in our August 1979 issue, described how and why the GPO is expanding and developing its earth stations to cope with the ever-increasing demand for this space-age communications medium. Not all satellite terminals are as huge as those at the Madley or Goonhilly sites though. The GPO's principal contractor, Marconi Communication Systems Ltd., is also very actively concerned in the development of *small* earth stations. Small means a complete data transmission terminal accommodated in a filing-cabinet sized housing, linked to a rooftop 3 metre dish.

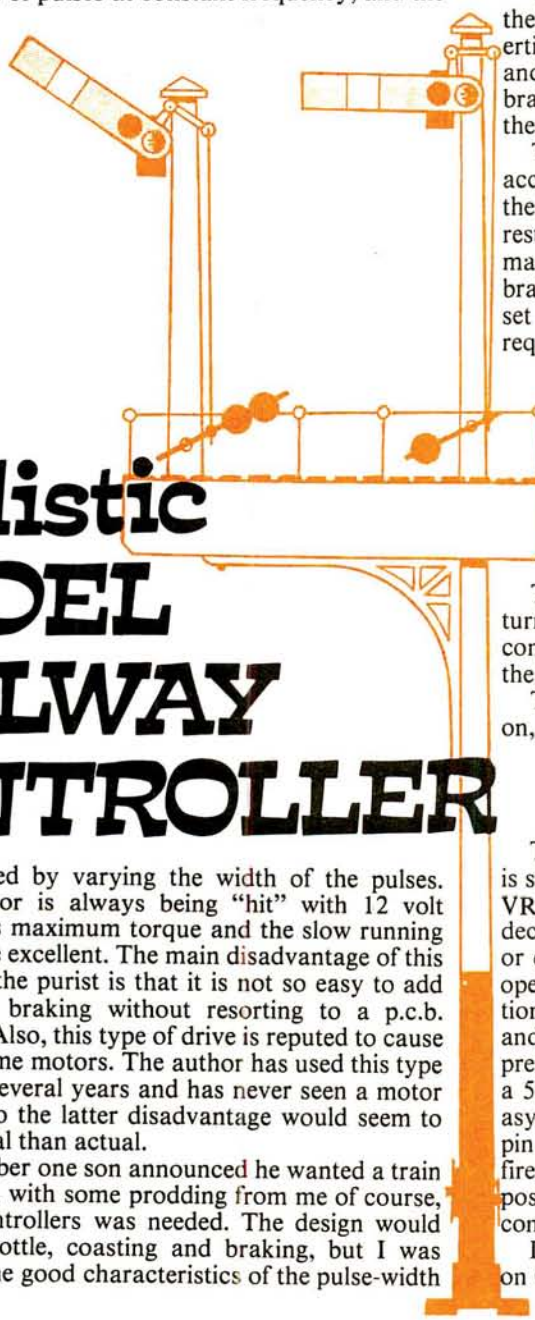
OTS, the orbital test satellite launched in May 1978—(for the European Space Agency)—is helping to prove the technology under-pinning small-scale terminals which have obvious implications for commercial users—high-speed data being the important application with so many computer users around.

To demonstrate the effectiveness of the new Marconi Data Transmission Terminal, two are at present linked via OTS, to enable the rapid transfer of data between the Rutherford Laboratories in Oxford and the European Nuclear Research Centre in Geneva. The idea is to speed up the exchange of vast quantities of high-speed data concerned with "atom smashing". Previously, a courier laboriously carried tapes from one lab to another but now, using the new terminals, the same amount of data can be transferred in less than two hours.

Real-time remote participation in experiments thus becomes a distinct possibility.

A Realistic MODEL RAILWAY CONTROLLER

E. A. PARR BSc C Eng MIEE



The control of a model train can be achieved by various means each having its own advantages and disadvantages as well as devotees who swear by their selected technique.

Controllers supplied with train sets are usually a variable resistance in series with the locomotive. This type of control has very poor characteristics. The loco will not run slowly and changing load causes the speed to vary drastically, because of the poor regulation of this type of controller.

An improvement is the variable transformer controller. The speed is controlled by a variable transformer similar to a Variac and the controlled a.c. is rectified before being fed to the track. The regulation is improved, but slow running is still poor.

Electronics can be used to build superior controllers. The simplest type is based on a conventional series regulator. The regulation of this type of circuit is excellent, and its slow running characteristics are quite good. With suitable RC networks progressive acceleration, coasting and braking can be incorporated into the design.

The second type of electronic controller is based on the techniques used in Thyristor drives. The traction supply consists of a train of pulses at constant frequency, and the speed is controlled by varying the width of the pulses. Because the motor is always being "hit" with 12 volt pulses it produces maximum torque and the slow running characteristics are excellent. The main disadvantage of this type of drive for the purist is that it is not so easy to add acceleration and braking without resorting to a p.c.b. full of op. amps. Also, this type of drive is reputed to cause overheating in some motors. The author has used this type of controller for several years and has never seen a motor even get warm, so the latter disadvantage would seem to be more theoretical than actual.

When my number one son announced he wanted a train set for Christmas, with some prodding from me of course, a re-think on controllers was needed. The design would have to have throttle, coasting and braking, but I was loath to discard the good characteristics of the pulse-width controller. A design eventually materialised which combined the characteristics of both voltage and pulse-width types.

The operation is shown in Fig. 1(c). The main adjustment of speed is done by a voltage control as Fig. 1(a), but, superimposed onto this is the 12 volt pulse train. The pulses are too narrow to cause the train to move, but are sufficient to let the voltage control work down to lower speeds than the usual simple control.

Because the main control is done by a voltage level, it is relatively easy to add the acceleration and braking controls. As an added luxury a separate "creep" control was added to allow the width of the pulse to be varied. This allows the speed to be controlled by varying the pulse width for delicate shunting operations.

Before describing the circuit, it is probably best to describe the controls. To people brought up on single knob controllers it probably seems very complicated. It does, in all honesty, take some practice to drive it, but the problems you encounter using it are the problems a train driver faces stopping a ten coach train, at a station, from 100 mph.

The two main controls are the throttle and the brake, the two secondary controls are creep for shunting and inertia. The inertia control simulates the weight of the train, and determines how fast the train can accelerate and brake. In normal operation the creep control is turned to the minimum position.

To start the train the throttle is opened and the train accelerates at a rate determined by the inertia control. If the throttle is now shut the train will coast and come to rest after a minute or so. To stop the train in a controlled manner it is necessary to shut the throttle and use the brakes. Braking is progressive with the maximum being set by the inertia control, so stopping a train at a station requires a fair bit of judgment and skill.

To drive the train in the creep mode the control is turned clockwise with the throttle in the off position. The control is not ramped and controls the speed directly and the brake has no effect.

There are three indicators showing power on, brakes on, and current overload.

Circuit Description

The circuit is shown in Fig. 2. The voltage to the track is set by the voltage on C8, and is increased by the throttle VR1 via D1 and the inertia control VR4. The voltage decreases slowly via R6 and R7 when the throttle is shut, or quickly via VR4 and VR2 (brake) when the brakes are operated. Note that S1 is coupled with the brake potentiometer. The value of C8 governs the rate of acceleration and deceleration and is largely a matter of personal preference. The pulse control is carried out by IC1. This is a 556 dual timer with the "A" side connected as a highly asymmetric 100Hz oscillator producing negative pulses at pin 5. The "B" side is connected as a monostable which is fired by the pulses from the "A" side. The output is a positive pulse train at pin 9, the width of the pulse being controlled by VR3, the creep control.

Diodes D4 and D5 form an OR gate to pass the voltage on C8 or the positive pulses, whichever is higher, to IC2, a

WRM256

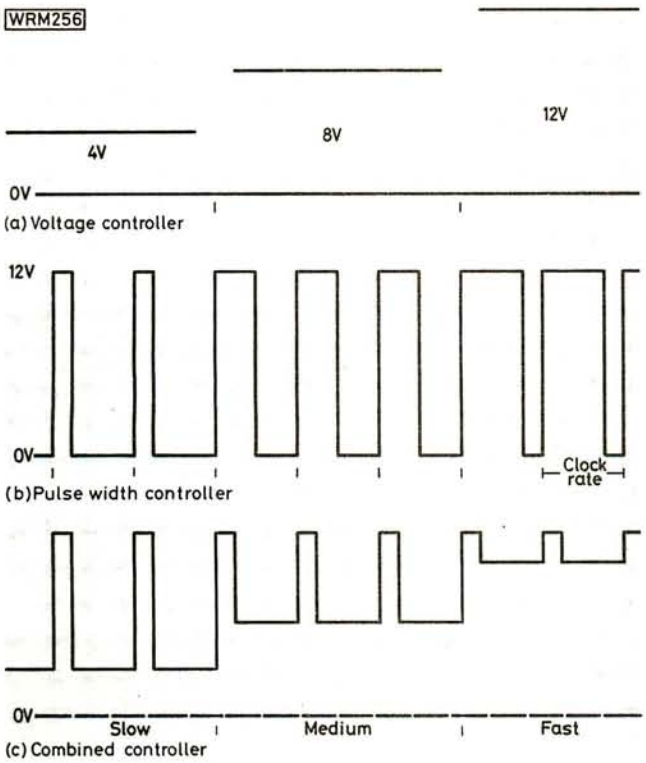


Fig. 1: The operation of the controller is based on the waveforms shown in this diagram

741 op. amp. This buffers the shaping circuit from the regulator transistors. Resistors R6 and R7 limit the voltage at pin 3 to about 13 volts, to prevent the 741 from doing funny things. The lowest voltage from the 741 is about 1·5 volts, but unlike the positive saturation this is predictable. With the throttle off and brakes full on the track voltage is about one volt. This is insufficient to move most conventional locos or heat the motor, and the author is working on using the small current at rest to provide indication of track occupancy. That, however, is another story.

The voltage from IC2 goes to Tr2 and Tr3, a Darlington pair, to provide the current for the track.

The return current from the loco passes through R10. If the voltage across R10 rises above 0·8V Tr1 turns *on* reducing the voltage at Tr2 base. The current is thus limited by the value of R10. In the prototype a 1 ohm resistor was used, giving a current limit of about 800mA. Indication of the current limit condition is provided by LED2.

The power supply is shown in Fig. 3. This is straightforward, but the loco 0V and the control 0V only meet at C1. This is most important to prevent noise from the loco interfering with the pulse control.

Construction and Use

The prototype was constructed on a p.c.b. as shown in Fig. 4. Components not shown on the p.c.b. are mounted on the control panel. The control panel can be of any size to suit the constructors whims or fancies.

The output transistor Tr3 is mounted on a heatsink to dissipate the 15 watts arising from a short-circuit condition. A small heatsink is provided for IC3. Two resistors can be used in parallel for R10 to alter the current limit value.

★ components

Resistors

¼W 5%

470Ω	1	R4
680Ω	3	R5,9,11
1kΩ	3	R2,3,8
56kΩ	1	R6
150kΩ	1	R1
680kΩ	1	R7

2W wirewound

1Ω	2	R10a,10b (see text)

Potentiometers

¼ inch shaft

500Ω lin.	1	VR1
25kΩ lin.	2	VR2,4 (VR2 with d.p.s.t. switch)
50kΩ lin.	1	VR3

Capacitors

Electrolytic

470µF 25V	1	C8
4700µF 25V	1	C1

Tantalum

10µF 16V	1	C3

Disc ceramic

0·1µF	5	C2,4,5,6,7

Semiconductors

Diodes

1N4001	4	D1,2,3,7
1N4148 or 1N914	3	D4,5,6
2A 100V bridge	1	BR1
Red l.e.d.	3	LED1,2,3

Transistors

2N3055	3	Tr1,2,3

Integrated circuits

556	1	IC1
741	1	IC2
7815	1	IC3

Miscellaneous

Printed circuit board, toggle switch d.p.d.t. (1); Transformer 15V 50VA (1); Sockets for IC1,2 (8-pin d.i.l. and 14-pin d.i.l.); Heatsink for IC3; Fuseholder (2); Knobs (4); Aluminium sheet for panel.

Testing of the unit is straightforward but as the unit is mains powered normal precautions should be taken to prevent shock. For people not used to fault-finding the following procedures might be helpful.

With the controller connected up, turn on and check for 20 to 25 volts across C1, and 15 volts across VR1. Turn VR1 from one end to another and check that the voltage on the wiper varies between 0 and 15 volts with respect to 0V. Turn the brake off and the inertia control and creep control to the minimum position. Turn the throttle down and dab a 100 ohm (or thereabouts) resistor across C8 to discharge it.

A meter connected to IC2 pin 6 should read about 1·5 volts. Slowly increase the throttle and the voltage on pin 6

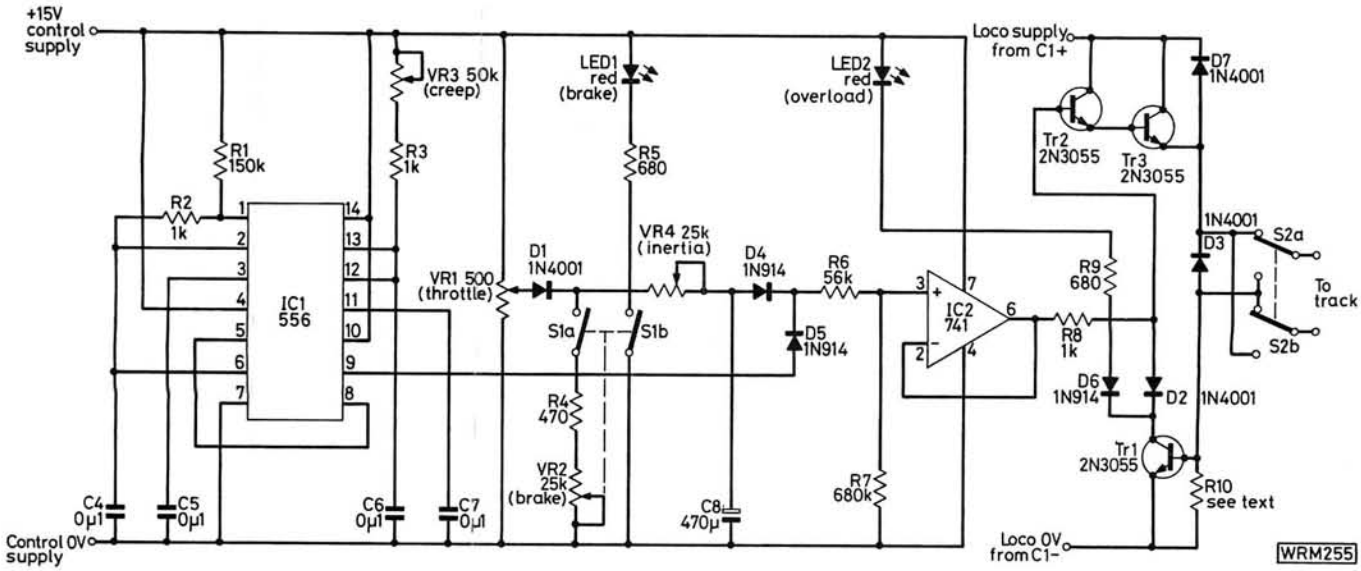
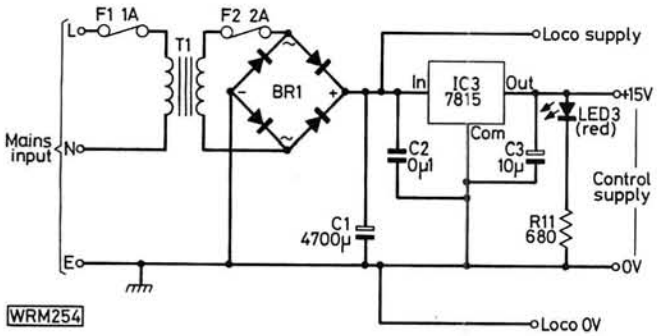


Fig. 2 (above): The circuit diagram of the controller. The separation of the traction supply from the control electronics supply should be noted as it is important to keep the large traction currents away from the control electronics

Fig. 3 (below): The circuit diagram of the power supply showing the separation of the control supply from the traction supply

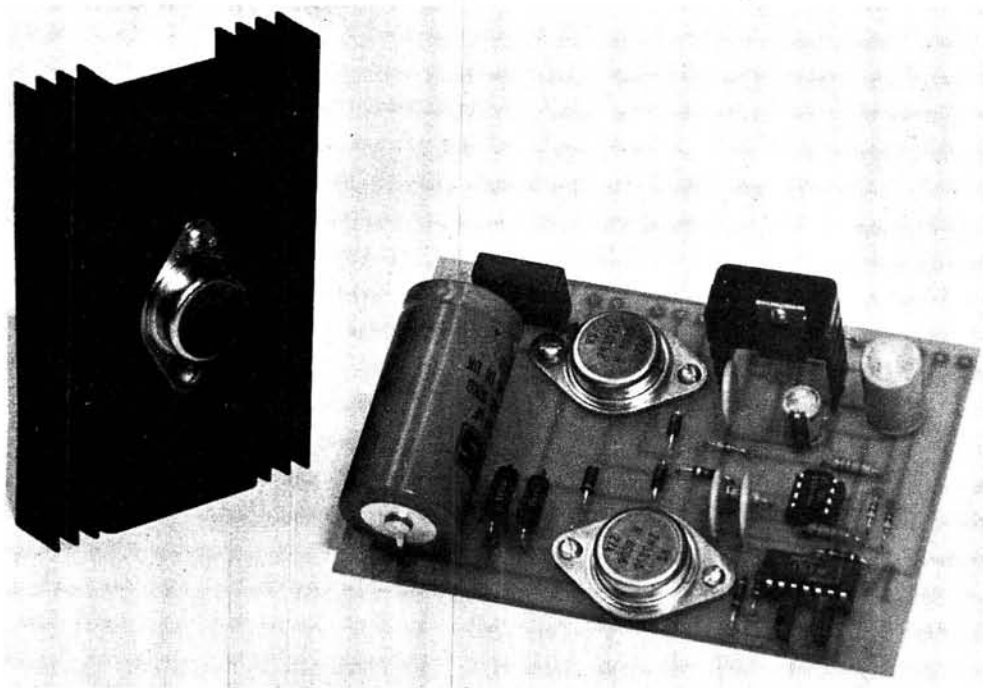


should rise in sympathy up to a maximum of about 13 volts. Shut the throttle, the output of IC2 should hold. Now operate the brakes fully and the voltage on pin 6 should fall back to about 1·5 volts.

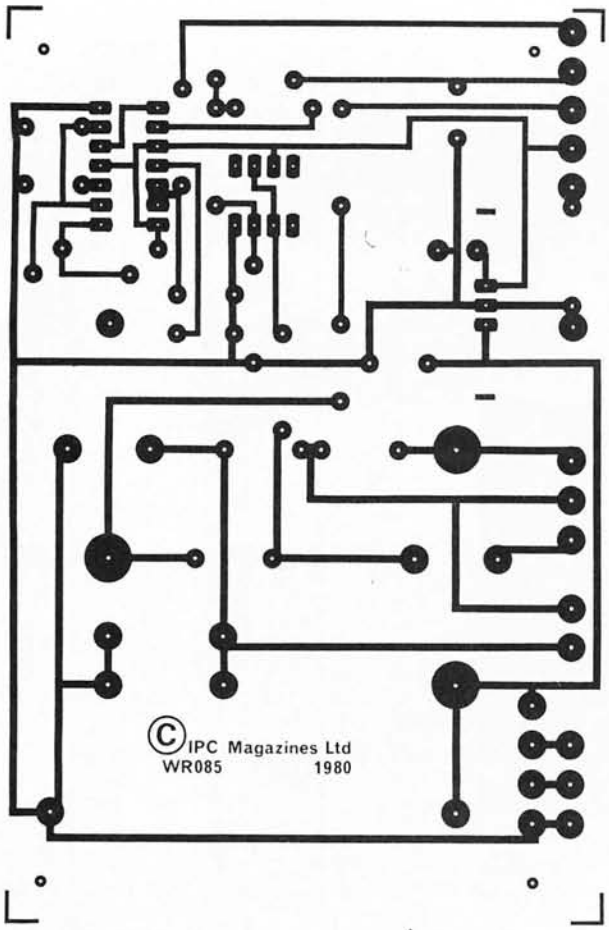
Repeat this test with the inertia control turned up, and observe that the voltage rises and falls exponentially.

With the circuit working up to IC2, repeat measuring the voltage at the output terminals to check that Tr1–Tr3 are operating correctly. If all is well, turn the throttle up to full, select a high current range on your meter, take a deep breath and put the meter across the output terminal. The unit should settle down at about 1A (depending on R10) and nothing should get too hot to touch.

Finally we need to check the creep control. The best way to do this is with a 'scope, but it is not essential. To test with a meter, shut the throttle and apply full brakes to ensure that C8 is discharged. Connect the meter to IC2 pin 6. Operating the creep control will cause the voltage to rise from about 1·5 volts to about 5 volts. If problems are



The p.c.b. and the output transistor mounted on its heatsink. The p.c.b. and the heatsink can be mounted in any suitable box either with or separate from the mains transformer. The controls can be mounted on any suitable panel in a position most convenient for the operator



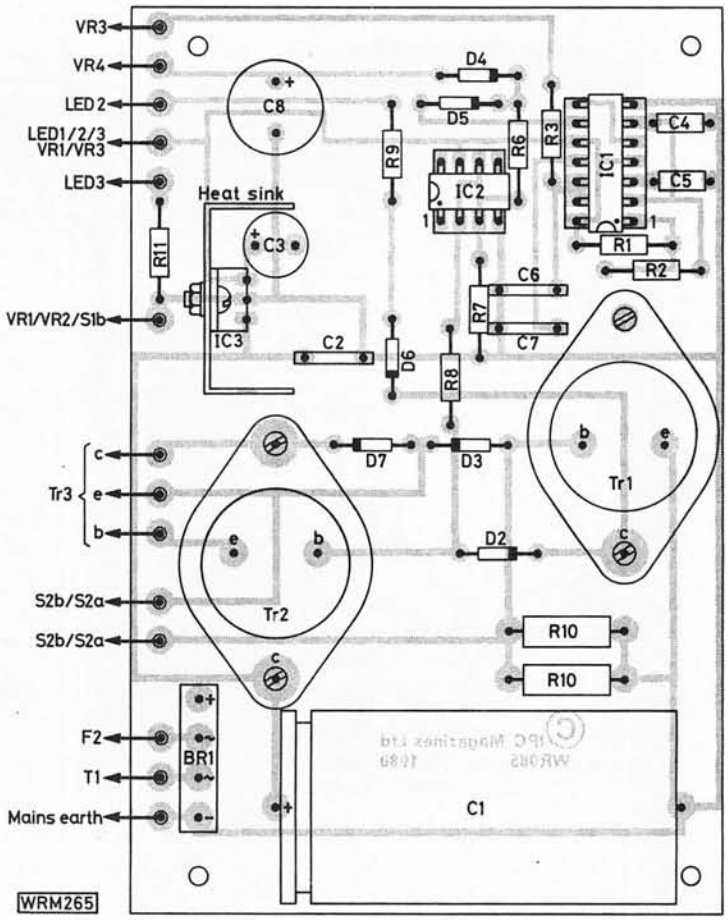


Fig. 4: The copper track pattern for the p.c.b. shown full size. The component placement drawing Fig. 5 is shown above right. Components not mounted on this board should be fitted onto the control panel using the tags on the potentiometers as mounting points

encountered, change C4 and C6 temporarily to 100µF. This will increase the period of the clock to 10 seconds allowing the operation of IC1 to be checked with the meter.

If any problems are found, obvious points to check are solder bridges on the p.c.b. tracks, crossed wires on the connections to the front panel and controls working the "wrong way."

Driving

Driving with the controller will at first be found to be very interesting. Most drivers have a tendency to start off with too much throttle so that the train accelerates up to a speed much too fast for safety, necessitating a quick shut off and a panic application of the brakes which makes the train stop in the middle of the countryside. Great fun for the onlookers! Once mastered, though, it is very satisfying to use.

The creep control will be found useful for shunting. Some locos sound rough when used with the creep control, giving off a 100Hz rattle. This does not seem to cause any problems, however, and is usually a sign of a poorly made motor with slack bearings. ●

KINDLY NOTE!

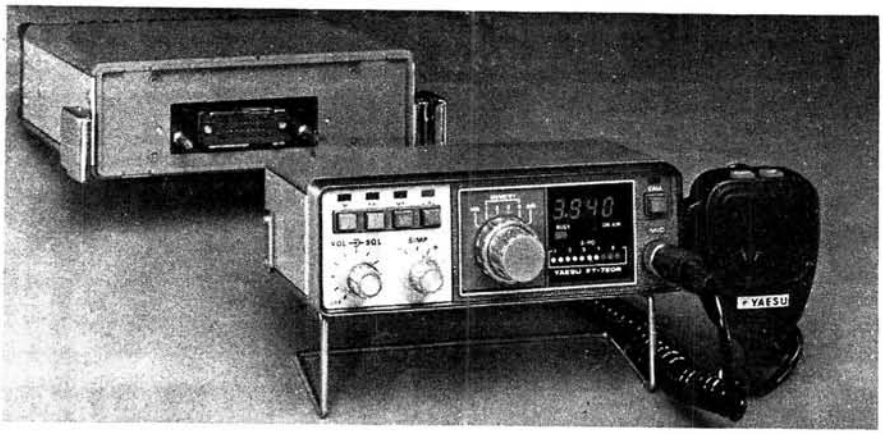
Porch Light Timer, November 1978
Pin 5 of the NE555 should be connected to the negative rail via a 0·01µF capacitor, not directly as shown on the circuit diagram and p.c.b. layout.

'2BCX 16-element 2-metre beam, February 1980
Quite a number of readers have constructed and are successfully using this aerial. Some, however, have chosen to make the driven elements, reflector and directors, etc., of 6mm ($\frac{1}{4}$in) aluminium rod or tube instead of 4·76mm ($\frac{3}{16}$in) rod as specified, and as a result found it difficult to get an accurate match to 50 ohms and consequently a rather high s.w.r.

Although it is quite in order to use thicker element material, this does necessitate using a slightly longer matching line (Fig. 5 (a) and (c) in the article). This line may be constructed either from rod of the original diameter or from 6mm (0·25in) rod or tube, but must be about 100mm (4in) longer so that the shorting bar as in Fig. 5 (b) and feed tapping points can be moved further out. All other dimensions and materials remain the same.

PRODUCTION LINES

alan martin



The latest idea in v.h.f. and u.h.f. mobile rigs is separates. The Yaesu FT-720R is such an animal with pluggable 70cm and 2m r.f. units. Further details of price and availability from: *Amateur Electronics UK, 508–514 Alum Rock Road, Birmingham B8 3HX. Tel: 021 327 1497.*

PCB Processor

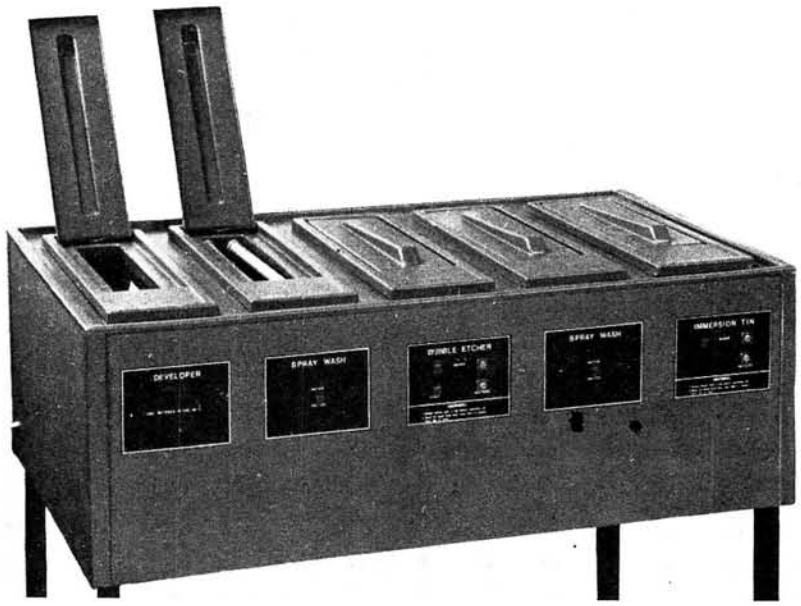
Recently introduced by Mega Electronics is a totally integrated bench-top p.c.b. production system.

Designated the BT-3007, this self-contained production system for p.c.b.s of up to 305 x 254mm incorporates five processing tanks, each of 5-litres capacity, housed together in a free-standing enclosure. These enable the complete production process—develop; wash; etch; wash; and tin—to be executed quickly and conveniently. Complete p.c.b. production times of less than 15 minutes are claimed.

Each tank is manufactured in impact-resistant, vacuum formed ABS, and they are located side-by-side in the free-standing housing. Important safety features include safeguards against spillage and damage during operation. Each tank can be easily removed from its housing for cleaning purposes, and incorporates a hinged ABS lid which greatly simplifies access to the tank for the insertion or removal of the board, and protects the user from splashing.

Standard domestic washing machine pipework is supplied with the system, ready for connection to water inlet and outlet facilities. Where no such facilities exist, the BT-3007 can be supplied with a re-circulation system costing an additional £140 plus VAT.

The BT-3007 measures 1016 x 609 x 787mm high and is supplied ready for connection and operation at a price of £405 plus VAT, and is available from: *Mega Electronics Ltd., 9 Radwinter Road, Saffron Walden, Essex CB11 3HU. Tel: (0799) 21918.*



Lightweight Tool Box

The new 151 Cantilever tool box from Raaco is made from rugged polypropylene and has overall dimensions of 500 x 220 x 220mm. Four tool trays each 480 x 75 x 35mm fold out when the lid is opened. The top two trays are provided with moveable dividers. A fold-flat lid and two safety catches complete an extremely lightweight package which is finished in brown and fawn with white compartmented tool trays.

The Raaco 151 Cantilever Tool Box costs £12.50 plus VAT and is available ex-stock from: *Toolrange Ltd., Upton Road, Reading RG3 4JA. Tel: (0734) 29446 or 22245.*

If you please

Would readers kindly mention "Production Lines", when applying to manufacturers or suppliers featured or this page.

DIL Heat Sink

This new product solves the problem of protecting delicate components when wave or reflow soldering. Beryllium copper spring construction fits 0·3, 0·4 and even 0·6in packages. For really large d.i.l. packages two or more heatsink clips may be used in tandem. The heatsink clip prevents overheating when hand soldering and is ventilated for maximum air flow. Holds securely in all positions—will not come off in handling. Precision made in Switzerland. The d.i.l. Heat Sink costs £1.75 each plus VAT and is available ex-stock from: *Toolrange Ltd., Upton Road, Reading RG3 4JA. Tel: (0734) 29446 or 22245.*

NEXT MONTH IN...

practical WIRELESS

use your 'MOBILE' RIG at 'HOME'

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Have you ever wished that you could operate your mobile rig from the comfort of your shack without having to hump the car battery as well? Build this five-amp stabilised power unit and operate 2m or 70cm in luxury

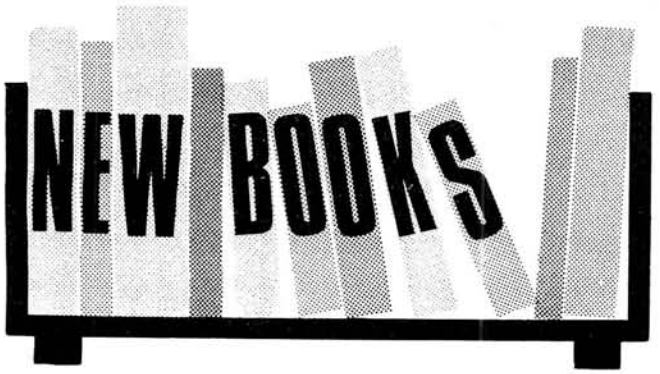
Beginners' metre CONVERTER

If you've had your appetite for amateur radio whetted by listening to the h.f. bands, why not build this simple 2-transistor converter which lets you tune 2m signals on the 29–30MHz band on your general coverage or amateur bands receiver

&

RTTY

RTTY, transmitting the printed word via radio, is a popular facet of amateur radio. This new series of articles will introduce you to the principles, the practice and the jargon, from basics to microprocessor-based systems



THE BEGINNERS' HANDBOOK OF AMATEUR RADIO
by Clay Laster W5ZPV
Published by Howard W. Sams & Co.
(UK Distributors Prentice-Hall International)
384 pages, 215 × 134mm. Price £6.45
This handbook is intended to prepare candidates for the United States FCC Novice Class licence examination. The regulations and procedure sections are, obviously, based on US requirements, which differ radically from those in the UK. The chapters on electrical and radio theory and practice are universal in appeal, though some of the circuit symbols differ from European conventions.

NEWNES BOOK OF AUDIO
Published by Newnes Technical Books
144 pages, 246 × 181mm. Price £4.95
A collection of articles by seven acknowledged experts in the hi-fi field: Donald Aldous, Dave Berriman, Clement Brown, Vivian Capel, John Gardner, Fred Judd and Gordon King. Titles include: Hi-Fi Systems, Cassettes and Cassette Recorders, Records and Record Players, Test Recordings, Tuners and Amplifiers, Aerials and Interference, Making Recordings, Microphones, Loudspeakers, In-Car Audio. There are also special items on: Copyright, Dolby, Connections, Record Manufacture, Radio Frequencies and Wavelengths, Record and Tape Care.

Profusely illustrated, this book would form an ideal introduction to the mysteries of hi-fi, or provide background information for anyone interested in improving their system.

IN GOOD SHAPE
by Stephen Bayley
Published by The Design Council
255 pages, 230 × 185mm. Price £10.00 (paperback £5.95)
An assemblage of essays, photographs and biographies intended to trace the development of industrial product styling during this century. For the majority, the interest will undoubtedly lie in the illustrations—more than 100 in number—showing all sorts of things, from fountain-pens to radios to aircraft. It is a pity that the photographs are in black-and-white only (some could have been of better quality) and that the book could not have been imaginative in its layout; it rather resembles a catalogue.

Some of the descriptions accompanying the product illustrations are irritating. The design of a Volvo car is praised, for example, by openly hostile criticism of that of the trusty Austin Cambridge of the same era, while the Boeing 707 is billed as "the first pure jet aircraft to make jet travel a commercial reality"—deHavilland's Comet is almost studiously ignored. The choice of products could, with benefit, have been much wider in scope and the book would have been more enjoyable (and probably more informative) if it contained fewer and more readable writings and more and better pictures. Some of the author's opinions seem odd; few will agree that "before 1900 there was no such thing as product design" or that the invention of the cylinder vacuum cleaner was "a towering intellectual achievement."

Not very good value for money.

RADIO HANDBOOK (21st Edition)
by William I. Orr W6SAI
Published by Editors and Engineers
(UK Distributors Prentice/Hall International)
1135 pages, 231 × 161mm. Price £12.70
There can be few design offices or labs concerned with h.f. radio communications that do not have a copy of the *Radio Handbook*, in one of its editions, on their bookshelves. It forms a comprehensive reference for both theory and practice of transmitters, receivers, aerials and test equipment for frequencies between 1·8 and 1296MHz. This latest edition covers such developments as phase-locked loops, microprocessors, frequency synthesisers and digital readouts.

SO YOU WANT TO BE A HAM
by Robert Hertzberg K4JBI
Published by Howard W. Sams & Co.
(UK Distributors Prentice-Hall International)
192 pages, 216 × 134mm. Price £4.25
This book provides a good insight into the amateur radio scene in the United States, and will be of interest to established operators. However, many sections could be highly misleading to a beginner outside the US, as the information given is, naturally enough, based on FCC regulations and practice.

AUDIO EQUIPMENT TESTS
by Gordon J. King
Published by Newnes-Butterworths
158 pages, 234 × 154mm. Price £6.50
Followers of our recent *Hi-Fi Glossary* have been introduced to many of the terms and standards concerned with the measurement of hi-fi performance. This book, by the same author, goes into greater detail about the various tests on: f.m. tuners, amplifiers, tape machines, tapes, record decks and loudspeakers; how to make the tests and evaluate the results. A final chapter investigates the thorny question of correlation between auditioning tests and instrument measurement.

ELEMENTS OF ELECTRONICS
by F. A. Wilson
Published by Bernard Babani (publishing) Ltd.
Book 3—Semiconductor Technology
204 pages, 180 × 109mm. Price £2.25
As mentioned in our February 1980 issue, this volume forms part of a new series intended to introduce the beginner to the hobby or career of electronics.

The subjects covered include: semiconductor physics, characteristics (the section on f.e.t.s would have borne a little expansion), rectifiers, amplifiers, oscillators, switching circuits, and integrated circuits. Appendices deal with abbreviations, circuit symbols, binary arithmetic, and graphs.

letters

The Editor,
PRACTICAL WIRELESS,
Westover House,
West Quay Road, Poole,
Dorset BH15 1JG

Back Numbers

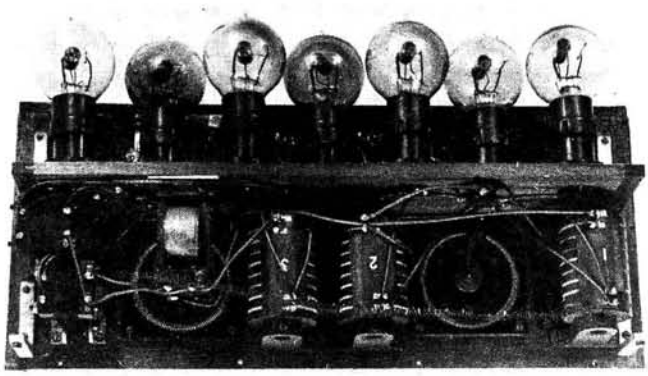
Sir: As storage space is at a premium in our house, I wonder whether readers would be interested in a considerable collection of back numbers of *"Practical Wireless", "Practical Television"* and also six volumes of *"Radio and TV Servicing"* by J. P. Hawker which I have for disposal?

The *PW* collection extends from 1957 until 1977 (almost complete) and that of *PT* from 1957–1975. Offers please on 0222-78799!

D. L. Hughes
"Mountain Air"
Began Road
St Mellone
Cardiff CF3 9XJ

Vintage Amplifier

Sir: In view of the death of Stanley Mullard, reported in your December 1979 issue, you may find the enclosed photograph to be of interest. This apparatus has, I suppose, been in the Department for over 50 years—it has recently been moved from lecture apparatus cupboards to the safety of the Kelvin Museum.



Although named "Seven Valve Amplifier", the device in fact consists of three untuned h.f. stages, a "leaky-grid" detector and three a.f. stages; it is, therefore, an early form of a.m. radio receiver! The wooden box in which the amplifier is normally housed has a circuit diagram inside its lid on which the capacitance values are expressed in "jars" (900 jars = 1μF)—it also bears a brass plate showing the maker's name: "S.R. Mullard, 71 Standen Road, London S.W.18". Research by the University's Archives Dept. revealed that the purchase from Mullard was completed on 2 August 1920; the actual design may well be of First World War vintage.

A few years ago, I showed and actually worked the device at a students' Open Day with the aid of a tuned frame aerial and a horn loudspeaker. The glare from the valves, I remember, was spectacular which was more than could be said for the volume and quality of the sound that they produced!

I wonder whether any of your readers have seen the Mullard Seven Valve Amplifier or similar before and can, perhaps, cast further light on its origins?

J. T. Lloyd
Department of Natural Philosophy
The University
Glasgow G12 8QQ

CB

Sir: It was with tremendous interest that I read the Epistle according to A. Dorsett in the December 1979 *PW*. As a person who has used Citizens' Band equipment in three countries, one of which being the USA, I feel I must point out some flaws in the gentleman's theories.

1. In the first place the most probable frequencies usable for CB in the UK would be u.h.f. As it is most likely that the number of CB operators would be very high in urban areas, the QRM would be of an exceptionally high order. Thus, the benefit of a CB call would be fairly well negated.
2. As a qualified person in the medical and paramedical fields, I should point out that it would be extremely difficult for an emergency message to be passed to a Doctor, Ambulance HQ, Police HQ, etc., in a more efficient manner than at present. Having heard the uproar and bad operating standards in CB countries, I surely doubt the efficacy of Mr Dorsett's claim. Manners simply do **not** exist in CB.
3. Now for the question of mugging. I can assure you that if a person has been mugged, he, or she, is not in a fit state (mentally or physically) to use even a simple CB set. Any witness would most likely be hot-footing it down the road as fast as possible.
4. The "learned" gentleman mentions O.A.P.s, bed-ridden people, etc. Most of these could not afford a CB set. (Believe me, they will not be inexpensive.) Does Mr Dorsett honestly believe that in all the cross chat, an old person's wavery voice would penetrate the QRM. Listen to the h.f. bands and some repeater frequencies.
5. I feel sorry for Mr D. He appears to have a very bigoted, biased and myopic attitude to Radio Amateurs. Why, he even used the idiotic name of "Ham". I have found the greater percentage of Amateurs to be helpful, courteous and unbiased towards CB. As for emergencies—I myself have utilised Amateurs in passing of messages (as per Licence Conditions) of a serious nature.
6. So I suggest to Mr Dorsett that he should remember that there is more to CB than he thinks. By all means—let us have CB. I, as an amateur, welcome it. Also how come Mr Dorsett? You say 30 years at sea in radio, and you fall apart at the thought of exams. Did you not sit a sea going exam?

D. Dhuglas
BSc, SRM, SRMN, GM4ELV
Arrochar
Strathclyde

POWER GAIN FROM TX AERIALS

F. C. JUDD G2BCX

The so-called gain of a transmitting aerial is dependent on the directivity alone, that is, by causing the power supplied to the aerial to be radiated in one or more specific directions. Even the simple dipole is a directional aerial. No aerial produces gain in the sense that it amplifies the power supplied to it, but assuming a perfect aerial with no losses, all the power supplied will be radiated. Also, no aerial exists that will radiate the power supplied in all directions around it (not to be confused with the omni-directional properties of a vertical dipole or similar aerial). By all directions is meant at every angle from a central point within a spherical area.

The Isotropic Source

It is convenient to assume that such an aerial does exist and which is known as an "isotropic radiator" better visualised perhaps as a point source of radiation at the centre of a sphere with an area $4\pi r^2$ as shown in Fig. 1.[1] It could be imagined as a small marble at the exact centre of an inflated and perfectly spherical balloon. If the radiated power from such a point source is "P" then, for a given distance "r", the unit power "P_r" arriving at any single point "p" on the surface area of the sphere will be

$$\frac{P}{4\pi r^2}$$

Because the radiation from an isotropic aerial would be uniform in all directions its gain would be absolute unity. This allows it to be used as a reference against which to compare the directivity and therefore the power gain of aerials having directive properties. As will be shown later, accuracy in this respect has proved to be equal to and even better than that obtained by direct measurement using a real reference aerial, such as a dipole.

If the isotropic aerial could be replaced by a real directional aerial, then the power from this reaching the surface of the sphere as in Fig. 2 would be concentrated through an area formed by a cross-section of the whole radiation field. The position of this cross-section is taken as being between the angles intersecting points where the power amplitude is 3dB down from maximum, i.e., at 0·707 of maximum radiation intensity.

If this cross-section were circular, with a diameter of say 40 degrees, then its area would be

$$\frac{\pi}{4}d^2 = \frac{\pi}{4}40^2 = 1256{\cdot}63$$

square degrees. The ratio of this area to that of the sphere in square degrees is a direct ratio of directivity and also the power gain of the directional aerial with reference to the isotropic source.[2] Taking the area of the sphere as $4\pi 57{\cdot}295^2$ or ≈ 41253 square degrees, the power gain of the directional aerial would be

$$\frac{41253}{1256{\cdot}63} = 32{\cdot}82$$

The power gain in decibels would therefore be 10Log_{10} 32·82 or 15·16dB, or more correctly, 15·16dBi ("i" indicating the gain over an isotropic source).

Application to Real Aerials

This method of assessing power gain can be applied with reasonable accuracy to all aerials having a main single lobe providing the maximum amplitude of side or rear minor lobes is more than 15dB down with respect to maximum amplitude in the main lobe. What we need to know otherwise is the area of the cross-section of the main lobe at half power which is −3dB or 0·707 of maximum radiation intensity, i.e., the intensity at the most forward tip of the main lobe.

Polar Co-ordinates

Radiation patterns are usually plotted in polar co-ordinates and the usual reference for maximum intensity is either 1 or 10. These figures are of little consequence providing the scale along the axis of the lobe plot is linear. It is only necessary to ascertain the 0·707 point of the

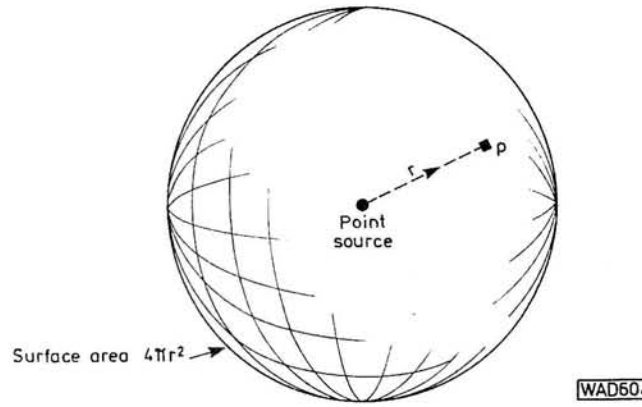


Fig. 1: Configuration of an isotropic radiator as a point source

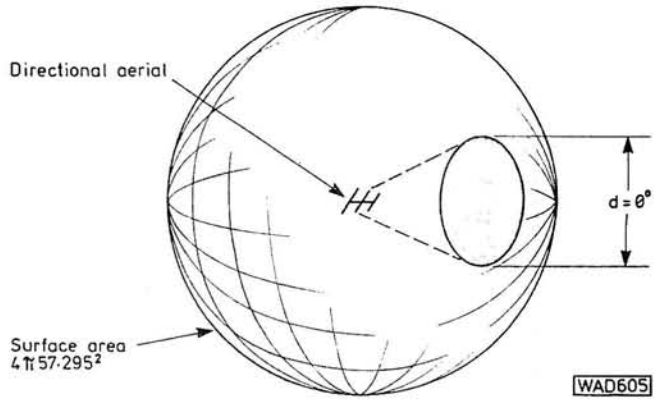


Fig. 2: Area of directed radiation in relationship to that otherwise produced by an isotropic source

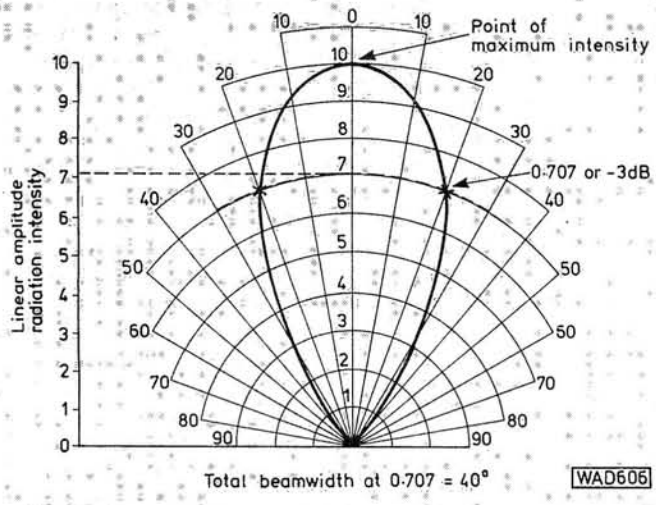


Fig. 3: How the beam width of radiation at −3dB is established with reference to absolute intensity

maximum and the angles where the lobe plot crosses this point as in Fig. 3.

The beamwidth at the −3dB points of commonly used aerials is, however, rarely the same for both horizontal and vertical polarisation, often being wider in one particular mode. Hence the reason for establishing the total beam area at −3dB which in some cases will, therefore, be elliptical. Typical polar patterns for vertical (V) and horizontal (H) modes are shown together in Fig. 4(a). In horizontal mode the beamwidth at the −3dB points is 34 degrees and in the vertical mode 40 degrees, thus producing the elliptical area as in Fig. 4(b). Taking the area of a sphere as before, we have

$$\frac{41253}{0{\cdot}78534 \times 34 \times 40} = 38{\cdot}624$$

this being the power gain. Converting to dB this becomes $10\text{Log}_{10}\ 38{\cdot}624 = 15{\cdot}86\text{dBi}$ (gain over an isotropic source).

It is more usual to refer to "gain over a dipole" (dBd), and since the power gain of a dipole over an isotropic source is 1·64, which is 2·14dBi, it is only necessary to subtract this from the gain of an aerial reference to an isotropic source. In the example above the gain over a dipole would be 15·86 − 2·14 which is 13·72dBd.

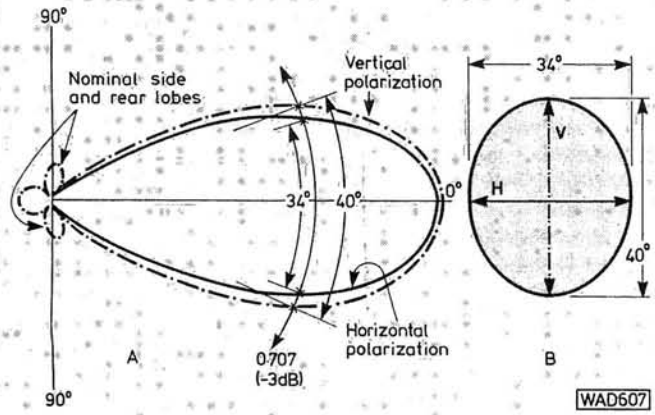


Fig. 4: How the total area of the beam at −3dB is established

However, it is possible to allow for this when using the "area of a sphere/area of lobe at −3dB" method and get the power gain over a dipole directly. The fact that the lobe cross-section might be elliptical or circular must first be taken into account. With the area of a sphere taken as 41253 square degrees, divide this by

$$\frac{\pi}{4}(\approx 0{\cdot}78534) \text{ which is } \approx 52525$$

Elliptical or circular areas in square degrees can now be derived from the beam widths in degrees for both horizontal and vertical modes which are simply multiplied together.

Next, the power gain of a dipole over an isotropic source must be accounted for by dividing 52525 by 1·64 which is ≈32027. The formula for gain over a dipole in dB now becomes

$$10\text{Log}_{10}\left(\frac{32027}{\theta_H \times \theta_V}\right)$$

where θ_H and θ_V are the half-power beamwidths in degrees for the horizontal and vertical modes respectively.

The graph in Fig. 5 gives a range of gain factors from 5 to 25dBd for the −3dB main lobe areas from 100 to 10 000 square degrees. Note the addition of 10 to the dB figure when the square degrees are between 100 and 1000. Accuracy of the method depends mainly on the accuracy of verifying the 3dB beamwidths in degrees in the first instance, but will generally be to within better than 1%. Checks carried out with both scale models and normal full-size aerials have proved that the method is viable.

Power Gain and Effective Radiated Power

Effective radiated power, or e.r.p. is the product of power fed to the aerial times its power gain. For example, an aerial having a gain of, say, 14dB over a dipole, would have a power gain of 25·12. Therefore, assuming no losses, the e.r.p. from ten watts fed to such an aerial would be 25·12 × 10 = 251·2 watts.

Provided they are well constructed with good insulating materials, etc., and in clear surroundings; v.h.f. aerials have little loss so a near true e.r.p. can be expected. Mismatch between feeder and aerial, or transmitter, and also feed cable loss will of course reduce the power actually reaching the aerial. A real 3dB loss in feed cable for example, would be a loss of half the power to the aerial.

Aerials for the h.f. bands generally exhibit higher self-loss due to conductor resistance and ground reflection losses because efficient operation of such aerials relies to a great extent on the effectiveness of the ground conductivity. However, to get some idea of the e.r.p. of an aerial, the real power gain must be known. Aerial gain will be quoted either in dBd or dBi so power gain could be that over a dipole or an isotropic source. If the latter, then the power gain figure will be larger. In the example given, 14dB over a dipole, the gain over an isotropic source would be 14 + 2·14, the power gain of which is approximately 41.

With 10 watts the e.r.p. would therefore be 410 watts but only with reference to an isotropic source, of course. So first establish how the aerial gain is quoted because it is usual to rate e.r.p. with reference to a dipole. Table 1 shows power gain from dB gain over a dipole, and it must be remembered that 2·14dB should be subtracted from the figures for dBd if gain is given with reference to an isotropic source.

Gain is Known but What is the Beam Width?

If the gain of an aerial is known with respect to a dipole, or an isotropic source, the beamwidth at the −3dB points can be verified to within a few degrees. The figure will not be precise if the beam area is elliptical but will otherwise give a reasonable indication for both horizontal and vertical mode. First find the real power gain over a dipole from the gain in dB, subtracting 2·14 if the gain is given with reference to an isotropic source.

For example, the gain is 12·5dBd so the power gain will be 17·78 and divided into 32027 equals 1801 square degrees, which is the beam area. The square root of this will give the approximate beam width at the −3dB points for both horizontal and vertical mode which would be $\sqrt{1801}$ or near enough 42·5 degrees.

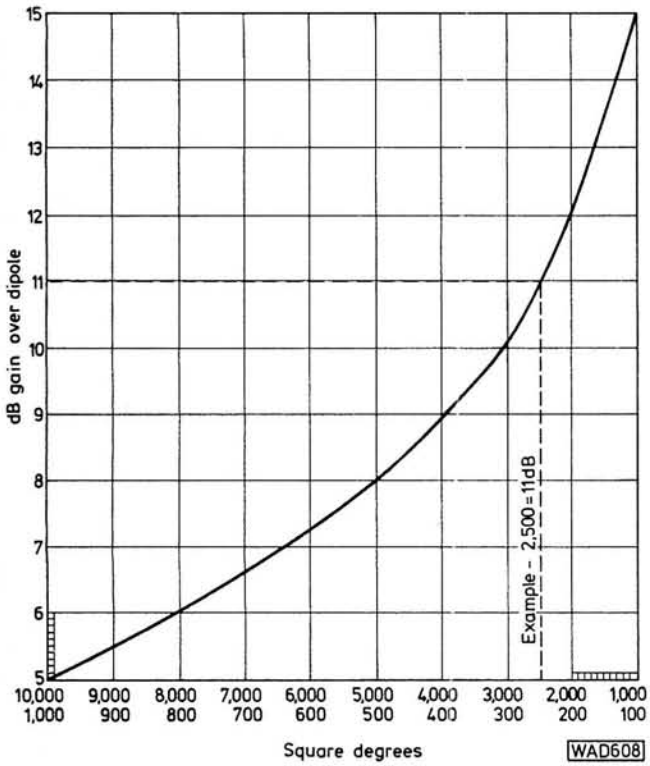


Fig. 5: Graph showing gain of aerial in dBd from a total beam area in square degrees. When lower degrees scale (100 to 1000) is used, add 10 to dB reading, e.g., 500 = 18dB

Table 1: Derivation of power gain from dB gain

dBd	Power Gain	dBd	Power Gain
3	1·995	10	10·00
4	2·512	11	12·59
5	3·162	12	15·58
6	3·981	13	19·95
7	5·012	14	25·12
8	6·310	15	31·62
9	7·943	16	39·81

Power Losses and Front to Back Ratio

Virtually all beam aerials have small rear and/or side lobes or both and generally speaking the higher the forward gain, the less will be the effective amount of radiation from such lobes. By effective is meant the amount in relationship to the full gain of the aerial and is normally expressed as a ratio in decibels. However, the term "front-to-back" implies the ratio of the main lobe level to that from a rear lobe and seemingly not to take any other minor or side lobes into consideration. The term "front-to-back" and the ratio expressed may not, therefore, give a true impression. Power radiated in any lobes other than the main lobe is power lost in the main lobe.

The amplitude of the main and side lobes is usually plotted on a "linear received units of voltage" scale which is used in most polar co-ordinate plots. To simplify things however, a typical Cartesian plot of the radiation from a beam aerial is shown in Fig. 6. Diagram (a) together with (b) is the equivalent in polar co-ordinates. The rear lobe amplitude is 1·3 relative to that of the main lobe maximum at 10. The ratio of these two levels expressed in decibels is

$$20\text{Log}_{10}\frac{V2}{V1}$$

where V1 is the level referred to, i.e. that of the main lobe. Therefore,

$$20\text{Log}_{10}\frac{1{\cdot}3}{10} = -17{\cdot}72\text{dB}$$

The side lobes in Fig. 6 would be

$$20\text{Log}_{10}\frac{0{\cdot}4}{10} = -28\text{dB}.$$

The minus sign indicates a level below that referred to (V1 = 10) and which would be termed 0dB.

Such ratios expressed in decibels, but from real power levels, would be exactly the same, but since power equals voltage squared, then the formula

$$10\text{Log}_{10}\left(\frac{V2}{V1}\right)^2$$

would give the same answer, e.g.

$$10\text{Log}_{10}\left(\frac{1{\cdot}3}{10}\right)^2$$

which gives −17·72dB.

The percentage of power lost in rear and other minor lobes is relatively small providing such lobes are below about −15dB. Nevertheless, a primary consideration in the design of any beam aerial is keeping minor lobes to the lowest possible level. With parasitic arrays, this entails critical spacing between elements and very careful adjustment of element lengths.

Gain and Effective Aperture

The effective aperture of an aerial may be larger or smaller than the physical area occupied by the aerial. Fairly high-Q parasitic and driven arrays commonly used by radio amateurs have an effective aperture which is considerably larger than the physical area they occupy, and is closely related to gain and/or directivity and frequency of operation.

Although it can be shown that the effective aperture is virtually the same for reception as it is for transmission, the reason is rather too complex to deal with here.[1] Nevertheless, effective aperture does have a direct relationship with the "reciprocity theorem" which indicates that the gain and directivity of an aerial are the same for transmitting or receiving.

Knowing the effective aperture of an aerial typical of those used for amateur radio, will add little or nothing to

what may already be known about its performance. It is dealt with here mainly out of interest and for commonly used aerials can be determined in "square wavelengths" from the simple formula

$$\frac{1{\cdot}64}{4\pi} G_p$$

where G_p is the power gain over a half-wave dipole. The effective aperture of a dipole which has a gain of unity (1), is

$$\frac{1{\cdot}64 \times 1}{12{\cdot}566} = 0{\cdot}13$$

square wavelengths.

Because the effective aperture is due to scattered radiation and its recapture, the area of the aperture tends to be elliptical as shown in Fig. 7(a). A graph for determining effective aperture for aerials with different power gains, or directivity, is shown in Fig. 7(b). The dotted line example shows that for a beam directivity of 2000 square degrees, which in power gain is

$$\frac{32027}{2000} = 16{\cdot}01 \text{ (gain in dBd is } 12{\cdot}04)$$

the effective aperture will be

$$\frac{1{\cdot}64 \times 16{\cdot}01}{4\pi} = \frac{26{\cdot}25}{12{\cdot}566}$$

or 2·08 square wavelengths. The real proportions of effective aperture can be better visualised if square wavelengths are converted to square metres.

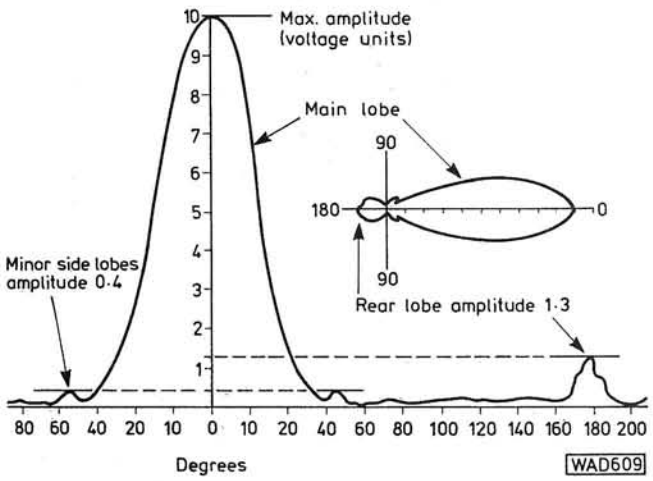


Fig. 6: How the dB level of rear and other minor lobes is related to gain of main lobe at maximum intensity

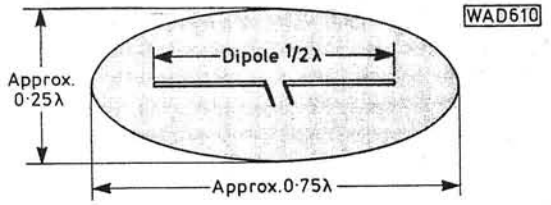
If the wavelength for the above example was 2 metres, corresponding to a frequency of 145MHz, the effective aperture area would be 2·08 × 2 = 4·16 square metres. As another example, an aerial with a gain of 3dB operating at 20 metres, or 14MHz, would have an effective aperture of

$$\frac{1{\cdot}64 \times 2}{12{\cdot}566} \times 20$$

or 5·2 square metres.

Gain by Stacking or Baying Aerials

This is a subject that would warrant a whole article, but suffice to say here that additional gain can be obtained by stacking aerials one above the other or by baying them side by side. The theoretical gain for a pair of identical aerials is 3dB, so if one aerial has a gain of 10dB then the gain from a pair would be 13dBd and not twice the gain as many suppose. However, the theoretical 3dB is rarely if ever obtained, and even with careful matching and phasing



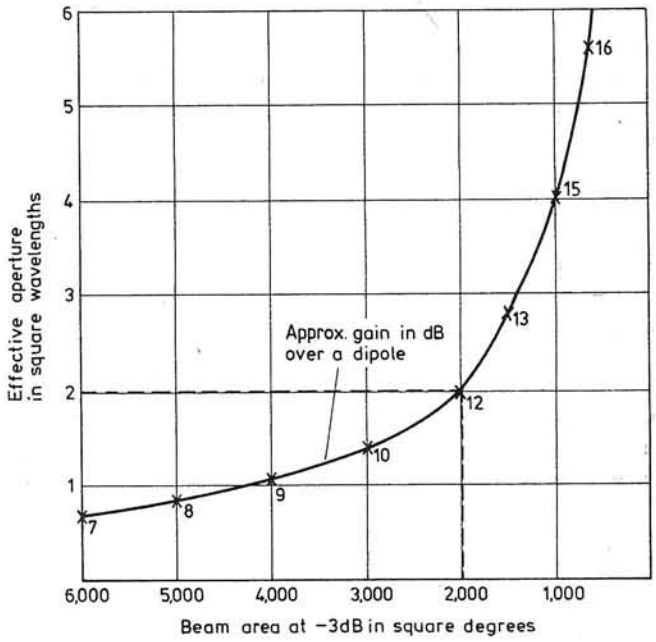


Fig. 7(a): Effective aperture of a half-wave dipole

Fig. 7(b): Effective aperture derived from total beam area or power gain. Note:

$$\textbf{Power gain} = \frac{32027}{\text{"n" square degrees}}$$

or from the table of dB to power gain

and the necessary wide spacing, the result will probably be no more than 2 to 2·5dB.

The fact that two aerials require twice the amount of material used for one is worth taking into consideration, particularly by those who construct their own aerials, and it may be cheaper to get a real 3dB extra gain by using a single aerial with that much higher gain built in.

Summary

It must be appreciated that reasonably accurate calculation of gain from beam directivity area assumes that losses due to the aerial itself, e.g. high radiation resistance, poor insulation and proximity losses, etc., are reasonably low. Losses due to feed cable mismatch or actual cable loss do not affect aerial gain or the radiation pattern, but power wasted by such causes is power lost to the aerial. Extensive tests with scale model aerials and full size operational aerials, using direct measurement against a reference dipole versus the beam area method, have proved the viability of the latter. Without carefully controlled and known conditions, the direct measurement or comparison method can be very seriously in error. ●

References

1. *The Services Textbook of Radio. Vol. 5. Transmission and Propagation. HMSO 1958.*
2. *Antennas. John D. Kraus. McGraw Hill Book Co. Inc.*

Looking in at Land's End

If at first you don't succeed.....

Denys Val Baker

An old mill-house nestling deep in a lovely valley in far flung Cornwall, the storm-swept western extremity of England; this was our new and romantic home.

When we moved in, solving the mundane problem of how to receive TV was not exactly a top priority matter—there was so much else to see and do. We had left the aerials installed at our previous house for the new occupant's use, but we had brought with us a tried and trusted set; if it was to be of any use, down here in the far West, a new aerial array would have to be installed.

Here, for the edification of *PW* readers, is the cautionary tale of a minor engineering saga.

Mr R.

At last, when we were sufficiently settled in to think about our evening relaxation, I let my fingers do the walking and rang up a firm of television engineers. Could they kindly come out and put up aerials for BBC1, BBC2 and ITV? There was a good solid chimney, I said—the job wouldn't take long.

Weeks passed, but at long last Mr R. duly arrived. In a smart van, complete with long aluminium ladders and coils of wire, he was a tall man wearing a beret and a perpetually worried look. The result, he gave us to understand, of having to cope with so many difficulties about people's television aerials. Aerials, not sets, interested him as a permanent challenge to his technical virility; we may not have realised it, but every aerial presented a unique problem of its own.

Mr R. took a glum look around our picturesque and rural setting—hills everywhere. Worse, hills capped by clusters of tall swaying trees; he gave a despairing shrug. When we had rung up he had been afraid of trouble at once: now that he could see for himself—well, there wasn't much doubt. We might as well advertise our set in the local paper and get rid of it. We'd never get any reception in a valley like this.

Mr R. didn't expect us to take his word for it—that was the depressing thing about him. He told us first what would not happen and then, almost cheerfully, went through the labour of proving that it couldn't happen. We were not even granted the brief pleasure of early false optimism—Mr R. *knew*. His lugubrious countenance and shrugging shoulders constantly confirmed that the whole thing was doomed.

Over a long and expensive period, however, we discovered that Mr R. was not a man to give up easily. He despaired as if by habit but could be goaded into repeated assaults against Fate.

Gloom

On this first day, Mr R. quickly erected his ladders, shinned up, wound several coils of cable around the chimney, put up three aerials, shinned down again—and stood looking at us with an expectant air of defeat.

"You'll never get a picture—never."

Even so Mr R. went in, switched on our set and twiddled the knobs vigorously. Beside him, my wife and I stood imbued with a growing sense of gloom. On the screen there flashed lines, shadows and dots. Nothing even resembling a picture.

"I told you so," said Mr R. moodily, "You'll never get a picture down there, I said. Didn't I Sam?"

Sam was Mr R.'s "mate". A nice friendly man who was full of hopeful suggestions. Like now. "Why don't we try running a cable higher and see what we get? Why don't we put in a couple of boosters and justify the length of the cable?" Most of Sam's suggestions seemed practical; designed to thwart Mr R.'s perpetual pessimism. With sinking hearts, however, we realised that it was Mr R.'s pessimism and not Sam's optimism that had true validity.

Mr R. was always gloomily right.

But, it must be stressed, curiously willing to put anything to the test. Egged on by Sam and ourselves and working himself like a beaver, Mr R. clambered all over our three acres of wild and undulating land. He began half way up the rockery at a point which must have been 80ft higher than the house, erecting a 24ft mast complete with guys. That didn't take long and it took an even shorter time for our massed deputation to discover that nothing had been achieved. The set produced a faint, garbled, high-pitched bleeping which Sam thought might be someone talking on ITV, and that was the peak of achievement.

Then it was that Mr R. and Sam set their eyes on "the trees", at a high-up spot bordering a neighbour's field. "Give me a tall tree," said Mr R., "and I've got a head start." Feeling a flicker of new hope, I left him to get on and came back an hour later to find guy-ropes stretching in all directions, a veritable cat's-cradle. High up in "the trees", which must have been 30ft tall, was yet another aerial.

"Ah!" I said eagerly, "that should do the trick, eh?" I thought that I sensed Sam silently agreeing with me.

"I'll be honest with you, sir. I don't think it will make a pennyworth of difference."

Fervently hoping that it would, since the project had already consumed a good many pennyworths, I joined the usual procession down to the lounge. Mr R. switched on the set: dots, flickers and suddenly, out of nowhere, a picture. Somewhat blurred, but a picture.

Post Office Pole

"That's ITV," said Mr R. dolefully. "Strongest signal around here, you see. Just wait until we try BBC."

We tried BBC. Out of the shadows, briefly, emerged the very distant outline of a pert little girl, smiling. Soon her smile began to fade, never to return. It was at that desperate moment that our thoughts turned to the very highest spot on our land, a whole 300ft above the house. Surely from *there?*

Even Mr R.'s pessimism was briefly shaken. Yes, he agreed unhappily, you *might* get something of a picture. But you'd need height and a good solid post. Did we happen to have a telegraph pole? Well, we didn't but the Post Office, we discovered, did. It was lying at the side of the road in a village 18 miles away; we would have to transport it ourselves though. A pick-up should be adequate for the job, they said.

I hadn't got a pick-up but did, however, have an old and battered saloon whose roof-rack had carried some strange objects but never, admittedly, a telegraph pole. One day, three of us drove over and heaved the slimy, mossy pole onto the roof. With its extremities protruding five feet beyond the ends of my aged vehicle, and with a chorus of alarming creaks as an accompaniment, somehow I managed to get it back home along the winding Cornish lanes. The next day, and it nearly killed us, we dragged its 24ft length up the steep slope of our field to the corner where I had already dug a hole. The GPO had recommended a hole at least five feet deep—below two feet, however, was solid granite and so I added a Heath-Robinson arrangement of wedges, ropes and copious quantities of cement to give extra support.

Nevertheless, it was up; Mr R. and his henchman came out, shinned up their ladders and tacked on the aerials. Gathered in the lounge, we actually witnessed reception of bearable quality—a miracle. Mr R. went away shaking his head, whether in gloom or satisfaction I could not be sure. I was sure only that our TV saga had by no means ended.

continued on page 76▶▶▶

HOTLINES

A REVIEW OF RECENT DEVELOPMENTS

In general, the author does not have any more information on products than appears in the article.

Nanobridge

Perhaps the smallest switch using a conventional "lever" is the dual in-line switch. Semiconductors could also be thought of as switches and could fairly claim to be smaller. In terms of switching, the smallest I've come across is a thing called the nanobridge. It's so small, that in its fabrication we're talking of widths and distances of less than 200 atomic diameters. One possibility is that very short switching times are achievable, probably only a few picoseconds. The bonding pads for these experimental devices are 80 nanometres thick and are formed from superconducting niobium. These are laid down using an electron beam which "writes" directly onto the wafer. The next stage is to deposit a 30 micrometre layer of niobium over the whole chip. This is coated with a thin film of silicone oil using a vapour deposition technique. The actual elements of the switching bridge pattern are then traced out using an electron beam again which has the effect of polymerising the oil film. Ion milling is then carried out which leaves the original bonding pads connected to the super-tiny bridge elements that do the switching. Researchers hope to study even smaller constructional dimensions, and separation distances of 40 to 50 Angstroms in tunnelling structures are mentioned.

Oil by Radio

Oil is commonly used in various forms of heating, but a new twist is to use heating to get the oil in the first place—and to heat it underground. Deep down in darkest USA experts have estimated millions of "barrels-worth" of oil in the form of shale deposits. Around 100 years ago, the discovery of crude oil, and the ease of mining it, made shale oil uneconomic. Today, it's a very different story. The clever part about this latest discovery is the proposed method of mining it. One way, used in the early days, was to heat the mined shale above ground to convert the Kerogen into oil and gas. This method has problems, like it requires huge amounts of cooling, and it produces pollution problems. So the experts are using electronics to heat the shale/Kerogen where it is—underground. The idea is to sink a number of antennas into the ground and to feed them with heat-generating radio frequencies. The process comprises two stages. First, power at around 1MHz is fed in. This raises the temperature to around 100°C causing the free water in the shale to evaporate and to escape in surrounding fissures. A further r.f. power signal is used, but the frequency is undefined. It is reported to be in the 100kHz to 100MHz region! This heat is applied until the Kerogen eventually becomes oil which is then pumped to the surface. Perhaps modulated r.f. could be used, say "Today in Parliament". The oil industry could thus provide amusement as well as oil thus allowing would-be political buffs to keep an ear to the ground, so-to-speak?

Small Hall Switch

Hall effect devices are at last surfacing in a number of applications, some of which could make them useful for the hobbyist. An advantage is their very small size. The UGN-3019T, for example, is about the same size as a 2N3819 f.e.t. and can be used for various switching applications such as a tilt sensor, limit switch, pressure switch and so on. This particular Hall effect device has a built-in voltage regulator to guarantee a stable performance over a range of operating voltages from 4·5V to 16V. The plastic encapsulated package has three leads and measures only 0·2mm thick.

Looking for Cancer

Cancer is a target for many medical researchers, and in a number of instances, electronics is helping. Like the latest device; a hand-held unit that can detect and treat certain cancers. The system comprises two main parts—a radiometer, and an oscillator. Apparently, cancerous tissue retains a tiny bit more heat than the surrounding normal, healthy tissue. The radiometer uses microwaves at 4·7GHz as a means of detecting this tiny temperature difference. Its complementary oscillator, operating at 1·6GHZ is used to attack the cancer. Early on in development work, researchers used a ferrite sphere which they "hid" in some dielectric material. A very small amount of microwave heating was applied and as a result, the hidden sphere was located to within 3mm. Temperature differences of 0·16°C were also detectable. This latest unit should be capable of detecting temperature differences of only 0·05°C. One exciting possibility is that these small units could be used to screen patients very quickly for cancer, and to be capable of detecting tumours that are so small they may otherwise have passed undetected. Checking a number of patients very quickly, and without any exposure to X-rays is attractive. The system currently has an output of 25W which, although low, is sufficient to raise the temperature of a tumour the few degrees needed to trigger regression.

Talking Calculators

Electronic calculators have come a long way from the first, large and clumsy four-rule beasties. Today there are types to appeal to almost everyone. They play tunes, give printouts and so on. The problem for most manufacturers seems to be finding a gimmick that will appeal. The latest one to shout for attention is one with an electronic larynx.

Already on sale in Japan for around £120, it has a built-in speech synthesiser causing the calculator to call out the function or number each time the user presses a key. When the "=" sign is pressed, it calls out the answer. Another feature is called memory playback. This allows you to recap what you've already fed in, i.e., what function and number keys you've already pressed. You can do this up to 100 steps back. As a double check, a 16-digit fluorescent display shows entries and results. Presumably there will be a version for lonely sea captains which, on switching on, will announce, "Hello sailor".

Ginsberg

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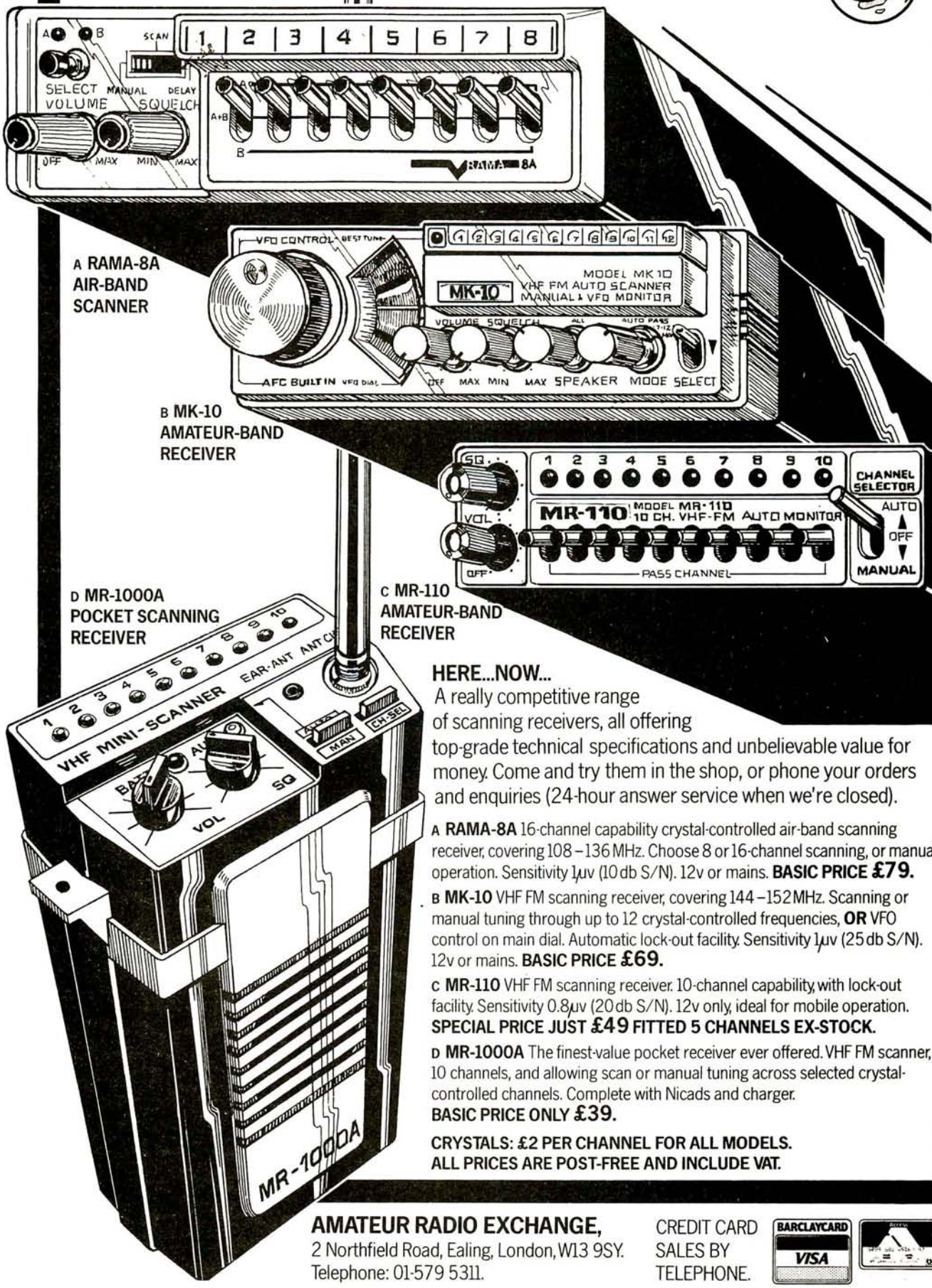

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MAKE A GOOD START

A GOOD START is essential to short wave listening and expert advice is important in achieving this – So here's some – If you've made up you're mind to buy a receiver you should be aware it will perform only as well as the antennna it sees. The old adage regarding wire antennas "As long and as high as you can" is still good, but at best is only good for PEAK PERFORMANCE on one or two frequencies, at worst none.

Whichever frequency you tune your receiver to, for PEAK PERFORMANCE on all frequencies you need good matching between your Receiver and Antenna to hear the best from it. If you plan to listen on the high frequency bands up to 30MHz then you know you can't have an antenna for every frequency! Or can you? – Well Not quite! BUT we can offer you MUCH IMPROVED PERFORMANCE from your receiver by using an antenna tuning unit, that will electrically change the length of your antenna to match the frequency you select – In other words – A MATCH AT ALL FREQUENCIES.

You'll see many antennas being advertised under gimmicky names, but when it comes down to it they're only random wires or odd configurations. At the end of the day, if you're expecting the performance the manufacturers want you to have, you'll still have to buy an antenna tuning unit.

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Base-Station Adaptor

(Part 5)

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All constructional work should now be completed and all components mounted in the diecast box complete with the p.c.b., all interconnections being made and soldered up. Checks for short circuits should now be made and if all seems satisfactory, then a start can be made on the setting up procedures and testing of the completed unit. As was mentioned last month, any transceiver with a power output of up to 1W in the 2m band may be used as the exciter equally as well as the "Nimbus" for which this amplifier was designed.

Initial Tests And Alignment

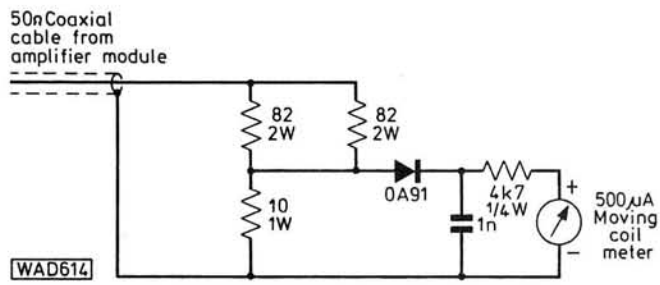
Carefully check the internal wiring before testing. Connect a supply, either 240V a.c. or 12V d.c. and check the voltage at Tr4 collector which should be approximately 12V. Connect the *PW* "Nimbus" (or an alternative low power 2m transceiver) to SK2 via a short length of 50Ω coaxial cable terminated each end with a PL259 plug. Connect a 50Ω aerial system to SK1 and select a channel on which a local signal can be heard, which may conveniently be your local repeater. Adjust TC1 and TC2 for maximum received signal. If an S meter is fitted to the transceiver, the adjustment of TC1 and TC2 can be finalised, if not, repeat the adjustment using a weaker signal, the correct position being already established roughly using the stronger signal. Control VR1 should now be set in its fully anti-clockwise position.

Terminate SK1 with a 50Ω resistive dummy load connected to a r.f. voltmeter, a sensitive v.h.f. watt-meter, or alternatively use the combined dummy load/output indicator described in Figs. 9(a) and (b). If desired, the entire dummy load assembly may be enclosed in a metal box in order to prevent radiation. The screen of the coaxial cable should be connected to the metal screening at the point of entry.

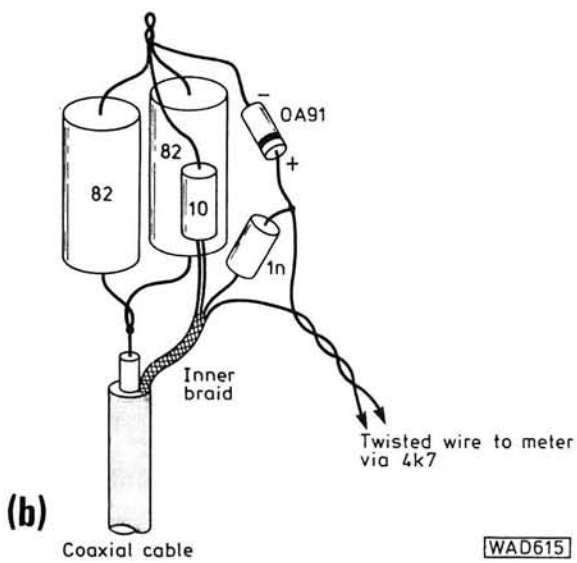
If an output indicator is not available then the forward position of S2 should be selected and the internal meter can then be employed. This is not quite as satisfactory as measuring the true output since it assumes that the v.s.w.r. bridge is operating correctly. Operate the p.t.t. switch on the "Nimbus" and check that the amplifier module relay operates properly.

Adjust TC3, TC4, TC5 and TC6 for maximum output. There will be quite considerable interaction between TC3/TC4 and TC5/TC6 therefore this adjustment should be repeated several times for optimum results. If maximum output coincides with TC5 at maximum capacitance, a small fixed capacitor of 22pF or 33pF may be wired in parallel with it.

Once maximum output has been achieved, the operation of the v.s.w.r. bridge can be checked. Switch S2 should be put in the forward position and VR1 adjusted for full-scale reading (100μA or 10 on the meter scale).



(a)



(b)

Figs. 9(a) and (b): Circuit and construction of the combined load and output indicator. Note: All leads, with the exception of the twisted wire connection to the meter must be kept as short as possible

Table 2

Meter Current (μA)	Actual scale reading	Approx. v.s.w.r.
100	10	infinite
90	9	9:1
80	8	6:1
70	7	4:1
60	6	3:1
50	5	2·5:1
40	4	2·1:1
30	3	1·75:1
20	2	1·5:1
10	1	1·3:1
0	0	1:1

Calibration markings for meter to read v.s.w.r. direct

Then S2 should be switched to reverse. Ideally, there should be no reverse indication at all which corresponds to unity v.s.w.r. or a v.s.w.r. of 1:1. In practice, some reverse power will be present due to an inevitable slight mismatch of the load. The v.s.w.r. should normally be less than 1·5:1 and will usually be around 1·2:1. Do not worry if the v.s.w.r. is 1·5:1, or even a little greater than this; the loss of signal due to a mismatch of this magnitude is quite negligible! A suitable calibration chart for the v.s.w.r. meter is shown in Table 2, with a typical meter scale depicted in Fig. 10.

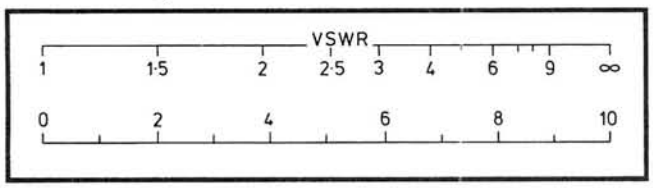


Fig. 10: Typical calibration of the meter scale

Adjusting The Protection Circuit

After completing the tuning-up procedure and having ensured that the power amplifier is operating correctly, the protection circuit may be adjusted. The amplifier should be terminated with a 50Ω resistive dummy load as before. Potentiometer VR1 should still be in a fully anti-clockwise position. Slowly move the slider clockwise until the trip operates which will be indicated by D6 becoming illuminated. Back-off the setting of VR1 slightly (the trip should still be operative and the p.a. disabled), and then reset the trip by temporarily switching off the mains or battery supply. After switching on again, the p.a. should return to normal operation with full r.f. output.

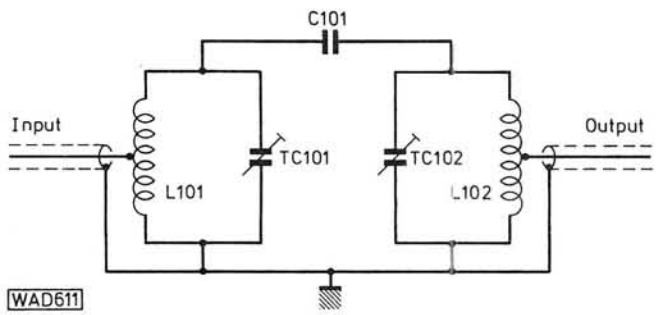


Fig. 11: Circuit diagram of the optional filter unit

To check that the protection circuit is operating correctly, temporarily disconnect the dummy load which should immediately operate the trip, D6 becoming illuminated and the r.f. output falling to zero. If this is not the case, repeat the adjustment procedure as detailed above but do not back-off the setting of VR1 quite so far. A little experimentation may be required to find the optimum setting of VR1, but if the trip fails to operate correctly, check the wiring around Tr3, CSR1 and Tr4.

Optional Filter Unit

Although the output signal from the power amplifier is substantially free from spurious signals, the addition of a high Q filter in the aerial feed line is an extra safeguard that allows the user to operate with the confidence that his transmitted signal is "clean" beyond reproach. Furthermore, a high Q aerial filter can have a dramatic effect on receiver performance. In this respect, it can help to eliminate the effects of second channel interference and considerably reduce blocking and cross-modulation effects when very strong out-of-band signals are present. This feature may be particularly important in urban areas where there are numerous other services operating in the v.h.f. spectrum.

The circuit of the filter unit is shown in Fig. 11. It consists of two parallel tuned circuits connected in a bandpass coupled arrangement. The Q of each tuned circuit is made as high as possible (in practice, an unloaded Q of greater than 150 can easily be achieved). Top coupling via a very small fixed capacitor is used to facilitate the transfer of energy from one tuned circuit to the other. The value of this capacitor is critical and should be large enough to permit adequate coupling between the two tuned circuits, but small enough so as not to cause interaction between the two. The value of capacitance also has an effect on the bandwidth of the filter, as well as the individual Q factors and the graphs shown in Fig. 12 illustrate this point.

This shows typical response curves obtained under various conditions of coupling. In curve "a" there is insufficient coupling, the bandwidth is restricted and the filter is very inefficient. The optimum degree of coupling is achieved in curve "b". Here the response is flat-topped,

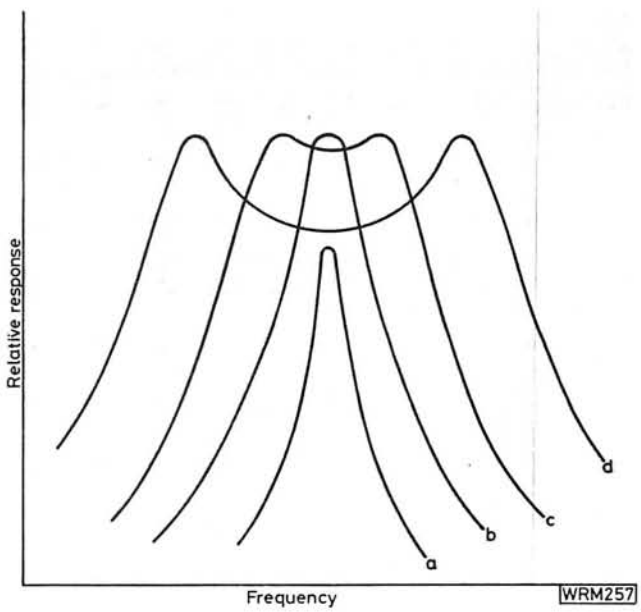


Fig. 12: Response curves for two parallel tuned circuits under various conditions of coupling

the bandwidth is adequate but not excessive and there is a negligible loss of energy in the filter. The effects of over-coupling are illustrated in curves "c" and "d". The response curve takes on a double-humped appearance with two quite distinct peaks in evidence. The bandwidth becomes excessive, particularly in "d" and there is a loss of response at the centre frequency of the filter.

Matching

Matching the filter unit to the nominal 50Ω input and output impedance is achieved by tapping the inductors at a suitable point (see Part 4). This tapping point is also critical and has a marked effect on the filter performance. Air dielectric trimmer capacitors (Jackson C801) are used to tune the filter since high r.f. voltages will be developed across the parallel resonant circuits.

The filter unit is housed in a small box which is fabricated from double-sided copper laminate board.

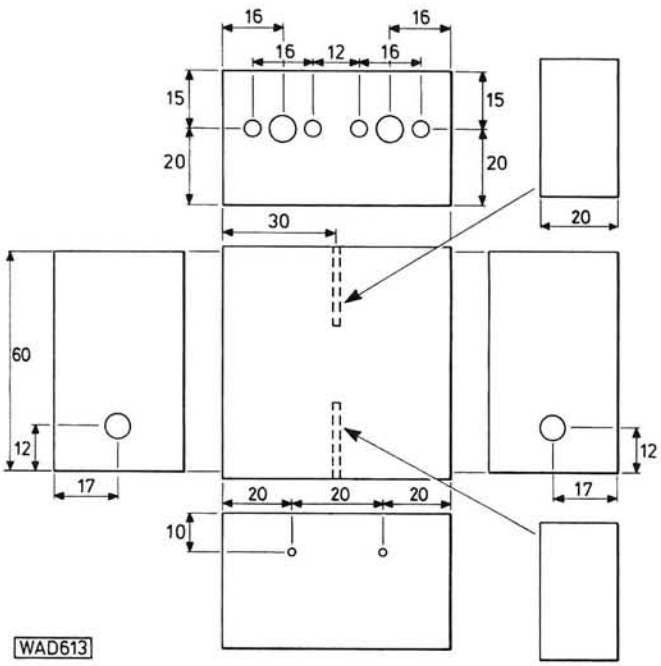


Fig. 13: Mechanical details of filter screening prior to assembly. All dimensions in mm

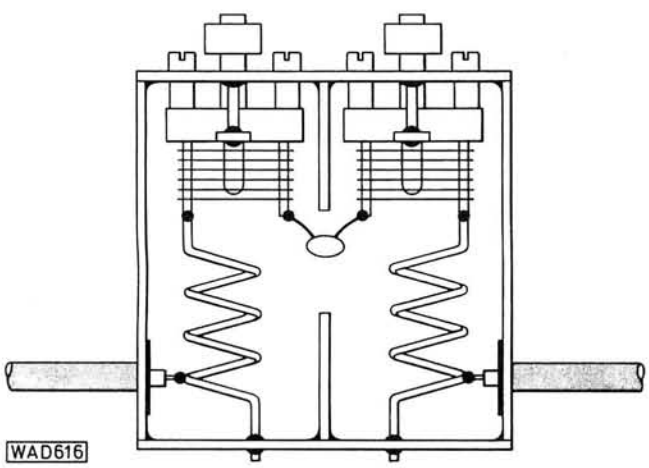


Fig. 14: Internal layout of the filter unit

★ components

OPTIONAL FILTER

Capacitors

Ceramic

2·2pF	1	C101

Air-spaced trimmer (see text)

2·5 to 25pF	2	TC101,102

Miscellaneous

Double-sided copper laminate board, 1·5mm thick

Cutting and drilling details are given together with the mechanical details of the assembly in Fig. 13, an internal view of the filter being shown in Fig. 14. The braid of the coaxial cable is fanned out and soldered to the internal walls. Constructors will find that the filter enclosure can be much more easily assembled if the copper laminate is carefully cleaned before soldering the component parts together. The response of the completed filter unit is shown in Fig. 15.

Setting Up The Filter

In the absence of special test gear, such as a spectrum analyser, great care and a good deal of patience is necessary in setting up the filter! It is important not only to ensure that the filter is tuned to the correct frequency but also to preserve a low v.s.w.r. as seen by the power amplifier. If the filter is not correctly adjusted, then the impedance seen by the p.a. will be widely different from the nominal 50Ω. The adjustment procedure is as follows:

1. Check, first, that the power amplifier is correctly tuned and is operated into a 50Ω resistive dummy load without the filter in circuit. The v.s.w.r. indication should be normal, i.e., less than 1·2:1, ideally 1:1
2. Insert the filter between the circuit board and the aerial socket as shown in Fig. 7. Terminate the aerial socket with the 50Ω resistive dummy load and connect a r.f. voltmeter

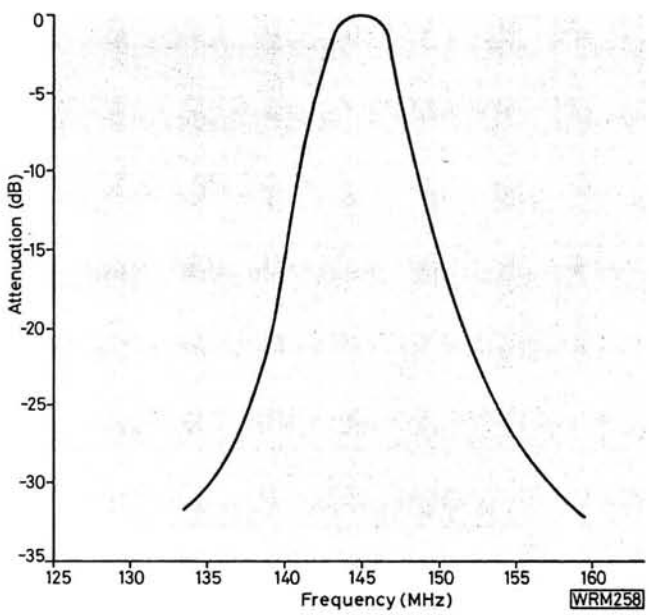


Fig. 15: The frequency response of the filter unit

Table 3.

Component	Receive(V)	Transmit(V)
IC1 input	17·5	17·3
common	1·25	1·25
output	12·5	12·4
Tr1 d	11·4	11·3
g2	0·35	0·35
g1	0	0
Tr2 c	11·3	do not measure
b	0	do not measure
e	0	0
Tr3 d	11·9	11·8
g	0	0
s	1·7	1·7
Tr4 c	11·9	11·8
b	11·9	11·8
e	11·3	11·1
Tr5 c	11·9	0·2
b	0	0·65
e	0	0
D6 anode	11·9	11·8
cathode	11·9	11·8
D7 anode	11·9	11·8
cathode	10	9·9

Test voltages measured with an electronic voltmeter of 10MΩ internal resistance

across this load. (Alternatively, the circuit shown in Fig. 9 may again be used.) Back-off VR1 in order to prevent the protection circuit from operating and then tune first TC101 and then TC102 for maximum output indication, ignoring the internal v.s.w.r. meter for the time being.

Note that there may be some slight interaction between TC101 and TC102 and it may be necessary to repeat the adjustment several times for optimum results.

3. When the position of maximum output has been achieved (this should be approximately the same as that obtained before the filter was inserted), check the v.s.w.r. indication. Almost certainly this will be abnormally high and it will then be necessary to vary the settings of first TC101 and then TC102 very slightly for the lowest possible v.s.w.r. whilst maintaining a consistently high level of indicated output power.

4. Re-adjust VR1 in order to render the protection circuit operative again following the procedure previously described.

The adjustment requires considerable perseverence but, with care, it should be possible to obtain a v.s.w.r. indication which is only slightly higher than that obtained without the filter (i.e., 1·2:1 as compared with, say, 1·1:1). If it is impossible to obtain a v.s.w.r. indication of less than 2:1 this could be indicative of the presence of spurious signals in the output and should be checked using an absorption wavemeter loosely coupled to L101, not L102. If necessary, the alignment of the power amplifier should be checked and the wavemeter used to examine the frequency spectrum of the incoming signal from the exciter.

As a final remark, the power amplifier module should not be operated on the air with the covers removed, to avoid stray r.f. leaking around the shack. ●

NEWS... NEWS... NEWS...

Rallies and Events

Worcester & District Amateur Radio Club hold their main annual event The Upton Mobile Rally on Sunday, 13 July at the Hill Junior High School, Upton-on-Severn which is just a few miles off the M5 motorway. Further details from: *Tony Blissett G8NSL, 26 Cherry Orchard, Holt Heath, Worcester. Tel: (0905) 620507.*

The Scarborough Amateur Radio Society have organised their mobile rally for Thursday, 17 July at Scarborough Technical College. Further details from: *The Sec G4JAQ, 43 Broadland Drive, East Ayton, Scarborough, North Yorks. Tel: (0723) 862638.*

Yeovil Amateur Radio Club G3CMH will be running special event stations at the following shows: International Air Day, on 2 August, at HMS Heron, Yeovilton, Nr Yeovil, callsign GB2FAA. Mid Somerset Show on 16 and 17 August at Shepton Mallet, callsign GB2MSS. Further information from: *D. L. McLean G3NOF, 9 Cedar Grove, Yeovil BA21 3JR. Tel: (0935) 24956.*

The British Amateur Electronics Club are holding their annual Amateur Electronics Exhibition between 12 and 19 July at The Shelter, The Esplanade, Penarth, S. Glam. Further details from: *Cyril Bogod, "Dickens", 26 Forrest Road, Penarth, S. Glam. Tel: (0222) 707813.*

Amateurs in Orbit

The National Aeronautics and Space Administration has formally agreed to launch Britain's first amateur spacecraft, UOSAT. It will form a secondary payload on the launch of the Solar Mesosphere Explorer mission from the Western Test Range in California, at present scheduled for 30 September 1981. The Thor-Delta launch vehicle is planned to place UOSAT in a circular polar orbit at a height of 530km. The launch opportunity is being provided by NASA in view of the satellite's potential contribution to space science education and to the investigation of radio propagation phenomena.

UOSAT is being built at the University of Surrey, in close collaboration with the international Amateur Satellite Corporation (AMSAT), the Amateur Satellite Organisation of the UK (AMSAT-UK) and the Radio Society of Great Britain. Much support is being given by Britain's electronics, telecommunications and space industries.

The purpose of the spacecraft is primarily educational. It will carry a series of high frequency radio beacons, enabling individual radio amateurs and science groups in schools and colleges to study the changing effects of the ionosphere on radio-wave propagation.

University of Surrey, Guildford, Surrey GU2 5XH. Tel: (0483) 71281.

air test

USER REPORTS ON SETS AND SUNDRIES

BEARCAT 220 FB
Scanning Receiver

In the USA, scanning monitor receivers are reckoned to be one of the most popular consumer electronics products. Over there, it is legal to listen to any marine, aircraft, private, mobile or public service (police, fire, etc.), radio traffic, except that there are restrictions in some states on monitoring police radio nets on receivers fitted in cars.

In the UK, the Wireless Telegraphy Act, 1949 makes it an offence for any member of the general public deliberately to listen to any transmission other than from an authorised broadcasting station or a licensed radio amateur. Nevertheless, receivers like the Bearcat 220 are enjoying a growing popularity, covering as they do a wide span of frequencies of interest to professional users, plus, in this particular set, the 4m, 2m and 70cm amateur bands.

Frequency coverage of the Bearcat 220 is 66–88MHz, 144–174MHz and 420–512·45MHz f.m., with sensitivities for 12dB SINAD from ±5kHz deviation quoted as 0·4μV on v.h.f. and 0·8μV on u.h.f. bands, plus 118–136MHz a.m. with sensitivity 1μV for 10dB S/N from a 60% modulated signal. The 66–88MHz band is provided on the UK version in place of the original 30–50MHz band, although signals in that range can still be tuned but with degraded performance due to the changes made to the tuning voltage.

Apart from the rotary Squelch and Volume controls, the whole receiver is controlled from a 24-button keyboard via three custom-designed i.c.s. To describe all the features in detail would take more space than we have available, but they can be summarised as follows: Scanning or Manually stepping through 20 user-programmed channels, with option of locking out (passing over) one or more channels, or pausing on one or more channels after carrier ceases, before resuming scanning; searching for signals in a band between two user-programmed frequency limits, or searching the marine or aircraft v.h.f. bands (pre-programmed); selection of scan or search rates of approximately 4 or 11 steps per second; priority monitoring of the frequency programmed into channel 1; direct keyboard access to any of the 20 user-programmed channel frequencies. Status and frequency are indicated on an 11-digit l.e.d. display.

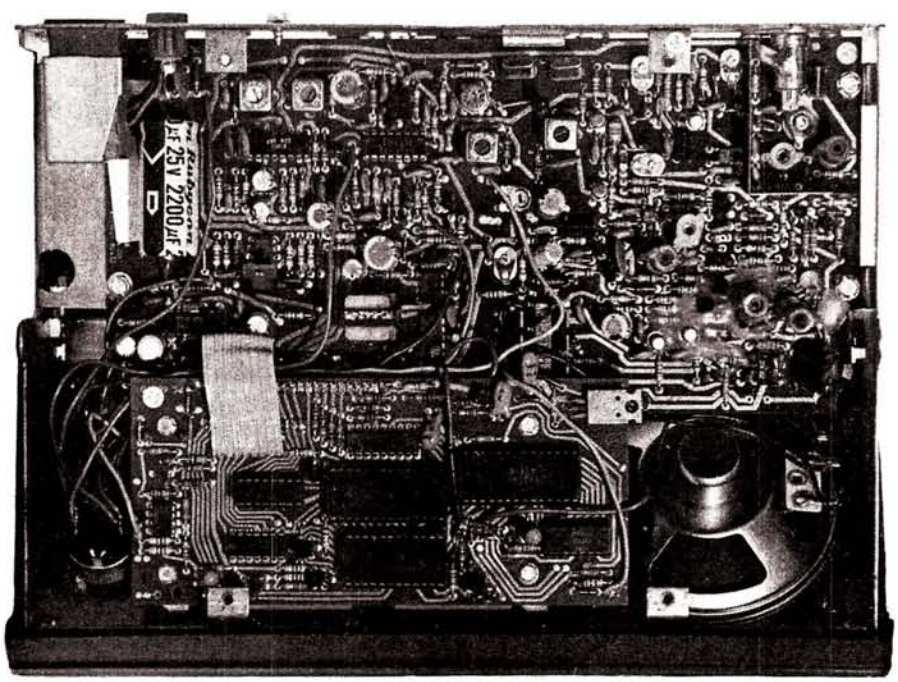
A built-in telescopic aerial is provided, plus a socket for an external aerial. Power supply requirements are 240V 50Hz 20VA, or 13·8V d.c. 9W, and internal batteries (two size AA) for memory back-up when external power is removed. Audio output is 2W into the internal 8Ω loudspeaker, or to an external speaker. The receiver measures 270 x 89 x 203mm and weighs around 2·3kg.

Results

Our tests on the Bearcat were carried out around the Poole area, which is obviously much quieter from a radio traffic point of view than, say, London. Signals were heard on all bands, though, and when using the internal aerial it was found possible to peak signals at u.h.f. by adjusting the aerial length.

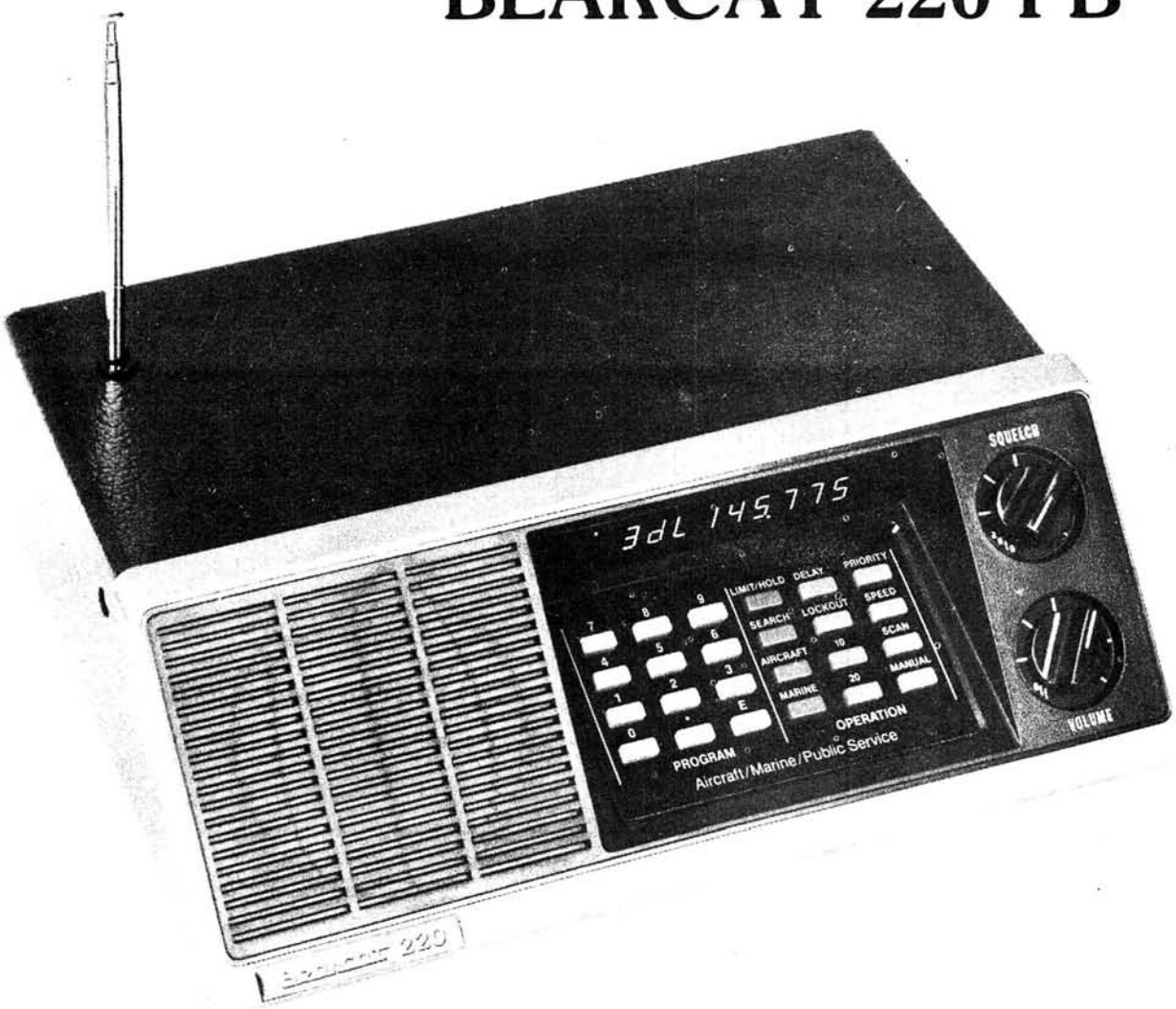
The only external spurious response noted was from the local 2m repeater, GB3SC, which comes up as an "image" when searching the aircraft band. This was particularly troublesome at one QTH, which is only about three quarters of a mile from the repeater. This sort of problem is mentioned in the handbook, with some hints on overcoming it and also the few internal spurii due to the synthesiser.

There are so many facilities built into the set that it takes some very careful reading of the handbook and a



An internal view of the Bearcat 220, a sophisticated piece of equipment

BEARCAT 220 FB



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The new digital flight scan receiver from Regency of America is a stunning improvement on any other air band monitor receiver. Utilising its own micro computer system to control an advanced synthesiser, the flight scan allows you to monitor any air band frequency in the range 108-136 MHz and to store up to 16 channels which can then be scanned continuously. Other features include fast keyboard entry of frequency, full band search facilities, channel lockout and much more. For the last word in air band monitors contact us today. Also available – M100 digital FM scanner covering 30-50 MHz, 144-174 MHz and 430-512 MHz.

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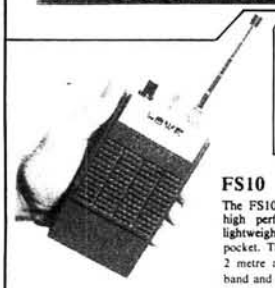
M100 FM SCAN **£192** inc VAT carr £4.50

R820

The ultimate in receiver design. **Trio R820.**
With more features than ever before available in a ham band receiver. This triple-conversion (8-83 MHz, 455 KHz and 50 KHz I.F.s.) receiver, covering **all** amateur bands from 160 through 10 metres, as well as several short wave broadcast bands, features digital and analog frequency readouts, notch filter, I.F. shift, variable bandwidth tuning, sharp I.F. filters, noise blanker, stepped R.F. attenuator, 25 KHz calibrator, and many other features providing more operating conveniences than any other ham band receiver. Price **£690-00,** including V.A.T. Carriage £4-50.

SP820

Matching speaker to fit the R820, with built-in filters, 8 ohms impedance.
Price **£37-95,** including V.A.T. Carriage £1-50.



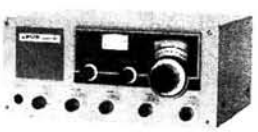
FS10

The FS10 VHF FM monitor receiver is a high performance unit in such a small lightweight package that it will fit into a pocket. The receiver can be aligned for the 2 metre amateur band or the VHF marine band and provides top performance on either band.
The FS10 automatically scans up to ten crystal controlled channels, stopping on any channel where a signal is present. Manual selection of any channel is also provided. Complete with rechargeable battery pack, charger and personal earphone with provision for external antenna.
Price **£82-00,** including V.A.T., crystals extra. (Fitted ten channels **£109-25,** including V.A.T.) Carriage £1-50.

AP12

The AP12 is a 12 channel crystal controlled airband monitor receiver covering a frequency range from 108 to 136 MHz which utilises a micro-computer which automatically peaks the R.F. oscillator and mixer stages in accordance with the crystal frequency in use. This means that you can install crystals for any frequency in the entire band without any drop in performance. Supplied complete with rechargeable battery pack, charger and personal earphone.
Price **£89-70,** including V.A.T. Fitted 12 channels: **£118-45,** including V.A.T. Carriage £1-50.

SRX30



The SRX-30 represents a new step forward for the keen short wave listener or the radio amateur who needs to tune frequencies outside the amateur bands.
In the past, the performance of general coverage receivers has been limited by the dificulty inherent in setting to a known frequency – OK, so you know that Radio Peking is on 8547 KHz but how do you set the receiver dial?
The SRX-30, due to application of new technology solves the problem by utilising a drift cancelling loop system converting to a very high (40 MHz) first IF so as to remove image interference problems. This is followed by a stable VFO controlled tunable second IF with excellent reset accuracy. The frequency range covered by the SRX-30 is 500 KHz – 30 MHz in thirty bands, each 1 MHz wide. If you wish to tune to say 14250 KHz, simply set the MHz dial to 14, the KHz dial to 250 and there you are, no fuss, no twiddling, no need to use calibrators, etc. (remember the drift cancelling system).
The SRX-30 is housed in a rugged metal case and operates from 240V ac mains or 12V dc supply. Reception modes are USB/LSB/AM/CW to cater for all HF operation and the receiver is equally at home on VHF using an external convertor.
This receiver combines small size, accurate readout, ease of use, all mode operation, mains/battery power supply and excellent performance at a remarkably low price.
See it, use it and you will like it.
Price **£178-00** including V.A.T. Carriage £4-50.

AMR217B

The AMR217B VHF FM monitor is an outstanding receiver suitable for either the 2 metre amateur band or the VHF marine FM band and can be supplied for either band on request. The AMR217B has an eight channel scanning facility and can also accommodate up to ten additional switched channels to extend its versatility even further. The receiver is extremely sensitive and is one of the best monitor receivers available to either the amateur or professional user. It is completely self-contained with a built-in speaker and operates from 240V AC mains or 12V DC supplies. A matching mobile mount is supplied to allow easy installation in boat or car.
price £120-75, including V.A.T. (fitted 8 crystals). Carriage £1-50.

SR9

The SR9 represents the finest value for money ever offered in the FM monitor receiver market. Available in two versions to suit the 2 metre amateur band or the VHF marine FM band the SR9 gives fully tunable coverage of either band and also incorporates the facility for installing optional crystals which will provide up to eleven fixed channels for the most popular frequencies.
The SR9 is completely self-contained with built-in speaker and requires only 12V DC at around 200 mA to operate. Mounting hardware is provided for easy installation anywhere.
Price **£46-00,** including V.A.T. Carriage £1-50.

R512

The R512 airband receiver is a high performance unit which automatically scans up to eight crystal controlled channels. The receiver will stop on any channel on which there is a transmission, stepping on again at the end of transmission. You may lock the receiver onto any channel of your choice for continuous monitoring and if any channel should be more or less permanently occupied you may also lock out the channel to permit scanning of other channels. These facilities are available on any or all channels.
Covering the full band from 108-136 MHz, the R512 is completely self-contained including built-in speaker and is supplied with mains and 12V DC power leads, whip antenna, mobile mounting bracket and personal earphone.
Price including five fitted channels is **£138-00,** including V.A.T. Carriage £1-50.

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lot of experimentation to find out just what you can and cannot do. The instructions, though fairly comprehensive, do not warn you what actions will cause you to over-write frequencies previously keyed in, which can be annoying, and some sections are a little confusing. For example, the word "channel" is used to mean two quite different things, and it is not immediately apparent that to carry out a user-programmed band search, you have to use part of the memory of one of the scan channels, though it doesn't matter which one. Altogether a useful and versatile unit, but really deserving of a better handbook.

The Bearcat 220 FB costs £241.50 including VAT, and is imported and distributed in the UK by **Radio Shack Ltd., 188 Broadhurst Gardens, London NW6 3AY, telephone 01-624 7174,** to whom we offer our thanks for the loan of the review unit.

AZDEN MEX-55 Mobile Microphone

The MEX-55 mobile microphone system in use, with (inset) a close-up of the amplifier and control box

Rigs offered for mobile use by radio amateurs on the 2m and 70cm bands are increasing in variety and facilities month by month, but one basic problem remains for those wishing to operate "on the road". How do you hold a fist microphone near your mouth and keep the p.t.t. button pressed while carrying out normal driving manoeuvres safely? Having an automatic gearbox on the car helps, of course, but even this is not the complete answer. Operating in urban conditions with a "manual" car is, to say the least, somewhat hairy.

One way of overcoming the problem is to use a tie-clip microphone, or similar, but then the mic is usually so far from the mouth that car noise impairs speech clarity. It was therefore interesting to receive for review the MEX-55, which seems to have all the answers.

The microphone itself is a noise-cancelling electret type, mounted on the end of a 300mm-long flexible goose-neck, which plugs into a mounting bracket designed to be fixed under the sun-visor base, or in some other spot convenient to the driver. Signals from the microphone pass via a 2·5m screened lead to a single-transistor amplifier, which is housed in a 25 × 40 × 74mm box designed to be clamped to the gear-shift lever. On top of that box is a long-arm toggle switch which controls the send/receive line of the transceiver. The lead to the rig is 1·5m long, and you have to provide your own plug to mate with its microphone socket. Two further leads go to a remote "On the air" indicator l.e.d. and a source of +12V respectively.

Results

Dealing with things in reverse order, once installed the whole system worked like a dream, the only criticism being that even when fitted in a shady spot under the dashboard, you can't see the transmit indicator in daylight. Obviously, a filament lamp would be more prone to failure, but there's plenty of power available in a car to furnish the hundred milliamps or so that would provide a really visible warning of key-down.

Installation did show up one or two snags, though nothing major. All the leads are permanently connected (short of unsoldering) which makes it impossible to feed them neatly down inside the gear-shift lever gaiter (if you have one) because of the size of the bits on the ends. The spiral cable-wrap shown in the photograph is not supplied, but was used to keep all the cables tidy. On cars with very short gear-shift levers there might be a problem in the overall height of the control box (74mm plus switch toggle and sleeved grommet).

A preset gain control is provided, with screwdriver access via a hole in the side of the box. When used with a KDK FM2025 2m transceiver, the preset had to be turned almost completely anti-clockwise to avoid car noise when on the move, and it was found that the difference between the right level and zero modulation was just the slightest tweak of the screwdriver. It would seem a good idea if the amplifier circuit could be modified to prevent the gain being reduced to zero at minimum setting of the potentiometer.

The instruction sheet provided gives hints on installation, and connection details for some of the more popular transceivers. The English used is a little quaint, though generally understandable.

The MEX-55 costs £28 including VAT, and is available from **Lowe Electronics Ltd., Chesterfield Road, Matlock, Derbyshire, telephone 0629 2430 or 2817,** to whom we offer our thanks for the loan of the review unit.

by Eric Dowdeswell G4AR

The allocation by the recent WARC of three entirely new bands to the Amateur service has come as a most pleasant surprise to the vast majority of amateurs. I think that it is true to say that most of us had quite expected that some of our present bands would be reduced in width or for some of our existing allocations to become shared bands.

At 10MHz we have a secondary 50kHz segment shared with fixed services, and there are exclusive amateur bands of 100kHz each from 18 068 to 18 168kHz and 24 890 to 24 990kHz. Altogether the immense amount of preparatory work spanning several years prior to the WARC by our own RSGB and the American ARRL, as members of the International Amateur Radio Union, has paid off handsomely, as have the efforts of many national societies that make up the IARU.

So, instead of six h.f. bands we shall have nine eventually. Unfortunately the excitement has to be tempered by the thought that it is going to be a couple of years before we get our first QSO on the 10MHz band, and if we manage anything on the other two bands inside five years it will be a miracle. Anyone contemplating buying any h.f. amateur bands gear now shouldn't really worry if it doesn't cover any of the proposed bands. Some of the more expensive equipment already available will cover any frequency virtually from 1·8 to 30MHz so no problems there.

With nine bands becoming available it could mean a radical change in the design of the gear, with the possibility of continuous coverage. The rapidly increasing use of digital frequency readout from frequency synthesisers should allow amateurs to ensure that they do not stray outside the amateur allocations, even using equipment having continuous coverage. In the past, the design of amateur equipment was simplified by the harmonic relationship that existed between bands so that generally, harmonics would fall in amateur space and not interfere with other services. Indeed, before the war it was necessary to submit evidence of this by sending a crystal certificate when applying for a transmitting licence! Now this long-standing relationship is to fall by the wayside with the new frequencies we are to have.

Initially, perhaps, we shall see new transceivers for the three bands designed to supplement existing gear rather than make it redundant. One bod who will be really run off his feet in future will be the contest operator who will have nine bands to monitor and work instead of just six!

Readers' Round-up

Having read this column for a while **Sam Mulholland** in Bangor, Co Down, was inspired to study for the RAE. Being only 14 the local tech college would not accept him for an RAE course. Nothing daunted, he and two other youngsters were taken under the wing of GI3KDR with the result that all passed the last RAE and Sam is now GI8WAZ! So who is the twit that decided that 14 years of age is too young to start an RAE course? Congratulations Sam and friends, may you have many happy hours on the air, and a big hand to GI3KDR who made it all possible.

Sam is going on to get his GI4 very soon but in the meantime wonders if anyone can loan him manuals on the AR88LF and the Solartron 'scope CD1014. Offers to Sam Mulholland at 12 Thornleigh Gardens, Bangor, Co Down, NI.

PW's RAE reprint was instrumental in getting **John Acton** in Iver, Bucks through the RAE which he took "just for a giggle"! Credits in both papers resulted in G8UXT coming into being. John was able to help a reader recently with a copy of an old manual, and was delighted to get a reply and thanks which has "restored my faith in human nature". We're not such a bad lot, OM!

Jim Proctor (Newcastle) has recently retired from the Government service having been concerned with radio gear for many years. He now intends to have a go at the RAE and judging by his remarks ought not to find it too difficult. He has used the code in the past so a bit of practice there won't come amiss. Problem, however, is how to convince his XYL that he needs £600 to buy a transceiver etc! Simple, OM, get her to take the RAE as well!

From 5 John Street, City Road, Cambridge, **Eric Symonds** writes to say that he has, among other receivers, a Hallicrafters S120 and would like to borrow or otherwise acquire a circuit diagram for same. In Leeds **Basil Woodcock** has an SRX-30 plus 66ft wire and a.t.u., but is thinking of adding something in the way of filters to try and get rid of the QRM, particularly on the 40 and 80m bands. Being essentially shared bands one must expect problems and the only mod worth making could be a better i.f. filter. Notch filters and the like, also suggested by Basil, are not of much use considering the short time taken by the average "over" compared to the time taken to adjust the filter. Basil did copy C5ATK, C6ACY, SV0WEE, VP8JO, VP2MGR and VP5WJR on 10m, plus FC6GY, HC5MC and VK7NHP on 15m.

What are the Wild Waves Saying?

WOW! **Arthur White** in Aisby, Grantham, has laid down a fine earth system of eight 200ft copper wires and associated earth stakes. With his 240ft aerial and a.t.u. plus the Eddy-

stone 888 receiver, Arthur would seem all set to go after he takes the RAE which ordeal ought to be over by this time. The earth system has improved his signals quite a bit but the big difference will be noticed when he comes to transmit, especially on the lower frequency bands. On 80m Arthur logged ZL4BO, just to prove the point, with lots of VKs and ZLs on 15m and 5L7F plus VK2NTQ who was mobile at the time.

First letter from **Andrew Soltysik** who lives in Hednesford, Staffs, reveals he has been listening for quite a while with his CR100, which cost him just £6, and a 67ft wire inside the bedroom. Andrew will also have taken the RAE by now but is not too sure his code is up to standard yet. Recent loggings included A3AFS, KL7HRN, S8AAA (Transkei), ZF1MA and ZL3AAA, all on 20m s.s.b. In Borehamwood, Herts, the tutor of **Jeff Weston** at the local amateur radio classes is no less than G3HB of RAE Manual fame. The FRG-7 and 80ft aerial has brought in VK9ABA, C5AAM, 5U7BE and 9Y4VU on 10m, VP2KAH, C5AAA, HC1DO, J6LFH, 4S7DJ and TJ1CC on 15m with ZB2GR and VP2SDA/HK1 for 20m while on 80m he found FM7WS for a good one.

In Truro, Cornwall, **Bill Rendell** has been delving into his valved AR3 to add a third i.f. stage and a mechanical filter, mainly to improve the skirt selectivity. On one morning he logged VKs on 7, 14 and 21MHz in just 15 minutes. On 7MHz it was CP1FFS, HT9MQ, VK2AVA, VK7GK, VP2VEJ, YS9RVE and ZP5CD, while on 14MHz C5AAS (QSL via G3CQP), C31LU, HS1WR, VK9XT, VP2E, VP2MH, VP2VBK and 6W8IP. On 21MHz SV0WEE wanted cards via Box 538 APO NY 00291, with M1C, SU1CR, VP2MGZ, VQ9JJ, VU2RX and ZD7HH (QSL W4FRU).

Ron Newall (Bracknell, Berks) now sports a 10/15/20m vertical ground plane and is pretty pleased with the results. He quotes some signals in dB's but really this is rather meaningless unless a reference level is quoted. Decibels represent a ratio and unless one has actually calibrated a receiver's sensitivity at a particular QTH the signal strength reports one hears over the air are just garbage! Ron does mention the frequently-met phenomenon of a signal being extremely weak, certainly not moving the S-meter, yet being perfectly readable so that a 5 and 1 report would not be out of place. On 10m Ron heard K7SE/PJ5, LU8EVC and 3D2LK, with 15m bringing in VK9XT and ZL4AV, with XE1FX on 20m.

While everyone else seems to have been hunting around the 10m band, the DX160 and 7MHz dipole of **Peter Hawkes** in Stourbridge W.Mids, worked well on 80m, finding CT2DG HI8ECS, HK6AQT, HR3JJR, HP2XSG, OD5MS, KP4WI, VP2EEW, YS9RVE, 4M3AZC, 9A1ONU (QSL I0MMI) and 9Y4NP for one of the best 80m logs I've seen for a while. Odd interesting ones on 10m were VS6AG and ZL4NR, plus VQ9CI and TJ1GC (QSL Box 1522, Douala) on 15m and TA1MB (QSL Box 1167 Istanbul) with FG7BG on the 20m band.

Allan Stevens in Crowthorne, Berks has not been too active of late but did find H44CP in the Solomon Is. on 10m, together with 9G1GX and ZL2RE, with 15m coming up with ZS3LK, a seldom-heard prefix, and a real rarity JT1BG in Mongolia on 20m with UA3DG seemingly in charge of the QSOs. This seemed to surprise Allan but since the JT1 is probably a Russian or Czechoslovakian it does make sense.

Regular RTTY reporter **Dennis Sheppard** has had some trouble with his Creed 7B machine, with a broken paper roll carrier, and would like to hear from anyone who can provide the necessary spare part. QTH in "Wayside", Vicarage Road, Minster, Sheerness, Kent or ring 0795 874416. His 250ft aerial has been reduced by gales to 132ft but this did not stop Dennis from copying RTTY from JA3VLD, JA6GIJ, XE1AFU, YV3BIA, ZS1Z, ZS2AB, ZS6BLV, 5N0DOG and 5N0SID on 28MHz. Interesting one on 21MHz was DK5BD/ST2 in the Sudan, G4BHT/4X4, JA1ACB, KL7IRT, VK5RT and VK5WV coming up with AH6AQ (old KH6), FK8CK, FR7BE, JA1DSI, KL7HDS, VK1GM, XE1CR, YV2RD, ZS6AKO and 9A1ONU (widely reported from San Marino) on the old 20m band.

Callum Lawlor BRS42922 in Wrexham (Clwyd) has been pretty active from 7MHz to 28MHz with his FRG-7 and Joystick aerial plus a.t.u. logging such as VK6NV and VS6CT on 10m, ZL1AFK and ZL4FT on 15m, and P29JS in a VK/ZL net seemingly on 20m.

In Sunderland, **Paul Barker** G4HPS has acquired a mini-beam even though he is not quite sure where he is going to put it but hopefully it will be on top of the garage. He has not been doing too badly on c.w. with an hour-long QSO with JA1PLI which included a few notes on gardening! Those worked on 10m c.w. included PP0MAG (Trinidade and Martin), UM8BMV, ZS4T and ZL1RK. On 15m it was C5AAP, HI6XQL, PP0MAG again, VE8RR, ZL2TX, 8R1J and 9H1EL. A QSO with ZB2CJ turned out to be old timer G3ATU also from Sunderland. Getaway reported was JT1BM in Ulan Bator.

Finally, phew, **David Coggins** old faithful from Knutsford, Cheshire, worked his way from 1·8 to 28MHz with his trusty FRG-7, 66ft inverted-V and a.t.u. to find half a dozen Ws on Top Band; HC1EE, K7SE/VP2A on Barbuda, TI2LL, 4Z4WZ and 9A1ONU on 80m plus EP2TY, HP3FL, TI2VVR, TR8DX, VP2EEV and XE3RT for 40m, not to mention ET3PG, FO8DO, VK9XT and WD4CVK/KH4 on Midway on the 20m band. Good catch on 15m was 8Q7AR on the Maldives with a clutch of three H44s in H44WH, H44PT and H44CB plus HM1EJ, ZS2KG, 9Q5GB and ZE3JO on the 10m band.

Clubs-in brief

Cheshunt & District RC. (G4ECT & G8KJF). A very nice Newsletter was accompanied by an excellent leaflet for newcomers showing a map and how to get to Church Room, Church Lane, Wormley, Herts by 8pm every Wednesday. Visitors can attend for four weeks without having to stump up so try the v.h.f. station set up on Baas Hill Common on June 4, or the Broxbourne School Fete on the 7th, or natternite on the 18th or even Paul Essery G3KFE of *SW Mag* giving forth on the 25th! Contact: Bill Pooley G8VBL, 36 Montayne Road, Cheshunt, Herts or Waltham Cross 32198.

Although only some three months old the **Bolsover ARC** already has over 25 members at its Wednesday evening 7.30pm meetings at the Angel Inn. Something for everyone is promised by John Lannigan G8TDU, 14 Keelby Road, Gainsborough, Lincs. The **North Bristol ARC** meets at the Self-Help Enterprise, Braemar Crescent, Northville, Bristol 7 on Fridays at 7.30 with RAE and Morse Classes so try G. Taylor G2HDG at 66 Burley Crest, Downend, Bristol for more info. Meetings at 1945 precisely are held at the YMCA, North Road, St. Helens on Thursdays by the **St Helens & District ARC,** or write to Paul Gaskell G8PQD 131 Greenfield Road, St Helens, Merseyside or try 0744 25472.

Wirral & District ARC meets Wednesdays at 8pm so note June 4, a visit to Liverpool Police HQ, June 11 Bring & Buy, June 18 is a visit to Speke airport control tower with June 25 being devoted to a DF hunt. Normal meeting place is the Committee Room, West Kirby Sports Centre but contact Ian Brooks G8PMW at 59 Mosslands Drive, Wallasey for info.

Now to the **Ipswich RC,** meeting second and last Wednesdays during school term at Handford House, Ranelagh Road, Ipswich with car parking facilities in the main school premises. Contact: Jack Toothill G4IFF, 76 Fircroft Road, Ipswich or ring 0473 44047 for meeting details. Morse classes are a feature plus club stations G4IRC, GB2IRC and G4CFI. The **Bury RS** meets second Tuesday of the month

formally but also other Tuesdays for Morse tuition at the Mosses Community & Youth Centre, Cecil Street, Bury, the June meeting being on the 10th with G8SMB holding forth on electronic traffic control systems.

On June 4 the **Northern Heights ARS** will be visiting the Oxenhope Research Station at Bradford University, with weekly meetings at 8pm at the Bradshaw Tavern, Bradshaw, near Halifax. Contact for info Geoff Theasby G8BMI, 12 Southfield Avenue, Riddlesden, Keighley or ring Keighley 62859. In June the **Wirral ARS** will be meeting on the 18th for a sale of surplus gear, having recovered from the NFD exertions, otherwise the first and third Wednesdays at 7.45 at the Sports Centre, Grange Road West, Birkenhead. Gordon Lee G3UJX is PRO at 30 Manor Drive, Upton or 677 1518.

Fridays sees the **Cambridge & District ARC** hard at it in the Visual Aids Room, Coleridge Community College, Radegund Road, Cambridge, at 7.30pm says David Wilcock G2FKS of 19 Cavendish Avenue, Cambridge, (0223 47220) with June 6 being devoted to a surplus gear sale. Newly reporting **Barking Radio & Electronics Society** G3XBF/G8GPK meets at the Westbury Recreation Centre, Westbury School, Ripple Road, Barking, Essex on Mondays (construction night), Tuesdays for Morse practice, and Thursdays which is the main club night. Try Dave Coundon at 111 Shelley Avenue, Manor Park. London E12 for latest meeting info.

Apologies to the several clubs whose forthcoming events have not been mentioned but we are short of space. However I'm glad to report that the Editor is arranging to provide for more copy very soon with a distinct possibility of a separate Club feature page before the end of the year.

BROADCAST BANDS

MEDIUM WAVE DX

by Charles Molloy G8BUS

Sometimes I feel this column could be more appropriately named Experimenter's Corner, and a recent letter from New Zealand has strengthened this view. **R. J. (Dick) Donald** ZL2KU has been experimenting with medium-wave loops, mainly in order to get rid of noise from fluorescent lighting. He started by using the standard one-metre square DXer's loop, and he mentions the need for a high ratio between the maximum and minimum capacitance of the system, in order to cover the band in a single range and so avoid the need for a switch and a fixed capacitor. The minimum capacitance of the tuning capacitor is important and it should be examined and any trimmer removed completely. A very good point and one easily overlooked.

The ZL2KU Loop

Dick has now constructed a circular loop to his own design. It consists of six turns of hook-up wire inside a piece of plastics water pipe, mounted on a frame and hinged to the bookcase holding the receiver (Fig. 1). The 6-turn winding is connected to one metre of 300 ohm ribbon feeder, which is led to two loading coils and a twin-gang tuning capacitor (value not stated). The loading coils came from his junk box. They are on a single 40mm diameter former which originally had 70 turns with a tap at the centre where both wires were brought out, so that it was possible to separate them into two windings. The wires at the centre were taken to the tuning capacitor and a link (single turn?) added over the centre. Equal numbers of turns were removed from the other two ends until resonance was achieved. The arrangement is shown in Fig. 2.

This loop is more pleasing to the eye than the standard square loop and Dick says he would be interested in hearing from any reader who might like to take the design further. The QTH is 10 Pembroke Street, New Plymouth, New Zealand.

Loading Coils

The purpose of adding loading coils to a loop is to increase the inductance of the tuned circuit, which is made up of the tuning capacitor and the inductance of the main winding of the loop. Fewer turns can be used on the loop and although this means reduced signal pick up it is the price one has to pay in order to have a more presentable piece of equipment, if it is to be used outside the radio shack.

It is possible to use loading coils to tune a standard one-metre 7-turn loop across the long-wave band. Some 2·5mH to 5mH of loading is required, and this can be a single inductor such as the Repanco High Q Choke Type CH1. It is inserted between the loop and tuner as shown in Fig. 3, the coupling winding being led off to the receiver as before. A shorting switch can be fitted across the loading inductor so that the loop is usable on either band as required, but care should be taken that leads are short otherwise pick-up will occur when a station is being nulled-out.

DX Heard

A newly-acquired Hammarlund SP600JX valved communications receiver is in use at Barking by **Andy Small** who is surprised at a scale accuracy of 5kHz on the medium waves. He thought accurate frequency readout was a modern thing. When connected to a long wire this rig pulled

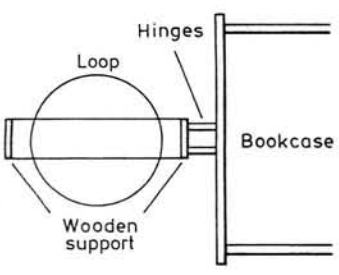


Fig. 1

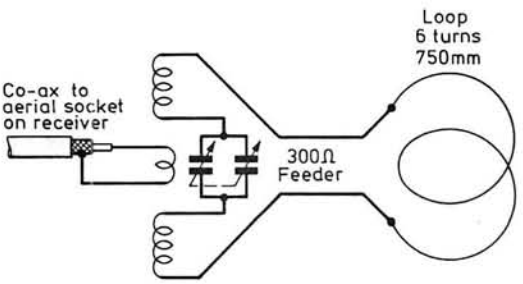


Fig. 2

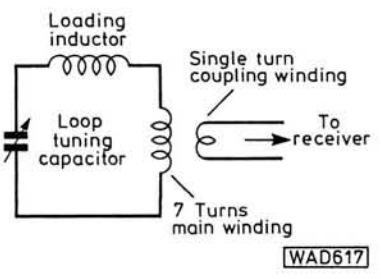


Fig. 3

Reports on the various bands are welcome and should be sent direct, by the 15th of the month, to:

AMATEUR BANDS Eric Dowdeswell G4AR, Silver Firs, Leatherhead Road, Ashtead, Surrey KT21 2TW. Logs by bands, each in alphabetical order.

MEDIUM and SW BANDS Charles Molloy G8BUS, 132 Segars Lane, Southport PR8 3JG. Reports for both bands **must** be kept separate.

VHF BANDS Ron Ham BRS15744, Faraday, Greyfriars, Storrington, Sussex RH20 4HE.

in KDKA Pittsburg on 1020kHz, WERE Cleveland on 1300, WPOP Hartford on 1410, WTOP Washington DC on 1500 and WITS Boston on 1510, all heard between 0030 and 0400 during March.

At Gainsborough a Realistic DX160 and 30m long wire are in use by 14-year-old **A. Brittain.** He logged WBZ Boston on 1030kHz, CBA Moncton NB on 1070, WWWE Cleveland on 1100 and WEGP Presque Isle, Maine on 1390, heard between 0100 and 0300 on April 7.

Local Radio enthusiast **James Turner** of Leamington Spa has a vintage Peto Scott valved receiver and he has managed to pick up Capital Radio on 1548kHz and BBC Radio 4 Redruth relay on 756kHz, both using a random wire serial. "Do local radio stations QSL?" he asks. Most of them do if you send return postage, and a list of addresses can be found in the *World Radio and TV Handbook.*

Direction Finding

From Pensilva in Cornwall comes an enquiry from reader **K. Lewis,** who has been trying to compare the direction of an unknown station with that of a known station such as WINS or Radio Margarita. He attached a pointer to the frame of his loop. It travels round a circle that is marked out in degrees. He tried this set-up with an unidentified Spanish-speaking station on 930kHz and the bearing precluded CX20 in Montevideo but suggested Venezuela, Colombia, Bolivia or Peru instead. He asks if there are any pitfalls and how accurate are the bearings.

You ought to be able to measure bearings with an accuracy of five degrees or better using the standard loop with balanced feeder to the dipole input to the receiver. Get hold of a copy of the *Great Circle DX Map* from the RSGB, 35 Doughty Street, London WC1N 2AE, which costs £1.99 post paid. This will give the true bearing of any part of the world from the UK. If you are using a compass remember that it indicates magnetic north and you will have to apply a correction to get the true bearing. This can be found on the Ordnance Survey map that covers your locality.

It is not safe to identify a m.w. station by anything other than the station identification, but it is a great help to know the bearing, and it can lead to some very interesting DX on occasion.

Heard on a Portable

Locate Radio Eireann on 567kHz (530m) after dark. It is right at the end of the band. Now tune down in frequency (up in wavelength). On 558kHz you should pick up Monte Ceneri in Switzerland, with its programmes in Italian. Next door on 549 there are two stations: Les Trembles (Algeria) and West Germany. The two are easily separated if you turn the receiver to make use of the directional properties of the internal aerial.

Return to 567 and now tune up in frequency. There are two German stations on 576, one in West and the other in East Germany. From my QTH they can be separated by rotating the Vega 204. Continue up the band and on 585 you will find Madrid. If you can null it out you will be left with Austria, France, Tunisia and Saudi Arabia any one of which may peak up above the others if you wait long enough.

Readers' Letters

A cry for help comes from Swedish reader **Lars Erik Olsson** of Terrassgatan 5 Gtr, S-98135, Kiruna, Sweden. He has a Hallicrafters S85 and he is trying to get hold of a manual for it and he wonders if any *PW* reader can help. A similar plea comes from **B. Pollard** who has acquired a Hallicrafters Sky Chief and an ex-WD R107. He is looking for any information on either set that he can photocopy, and he lives at 3 Deepdene Mansions, Rostrevor Road, London SW6. **Hal Graepel** (EI1DA) sings the praises of his newly-acquired Eddystone 880 valved receiver, and well he might as this was one of the higher-priced models. Thanks for the copy of the specification Hal, it will be useful for future reference.

SHORT-WAVE BROADCASTS

by Charles Molloy G8BUS

The three short-wave bands of a newly-purchased radio cassette have intrigued reader **G. Richardson,** who says that although he did not purchase the set for the short-wave bands, it seems a pity having them and not using them. The bands he refers to stretch from 1·6MHz to 4MHz, 4MHz to 10MHz and 10MHz to 22MHz, and the question is: "What can I hope to hear on them?"

10MHz to 22MHz

If we look closely at this band we find two significant differences between it and the medium-wave band. First, it covers a much larger portion of the frequency spectrum. There is room for nearly twelve times the number of stations that are on the medium waves, and as a result they are much closer together on the scale. Secondly, it is a shared band, with broadcasting stations clustered round 11MHz (known as the 25m band), 15MHz (19 metre band), 18MHz (16m) and 21·5MHz (13 metres). In addition there are radio amateurs on 14MHz (20m band) and 21MHz (15m band). The rest of the space between 10MHz and 22MHz is occupied by commercial users. In the UK it is illegal to listen deliberately to these "Point-to-Point" transmissions, and reports of reception of them cannot be included in this column.

The 13, 16 and 19m broadcast bands are used for long-distance daytime reception, and at this time of the year stations can be heard on them virtually round the clock. In winter, silence prevails on them after dark, but the 25m band is good for day and night reception throughout the year.

4MHz to 10MHz

Stations are not so close together on this band, which covers about six times the frequency range of the medium

waves. International broadcasting takes place just above 6MHz (49m band), 7MHz (41m band) and below 10MHz (31m band). Short- to medium-range stations will be heard during the day and longer distance reception will be possible after dark. Radio amateurs will be found on 7MHz (40m band). The major Tropical Band (60 metres) extends on either side of 5MHz and is used for local broadcasting in tropical areas where static, caused by thunderstorms, restricts the range of medium-wave stations. Some of these tropical broadcasters can be picked up in the UK after dark, but generally as weakish signals along with QRM (interference). They are much sought after by DXers, just for the sake of picking them up rather than for any programme content.

1·6MHz to 4MHz

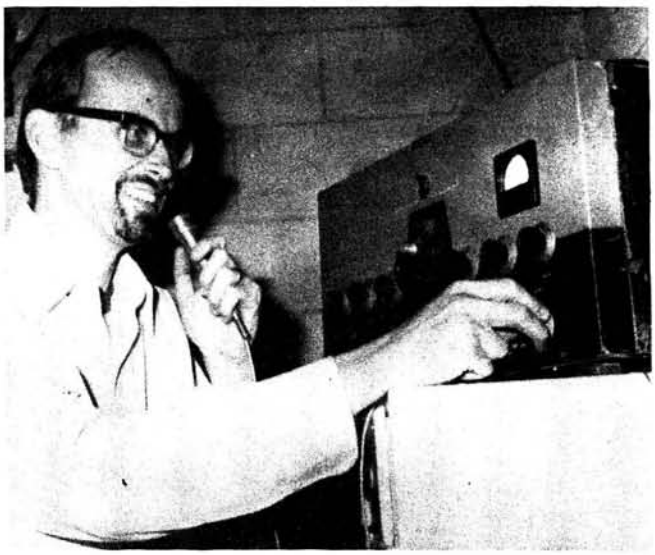
This is the least interesting of the three bands from the broadcasting point of view. Reception is similar to the medium waves, with a path of darkness between transmitter and receiver being required for anything but local reception. The 75m band, just below 4MHz, is the only portion used for international broadcasting and a few European stations can be picked up there. There are two amateur bands, 160m (1·8MHz to 2MHz) and the well-known 80 metres (3·5MHz to 3·8MHz). There are also two tropical bands: 120 metres, covering 2·3MHz to 2·5MHz, and the 90m band (3·2MHz to 3·4MHz), but the casual listener is unlikely to hear anything on either of them.

Altogether there is plenty to hear on these three ranges even when using the whip-type aerial fitted to many portable receivers. International broadcasters use high-powered transmitters so that their programmes can be picked up easily with this type of equipment.

HCJB on 11 Metres

The Voice of the Andes, with the callsign HCJB, is conducting an experimental transmission from its site near Quito in Ecuador. The equipment being used is a converted 100 watt amateur transmitter modified for improved audio response, and the aerial is a 5-element quad which is aimed at the part of the world where reception is expected to peak during various hours of the day.

The transmissions are on the air 24 hours a day on 26 020kHz (26·02MHz) in the 11 metre broadcast band,



Engineer John Stanley tuning HCJBs 11m transmitter

and consist of relays of the normal HCJB programmes, mainly the English ones. I have heard this station several times using the BRT400 with 60ft long wire and a.t.u., usually in the afternoon or evening.

Reporting Codes

"What does Propagation Disturbance sound like?" asks **I. R. Taylor,** who is referring to the "P" in the SINPO code. He goes on to say that amateur and professional radio books go to great depths describing propagation and its problems but not what it sounds like. "Would I be correct in thinking that the signal fades?" he asks.

Yes it does, and there is an alternative code called SINFO where "F" simply means fading, F1 being more than 60 fades per minute, F2 20 to 60, F3 5 to 20, F4 1 to 5 and F5 nil. Presumably one needs a stop watch to measure it. There is also the semi-professional SINPFEMO code where "S" = Signal Strength, "I" = Interference, "N" = Noise, "P" = Propagation Disturbance, "F" = Fading, "E" = Modulation Quality, "M" = Modulation Depth, "O" = Overall Merit.

I know a well-established, highly-respected DX club that uses terms like Good, Weak, Poor in its logbook section but perhaps this is too easy in an age when everything has to be quantified. The BBC and Radio Canada International now recommend listeners to use the SIO code which is an abbreviated form of SINPO/SINFO. "S" stands for Signal Strength, "I" for Interference and "O" for Overall Merit. There are five degrees of each. For "S" and "O" numeral 5 = Excellent, 4 = Good, 3 = Fair, 2 = Poor, 1 = Unreadable. For "I", 5 = nil, 4 = slight, 3 = moderate, 2 = severe, 1 = extreme.

A rating of SIO 333 would therefore mean signal strength fair, interference moderate, overall signal moderate. Personally I do not like to use a higher digit for "O" than is used for either of the other two. If for example you give a signal a rating of 334 then you only have "O" = 5 to describe the various permutations of 4 and 5 that could occur with "S" and "I" should the signal improve, but I'm sure there are many who would disagree with me.

Handicapped Aid Programme

John Rose of HAP "UK" informs me that an additional set of six tapes are being produced and details of them will be broadcast soon over Radio Canada International's *DX Digest* programme. The price of each tape will be £4. The existing Series 1 covering Station Identification and Foreign Language Recognition, and Series 2 which is the All-round DXer Course will continue, the price of these tapes either as cassette or reel-to-reel is now £3 per item. Enquiries regarding tapes should go to HAP "UK", PO Box 4, St Ives, Huntingdon, Cambs.

Readers' Letters

A transmission by Adventist World Radio on the 49m band has puzzled **David Griffin.** AWR is not a broadcasting station but a religious organisation that hires time from a number of stations. **Roy Patrick** (Derby) mentions that AWR is on the air daily at 1800 over Radio Andorra, which has moved from 6215kHz to 6219kHz to avoid commercial QRM. Roy refers to the IBA broadcast (Israel) on the 10m amateur band which has moved from 29 700 and is now on another odd channel 27 900 in the CB and model aircraft bands. A Grundig Satellit 3400 connected to a whip on the top of the house pulled in Radio Zambia on 17 895 at 2000 and Saudi Arabia on 11 855 at 1930 for **D. A. Wallace** of

Teignmouth. **G. Jones** is looking for a list showing the position of stations on the main s.w. bands. The newly-published *Guide to Broadcasting Stations* published by Newnes Technical Books, Borough Green, Sevenoaks, Kent TN15 8PH and available from booksellers should meet the need. It was advertised on page 6 of the May issue of *PW*. A final word from a listener to RCI's *DX Digest* who suggested an RI reporting code with "R" = readability and "I" = Interference. The ultimate in simplicity!

VHF BANDS

by Ron Ham BRS15744

A fascinating aspect of propagation is that the expected disturbances to radio signals do not always happen. For instance, during the first half of April the massive solar storm produced no major upset or aurora, and although the atmospheric pressure was at 30·5in for several days, v.h.f conditions were only a little above normal.

Solar

After a quiet period from March 1 to 26, **Cmdr Henry Hatfield,** Sevenoaks, and I recorded several small bursts of solar radio noise, at 136 and 143MHz respectively, from March 27 to 31 and the bursts on April 2 developed into a noise storm on the 3rd. The fine weather enabled Henry to study the sun's surface with his spectrohelioscope, and on the 5th he located a large group of sunspots coming around the north-east limb. On the 6th, the group became very active; "It was like a giant bonfire to look at," said Henry. This solar storm continued until April 11, and then died away with a few small bursts on the 12th and 13th. The solar noise was so strong on the 7th and 8th that our pens were "off scale" throughout the observations.

Reg Taylor, Shillington, Herts, making solar observations at 151MHz with an 8-element Yagi feeding his receiver, recorded several large bursts during the peak of the event, sending his pen hard against the stops. Down in Bristol, **Ted Waring** counted 18 sunspots on April 2, 47 on the 5th, 50 on 6th, 53 on 7th, 65 on 8th, 67 on 9th, 59 on 10th and 83 on 12th. **Harold Brodribb,** St. Leonards-on-Sea, heard a strange hiss in the background of his 28MHz receiver on the 8th. This, Harold, was the solar noise which was so strong on that day, due no doubt to the ionosphere being disturbed sufficiently to let the 10m waves through, instead of reflecting them back.

The 10m Band

During the period March 21 to April 13, Ted Waring often received signals from the International Beacon Project stations in Bahrain A9XC, 28·245MHz, Bermuda VP9BA, 28·235MHz, Cyprus 5B4CY, 28·220MHz, Germany DL0IGI, 28·205MHz and Mauritius 3B8MS, 28·210MHz at strengths between 2 and 4. I heard the beacons A9XC, DK0TE 28·257MHz, DL0IGI and 5B4CY at strengths varying between 2 and 8, almost daily from March 18 to April 6, when the solar storm upset the band which did not begin to return to normal for several days. Normally, the signal from DK0TE is about 529 with me, but at 1239 on April 21 it was pounding in at 589 while the others, DL0IGI, 5B4CY and VP9BA were at 529.

At 0846, 0914 and 0838 on March 17, 18 and 20 respectively, I received very strong signals from JA7OWD, and other JAs were prominent around similar times on March 21, 22, 24, 29, 31 and April 1, 3, 4 and 6. Both Harold Brodribb and I noted the strength of the QSOs between Japanese and Russian stations early on April 1. During the contest on March 30/31, **Harold Goble** G4FDQ, Lancing, worked many JAs and conditions were so good on the 30th that he worked all Continents in 34 minutes, using s.s.b., between 1024 and 1100. "At times," said Harold, "signals from the whole world could be heard." Conditions fell off on the 31st and a W7 told him that signals from G were dropping out, no doubt due to the prevailing solar activity, because after the peak of the solar storm the band was dead for long periods on several days between April 7 and 16. Both Harold Brodribb and **Gordon Goodyer,** RS 37345, Petworth, Sussex, also commented about the poor conditions on 10m.

Around 1302 on April 2, I heard both sides of a QSO, at 55, between VS6AG and 5B4EP, while K2IJL was talking about the "weird conditions" on the band. One example was at 1327 on the 16th, when the only signals I could hear on the band were in a local QSO, at strength 7, between two stations in the USA.

Tropospheric

On April 5, **George Grzebieniak** RS41733, London, heard G4FRE, Warwickshire, and on the 6th he heard local station G3TDG and G3WOH from Merseyside, all on 70cm. George took his gear: 19-element Yagi, Microwave Modules Converter and DX-160 communications receiver (Fig. 1) out portable for the RSGB 432MHz contest on April 13. Among the 80 stations he heard were several from the Norwich and Ipswich areas plus a GM, a GW and F1ANH.

Around 0800 on April 12, Harold Brodribb heard about twenty French stations in Band II and about five editions of BBC Radios 2, 3 and 4 on his Bush VHF80 receiver and a 2-element loft aerial. Harold also told me that his usual local stations, Brighton, London, Medway and Solent, were swamped out by French stations.

Ken Smith, BRS20001, Horsham, heard French stations in Band II during the early evening of the 17th, and

Fig. 1: The 70cm contest station of George Grzebieniak RS41733/P

periodically between the 11th and 16th I could hear mobile stations working through the Bristol Channel repeater GB3BC, R6.

DXTV

While I was receiving pictures from the IBA transmitter at Lichfield, Ch. 8, during the evening of March 15, **David Appleyard,** Uppsala, Sweden, was also enjoying the good tropospheric conditions and writes: "I spent the evening watching Finnish TV1 in colour from Turku on E7. I saw *Starsky and Hutch* for the first time at 2025GMT." During the morning of the 16th, David watched a children's programme and cartoons, followed by interviews with the 1979 Nobel prize winners, from Finnish TV1 on E5, from the island of Åland. (Ahvenanmaa in Finnish.)

After a tune through Band I, at 0827 on April 4, I soon realised that a sporadic-E disturbance was in progress. Further tuning, with the R216 fed by a dipole, found Ch. R1 sound on 56·25MHz, strong signals from several east-European f.m. broadcast stations between 65 and 71MHz, many continental radiotelephones between 40 and 50MHz and a 599 signal from the German 10m beacon DL0IGI. At 0920, **Paul Farrugia,** Cardiff, using a JVC 3040 received strong pictures from RAI, Italy on Ch. 1A (Fig. 2), Norway Melhus at 1129, Steigen at 1236 on E2, Hemnes at 1232 on E3 and RTVE Spain at 1349 (Fig. 3). Paul is puzzled by the fact that when he received the signal from Spain his best aerial direction was a semi-circle, W-N-E. This is not unusual during a sporadic-E event Paul, because there is little doubt that, at that particular time your aerial was pointing towards the cloud of ionised gas which was reflecting the Spanish signal. Like me, **Nicholas Brown,** Rugby, watched an orchestra on R1 between 0910 and 0930, and later Nicholas received the test card from RAI and the same Norwegian test cards that Paul received, plus Televerket. From 1324 to 1345, on Chs. E2, 3 and 4, he saw colour bars/grey scale with digital clocks and identification "Control Central RTVE" followed by the "RTVE Cadena 1" test pattern. Nicholas also noticed that at times the signals were stronger on his vertical dipole than on his horizontal dipole. This again is typical of the erratic behaviour of signals when their paths are being influenced by sporadic-E.

Harold Brodribb saw an orchestral programme with close-ups of the conductor, female singer and violins on his modified Bush TV125 receiver. "Very good sproadic-E event" writes **Steve Scott** G4CKR, Stockport, who with a converted Murphy V1913 TV receiver and a rooftop dipole, received good test cards from Italy, Norway and Spain between 1050 and 1350. Steve found TV DXing fascinating and, like us all, is looking forward to the sporadic-E season. Sam Faulkner noted an increase in Band I activity during the second week in April, and around 1200 on the 12th he saw part of a commercial, which interrupted a 19th century war film and a station ident from Italy. Sam is very pleased with the performance of the *PW* Wideband Preamplifier which he has built and is using to boost signals on the 20, 15 and 10m bands and Band I TV.

Slow Scan TV

At 1730 on March 20, Sam Faulkner received SSTV pictures on 10m from IT9TNY; at 1930 on the 23rd, N0ADU; around 1700 on the 28th, KA6FEJ, N9TV and WA7WOD; and between 1900 and 1930 on April 6 he received EA8ER, K1CBO, WB1ARX and WB3KAV. Sam said that 10m conditions are beginning to favour signals from Africa, because he has copied ZE and ZS stations on s.s.b., and hopes to receive SSTV pictures from that area soon. Among the 35 first-time 2-way QSOs made in March by **Richard Thurlow** G3WW,

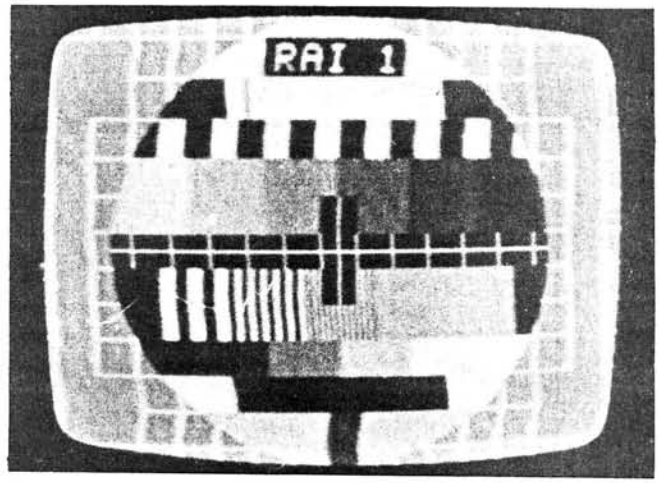


Fig. 2: Italian test card received by Paul Farrugia at 0920 on April 4

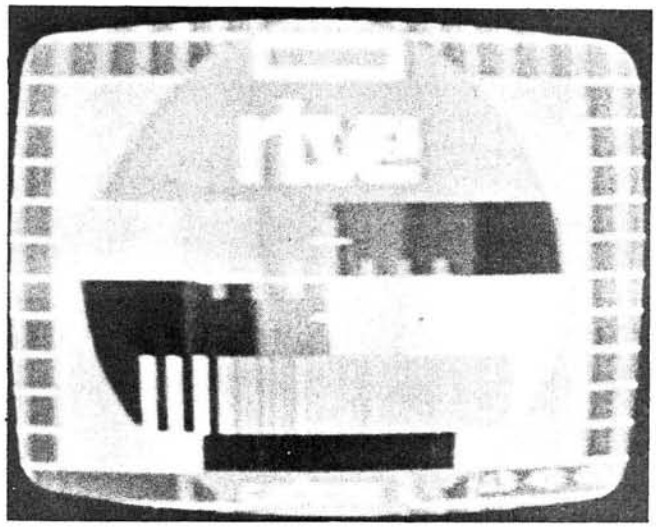


Fig. 3: Spanish test card received by Paul Farrugia at 1349 on April 4

Fig. 4: The colour picture recorded by W1VRK and received back at G3NOX after a journey of some 7000 miles on 28·680MHz

March, Cambridge, were signals from DL, EA, F, HB9, OE, VE, VP2 and W. During the USA SSTV contest on March 8/9, Richard made 54 2-way QSOs, of which 34 were in the 10m band. From 0921 to 1048 and 1520 to 1825 on April 5, he took part in the German SSTV contest and worked W2WHK and WB3ABP on 28·682MHz, and among his 22 2-way QSOs on 20m were stations in DK, EA, HA, I, JA, LZ, OE, OH, OK and SM.

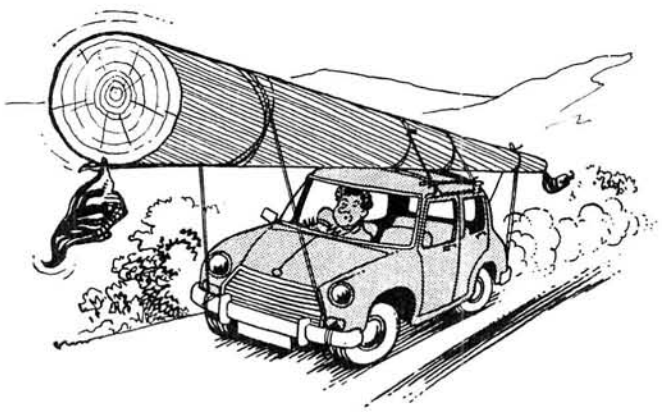
Congratulations to G3NOX, on a 2-way colour SSTV QSO with K2RZ for a transatlantic "first" using the new method of colour SSTV with three ROBOT 400 scan converters, an old Pye monochrome studio TV camera and three colour filters. My thanks to Richard Thurlow who explains: The original photograph is placed in front of his Pye camera which views it in turn through the red, green and blue filters consecutively. The camera output from each colour filter is fed independently into the memories of each of the three Robot 400s and the three memories are then combined electronically to produce the full colour picture. The colour picture (Fig. 4) was transmitted on 28·680MHz through an IC-701 transceiver to W1VRK who recorded the whole transmission on an ordinary C-60 cassette tape and transmitted it back to G3NOX, who fed the three colours back through his ROBOT 400s and then on to his monitor.

News Items

Congratulations to **Jeremy Judd,** West Chiltington, Sussex, who has passed the RAE and intends using his new call-sign, G8VYD, for 2m mobile work. **David Wakefield** G8RVK, has joined the Amateur Radio Club at RAF Cosford and hopes to be transmitting from there.

LOOKING IN AT LAND'S END

▶▶▶*continued from page 55*



And, of course, it hadn't. A few weeks later we were struck by a terrible Atlantic gale which bent the topmost aluminium tube over in a U-shape. Stung by this, we paid for a replacement made of sterner stuff and so far this has survived.

There have been other diversions, of course. On three occasions, the aerial cable has been eaten through by rats or badgers—sometimes, too, the violent winds swing the aerials round and these have to be realigned. In-depth technical investigations have resulted in the acquisition of innumerable extra boosters as a result of which, so long as others things are functioning, *we now have almost perfect reception!* That the whole thing has cost us the best part of £1000 and whether the quality of the programmes justifies that expense, are matters that I try not to think about.

We do, after all, live almost at Land's End. ●

VHF PERSONALITY

VIC HARTOPP

by RON HAM

Back in 1931, Vic Hartopp built his first one-valve receiver and, like many others, became fascinated with the amateur and commercial signals on the short-wave bands. In the years that followed, Vic constructed many sets using one, two, three and more valves in an endless quest for more sensitivity. In fact, he continued to make his own equipment until late in 1960.

Vic's enthusiasm as an experimenter played a major part in the development of post-war v.h.f. and u.h.f. communications, both for amateur and professional users, because he spent 25 years of his working life at Jaybeams, the aerial manufacturers in Northampton. Vic first joined the firm as a laboratory assistant and for many years built and tested radiotelephone aerials. He was part of the team which designed aerials for repeaters, satellite tracking, transmitters and several specialised projects for major industrial concerns. In time, he became the firm's Chief Development Engineer and ultimately Technical Director, and was frequently called upon to give lectures and advice on aerials to many amateur radio organisations, colleges and learned societies. Although a very busy man, he always found time to chat about an individual problem and like many others, I consulted Vic before building the aerial for my radiotelescope.

Whenever possible he assisted his local radio club during v.h.f. contests and field day events, and although he passed the RAE in 1965 he did not apply for his licence until 1969, when, as G8COB, he began piling up QSOs with his multitude of friends in the world of amateur radio. Today he uses an IC201, but still has regular contacts with a friend using his home-made gear. Now in retirement, Vic is collecting vintage communications receivers, compiling a scrapbook of receivers from the late 1930s to about 1960 and is currently renovating a Hallicrafters SX28 to add to his collection.

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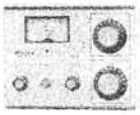

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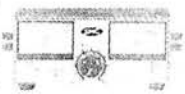

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Calibrated to 3:1 SWR. 50 ohms
Relative Power. SO239 sockets
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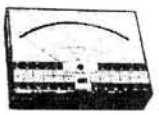

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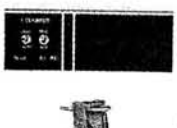

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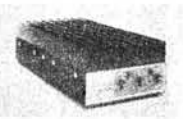

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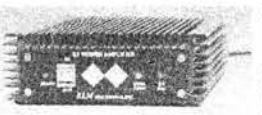

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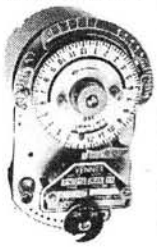

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Made by Goodmans so there's none better. 4 ohm coil. Price **£3.50** + 45p. Post £1.00.

8 OHM TWEETER
Made by Goodmans. 3½" square, 4" across fixings. Price **£1.50** + 22p. Post 30p.

ROTARY SOLENOID
As most customers know we have solenoids of the normal types for pulling and pushing through a magnetic assembly. We have now acquired some which have a rotating action. D.C. operated. A shaft which comes out of the centre, rather like a motor spindle, travels approx. 90°. Price **£5** + 75p.

WATERPROOF HEATING WIRE
As used for electric blankets, etc. This has dozens of other applications—in gloves or socks for people with poor circulation are obvious uses. One unusual use suggested by a customer is a 'grow' bag heater. The wire which consists of an element wound on glass fibre then PVC covered has a resistance of 60 ohms per yard. The price is **20p** + 3p per yard.

TELEPHONE PICK-UP coil attaches by suction to phone body, enabling conversation to be recorded, put through amp or headphones. Price **£1** + 15p.

TRANSDUCERS
As used remote control T.V. receivers. Price **£1.50** + 22p.

2½" ROUND PANEL METERS
All flush mounting through 2½" round hole, with flange makes item 3" wide approx. Made to stringent Ministry specifications. We have the following types in stock, all are moving coil unless otherwise stated. **VOLTMETER** Scaled 0-200 volts, res. 2,500 o.p.v. Price **£2** + 30p. **MICRO AMPMETER** 500 UA—scaled 0-5. Price **£2.50** + 38p. **MILLIAMP METER** 500 MA—scaled 0-500 mA. Price **£2** + 30p. **AMPERE METER** Hot wire, scaled 0-9 amp. Price **£2** + 30p. **DUAL RANGE** Scale calibrated 0-10v and 0-500v flush mounting this has internal resistor for the 10v range but would require ext. resistor for the 500v range. A very sensitive 20k per volt movement. Made for G.P.O. so obviously very good. Price **£3.00** + 45p.

0–1 MA PANEL METER
2" square made by Sifam for Ferrograph for peak level indication, so reads right to left—1 milliamp f.s.d., scaled 0-1. Price **£3** + 45p.

VU METER
Edgewise mounting, through hole size 1⅛" × ¼" approx. These are 100 micro amp f.s.d. and fitted with internal 6 volt bulb for scale illumination, also have zero reset. The scale is not calibrated but has very modern appearance. Price **£2.50** + 38p.

BALANCE METER
Edgewise mounting 100 UA centre zero. Price **£2.00** + 30p.

1⅞" SQUARE PANEL METER
Eagle full vision plastic front. 50 UA. Price **£4.00** + 60p. **1 mA.** Price **£3.50** + 53p.

LARGE PANEL MOUNTING MOVING COIL METER
Size 5" × 4" 200-0-200 UA. It has a plain scale, also it is a fairly easy job to reset the pointer to the left-hand zero position and thus obtain a 0/400 UA movement. Made by Sangamo Weston. Price **£6** + 90p.

GALVANOMETER 7-0-7 UA f.s.d.
Moving coil precision laboratory instrument of extremely high sensitivity (0.3 UA per division). Size approx. 6½" × 2½" × 2". Price **£12** + £1.80.

4" SQUARE PANEL MOUNTING moving coil movement with scale for multi-range test meter made for the Taylor Electric Co., a truly beautiful instrument with mirrored scale, end stops and zero adjustment. If you have contemplated building a 20,000 o.p.v. multi-tester then this is your chance. Price **£4.50** + 68p.

3" EDGEWISE PANEL METER
0-25 MA moving coil made for the G.P.O. A very useful instrument especially when panel space is limited. Price **£2.50** + 38p.

SPEAKER CABINETS
Simulated teak finish, nice handy size 11" × 8" × 4½" approx., modern black sponge type front. Price **£2** + 36p, post £1.50. Special price to bulk buyers.

12v SUBMERSIBLE PUMP
Our drill pump is useful, but this new one is even more so. Just join it to your car battery, drop it into the liquid to be moved and up it comes, no messing about, no priming, etc., and you get a very good head. Suitable for water, paraffin and any non-explosive, non-corrosive liquid. One use if you are a camper, make yourself a shower. Price **£6** + 90p. A free gift, first 100 purchasers will get tap with built in switch and length of plastic tubing.

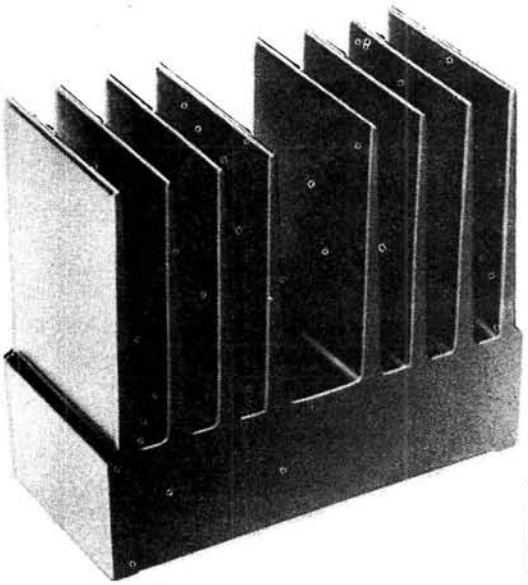
E.H.T. MAINS TRANSFORMER with inductance control, normal primary, secondary output by our equipment, 3·5 kv 3 mA. E.H.T. voltage can be varied by applying a DC voltage to the lower normally unused bobbin. We are not sure how much the voltage may be increased or decreased but using a 9 volt battery we seem to get a rise or fall of about 50 volts. Ex unused P.S.U.'s. Price **£2** + 30p. Post 40p.

SHORT WAVE CRYSTAL RADIO
All the parts to make up the beginners model. Price **£2** + **30p.** Crystal earpiece **57p** + **8p.** High resistance headphones (give best results) **£3.25** + **50p.** Kit includes chassis and front but not case.

RADIO STETHOSCOPE
Easy way to fault find—start at the aerial and work towards the speaker—when signal stops you have found the fault. Complete kit **£4.25** + **65p.**

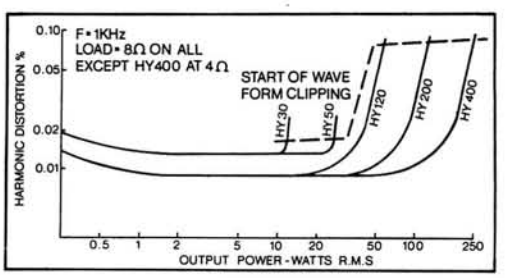
INTERRUPTED BEAM KIT
This kit enables you to make a switch that will trigger when a steady beam of infra-red or ordinary light is broken. Main components—relay, photo transistor, resistors and caps, etc. Circuit diagram but no case. Price **£2** + **30p.**

Simply ahead...



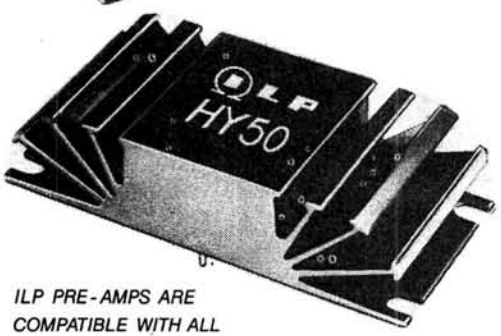
POWER AMPLIFIERS

ILP Power Amplifiers are encapsulated within heatsinks designed to meet total heat dissipation needs. They are rugged and made to last a lifetime. Advanced circuitry ensures their suitability for use with the finest loudspeakers, pick-ups, tuners, etc. using digital or analogue sound sources.



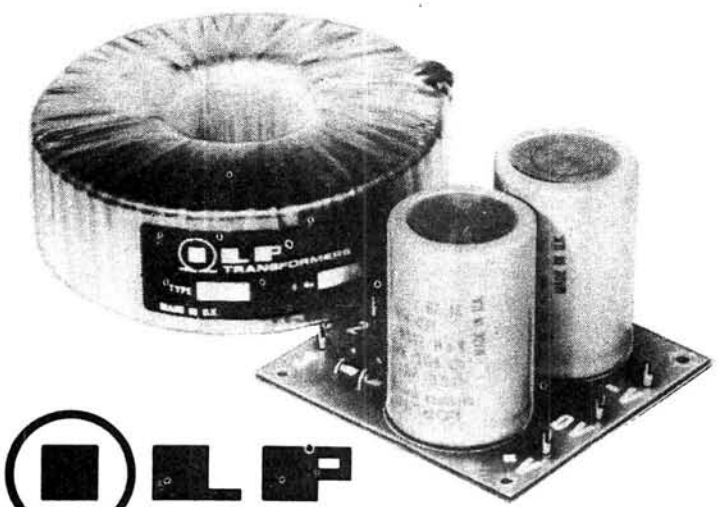
Model	Output Power R.M.S.	Distortion Typical at 1KHz	Minimum Signal/ Noise Ratio	Power Supply Voltage	Size in mm	Weight in gms	Price + V.A.T.
HY30	15 W into 8 Ω	0.02%	100 dB	-20 -0- +20	105x50x25	155	£6.34 + 95p
HY50	30 W into 8 Ω	0.02%	100 dB	-25 -0- +25	105x50x25	155	£7.24 + £1.09
HY120	60 W into 8 Ω	0.01%	100 dB	-35 -0- +35	114x50x85	575	£15.20 + £2.28
HY200	120 W into 8 Ω	0.01%	100 dB	-45 -0- +45	114x50x85	575	£18.44 + £2.77
HY400	240 W into 4 Ω	0.01%	100 dB	-45 -0- +45	114x100x85	1.15Kg	£27.68 + £4.15

Load impedance - all models 4 Ω - ∞
Input sensitivity - all models 500 mV
Input impedance - all models 100K Ω
Frequency response - all models 10Hz – 45 KHz – 3dB



ILP PRE-AMPS ARE COMPATIBLE WITH ALL ILP POWER AMPS AND PSUs

POWER SUPPLY UNITS



ILP Power Supply Units with transformers made in our own factory are designed specifically for use with ILP power amplifiers and are in two basic forms – one with circuit panel mounted on conventionally styled laminated transformer, for smaller PSU's – in the other, for larger PSU's, ILP toroidal transformers are used which are half the size and weight of laminated equivalents, are more efficient and have greatly reduced radiation.

PSU 30 ± 15V at 100mA to drive up to 12 x HY6 or 6 x HY66 **£4.50** + £0.68 VAT

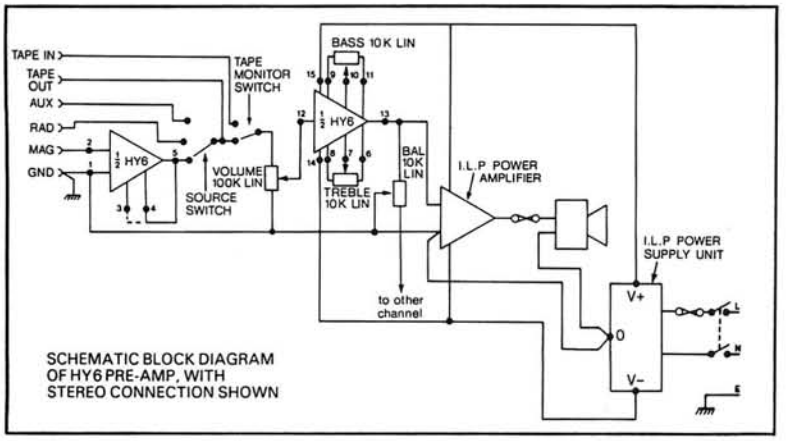
THE FOLLOWING WILL ALSO DRIVE ILP PRE-AMPS

PSU 36 for 1 or 2 HY30's **£8.10** + £1.22 VAT
PSU 50 for 1 or 2 HY50's **£8.10** + £1.22 VAT
PSU 60 with toroidal transformer for 1 HY 120 **£9.75** + £1.46 VAT
PSU 70 with toroidal transformer for 1 or 2 HY120's **£13.61** + £2.04 VAT
PSU 90 with toroidal transformer for 1 HY200 **£13.61** + £2.04 VAT
PSU 180 with toroidal transformer for 1 HY400 or 2 x HY200 **£23.02** + £3.45 VAT

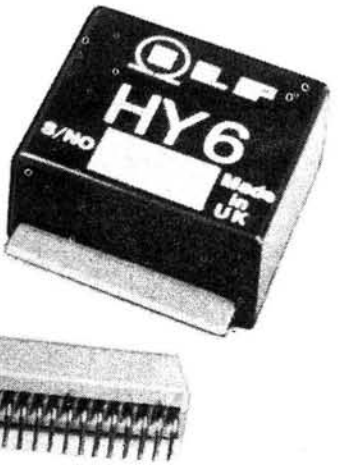
ILP

AVAILABLE ALSO FROM WATFORD ELECTRONICS, MARSHALLS AND CERTAIN OTHER SELECTED STOCKISTS.

this time with two new pre-amps



SCHEMATIC BLOCK DIAGRAM OF HY6 PRE-AMP, WITH STEREO CONNECTION SHOWN



HY6 *mono* HY66 *stereo*

When ILP add a new design to their audio-module range, there have to be very special reasons for doing so. You expect even better results. We have achieved this with two new pre-amplifiers – HY6 for mono operation, HY66 for stereo. We have simplified connections, and improved performance figures all round. Our new pre-amps are short-circuit and polarity protected; mounting boards are available to simplify construction.

Sizes – **HY6** – 45 x 20 x 40 mm. **HY66** 90 x 20 x 40 mm. Active Tone Control circuits provide ± 12dB cut and boost. Inputs Sensitivity – Mag. PU. – 3mV: Mic – selectable 1-12mV: All others 100mV: **Tape O/P** – 100mV: **Main O/P – 500mV:** Frequency response – D.C. to 100KHz – 3dB.

HY6 mono
£5.60
+ VAT 84p

HY66 stereo
£10.60
+ VAT £1 59

Connectors included

B6 Mounting Board
78p + 12p VAT

B66 Mounting Board
99p + 15p VAT

- **LOW DISTORTION - Typically 0.005%**
- **S/N RATIO - Typically 90 dB (Mag. P.U. – 68 dB).**
- **HIGH OVERLOAD FACTOR – 38 dB on Mag. P.U.**
- **LATEST DESIGN HIGH QUALITY CONNECTORS.**
- **REQUIRE ONLY POTS, SWITCHES, PLUGS AND SOCKETS.**
- **COMPATIBLE WITH ALL ILP POWER AMPS AND PSUs.**
- **NEEDS ONLY UNREGULATED POWER SUPPLY ±15V to ±50V.**

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N.B. All these Special Prices include VAT!

7400 TTL and LS

	std N	LS		std N	LS		std N	LS		std N	LS
7400	14p	19p	7430	17p	—	7496	64p	—	74166	144p	—
7402	15p	19p	7432	29p	—	74107	35p	—	74170	197p	—
7403	15p	21p	7440	19p	—	74121	30p	—	74174	106p	106p
7404	16p	21p	7442	62p	85p	74123	56p	—	74175	85p	—
7406	32p	—	7447	62p	—	74126	59p	—	74177	89p	—
7408	18p	23p	7473	34p	—	74132	—	74p	74180	98p	—
7410	15p	21p	7474	31p	43p	74145	85p	—	74188	245p	—
7411	23p	—	7475	37p	—	74150	101p	—	74193	101p	—
7412	26p	21p	7483	83p	101p	74153	73p	—	74195	95p	—
7414	59p	—	7485	105p	106p	74157	84p	84p	74196	203p	117p
7420	17p	21p	7486	35p	43p	74161	85p	85p	74221	180p	—
7421	33p	—	7490	33p	84p	74163	—	85p	74H00	37p	—
7427	31p	—	7492	55p	—	74164	112p	—	74H04	47p	—
7428	40p	—	7493	33p	84p	74165	119p	—	74H10	42p	—

All our i.c.s are brand new, fully guaranteed, mostly National and Texas

LINEAR INTEGRATED CIRCUITS

CA3046	94p	SL613C	£3.86	SL1611	£1.60	TAD100	£1.98
LM309K	£2.02	SL620C	£4.60	SL1612	£1.60	TBA120	87p
LM342/6	85p	SL621C	£4.60	SL1613	£2.50	TDA440	£3.48
LM380	£1.18	SL622C	£11.05	SL1621	£2.35	UL914	£1.60
LM1889	£3.05	SL623C	£8.15	SL1623	£2.85	555 Timer	30p
LM3900	93p	SL624C	£4.15	SL1626	£2.93	710 Op Amp	82p
SL301	£2.35	SL630C	£3.15	SL1630	£1.60	741 Op Amp	52p
SL439	£2.50	SL640C	£4.80	SL1640	£2.40	78L08	80p
SL610C	£3.10	SL641C	£4.80	SL1641	£2.27	7805	90p
SL611C	£3.10	SL1496	£1.00	SL6640	£4.30	7812	90p
SL612C	£3.10	SL1610	£1.60				

SPECIAL FUNCTION I.C.s

AY5-1013-UART	£4.85	ICM7208 7 digit 2MHz Frequency Counter	£16.72
2102/2602B-1024 Bit Memory	£1.30	ICM7216D 8 digit 10MHz Frequency Counter	£20.92
2102-1B 500nS version of 2102	£1.95	ICM7226A 8 digit 10MHz Frequency Counter	£28.86
2112-2-4 x 256 Bit Memory	£3.73	LS7031 8 digit 5MHz Frequency Counter	£13.88
75107 Line receiver	£2.08	SFF96364E VDU 16 Lines, 64 characters/line	£13.75

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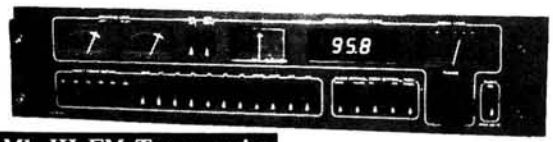


Mk III FM Tuner series

Carriage for Mk III tuner £3 inc

The Mark III series FM tuner has been updated, and now includes a centre zero tuning meter as standard. The instruction manual has been meticulously revised, enabling easy assembly by constructors of various levels of experience - a preview copy may be purchased for £1.00.

Mark III A series 'Reference series' tuner modules .....£171.35 inc.
Mark III B series 'Hyperfi' modules, with switched IF BW, pilot cancel decoder .....£198.95 inc.

A matching synthesiser unit will be made available later this year, and can be retrofitted to either version. All versions include digital frequency readout/clock, VU deviation meters, 6 preset stations, 10 turn pot manual tuning, toroidal PSU, output level adjustment, 110/240v AC input. Full alignment service available.

Power Amplifier

Style and performance - with a real 'belt and braces' PSU design.

After a couple of preview comments, it seems that many of you are waiting to hear about the matching HMOSFET power amplifier for the Mk III tuner. Well, it's out at last - complete with twin toroidal PSUs for comfortable 80W RMS per channel, over 100W peak, but limited by thermal shutdown of the HMOS. 10W-100W log LED output peak indicator, DC offset protection and switch-on pause relay. AC or DC input coupling, direct or relay protected output terminals. The works.
Only one version of this item: Complete kit .....£178.25 inc. Carr. £5.

Preamplifier

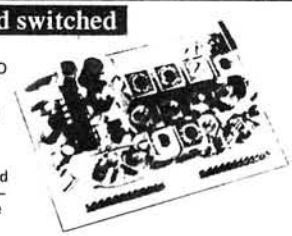
More features and facilities, thanks to DC switching and control design

Previewing the most comprehensive audio preamplifier yet..... DC switching of 7 inputs, plus two tape in/outs. 2 low pass, 2 high pass active filters, genuine volume related loudness, 1dB channel matching, with DC volume, balance, bass and treble controls. Suitable for bus/remote control, tape dubbing, switched monitor etc. 80dB S/N+, THD -75dB or better. Pluggable PU equalization boards, tone control override. Price for complete unit about £149 ex VAT.

Radio/Audio/Communications Modules

LW-MW-SW-SW DC tuned and switched

91072- All switching of bands by a single pin to gnd. Varicap tuned, with LO output for synth. MW/LW version or MW/LW plus 1 or 2 SW bands
MW/LW: £15.58 +1SW £16.73



VHF Tunerheads

Europes largest stock range for broadcast and communications. Probably also the world's – details in the catalogues and PL. Specials are also supplied in the region 30-220MHz.

Pilot Cancel PLL Stereo decoders

944378-2 £26.45

Again, Europe's widest range of stereo decoders including pilot cancel PLL types. The pic shows the 944378 - pilot cancel including post decoder 26/38kHz filtering and muting preamp output

Switched bandwidth FM IF strips

Broadcast FM IF strips for all occasions, including the new 911225 - with diode switched narrow filter option, ultra linear phase ceramic filters, 84dB S/N, and 0.04% THD (40kHz deviation). Plus usual things like AGC, AFC, dev. mute, level meter drive. £23.95 (supplied in screen can with 0.1 edge connection system)
Also the 7230 hyperfi series - as the 911225, but with slope controlled AFC that operates in conjunction with signal level - and an extra IF amp stage for DXing.

Various digital frequency displays

The World's largest range of receiver DFMs is now joined by the DFM7 (shown) - and L shaped version of the DFM3 with remote display mount connector possibility . 1kHz SW resolution with 455kHz or 10.7MHz offsets, 100Hz res up to 3.9999MHz, and VHF to 299.99 MHz in 10kHz steps : £41.75

Semiconductors

Radio/Communications ICs

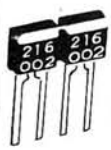
FOR COMPLETE LISTINGS – SEE OUR NEW PRICELIST

CA3089E	2.11	HA1197	1.61	SD6000	4.31
CA3189E	2.53	CA3123E	1.61	TDA4420	2.59
HA1137W	1.95	TDA1072	3.09	MC1330P	1.38
HA11225	2.47	TBA651	2.53	MC1350P	1.38
HA12412	2.81	TDA1090	3.51	KB4412	2.24
KB4420	1.95	TDA1220	1.61	KB4413	2.24
TBA120S	1.15	TDA1083	2.24	KB4417	2.53
KB4406	0.80	TDA1062	2.24	MC3357P	3.16

SL1610	1.84	SL1626	2.80
SL1611	1.84	SL1630	1.86
SL1612	1.84	SL1640	2.17
SL1613	2.17	SL1641	2.17
SL1620	2.50	SL6600	4.31
SL1623	2.80	SL6640	3.16
SL1624	3.77	SL6690	3.68
SL1625	2.50	MC1496	1.44

VARICAP DIODES.....
A section from our PL:

BA102	0.35	16:1 ratio AM tuning	
BB204	0.41	KV1215 9v triple	2.93
BB105	0.41	KV1211 9v dual	2.01
BB109	0.31	KV1225 25v triple	3.16
MVAM2	1.93	BB212 9v dual	2.25



POWER MOSFETS

100W PA's made simple

Since pioneering the 100W complementary MOSFET technique - Hitachi have developed a range of output devices and drivers that ought to revolutionise opinions and attitudes towards the design of all LF amplification systems. We have a new 48 page application note (£1.50 inc) and complete sets of parts, modules and now the new complete PA system (see above).

2SK133	120v N-ch 100W MOSFET	£6.33	2SJ48 Pch complement	£6.33
2SK135	160v N-ch 100W MOSFET	£7.29	2SJ50 Pch complement	£7.39
PA101B	Kit for 100W MOSFET PA less Heatsink £16.10. (£23 inc heatsink/bkt)			

ULTRA LOW NOISE PU PREAMPLIFIER

The HA12017 is the last word in PU preamps, and general low noise audio design. It is an SIL IC, with 86dB S/N in RIAA configuration, 10v RMS output capability, 0.002% typ THD at 10v RMS output (imagine the overload margin !!). It comfortably supercedes discrete circuit designs in terms of price/performance, and takes the art beyond the TDA1042's capabilities. (Replaces HA1457) £1.80 each - or an RIAA applications PCB with two ICs for £5.75. Complete with Rs&Cs £9.95.

Radio Control ICs

We have various RC ICs, including NE544 NE5044, and two new ones from OKI

KB4445 - 4 channel dig.prop. FM TX IC. 30mW out (amplifyable) -£2.30 inc
KB4446 - 4/5 ch. dig. prop FM RX IC. Suits KB4445 or RCME syst. £2.65.
KB4445/6 pair: £4.75. New 8 page data sheet 35p + SAE. More RC ICs in list

CMOS, LPSNTTL, TTL, MPU: Listings in the new pricelist.

Most CMOS is available in low volume - also LPSN. Standard linears and TTL OK.

Things like ICM7216B, ICL8038, 8080A, 6800P, 2708, NE555,NE556, etc

Coming Soon.....

Contain yourselves, RF fans ! Not yet ready for a full launch until autumn, but previewed here:-

SSB transceiver system : 10kHz to 1000MHz !!

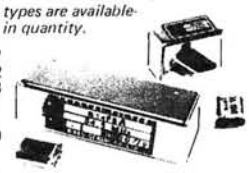
A modular VLF to UHF SSB TX/RX system at last. With the correct first mixer, the basic PCB covers 10kHz to 1000MHz - using LO fed from ext. source (Our 2 IC Mullard synth for instance) and RF PA for TX OP. 0.2uV basic sensitivity in HF , Typ cost for HF synth SSB RX will be less than £200. Add an RF PA for full TRX for another £50. See one in our foyer, and marvel.

Components

Crystal Filters

Most popular types are available ex-stock, and in quantity.

10.7MHz	25kHz Channel spacing 8pole	£16.67
	12½kHz ..	£17.82
	2.4kHz SSB	£19.78
	Monolithic dual roofing filter	£2.30
34.5MHz	1.3dB loss, 80dB stopband HF first filter in synth. RX	£36.80
RC XTALS	FM pairs (no spilts)	£3.74
	AM pairs ..	£3.57
USB/LSB	Xtals for 10.7SSB filter	£2.88 ea



Piezo Sounders

The most efficient warning sounders yet

The latest thing in electro-acoustic efficiency. 1mA of drive from CMOS will give an SPL of 83dB - 10v RMS drive from CMOS uses 3mA for 100dB SPL at 4.8kHz (88dB at 1.65kHz)
The data sheets shows various drive circuits, and give full specifications with regard to broadband responses and power consumption etc. 1 off 44p inc. 100 off 28.75p (25p ex vat)

Keyboard switches and caps

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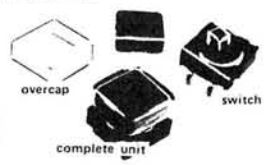

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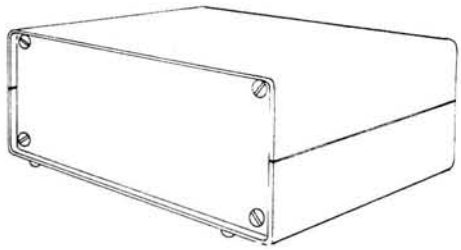

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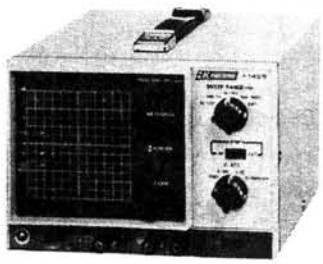

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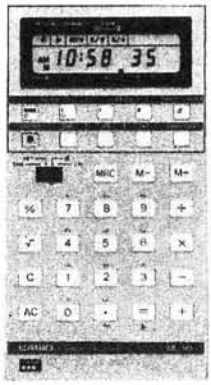

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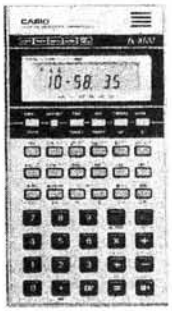

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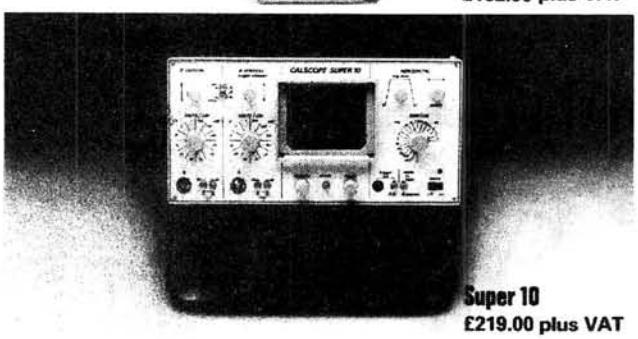

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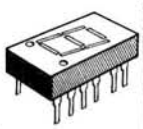

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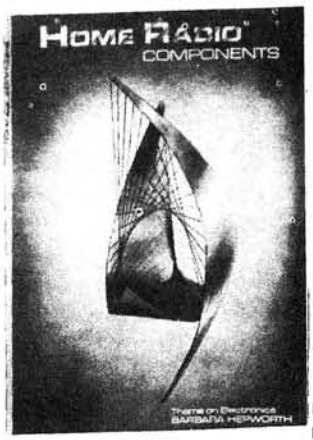

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