practical WIRELESS

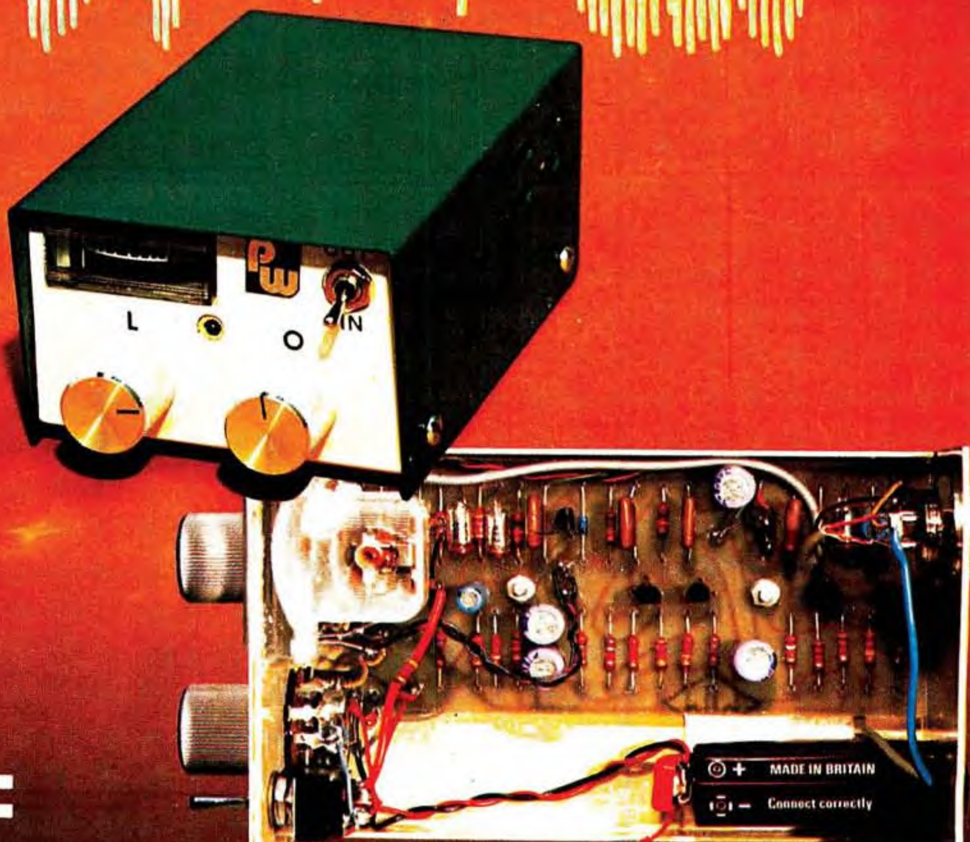
55p

Australia 95c
New Zealand $1.10
South Africa 90c
Malaysia $2.75

JAN 1980

AF Speech Processor

TX



ALSO:

WIDEBAND RF PREAMPLIFIER

ELIABILITY IN ELECTRONIC CIRCUITS

SEIKO MEMORY BANK

Calendar watch M354
Hours, mins., secs.
Month, day, date in 12 or 24 hour format all indicated continuously.
Monthly calendar display month, year and all dates for any selected month over 80 year period.
Memory bank function.
Any desired dates up to 11 can be stored in advanced.
2 year battery life.
Water resistant.
Metac Price

£79.50 **M11**

SEIKO Alarm Chronograph

With WEEKLY Alarm.
Hours, mins, secs, month, date, day, am/pm.
Weekly alarm – can be set for every day at designated time e.g. 6.30 am on Mon, Wed and Friday.
Alarm set time displayed above time of day.
Full stopwatch functions, laptime, split etc.

£89.95 **M10**

SEIKO Melody Alarm Chronograph

Chiming Alarm, plus chrono.
Hours, mins, secs, date, day, 24 hour alarm, 12 hour chronograph, 1/10th secs, Laptime, Back light, Stainless steel, mineral glass.

METAC PRICE
£92.95 **M19**

SEIKO Calculator Watch

Full specification calculator with memory, plus multi function watch.
Hours, mins, secs, day, date, backlight, Automatic calendar.
Long life battery.

£99.95 **M27**

CASIO CHRONO 95QS-3LB

Stainless steel case, water resistant to 66 feet.
Hours, mins, secs, am/pm, year, month, date, day.
Auto-calendar pre-programmed until the year 2029.
12/24 hour. Stopwatch function.
Range 7 hours. 1/100 sec. (Mode) Net time/lap-time/ 1st-2nd place times.
Dual time function.
Accuracy 15 secs per month.
Battery life approx 4 years.

£22.95 **M22**

CASIO LADIES 86CL-23B-1

Elegant slim line.
Stainless steel bracelet, fully adjustable.
Hour, mins, 10 sec symbol second by flash, am/pm.
Month, date, day.
Auto-calendar preprogrammed for 28th day in Feb.
Accuracy per month 15 secs.
Battery life approx 15 months.

£29.95 **M23**

CASIO F-200 Sports Chrono

Attractive Mans watch in black resin with mineral glass.
Hours, mins, secs, am/pm.
Month, date, alpha-numeric day.
Auto-calendar set 28th Feb.
Stopwatch working range 1 hour, units 1/100 sec. Mode, Net Time/lap/time/ 1st-2nd place times.
Accuracy approx 15 secs per month.
Battery 12 months.

£14.95 **M24**

CASIO ALARM CHRONO 81CS-36B

Hours, mins, secs, day, and also day, month and year perpetual automatic calendar.
100th sec chronograph to 7 hours.
Net time/lap/time/1st and 2nd place times. User optional 12/24 hr display. 24 Alarm. User optional, hourly chime.
Backlight, mineral glass, stainless steel.
Water resistant to 100ft.
Battery life approx 4 years.

£34.95 **M25**

BELTIME Chronograph

(9-Functions)
Hours, mins, secs, day, date, month, interchange feature, automatic calendar, backlight, Net time/lap/time.
Stainless steel bracelet.
Battery life 1 year.

£14.95 **M34**

BELTIME Multi Alarm

29 Functions
Hours, mins, secs, date, day.
Alarm, chronograph, Light.
Watch 8 functions, Alarm 4 functions, chronograph 17 functions.
Stainless steel bracelet.

£29.95 **M35**

CASIO F-8C 3 Year Battery life.

Hours, mins, secs, am/pm, date, day.
Auto calendar set 28th Feb.
Stopweatch function.
Accuracy 15 secs per month. Battery life approx 3 years.

£9.95 **M36**

CASIO CALENDAR 200 47CS-23B-1 Black. Stainless steel.

Hours, mins, 10 second symbol, second (by flash), am/pm. Month, day, date.
Auto-calendar set from 1901 to 2009.
Full month calendar display.
Dual time function.
Accuracy 10 secs per month. Battery life approx 15 months.

£59.95 **M37**

MELODY Multi Alarm Chronograph

Hours, mins, secs, Day, Date, Count-down alarm, Dual time zone, 1/100th sec stopwatch. Lap/split time, 1st and 2nd place times, Melody test function.

£26.95 **M30**

DUAL TIME-ALARM CHRONOGRAPH

Incorporating module of world famouse Japanese watch manufacture.
Hours, mins, secs, days of week, month, day and date, 24 hour alarm, 12 hour chronograph, 1/10th secs, lap time, Back light, stainless steel case and bracelet, Mineral glass, Battery hatch, long life battery.

£35.00 **M12**

PICOQUARTZ Microprocessor Alarm Chronograph

Multilanguage–day of the week can be set to English, French, German, Italian or Spanish.
Chime – every full hour combined with a response signal, beeping at every pressing of the functions.
Can be switched off.
12-24 hour format.
Backlight.
Chrono – 1, full scale chrono with lap, counting hours upto 24 hrs. Mins, secs, 1/100th secs.
Two Alarm systems.
Two time zones.

£37.95 **M32**

SEIKO CHRONOGRAPH

Hours, mins, secs and day of the week.
Month date and day of the week.
Stopwatch display – Hours, mins, secs up to 12 hours (mins, secs, 1/100 secs up to 20 minutes).
Lap timing.
Continuous time measurement of two competitors.
Stinless steel, mineral glass.

£56.00 **M33**

Metac ELECTRONICS & TIME CENTRES

North & Midlands
67 High Street, DAVENTRY
Northamptonshire
Telephone: 03272 76545

South of England
327 Edgware Road
LONDON W.2
Telephone: (01) 723 4753

practical WIRELESS

JANUARY 1980
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BRITAINS LEADING JOURNAL FOR THE RADIO & ELECTRONIC CONSTRUCTOR

Published by IPC Magazines Ltd., Westover House, West Quay Rd., POOLE, Dorset BH15 1JG

QUERIES
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.

Components are usually available from advertisers. A source will be suggested for difficult items.

SUBSCRIPTIONS
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Limited stocks of some recent issues of *PW* are available at 85p each, including post and packing to addresses at home and overseas.

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All reasonable precautions are taken by *Practical Wireless* to ensure that the advice and data given to readers are reliable. We cannot however guarantee it and we cannot accept legal responsibility for it. Prices are those current as we go to press.

NEWS & VIEWS

FOR OUR CONSTRUCTORS

GENERAL INTEREST

We regret that Hi-Fi Glossary Part 4 has had to be held over

Our February issue will be published on 4 January
(for details see page 47)

All these advantages...

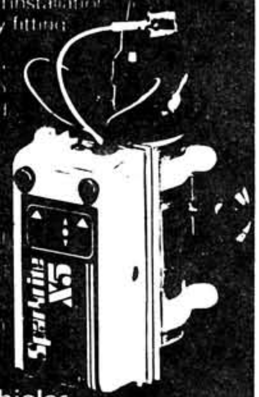
- Instant all-weather starting
- Smoother running
- Continual peak performance
- Longer battery & plug life
- Improved fuel consumption
- Improved acceleration/top speed
- Extended energy storage

..in kit form

SPARKRITE X5 is a high performance, top quality inductive discharge electronic ignition system designed for the electronic D I Y world. It has been tried, tested and proven to be utterly reliable. Assembly only takes 1-2 hours and installation even less due to the patented 'clip on' easy fitting.

The superb technical design of the Sparkrite circuit eliminates problems of the contact breaker. There is no misfire due to contact breaker bounce which is eliminated electronically by a pulse suppression circuit which prevents the unit firing if the points bounce open at high R P M. Contact breaker burn is eliminated by reducing the current by 95% of the norm.

There is also a unique extended dwell circuit which allows the coil a longer period of time to store its energy before discharging to the plugs. The unit includes built in static timing light, systems function light, and security changeover switch. Will work all rev counters.



Fits all 12 v negative-earth vehicles with coil/distributor ignition up to 8 cylinders.

THE KIT COMPRISES EVERYTHING NEEDED
Die pressed case. Ready drilled, aluminium extruded base and heat sink, coil mounting clips and accessories. All kit components are guaranteed for a period of 2 years from date of purchase. Fully illustrated assembly and installation instructions are included.

Roger Clark the world famous rally driver says "Sparkrite electronic ignition systems are the best you can buy"

Sparkrite

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SINGLE TRACE OSCILLOSCOPE
- **10mv/div**
- **5MHz**
- **BRITISH**

£125.00*

SAFGAN ST-45

TRIGGER
Internal: 0.5div (10Hz – 2MHz), 1div (2MHz – 5MHz). External: 100mv (10Hz – 2MHz), 200mv (2MHz – 5MHz). Bright Line Auto; trace free-runs in absence of signal. Trigger Level: Selects triggering point. Trigger (+)ve and (–)ve slope selection.

DISPLAY
Graticule: Blue, ruled 8×10 div's (6.4cm×8cm). CRT: Thorn – Brimar 1.5Kv Monoaccelrator/P31.

GENERAL
Power consumption: 10VA approx. Mains Selection: 200V – 220V – 240V rms (40Hz – 60Hz). Size: W – 165mm; H – 215mm; D – 300mm. Weight: 10lbs – 4.5 kg approx. Case, aluminium with black PVC finish and black handle; front panel white with black control knobs. Black feet and tilt-bar.

ST-45 SPECIFICATION

VERTICAL SYSTEM
Sensitivity: 10mv/div – 5V/div in 9 cal. steps. Bandwidth (3dB). DC Coupled: DC – 5MHz. AC Coupled: 5Hz – 5MHz. Risetime: 70nsec. Input Impedance: 1MΩ +22pf approx. (for all ranges). 50Ω for 10mv/div – 50mv/div. Input coupling: AC, GND, DC. Max Input volts: ±400V peak. Accuracy: ±5%.

HORIZONTAL SYSTEM
Timebase speeds:- 50ms/div – 1μsec/div in 15 cal. steps. with ×5 Multiplier to 250m sec/div and ×5 Expansion to 200n sec/div. External – x sensitivity: 1V/div. External – x Bandwidth: 500KHz. Accuracy: ±5%.

ACCESSORIES
Passive Probe switched (X1; REF; X10) 100MHz bandwidth £11.50 + VAT. BNC to 4mm Socket Adaptor £2.95 + VAT.

ORDERS TO: **SAFGAN ELECTRONICS LTD., 56 Bishops Wood, St. Johns, Woking, Surrey GU21 34B or TEL: Woking 66836**

Please send me ...... ST-45 ...... Probe ...... Adaptor
I enclose PO/Cheque .... (Goods + 15% VAT + P&P £3.00)
Name ....
Address ....

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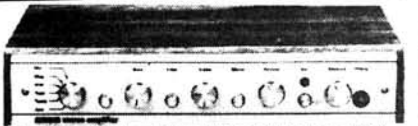
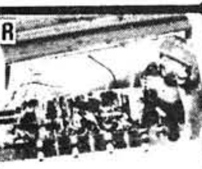


20 x 20 WATT STEREO AMPLIFIER

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 sockets. 20 x 20 watts RMS 40 x 40 watts peak for use with 8 to 15 ohm speakers. Size 14¾" x 3" x 10" approx. *NEW* feature—units now includes a built in four channel stereo sound facility

£31.90 £3.00 p&p

30x30 WATT AMPLIFIER IN KIT FORM



For the experienced constructor complete in every detail, same facilities as Viscount IV, but with 30x30 output 60x60 watts peak. For use with 4 to 15 ohms speakers

£31.50 p&p £3.00

SPECIAL OFFER

30 x 30 WATT AMPLIFIER KIT
with BSR P200 belt drive deck and Shure M75 cartridge.

£57.00 + p&p £6.00

EMI SPEAKER BARGAIN

Stereo pair 350 kit. System consists of 13" x 8" approx woofer with rolled surround, 2½" approx Audax tweeter, crossover components and circuit diagram. Frequency response 20 Hz to 20 KHz. Power handling 15 watts RMS 20 watts max. 8 ohm impedance.

£15.25
Per stereo pair
£3.65 p&p

BSR P200

Belt drive chassis turntable unit semi-automatic, cueing device.
£25.50 p&p £2.60

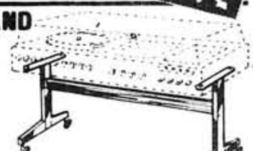
A.D.C. QLM 30 Mk III Magnetic Cartridge to suit.
£7.95

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 **£11.25** p&p £2.75

GARRARD DECK MODEL CC 10A

Record changer with cueing device fitted with stereo ceramic cartridge ready to fit into your own plinth
£8.15 p&p £2.05 Size 12" x 8½"

UNIT AUDIO STAND



Can be used with TV too! Finish in chrome with decorative wood spacer fitted with 4 Kenrick Mini Meteor castors

£3.95 £1.50 p&p
24" x 12½" x 11½" approx.

BARGAIN FOR PERSONAL SHOPPERS ONLY

Altone UA4 Stereo System

Features 8 watt total output. Full size BSR manual turntable with cueing and auto return. Socket for tape in and out and stereo headphones

complete with speakers **£35.75**

Micro Cassette Recorder
Pocket size—home or office use or when travelling. **£14.25**

Battery operated fluorescent camping lamp.
Runs off 8 U2 batteries. **£4.80**

Mullard

AUDIO MODULES IN BARGAIN PACKS

CURRENT CATALOGUE PRICE £ AT OVER 25 PER PACK

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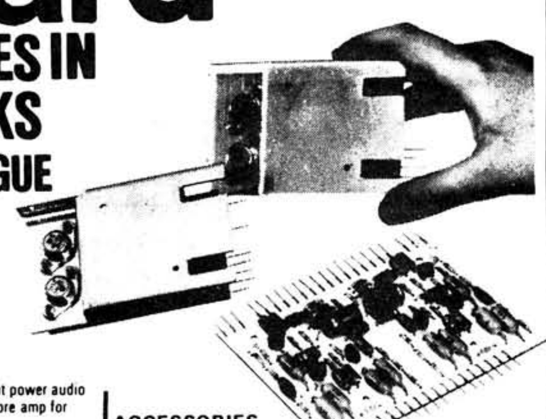
ACCESSORIES ARE ONLY AVAILABLE TO THOSE CUSTOMERS WHEN BUYING OUR BARGAIN PACKS



1 PACK 1. 2 x LP1173 10w RMS output power audio amp modules, + 1 LP1182/2 Stereo pre amp for ceramic and auxiliary input.
OUR PRICE p+p £1.00 **£5.00**

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
illus. OUR PRICE p+p £1.00 **£7.65**

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 £1.50 p&p
AVAILABLE ALSO TO PURCHASERS OF THE 10 + 10 AMPLIFIER KIT

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 **£4.05**
per stereo pair plus £1.55 p&p

10 + 10 AMPLIFIER KIT

An opportunity to buy a 10 watts per channel stereo amplifier kit which is suitable for use with a ceramic cartridge. The amplifier utilises proven Mullard modules and is available at a very competitive price. The amplifier kit comes complete with instructions and includes: a Mullard LP1183 stereo preamplifier module, two LP1173 power amplifiers with integral heatsinks, a power supply, Zobel networks, front and back mounting panels, a finished fascia panel, all control potentiometers (bass, treble, volume and balance), switches, input, output and headphone sockets, wire, and an easily assembled wrap around cabinet to house the finished unit.
Size approximately 9¼" x 8¾" x 4"
p&p £2.25 **£12.25**

BARGAINS FOR PERSONAL SHOPPERS

LCD Solar 5 function with backlite stainless steel finish case and strap	**£7.40**
LCD Solar Chrono 9 function with backlite stainless steel finish case and strap	**£9.55**
Chrono stop watch 9 function with back lite stainless steel finish case and strap.	**£8.95**
Solar Alarm LCD stainless steel case and strap.	**£21.95**
AM/FM DIGITAL CLOCK RADIO Accurate 4 Digit Electronic Clock with ½" LED display Buzzer and snooze timer	**£12.20**
100 Watt Power Amp Module	**£14.25**
Mains power supply for above unit	**£3.60**
DECCA 20w Stereo speaker kit comprising 2 8" approx bass units + 2 3½" approx tweeter inc crossovers	**£20.45**
'VIDEOMASTER' Super Score TV Game with pistol mains operation	**£15.95**
PORTABLE RADIO/CASSETTE RECORDER, AM/FM with clock LW, MW, SW, VHF mains/battery operation	**£42.90**
ISP Radio Cassette recorder Mains/Battery AM/FM built in mic auto stop.	**£24.50**

100 WATT MONO DISCO AMP

Size approx 14" x 4" x 10¼"
Brushed aluminium fascia and rotary controls
Five vertical slide controls, master volume, tape level, mic level, deck level, L PLUS INTER DECK FADER for perfect graduated change from record deck No. 1 to b 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
p&p £4.05 **£66.45**

50 WATT MONO DISCO AMP

£30.60
p&p £2.70
Size approx. 13⅜" 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.

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All items subject to availability. Prices correct at 1.8.79 and subject to change without notice
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Ariston pick-up arm manufactured in Japan. Complete with headshell. Listed price over £30.00.

OUR PRICE £11.95
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P.C.B'S FOR PRACTICAL WIRELESS PROJECTS

Dec. 78.	Car Radio L.W. Converter	R032	Price £2.79 & 20 pence p & p.
Jan. 79.	Acoustic Delay Line	R018	Price £3.77 & 20 pence p & p.
Jan. 79.	Dorchester	R033	Price £11.00 & 30 pence p & p.
Jan. 79.	Sandbank Met. Det.	R035	Price £3.41 & 20 pence p & p.
Feb. 79.	Hythe Receiver	WR037	Price £6.34 & 20 pence p & p.
March 79.	Hythe Receiver	WR038	Price £2.98 & 20 pence p & p.
March 79.	Soudlite Converter	WK001	Price £6.33 & 20 pence p & p.
March 79.	Tone Burst Generator	R023	Price £1.71 & 15 pence p & p.
March 79.	Wide Band Noise Source	WR036	Price £0.74 & 12 pence p & p.
April 79.	FM Multitester	WR040	Price £3.05 & 15 pence p & p.
May 79.	Car Test Probe	WR042	Price £0.96 & 15 pence p & p.
May 79.	Follow up to PW Gillingham	WR044	Price £1.45 & 15 pence p & p.
May 79.	PW Imp	WR043	Price £1.52 & 15 pence p & p.
May 79.	Inline Crystal Calibrator	WR041	Price £1.68 & 15 pence p & p.
June 79.	Jumbo Clock		Price £9.52 & 30 pence p & p.
June 79.	Logical O's+X's	WR046/7/8/9	Price £12.84 & 30 pence p & p.
June 79.	Trent	WR050	Price £4.06 & 20 pence p & p.
July 79.	AAM/FM Frenquency Readout	WR052	Price £3.66 & 20 pence p & p.
	V.MOS Top Band Transmitter	WR056	Price £4.08 & 20 pence p & p.
	Sound Operated Switch	WK005/6	Price £3.74 & 20 pence p & p.
	Inexpensive A/F Voltmeter	WR055	Price £1.15 & 15 pence p & p.
August 79.	Telephone Bell Repeater	WR053	Price £1.15 & 15 pence p & p.
August 79.	Automatic Intercom	WR043	Price £6.20 & 20 pence p & p.
Sept. 79.	Automatic Intercom Part 2	WR058	Price £0.60 & 12 pence p & p.
Sept. 79.	Noise Blanker	WR057	Price £1.24 & 12 pence p & p.
Oct. 79.	Burglar Alarms	WR059	Price £1.23 & 15 pence p & p.
Oct. 79.	Burglar Alarms	WR060	Price £1.91 & 20 pence p & p.
	Radio Control Receiver	WR064	Price £2.92 & 20 pence p & p

FULL RANGE OF R.S. COMPONENTS
AVAILABLE

P.W. JUMBO CLOCK KIT **£31.00**
All prices include V.A.T.

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Tel. 061-428-4497.

Please state type number and enclose cheque or postal order.

POWER UNIT INVERTOR I/P 115v 50c/s provides a high & low voltage O/Ps at 25Kc contains 6 pot cores inc types FX2240/42/43, 2×HV TO. 3 pwr tranis, 4×400v 3 amps diodes, 8×BC107, 2×BFY52, (transistor types may vary) 2×Thyristors, Zener & swt diodes, elec conds, 3×20mm fuse holders, all in screened case size 9×3½×4" with circ. £4.50 or 2 for £8.

RECEIVER UNIT. small high performance receiver uses 7 min. plug-in valves covers 2.5 to 20Mc/s in 3 bands as RF stage, B.F.O. volt stab, provides O/P for high res or crystal earphones, direct freq cal with geared drive, size 5 ×3¾ ×3½" these req ext supplies of 200v 40Ma DC & 6.3v AC 1a. Supplied tested with circ, no ext case. £25.00.

SELECTIVE CALLING UNITS contain telephone dial small 500Ua meter, low volt stab power unit, 9 circ brds, lamps, relays, swts etc thought to generate dialling tones that can be selected on front panel, 200/250v I/P transis units new cond with circ details £22.

MAINS TRANS pria 200/250v sec 340-250-0-250-340v at 210Ma plus 6·5 at 5 amps twice & 5v ct at 5 amps size 5×5×6" we have tested these a 700v DC at 250Ma using full sec with no L.T. load, will also give 17·6v at 5 amps new boxed £8.50.

RECEIVER UNIT small 5 valve, Superhet inc BFO covers 2 to 8Mc/s in two bands direct calibration reqs 135v HT & 1.5V DC in case size 8×5×4" for use with high or low res phones with circ. £13.

INDICATOR UNIT with 3" CRT type 3WP1 (more modern than 3BP1) plus 13 miniature valves in case size 10×8×21" contains 400c P.U. with circ £25.

PANEL METERS mixed mostly 2 & 3" dia types 4 different for £4.

TRANSMITTER ASS. Small low power 15/25w 2·5 to 20Mc/s Tx unit crystal controlled sold for breakdown contains 2x 175Pf Tun cond, miniature 500Ua meter, morse key, coils, swts, RF chokes, knobs etc. Supplied less valves, contains most parts for Rx or Lp Tx ATU with circ. £8.50.

TRANSIS INVERTOR 12v DC I/P O/Ps 425v DC at 120Ma or 180v DC 40Ma also 6·3v DC at 2·5 amps in case size 5½×4×3"' tested with circ. £10.50.

MAINS TRANS Pria 200/250v sec 225-135-0-135-225 at 70Ma 6·3 2a & 6·3 700Ma. £4 matching choke £1.50 also C core trans sec 250v 60Ma & 6·3v 3 amps £3.

MOTOR for use on 115v AC rated 1/18th HP int at 5000 RPM brush type size 5" by 2¼" dia with pinion 3/8th by ¼" fitted govenor reqs ext 220 ohm 25 watt res & .luf cond, new American spares okay for PCB Drills. £6.50.

VARIABLE STABILISED P.U. Solartron bench type 200/250v I/P O/P var from 0 to 500v DC at up to 150Ma floating O/P also 6·3v 5a fitted Volt/Ma meter overload protection on 19" panel size 9" high 13½" deep no ext case £35. We have a few table cases intended to take two of these units at £12.

GRID DIP OSC. American Services pattern PRM-10 covers 2 to 400Mc/s cont uses set of 7 plug in coils with direct calibration as 4 functions Grid Dip, Osc Det, Absorbtion W.M. & Sig Gen for use om 115v 50c/s 25 watts, the head unit with indicating meter can be removed from carrying case which contains P.U. and function selector swts, the head unit measures 7×4×3 exc coil, meter 100 Ua·5 valves inc rect. All contained in carrying case size 11×9×5" with circ. £55 new cond or £45 good S/Hand cond.

HELIPOTS & DIALS standard 10 tr dial to fit 3/8th bush £1.50 or with 100K helipot £2.

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BC157	.09
BC158	.09
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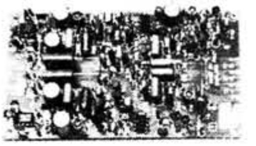
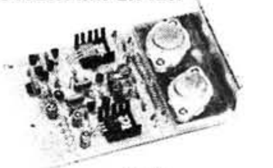


MC 1



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Suitable for nearly all moving-coil cartridges. Send for details.

X02 : X03 – ACTIVE CROSSOVERS

X02 – two way, X03 – three way. Slope 24dB/octave. Crossover points set to order within 10%.

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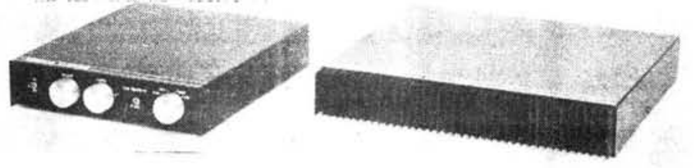

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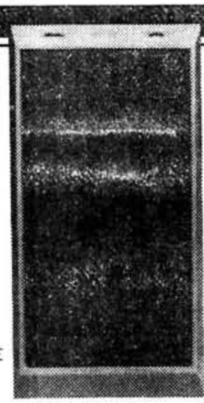

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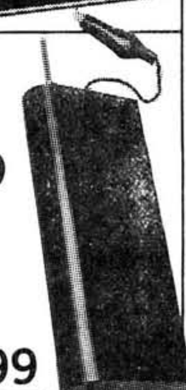

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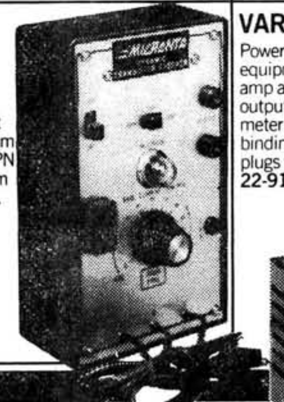

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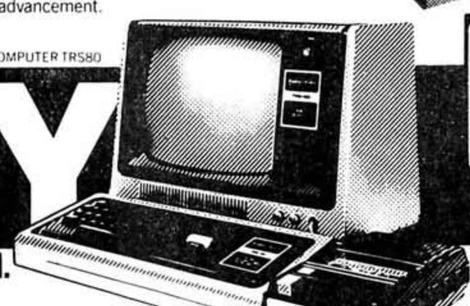

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92	2 0	**32.40**	O.A.

50 VOLT RANGE

Pri 220/240V Sec 0-20-25-33-40-50V Voltages available 5, 7, 8, 10, 13, 15, 17, 20, 33, 40 or 20V-0-20V and 25V-0-25V.

Ref	Amps	Price	P & P
102	0.5	**3.75**	0.90
103	1.0	**4.57**	1.10
104	2.0	**7.88**	1.31
105	3.0	**9.42**	1.52
106	4.0	**12.82**	1.73
107	6.0	**16.37**	1.89
118	8.0	**22.29**	2.39
119	10.0	**27.48**	O.A.
109	12.0	**31.79**	O.A.

MAINS ISOLATORS (SCREENED)

PM 120/240 Sec 120/240V CT

Ref	VA	Price	P & P
*07	20	**4.84**	0.91
149	60	**7.37**	1.10
150	100	**8.38**	1.31
151	200	**12.28**	1.31
152	250	**14.61**	1.73
153	350	**18.07**	2.12
154	500	**22.52**	2.47
155	750	**32.03**	O.A.
156	1000	**40.92**	O.A.
157	1500	**56.52**	O.A.
158	2000	**67.99**	O.A.
159	3000	**95.33**	O.A.

*Pri 0-220-240V Sec 115 or 240V. State sec. volts required.

CASED AUTO TRANSFORMERS

240V cable in 115V USA flat pin outlet

VA	Price	P & P	Ref
20	**6.55**	1.03	56W
75	**8.50**	1.31	64W
150	**11.00**	1.31	4W
200	**12.02**	1.67	65W
250	**12.55**	1.67	69W
500	**20.13**	1.89	67W
1K	**30.67**	2.65	84W
1.5K	**33.02**	O.A.	93W
2K	**54.97**	O.A.	95W

60 VOLT RANGE

Pri 220/240V sec 0-24-30-40-48-60V. Voltages available 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 or 24V-0-24V or 30V-0-30V.

Ref	Amps	Price	P & P
124	0.5	**4.27**	1.10
126	1.0	**6.50**	1.10
127	2.0	**8.36**	1.31
125	3.0	**12.10**	1.31
123	4.0	**13.77**	2.12
40	5.0	**17.42**	1.89
120	6.0	**19.87**	2.12
121	8.0	**27.92**	O.A.
122	10.0	**32.51**	O.A.

12 OR 24V OR 12-0-12V

Pri 220-240 volts

Ref	Amps 12V	Amps 24V	Price	P&P
111	0.5	0.25	**2.42**	0.52
213	1.0	0.5	**2.90**	0.90
71	2	1	**3.86**	0.90
18	4	2	**4.46**	1.10
85	0.5	2.5	**6.16**	1.10
70	6	3	**6.99**	1.10
108	8	4	**8.16**	1.31
72	10	5	**8.93**	1.31
116	12	6	**9.89**	1.52
17	16	8	**11.79**	1.52
115	20	10	**15.38**	2.39
187	30	15	**19.72**	2.39
226	60	30	**40.41**	O.A.

SPECIAL OFFER

Multimeter 20KΩ B/V – with combined audio/I.F. test oscillator at 1 KHz and 465 KHz AC/DC to 1000 volts DC current to 500mA resistance to 1KΩ. Size 160x97x40mm **£8.50** P & P £1.00 VAT 15%.

END OF LINE OFFERS

Ref				P · P
30-Isolator 240V:240V 200VA			**£4.54**	£1.04
62-Isolator 240V:240V 250VA			**£5.62**	£1.04
M616 – 0-240V: Screen 1) 13-0-13 1A. 2) 12V 150ma			**£2.10**	60p
M489 – 0-240V: 1400V ≠ 150ma, 6.3V ≠ 4A			**£5.50**	£1.04
M708 – 6K to 3KΩ matching trans. 5 watt			**90p**	40p
M679 – 0-120V × 2; 36V 1.6A			**£3.00**	78p
M865 – 100V Line to 4Ω 10 watts			**£1.90**	60p
M973 – 100V Line to 8Ω 40 watts			**£2.90**	60p
M1015 – Chcke 8A ≠ 5mH 150A Surge			**£1.50**	45p
M1020 – 0-240V 12-0-12V ≠ 50ma			**75p**	30p
M1126 – 120/240V: 9-0-9V ≠ 1A			**£1.79**	71p
M1130 – 0-240 4500V ≠ 10ma			**£4.86**	£1.08
M1165 – 0-115-240V: 14V 50ma			**75p**	30p

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110K/120K/130K/180K/220K/270K/300K
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P.W. Purbeck osciloscope transformer 250-0-250; 6.3V; 12.9V **£7.51** £1.04

SCREENED MINIATURES

Ref	mA	Volts	£	P&P
238	200	3-0-3	**2.83**	0.63
212	1A, 1A	0-6, 0-6	**3.14**	0.90
13	100	9-0-9	**2.35**	0.44
235	330, 330	0-9, 0-9	**2.19**	0.44
207	500, 500	0-8-9, 0-8-9	**3.05**	0.85
208	1A, 1A	0-8-9, 0-8-9	**3.88**	0.90
236	200, 200	0-15, 0-15	**2.19**	0.44
214	300, 300	0-20, 0-20	**3.08**	0.90
221	700 (DC)	20-12-0-12-20	**3.75**	0.90
206	1A, 1A	0-15-20-0-15-20	**5.09**	1.10
203	500, 500	0-15-27-0-15-27	**4.39**	1.10
204	1A, 1A	0-15-27-0-15-27	**6.64**	1.10
239	50	12-0-12	**2.88**	0.37

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2 windings 0-36V-48V/36V-0-36V 48V-0-48V 72V or 96V.

Amps	Ref	Price	P & P
½	430	**4.88**	0.76
1.0	431	**8.12**	0.99
2.0	432	**13.35**	1.31
3.0	433	**16.17**	1.40
4.0	434	**20.65**	2.11
5.0	435	**29.30**	2.47
6.0	436	**36.69**	O.A.
8.0	437	**40.03**	O.A.

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43mm × 43mm		82mm × 78mm	
0 50μA	**6.20**	0 50μA	**6.70**
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0 30V	**5.95**	0 30V	**6.70**

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Ref			P & P
171	500 mA	**2.30**	0.52
172	1A	**3.26**	0.90
173	2A	**3.95**	0.90
174	3A	**4.13**	0.99
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Ref	VA (Watts)		£	P&P
113	15	0-115-210-240	**2.73**	0.81
64	75	0-115-210-240	**4.41**	1.10
4	150	0-115-200-220-240	**5.70**	1.10
67	500	0-115-200-220-240	**12.09**	1.91
84	1000	0-115-200-220-240	**20.64**	2.39
93	1500	0-115-200-220-240	**25.61**	OA
95	2000	0-115-200-220-240	**38.31**	OA
73	3000	0-115-200-220-240	**65.13**	OA
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AC153K	£0·35
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AC165	£0·23
AC166	£0·23
AC167	£0·23
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AC169	£0·23
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AC176	£0·21
AC176K	£0·30
AC178	£0·29
AC179	£0·29
AC180	£0·23
AC180K	£0·32
AC181	£0·23
AC181K	£0·32
AC187	£0·21
AC187K	£0·32
AC188	£0·21
AC188K	£0·32
ACY17	£0·40
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ACY19	£0·40
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ACY21	£0·40
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ASY28	£0·44
ASY29	£0·44
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ASY51	£0·35
ASY52	£0·35
ASY54	£0·35
ASY55	£0·35
ASY56	£0·35
ASY57	£0·35
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BC116A	£0·22
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BC120	£0·46
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BC141	£0·32
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BC143	£0·25
BC145	£0·53
BC147	£0·08
BC148	£0·08
BC149	£0·08
BC150	£0·23
BC151	£0·25
BC152	£0·25
BC153	£0·29
BC154	£0·22
BC157	£0·12
BC158	£0·12
BC159	£0·12
BC160	£0·30
BC161	£0·44
BC167	£0·14
BC168	£0·14
BC169	£0·10
BC169C	£0·12
BC170	£0·10
BC171	£0·10
BC172	£0·10
BC173	£0·10
BC174	£0·17
BC175	£0·40
BC177	£0·18
BC178	£0·18
BC179	£0·18
BC180	£0·29
BC181	£0·10
BC182	£1·25
BC182L	£0·10
BC183	£0·10
BC183L	£0·10
BC184	£0·10
BC184L	£0·10
BC186	£0·25
BC187	£0·25
BC207	£0·13
BC208	£0·13
BC209	£0·14
BC212	£0·10
BC212L	£0·10
BC213	£0·10
BC213L	£0·10
BC214	£0·10
BC214K	£0·10
BC225	£0·30
BC226	£0·41
BC227	£0·18
BC238	£0·18
BC251	£0·17
BC251A	£0·18
BC301	£0·32
BC302	£0·33
BC303	£0·32
BC304	£0·44
BC327	£0·18
BC328	£0·17
BC337	£0·17
BC338	£0·17
BC440	£0·35
BC441	£0·35
BC460	£0·44
BC461	£0·44
BC477	£0·23
BC478	£0·23
BC479	£0·23
BC547	£0·12
BC548	£0·12
BC549	£0·12
BC550	£0·16
BC556	£0·16
BC557	£0·15
BC558	£0·14
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BCY32	£0·69
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BD176	£0·69
BD177	£0·78
BD178	£0·78
BD179	£0·86
BD180	£0·86
BD181	£0·98
BD182	£1·04
BD183	£1·09

Type	Price
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BD185	£0·78
BD186	£0·78
BD187	£0·86
BD188	£0·86
BD189	£0·90
BD190	£0·90
BD195	£1·04
BD196	£1·04
BD197	£1·09
BD198	£1·09
Type	Price
BD199	£1·14
BD200	£1·14
BD201	£0·92
BD202	£0·92
BD201/ 202mp	£1·96
BD203	£0·92
BD204	£0·92
BD203/ 204mp	£1·96
BD205	£0·92
BD206	£0·92
BD207	£0·92
BD208	£0·00
BD222	£0·00
BD225	£0·54
BD232	£0·63
BD233	£0·55
BD234	£0·63
BD235	£0·63
BD236	£0·67
BD237	£0·63
BD238	£0·69
BD239A	£0·58
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BF115	£0·25
BF117	£0·58
BF118	£0·86
BF119	£0·86
BF121	£0·58
BF123	£0·69
BF125	£0·58
BF127	£0·68
BF152	£0·29
BF153	£0·29
BF154	£0·25
BF155	£0·40
BF156	£0·32
BF157	£0·32
BF158	£0·32
BF159	£0·32
BF160	£0·35
BF162	£0·32
BF163	£0·35
BF164	£0·55
BF165	£0·55
BF167	£0·28
BF173	£0·23
BF176	£0·44
BF177	£0·30
BF178	£0·30
BF179	£0·35
BF180	£0·35
BF181	£0·35
BF182	£0·35
BF183	£0·35
BF184	£0·23
BF185	£0·23
BF186	£0·30
BF187	£0·30
BF188	£0·46
BF194	£0·12
BF195	£0·12
BF196	£0·12
BF197	£0·14
BF198	£0·16
BF199	£0·16
BF200	£0·35
BF202	£1·04
BF222	£1·04
BF224	£0·20
BF240	£0·20
BF241	£0·20
BF244	£0·35
BF257	£0·29
BF258	£0·29
BF259	£0·40
BF262	£0·69
BF263	£0·69
BF270	£0·41
BF271	£0·36
BF272	£0·92
BF273	£0·41
BF274	£0·44
BF324	£0·40
BF336	£0·35
BF337	£0·35
BF338	£0·44
BF457	£0·43
BF458	£0·43
BF459	£0·44
BF596	£0·32
BFR39	£0·28
BFR40	£0·29
BFR79	£0·32
BFR80	£0·32
BFX29	£0·25
BFX30	£0·35
BFX84	£0·25
BFX85	£0·28
BFX86	£0·29
BFX87	£0·25

Type	Price
BFX88	£0·25
BFX90	£0·43
BFY50	£0·18
BFY51	£0·18
BFY52	£0·18
BFY53	£0·18
BIP19	£0·44
BIP20	£0·44
BIP19/20	£0·92
BSX25	£1·67
BSX19	£0·21
BSX20	£0·21
BSY25	£0·18
BSY26	£0·18
BSY27	£0·18
BSY28	£0·18
BSY29	£0·18
BSY38	£0·22
BSY39	£0·22
BSY40	£0·33
BSY41	£0·33
BSY51	£0·29
BSY95	£0·15
BSY95A	£0·15
BRY39	£0·52
BU105	£1·84
BU105/02	£2·24
BU204	£1·81
BU205	£1·81
BU208	£2·19
BU208/02	£2·59
MJE2955	£1·04
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MJE3440	£0·60
MP8113	£0·60
MPF102	£0·32
MPF104	£0·40
MPF105	£0·40
MPSA05	£0·23
MPSA06	£0·23
MPSA55	£0·23
MPSA56	£0·23
ND120	£0·21
OC20	£2·13
OC22	£1·73
OC23	£1·73
OC24	£1·55
OC25	£1·15
OC26	£1·15
OC28	£0·92
OC29	£1·09
OC35	£1·04
OC36	£1·04
OC41	£0·23
OC42	£0·25
OC44	£0·28
OC45	£0·23
OC70	£0·28
OC71	£0·17
OC72	£0·28
OC74	£0·30
OC75	£0·35
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OC82D	£0·35
OC83	£0·30
OC84	£0·44
OC139	£0·92
OC140	£0·92
OC169	£0·40
OC170	£0·40
OC171	£0·40
OC200	£0·44
OC201	£1·09
OC202	£1·38
OC203	£0·98
OC204	£1·04
OC205	£1·32
TIC44	£0·33
TIC45	£0·40
TIP29A	£0·46
TIP29B	£0·48
TIP29C	£0·51
TIP30A	£0·46
TIP30B	£0·48
TIP30C	£0·51
TIP31A	£0·46
TIP31B	£0·48
TIP31C	£0·51
TIP32A	£0·46
TIP32B	£0·48
TIP32C	£0·51
TIP41A	£0·51
TIP41B	£0·53
TIP41C	£0·55
TIP42A	£0·51
TIP42B	£0·53
TIP42C	£0·55
TIP2955	£0·69
TIP3055	£0·53
TIS43	£0·25
TIS90	£0·21
UT46	£0·23
ZTX107	£0·12
ZTX108	£0·12
ZTX109	£0·12
ZTX300	£0·14
ZTX301	£0·14
ZTX302	£0·18
ZTX303	£0·18
ZTX304	£0·23
ZTX330	£0·17
ZTX500	£0·15
ZTX501	£0·14
ZTX502	£0·18
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Type	Price
ZTX504	£0·29
ZTX531	£0·29
ZTX550	£0·18
2N388	£0·41
2N388A	£0·64
2N404	£0·23
2N524	£0·46
2N527	£0·58
2N598	£0·46
2N599	£0·53
2N696	£0·15
2N697	£0·14
2N698	£0·14
2N699	£0·37
2N706	£0·12
2N706A	£0·14
2N707	£0·55
2N708	£0·16
2N711	£0·35
2N717	£0·35
2N718	£0·29
2N718A	£0·58
2N726	£0·33
2N727	£0·33
2N743	£0·23
2N744	£0·23
2N914	£0·17
2N918	£0·35
2N929	£0·23
2N930	£0·21
2N946	£0·46
2N1131	£0·21
2N1132	£0·21
2N1302	£0·17
2N1303	£0·21
2N1304	£0·21
2N1305	£0·21
2N1306	£0·29
2N1307	£0·29
2N1308	£0·35
2N1309	£0·35
2N1599	£0·40
2N1613	£0·23
2N1711	£0·23
2N1889	£0·52
2N1890	£0·52
2N1893	£0·35
2N2147	£0·86
2N2148	£0·81
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2N2193	£0·44
2N2194	£0·44
2N2217	£0·25
2N2218	£0·25
2N2218A	£0·23
2N2219	£0·23
2N2219A	£0·28
2N2220	£0·23
2N2221	£0·23
2N2221A	£0·25
2N2222	£0·23
2N2222A	£0·23
2N2368	£0·21
2N2369	£0·16
2N2369A	£0·16
2N2411	£0·29
2N2412	£0·29
2N2646	£0·54
2N2711	£0·25
2N2712	£0·25
2N2714	£0·25
2N2904	£0·21
2N2904A	£0·24
2N2905	£0·21
2N2905A	£0·23
2N2906	£0·18
2N2906A	£0·22
2N2907	£0·23
2N2907A	£0·25
2N2923	£0·17
2N2924	£0·17
2N2925	£0·17
2N2926G	£0·10
2N2926Y	£0·09
2N29260	£0·09
2N2926R	£0·09
2N2926B	£0·09
2N3010	£0·75
2N3011	£0·17
2N3053	£0·18
2N3054	£0·46
2N3055	£0·46
2N3391	£0·23
2N3391A	£0·25
2N3392	£0·23
2N3393	£0·23
2N3394	£0·23
2N3395	£0·25
2N3402	£0·24
2N3403	£0·24
2N3404	£0·33
2N3405	£0·48
2N3434	£0·18
2N3415	£0·18
2N3416	£0·33
2N3417	£0·33
2N3614	£1·15
2N3615	£1·21
2N3616	£1·21
2N3646	£0·10
2N3702	£0·09
2N3703	£0·09
2N3704	£0·08
2N3705	£0·08
2N3706	£0·09
2N3707	£0·09
2N3708	£0·08
2N3708A	£0·08

Type	Price
2N3709	£0·08
2N3710	£0·08
2N3711	£0·08
2N3772	£1·84
2N3773	£2·53
2N3819	£0·21
2N3820	£0·40
2N3821	£0·69
2N3823	£0·69
2N3903	£0·12
2N3904	£0·12
2N3905	£0·12
2N3906	£0·12
2N4058	£0·14
2N4059	£0·16
2N4060	£0·16
2N4061	£0·14
2N4062	£0·14
2N4921	£0·63
2N4923	£0·75
2N5135	£0·12
2N5136	£0·12
2N5138	£0·12
2N5172	£0·16
2N5194	£0·64
2N5245	£0·46
2N5294	£0·39
2N5296	£0·41
2N5457	£0·37
2N5458	£0·37
2N5459	£0·40
2N5551	£0·41
2N6027	£0·39
2N6121	£0·81
2N6122	£0·81
2S301	£0·58
2S302	£0·49
2S302A	£0·49
2S303	£0·64
2S403	£0·82
2S305	£0·92
2S306	£0·92
2S307	£0·92
2S321	£0·66
2S322	£0·49
2S322A	£0·49
2S323	£0·66
2S324	£0·82
2S325	£0·00
2S326	£0·82
2S327	£0·82
40311	£0·42
40313	£1·09
40316	£1·09
40317	£0·46
40326	£0·46
40327	£0·52
40346	£0·52
40347	£0·75
40348	£0·92
40360	£0·41
40362	£0·44
40406	£0·52
40407	£0·40
40408	£0·60
40409	£0·86
40410	£0·86
40411	£0·00
40430	£1·09
40476	£1·84
40494	£0·81
40495	£0·92
40512	£1·55
40594	£1·04
40636	£1·27

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7400	£0·10	7427	£0·28	7473	£0·29	74110	£0·41	74166	£0·90
7401	£0·13	7428	£0·30	7474	£0·29	74111	£0·67	74174	£0·75
7402	£0·13	7430	£0·15	7475	£0·33	74118	£0·92	74175	£0·71
7403	£0·13	7432	£0·25	7476	£0·29	74119	£1·36	74176	£0·67
7404	£0·13	7433	£0·35	7480	£0·51	74121	£0·28	74177	£0·67
7405	£0·13	7437	£0·24	7481	£0·98	74122	£0·45	74180	£1·73
7406	£0·25	7438	£0·24	7482	£0·78	74123	£0·46	74181	£0·67
7407	£0·25	7440	£0·14	7483	£0·67	74136	£0·60	74182	£0·81
7408	£0·15	7441	£0·58	7484	£1·01	74141	£0·63	74184	£0·81
7409	£0·15	7442	£0·46	7485	£0·78	74145	£0·63	74190	£0·78
7410	£0·13	7443	£0·81	7486	£0·25	74150	£0·78	74191	£0·71
7411	£0·20	7444	£0·81	7489	£1·96	74151	£0·55	74192	£0·69
7412	£0·17	7445	£0·75	7490	£0·37	74153	£0·55	74193	£0·67
7413	£0·28	7446	£0·69	7491	£0·74	74154	£0·94	74194	£0·71
7414	£0·58	7447	£0·55	7492	£0·40	74155	£0·58	74195	£0·69
7416	£0·26	7448	£0·64	7493	£0·35	74156	£0·58	74196	£1·21
7417	£0·26	7450	£0·13	7494	£0·86	74157	£0·58	74197	£1·21
7420	£0·13	7451	£0·13	7495	£0·58	74160	£0·67	74198	£2·13
7421	£0·23	7453	£0·13	7496	£0·58	74161	£0·71	74199	£2·13
7422	£0·18	7454	£0·13	74100	£0·98	74162	£0·71		
7423	£0·24	7460	£0·13	74104	£0·45	74163	£0·71		
7425	£0·22	7470	£0·29	74105	£0·44	74164	£0·78		
7426	£0·26	7472	£0·23	74107	£0·28	74165	£0·78		

CMOS ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CD4000	£0·16	CD4015	£0·94	CD4026	£1·38	CD4043	£1·01	CD4070	£0·20
CD4001	£0·23	CD4016	£0·49	CD4027	£0·58	CD4044	£0·94	CD4071	£0·20
CD4002	£0·18	CD4017	£0·94	CD4028	£0·78	CD4045	£1·01	CD4072	£0·20
CD4006	£1·06	CD4018	£0·98	CD4029	£0·98	CD4046	£1·50	CD4081	£0·20
CD4007	£0·20	CD4019	£0·48	CD4030	£0·55	CD4047	£1·00	CD4082	£0·25
CD4008	£1·06	CD4020	£1·04	CD4031	£2·30	CD4049	£0·55	CD4510	£1·27
CD4009	£0·52	CD4021	£0·94	CD4035	£1·38	CD4050	£0·55	CD4511	£1·44
CD4010	£0·55	CD4022	£0·94	CD4037	£1·09	CD4054	£1·27	CD4516	£1·15
CD4011	£0·23	CD4023	£0·22	CD4040	£1·01	CD4055	£1·15	CD4518	£1·15
CD4012	£0·22	CD4024	£0·75	CD4041	£0·87	CD4056	£1·55	CD4903	65p
CD4013	£0·48	CD4025	£0·22	CD4042	£0·83	CD4069	£0·20		

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Type	Price	Type	Price	Type	Price	Type	Price
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CA3014	£1·55	LM304	£1·84	MC1350	£1·38	TAA550B	£0·49
CA3018	£0·75	LM308	£1·15	MC1352	£1·61	TAA621A	£2·30
CA3020	£1·96	LM309	£1·73	MC1469	£3·39	TAA621B	£2·88
CA3028	£0·92	LM320-5V	£1·73	MC1496	£1·04	TAA661	£1·73
CA3035	£1·01	LM320-12V	£1·73	NE536	£3·06	TAD100	£1·50
CA3036	£1·15	LM320-15V	£1·73	NE550	£1·09	TBA540	£2·42
CA3042	£1·73	LM320-24V	£1·73	NE555	£0·28	TBA810S	£0·86
CA3043	£2·13	LM380	£0·98	NE556	£0·69	TBA810	£1·13
CA3046	£0·81	LM381	£1·67	NE565	£1·38	TBA820	£0·81
CA3052	£1·84	LM3900	£0·67	NE566	£1·73	TBA9200	£2·98
CA3054	£1·27	MC1303L	£0·98	NE567	£1·96	TCA270S	£2·30
CA3075	£1·73	MC1304	£2·19	UA702C	£0·53	TBA800	£0·92
CA3081	£1·73	MC1310	£1·09	72702	£0·53		
CA3089	£2·30			UA703	£0·29		
CA3090	£4·14			UA709	£0·29		
CA3123	£2·19			72709	£0·53		
CA3130	£1·07			7099	£0·29		
CA3140	£0·81			UA710C	£0·46		

DIODES

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AA110	£0·09	BAX13	£0·08	BY164	£0·59	OA10	£0·40	SD10	£0·07
AA120	£0·09	BAX16	£0·09	BY176	£0·86	OA47	£0·09	SD19	£0·07
AA129	£0·09	BY100	£0·25	BY206	£0·35	OA70	£0·09	IN34	£0·08
AAY30	£0·10	BY101	£0·25	BYZ10	£0·52	OA79	£0·12	IN34A	£0·08
AAZ13	£0·17	BY105	£ ·	BYZ11	£0·52	OA81	£ ·	IN914	£0·07
BA100	£0·12	BY114	£0·25	BYZ12	£0·46	OA85	£0·12	IN916	£0·07
BA102	£0·37	BY124	£0·25	BYZ13	£ ·	OA90	£0·12	IN4148	£0·07
BA148	£0·17	BY126	£0·17	BYZ16	£0·47	OA91	£0·12	IS44	£0·96
BA154	£0·14	BY127	£0·18	BYZ17	£0·41	OA95	£0·12	IS920	£0·07
BA155	£0·16	BY128	£0·18	BYZ18	£0·41	OA182	£0·15		
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400	TR16a/400	£0·89	BR100 £0·23	D32	£0·23

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400v RMS	BR1 400	£0·41	400v RMS	BR2 400	£0·67
			1000v RMS	BR2 1000	£0·78
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Comprising of all parts except 2 PP3 Batteries 1 Euroboard.
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Panel mounting 1¼in.	510	£0·37

QUICK BLOW 20mm

Type	No.		Type	No.		Type	No.	
150mA	611	7p	1A	615	6p	3A	619	6p
250mA	612	6p	1·5A	616	7p	4A	620	10p
550mA	613	6p	2A	617	6p	5A	621	6p
800mA	614	8p	2·5A	618	7p			

ANTI-SURGE 20mm

Type	No.	Type	No.	Type	No.
100mA	622	1A	625	2·5A	628
250mA	623	2A	626	3·15A	629
500mA	624	1/6A	627	5A	630

All **8p** each

QUICK-BLOW 1¼in.

Type	No.	Type	No.	Type	No.
250mA	631	500mA	632	800mA	634

All **8p** each

Type	No.	Type	No.	Type	No.
1A	635	2/5A	638	4A	641
2A	637	3A	639	5A	642

All **60** each

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BA BOLTS–packs of BA threaded cadmium plated screws slotted cheese head. Supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
1in. OBA	839	£1·38	½in. 4BA	846	£0·37
½in. OBA	840	£0·86	¼in. 4BA	847	£0·29
1in. 2BA	842	£0·75	1in. 6BA	848	£0·46
½in. 2BA	843	£0·52	½in. 6BA	849	£0·24
¼in. 2BA	844	£0·60	¼in. 6BA	850	£0·20
1in. 4BA	845	£0·51			

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Type	No.	Price	Type	No.	Price
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2BA	856	£0·55	6BA	858	£0·28

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Type	No.	Price	Type	No.	Price
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OBA	860	£0·14	6BA	862	£0·14

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Type	No.	Price	Type	No.	Price
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114	5 pin DIN plug to 3·5mm Jack connected to pins 3 & 5 length 1·5m	£0·98
115	5 pin DIN plug to 3·5mm Jack connected to pins 1 & 4 length 1·5m	£0·98
116	Car aerial extension screened insulated lead. Fitted plug and socket	£1·44
117	AC mains connecting lead for cassette recorders and radios 2 metres	£0·78
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119	2 × 2 pin DIN plugs to stereo Jack socket with attenuation network for stereo headphones. Length 0·2m	£1·04
120	Car stereo connector. Variable geometry plug to fit most car cassettes. 8-track cartridge and combination units. Supplied with inlined fuse power lead and instructions	£0·69
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126	5 pin DIN plug to Tinned open end. Length 1·5m	£0·85
127	5 pin DIN plug to 4 Phono Plugs. All colour coded. Length 1·5m	£1·49
128	5 pin DIN plug to 5 pin DIN socket. Length 1·5m	£0·92
129	5 pin DIN plug to 5 pin DIN plug mirror image. Length 1·5m	£1·21
130	2 pin DIN plug to 2 pin DIN inline socket. Length 5m	£0·78
131	5 pin DIN plug to 3 pin DIN plug 1 & 4 and 3 & 5 Length 1·5m	£0·95
132	2 pin DIN plug to 2 pin DIN socket. Length 10m	£1·13
133	5 pin DIN plug to 2 Phono plugs. Connected pins 3 & 5. Length 1·5m	£0·86
134	5 pin DIN plug to 2 Phono sockets. Connected pins 3 & 5. Length 23cm	£0·78
135	5 pin DIN socket to 2 Phono plugs. Connected pins 3 & 5. Length 23cm	£0·78
136	Coiled stereo headphone extension lead. Black, length 6m	£2·01
178	AC mains lead for calculators, etc	£0·52

TRANSFORMERS

MINIATURE MAINS Primary 240V

No.	Secondary	Price
2021	6V–0–6V 100mA	£1·04
2022	9V–0–9V 100mA	£1·04
2023	12V–0–12V 100mA	£1·29

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Multi-tapped secondary mains transformers available in ½ amp, 1 amp and 2 amp current rating. Secondary taps are 0–19–25–33–40–50V. Voltages available by use of taps. 4, 7, 8, 10, 14, 15, 17, 19, 25, 31, 33, 40, 25–0–25V

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162	5¼in	4in	1½in	£0·97
163	4in	2½in	2in	£0·87
164	3in	2in	1in	£0·60
165	7in	5in	2½in	£1·43
166	8in	6in	3in	£1·82
167	6in	4in	2in	£1·18

SLOPE front aluminium boxes with black vinyl base and sides & aluminium back, top & front–strong construction easily accessable.

169	2 1/8in	5 3/8in	2¾in	12in	3½in	8in	£5·45
168	2 5/8in	7¼in	4in	16in	4½in	11in	£8·31

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Service

AS I've mentioned on this page a couple of times in recent months, we've been having considerable trouble with delays to publication. These delays have stemmed from a variety of causes, and as fast as we've got over one difficulty, another one has arisen to plague us. We know it's been a frustrating time for you, and it's been frustrating for us too, not least because there was no practical way of keeping you informed on the situation.

I hope that steps recently taken to overcome the problems will prove to have been successful, and that you are able to read this on the scheduled publication date, which is the first Friday in December. Thank you for bearing with us so patiently.

A further apology is due to readers who have written to us and have sometimes had to wait a long time for a reply. This has been due to editorial staff shortages, which are hopefully now a thing of the past.

Unfortunately, we do have to impose certain rules on readers' queries, otherwise we'd spend most of the day answering them, and the magazine just wouldn't get published. We ask you to note the following:

1. We cannot deal with technical queries by telephone. Please put your problems in a letter, and enclose a stamped addressed envelope or, for overseas readers, an International Reply Coupon (three IRCs for an Airmail reply).

2. We cannot provide information or advice on service or spares for commercially-made items of radio, TV, etc.

3. We cannot provide information on modifications or adaptations of our published projects.

4. We will try to provide advice on problems related to projects published in *Practical Wireless*, including sources of components for those projects. To allow us to give an efficient service on such queries, I regret that we will in future have to limit them to projects published within the previous three years.

Details of corrections or any additional information on projects are published in the first available issue, in our "Kindly Note" section or as a "Follow-up", and are listed in the annual indexes. To save time and postage, you are advised to look there first, whenever possible.

Finally, on a somewhat more positive note, I would like to thank all those readers who took the trouble to complete and return our recent questionnaire card. Broadly speaking, you seem to like the magazine the way it is, but we plan to make some minor changes over the next few months as a result of your suggestions. And we have one or two ideas of our own which we hope will prove to be of interest.

* * * *

May I take this opportunity to wish all our readers a very happy Christmas and a healthy and prosperous 1980, on behalf of all the staff on *PW*.

PW PERSONALITY

J. Brian Dance, M.Sc—Contributor to *PW* since 1959

Brian's interest in electronics started way back in the post-war years whilst working for Chemistry degrees at Birmingham. Except for a year in Harwell's "Zeta" group, he has been employed as a lecturer and has worked on neutron spectroscopy and on the thermoluminescence of meteorites at universities. He lectures at North Worcestershire College, Bromsgrove.

Brian is the author of 7 books and about 500 other technical publications. He is single and suggests this is the reason he can find time for so much writing. He is especially interested in the latest i.c.s and in space developments, but finds some relaxation in playing tennis.

He feels the major attraction of authorship is the wide variety of topics about which one learns (unlike research where a problem can take many years), but feels it is a pity he does not meet more of his readers.

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

Surround-Sound Test

The first experimental transmissions of an improved stereo-compatible system of "surround-sound" broadcasting developed by IBA engineers have been made on the Independent Local Radio station "Radio Victory" at Portsmouth.

On Sunday, 23 September 1979 a two-hour concert recorded by IBA and Radio Victory engineers at Chichester Cathedral last July was broadcast in surround-sound on Radio Victory's v.h.f./f.m. service on 95·0MHz.

The surround-sound system uses a 3-channel matrix transmission system that has been developed at the IBA engineering centre at Crawley Court, Winchester, to improve stereo-compatibility beyond that found possible with "2-channel" and "2½-channel" systems.

These experiments are part of an IBA investigation into surround-sound techniques with particular reference to the "ambisonics" techniques of the National Research Development Corporation.

Continuing IBA work has underlined the advantages of a full "3-channel" system using a new IBA matrix, particularly in respect of the excellent compatibility for listeners using conventional mono or stereo equipment. The penalties imposed by such a system may be a slight reduction of coverage area and non-compatibility with the earlier "surround-sound" systems.

IBA engineers stress that these "3-channel" experiments are not yet at a stage where it is possible to recommend a "surround-sound standard" for national or international use. It is, however, felt that any such standard, if it is to be worthwhile, must provide the highest achievable technical quality for all listeners and be shown to offer a significant improvement over the existing high-quality v.h.f./f.m. stereo system currently used on all ILR services.

It is anticipated that further experimental transmissions will be made during the next few months and will be announced locally.

To assist in this work the IBA has equipped two vehicles as a special "surround-sound" mobile recording unit, believed to be the most technically-advanced "surround-sound" unit yet built.

IBA, 70 Brompton Road, London SW3 1EY. Tel: 01-584 7011.

Sanken in the UK

Following a fact finding mission to the UK and a study of the potential market for their products, Sanken Electric Co Ltd. of Tokyo have chosen FieldTech Ltd. of London Airport to be their principal distributors in the UK.

FieldTech will now be marketing Sanken's comprehensive range of power amplifiers, servo amplifiers and voltage regulator modules; power transistors, diodes, rectifiers, varistors, etc. Sanken also manufacture a competitive range of indicators and round or rectangular l.e.d.s.

Further details from: *FieldTech Ltd., Heathrow Airport-London, Hounslow, Middx. TW6 3AF. Tel: 01-759 2811.*

New Catalogues

TK Electronics, the electronic component and kit supplier have their latest catalogue ready for distribution. The catalogue offers many devices at very competitive prices and a digital thermometer that is claimed to be probably the lowest priced on the market. The catalogue is available free on receipt of a 9in × 6in s.a.e. *TK Electronics, 106 Studley Grange Road, London W7 2LX. Tel: 01-579 9794.*

Bernard Babani (Publishing) Ltd. inform me of the availability of their latest catalogue of Radio and Electronics books which includes many titles that will be produced early in 1980.

To obtain your free copy of this catalogue, apply enclosing an s.a.e. and a copy will be sent by return. *Bernard Babani (Publishing) Ltd., The Grampians, Shepherds Bush Road, London W6 7NF. Tel: 01-603 2581/7296.*

South West Aerial Systems catalogue and price list is now available. One aspect of the service the company provides, is that of a customer consultancy and system planning, or in the case of reception problems, the company will assist in resolving it. The catalogue costs 20p, and is available from: *South West Aerial Systems, 10 Old Boundary Road, Shaftesbury, North Dorset. Tel: (0747) 4370.*

Verospeed's latest catalogue is now available. This free, 84-page catalogue, is available on application to: *Verospeed, Barton Park Industrial Estate, Eastleigh, Hants. Tel: (0703) 618525.*

Doram returns

One of the early leaders in the home electronics market, Doram Electronics Ltd. is shortly to be relaunched under new ownership. Doram was formed by the Electrocomponents Group in 1974 to distribute the products of its subsidiary RS Components, by mail order, to electronics enthusiasts.

The new owners, the de Boer organisation, based in Eindhoven, centres around a shop and mail order business and was established over six years ago by Mr Ruud de Boer. The acquisition of Doram will enable the Dutch group to expand in the fast growing UK home electronics market. The product range will include both kits and components and will be based on the current Dutch catalogue, rather than any lists or catalogues previously issued by Doram.

Further details from: *Doram Electronics Ltd., Fitzroy House, Market Place, Swaffham, Norfolk PE37 7QH. Tel: (0760) 21627.*

Pointing the Right Way

The RSGB have reprinted a second edition of their *Great Circle DX Map.*

This colourful wall map, measuring 760 × 620mm, shows the true bearing from the UK of countries throughout the world. It is therefore invaluable for radio enthusiasts with directional antennas. Amateur radio prefixes are included, and the map is plastic laminated for extra durability.

The UK price is £1.50 through normal outlets, or £1.99 direct from the RSGB, which includes p&p.

RSGB, 35 Doughty Street, London WC1N 2AE. Tel: 01-837 8688.

Meetings

The East London RSGB Group have arranged the following meetings at *Wanstead House, 21 The Green, Wanstead, London E11.* All meetings commence at 3pm on 3rd Sunday of the month.

December 16—Annual business meeting and bring-and-buy sale.

January 20, 1980—Ken Smith G3JIX, will talk about Radio Astronomy, Ken has a great knowledge of radio and astronomy and the lecture should be fascinating.

Further details from: *Hon Sec, Rod Holmes G3PKQ. Tel: 01-558 2928.*

Model Radio Control

Part 2

THE PW FM-80 SYSTEM

J. BURCHELL & W.S. POEL

The receiver described in the first article is for a 5-channel control system, with four proportional channels, and one switched function channel. For the majority of models, this is sufficient, and the advanced modeller requiring more channels would usually be trying to control some very exotic model and in most cases probably has little interest in building the radio equipment as well as the model.

Encoder

To encode the 5-channel system, it was necessary to choose an approach that would be reliably repeatable, with as few setting up functions as possible. The circuit of Figure 2 is such a system, using common c.m.o.s. since the high impedance presented by c.m.o.s. enables the values of the timing RC constants to be accurately predetermined, as long as reasonably tightly toleranced components are used. The operation is quite easy to understand.

The master clock squarewave, simply derived from a c.m.o.s. two-inverter oscillator (IC2, R9, 10 and C5) could be used to drive a 4017 i.c. to sequentially select the appropriate timing resistors in conjunction with a common timing capacitor, but this type of selection circuit involves the use of isolating diodes, and some experiments revealed that the use of diodes in the near vicinity of the transmitted r.f. field was a source of potential nuisance. And a timing circuit is not the sort of thing that is readily decoupled with 10nF ceramic discs!

The approach used employs separate RC combinations at each output, with 2·2μF and 5kΩ being the values of the capacitor and stick pot respectively. Since the c.m.o.s. does not load this combination, it is easy to scale the values of the timing capacitor to suit different values of stick pot that may be encountered. It should be noted that the control stick potentiometers do not cover more than a fraction of their potential travel, usually swinging some 60 degrees. The standard servo control period is 1ms to 2ms with the centre point at 1·5ms so the values of R and C are chosen to permit this timing range with only a small proportion of the total track travel. Sufficient lattitude to allow for the use of a mechanical trim is also necessary, to ensure that the sticks may be fully "zeroed" with respect to the servo output positions. Having read one channel of the encoder, the 4017 is clocked to look at the next, and so on until the final pulse, when the decoder is wired to skip a pulse, and then reset. The missed pulse thus effectively provides the synchronising period of the system, and is always related to the data rate. This is a fixed frame transmission, where the channel length is constant, and the period between the information pulses is simply the difference between T2 and the information pulse.

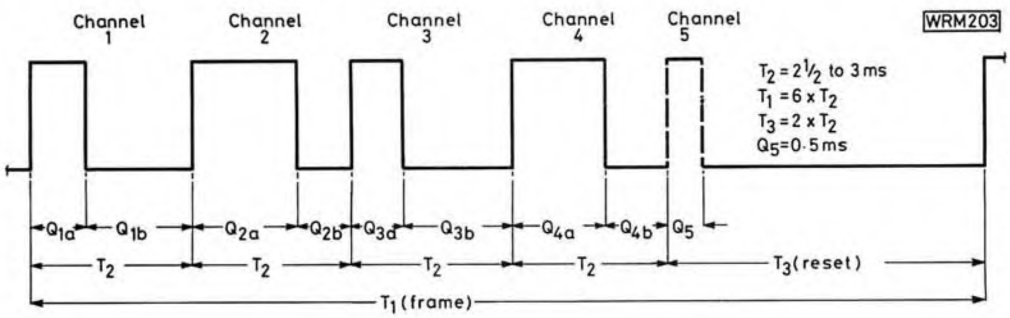


Fig. 1: The encoder output waveform showing the fixed frame length, the reset or synchronising pulse and the individual channel pulses (Q1a etc). Channel 5 is non-proportional and is intended for such applications as retracting under-carriages

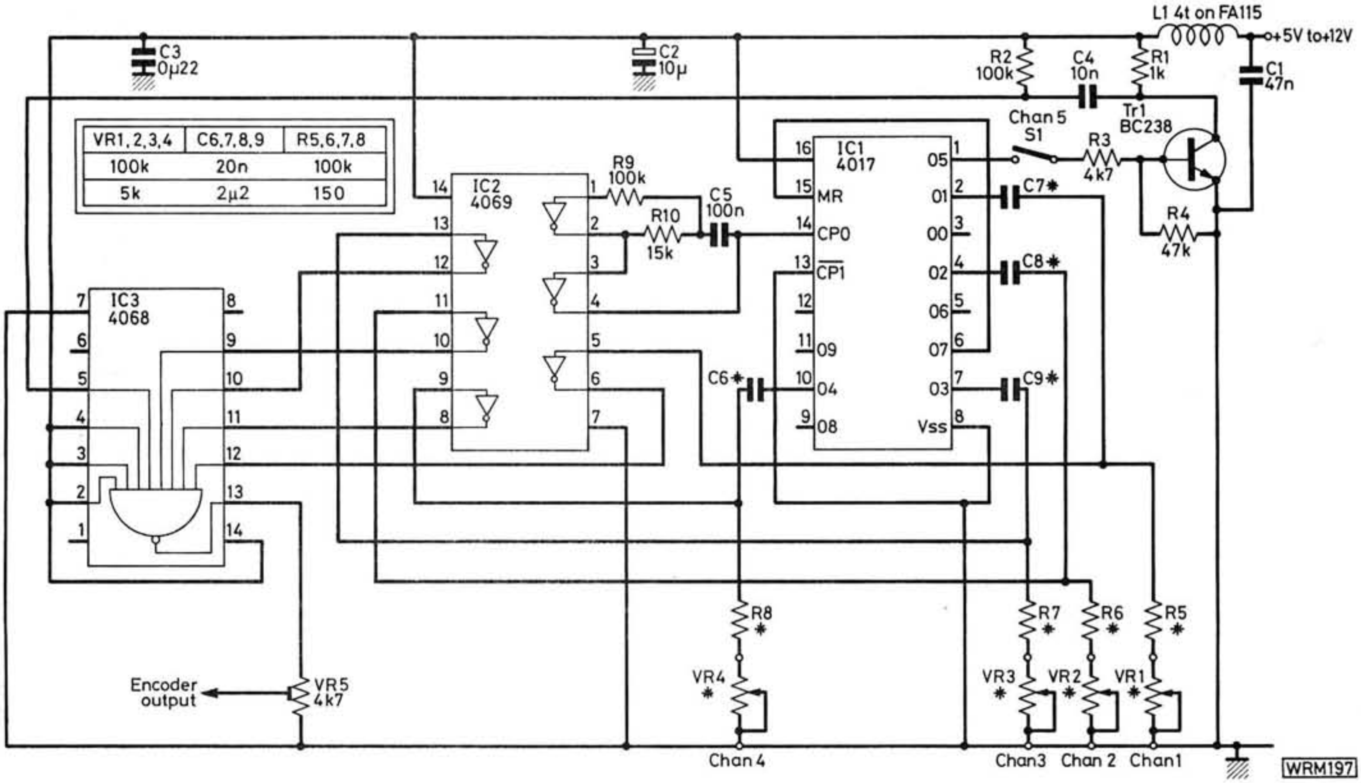


Fig. 2: Circuit diagram of the encoder. The components marked with an asterisk fix the timing periods and the values depend on the total track resistance of the control stick potentiometers. For 5kΩ pots the capacitors should be 2·2µF tantalums with the positive lead connected to the appropriate pin of IC1.

When initially setting up the encoder, the fixed frame system is marginally easier to set up than the more common variable frame encoder, since the clock runs the whole time, not being interrupted by the various channel pulses.

The various timing pulses are combined in a 4068, eight input NAND gate to provide a data train to modulate the transmission. A preset (VR5) is provided to adjust the deviation of the transmitter, which should be about 2kHz. Setting the deviation can be an awkward matter, since different crystals tend to have different pulling characteristics, as do the varicap diodes used in the modulator, so fixed values are not really advised.

Transmitter

The design and development of the transmitter looked to be a fairly mundane piece of work, when set against a background of computer-driven frequency synthesisers and such exotica. However, the illusions were fairly soon shattered, when the parameters were considered in greater detail, since the usual three transistor circuit is designed round the ouput frequency all the way through, using a.m. and 27MHz 3rd overtone crystals.

For f.m. it is necessary to use a fundamental mode crystal in an untuned or Colpitts circuit (Fig. 3), since the variation of capacitance in the modulator produces far

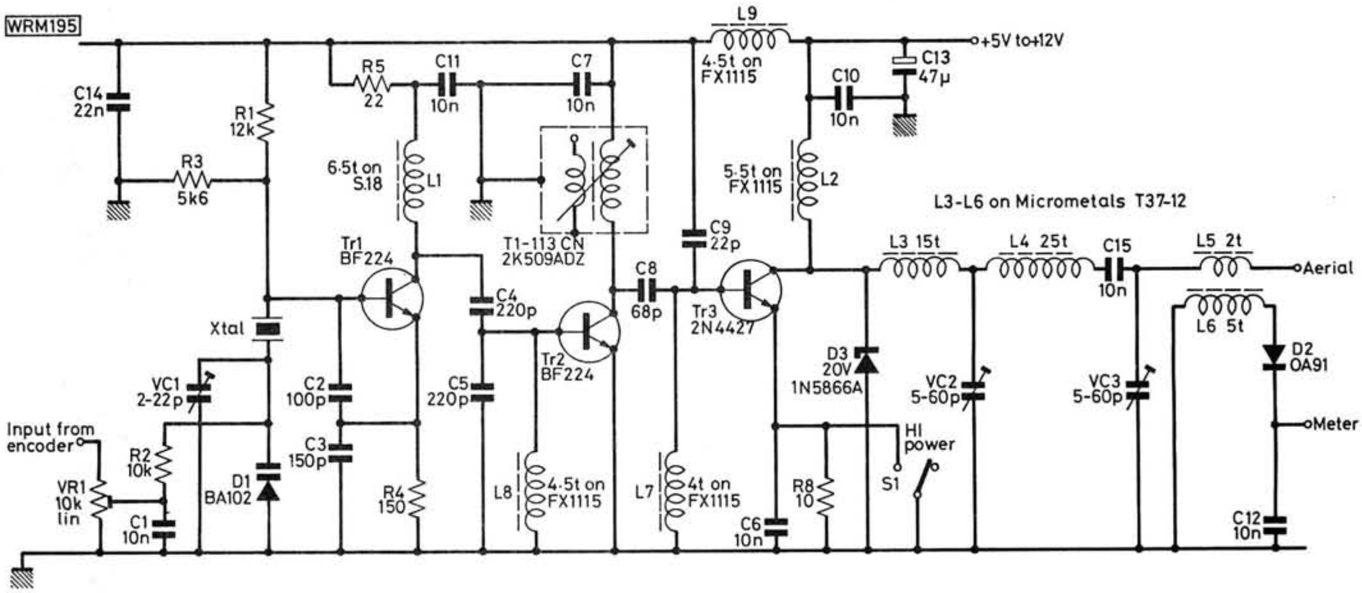


Fig. 3: Circuit diagram of the transmitter. The value of R8 can be changed to alter the power output of the transmitter when S1 is switched to Low Power

Galaxy Models' Mini-Escort trainer fitted with Flash 15 motor

more deviation of a tolerably linear fashion than trying to waggle a 3rd overtone crystal configuration. Thus the crystal operates in a parallel load fashion, with a varicap in the load circuit, providing deviation at a level set by VR1. CT1 provides a trim adjustment of the output frequency, but it should be remembered that as the total load capacity is increased by altering TC1, so the deviation caused by the varicap is slightly decreased, as it is a smaller proportion of the total load capacity.

In any case, the larger the load capacity gets, the less is the effect on the crystal frequency. Capacitors C2 and C3 provide feedback in true Colpitts fashion, and the tuned collector load formed by L1, C4 and C5 selects the 27MHz component for subsequent amplification, thus turning the basic Colpitts circuit into a Clapp oscillator.

The next stage is self biased in Class C with a small choke (L8) in the base circuit. Here the ubiquitous FX1115 ferrite bead is used to good effect, since it must be noted that with only 5 turns or so, a rather surprisingly large amount of inductance may be achieved. About 15–20µH, in fact. This is so large that it was checked and re-checked, since this implies an enormous permeability for the material used. Little wonder it is so effective in various decoupling and isolation functions.

Tr2 is operated with a grounded emitter, and originally it was proposed to vary the power level of this stage to control the overall output, by switching an emitter resistor in and out of circuit. However, subsequent development showed this caused too much of a detuning effect on the L1/C4/C5 arrangement due to the variation of input capacitance of Tr2, that this feature was moved forward a stage to the output transistor, where the detuning effect had less effect on the spectral purity of the equipment. The feed from Tr2 to the output stage is similar to the preceding stage, except that a 7KN series Toko coil is used.

For low powered applications, the aerial may be taken directly from the tapping. It is also screened which, because of the proximity of L1, helps to prevent input-output feedback problems.

Output Stage

The output stage uses a TO39 case transistor. Nothing very special here, since although a v.m.o.s. f.e.t. was tried and tested, they are not intended for this type of work and while one batch of devices just about worked, another batch did not.

All v.m.o.s f.e.t.s are not really suited to working with a power rail lower than 12V, and since the battery supply for the transmitter was designed around NiCad style cells it is far better to work with 12V down to 5V as the operational range. The device chosen performs admirably between 5 and 12V, with little discernible output change. The output at 9V being in excess of 1W in high power mode, and about 400mW with a 5V supply. A small heatsink is required for the output device to ensure longevity, and a zener diode is placed from the collector to ground, to catch any high voltage spikes that occur either during tune up operations, or when the antenna length is varied in the field.

The output network itself has evolved from a simple pi-network, to a more complex arrangement. However, the reasons are twofold, since although simplicity of tune-up is desirable, it rarely leads to an optimised output spectrum. The circuit around T1 is necessary to optimise the 27MHz drive, and minimise the remnants of the 13MHz fundamental, so L4 and L5 are essential to provide an r.f. output that can be accurately set up using a field strength meter. Since this circuit is capable of more power than the average, it is necessary to keep the stray fields to a minimum, or the encoder will be found to malfunction due to extraneous r.f. pickup on control leads. At 27MHz this isn't too serious, but as the frequency increases, it gets progressively worse. This basic circuit will retune easily enough to frequencies up to 50MHz.

Output Monitoring

The performance of the circuit is monitored via L5 and L6 which form a small current transformer with negligible loading on the transmitter circuit. Monitoring in this way is a far more satisfactory means of checking circuit behaviour than many of the age-old practices seen in r.c. Simple proximity "wavemeters" can be positioned such that it is the field from the tank coil, rather than the aerial itself, which is being monitored.

In the set-up process, the number of turns of L7 may be slightly increased to improve sensitivity, but in most instances, the circuit will set up almost instantly, simply tuning for maximum meter deflection with the chosen aerial. The meter should have a f.s.d. of 200µA.

Generous decoupling is provided throughout the circuit and is probably rather more than necessary. Ceramic capacitors should be used throughout.

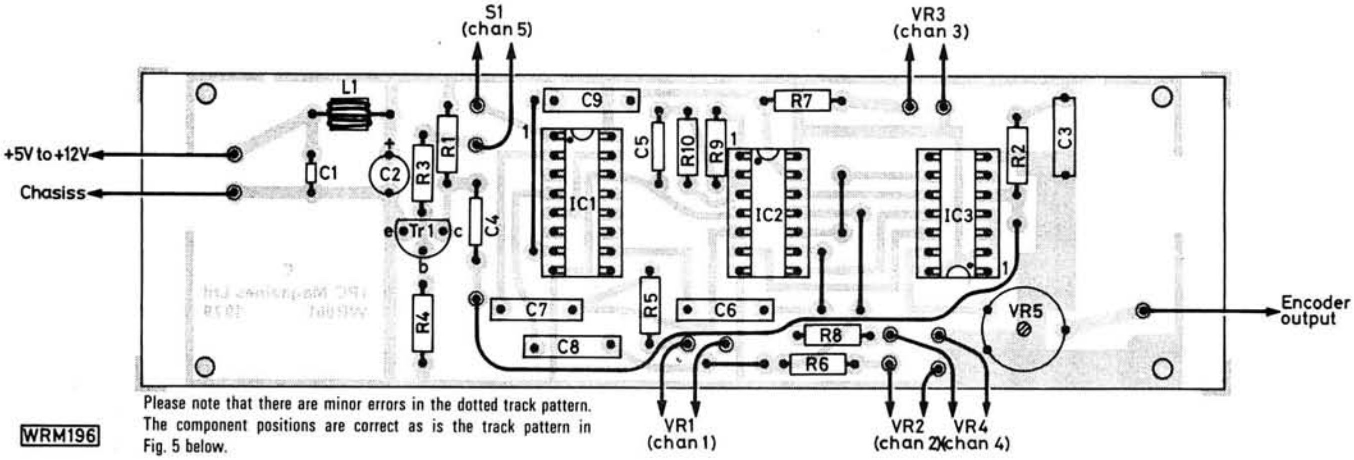
The Hi-Lo power switch selects the value of the emitter resistor in the output stage, whereby the power is cut to a level set by the resistor value. A value of 22Ω drops the power down to 100mW, although individual users may wish to change this to suit a particular application. The use of f.m. enables easy power changes, whereas a.m. usually requires a retune for best modulation characteristics when switching such power levels around. Also, of course, f.m. allows easy frequency multiplication remembering to reduce the deviation accordingly.

Although 27MHz is a long way from the 459MHz band available at u.h.f. in the UK, it just so happens that 459 is exactly 17 times 27, so those of you familiar with v.h.f. and u.h.f. might like to bear that in mind!

Construction

The complete transmitter is built on two printed circuit boards, one of which is the encoder and the other the actual transmitter unit. Both of these boards are straightforward and should present no problems to the constructor. Sockets are used for the i.c.s on the encoder board and, of course, all the normal precautions should be taken when handling these c.m.o.s. devices.

The transmitter board has several r.f. chokes which are wound on ferrite beads as shown in Figure 9. When winding these care must be taken not to scrape the enamel coating off of the wire on the edges of the beads.



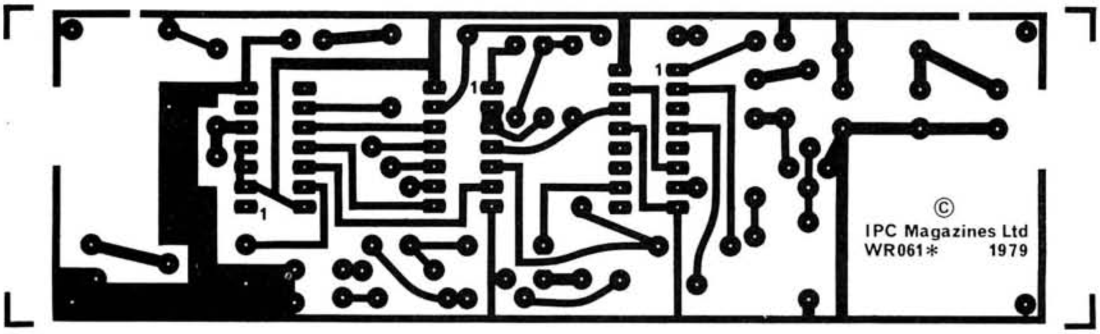


Fig. 4 (top): The component placement for the encoder board. Fig. 5 (above): The copper track layout is shown full size

The chokes which are wound on the torroidal dust cores should give no trouble if the drawings are followed.

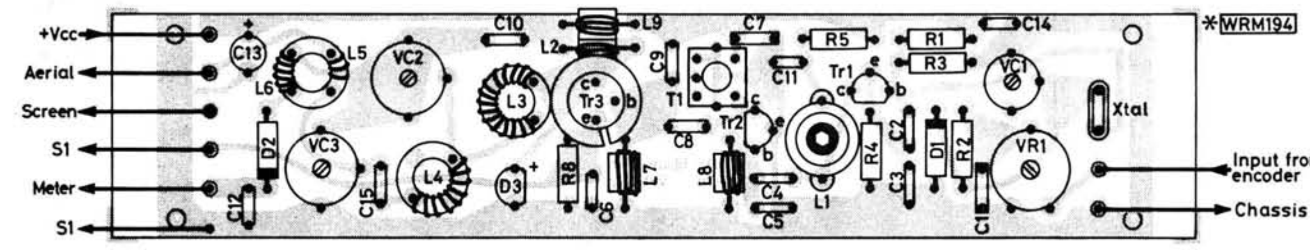
The r.f. power output transistor should have a push-fit finned heatsink fitted and to give sufficient clearance between the transistor can and the aerial fixing screw, the transistor should be mounted close to the p.c.b., preferably using a transistor mounting pad.

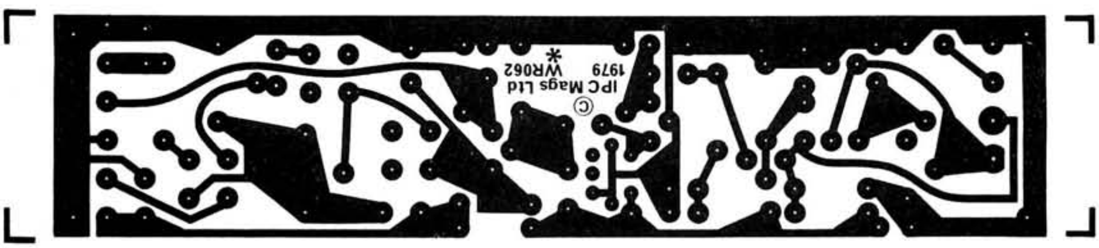
The passive components should be as small as possible and in general capacitors are the sub-miniature disc ceramic varieties.

The transistors used are from Texas Instruments' Silect range and care must be taken to ensure that the lead configuration of each is checked. The component placement drawing (Figure 6) shows BC224B types.

The encoder board is straightforward. The remarks on component size applies equally to this board as available height above the board when installed in the case is limited. The four timing capacitors are small tantalum bead types and the positive lead of each should go to the appropriate pin on IC1.

The case chosen for the *PW* FM-80 transmitter is a red and black version of Micron's de-lux PL7-D case. This is elegantly styled, robust and easily assembled, giving the transmitter a really professional look. The case is supplied





Figs. 6 and 7: The component placement and copper track plan for the transmitter board shown here full size. Care must be taken to ensure that the lead-outs of Tr1 and Tr2 are checked carefully

★ components

Transmitter

Resistors

¼W 5% Carbon Film

10Ω	1	R8
22Ω	1	R5
150Ω	1	R4
5·6kΩ	1	R3
10kΩ	1	R2
12kΩ	1	R1

Potentiometers

Min. horizontal preset

10kΩ	1	VR1

Capacitors

Ceramic disc

22pF	1	C9
68pF	1	C8
100pF	1	C2
150pF	1	C3
220pF	2	C4,5
10nF	7	C1,6,7,10,11,12,15
22nF	1	C9

Tantalum

47µF 16V	1	C13

Trimmer

2-22pF	1	VC1
5-60pF	2	VC2,3

Inductors

Toko 113CN2K509ADZ	1	T1
Toko M-20068	1	L1

L2,7 to 9 wound on FX1115 ferrite beads (see text)
L3 to 6 wound on Micrometals T37-12 ferrite cores (see text)

Semiconductors

Diodes

BA102	1	D1
OA91	1	D2
1N5866A	1	D3

Transistors

BF224	2	Tr1,2
2N4427	1	Tr3

Miscellaneous

Crystal (see text); Cambion miniature jacks (see text) (2); TO5 heatsink (1); 28 s.w.g. self-fluxing enamelled copper wire (2m); p.c.b.(1); s.p.d.t. min. rocker switch (1).

Encoder

Resistors

¼W 5% Carbon film

150Ω	4	R5,6,7,8
1kΩ	1	R1
4·7kΩ	1	R3
47kΩ	1	R4
100kΩ	2	R2,9

Potentiometers

Min. horizontal preset

4·7kΩ	1	VR5

Capacitors

Disc ceramic

10nF	1	C4
47nF	1	C1

Polyester

0·1µF	1	C5
0·22µF	1	C3

Tantalum

2·2µF 35V	4	C6,7,8,9
10µF 16V	1	C2

Inductors

L1 wound on FA1115 ferrite bead (see text)

Semiconductors

Transistors

BC238	1	Tr1

Integrated circuits

4017	1	IC1
4069	1	IC2
4068	1	IC3

Miscellaneous

14 pin d.i.l. sockets (2); 16 pin d.i.l. socket (1); p.c.b.(1); s.p.d.t. min. rocker switch, Micron (1).

Mechanical parts

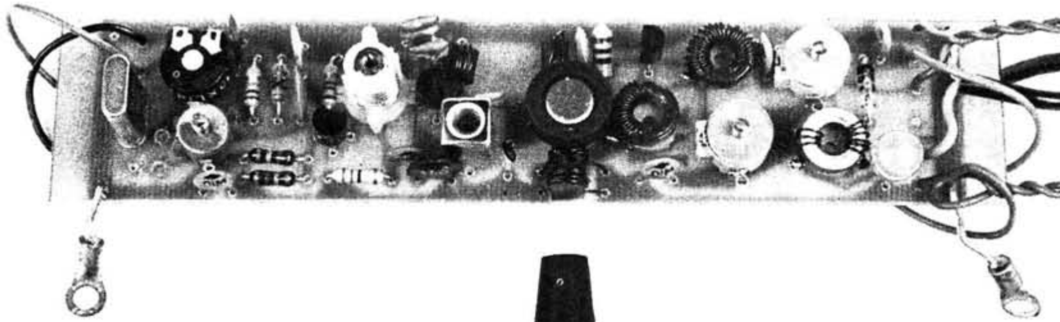
Case, Micron de lux Red MRC30 (1); Open gimbal stick units, Micron MRC27, with 5kΩ pots (2); Meter (see text); Telescopic aerial; Miniature toggle switch d.p.d.t.; Battery charger socket, SLM; 4·8V NiCad battery packs (2); Cable tie and base, self adhesive (2); Solder tags, 6BA (4).

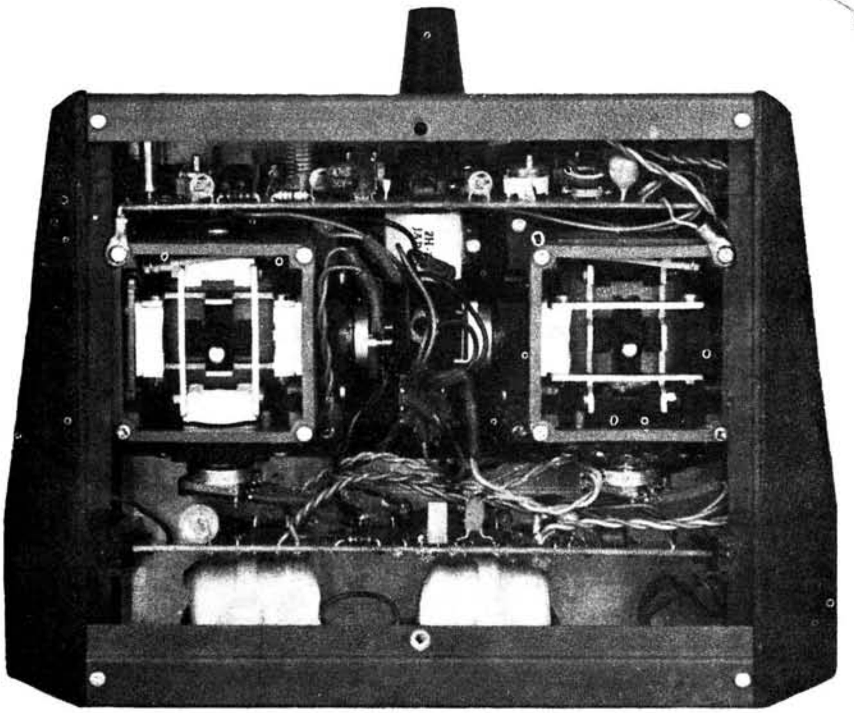
in knocked-down form with two plastics moulded end cheeks, a plastics front panel, top and bottom metal pressings, the back and all necessary screws. A removable cover fills the crystal access hole and the aerial mount fits into a punched hole in the top panel.

The Case

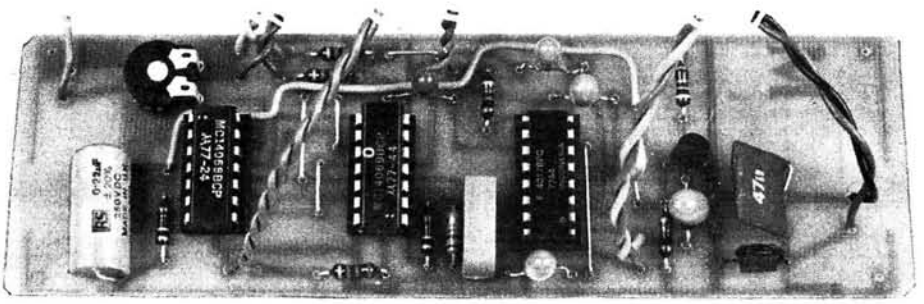
The case should be assembled and the two open gimbal stick units screwed into position on the front panel. It helps if this is done before the case is screwed together. The meter and on-off switch should also be fitted along with the neck strap attachment. The SLM charger socket is mounted in the cut-out in the bottom of the case.

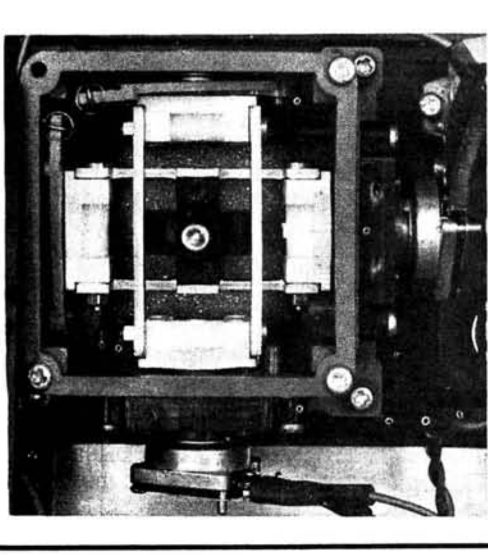
With the case assembled the two boards can be positioned as shown in the pictures. The transmitter board mounts in the top of the case with the crystal positioned under the crystal access hole. The front edge of the board rests on the plastics lip of the front panel held in place by the small moulded pins. The board is anchored by two short lengths of 18 s.w.g. tinned copper wire soldered into the two vacant corner holes on the back edge of the board

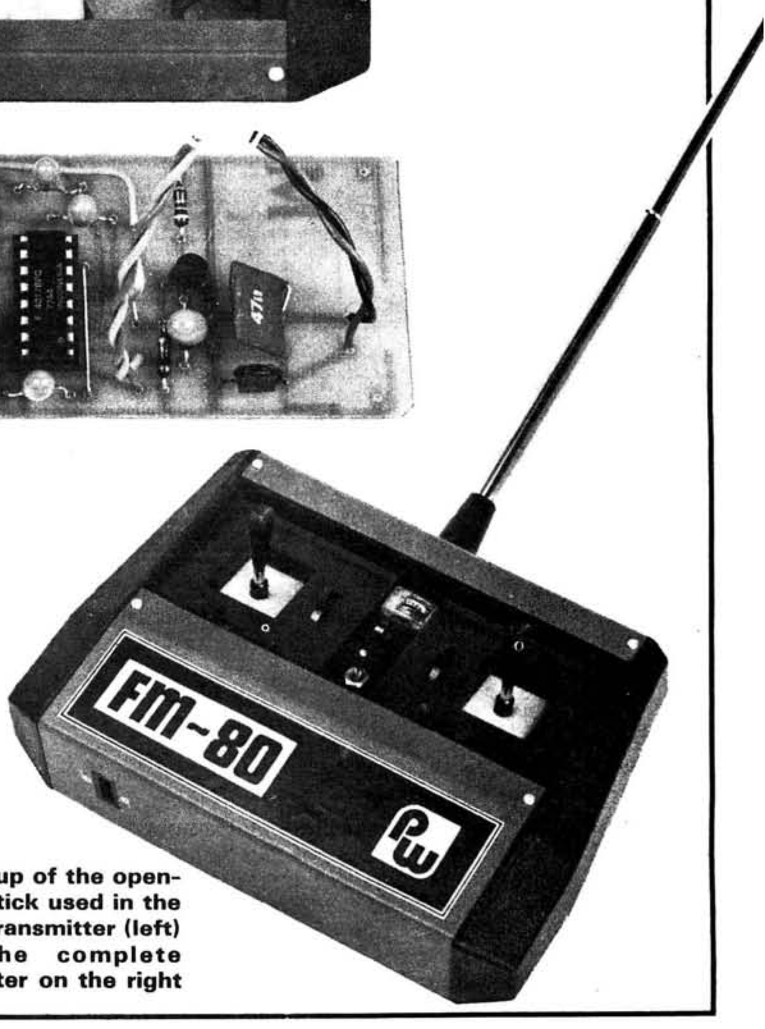




The photograph on the left shows the completed transmitter with both boards and the control sticks correctly positioned. The transmitter board is shown at the top and the encoder board below the case







A close up of the open-gimbal stick used in the FM-80 transmitter (left) with the complete transmitter on the right

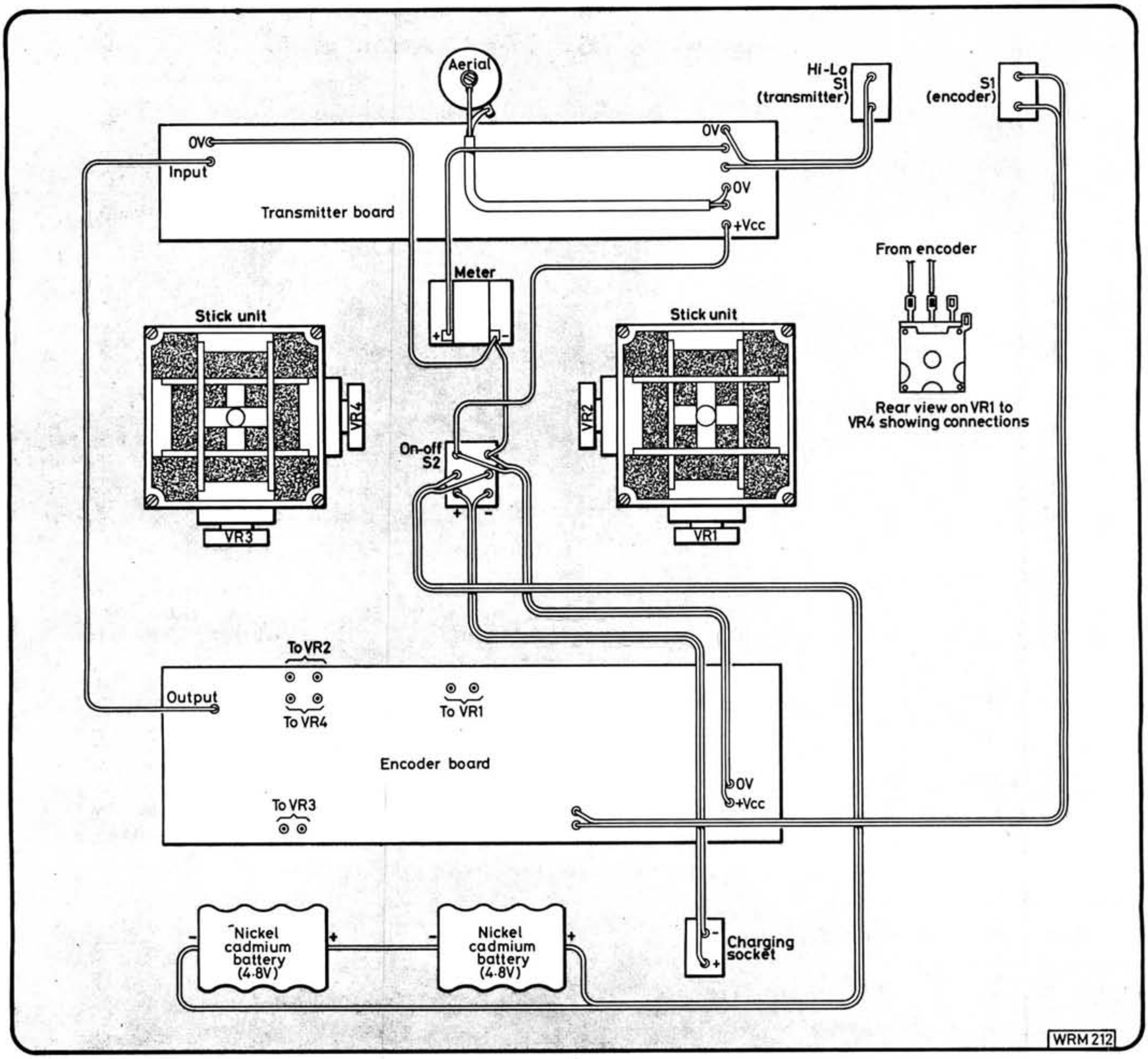


Fig. 8: The wiring layout of the complete transmitter and encoder. Care must be taken not to short out the battery terminals. The stick unit pots VR1 to VR4 must be set to 1·5kΩ before connecting wires are attached

and suitably bent to allow the wires to be soldered to two 6BA solder tags trapped under one fixing screw of each stick unit. The transmitter p.c.b. should be held by these wires so that the back of the board is almost touching the meter case. The crystal is mounted in a pair of Cambion low silhouette jacks (450-3704-1-03).

The encoder board is fitted into a pair of plastics slides which clip to the end cheeks of the case and are held in place with a small dab of Araldite Rapid epoxy adhesive. This allows the encoder board to be slid out of the case for access to the batteries and also to make wiring-up easier. With both boards in position and the lead-out wires soldered to the p.c.b.s the connections can be made to the stick pots. Only two leads go to each pot., the other end of the track may be connected to the wiper by a short wire link at the pot. Small rubber sleeves should be used at the pot. terminations to give extra strength to the joint. Each pot. should be set to about 1·5kΩ with the stick centralised and the connections made to this end of the pot.

Batteries

The batteries, two 4·8V packs of NiCad rechargeable cells connected in series to give 9·6V, are held in two self-adhesive nylon cable ties which are fixed to the metal bottom of the case. The leads from the battery packs are taken around the end of the encoder board and to the centre tags of the on-off switch. The battery charger socket is connected to this switch to allow the charger to be connected to the batteries only when the switch is in the off position. The other tags on the switch are taken to the two p.c.b.s.

The aerial is wired to the transmitter board using a short length of r.f. screened cable which is connected to the aerial retaining screw by a solder tag. The braid is connected to another tag which is simply trapped between the aerial holder and the metal case while the retaining screw is tightened. The telescopic aerial is then screwed finger tight into the holder.

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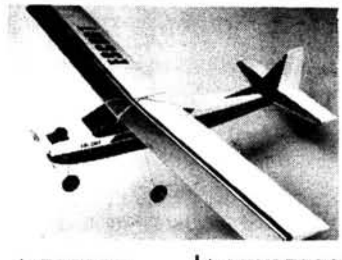

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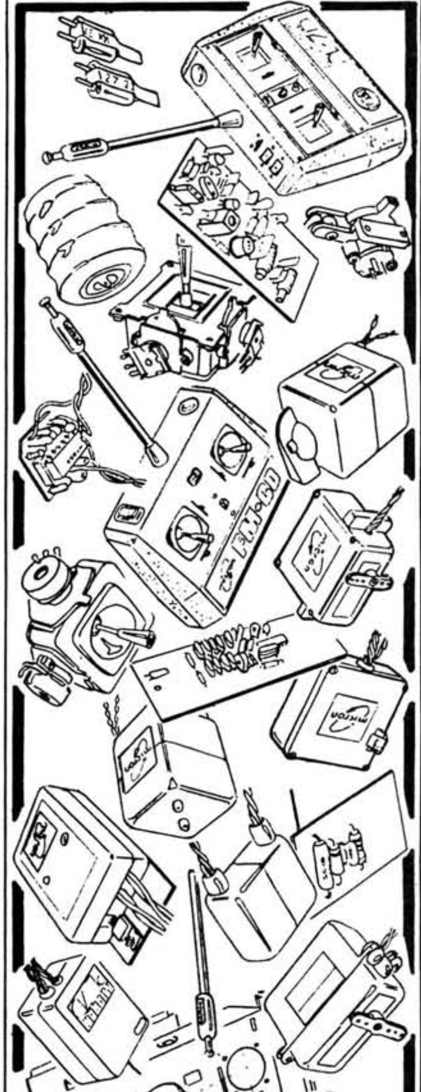

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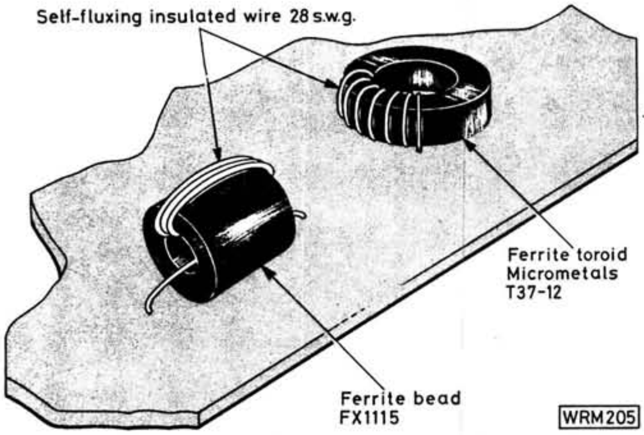


Fig. 9: The correct method of winding the r.f. chokes and torroidal inductors

The stick movement should be checked together with the action of the trim tabs, making sure that the connections to the pots do not foul any part of the encoder board.

Finally, if you opt to fit the fifth channel and the Hi-Lo power switches these are mounted on the top of the case at the opposite side to the crystal access hole. Micron can supply ready punched cases and switches to fit if required.

Setting Up

All wiring and p.c.b.s should be carefully checked before switching on and the NiCad batteries should be checked to ensure that they are fully charged and connected correctly.

The output level preset on the encoder board and the input level preset on the transmitter board should be set to give a low level of modulation before switching on.

If all seems to be in order the power can be switched on and the transmitter checked for operation. The meter should deflect to show that r.f. power is being pushed up the aerial. To tune the transmitter for maximum output it is necessary to have the p.c.b. removed from the case to enable the various trimming capacitors and coils to be reached. The total current taken should be about 200mA with a 9V supply rail and S1 in the high power position.

Tune L1, T1 followed by VC2 and VC3 to give maximum output as indicated by the meter. If you have a frequency counter capable of measuring at 27MHz this can be used to check the frequency of the output. Slight adjustment of the frequency can be made with VC1.

To check the operation of the encoder a scope is really needed. However it is possible to use the receiver and a known good servo to set the pulse width for each channel to the correct 1·5ms centre and 1 to 2ms swing.

The modulation can be set using the frequency meter by disconnecting the input from the encoder and holding the top of VR1 on the transmitter board to the positive supply rail, noting the frequency at the transmitter output. The deviation can be set by adjusting VR1 to give the desired 2 or 3kHz change in transmitter frequency.

Next month we will describe the servos to suit the *PW* FM-80 system. For the model boat or car enthusiast a simpler 2-channel transmitter will be outlined later in the series together with details of installing the complete system in various types of models.

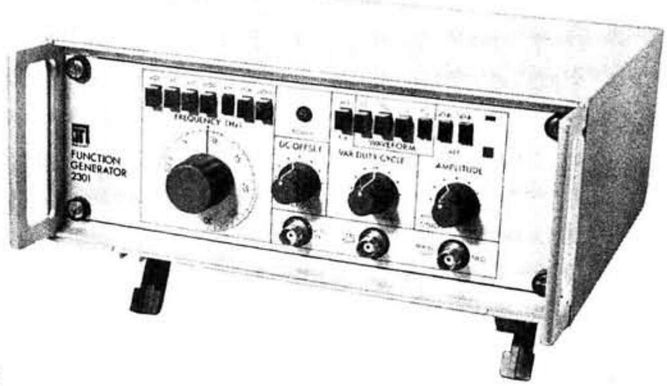
A licence is required to operate radio control equipment. This costs £2.80 for five years. Application forms are available from: The Home Office, Radio Regulatory Dept., Waterloo Bridge House, Waterloo Road, London SE1 8UA

SPECIAL PRODUCT REPORT

2301

FUNCTION GENERATOR

RADAT INDUSTRIES



A function generator is of much more use in a lab than a simple sine wave oscillator. The ability to produce a wide variety of different shaped waveforms gives the user the means with which to test the correct functioning of most of the projects he is likely to build.

The Radat 2301 Function Generator is a well built instrument which can produce rectangular pulses, triangular and sinusoidal waveforms, each type having a variable duty cycle. A simple d.c. level can also be set.

The frequency range covered starts at 0·1Hz and goes up to 3MHz. Seven push buttons are used to select the range multiplier with one calibrated dial to vary the frequency setting over the range 1 to 30.

All the controls are mounted on the front panel and are simple to use, being clearly labelled. The two output sockets are 50Ω BNC types and one is intended to provide a suitable output for matching into TTL logic.

Push-buttons are also used to select the waveform shape,

continued on page 54▶▶▶

★ specification

Waveforms

Main output: sine, square, triangle, adjustable d.c. level. Without offset, all waveforms are symmetrical about ground. All waveforms may be offset. Output impedance 50Ω.

TTL output: TTL signal, coherent with the signal at the main output. Fan-out minimum 2TTL loads, rise and fall time, max: 50ns, typ: 15ns.

Waveform Characteristics

Sine distortion: 1% 10Hz to 200kHz.

Triangle linearity: deviation from best straight line better than 1%, 1Hz to 100kHz.

Square rise and fall time: 50ns into 50Ω.

Total aberration: less than 5%.

Duty cycle: 50% ± 1% in NORMAL mode
5% to 95% adjustable in VAR DUTY CYCLE mode.

Duty cycle change vs. frequency change: 2%.

Stability of frequency, amplitude, and offset better than 1% for 24 hours.

External sweep: External 10V d.c. or a.c. voltage at the VCO input changes the output frequency over a 1000:1 range. Bandwidth 100kHz, maximum slew rate 0·3 V/μs, input impedance 10kΩ.

Frequency:

Range: 0·03Hz to 3MHz in 7 decade ranges.

Dial accuracy: 3% of full scale.

Dial range: 100:1.

Amplitude (main output)

Max output: 20V p.p into o.c.
10V p.p. into 50Ω.

Step attenuator: 0 to 60dB in 20dB steps.

Amplitude vernier: 10:1 (20 dB) continuous.

Sine flatness: better than 2%.

15V. 1A output amplifier protected against short-circuit or external voltage.

D.C. Offset continuously variable ±10V o.c., with on-off switch on front panel. Total signal plus offset limited to ±10V o.c. independent of vernier control and attenuated proportionally with step attenuator.

Power: 220–230 Vac ±10% or 110–115 Vac ±10% 50–60Hz, 15W.

Dimensions: 278 × 110 × 250mm.

Weight: 3·5kg.

From Wembley to the Weser...

Joe BISHOP

A New Television Service For British Forces Germany

Since the end of the Second World War, a substantial portion of the British armed services has been stationed in West Germany. First as a part of the Forces of Occupation and then, after the birth of the new Federal Republic of Germany in 1949, as part of NATO's answer to the ever-burgeoning armies of the Warsaw Pact, the United Kingdom has maintained this continuous military presence on the European mainland.

British servicemen and their families have come and gone in their many thousands, and each has played a major or minor role throughout this long period in "keeping the peace"—enabling Britain to honour her expensive but vital obligations. The aim of all this effort has been to preserve some balance in a situation of almost complete impasse.

After a staggering 34 years, both sides are still implacably staring at each other across barbed-wire, minefields and bare earth, stretching in an unbroken ribbon from the Baltic to Czechoslovakia. Watchtowers stand like sad sentinels along this shabby divide, where two ideologies stand face-to-face.

Background

Away from the frontier and despite the passage of time many other old problems also remain; problems which exist mainly because the British Forces community in West Germany is, despite its air of permanence, a transplanted one. Only a relative handful of the British people working for the forces in Germany have spent a substantial part of their working lives there and have, as a result, been able to integrate with, and understand the culture of their host nation. There is often, therefore, a sense of isolation and solitude to which the young families, in particular, are subject. For many people, accustomed to everyday life among their relatives and friends in the UK, life becomes a battle against loneliness when the breadwinner is away on manoeuvres or perhaps completing a tour of duty in Ulster.

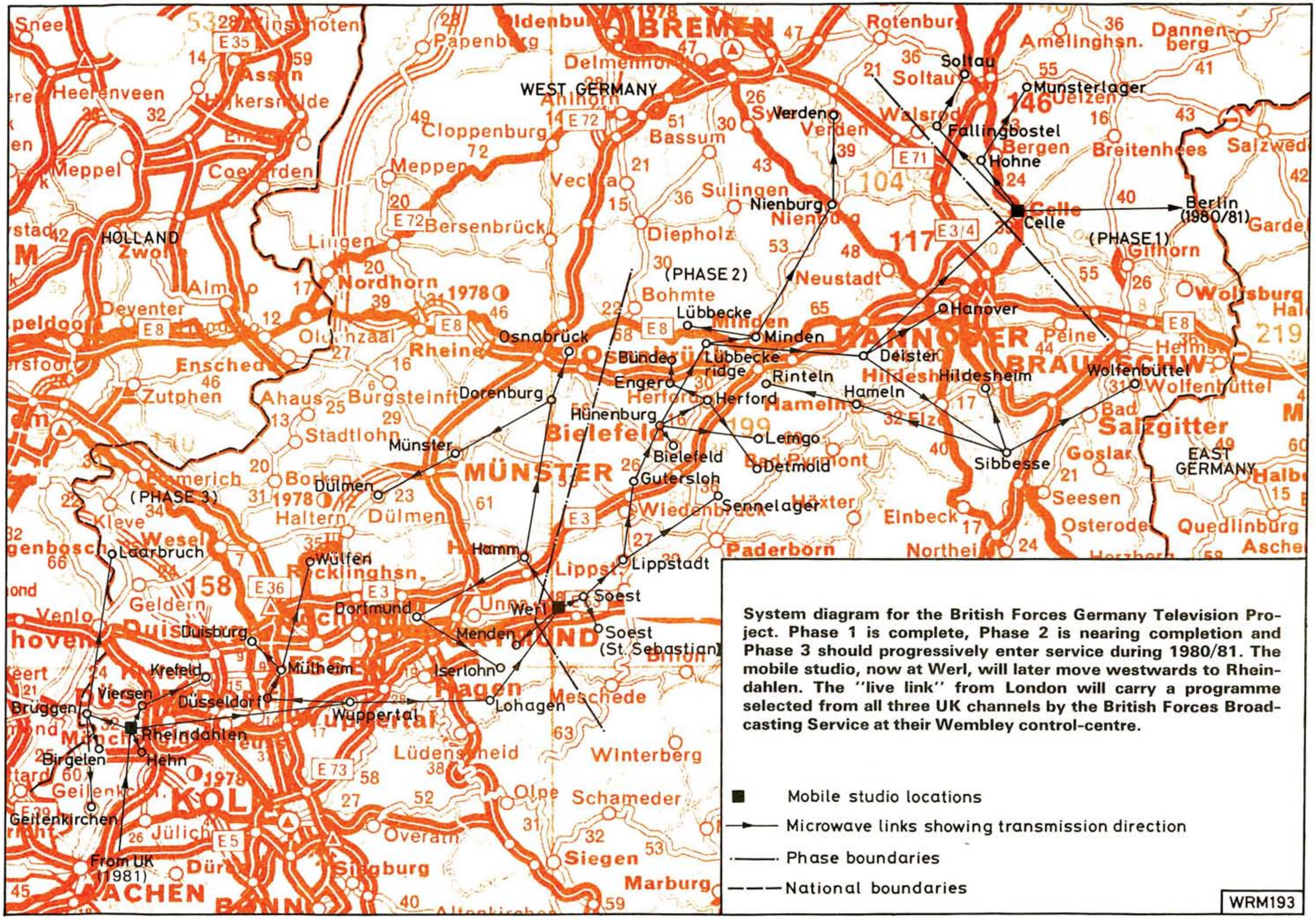
Senior officers have always recognised this problem, but in a defence environment the resources that can be deployed to overcome it are limited. The British Forces in Germany have, in addition to the traditional "mess" facilities, their own cinema circuit and same-day newspaper distribution system, their own newspapers in fact. German language training is taken seriously and, out of the British Forces Network of the days of occupation, was born the British Forces Broadcasting Service which has for many years provided the forces community with home-grown radio entertainment—f.m. and now in stereo as well.

To improve the lot of the serviceman still further and to bring him into line with his NATO colleagues, it was decided that a single-channel colour television service should also be provided. The technical, legal and organisational problems were formidable in the extreme and delays have been plentiful. But now BFBS is in the TV business with a vengeance, providing programmes to an eager audience which is growing rapidly as the British Forces Germany Television Project expands towards completion. The contract for the design and supply of the system was placed with Marconi Communication Systems Limited as probably the only British company with sufficient total capability, but also no less involved are a host of civil servants and serving soldiers without whose efforts the project would never have got off the ground.

Certainly, the new service has added a new and much-needed dimension to life in married quarters, and the feeling is that it has also had a quite marked and beneficial effect on welfare statistics.

Planning

There is no doubt that, from its inception, the project presented the engineers and planners with an interesting and unusual problem. Under normal circumstances, once the decision to introduce a broadcasting service has been made, the priority is to get it going for the most people as quickly as possible. It is generally, therefore, the most populous areas that benefit first—and it is in the most populous areas (the big cities) that the studios etc. are normally located. Thus BBC Television, for example, started at Alexandra Palace in 1936 and gradually expanded outwards (WWII permitting) as public demand increased and the state of the art improved. It was only many years later that TV reached the nethermost regions of the British Isles.



System diagram for the British Forces Germany Television Project. Phase 1 is complete, Phase 2 is nearing completion and Phase 3 should progressively enter service during 1980/81. The mobile studio, now at Werl, will later move westwards to Rheindahlen. The "live link" from London will carry a programme selected from all three UK channels by the British Forces Broadcasting Service at their Wembley control-centre.

In BAOR, however, the situation and needs are very different from those of a normal civil population. Here, the initial priority was to provide the service to the people in most need; those who were furthest from the United Kingdom, whose social amenities were the most rudimentary and whose geographical location and environment were the most bleak. It was decided that the Army garrisons in the north-east of the region, immediately adjacent to the East German frontier, should receive the service first. The system had to be installed, as it were, "back to front".

Phase 1 of the system (see map) consisted of only five stations fed by a videotape control centre located at Celle. Studio complexes and direct reception from London were out of the question, so tapes were flown out daily for onward transmission to the audience (and still are).

As the system expanded the VTR centre would be required to move and so it was put on wheels—this successful example of typically British innovation was designed for BFBS by London Weekend Television, and is now parked at Werl, where it arrived on 11 December 1978 after an overnight move from Celle. Its final resting place will be at Rheindahlen, sometime in 1981.

The reversal of normal priorities was only a facet of the overall problem, however. To make matters more difficult, not only were the snags geographical in nature. There were questions of copyright and points involving national broadcast agreements to be resolved; planning permission for towers to be obtained; frequency planning to be carried out and agreed with the Deutsche Bundespost (DBP), the licensing authority; plans for towers, power supplies and fenced enclosures to be drawn up by the Property Services Agency.

It was also necessary to restrict the audience, as far as possible, to the British Forces and their families stationed in Germany. Thus it is CCIR television System I that is used (6MHz separation between sound and vision channels as in the UK) instead of System G (5·5MHz separation)

Videotape operator Maria Linne in BFBS TV's mobile control room at Werl, W. Germany

Photo courtesy BFBS

which is used for German national TV. Transmitter output power is deliberately limited to the minimum required to achieve an acceptable signal thoughout the service area and in many cases, the transmitters are rated at only 2·5W; the most powerful will be rated at only 200W. Naturally, the less power the greater the number of transmitters that are required to provide the desired coverage.

With over 3000 television transmitters already on the air in West Germany, the planning required in order to avoid mutual interference was, to put it mildly, very intricate!

An existing steel-lattice tower, modified to carry BFBS TV as well as military traffic

Photo courtesy MoD

Distance

Additional problems that had to be overcome at an early stage stemmed from the sheer distance between London and the furthest transmitter in Germany. In any system, television signals are conveyed from the studio and switching complex to the broadcast transmitters via a "bearer network". Nowadays, this could consist of a mixture of coaxial or fibreoptic landlines, line-of-sight microwave paths or satellite communication links. The particular snag with the Forces system, of course, was that the bearer network would cross the territory of five different nations—each with its own laws, procedures and quirks.

Initial studies, not unnaturally, centred around finding a method of conveying the BFBS channel directly from the UK to Germany without troubling the French, Belgian and Dutch authorities. All the extra planning and negotiations that this would involve made these studies eminently worthwhile: but after careful consideration of tropospheric scatter, a satellite link and even the use of a balloon as a sky-reflector, it was a chain of microwave stations coupled with some rented capacity that was selected as the optimum method of crossing the Channel, France and the Low Countries.

At the present time, negotiations are substantially complete and it should be possible, barring unforeseen difficulties, to "feed" the BFBS transmitters direct from London sometime in 1981. Particularly when it is borne in mind that planning and feasibility studies are well advanced to extend the system onwards into Berlin, this will create, in terms of physical size, what is probably the largest private colour television system in Europe; the path-length from end to end will be over 1000km. From Wembley to the Weser and beyond . . .

Composite Signal

A television video signal is a complicated waveform at the best of times. Although its basic shape grew out of the work of John Logie Baird, technology has moved on. The advent of u.h.f. 625-line television, offering the consumer firstly enhanced definition and then (wonder of wonders!) colour, has transformed the archetypal waveshape into the somewhat complex form depicted in Fig. 1(a), actually a standard UK vision test signal.

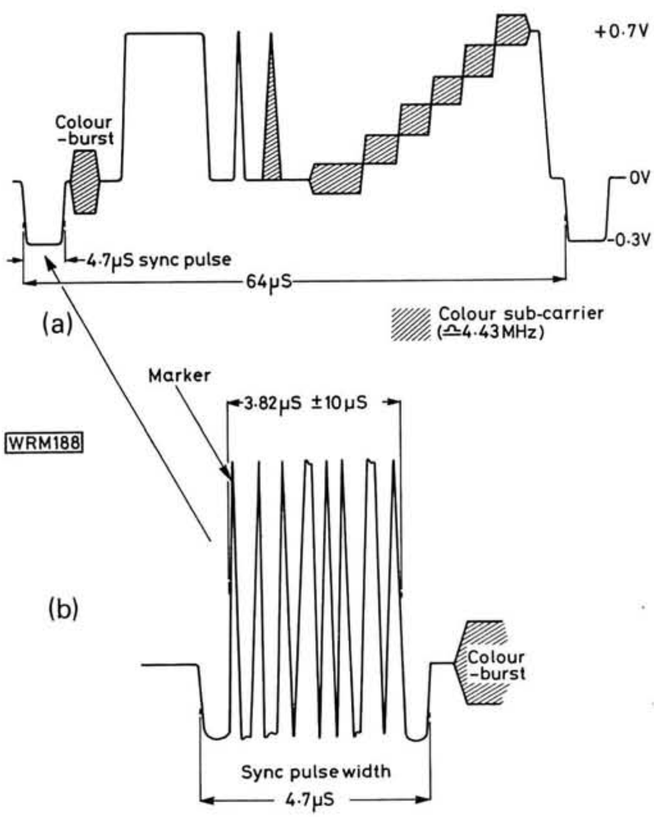


Fig. 1(a): Test signal without sound-in-syncs. Fig 1(b) shows how the encoded audio is inserted into the sync pulse

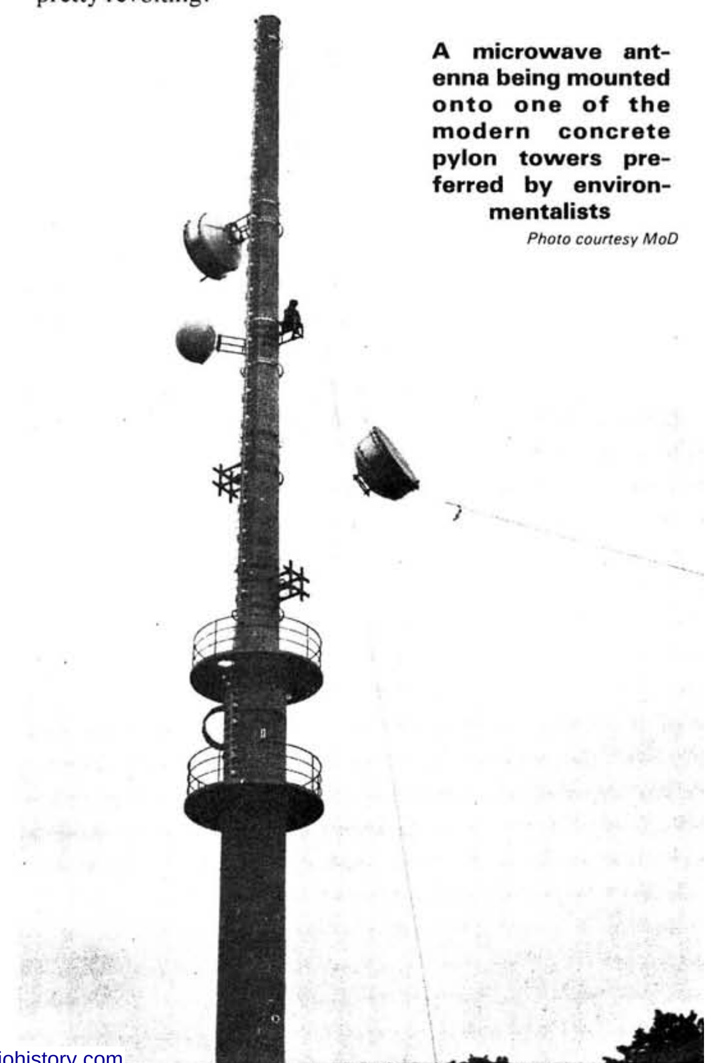
To complicate matters further, the waveform can also be made to incorporate "sound-in-syncs" information, hence this complete signal might properly be described as a "composite television signal". It is a baseband (pre-modulation) signal such as this that is fed into the BFBS system; the audio is combined with the video by encoding the sound into digital form, and then neatly slotting the resulting data stream into the sync. pulses of the video waveform. It therefore becomes possible, throughout the bearer network, to process the sound and vision as a single entity. Using digital techniques means that there is no appreciable loss of sound quality beyond that introduced by the encoding and decoding process itself—you either have sound, or you don't!

Microwave System

The composite waveform, which contains frequency components extending from d.c. to 6MHz, is fed through the microwave bearer system by causing it to frequency-modulate a 70MHz carrier, with a deviation of ±8MHz. As 70MHz is the CCIR-recommended i.f. mainly employed in wide-band radio transmission, up and down conversion from s.h.f. is accomplished using well-tried and established techniques. As far as the microwave system is concerned, the composite TV signal might just as well be 1500 telephony channels! This modulated 70MHz carrier is fed directly from equipment to equipment through the microwave chain. It is demodulated only on arrival at a site where it is required to drive a broadcast transmitter.

With such a large bandwidth to accommodate, one of the principal design considerations for the bearer equipment is to incorporate effective "amplitude response equalisation" and "group delay equalisation". The former consists simply of ensuring that, whatever frequency the equipment is passing through its designed bandwidth at any given moment, the amplitude of the output signal remains unchanged. Amplitude variations in an f.m. system appear as the arch-enemy, distortion—to be avoided at all costs! The latter is a more difficult concept to grasp.

Without going into a singularly indigestible explanation, one has "delay" problems if components of the signal fail to have the same relationship *in time* at the output of the demodulator as they possessed at the input to the modulator—in other words, parts of the signal arrive late. With the PAL system of colour television, depending very much as it does on the relationship between the black-and-white (luminance) and colour (chrominance) information, the effects of this type of non-linearity can be pretty revolting!



A microwave antenna being mounted onto one of the modern concrete pylon towers preferred by environmentalists

Photo courtesy MoD

The studio control room at the London Control Centre. Left to right Amanda Craig, David Gray, Corinne Schnabel and John Harrison

Photo courtesy BFBS

The necessity of obtaining an above-average link performance was a problem encountered while the project was still at the planning stage. By the time the signal arrived at one of the furthest extremities of the system (Munsterlager, for instance, 941km from London), it would have passed through 30 equipments in tandem—was there a line-of-sight equipment of British manufacture (costs, and particularly foreign-exchange costs, had to be kept to an absolute minimum) which possessed the exacting performance parameters required? It transpired that there was certainly none available "off the shelf" and the Phase 1 stations, in order to meet the original deadline, employed Norwegian-made NERA microwave equipment.

The sub-contract for the microwave used in later phases was subsequently awarded to Ferranti Limited, who produced a terminal complete with "hot standby" and logic-controlled automatic changeover. The equipment is accommodated within a single 19in rack and uses frequencies allocated within the 8GHz military band—the Werl area is an exception, where frequencies in the 9–10GHz band were used to avoid interference from an adjacent Belgian forces system.

Broadcasting Stations

On completion, there will be over 40 broadcast transmitters operating throughout the system—each will have been individually planned and approved and many will have been the subject of a local-planning argument. The photograph shows the Marconi B7303 u.h.f. transmitter which is standard throughout the system—either as a transmitter in its own right or, in the case of the more highly-powered stations, as a "drive unit" for a triode power-amplifier (manufactured by Magnetic AB of Sweden), which is then rated according to the e.r.p. (effective radiated power) required from the broadcast aerial array.

The "polar diagram" for a typical transmitter is shown in Fig. 2—this depicts the necessary and, indeed, licensed radiation characteristics for the broadcast aerials as determined by the distribution of the British Forces population in the service area, and the terrain within that area. A broadcast array to produce the desired radiation pattern is arrived at by means of computer calculations. In essence, the array consists of a number of standard broadcast panel-aerials positioned and differentially fed so as to squirt the required e.r.p. in each direction.

Some of the transmitters will be housed in existing buildings and will use existing towers which may have been strengthened to cope with the extra loading. However, in the majority of cases, neither suitable buildings or towers were available within the area selected for the transmitter site. For ease of installation and to minimise the amount of on-site installation work required, Marconi developed a special vehicle-transportable container. The idea was to save time and to keep costs to a minimum—containerisation effectively means that some in-station testing can be accomplished before the equipment leaves the factory. This reduces the amount of installation effort required on site, and means that the complete station can be moved from the factory at Chelmsford to its German destination as a single entity.

The containers themselves are designed to require minimum maintenance and were especially developed for the project; normal airtransportable containers were ruled out as being unsuitable and too costly for this particular application.

Planning Delays

The most obvious thing about any broadcast station is, of course, the tower on which the broadcast and microwave aerials are mounted. And, it was in seeking planning approval for such towers from local authorities that many of the delays in bringing the project to fruition occurred. This is really quite understandable as the process of obtaining planning permission is necessarily complicated and time-consuming. The overall priority must be to protect the environment.

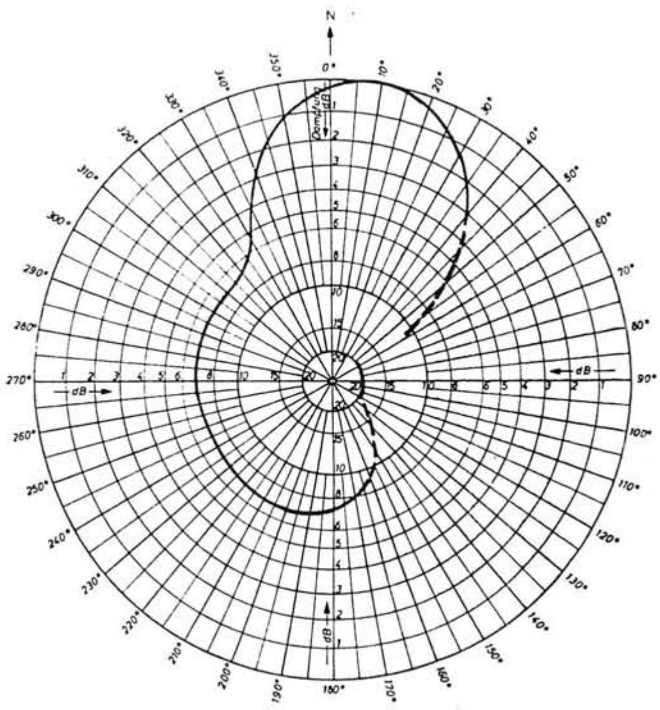


Fig. 2: Polar diagram for a typical transmitter used in the system described

Therefore, in many cases, plans were submitted, were rejected and then re-submitted and so on. It has taken two years or more in such instances, for the planning approval procedure to be completed.

Where existing towers have been used, they are generally of lattice form, but today the type of structure that is preferred from an aesthetic point of view is the self-supporting concrete pillar. The photograph shows the type of tower being used in the new system. This type is manufactured by the Pfleiderer company of West Germany and has the advantages of requiring only nominal ground area, very little maintenance and being very stable in high winds. The broadcast aerials can be conveniently mounted at the top with an unobstructed view in all directions.

Programmes and Organisation

The television service for the British Forces in Germany consists of only a single channel. As the aim is to enable the viewer, as far as possible, to enjoy the same programmes as he would "back home", the bulk of the broadcast material is taken from the output of all three UK channels—some of the more popular "oldies" are interleaved for good measure. Therefore, the scope and quantity of TV material available to BFBS is enormous and the new channel should be able to pick and choose from the best of the UK's national television output. At the same time, a number of programmes are specially produced—German lessons are an obvious example.

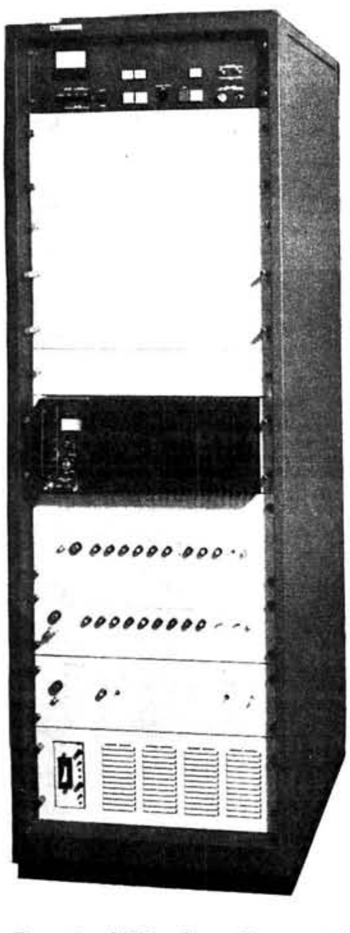
One delight that the BFG viewer is denied, however, is the full-length feature film. Copyright aspects of the service mean that BFBS are not able to screen *The African Queen* or *The Great Escape* once, let alone twenty times, or any of those other old movies that the British public holds dear (or does it?). The philosophy underpinning the selection of material, BFBS's Programme Controller John Harrison told me, is a concern to maintain a balance between news, shows, quizzes etc. as close as possible to that of the total UK national output.

At the present time, all the programmes, "trailers" and announcements are pre-recorded in London—the tapes are flown out to Germany on a daily basis. They are then fed into the system from the mobile VTR centre at Werl. With the establishment of the direct microwave link with London next year, principal control of the programme output will move from Germany to England—in fact, to BFBS's own control-centre in Wembley. It will be at this time that the Forces viewer will be able to receive television news programmes for the first time.

Technical support, maintenance of studio facilities and the supply of pre-recorded material will continue to be provided by London Weekend Television (as BFBS's contractor) but presentation, content and broadcast control will be the firm responsibility of BFBS as at present.

The maintenance of the broadcast transmitters and the bearer network within West Germany itself is directly provided by the Royal Corps of Signals—as the routes and towers used by existing military communications systems were employed wherever possible in the new TV system, it made sense, of course, to combine to military and TV maintenance commitments. Unnecessary duplication is therefore avoided and the cost of maintaining the new system is reduced to a minimum. Maintenance of the new network is accordingly the responsibility of specialist engineers employed by the MoD.

Test equipment, training and numbers of staff are gradually being augmented to take account of this new commitment but there is no doubt that this could be an area of difficulty—nowadays there simply are not sufficient people around with the wide range of requisite skills!



Marconi B7303 u.h.f. transmitter of the type used throughout the system

Photo courtesy Marconi Co.

And Next?

In no time at all, the BFG community will have become completely used to having a unique television channel which caters to its specific needs, the programmes presented by people who have a detailed knowledge of, and insight into the military way of life. Proposals are already in hand for a BFBS television studio at Rheindahlen and even the possibility of transmitting Teletext over the new system is being studied, perhaps with a view to inserting a few pages especially for military use.

Television is in BAOR to stay, taking its place alongside the other organisations whose prime concern is the morale and welfare of their British Servicemen and their families overseas. ●

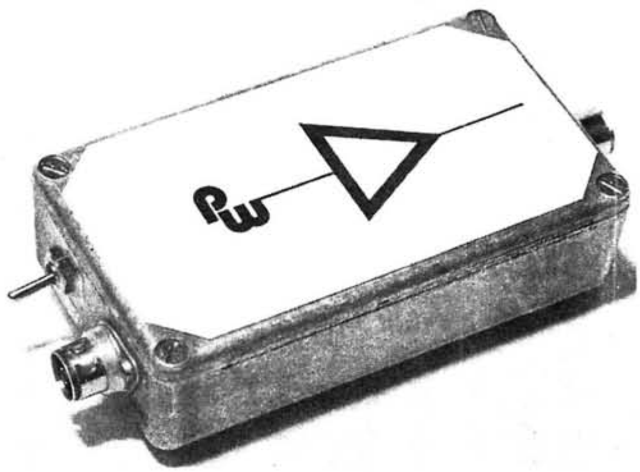
Acknowledgements
The Author would like to thank The Directorate of Military Communications Projects (Ministry of Defence), The British Forces Broadcasting Service, Marconi Communication Systems Limited and The Chief Signal Officer, BAOR for their kind cooperation and assistance in the preparation of this article.

A WIDEBAND RF PREAMPLIFIER

M. TOOLEY BA G8CKT & D. WHITFIELD BA MSc G8FTB

The wideband r.f. pre-amplifier described in this article provides a gain of greater than 20dB over a wide range of frequencies from 200kHz to over 50MHz, making it ideal for use with a large variety of test equipment including oscilloscopes, r.f. voltmeters, digital frequency meters and wavemeters. The unit can enable a considerable increase in sensitivity to be achieved which is particularly useful when measuring very low voltage signals. It can also be used as an untuned pre-amplifier for use with receivers on all bands from l.f. to v.h.f.—it will give a useful boost to the performance of any receiver when an inefficient aerial system is being used, for example.

The pre-amp is powered by an internal 9V battery—this further adds to its versatility when it is used as an r.f. "gain block". In this role, it can be inserted into the signal line whenever the need arises.



Circuit

The complete circuit of the device is shown in Fig. 1. The transistor is operated in the common-emitter mode; its base bias is made adjustable by means of VR1. A relatively low value of collector load resistor is employed and this, together with the very high transition frequency (2GHz at 10mA collector current) of the specified transistor, ensures a flat response over a very wide frequency range. Signals are capacitively coupled into and out of the stage; the values of coupling capacitor were chosen so that low frequency roll-off occurs at approximately 200kHz.

★ specification

Amateur Band Performance

Frequency (MHz)	Gain (dB)
1·8	
3·5	22
7	
14	
21	21·5
28	21
70	19·5
144	17

Input Impedance
250Ω (measured at 10MHz)

Output Impedance
400Ω (measured at 10MHz)

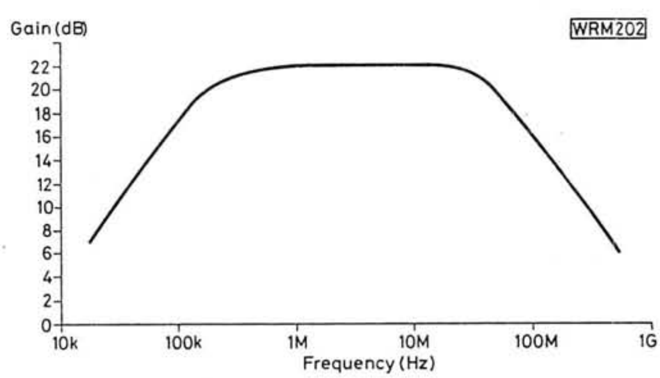
Gain
20dB over the range 200kHz to 50MHz
10dB over the range 30kHz to 200MHz
(measured with 50Ω source and load impedances)

Minimum Source and Load Impedance
50Ω

Power Requirements
9V at 17·5mA (typical)

Construction

With the exception of the coaxial sockets, battery and switch, all the components are mounted on a small printed circuit board; the copper track pattern and component layout are shown in Fig. 2. *Constructors are strongly advised to follow the recommended p.c.b. layout* as the performance at high frequencies (50MHz and upwards) largely depends upon the stray reactances present in the circuit. If the layout is not used then it is most important to



Frequency response

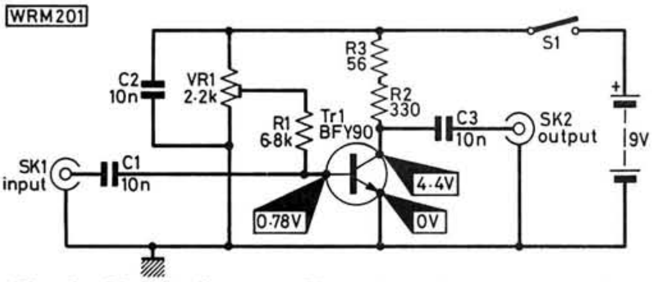


Fig. 1: Circuit diagram. Note that the top end of C2 should go to the junction of R2/R3, not to +9V as shown

keep the wiring as neat and compact as possible, and to ensure that an adequate earth plane (e.g., copper foil or tinplate) is used for all common earth connections. Take care to insert the transistor correctly and to cut the lead-wires as short as possible (about 2·5mm); the object is to mount Tr1 so that its underside is flush with the surface of the p.c.b.

The circuit board is mounted in a diecast or aluminium box using four short threaded spacers—these should be of metal in order to ensure an effective earth connection to the case. The input connection should be taken directly from the input socket (SK1) and a short length of coaxial cable (miniature 50Ω) should be used to link the p.c.b. to the output socket (SK2). The choice of type of socket is left to the individual constructor as it must obviously be compatible with the rest of his equipment. Suitable types are 50Ω BNC, "UHF" (SO239) or standard Belling-Lee sockets.

The PP3 or similar type of battery should be housed inside the box adjacent to the p.c.b. and may be retained by means of a small aluminium bracket. For the electrical connection, use a snap-fit battery connector.

Initial Checks and Use

Having carefully inspected the printed circuit board and its associated wiring, connect the battery, switch on and measure the supply current which should be 10–20mA. If this is not the case, adjust VR1 until 15mA is being drawn from the battery. Now connect the pre-amplifier into the coaxial line between aerial and receiver and then tune to a steady carrier between 5 and 15MHz. Adjust VR1 for maximum indication on the receiver's signal-strength meter and then repeat the procedure at v.h.f. (a receiver for the 144MHz band would be ideal for this purpose), once more adjusting VR1 for maximum "S" meter indication. The wideband r.f. pre-amp. is now ready for use.

It is recommended that the device is used only with screened coaxial input and output leads. It is also worth noting that when the pre-amplifier is used in an unmatched system, it is important to keep the lengths of coaxial cable to a minimum. ●

★ components

Resistors

⅓W 5% Carbon film

56Ω	1	R3
330Ω	1	R2
6·8kΩ	1	R1

Capacitors

10nF	3	C1,2,3

Transistor

BFY90	1	Tr1*

Potentiometer

Horizontal mounting, sub-miniature pre-set

2·2kΩ	1	VR1

Miscellaneous

Coaxial sockets (2) to suit individual preference; sub-miniature toggle switch s.p.s.t. or s.p.d.t.; printed circuit board; snap-fit battery connector for PP3 battery; diecast aluminium box; 6BA threaded spacer (4) 6mm long.

* Available from Marshalls, R.S.T., etc.

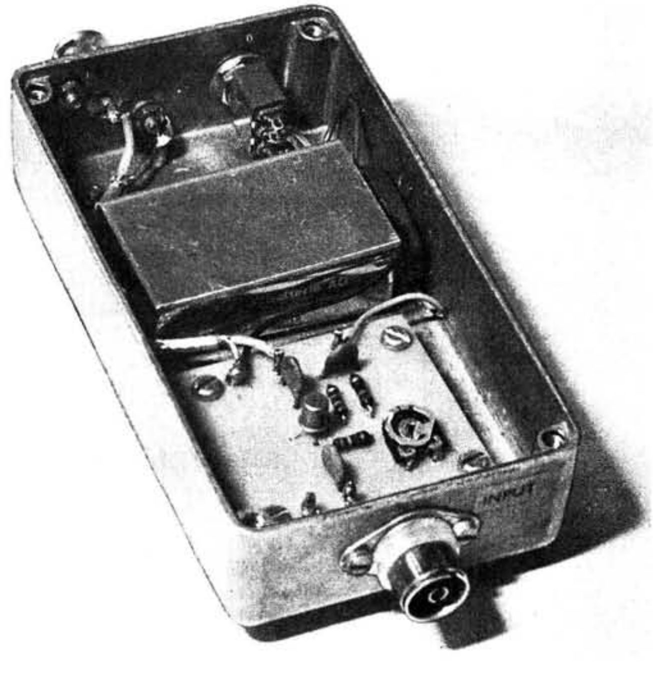
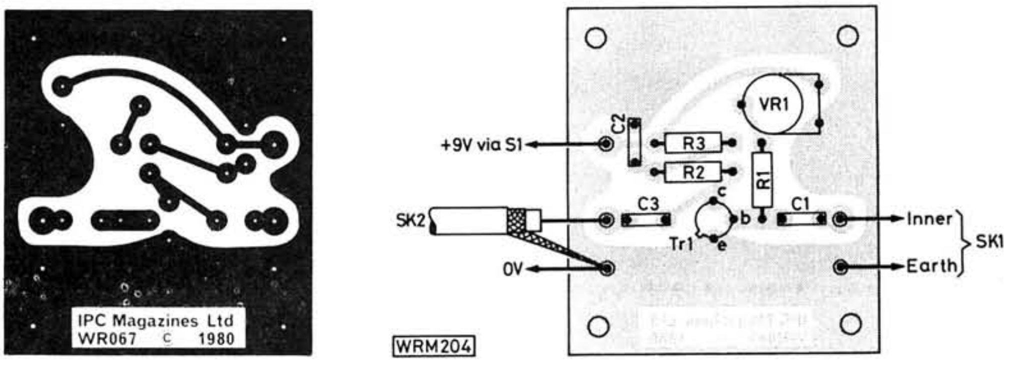


Fig. 2: Copper pattern and component layout, shown full size



PRODUCTION LINES

alan martin

New Kits

Suretron Systems (UK) Ltd. announce the availability, in kit form, of two proven-quality electronic ignition systems. Called the Surefire C300 and ES200, they are suitable for vehicles with up to eight cylinders.

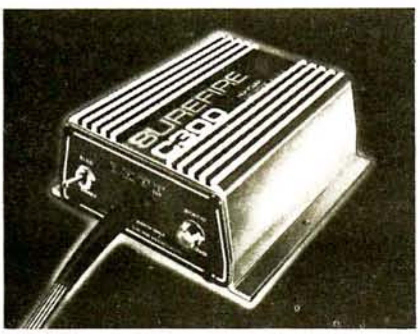
The C300 is a high energy capacitive discharge system incorporating a high output short-circuit-proof inverter, pulse processor circuit (overcomes contact-breaker problems) and transcient overload protection. Available in negative and positive earth versions with coil ignition. Ideal for fuel injection, sports carburation, oily engines and two strokes.

The ES200 is a high performance inductive discharge system incorporating a selected output Darlington, electronic variable dwell circuit to maximise spark energy at all engine speeds, pulse processor circuit, coil governor to protect the coil and produces a long-burn output that is suitable for all negative earth cars.

The kits comprise an anodised extruded aluminium case, p.c.b., static timing light, p.c. mounted security changeover switch, selected power semiconductors, capacitors, resistors, in fact everything down to the last nut and bolt and fully illustrated instructions.

The prices which include VAT and P&P are: ES200–£13.95 and the C300–£17.95. A special introductory offer of £2.00 off is available now.

Further details from: *Suretron Systems (UK) Ltd., Piccadilly Place, London Road, Bath BA1 6PW. Tel: (0225) 23194/313846.*



Voltage tester

The "Universal Voltage Tester AB070", is designed to detect voltages between 4·5V and 380V without switching. It indicates the polarity of d.c. voltages by the illumination of an l.e.d. against positive or negative symbols, alternate flashing of the l.e.d.s indicate a.c. voltages. The tester requires up to 1·5mA to operate and has a response time of 3ms.

Ideal for many applications in the telecommunications, R & D, automotive and servicing industries, the tester costs £4.50 (excluding VAT) and is available from: *Verospeed, Barton Park Industrial Estate, Eastleigh, Hampshire SO5 5RR. Tel: (0703) 618525.*

Light Show

Using the latest developments in CMOS and Schottky Bipolar integrated circuitry, TUAC introduce the "Starchaser 4000", a programmable, four-channel—750W per channel—sound-to-light system.

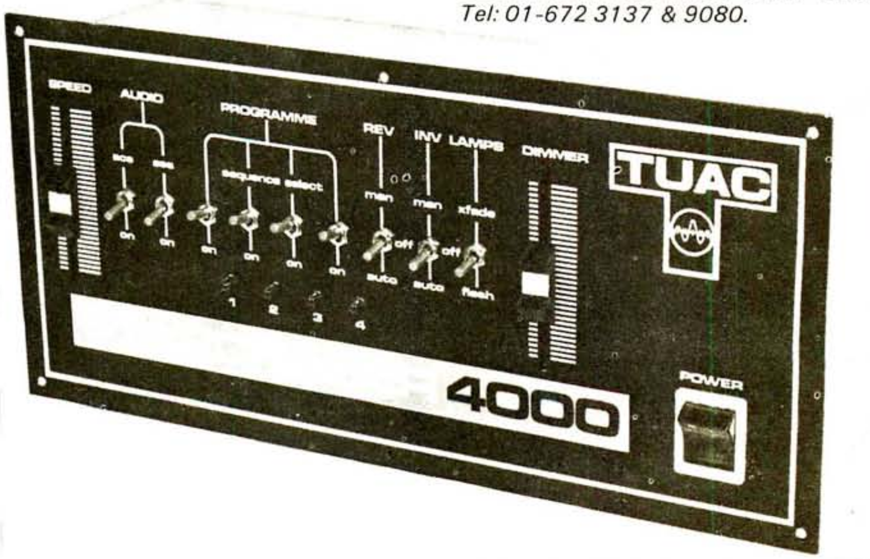
The Starchaser 4000 initially provides 16 distinctive and varied patterns selectable by four switches, which form the basis. A further five additional effects switches allow the operator the scope to obtain over 1000 different patterns and effects.

Automatic gain control (a.g.c.) is a standard feature, and zero reference triac firing is incorporated to eliminate all interference. Smooth operating sliders ensure accurate control settings, and l.e.d. panel indicators enable the user to instantly determine each programme selected.

Additional features include a master dimmer control, speed control and crossfade which allows each channel light to brighten and dim at a controlled rate, producing a merging effect, a short-on-time facility reduces the lamp-on time of any channel during sequencing, producing a simulated strobe effect.

The Starchaser 4000 measures 330 × 150 × 100mm, weighs 2·3kg (5lb), costs £99.00 inc. VAT and carries a full 12 month guarantee.

Further details from: *TUAC, 119 Charlmont Road, London SW17 9AB. Tel: 01-672 3137 & 9080.*



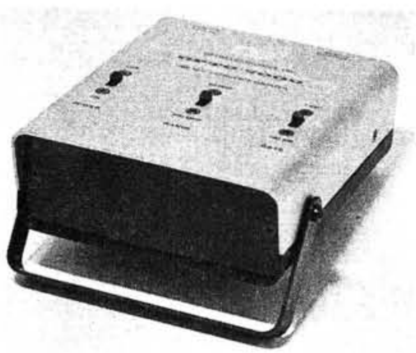
Test Equipment

Maclin-Zand Electronics Ltd. offer two test instruments, the OPTO-7000 miniature 600MHz digital frequency meter and the M-1200B digital multimeter.

General specification of the OPTO-7000 includes: Two switch-selectable frequency ranges; Range 1, 10Hz to 60MHz and Range 2, 10 to 600MHz. Input impedance; (Range 1) 1MΩ shunted by 20pF and (Range 2) 50Ω. Input protection; 100V up to 10MHz, 50V up to 60MHz and 2V max, Gate sampling time; (Range 1) 100 milliseconds, (Range 2) 1 second. Resolution; (Range 1) 10Hz and (Range 2) 100Hz. Sensitivity; (Range 1) <10mV, (Range 2) <75mV. Counter accuracy; ±1 count, dependent on temperature stability and ageing. The display incorporates seven 10mm (0.4in) red l.e.d.s and the decimal point is autoranging on both ranges. Power requirement is 7·5 to 15V a.c./d.c. at 1·5W, with optional four AA size Ni-Cad batteries and constant current charger. Weighing 14oz the OPTO-7000 measures 130 × 108 × 32mm and costs £120 plus VAT and £3 P&P.

General specification of the M-1200B includes: Five d.c. and five a.c. volt ranges between 200mV and 100V. Four d.c. and four a.c. current ranges between 2mA and 2A. Accuracy over d.c. ranges 1% ±1 digit, resolution 100μV and 1μA with overload protection of 100V max. on volt ranges and 2A fuse and diodes on current ranges. Accuracy over a.c. ranges 1·5% ±2 digits, resolution 100μV and 1μA with overload of 600V on the 200mV scale, 1000V max. and 2A fuse and diodes on current ranges. Resistance is measured over six ranges between 20Ω and 20MΩ, accuracy is 1% and resolution 0·01Ω. The M-1200B is powered by four HP11 batteries with provision for a 6–9V d.c. adaptor. Weighing $2\frac{1}{4}$lb and measuring overall 210 × 146 × 57mm, the M-1200B costs £55 plus VAT and £3 P&P.

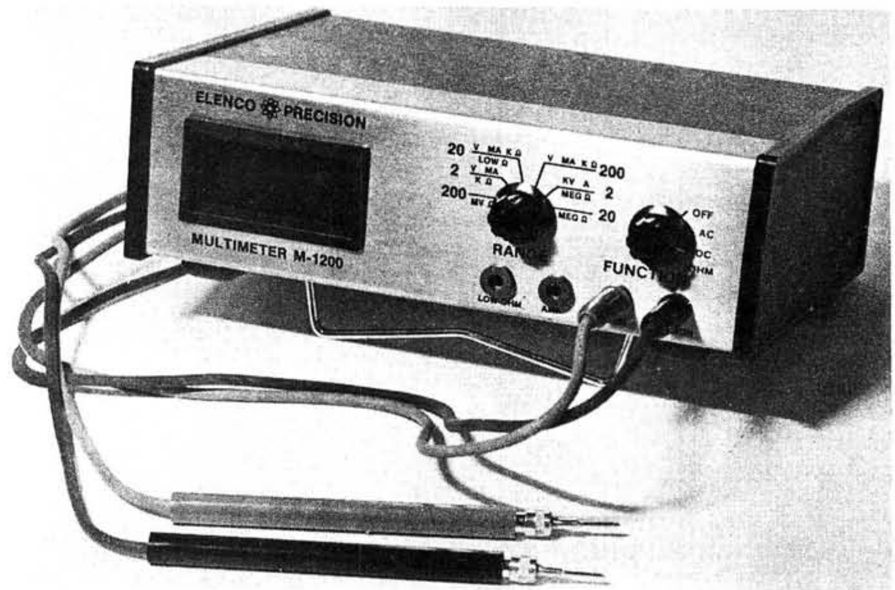
Both units are available from: *Maclin-Zand Electronics Ltd., 38 Mount Pleasant, London WC1X 0AP. Tel: 01-837 1165.*



Low-Cost Mini-Scope

The Safgan ST-45 is a single trace oscilloscope with 5MHz bandwidth, 10mV/division sensitivity and a fairly large display area of 80 × 64mm with a graticule ruling of 10 × 8 divisions. The vertical amplifier which has 1MΩ plus approx. 22pF input impedance uses an f.e.t. input stage followed by stages consisting of transistor arrays in order to achieve minimal drift of trace with temperature changes. Overall amplifier bandwidth is close to 6MHz (although it is specified at 5MHz) with good pulse response characteristics. Input attenuator stages are set for best pulse shapes and has ±5% accuracy on all ranges. 50Ω input impedance attenuator settings are useful for r.f. work. Overall timebase speed range from 250ms/div to 200ns/div including multiplier and ×5 expansion facilities; all timebase speeds are calibrated to ±5% accuracy. External X-sensitivity is 1V/div with 500kHz bandwidth. The trigger system offers solid triggering below 0·5 div for internal and 100mV for external modes for a wide range of frequencies and incorporates an auto bright line facility. Trigger level and + ve, − ve slope selection on both internal and external trigger modes is incorporated. The c.r.t. is a 1·5kV mono-accelerator made by the Thorn Brimar Group and has a very bright, clear, well defined display even at the fastest sweep speed of 200ns/div. The instrument is mains powered with a power consumption of approx. 10 watts. Overall dimensions of the black p.v.c. finished aluminium case are 216 × 165 × 280mm deep and the cream-white front panel is silk-screened with black annotations.

The ST-45 costs £125 plus VAT and is available from: *Safgan Electronics Ltd., 56 Bishops Wood, St John's, Woking, Surrey GU21 3QB. Tel: (04862) 66836.*



Above shows the M-1200B digital multimeter and left the OPTO-7000 digital frequency meter

If you please

Would readers kindly mention "Production Lines", when applying to manufacturers or suppliers featured on these pages.

QSL Cards

Since the introduction of the *"PW QSL Cards"* service for the radio amateur and short wave listener, the service has proved to be highly successful. For details and order coupon, see page 67.

May I also take this opportunity to wish all our readers a very happy Xmas and a prosperous 1980.

RADIO SPECIAL PRODUCT REPORT

KDK

FM2016E 2m FM Digital Synthesized Transceiver

With the vast amount of fully synthesised 2-metre transceivers on the market today, the amateur contemplating the purchase of such an item has to ask himself the following questions:

1. What can I afford?
2. Is the price indicative of the performance and quality?
3. Am I going to buy something which will give me years of service?

A fairly recent arrival on the scene is the FM-2016E from Kyokuto Denshi Kaisha Ltd. (KDK for short). From the gen given in the adverts, this looks a very interesting rig, offering a lot of facilities at a reasonable price, but not too much seems to have been heard of it. So, we thought we would give it a trial.

Obviously, the most important part of any synthesised rig is the synthesiser, so the examination began there. The CMOS unit provides a good, clean and pure f.m. signal. The receiver uses dual-gate MOSFETS for the r.f. amplifier and first mixer, providing superior intermodulation and cross-modulation characteristics as well as excellent sensitivity. An all-electronic tuning circuit using varicap diodes tracks the receiver front-end throughout the frequency range. Selectivity is provided by a crystal filter in the first i.f. and a ceramic filter in the second i.f. A ceramic discriminator is used to provide greater temperature stability and long-term stability. Adjustment of the received frequency by the RIT (Receiver Incremental Tuning) control is by varicap in the second local oscillator.

The transmitter is of the single conversion type, employing a balanced mixer. Five stages of electronic tuning, similar to that employed in the receiver, plus a four-stage low-pass filter in the transmitter output, results in a very clean f.m. signal. Modulation is by direct varicap control of the v.c.o. in the synthesiser. The transmitter is very tolerant of mismatched loads, and will stand up to an infinite v.s.w.r. The output transistor is a new silicon device, the 2SC1729.

Under normal mobile conditions, the FM-2016E proved to be a very exciting rig to use. The front panel of the set has eleven easily accessible controls which, after a short while, can be operated without even looking. This is, of course, exactly what you want for safe driving and easy operation. If you're thinking "I want a rig I can use as a base station as well as a mobile", don't worry—this little fellow has all you could look for in an f.m. transceiver for either application.

Facilities

Probably the best way of conveying the facilities offered is by a brief run-down on the functions of the front-panel controls. First, the top row, running from left to right.

1. High Power/Off/Low Power. Switches the set on and off and selects transmitter power level by varying the gain of a buffer stage. Measured power output of the evaluation model was 19·2W and 1·9W respectively.

2. Tone/Off/RF Attenuator. With the switch in the up position, pressing the microphone p.t.t. gives 0·5s of 1750Hz tone for repeater access. In the down position, the gain of the receiver r.f. amplifier stage is reduced by 10dB, for protection against strong signals.

3. Close/Off/Open. This switch allows the scanner to look for either a busy channel or a free channel, at will. Once a channel has been found, setting this switch to off allows it to be held indefinitely.

4. Digital Readout of Frequency/Tx–Rx Indicators. Two l.e.d.s show transceiver status. The Rx Indicator is lit only if the incoming signal is strong enough to open the squelch.

5. Main Tuning Knobs. Concentric selectors for 100kHz and 10kHz steps. End stops allow the frequency to be set by counting "clicks", rather than having to look at the display when on the road (see also "9").

6. Meter. This has three functions, selected by a push-pull switch combined with the RIT control below it (see "7"). On receive, the meter can be either an "S" meter, or a discriminator, allowing accurate tuning by means of the RIT control. On transmit, the meter gives an indication of output power.

Now we move on to the bottom row, starting at the right-hand end.

7. RIT Control/Meter Control. This has been covered under "6" above. The range of the RIT control is approximately ±5kHz.

KYOKUTO

KYOKUTO DENSHI COMPANY LIMITED

KDK FM2016E 2m FM DIGITAL SYNTHESIZED TRANSCEIVER

The KDK FM-2016E is a 12V DC two metre FM transceiver for mobile and base station use. It has been compactly designed with emphasis on maintenance and ease of use by using the latest CMOS IC digital PLL circuitry. Rx 144·000–148·995MHz and Tx 144·000–145·995MHz. Direct readout of operating frequencies by large size LEDs.

The most commonly used, 100kHz and 10kHz, switches are mounted coaxially. These will not go below the 0 or above 9 position facilitating frequency changing by feel only, for "eyes-on-the-road" motoring and use by those with impaired sight.

An electronic memory using CMOS RAMs (Randon access memory ICs drawing only 25nA!) allows any four of the 1,000 channels to be written-in (stored) at a flick of a switch. An auto-charging back up NiCad battery maintains the RAMs contents after disconnection from the power.

The plus 600kHz and minus 600kHz positions of the mode switch provide for normal repeater operation. In position 1T–2R the set Tx's on the frequency in memory channel 1 and Rx's on memory channel 2 (likewise the 3T–4R position). This provides for non-standard shifts, and is also convenient for use in conjunction with up-converters.

The memory may be scanned in the "closed" mode, (the scanner will stop at the first channel in use) or in the 'open' mode, (stopping at the first empty channel). Scan-hold allows transmission immediately the scanner stops.

Dual-gate MOS-FETs are used for the RF and mixer to provide superior inter-modulation characteristics with high sensitivity. Performance is held constant across the wide frequency range covered, by automatic electronic tuning.

A monolithic crystal in the first IF and a commercial quality 15-pole ceramic filter in the 2nd IF provides extremely sharp selectivity. The 2nd IF is built with discrete components to keep stray coupling to a minimum and a ceramic discriminator has been adopted for excellent temperature stability and long-term alignment.

The RIT (Receiver incremental tuning) and centre zero meter for contacts with off-frequency or drifting stations.

The single conversion transmitter uses a balanced mixer, five stages of electronic tuning, and a four-stage low pass filter for a clean, spurious-free signal.

The ultra-modern silicon transistor in the final will survive even on infinite VSWR.

Power: HIGH (15 Watts) and LOW.

Direct FM of the VCO results in superb audio.

A two mode (burst or continuous) tone generator is adjustable from 1,750 to sub-audible frequencies.

A 5-pin "DIN" connector is provided on the rear panel for a KDK SC-12A SELCALL (tone encoder-decoder) unit, headset-microphone combinations or similar.

The 2016E is supplied with microphone, mounting bracket, leads, and an excellent handbook.

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8. Write/Off. When this switch is moved to the "Write" position, the frequency selected on the tuning knobs will be written into memory. If a memory channel is selected by the switch "11", the previous frequency stored in that position will be over-written. If a memory channel is not selected, the new frequency will be automatically stored in channel 4.

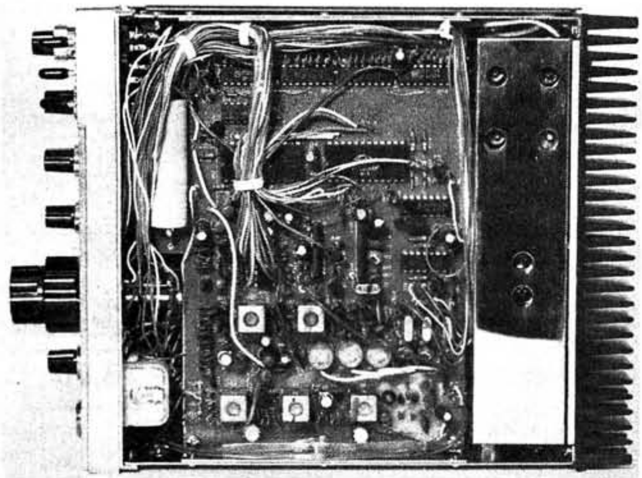
This is a very attractive feature of the rig. Suppose you're driving through an area and tuning around, and come across the local "natter" channel. A quick flick to "Write" will store it in position 4 ready for use on your return journey, without having to make any other adjustments.

The selected frequency data is stored in CMOS RAMs (random access memories), which are powered by a nickel cadmium battery when the transceiver is disconnected from the external power supply. Consumption from the battery is around 25nA (yes, nano-amperes) and the battery is kept charged whenever the rig is in use.

9. 5 Up/Off. This allows the units kHz digit of the selected frequency to be set to 0 or 5.

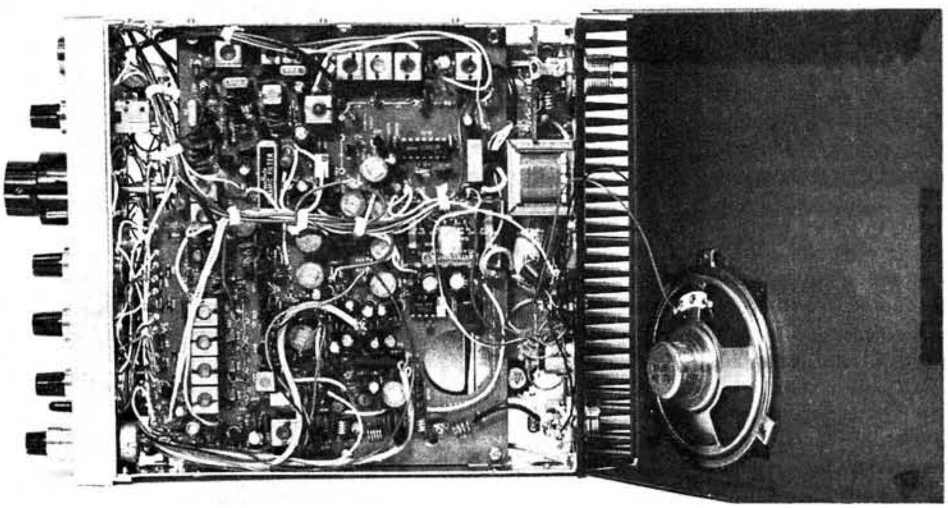
10. 144/145/146/147/148MHz. This is obviously the band selector switch, but be careful. Although the transmitter is limited to 144–145·995MHz, by switching to +600kHz on the Mode switch (see "12"), you could transmit out of band without realising it. The next thing you'll know, the man from the Home Office could be knocking on your door.

11. Off/1/2/3/4/Scan. This is the Memory switch, allowing you to store and recall your four favourite frequencies,



★ specification

Frequency Coverage:	144·000–148·995MHz (receive)
	144·000–145·995MHz (transmit)
Memory:	4 channels
Scanning:	Scanning of 4 memory channels for open and closed channels
Frequency Stability:	Better than ±0·002%
Useable Temperature Range:	–20° to +60°C
Power Source:	13·8V d.c. ±10%, negative earth
Aerial Impedance:	50Ω nominal, unbalanced
Current Consumption:	Less than 0·6A (receive)
	Less than 3A for 15W (transmit)
	Less than 1·3A for 1W (transmit)
Dimensions:	180 × 60 × 195mm
Weight:	2·5kg
TRANSMITTER	
Power Output:	15W (HIGH), 1W (LOW)
Emission:	F3 (direct varicap f.m. of v.c.o.)
Deviation:	±5kHz (factory set)
Spurious Emissions:	More than 60dB below carrier
Microphone:	600Ω dynamic with p.t.t.
Repeater Tone:	1750Hz, continuous or toneburst
RECEIVER	
Sensitivity:	Less than 1μV input for 30dB S/N
	Less than 0·25μV for 20dB quieting
Squelch Sensitivity:	Less than 0·2μV
Bandwidth:	±8kHz (6dB), ±16kHz (70dB)
Intermediate Frequencies:	16·9MHz (1st), 455kHz (2nd)
Image Rejection:	Better than 70dB
Audio Output:	More than 1·5W at 10% t.h.d.
Output Impedance:	8Ω internal loudspeaker
	4–8Ω external loudspeaker



Top and bottom views of the FM2016E with covers removed. In use, some space is required under the set, for sound to escape from the loudspeaker

continued on page 66 ▶▶▶

letters

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

CB in Germany

Sir: I read with interest the item concerning CB in the USA in *VHF Bands* in the August 1979 issue of *PW,* and am pleased to note that the seemingly controversial subject of CB is getting more of an airing in popular technical publications in England.

As an expatriate who has lived in Bavaria for the last six years, I have taken advantage of the privilege granted by the PTT in 1975 and installed a mobile CB set in my car and a fairly sophisticated base station at home. As you probably know, maximum output power is restricted to 500mW, 12-channels in the 27MHz band being set aside exclusively for CB. Directional antennae are forbidden, although ground plane elements are permitted with base stations.

Every "approved" transceiver has an FTZ number stamped somewhere on its chassis (Funk Technische Zullassungstelle Pruf Nummer), indicating that the design has been checked and approved by the appropriate government authorities. I say "approved" transceivers, because it is easy to buy a Japanese or American imported set which does not comply with the emission regulations, i.e., 4W, 40-channel, and of late a very sophisticated 18W, 120-channel s.s.b. job. "After-burners" ("add-on" power amplifiers) are also available, capable of increasing a 500mW to some 20W or more. It is not known whether legislation is in the pipeline to block the import and sale of this equipment.

When one purchases an approved apparatus for use in the car, a set of rules and regulations (a commodity for which the Germans are noted!), an FTZ certificate corresponding to the set purchased, and a licence granting the purchaser permission to use the equipment in accordance with the regulations, is included. These documents must be kept with the car papers, and may be inspected together with the set at any time by a policeman or any authorised agent for the PTT. The latter are also empowered to carry out tests on the equipment to ascertain whether any "modifications" have been incorporated. There is no licence or registration fee for mobile installations.

Operators of home stations however, must register with the Post and Telecommunications authority and pay a monthly fee of DM15.00 (about £4). Call signs (or more precisely, call names) are either dreamed up by the operator or allocated by the PTT, where several "Tweeties" or "Bushy Bears" might cause confusion.

As with most privileges granted by any authority, there are regrettably those who abuse them as well as those who avail themselves of the opportunity in a responsible manner. No one would deny that Germany has its quota (albeit tiny when compared with the majority) of rogue CBers. There are those, for example, who squirt 18 watts of r.f. down a transmission line, oblivious of output transistor parameters, s.w.r.s, etc., but since this invariably results in TVI and breakthrough on approved sets operated by the serious CBer, they don't operate for long, at least in our area!

It seems to me that there are three distinct "types" of CBers: the 120-channel, 18W cowboys (a tiny minority); the CBer who uses his (or her) set as an extension to the telephone—particularly useful for the house-bound or for invalids—for old people living on their own, and as your own correspondent John Keegan mentioned, in an emergency on the highway, especially at night; and finally, there is the chap who is considering amateur radio as a hobby, but for the moment content to carry out experiments in propagation using very low power equipment. I for one, enjoy this aspect of the hobby, particularly as my QTH is in a valley surrounded by mountains, buildings and forests, and "getting out" is sometimes a real challenge.

In conclusion, it must be significant that in this area alone, the number of applications to sit the German radio amateurs' examination has tripled in the last four years. The local education committee is running for the first time two RAE courses at the nearby Hochschule. I shall be enrolling this week.

So I would say to all anti-CBers: accept the fact that CB is here to stay, and it will certainly come to England. Better to have a properly controlled CB facility available to those who can show they'll use it responsibly, than illegally imported sets, illegally and irresponsibly operated.

"Bird Dog"
V. A. Sancto
Miesbach
West Germany

Pen-Pals

Sir: I am very interested in radio and would dearly like to correspond with someone in Great Britain, whose interests include amateur radio.

Marc de Moor-Vulsteke,
Vredestraat 13,
B-9720 de Pinte,
Belgium

Sir: I am a regular reader of *Practical Wireless* and would like to correspond with other readers, with the object of exchanging ideas, books, circuits, etc.

Sam Hosenbocus
11 Claremont Grove
Leeds
LS3 1AX

?????

Sir: I wonder if any of your readers could settle a difference of opinion between two "old timers"?

I remember one cold and wet December evening in 1929, 30, 31?, when my brother and I walked into our local radio shop, with the current issue of *Popular Wireless* to purchase the parts to build the *Popular Wireless "Super Quad".*

The Question is was the design by the late John Scott-Taggart and what was the date of the issue in which it was published?

R. Roebuck,
19 Park Road,
Ashley,
New Milton,
Hampshire

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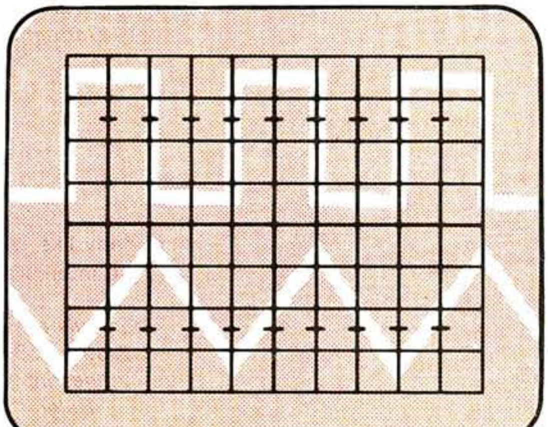

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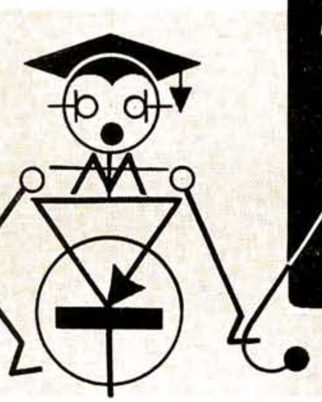

ELECTRONICS IN SCHOOLS

A look at some of the fascinating electronics projects being undertaken in schools today, in this case a logic tutor and an electrocardiograph

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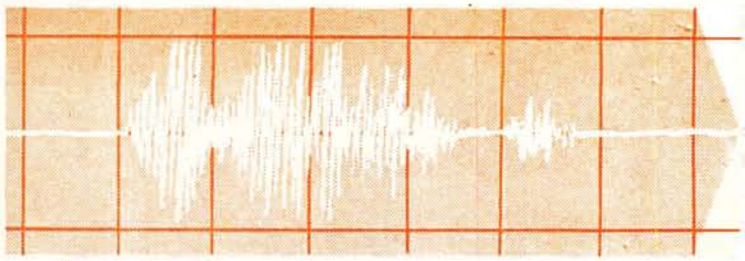


AF Speech Processor

E. A. RULE G3FEW

With any communication system it is important that the greatest amount of information is passed with the minimum amount of expense and effort. For some years the use of single sideband transmission has been a very popular method of achieving this aim, especially among Radio Amateurs, and it has proved to be a very efficient system in comparison with double sideband a.m. or f.m. transmission. Nevertheless, it is possible to improve the communication efficiency still further by "processing" the speech waveform before applying it to the transmitter.

In practice it is possible to obtain an effective increase in "talk power" equivalent to a tenfold increase in transmitter power—a 200W transmitter sounds like a 2kW one at the receiving end! When it is considered that this can actually be achieved without using bigger power supplies or final stages, but by using only a relatively simple speech processor, the advantage in cost alone is considerable.

This circuit is not "just another processor", but the result of much painstaking research into the reasons why some processors work and others do not. Many hours of testing prototypes and examining other methods of enhancing communication efficiency, have resulted in a device that is as effective as the best but remains simple to construct. As such, it does not incorporate any expensive components.

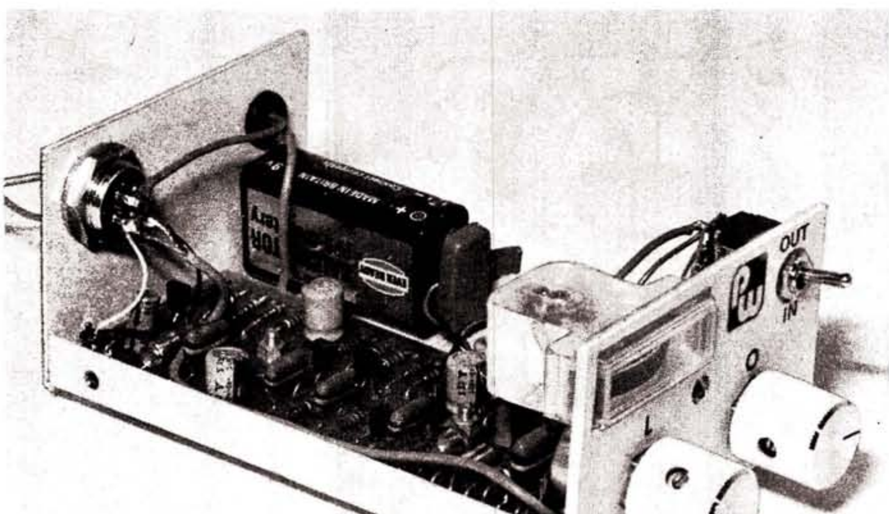
Response

The overall frequency response is one of the most significant parameters in any communication system. A study of s.s.b. transmitters in amateur use showed that, in general, the frequencies below 300Hz and above 3kHz are internally filtered out; there are slight differences between the various designs but 300Hz to 3kHz is the normal audio pass-band.

It may be considered that if a transmitter already possesses filters intended to tailor the response then no further filtering is required—nothing could be further from the truth and it is this misconception that causes so many designs to fail. It is of paramount importance, moreover, that the filtering in the processor is carried out in the correct sequence.

In the circuit of the *PW* Speech Processor, frequencies below 300Hz are removed before the limiter stage by an 18dB/octave filter so that the unwanted frequencies do not produce harmonics which would fall into the wanted 0·3–3kHz band. These harmonics would be produced by the limiter stage which, of course, is a non-linear device. If these lower frequencies were not removed, their harmonics would add considerably to the distortion in the final transmission thus wasting power. The frequencies above 3kHz are also removed, but after the limiter stage so that the harmonics produced from the 0·3–3kHz audio band are prevented from reaching the transmitter.

If they did reach the transmitter, all manner of nastiness would result, of course. Transmission bandwidth would be increased, interference would be caused to adjacent transmitters and so on. Now that the mean voltage of the audio signal has been stepped up by the processor action, the built-in filtering is no longer really able to cope. It would, of course, reduce the unwanted harmonics—but not by a sufficient amount and hence the filtering provided



Front view of the *PW* Speech Processor

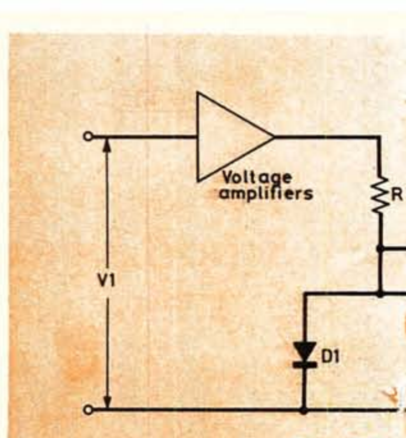


Fig. 1: Bas

within the processor itself. Naturally, it is important that the filter used and the subsequent amplifying stages do not themselves introduce harmonics! Again, the final transmission would then occupy an excessive bandwidth.

The *PW* processor uses an active filter and any spurious products are of a very low order.

Distortion

This is another very significant parameter, of course. The main aim must be to keep the distortion in the audio signal applied to the processor to a minimum; any distortion present will be worsened by the limiter action. Similarly, the input stages of the device must be designed with low distortion in mind.

Such stages are used throughout the *PW* Speech Processor and employ methods common to the hi-fi scene. Use of negative feedback and careful selection of transistor type has resulted in a total distortion of less than 0·1% before the limiter.

S/N Ratio

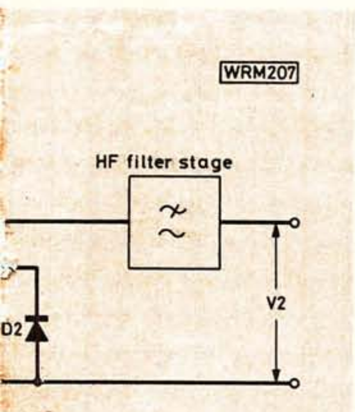
A very high signal-to-noise ratio is vital in any speech processor. A normal transmitter may have an overall S/N ration of 40dB (the noise constitutes 1% of the total signal, in voltage terms), but if this same S/N ratio of 40dB applied to the processor also, however, the noise would only be 20dB down on the signal at the transmitter output (it would constitute 10% of the total transmitted signal). In practice, the situation would be worse as the existing noise in the transmitter would be added to the processor noise ($N_{to} = \sqrt{N_p^2 + N_t^2}$ where N_{to}= total noise, N_p = processor noise and N_t = transmitter noise).

For a 3mV input signal the pre-limiter stages of the *PW* design have a S/N ratio of 60dB—with the use of a high output microphone this figure can be further improved to 80dB. From this it can be seen that with 20dB of extra gain applied to the speech by the processor, the noise will still be more than 40dB down overall and can be ignored for all practical purposes, even when a low output microphone is being used (Fig. 2).

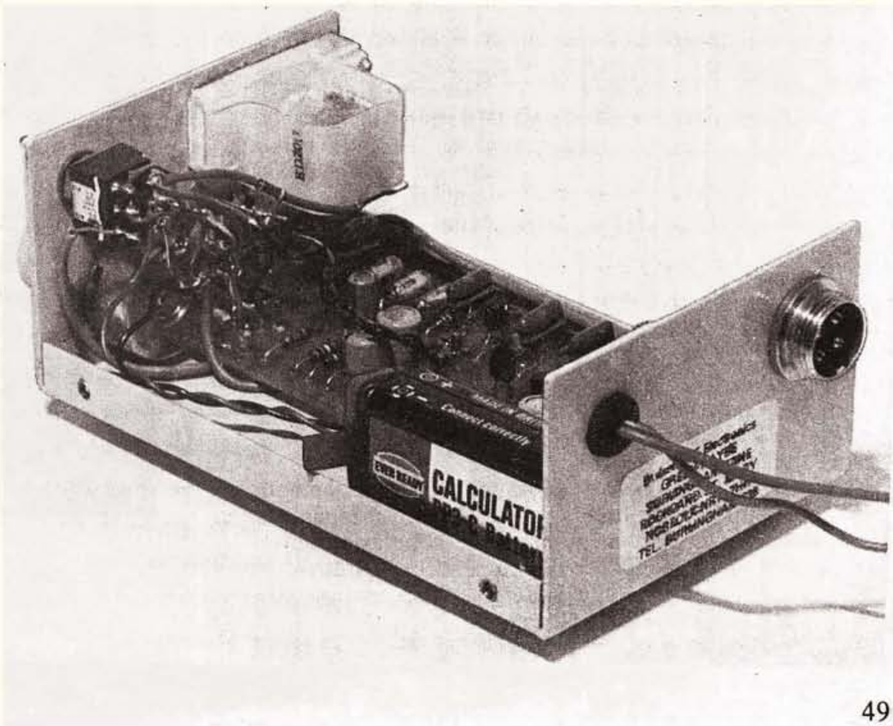
Basic Principle

The simple "block diagram" of the *PW* processor is shown in Fig. 1. If a silicon diode is fed from a high impedance source, then the voltage across the diode will follow an approximate log law relationship relative to the current through the resistance (R). Therefore the output voltage (V2) will have a log law relationship to the input voltage (V1); it is upon this relationship that the action of the device is based (Fig. 2).

Figure 3 shows the effect on a sine-wave signal as the input voltage is increased. Even with a 20dB gain applied, the signal is not being clipped, but has rounded edges. Figures 4(a)-(e) show the results obtained from the



c circuit



Rear view: Note how R16 is connected between S1 and the meter completed processor—the effects of the high frequency filter are quite plain. The output waveform, although distorted, is reasonably clean, simplifying the task of the built-in transmitter filter.

The photograph in Fig. 5 shows the effect of the processor on the word "Hello". Note the spread above and below the main body of the trace—this consists mostly of wasted speech peaks which do not contribute anything to the readability of the transmission. The lower trace shows how these peaks have been removed after "processing" and how the mean signal voltage has been considerably increased.

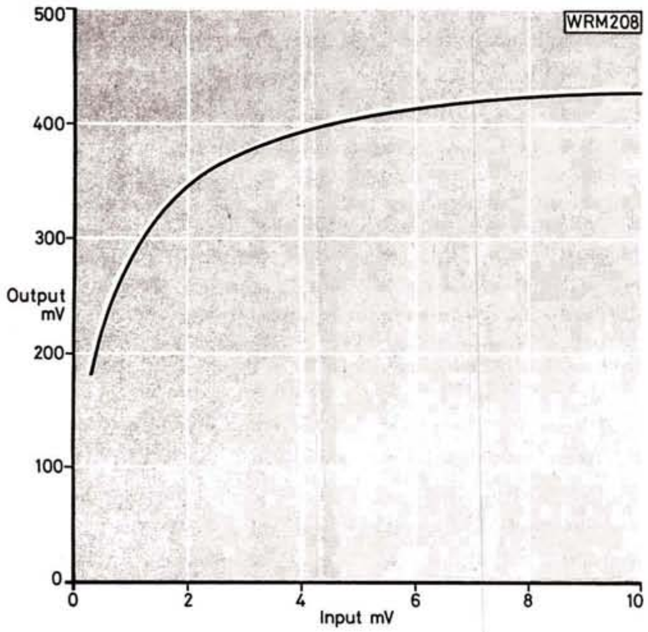


Fig. 2: The output signal voltage is progressively limited as the input voltage is increased

Circuit

The circuit diagram of the device is shown in Fig. 6. The microphone is connected via an r.f. filter C1/R1/C3 to the low-noise amplifier Tr1/Tr2. Negative feedback is applied to minimise distortion and to stabilise the d.c. bias conditions. The signal is then passed to Tr3 and Tr4 via VR1, the limiter gain control. Transistors Tr3 and Tr4 form a second low distortion amplifier with similar characteristics as Tr1/Tr2. The signal is now at an appropriate level for feeding to the limiter stage R14/D1/Tr5. Low frequency filtering is provided by the combined action of C5/VR1, C6/R11, C8/R14 and is aided by the small values of decoupling capacitor used in the emitter circuits of Tr2 and Tr4 (C4 and C7).

The limiter stage differs slightly from the basic form shown in Fig. 1. Resistor R14 forms the high impedance feed to the two diodes which consist of D1 and the base-emitter junction of Tr5. Substituting Tr5 for the "D2" shown in Fig. 1 makes it possible to connect an l.e.d. or moving coil meter (or both!) in series with its collector. This provides a good indication of the actual amount of processing being applied, for the current flow through the collector of Tr5 is roughly similar to the current flow through D1 and D2 in our elementary circuit (Fig. 1). A 100μA f.s.d. meter is capable of showing the full range of

(a)
(b)
(c)

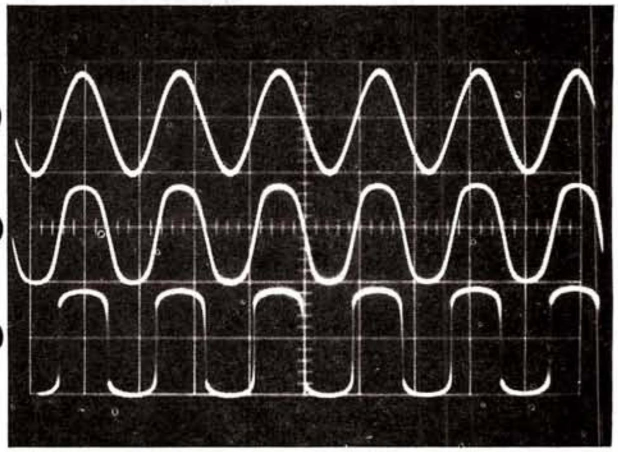


Fig. 3: Traces (a), (b) and (c) show the ouput wave shape of the basic circuit for inputs 0dB, 6dB and 20dB above the diode conduction point

(a)
(b)
(c)
(d)
(e)
(f)

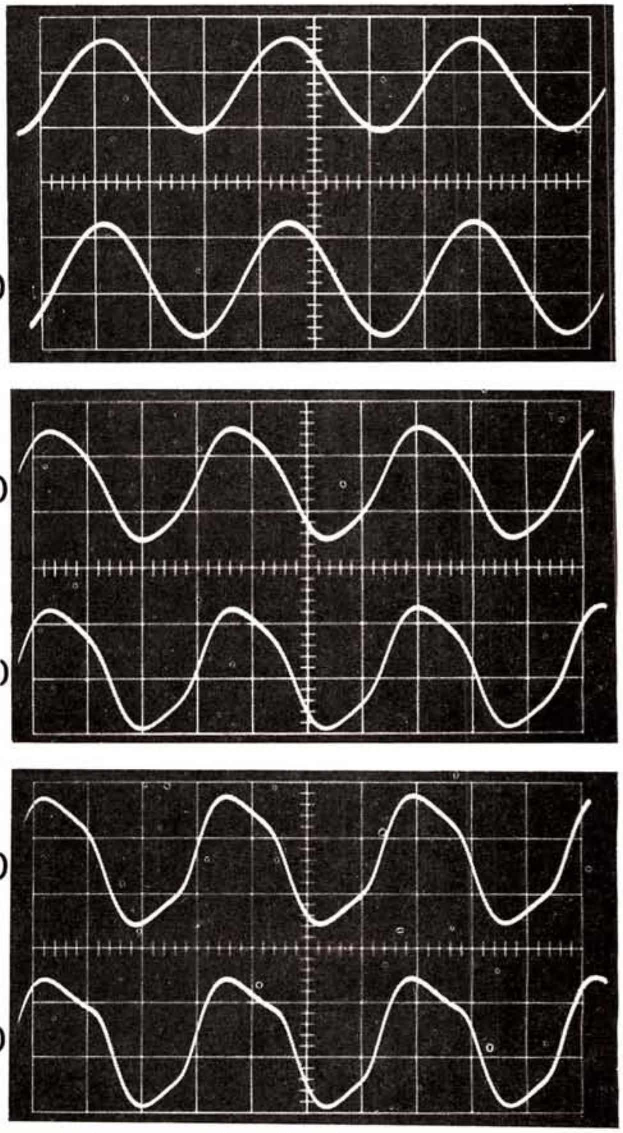


Fig. 4: The traces show the processor output for increasing input signal voltage. (a) and (b) are the outputs below and at the limiting threshold, (c)–(f) are those for inputs 6dB, 12dB, 18dB and 24dB above it

processing if connected as shown—from the threshold of limiting to the maximum practical level. If an l.e.d. is substituted for the meter, the range of indication is naturally not so sensitive.

From the limiter stage the signal is fed to the high frequency filter which consists of R17/R18/R19 and C12/C13/C14. Transistor Tr6 is "bootstrapped" to provide a high impedance input for the filter and to obtain a better slope; the component values have been selected to avoid "ringing". The combined response of both filters is shown in Fig. 7—the output is taken from the emitter circuit of Tr6 via the output level control, VR2.

Power Supply

The author used an internally mounted 9V PP3 battery, but it is suggested that, if possible, the supply voltage should be obtained from within the transmitter itself. A supply of 8–15V should be quite satisfactory but it should be well decoupled and a Zener diode (D2) used as a precaution against hum, etc. A suitable method of doing this is shown in the circuit diagram.

Setting Up

After connecting a microphone to the input of the processor and a transmitter to its output, the following method of setting up is suggested. Having switched the device out of circuit (S1), adjust the transmitter for the normal modulation level and then turn VR1 and VR2 to minimum. Switch the processor into circuit and, talking normally into the microphone, adjust VR1 until the l.e.d. or meter starts to indicate; the l.e.d. should flash only on speech peaks or, if you wired in a meter, its pointer should deflect to approximately two-thirds f.s.d.

Now adjust VR2 so that the transmitter is modulated to a suitable level—this will normally result in a higher reading than without the processor in circuit. Taking the FT200 as an example, normal modulation caused the meter to read 180mA; with the processor in circuit the p.a. meter hovered around the 400mA mark. Some trial and error may be needed in optimising the settings for a particular rig, but normally only VR2 will require adjustment.

A more precise method of setting up is to use an oscilloscope, if one is available. Connect the output of the

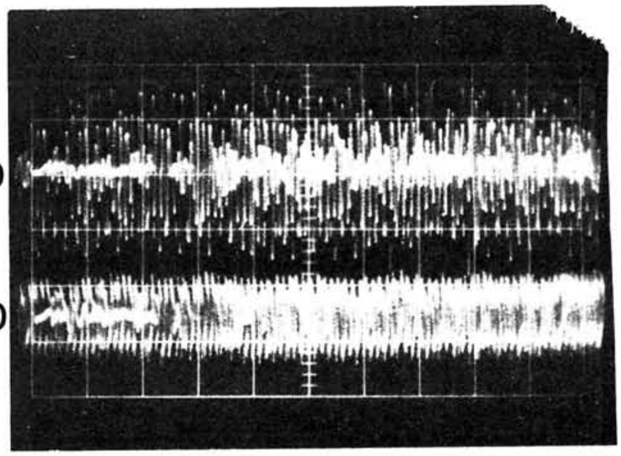
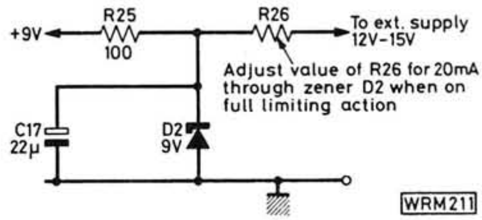


Fig. 5: The word "Hello" before and after processing

processor to the input of the 'scope and the microphone to the input of the processor. Now, with the processor switched out of circuit, speak into the microphone adjusting the sensitivity of the oscilloscope until the voice *peaks* can be seen. Note the level of these peaks for these represent the 100% modulation point in normal use with that particular microphone. Switch the device into circuit, turn the limiter control to maximum and then adjust the output control until the output is the same *peak* level as given by the microphone. Now reduce the limiter control until the meter is deflecting to about two-thirds f.s.d. The processor is now correctly set up for the microphone and transmitter in use (providing that these were being correctly used in the first place!).

Some readers may feel concerned about the effect of the extra audio on the p.a. dissipation of the transmitter. Tests carried out by the author on the p.a. of the FT200, using a temperature probe, showed no measureable increase in temperature *provided that the p.a. was kept correctly tuned.* In other words, be sure to re-tune after a change of transmitting frequency—after all, we do want as much of the power as possible to go into the aerial!



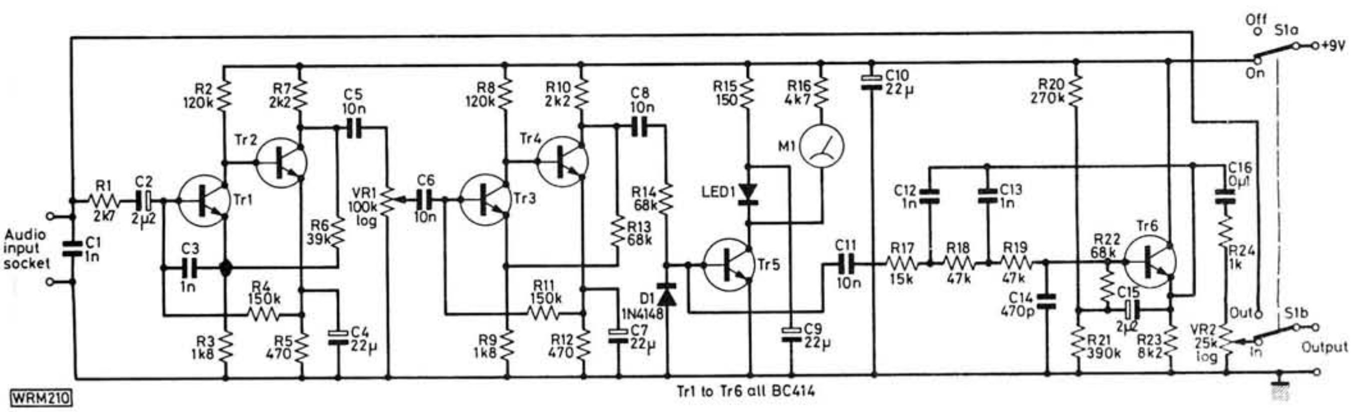


Fig. 6: Circuit diagram. Components R16, M1 and LED1 are not p.c.b. mounted

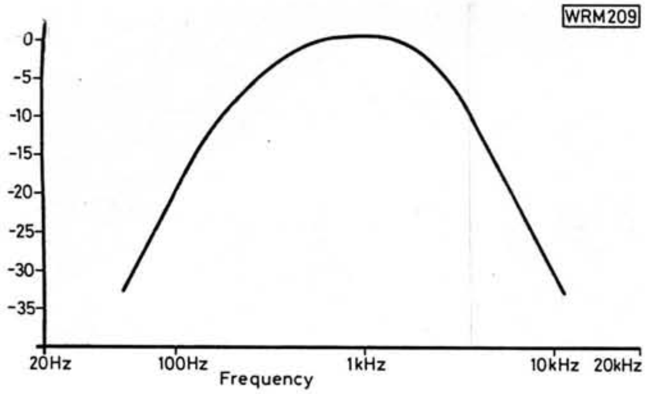


Fig. 7: Overall frequency response

Construction

The construction method will depend on the personal choice of the individual, naturally, and also to a certain extent on matching the style to that of his existing equipment. The final wiring layout is not critical as long as the p.c.b. is as shown in Fig. 9. An enclosed metal box *must* be used in order to prevent r.f. from getting into the processor wiring.

The author has made two versions of the device, one in a diecast box with pre-set controls (as it is always used with the same transmitter, no further adjustment was needed after the *initial* setting-up) and the other built into an RS Components metal box (Type 509–715—135 × 80 × 55mm). The drilling details are shown in Fig. 8. The dimensions of the meter cut-out will, of course, depend on the type used; therefore, none have been specified. The same applies to the audio input socket; this will depend on the type of microphone used.

The output leads are brought through a grommet at the rear and are terminated in a plug that is compatible with the constructor's transmitter. The dimensions that are given suit the listed components—if other types or larger components are used then it is suggested that a larger box would house the device more comfortably (for example, RS Type 509–967—179 × 97 × 74mm).

The p.c.b. is mounted on 6BA screws with a nut acting as a spacer between the p.c.b. and box. These screws are earthing points for the board and it is therefore important to obtain a good contact—using a lockwasher will assist here. The remainder of the wiring is straightforward and only the lead between the input and S1 needs to be screened.

All components are mounted on the p.c.b. except for C1 and R16. The value of R16 may need to be varied, in fact, to suit the particular type of meter used. Choose its value so that f.s.d. is indicated at the point where

[continued on page 54 ▶▶▶

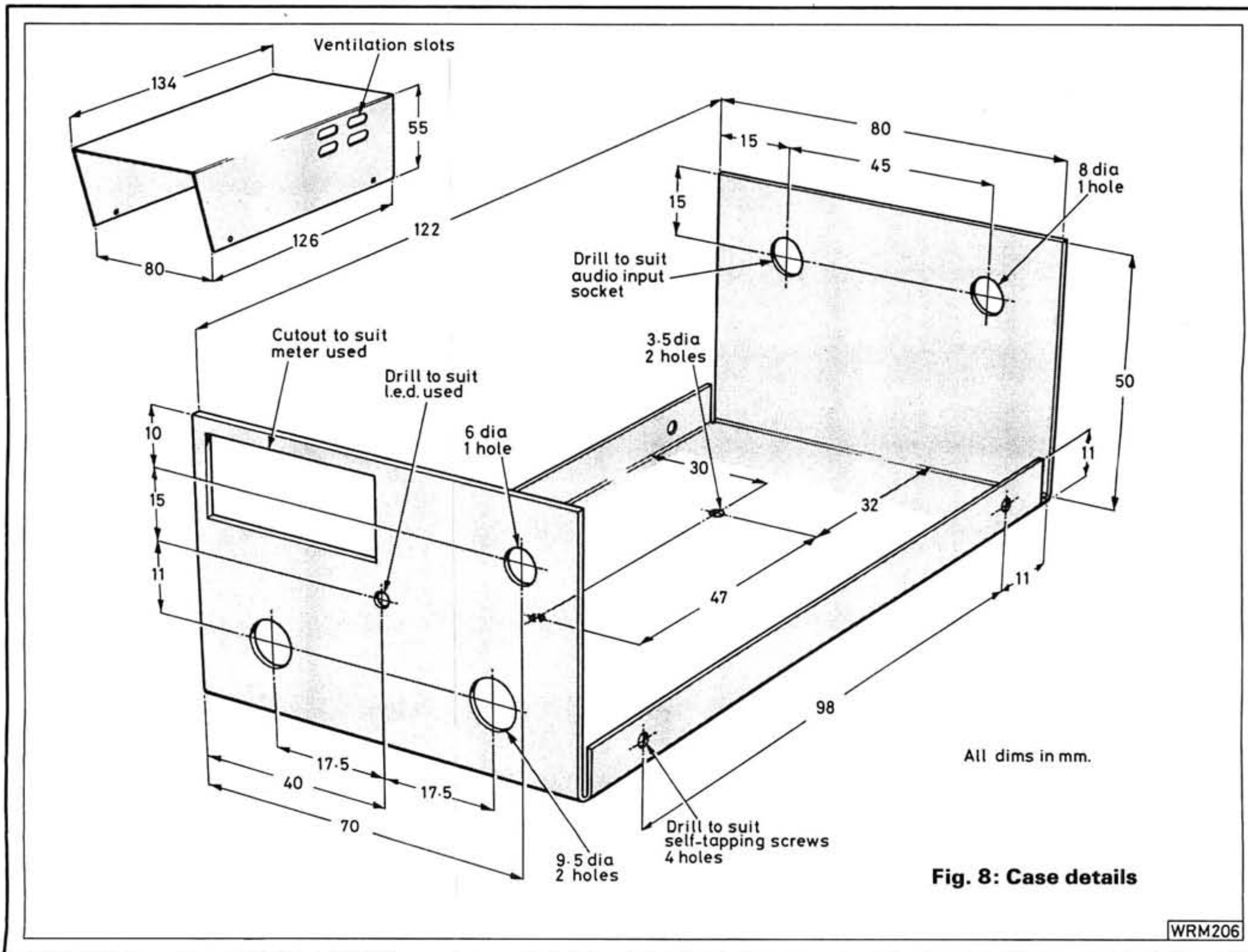


Fig. 8: Case details

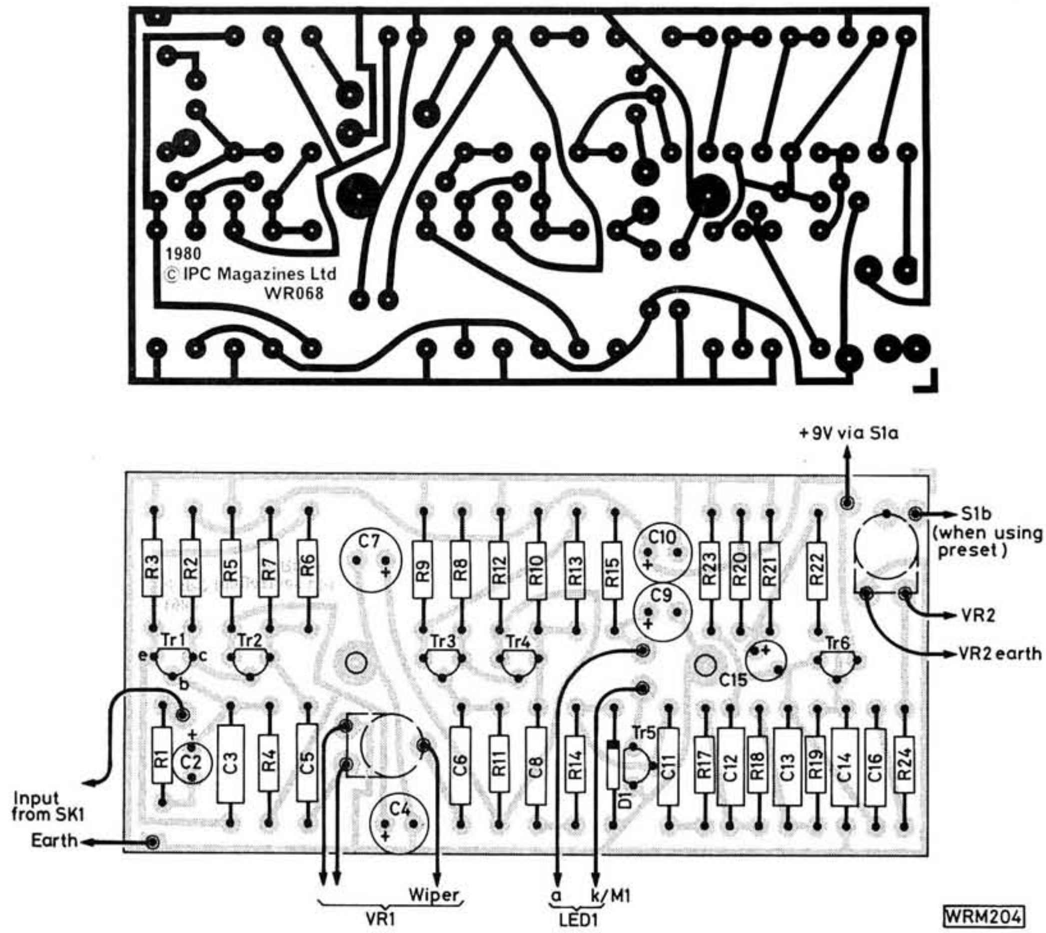


Fig. 9: Copper pattern and component layout shown full size

★ components

Resistors
¼W 5%

100Ω	1	R25
150Ω	1	R15
470Ω	2	R5,12
1kΩ	1	R24
1·8kΩ	2	R3,9
2·2kΩ	2	R7,10
2·7kΩ	1	R1
4·7kΩ	1	R16
8·2kΩ	1	R23
15kΩ	1	R17
39kΩ	1	R6
47kΩ	2	R18,19
68kΩ	3	R13,14,22
120kΩ	2	R2,8
150kΩ	2	R4,11
270kΩ	1	R20
390kΩ	1	R21

Potentiometers

25kΩ	1	VR2 (log) (use miniature horizontal-mounting type if to be p.c.b. mounted)
100kΩ	1	VR1 (log)

Miscellaneous
100μA f.s.d. meter (1); d.p.d.t. toggle swich (1); suitable metal box (1); coaxial sockets (2); battery lead (if used); printed circuit board (1).

Capacitors
Polystyrene

470pF	1	C14
1nF	4	C1,3,12,13

Polyester

10nF	4	C5,6,8,11
0·1μF	1	C16

Electrolytic 63V

2·2μF	2	C2,15
22μF	5	C4,7,9,10,17

Semiconductors
Light-emitting diodes

TIL209	1	LED1

Diodes

BZY88C9V1	1	D2
1N4148	1	D1

Transistors

BC414	6	Tr1–6 BC109 may also be used

maximum limiting is achieved (where there is no increase in meter reading for an increase in applied signal). Capacitor C1 is mounted directly across the audio input socket and the l.e.d. is a push-fit in the front panel.

In Use

Once the correct settings have been arrived at, do not make continual adjustments in an effort to improve things. Reports will vary and will, as ever, depend very much on the type of receiver in use, operator experience, etc.

Do *not* turn the limiter gain control up too high—if the meter or l.e.d. is indicating as described under "Setting Up", the talk-power will be impressively increased.

With some microphones, it may be found that the output may be too low to drive the processor into limiting—if this is so, changing R6 from 39kΩ to 68kΩ will double the gain of the processor pre-amp. stage. If this is still insufficient, a low-noise pre-amp. should be inserted between the microphone and processor input.

Although designed for s.s.b. transmission, the processor will work just as effectively with a.m. and f.m. The author has found that improvements of 2 or 3 "S" points can be anticipated in reports. When the prototype was first tried, a large number of stations were surprised that a processor was in use—evidently they had thought that a linear, at the very least, was being used! ●

KINDLY NOTE!

Burglar Alarms, Sept.–Oct. 1979

In describing how the home-constructor might go about installing a security system capable of satisfying British Standard Institute specifications, we erroneously referred to "BS3545". The relevant BS dealing with intruder alarms is BS4737.

SPECIAL PRODUCT REPORT
Radat 2301 Function Generator

▶▶▶*continued from page 31*

switch in the variable duty cycle control and also select the output attenuator setting. This has 20 and 40dB stages and the two buttons pressed in together provide 60dB of attenuation.

Output amplitude is continuously variable with the amplitude control which also incorporates the power on-off switch.

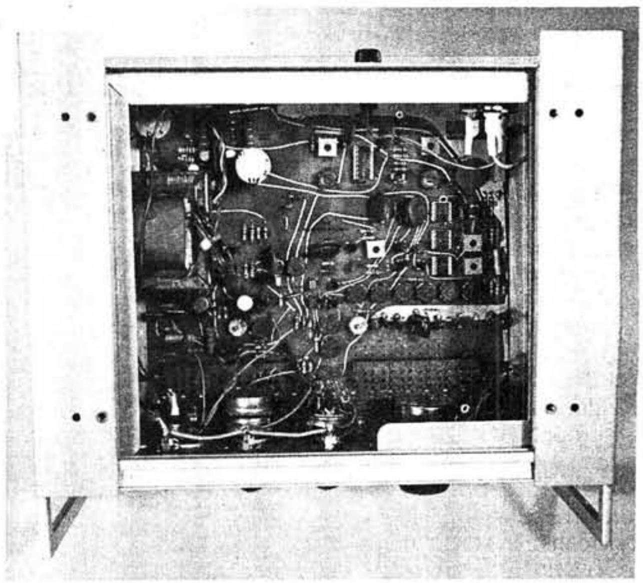
A third BNC socket allows an external voltage to be applied to control the frequency of the f.g.

Construction

The construction of the instrument was of a high standard, the metal case having a removable bottom panel which allowed easy access to the one printed circuit board carrying most of the components.

Results

Without very accurate test equipment it was not possible to check the performance against the manufacturers specifications, but using a Scopex 4D10A oscilloscope to monitor the output waveforms it would appear that the function generator does what the makers claim, although it needed setting up internally to give repeatable mark-space ratios.



The TTL output varied with the waveform selected and the setting of the d.c. offset control although, of course, the TTL output should not have been affected. The frequency scale was not accurately calibrated between 0·3 and 5 making it virtually unusable. However these faults could probably have been adjusted out. Full instructions are given to enable maintenance and alignment to be carried out and the handbook provides a full components list, p.c.b. layout and specifications.

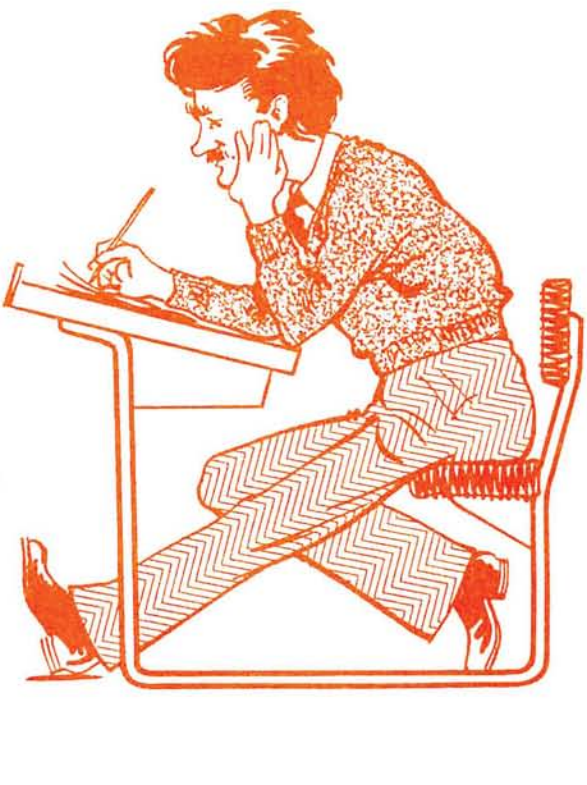
Price

The 2301 function generator. £159.85 inc. VAT.

The 2301 function generator was supplied by Kramer & Co., 9 October Place, Holders Hill Road, London NW14 1EJ. Tel: 01-203 2473.

Assessing the new RAE

by *Arthur HARADA M.Ed, Dip.SP.Ed, ACP, G4INX



Undoubtedly, the results of the latest RAE have caused pleasure to many and disappointed others, be they candidates or qualified radio amateurs. The latter are mentioned as there still exist amongst them certain misgivings and misunderstandings about the present RAE. The twofold purpose of this article, then, is first to reiterate in part the rationale behind the present exam being based on answering multiple choice items. Secondly, to provide some suggestions as to how the RAE may be diversified in order to encompass and encourage, amongst other things, the needs of the candidate with practical ability in amateur radio construction, in contrast to one who knows the theory but is useless with a soldering iron.

Multiple Choice

The main arguments for the use of multiple choice items are applicable to all examinations using this type of evaluation. First, such questions are objective as each question and its alternative answers are so structured as to free the result from interference by the examiner. Secondly, many more questions can be posed in the time allowed, resulting in a more even sampling of the syllabus and thus improving the reliability of the scores. Finally by avoiding the need for candidates to write out their answers, more opportunity is given for less hasty thinking as well as the avoidance of over-elaborated, tangential and lengthy answers to questions not asked. Since reliable and valid objective tests necessitate a great deal of skill and time in their construction, the City and Guilds of London Institute are endeavouring to build up an item bank—questions of known difficulty for a specific span of ability. This explains the non-availability of the last RAE's contents. Into this bank the Institute might wish to consider in future accepting questions (and their answers!) from candidates and licensed radio amateurs, thus fostering stronger bonds of personal participation in the hobby.

It is very deceptive thinking on the part of candidates or anybody else to think that guesswork will gain at least a pass in both sections, the choices accompanying each question tend to differ marginally. In fact the pass rate for the RAE May 1979 was 63·5% (1771 successful candidates) compared with 63% for the December 1978 exam and 65·3% for the one held in May 1978, the last two requiring written answers. To conclude whether the new RAE format significantly improves or reduces a candidates chances of passing is too premature. Furthermore, it would be a highly questionable exercise to try to draw sound comparisons between the past and present systems using the pass rate as a criterion. This is because one must recognise also the very real possibilities that future candidates will be better prepared—the growth in RAE classes, the increasing number of readily available and relevant publications in electronics, and the incorporation of that subject into many schools' curriculum being just some of the contributory causes.

Practical

The failure rate in each section of the RAE May 1979 was 27·7% in Part 1 and 40·9% in Part 2, rates which were in keeping with the general trend of past RAE's, and a feature that brings me to my final point, namely, the RAE's excessive theoretical bias. Perhaps what is needed to strike a balance is the addition of a practical section. For example, the candidate under examination conditions may be asked to tune up an h.f. transceiver and then conduct a series of suitable but differing mock QSOs, or be required to construct a simple device using his/her own components but following a circuit supplied by the examiners. Instead of having to solder (sic) on without help, candidates would have more incentive to join amateur radio clubs where they could receive guidance and tuition plus the opportunity of being examined in the RAE's practical part by practising amateurs. As at present special arrangements would have to be made for disabled candidates. There is also the possible problem of subjectivity by an examiner which could be avoided by a committee of examiners at local level. By using this new form of assessment pirating and obscene QSOs may be eradicated or reduced, the spirit of home-brewing equipment will be maintained if not improved, and candidates will feel that more of the spectrum of their hobby has been appreciated.

The author acknowledges the assistance of Susan Conacher, RAE section, City and Guilds of London Institute, in providing the statistical information. ●

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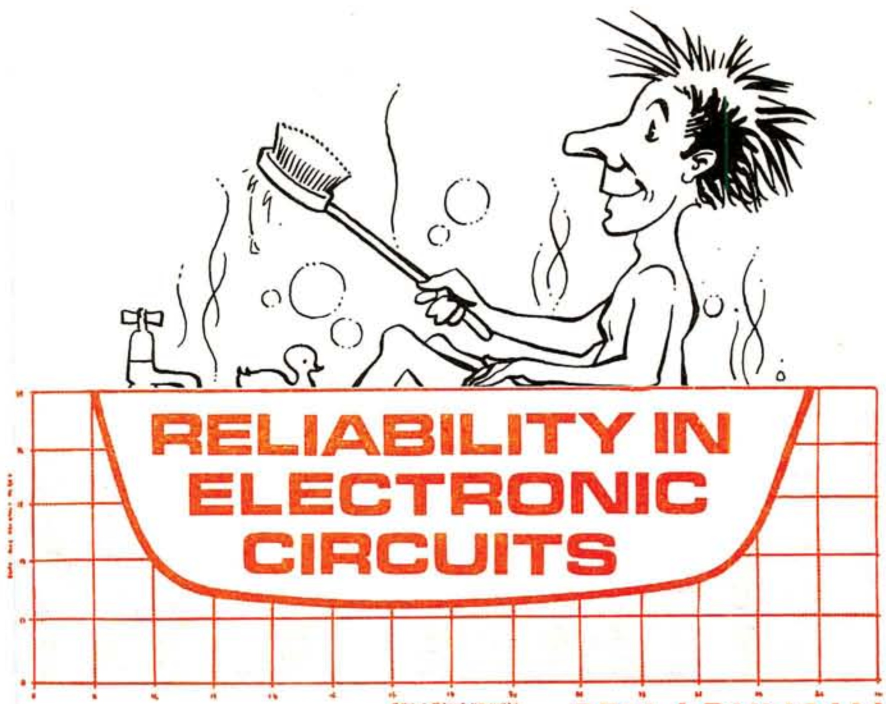


RELIABILITY IN ELECTRONIC CIRCUITS

BEN J. DUNCAN

Entropy, symbolised by the Scorpion throughout history, is the universe's tendency to destruction, dissipation, death and decay. Because of this immutable principle, 100 per cent reliability for any length of time is a myth. Fortunately, great reliability is rarely required for more than a few years, with the exception of massive capital investments in military, aviation and telecommunications systems. Even these have to be serviced! A knowledge of the required lifespan of the equipment is helpful, so that effort is not wasted in attaining an unwanted lifespan. Reliable equipment need not be expensive provided the designer has the skill to make a circuit no more reliable than it needs to be.

Contrary to popular opinion, well designed electronic equipment is inherently very reliable. Most failures in well designed equipment are due to mechanical components, or in areas of high electrical stress. Much of the skill in equipment design lies in identifying such areas, and choosing appropriate components.

The General Pattern of Reliability

The bathtub curve in Fig. 1 depicts the general pattern of component failure. In the infant mortality phase, weak and faulty components are weeded out. This phase usually lasts for 100 to 300 hours. High reliability equipment is often soak tested for this period in order to weed out faults before the equipment passes into service. Thereafter, component failures are infrequent and occur at a constant rate. The wear out phase may begin after 500 hours in the case of a highly stressed component (a) or it may occur after some 100 000 hours (b) in small signal circuitry. Component failures then become increasingly frequent. It is important to appreciate that this graph does not imply nor preclude the failure of any given component *at any time whatsoever*. It merely represents a general pattern.

If we are producing millions of identical items, say, television receivers, then we can make use of statistical information on component failure rates to calculate the typical reliability of any given sample. This is usually expressed as a confidence figure, for example: we can be 37 per cent certain that the receiver will operate for 5000 hours or 90 per cent certain that it will operate for 500 hours. These figures are meaningless when equipment is constructed in small quantities. In this case, all one can do is to identify the areas and types of stress in a circuit and rate or protect components appropriately; attention will now be turned to component stresses.

Component Stresses

Temperature has a great effect on the lifespan of components. The rate of chemical reactions is doubled for a 10°C rise in temperature. This fundamental thermodynamic law affects particularly the diffusion of impurities in components, especially semiconductors. Although most silicon power transistors, for instance, will happily operate at 100°C, the rate of deleterious chemical reactions will be some 256 times greater than at 20°C. Moreover, leakage current increases by the same order of magnitude. *Small changes in temperature significantly affect component lifespan.* A good rule of the thumb for longevity is to maintain temperatures as close to 20°C as possible.

Extremes of temperature, whether high or low, can result in differential contraction or expansion of encapsulation materials, quite apart from chips and internal connections. For instance, glass-metal seals on metal-can transistors can split at low temperatures, allowing the ingress of moisture and contaminants.

Another aspect of temperature, of particular interest to designers of power semiconductor circuits, is thermal cycling. As a power transistor heats up, the internal connections expand. After use, they cool down and contract. After, say, 5000 cycles of heating and cooling, metal fatigue occurs internally. Localised hot spots then occur, and eventual failure may be due to thermal runaway or lead fracture. Specially constructed and

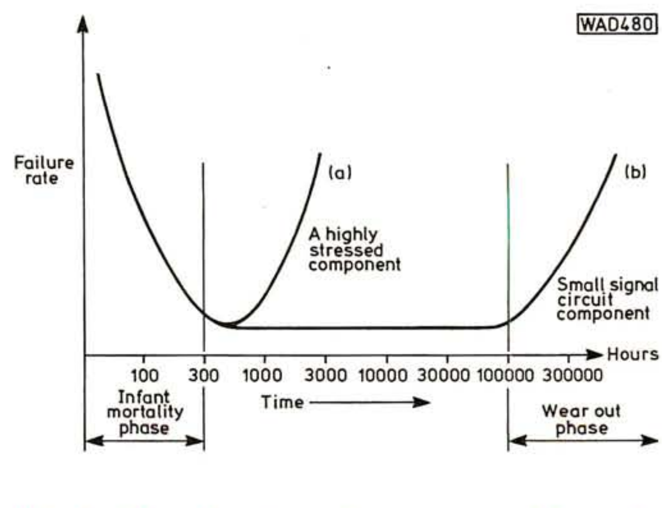


Fig. 1: General pattern of component failure, the familiar "bathtub" curve

selected transistors are available which can withstand extremes of thermal cycling, in high power relay drivers for example. Careful selection of standard devices and good heatsinking is an alternative solution. If the change in temperature (Δt) is reduced by 20°C, from 80°C to 60°C, the endurance of a 2N3055 transistor is increased eight times to 650 000 cycles. Conversely, for Δt = 125°C, endurance is only 15 000 cycles. (These figures refer to 10 watts dissipation—at higher powers, endurance is lessened).

Thermal cycling stress also affects passive components, but to a lesser degree. It is obviously of most significance in equipment that starts off in low ambient temperatures and runs at high temperatures. Cycling stress can be minimised by resisting the desire to turn equipment off (and hence let it cool down) when it is to be used again shortly.

Finally, passive components, particularly resistors, must be derated at high ambient temperatures, in order to compensate for self-generated heat.

Other Physical Stresses

Other physical stresses are of relatively minor importance when compared to temperature induced stresses. They can be avoided to an extent by careful component selection and enclosure design. The stresses referred to are typically vibration, humidity and sunlight. Vibration and shock, unless extremely severe, will usually only be of concern in circuits utilising relays, thermionic valves, transducers and filament lamps. However, large wire-ended components mounted on tags are prone to metal fatigue and contact loosening when subjected to vibration. Close-mounted components on printed circuit boards are relatively free from problems of this nature.

If high humidity is anticipated, metal-cased transistors are preferred to plastic encapsulations. In mildly corrosive atmospheres, silver-plated or tinned pressure contacts (on connectors, switches and relays) are prone to degradation; gold-plated contacts and wiping switch contacts are to be preferred in these circumstances. Other contact materials are available for extreme environments. Note that the copper to aluminium leadout connections on electrolytic capacitors are prone to oxidisation and decay. Silicone grease is a good barrier against moisture and corrosive vapours.

Equipment that is exposed to strong sunlight is prone to degradation of plastics components; the sun is a very potent source of ultraviolet radiation, which catalyses chemical reactions which would normally occur only over a very long length of time.

Electrical Stresses

The electrical ratings of components are naturally well documented and data is readily available. However, awareness of transient electrical stresses is not common. Because electronic components can be destroyed or damaged in extremely short periods—typically a few milliseconds—a knowledge of transient overcurrents and overvoltages is essential if the components in many circuits are to be adequately rated.

Current surges are caused by motors, incandescent lamps and capacitive loads. Inductors, logic circuits, incandescent lamps, fuses, contactors, relays (and other high-speed switches), transformers and rectifiers are capable of generating voltage transients of a high magnitude.

Secondary breakdown is an aspect of power transistor selection that can pass unnoticed. It is a localised form of thermal runaway, and for a given voltage, may well limit the useful power handling capabilities to a figure well below that implied by the "P_{tot}" value given in short-form data sheets. The secondary breakdown characteristics of transistors are shown in an "SOA" graph. (Safe Operating Area.) In audio applications, the d.c. curve must be used. Fig. 2 shows the SOA characteristics of a common power transistor.

Voltage derating can provide useful increases in component lifespan, particularly with regard to incandescent lamps and capacitors. For instance, if a lamp is operated at a voltage 10 per cent below its nominal rating, its lifespan will be typically five times as great. The lifespan of lamps can also be extended by limiting the surge current that occurs at switch on; hence the use of a thermistor in projection lamp control gear.

Table 1
Temperature range of common components

Component	*Rated temp. °C	Ambient temp. range Min. °C	Max. °C
Resistor, carbon film	70	−40	+125
Resistor, oxide	70	−55	+150
Resistor, wirewound	70	—	+310
Bridge rectifier, 25A	25	−55	+150
Op. amp., LM741C	—	0	+70
Op. amp., LM741A	—	−55	+125
Switch, push-button	—	−30	+55
Mains transformer	45	—	—
Wire, 1·5mm², pvc ins.	25	—	—
Capacitor, polycarbonate	—	−55	+100
Edge connector, 0·1in	—	−55	+110
Box, ABS plastics	—	−20	+85
Light emitting diode	25	—	—

*Temperature when the component is run at maximum rating.

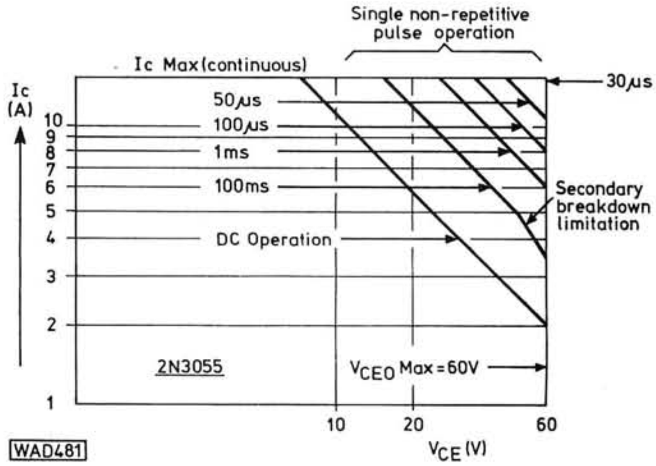


Fig. 2: A power transistor Safe Operating Area (SOA) graph

Miscellaneous Considerations

Mechanical stresses on component encapsulations are infrequently considered. Compromise is required when power semiconductors are mounted. For this reason, metal clips are the most reliable way of mounting plastic power transistors; the mounting pressure is sufficient to maintain low thermal resistance yet at the same time excessive pressure, which may crack the case, is avoided. Stud-mounted thyristors and rectifiers can suffer internal deformation if the stud nut is tightened excessively. On the other hand, it must be sufficiently tight for good heat transfer and moreover, must remain tight for reliability. Fortunately, the optimum torque can be found in data sheets. As a rule of the thumb, the tightness attained by using a pair of pliers is usually sufficient for 28UNF studs. It is not unknown for plastic power devices to be torn from their header by careless mounting; alternatively, a small crack may appear, rendering the chip vulnerable to contaminants. *All electronic components are inherently fragile,* particularly until they are safely mounted.

Even if a piece of recently completed equipment is already working, inspection for physical defects is strongly advised. Residual solder waste and wire slivers may float around and cause problems, such as short-circuits, at a later date. Accumulations of flux should be cleared from high voltage or high impedance circuit boards; methylated spirits is the usual solvent. Nuts should be inspected for tightness and shakeproof washers used, particularly if the equipment is to be carried around regularly.

Finally, the equipment should be soak tested, preferably under full load or at full power, and if possible, under the design environmental limits. At this point, internal temperatures should be monitored and "hot spots" and other anomalies should be investigated. Heat sensitive recording labels are an expedient way of performing these investigations. As the ambient temperature inside a well-ventilated case may take two hours to reach equilibrium, immediate measurements are of little value.

Practical Circuit Considerations

The high current power supply shown in Fig. 3 is typical of circuits intended for high power audio amplifiers. Electrical aspects are considered first:

1. Transformer T1 causes an inrush current, typically an order of magnitude greater than the nominal supply current, when it is initially energised. Consequently S1 must be rated at some 10 to 15 amps for longevity.

2. The fuse FS1 must be able to withstand the inrush current, yet must blow swiftly if the output terminals are short-circuited. If a "quick-blow" fuse is used, it will have to be rated at such a high current to meet the first criterion that it is likely to take several minutes to blow in the case of a short-circuited output—if at all! An antisurge fuse must be used. Because fuse tolerances are wide and the magnitude of the inrush current cannot be accurately determined, the lowest rating which will not blow on account of inrush current is usually found by trial and error. A suitable rating is 1A, and whilst slightly lower ratings will give better protection, there is the risk of "nuisance blowing".

3. Mains supplies can be rife with transient voltages; their magnitude and likelihood cannot, unfortunately, be predicted. C1 and voltage-dependent resistor VDR1 are added to protect the bridge rectifier and power amplifier semiconductors.

4. Although the mean supply current is nominally 2 amps, the bridge rectifier is rated at 12·5A. Such a rectifier will have an adequate I_{FSM} (maximum forward surge current) rating when C2 and C3 are initially charged. Furthermore, a short-circuited amplifier output is capable of drawing a large current from the supply before protection circuitry has time to operate. A generously rated bridge has a better chance of survival under these circumstances.

5. The rectifier's peak reverse voltage rating (V_{RRM}) is 200V. This gives additional protection against transients, including those generated by the transformer at switch-on, should C1 fail. In general, the rectifier V_{RRM} rating should be at least 50 per cent greater than the input voltage. This allows for supply voltage variations, harmonic content and transformer regulation; when the supply is unloaded, the output voltage may be 5–15 per cent higher than normal. Likewise, C2 and C3 are given generous voltage ratings.

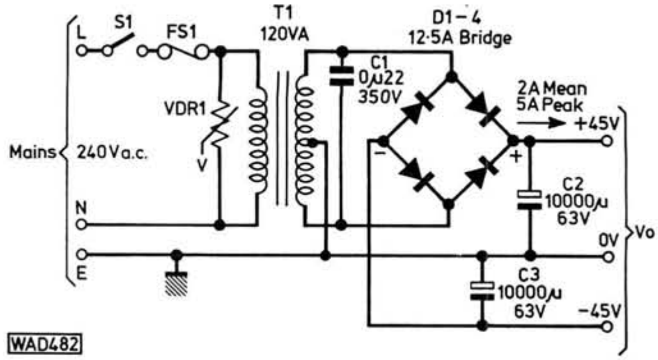


Fig. 3: Circuit of a typical high-current power supply, such as might be used in an audio amplifier

Physical Aspects

1. Transformer T1 will run at some 50°C, or higher if ventilation is poor and the amplifier is driven hard. The

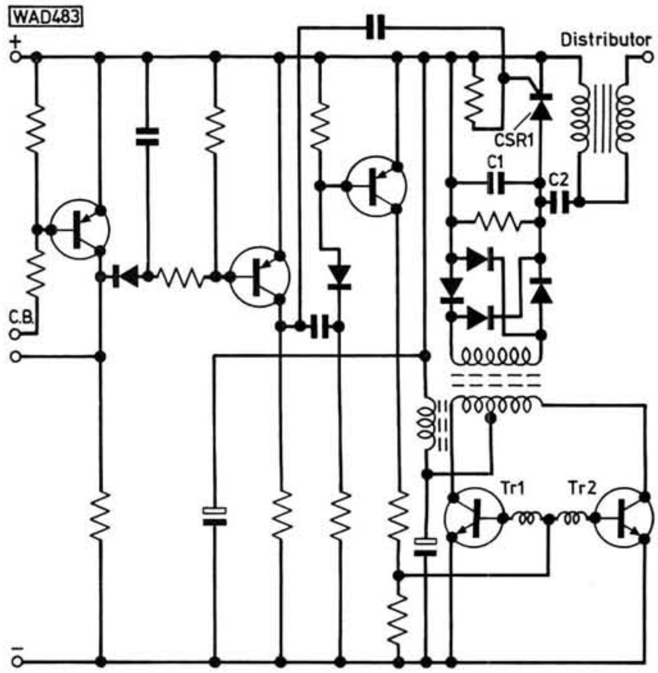


Fig. 4: Circuit of an electronic ignition system, with critical components identified

transformer is the main source of heat and its siting with regard to ventilation should reflect this. If it is necessary to mount C2 and C3 close to the transformer, a heat-shield may be constructed of bright aluminium or stainless steel. C1 will usually be wired across the transformer; therefore it should be chosen to withstand high temperatures.

2. The tags on C2 and C3 are prone to failure through mechanical stress. This is largely avoided by careful routing of the wiring.

3. Switch and fuse contacts are prone to tarnishing and oxidisation. Fortunately, a small amount of contact resistance is rarely a problem here. Wiping contacts can be used in difficult circumstances.

The circuit of Fig. 4 is a typical electronic ignition system. Electrical rating considerations are not pursued in detail because they are relatively specialised, although strobes, invertors and flashguns are close relatives. The key considerations are:

1. Tr1 and Tr2 should be chosen for good thermal cycling characteristics.

2. C1 and C2 are highly stressed by the fast high voltage pulses (2kHz, 400V) from the invertor. Voltage derating is usually necessary at the aforementioned frequency if mixed dielectric types are used. A polypropylene capacitor is unlikely to require derating at 2kHz and is eminently suited to this application.

3. The thyristor, CSR1, must be protected from transient voltage spikes of around 1kV to which it can be subjected if the secondary is unloaded, i.e., a spark plug is removed.

Table 2
Component selection for reliability

Component	Failure rate	Notes
Resistors:		
Carbon film, high stability	Low	—
Metal oxide and metal glaze	Very low	
Capacitors:		
Polycarbonate	Very low	Self healing, low loss
Polystyrene	Very low	Unsuitable for high temperatures
Metallised polyester	Very low	Self healing. For arduous conditions, e.g., mains supply
Polypropylene	Very low	Withstands high voltage pulses
Electrolytic	High	Ripple current and ambient temperature critical. "Computer" types are more reliable
Connectors and switches	Low	Identify surge currents. Use appropriately plated contacts
Indicators:		
Light emitting diodes	Very low	Good vibration immunity. Use minimum current
Incandescent filament	High	For high temperature applications
Relays, d.i.l.	Low	Excellent environmental protection
Potentiometers, Cermet preset	Low	Excellent environmental protection. Suitable for high temperatures
Integrated circuits, ceramic case	Very low	Excellent environmental protection
Alarm annunciators:		
Solid state	Very low	Good vibration resistance
Electromechanical	Low	For extremes of temperature, e.g., outdoor use
Transistor, power	High to medium	Take account of effect of high temperature on parameters, also thermal cycling and secondary breakdown characteristics

Environmental conditions can be extremely taxing in an application of this nature. Night-time winter temperatures may be lower than −15°C. When a car that has been cruising at high speeds comes to a standstill, the engine compartment temperature may exceed 80°C. This is *ambient* temperature—power semiconductors will be considerably hotter. At low temperatures, the gain of semiconductors decreases. In perpetually cold temperatures, germanium devices are to be preferred, but cannot be used here because of the high temperature extreme. At −10°C, the gate sensitivity of the thyristor will be poor. More current can be readily applied, but this aggravates gate dissipation when the ambient temperature rises. At high temperatures, thyristor leakage current (I_{DROM}) may become troublesome, causing C2 to be discharged prematurely. C1 and C2 may require derating for the same reason. Finally, thyristor commutation capability is degraded at high temperatures.

Protecting the circuit from salt, oil, grease and moisture is relatively easy if a diecast box is used. Silicone grease gives added protection. However, Tr1 and Tr2 should ideally be mounted externally, to minimise temperature rise inside the box. In this case they are vulnerable to heat radiated from the engine, quite apart from the aforementioned contaminants. Mechanical damage is also a possibility. Plastics covers and diligent location will largely obviate these problems.

Conclusion

Reliability is most difficult to attain in harsh environments and power circuits. In many circuits, considerable experience or knowledge is required in order to seek out highly stressed components. Even then, further skill is needed in order to locate suitable components or to modify the circuit in order to remove or reduce the stress. Once this has been achieved however, there is great beauty in equipment that works—and goes on and on working—with minimal attention. Unlike large manufacturers of consumer goods, the home constructor can afford a few pennies in order to make his equipment reliable. In this sense, he wins! ●

BURGLAR ALARMS PART 3

The PW 'PARKHURST'

A MICROWAVE MOTION DETECTOR UNIT

P. J. WALES

In Parts 1 and 2 of our Burglar Alarms series, we described how the d.i.y. fanatic can instal a security system in his home to his own specifications and design. Mass-produced devices and home-assembled electronics are combined to provide a system as simple or as complicated as the constructor requires—either very basic or providing protection to British Standard BS 3545. We described how the security devices functioned, what type of intrusion they are designed to combat and how they, and the whole system, can be constructed so as to be "self-protecting", using a 24-hour live loop.

One device that we mentioned but did not describe in detail, however, was the "microwave motion detector". All the other devices incorporated in our security loop are "trap sensors" requiring the intruder to physically disturb some form of electro-mechanical gadget.

With the *PW* "Parkhurst", however, all he has to do is move and the alarm is sounded, even if there is a door or wall between him and the unit. Thus the level of protection that is provided is very high indeed if the detector is carefully sited and set up.

Basic Principle

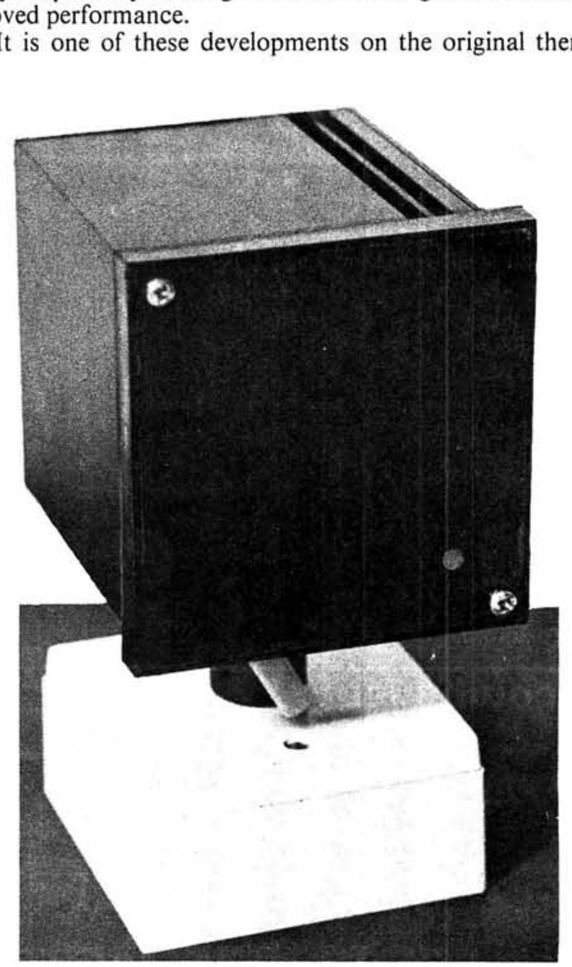
Microwave detection devices work by exploiting the phenomenon of "Doppler effect"—the small change in frequency arising from a difference in velocity between a source of wave radiation and a point of perception. The rising and falling note of a passing car-horn is the most obvious illustration—the received frequency is slightly different from the transmitted frequency.

In the case of a microwave motion detector, providing everything in the area under surveillance remains motionless, the frequencies received by the mixer diode stay exactly equal and it produces no output. If motion does occur, however, then the received signal, having been reflected from the moving object, undergoes a Doppler shift of approximately 30Hz/mph. The mixer diode thus produces a low frequency a.f. output with a level of a few microvolts which is processed and used to trigger the alarm.

Development

It was the introduction of the CL 8960 "twin cavity module for presence detection" by Mullard Limited which enormously simplified the manufacture of microwave detection devices. Mullard quickly dominated the UK market with the new device and other manufacturers could only respond by making variants claiming to have an improved performance.

It is one of these developments on the original theme



that forms the heart of the *PW* "Parkhurst"; the GDHM series manufactured by Plessey Microwave and Optoelectronics Limited. This type was evolved in order to capture a share of the European market—larger, but with much more stringent regulations limiting out-of-band harmonic radiation.

The early devices were mostly unable to satisfy these requirements. With the GDHM, however, by introducing cleverly-designed thin metal filters in and around the resonant cavity, the spurious content of the transmitter output was drastically reduced.

The microwave head itself consists of two special-purpose diodes, one acting as an oscillator and the other as a mixer, mounted in a tuned resonant cavity. Fixed to this is a detachable horn antenna which produces the required radiation characteristic. The current drain of the diodes used in the original versions was 150mA or so from a 7V supply; the diodes incorporated in the "Parkhurst" require only 50-60mA from an 8V supply and this has led to a significant improvement in performance compared with that achieved in the early days. If the current required is low, then producing a low-noise power source is made much easier.

The nominal frequency used for these devices is 10·6879GHz and is set by the supply voltage and the resonant frequency of the cavity within which the diode is located. In the case of the GDHM, the frequency varies at a rate of 1MHz/volt and thus a variation of one microvolt in the supply voltage will produce a frequency shift of 1Hz. The need, therefore, is for a really well regulated supply and that used in the "Parkhurst" has been devised especially for the GDHM and *cannot be used with other types of microwave head.*

The author has designed a horn antenna which is particularly suitable for this application and, for the "Parkhurst", Plessey Ltd. have made available one of their antennae with very similar characteristics.

With a gain of 7dB, it enables the "Parkhurst" to produce a detection volume which is capable of picking up movement a staggering 175ft away! However, in the interests of very high reliability the gain of the amplifier which is fed by the output from the mixer diode is reduced so that the range is deliberately limited to 75ft. This should, of course, be quite adequate for all but the most stately of homes!

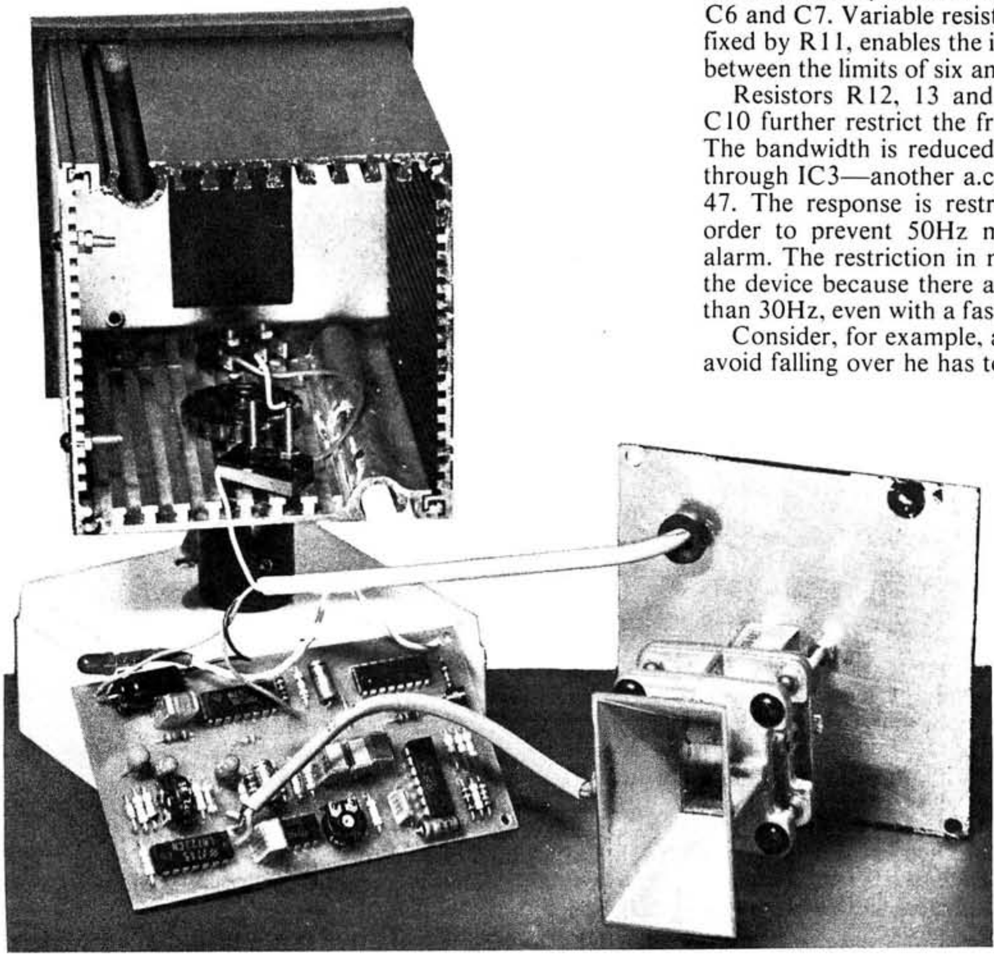
Circuit

The circuit diagram is shown in Fig. 1. Integrated circuit IC1 is an LM723 voltage regulator which has a very low output noise level. With decoupling provided by C3, and the 10μF capacitor which is supplied ready-wired to the GDHM, the noise level applied to the Gunn diode via the supply rail is around 0·1μV. Diode D1 and R1 provide +6V for the op. amplifiers and their c.m.r.r. (common-mode rejection ratio) effectively nullifies any noise voltages on the supply line.

The f.e.t. input amplifier IC2 has characteristics similar to those of the ubiquitous 741 except that the LF356 takes a very low input current and possesses a very low input noise level. The amplifier is arranged in an a.c.-biased configuration and has a maximum gain of 270; its frequency response is shaped to be 0·1-100Hz (at the 6dB points) by C6 and C7. Variable resistor VR2, its minimum resistance fixed by R11, enables the installer to set the effective range between the limits of six and 75ft.

Resistors R12, 13 and 14 together with C8, C9 and C10 further restrict the frequency response to 0·5-50Hz. The bandwidth is reduced still more as the signal passes through IC3—another a.c.-biased amplifier with a gain of 47. The response is restricted to such narrow limits in order to prevent 50Hz mains hum from activating the alarm. The restriction in no way affects the sensitivity of the device because there are always Doppler shifts of less than 30Hz, even with a fast-moving target.

Consider, for example, a fast-running man—in order to avoid falling over he has to place each foot on the ground



The *PW* "Parkhurst"—a view showing the major components

in turn. Obviously, when the foot is on the ground it is stationary—therefore, when it is lifted in the act of taking the next pace it must cause Doppler shifts in the range 0-30Hz as it accelerates from rest to 1mph!

Resistors R18 and 19 provide a 1V hysteresis on the input of IC3b to remove the effects of any low level noise at the output of IC3a. The output of IC3b swings from one rail voltage to the other as motion is detected. Its output is fed into the digital filter via inverter IC6a and also drives the "Walk Test" l.e.d. via Tr1. This causes the LED1 to flash when motion is detected.

The "high-pass digital filter" is used to remove any false alarms caused by occasional transients (the fridge switching on perhaps). Any received signal causes D2 to conduct and remove the "reset" condition from pin 15 of the decade-counter IC4. If no further alarm signals are received before C13 can recharge, the counter is reset and any further alarm signals must restart the count from zero. When there is an actual intruder walking in front of the device the delay introduced by this part of the circuitry, it must be pointed out, is infinitesimal.

The remainder of IC6 (gates c-f) is connected as a latch which, when set, will reset itself after five seconds. Gates c-f would behave as a normal bistable latch; it is the addition of R24, C14 and D3 which cause it to self-reset after five seconds. The effect of the latch is to switch R2 to the 0V rail at all times when the unit is not detecting motion, and to the +12V rail when it is.

Resistor R2 is connected as Rx(loop) when the "Parkhurst" is connected into the security system described in Parts 1 and 2 of the series. Its value can be varied in the way described in Part 2.

WIRELESS TELEGRAPHY ACT 1949

Readers are advised that they will require a "Telapproach" licence before they can legally use this apparatus. The *PW* "Parkhurst" has been type-approved and application should be made to Licensing Branch, Radio Regulatory Dept., Home Office, Waterloo Bridge House, Waterloo Road, London SE1 8UA quoting *"PW Parkhurst"*. The licence costs £1.40 and is valid for five years.

Assembly

Whether you have purchased the "Parkhurst" as a complete kit or section by section when you get to the GDHM—LEAVE IT ALONE!! The diodes used are extremely sensitive to static and if you touch their ends with your fingers you have a 90% chance that the junctions will be destroyed. By the same token, the devices can *not* be tested by means of a multimeter switched to the ohms range either—that is an even quicker way of destroying them! The mixer diode is a Schottky device with no protection diodes and is therefore particularly prone to damage by static discharge—it you thought that CMOS i.c.'s were easily damaged in this way, this item will make them appear about as sensitive as valves by comparison!

Start by assembling the p.c.b.—this should be quite straightforward. Remember to take the usual precautions with the CMOS i.c.'s. Use a well-earthed soldering-iron, avoid touching the pins with your fingers and keep them in the conductive foam until required.

To test the board, first set the output of IC1 to exactly 8V by adjusting VR1 and then, with the mixer diode side of C5 shorted to the 0V rail check the d.c. voltage present at the outputs of IC2 and IC3a. This should be within 0·5V of 6V. Briefly removing and replacing this short-circuit should cause LED1 to glow dimly for a short period, and the voltage applied to R2 to go positive for about five seconds. This procedure checks that the alarm is being correctly triggered when 50Hz is fed through the amplifier—the fact that LED1 glows only dimly at this stage is nothing to worry about (it is, in fact, only being illuminated for 50% of the time).

Now, if you wish, you may connect the GDHM itself. Before starting, however, take extra care and time in taking the necessary precautions to avoid that dreaded static. In general terms, everything must be earthed—including you!

One good way of achieving this is to carry out the work on the draining surface of a stainless-steel sink unit; this is well earthed through the water supply system and placing the p.c.b., GDHM and tools on it will ensure that they are all at the same static potential. Rather than chain yourself to the same sink, it should be sufficient if you touch it with the palms of your hands occasionally during the operation of soldering the connections to the oscillator and mixer diodes. This should make sure that your skin has the same potential as the other items; take particular care to touch the earthing surface (i.e. the sink) after picking up or setting down tools. Which leaves only the soldering iron. Here the main hazard, as far as the diodes are concerned, is from leakage within the iron itself. Accordingly, before contact is made between the iron and the work, pull out the mains plug and use the residual heat to do the job.

Start by preparing a piece of twin-core screened cable of the correct length and then attaching one end of it to the p.c.b. as per the connections shown on the component layout. Now attach the screen to the body of the GDHM (see photo; no special precautions are needed for this) before pulling out the mains plug and quickly soldering the connection to the oscillator and mixer diodes. Check after completion that (a) the joints are sound and (b) that you have connected the wires the correct way round! The mixer diode is the one nearest the antenna with a 10kΩ resistor attached to it.

Now you are ready to begin testing. Before you apply 12V however, examine the mixer diode very carefully and you will see that there is a circlip just underneath the resistor which is designed to protect the devices against static discharge during transit (this does *not* mean that the precautions detailed above are any less necessary!)

After you have carefully removed this, switch on and wave your hand in front of the antenna—the l.e.d. should flash wildly, indicating that the device has detected the movement of your hand. Do not, at this stage, try range tests—the head has to be mounted in its case in order to prevent rearwards transmission before meaningful results can be obtained.

Case

The specified case is one supplied by West Hyde Developments Limited. Any case can be used, providing that it satisfies the requirements that it (a) should be of all-metal construction and (b) that a thin plastic cover for the microwave aperture is available. Strictly speaking, this should be manufactured from 0·5mm Cobex sheet—this is very rigid and is virtually transparent to microwave radiation.

The West Hyde case is offered with an option of metal

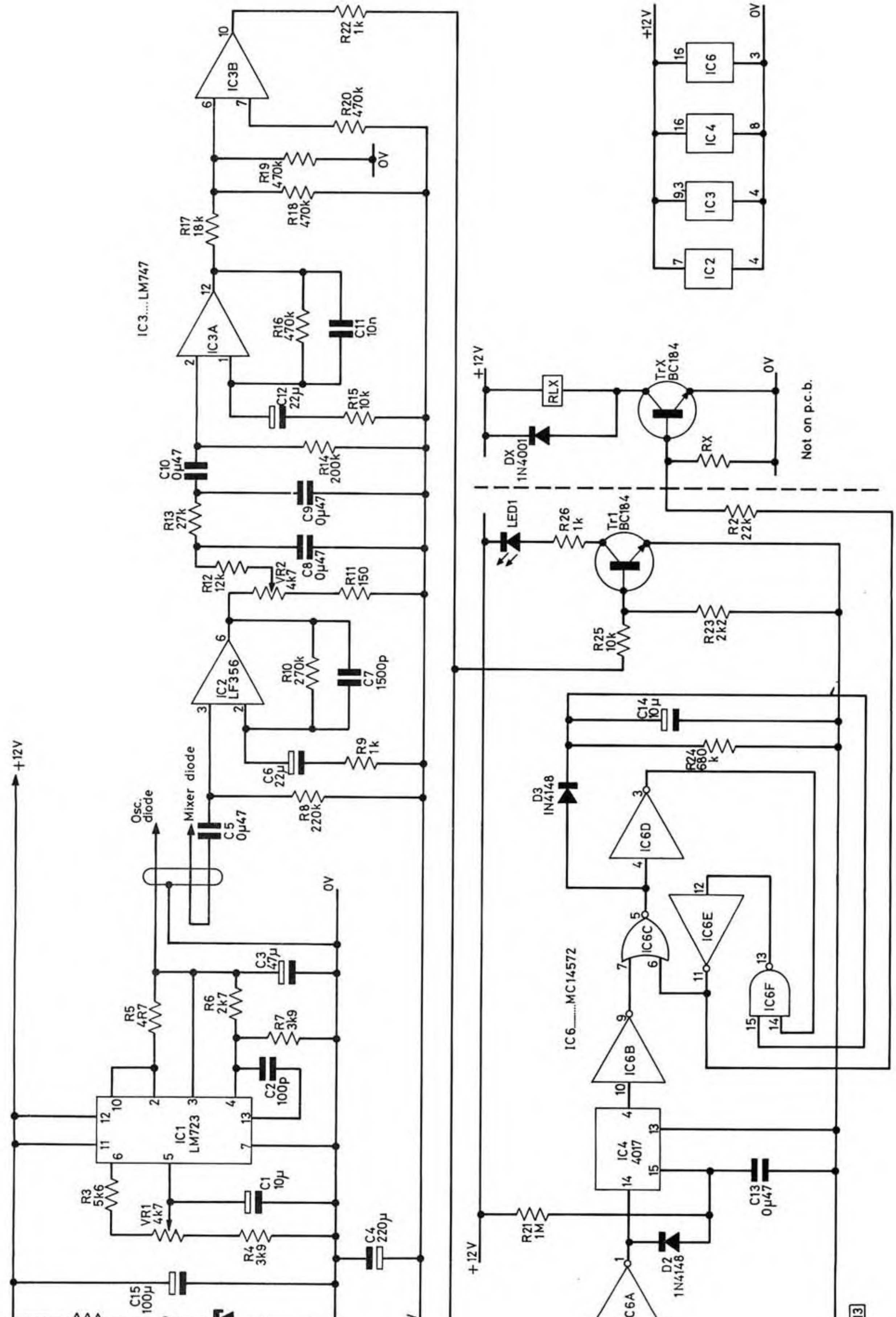
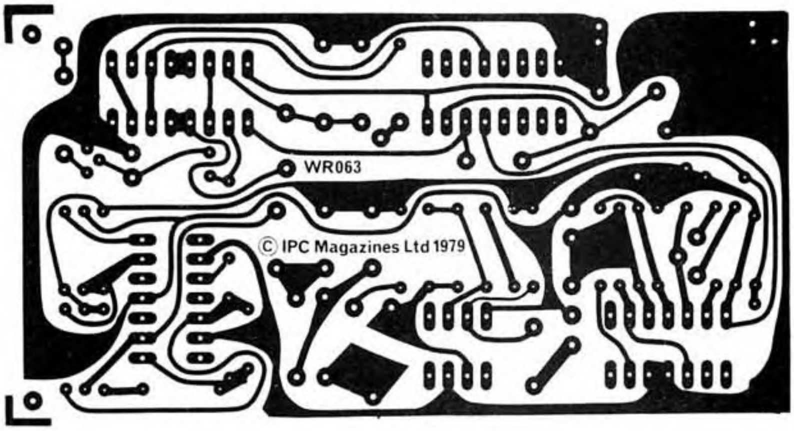
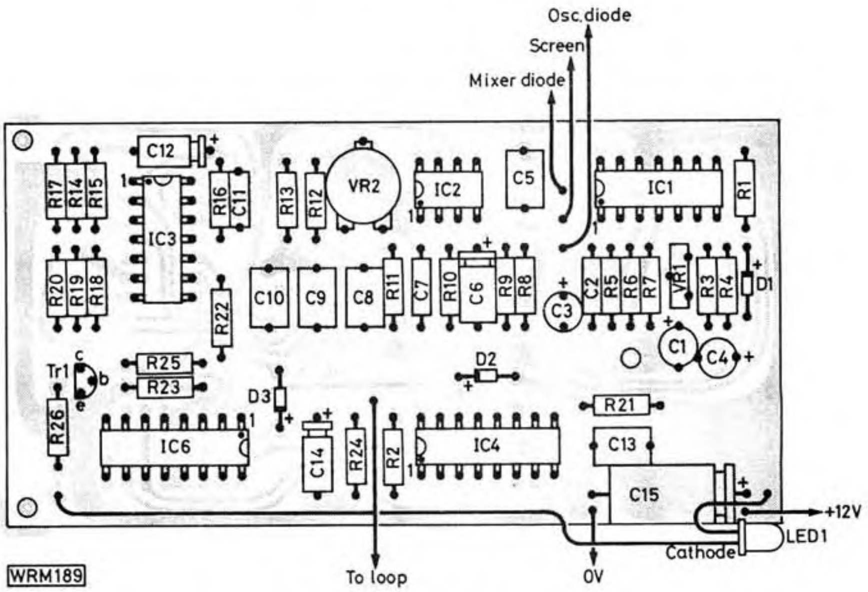


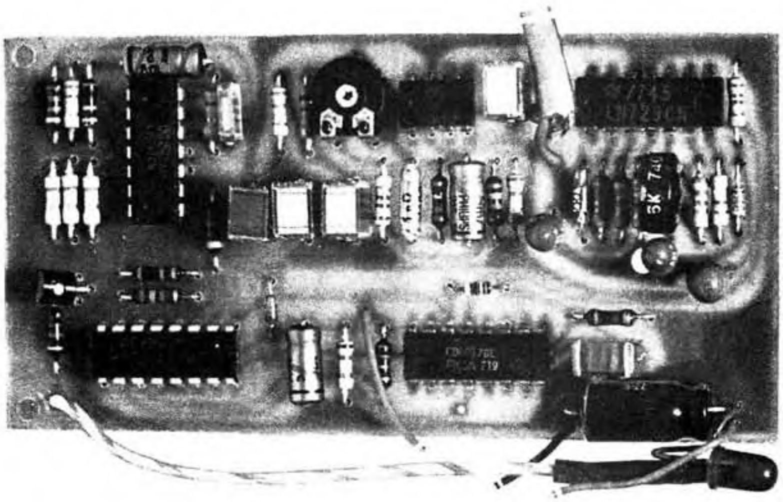
Fig. 1 : The circuit diagram of the *PW* "Parkhurst" motion detector



Copper track pattern (full size)



Component layout



★ components

Resistors		
¼ W 5%		
150Ω	1	R11
1kΩ	3	R9,22,26
1·5kΩ	1	R1
2·2kΩ	1	R23
2·7kΩ	1	R6
3·9kΩ	2	R4,7
4·7kΩ	1	R5
5·6kΩ	1	R3
10kΩ	2	R15,25
12kΩ	1	R12
18kΩ	1	R17
22kΩ	1	R2
27kΩ	1	R13
220kΩ	2	R8,14
270kΩ	1	R10
470kΩ	4	R16,18,19,20
680kΩ	1	R24
1MΩ	1	R21
Capacitors		
Tantalum		
10µF 16V	2	C1, 14
22µF 16V	2	C6, 12
47µF 16V	1	C3
Electrolytic		
100µF 25V	1	C15
Polycarbonate		
10nF	1	C11
0·47µF	5	C5, 8, 9, 10, 13
Polystyrene		
100pF	1	C2
1500pF	1	C7
Potentiometers		
4·7kΩ	2	VR1, 2
Semiconductors		
Diodes		
1N4001	1	DX
1N4148	2	D2, D3
ZF6·2	1	D1
Red l.e.d.	1	LED1
Transistors		
BC184	2	Tr1, X
Integrated Circuits		
LM723	1	IC1
LF356	1	IC2
LM747	1	IC3
CD4017BE	1	IC4
MC14572	1	IC6

Miscellaneous

GDHM microwave head; case CONTIL-DIN (West Hyde); Relay. Microswitches V3 lever (2).

or plastic front panels—in the construction of the prototype both were used. The metal front panel has a cut-out for the microwave horn and a hole to enable LED1 to be visible (Fig. 3).

For an attractive appearance, spray the case with a matt black finish—spray one side of the plastic panel also. Assemble the metal and plastic panels into the front of the case with the painted surface of the plastic panel to the inside. Carefully scribe a circle through the l.e.d. hole in the metal plate—this will be visible from the outside as a neat red circle when LED1 is illuminated.

Mount the two tamper-proofing microswitches into the slots in the case using 2·5mm screws. Adjust the positions of the switches so that removing the front or rear panels will cause them to open—these are connected in parallel so that the operation of either will break the 24 hour loop and cause the main security alarm to be sounded.

The GDHM itself is fixed to the rear panel using long 3mm screws, with two nuts per screw. Use the nuts to adjust the position of the microwave head so that the edges of the horn fit snugly against the cut-out in the front panel.

The p.c.b. can now be mounted on 6BA screws using two nuts as spacers. The l.e.d. can now be lined up with the hole in the front panel. The final wiring can now be completed and the unit assembled for range testing.

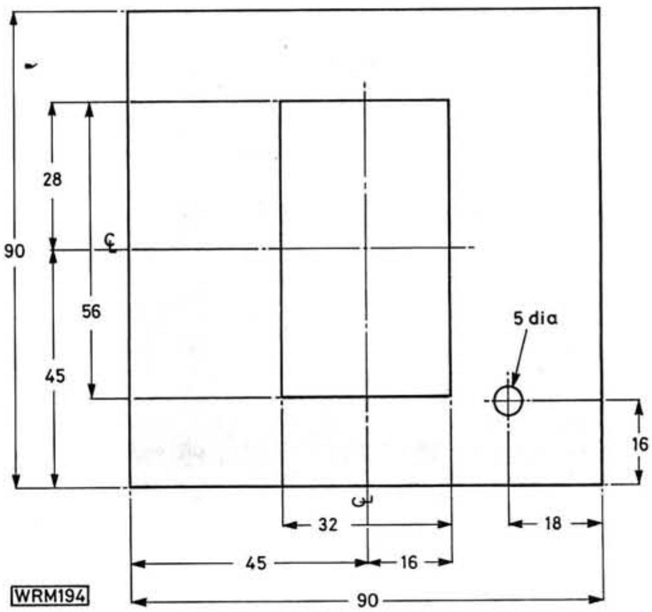


Fig. 3: Front panel details

Siting

Before final testing, the performance required should be evaluated; siting the unit requires careful consideration. Firstly, the possibility of false alarms must be considered—fluorescent lights are one source of them as the ionised gases cause reflections of the microwave radiation at 100Hz. It is therefore necessary to keep well away from them.

Other sources of false alarms include any slow-moving objects—clock-pendulums for example. Movement outside the protected area may also set off the alarm: people passing by windows or thin doors could trigger the unit if it is pointed towards them. Fig. 4 shows some suggested sitings for the unit.

The module must be firmly mounted and, at the same

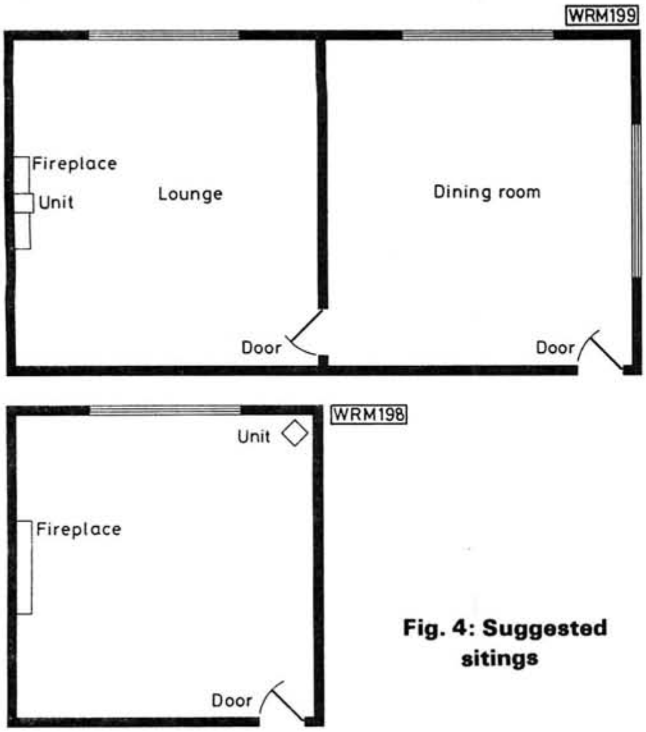


Fig. 4: Suggested sitings

time, remain adjustable. The easiest way to do this is to mount it on a ball-joint which can then be set into a domestic switch panel with a blanking-plate. Suitable ball-joints are available from good photographic shops.

The light-switch fitting (from any electrical retailer) should be firmly screwed to the wall or shelf etc. Bear in mind, though, that a cable has to be run to the unit—it is better, naturally, if this can be concealed in some way. Having decided on the best location, mount the unit and wire it into the security loops.

Testing

Testing is carried out using only the "Walk Test" l.e.d.

Given that the maximum range of the unit is 75ft, gauge the approximate setting of VR2 and, having replaced the front panels, walk carefully around the room ensuring that the l.e.d. flashes appropriately. The next step is to seek the aid of an assistant who should sit motionless in the room and watch the l.e.d. as you walk around outside the protected area, testing for spurious alarms. Alternatively, you could watch LED1 through windows or an open door as you carry out the test.

As a final check, secure the area, turn the system on and then walk outside the protected area to test for spurious alarms. Now turn the system off, enter the microwave-protected room and close the door. An assistant should now turn the system on and ensure that the alarm is triggered every time you move.

Conclusion

The "Parkhurst", when added to a complete system will certainly add tremendously to the level of security. It can be installed on its own—but do not forget that security can still be enhanced by the addition of the locks, protection devices etc. that we described in Parts 1 and 2.

With the addition of the "Parkhurst" to the complete and comprehensive system that we have described in this series, you should definitely be able to rest easy in your bed at night!

RADIO SPECIAL PRODUCT REVIEW KDK FM2016E

▶▶▶ *continued from page 45*

or to scan them for a free or busy channel. Remember, though, that you should programme your least favourite channel into position 4. As mentioned under "8", this is the channel that will be over-written if the "Write" feature is used without a memory channel selected.

12. Sim/−600/+600/1T-2R/3T-4R. This selector allows normal simplex operation in the Sim position. The −600 position is for use with UK repeaters, where the input channel (mobile transmit) is 600kHz below the output channel (mobile receive). The +600 position gives the opposite shift, for reverse or continental repeater operation. The remaining two positions allow two non-standard shifts to be programmed in by storing the appropriate transmit and receive frequencies in memory channels 1 to 4. This facility is useful if the rig is to be used with an up-converter for the 70cm band.

13. Volume/Squelch. The outer (larger) knob controls the squelch threshold, and the inner (smaller) knob controls the volume.

On the rear panel are the aerial connector (SO-239, "UHF" type), d.c. power connector, external speaker jack (4–8Ω) and Sel-call connector. The last one also offers a connection point for remote microphone/headset combinations, etc.

Results

Now to the results of our trials. We gave the rig just about every test we could think of, and it acquitted itself admirably on both speech and RTTY. Aerials used were a Ringo Ranger Colinear for base station tests and a 5/8λ magnetic mount when going mobile. The set comes complete with a good installation kit, comprising a power cable 2m long, with line fuse-holder and a spare 5A fuse; miniature jack plug to fit external speaker jack; mounting bracket suitable for mobile (under-dash) or base station use, with mounting hardware. The handbook includes a good circuit diagram, operating instructions, basic internal adjustment details, internal photographs identifying principal sections (component references are printed on the p.c.b.s), block diagram, comprehensive circuit description and specification. About the only thing missing is a components list.

The one criticism that we would make of the set is the difficulty of turning the small control knobs with even the slightest amount of grease or oil on the fingers. Eating chicken and chips when operating mobile is very definitely out! Obviously, the knobs have to be small to get all those controls onto such a small panel area. They could, though, be of a type providing a more positive grip, without being any larger.

There it is then, a rig worthy of serious consideration by anyone looking for a versatile base station-cum-mobile. By the visible quality of construction, it should go on performing well for a long time to come.

Costing £250.00 including VAT, the KDK FM-2016E transceiver reviewed was kindly loaned by South Midlands Communications Limited, S.M. House, Osbourne Road, Totton, Southampton SO4 4DN, Tel: 0703-867333, and we would thank them for their invaluable assistance in this respect.

ON THE AIR

AMATEUR BANDS

by Eric Dowdeswell G4AR

Some readers who have decided to fit a digital frequency readout to their receiver have mentioned one or two problems that have arisen in consequence. Usually, when the display is reading the frequency correctly from a known station, the signal strength is down, but may be peaked by slight retuning when the frequency indication then becomes incorrect.

Now there are some inter-dependent points here that ought to be understood. First of all, it is the receiver's local oscillator frequency that is actually being measured and not the signal itself. But because the oscillator is operating, in a simple superhet, at the signal plus the frequency of the intermediate amplifier stages (i.f.) this "offset" equal to the i.f. has to be allowed for in the digital readout circuitry. So if the readout unit has a fixed offset of, say, 455kHz and your set has an i.f. of 465kHz then the signal will be very weak or even inaudible at 10kHz off the i.f. but can be peaked by retuning, when the readout frequency will be wrong by about 10kHz.

So it is very important for best results that the offset should be adjustable, and this should be ascertained either from the circuit diagram of the digital display or from the supplier. The precise centre of the i.f. passband may vary from the nominal figure quoted in the manual, such as 455, 465 or 470kHz, and must never be taken as gospel. This particularly applies to older sets with tunable i.f. transformers, where the set may have been aligned several times in its lifetime and the original i.f. shifted considerably from its nominal value, especially if it has been done by ear rather than with proper test equipment.

So the answer to adding a digital display to a receiver is to tune in to a broadcast station of known frequency and to peak it carefully using the set's S-meter, or a d.c. voltmeter connected accoss the a.g.c. line and earth, and then to adjust the digital display offset until the indicated frequency is correct. This procedure is particularly essential with a receiver having a crystal or mechanical filter in the i.f., where the passband may be quite narrow and careful tuning is necessary.

When tuning to s.s.b. stations it should be remembered that to resolve speech correctly the set's carrier insertion oscillator (or b.f.o.) has to be adjusted very precisely indeed to place the signal on the right part of the i.f. response curve. When the tuning is correct the indicated frequency will be slightly different from the nominal carrier frequency of the transmitter, but this is not of great importance in amateur work.

One last warning. When using a broadcast station to check the digital display indication, use a station belonging to a network of known repute such as the BBC. Avoid stations in obscure places in Asia, Africa and South America who make changes to their nominal frequencies, often to avoid interference. A crystal calibrator can be used of course but it is nice to pick up a station of known frequency and see the display agree with it!

Here and There

It's hallo and congrats to **Bill Kerr** of Aldershot, Hants, who passed his RAE and intends to get the code test over with so that he can get his G4 straight away. The new format for the RAE instituted this year does not seem to have had any effect on the speed at which the exam results are issued but let us not condemn the system until after the forthcoming exam this month.

In Haverfordwest, Dyfed, **Andrew Price** has got off to a good start in amateur radio with an HAC straight receiver, courtesy of Dad, but so far it's mostly DX like Radio Moscow! However Andrew realises that it is better if he gets a communications style set in due course.

An interesting letter from **Tim Harrowell** G3IMI of Harrow, Middx who wrote to Yaesu about an improved filter for his FRG-7 and got back a detailed description on fitting one of the filters as used in the FRG-7000 digital readout receiver. If anyone with an unmodified FRG-7 is interested I'll send a copy of Tim's letter. Send me a s.a.e. with the outside envelope marked "FRG-7" and I'll oblige, but do not include any other correspondence. Tim is now happy with his FRG-7 on s.s.b!

The response to my bit on CB radio evoked a lot of agreement on the attractiveness of "illegality" to those who use CB here, but I'd like to make it clear that I support CB in the UK provided it is put on the right frequency, preferably v.h.f. or u.h.f. One or two readers still thought it ought to be a quick way to working the world!

Around the World

Yards of copy from RTTY addict **Dennis Sheppard** (Sheerness, Kent) convinces me that he is quite active in that mode! He's very pleased with the results obtained with a delta loop on 10m and is hoping to get two more masts up soon to support other loops. He is using a Windom for other bands. He found stuff like JA1DSI, K7BV, KE4V, PS7JA, PY2YFG, VE3JKZ, and 4X4MR on 10m with JA1ACB, TI2CAH, VK2ADZ and 5R8AL in

Madagascar on 15m. Twenty metres came up with AH6D in Hawaii, FK8BH in New Caledonia, FP8DF, PS7CP, VK2EG, VK7HV, ZS1Z and 3D2BM. Dennis has been monitoring conditions on 10m via the VP9BA beacon on 28·283MHz.

The Drake R4C receiver of **Bernard Hughes** of Worcester has not been idle with catches like D4CBC, FM7WS, KP4AAL, OX3HA, PY7FUP, XE1ABC and YS9RVE for some pretty good DX on 3·5MHz. On 21 it was CO2OM, KX6SA, VR3AH, VS6YV, and 9L1AP while 28MHz brought in S8AAT, VP8QJ, VU2RYX, YB0WR, 3B8CF and 9L1CA. Bernard has dipoles for each band plus a 66ft wire for general use.

Bill Rendell, down in Truro, Cornwall, is engaged on a personal target of hearing the antipodes at least daily and to date had done so for 130 days. He got worried one day when VK3MO was down to a 5 and 8! For those who have not heard him, VK3MO sports an 8-element (yes, eight!) quad, four of them at 47ft and the other four at 120ft! A rarity was VK8OB of Alice Springs on 15m at 1428GMT where he has also found VK1KB, VP8SB, VS6HG, VQ9DS on Diego Garcia (QSL Box 6168, APO San Francisco 96519) and also VQ9JJ of the same place but QSL W5RU. Also on 15m were: 3B8CF (QSL WA2NHE), 3D6BP (QSL W1OX) and 3V8ONU (QSL DK6NF). On 20m Bill found C5AAP, HP1XOJ, VP8QI on Argentine Is and XT2AZ who, says Bill, is a new mate for XT2AV.

A new a.t.u. built by **Dave Coggins** (Knutsford, Cheshire) also has a crystal calibrator in it which he is finding invaluable, as the calibrator "on" position switches the aerial out, leaving good clean markers. His DX160 and 66ft aerial found good DX from 10 to 160m like AP2KS, VS6FI, VU2DK and VQ9JC on 10m, KG6SW and TR8RG on 15 and C21AM (Nauru), FO8AK, YJ8PD, ZK1BQ, and 3D2WR on Fiji on 20m. Top Band came up with VP2KAD on St Kitts working into Europe in the early hours of the morning, around 1850kHz.

Bob Bell of Blyth, Northumberland, has been spending his hard-earned cash on a new garden shed to accommodate his FRG-7, thereby losing all the TV mush plaguing him in the past. Double glazing looks like some long winter sessions are in the offing! Personally, I have always maintained, quite wrongly of course, that the best DX is got on a cold crisp winter's night when there is a lovely full moon shining! On 28MHz it was ZS6PP, HK4EIM for Bob, with VK8NDZ, JA6GDP, ZF1MT, PS7JD and VK1KB on 21MHz using a.t.u. and a 75ft wire or 33ft vertical.

A short log from brothers **John and Steven Goodier** (Marple, Manchester), who have both been hard at it for the RAE, so let's wish them luck and hope *PW* is out soon enough for them to read this. Their FRG-7 snagged a nice one in J27AW in Djibouti, on the mainland across from Aden if you look at the map, plus another lovely in VK0PK on MacQuarrie Is, VP8VN on South Sandwich Is and VR1PS in the Gilberts, not to mention YJ8XR in the New Hebrides, so it seems the lads have their own propagation duct to that part of the world! From one extreme to the other, with **David Rhymes,** living near Oxford, dumping his 1155 set he's had for 30 years for a digital readout FRG-7000! I imagine he noticed a difference! He has three long wires so it is not surprising he logged C6ACY, HH2A, J6LCT, N6AFH on US Samoa, VP2KC, and VP8SB of Adelaide Is, all on 20m, with CP8AB and 9N1MM of Kathmandu on 15m, and C5AAP with VS6FI on the 10m band.

Allan Stevens (Crowthorne, Berks) expresses the hope that *PW* will soon be back on its publication schedule so that the DX info will be of some use to him! Several readers have suggested that a note giving the reasons for the delays might not come amiss but, so far, not a peep from Hon Editor! Allan was pleased to find K2ODX who became HP1XPK when the Canal Zone changed status recently, plus 3D6BW, 6Y5HM and VU2GO on 28MHz. 15m produced 3B8CF, 4N0MP (Yugoslavia) and UM8FK.

Peter Hawkes of Stourbridge (W. Mids) was delighted to find that G8RTP was a workmate so a firm link has been forged. His DX160 and 55ft aerial stuck mainly to the higher frequency bands with 10m providing 5Z4CD, HZ1AB, with VQ9DS and "579WARC" on 15m. Looks like a wise guy here! 20m looked like SU1ER, C6ACM, and VP8PU. However, a brief look on 7MHz found 8P6AH and CM1RH for a rare one with 80m bringing K6SVL/VP9, YV5ANS and C31LC.

All the above reports except the first are for s.s.b.

> 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.

Winter Sports

With winter upon us there is only one place to be, if not in the shack, and that is at the local radio club! So it's the **St Helens ARC,** Wednesdays at YMCA, 107 Corporation Street with a warm welcome at 7.45pm and don't forget the Morse classes beforehand. Write to: Paul Gaskell G8PQD, 131 Greenfield Road, or ring 25472. **Maidenhead ARC,** first Thursday and third Tuesday every month at 7.45pm at the Red Cross Centre, The Crescent, with details of meetings from John Patrick G3TWG, Bedford Lodge, Camden Place, Bourne End, Bucks, or ring 25275.

Only programme detail I have for the **Edgware RS** is a bumper pre-Christmas junk sale on Dec 13 which ought to be well worth while. Otherwise meetings on second and fourth Thursdays at the Watling Community Centre, 145 Orange Hill Road, Burnt Oak at 8pm. Innovation in October was a DF hunt using Top Band and, says the *Edgware Ham News,* "no complicated or expensive gear. Complexity is oft the way to get lost in a superior fashion." Too true! Incidentally, the Edgware "B" station was leader in the open section on 1·8MHz in this year's NFD and second in the restricted section. Publicity Officer (no less!) is Howard Drury G4HMD, 39 Wemborough Road, Stanmore, Middx.

Ken Crouch has got himself a handy callsign G8KEN! He's been telling me about the **Dover RC,** of which he is chairman, and which meets at the YMCA, Godwin Road on Wednesdays. Club call is G3YMD and the "Young Men of Dover" would welcome new members so trot along on Dec 12 for a talk, amongst other attractions, on radio isotopes or/and Dec 19 for a grand Christmas party, venue to be announed later. Contact: G4EGQ on Dover 203000.

Last meeting of the year for the **Torbay ARS** is Dec 15 when the society's Christmas party will be held at the club's HQ at Bath Lane, rear of 94 Belgrave Road, Torquay. Recent issue of the club magazine *Tars Talk* encloses a complete membership list which must be of great value especially to the newcomer to the club. I wonder how many other clubs could benefit from issuing such a list. Membership Sec is C. Coker G4FCN, 2 Causeway Cottages, Ipplepen, Devon or telephone 812117.

Society secs, etc., should note that information on club meetings and the like must reach me at least six weeks in advance of publication in *PW*, and by the 15th of the relevant month, not forgetting that *PW*, normally, is published on the first Friday of the month but dated for the following month.

Let me wish all readers of *PW* and especially those who wade through this column all the very best of season's greetings. May Father Christmas's sledge be full of nothing but amateur radio goodies! Once again every good wish for the success of those who will be taking the December RAE.

BROADCAST BANDS

MEDIUM WAVE DX

by Charles Molloy G8BUS

There is a widely held belief that m.w. DXing is very difficult, that it requires a receiver with high sensitivity and narrow selectivity, that a directional aerial such as the m.w. loop is essential, and that considerable DXing experience is required before worthwhile results can be obtained.

There is an element of truth in all this but on the other hand there is a lot of DX to be found without too much difficulty. The correct time to listen is of major importance. Tune round the band during the day. Only a few signals will be heard as only the ground wave is being received. Sky wave reception (DX) is only possible when the path between transmitter and receiver is in darkness.

The medium waves are intended for local broadcasting and only a small number of signals will be beamed towards the DXer. He is really an eavesdropper into domestic broadcasting in other parts of the world. This means interference from stations nearer home and variable propagation on the DX path. Your signal may be good one night and absent the next. Slow fading is normal and can cause a DX signal to be missed very easily.

For Beginners

In order to introduce newcomers to DX on the medium waves I have rigged up an Eddystone EB36 broadcast receiver, an a.t.u. and a 60ft end-fed outdoor aerial and I hope to report DX heard with this set-up over the next month or two. The EB36 is intended for use as a marine receiver and is similar to the EC10. It has a tuned r.f. stage. The selectivity is fixed at 5kHz at the 6dB points, wider than I would like for DXing but similar to many receivers used by DXers.

Locate the French network on 1404kHz. It signs off at 2300 and when the carriers go off you should hear Conakry in the Republic of Guinea. The language is French, the announcement is "La voix de la Revolution" and it often broadcasts music which has been called African Pops. Conakry is nearly always audible and is on the air most of the night. It suffers from occasional QRM from a Russian on the same channel.

Tune to Brussels on 927kHz. It signs off at 2245 and when the final tuning notes and the carrier are off you ought to hear Zykanthos in Greece. Reception is a bit variable but it can usually be heard until 2305 when it goes off for the night. Now tune up to 930kHz. With a bit of luck you may hear CJYQ in St John's Newfoundland. Remember though, slow fading is normal and conditions vary from night to night.

Beacons

"While tuning around the l.w. band with my 5-valve Philco and 60ft long wire I managed to pick up some odd signals in Morse between 300 and 375kHz," writes **G. R. Perry** from Cardiff. The signals you heard are navigation beacons and the identification in Morse is not a callsign but is an abbreviation based on locality. ORM on 316kHz is at Ormskirk near Southport.

Radio Officer **Colin Stewart** has listed some beacons in the range 290 to 310kHz that might be generating harmonics on the medium waves. The problem however has already been solved by **Geoff Halligey** who reports that SW on 930kHz is not a harmonic. It actually transmits on this frequency and it is located at Vykhma in Estonia. Evidently there are quite a number of air navigation beacons operating on the medium waves, a band that is supposed to be reserved exclusively for broadcasting. Presumably they are sited so that no interference is caused in the service area of any medium wave transmitter and it is only the m.w. DXer who experiences this type of QRM.

Loop Problems

A tuning capacitor of 500pF is specified for use with the standard 40 inch m.w. loop. Although this value is not critical, for example a variable capacitor with a value of 470pF would do instead, a tuner of only 250pF is much too low. If a variable capacitor of this value is used then the loop will tune over the high frequency part of the medium waves only.

This happened to reader **A. C. Jacklin** who used a small, totally enclosed type of variable capacitor recovered from a scrap radio, reasoning that since the radio covered the medium waves then the tuner must have a value of 500pF. Unfortunately this is not so. Modern radios use high inductance tuning coils which are tuned by variable capacitors of around 250pF in value which are not suitable for use with a loop.

Why can't we have a loop with a high value of inductance? Because it would also have a high value of self capacitance. Modern tuning coils use ferrite cores which permit a high inductance to be obtained with low self capacitance. Ideally a loop should resonate with its own self capacitance at the highest frequency to be used. Then a variable capacitor is connected to it, which has a great enough value to tune to the lowest frequency required. In practice this is what happens with the 40 inch loop. It self-resonates around 1600kHz and 500pF is required to tune it to 540kHz. The number of turns determines the highest frequency, the capacitance of the tuner determines the lowest frequency.

Remotely Controlled Loops

There are occasions when a loop cannot be used beside the receiver, perhaps because of lack of space or because the location is unsuitable. The solution is to have a remotely controlled loop higher in the house, probably in the loft.

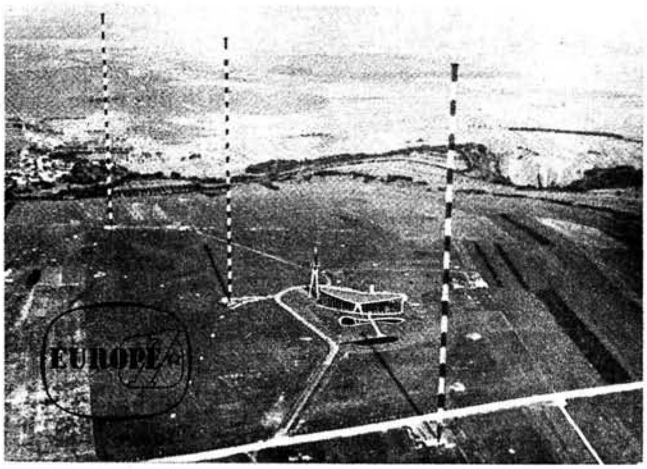
Such a loop can be attached to a rotator of the type that Radio Amateurs use with their v.h.f. aerials, or it can be left pointing in the best direction for North American DX, for example. A fixed loop can even be wound round the rafters, held in position by cup hooks.

How do you tune the loop? One method is by a varicap, using a circuit like the one in this column is the September issue. Why use a varicap? Why not run a length of cable from the main winding of the loop to a tuning capacitor located beside the receiver? Reader **George Harpur** tried this and found he could not tune the loop. The reason is that the capacitance of the cable was in parallel with the tuning capacitor and was detuning the loop. A 15ft length of coaxial cable with a capacitance of 20pF per foot would put 300pF in parallel with the tuner. The range of capacitance would then be from 300 (0+300) to 800pF (500+300) instead of 0 to 500pF.

It is possible to get round this problem by using cable that has a low capacitance. Standard 300Ω flat twin feeder has a separation of half an inch between conductors and a capacitance of 4pF per foot, so that a 15ft length will put only 60pF across the tuner. This may be enough to prevent the loop being tuned to a high enough frequency and you may have to remove a turn or two from the loop to counter this.

In order to tune to the l.f. end of the band, a higher value than 500pF may now be required but it is at least feasible to tune a remotely situated loop by this method. I have used 20ft of feeder and a 1000pF variable (twin gang 500pF) with success.

There is no problem with the normal connection between the single (link) turn and the aerial and earth inputs to the receiver though you might just as well use 300Ω feeder for this as well. Twin 300Ω feeder is available from shops that cater for Radio Amateurs, who use it with folded dipoles.



Long Wave DX

"Is there such a thing as long wave DX?" asks **Christopher Steele** (East Ham) who is a newcomer to the hobby. Indeed there is and logs do appear in this column form time to time. Many receivers do not cover the long waves though. Propagation is similar to the medium waves but the ground wave travels much further. There are a few exotic catches to be made, such as Azilal in Morocco on 209kHz, Tipaza, Algeria on 256 and Turkey on 182kHz. The QSL cards shown here are from Europe No 1 on 182kHz which is not DX, and from Reykjavik, Iceland on 209kHz which is.

BROADCAST BANDS

SHORT-WAVE BROADCASTS

by Charles Molloy G8BUS

It is from readers of this column that I receive the stimulus for much of what I write, and a letter from **John Dainty** (BRS42293) is no exception. John says that information is difficult to come by on the listening (receiving) efficiency of aerials, most of the published material being orientated towards transmitting. He feels that one could get away with Paxolin insulators for receiving instead of ceramic or glass types.

Whatever the relative merits of Paxolin, glass or ceramic might be, there is no doubt that available information about aerials is orientated towards transmitting efficiency, the one notable exception being the information produced by G2DYM and mentioned in the October 1979 issue of this column.

Although the sensitivity of a receiver is measured in microvolts and consequently the current flowing into the receiver aerial socket will be in microamps or of that order, the wire usually specified for receiving aerials is capable of carrying enough current to supply an electric fire. If such heavy gauge wire is required for electrical reasons then why isn't it used for the winding on a ferrite rod aerial? High voltage insulators are clearly unnecessary for an aerial used solely for receiving, but they are often supplied in aerial kits. How has this situation arisen?

Reciprocity

In a contact between two radio amateurs, the same aerials are often used alternately for transmitting and receiving. A good transmitting aerial will also be a good receiving aerial. This statement is justified by the law of reciprocity which means simply that an electric circuit will have the same properties in either direction, which is only common sense. Consequently, amateur radio literature concentrates on transmitting aerials.

Receiving Aerials

One must be careful though how to apply reciprocity. If I tune into a broadcasting station which is pumping 100kW into an 800ft mast then clearly it would be to my advantage to swop places with the transmitter. I had a letter from a reader not so long ago who tried an 800ft mast for DXing and the results were phenomenal. But would the transmitting engineer care to have my long wire, to say nothing of a ferrite rod aerial? Obviously not. So a good receiving aerial need not match up to the standards required for transmitting.

This leaves the field wide open for the experimenter. He can try anything as there are few precedents. The proverbial piece of wet string will not do, but it is worth remembering that in the early days of wireless bedsprings were often tried as an aerial. I tried it myself as a schoolboy though not, I may add, with a mains operated receiver.

For a number of years I used nothing else for outdoor aerials except the plastic-covered steel wire available in garden shops. It is cheap, easily obtainable in lengths up to 600ft and withstands gale force winds from the Irish Sea. A couple of years ago I replaced this wire on my 90ft long wire with plastic-covered, copper-coated steel wire which in theory should give better results. I haven't noticed any improvement and when the 90 footer is next due for an overhaul it will be changed back to garden wire.

120 Metre Band (2300 to 3498kHz)

"Is it possible to hear any broadcasting stations on the 120m band," asks **Jim Edwards** who lives near Wigan. Jim has been successful on the 75m and 90m tropical bands but so far he has heard nothing on 120.

It is difficult on 120. Reception is similar to the medium waves with slow fading, and of course a path of darkness between Tx and Rx is essential in order to hear anything other than MSF on 2500kHz. MSF is the time and frequency standard station at Teddington and is useful for locating the h.f. end of the band. An added disadvantage on 120 is telegraph interference as the band is only used for broadcasting in tropical areas. I do listen a bit on 120m and a few extracts from my log may help. The receiver is a BRT 400 with digital readout, connected to a 60ft long wire via an a.t.u.

On 18 August I picked up a Chinese station on 2490kHz at 2030 GMT, SIO 232 and another on out-of-band 2600kHz, SIO 333 a few minutes later. These two can usually be heard and 2490 is easy to locate as it is just below MSF. The two stations were carrying different programmes which agrees with the *WRTVH* which lists them both at Fuzhou. September 13 brought Gweilo in Zimbabwe/Rhodesia on 2425kHz at 2130. It was only audible on peaks and could easily have been missed. Two harmonics of m.w. stations were picked up on September 16. BBC Radio 3 was SIO 322 on 2430kHz (twice 1215) at 2035 and a Yugoslav was heard on 2466 (2 X 1133), SIO 232 at 2040.

World Radio and TV Handbook

The 1980 edition of the *WRTVH* will be available in January at an unchanged price of £8.50. It is supplied by Argus Books, 14 St James Road, Watford, Herts, though copies can be ordered from W. H. Smith. **Andy Sennitt,** who is the Assistant Editor, tells me that the *Listen to the World* section will be re-instated with articles on receivers, propagation, etc. Perhaps the most valuable part of the handbook is the country by country sections which give addresses, interval signals, frequencies and schedules. There is also a Newsletter which up-dates the schedules in May, August and September.

Readers' Letters

An SRX-30, a.t.u. and 40ft inverted "L" aerial are in use in Leeds by **B. Woodcock** who has heard two unidentified stations. On 5300kHz he picked up a broadcast calling itself Shannon Volmet, which he cannot trace in the *WRTVH*. This is not a broadcasting station. It is a "met" station and is not intended for reception by the general public. The second was on 17 820 and requested postcards giving details of reception to Mailbox 1, Libreville. The country is the Republic of Gabon in West Africa which is conducting test transmissions on a number of frequencies. The *WRTVH* lists 6030, 7200, 15 300 and 9650kHz with powers of 500kW.

Reader **T. J. Jordan** is looking for a photocopy or an original instruction handbook for his newly acquired Trio 9R-59D receiver. Replies direct to: 12 Upton Lane, Forest Gate, London E7 9PA. Postage and copying costs will be refunded. The QSL policy of Radio Finland is referred to by **James Jackson** of Dunfermline. Frankly this station puzzles me. Over the air they say QSL cards are out, Listeners cards are in. If you write, you get a QSL card.

"I have found a number of stations operating between 8 and 9MHz," writes **Richard Everitt** who uses a Telefunken domestic receiver with 40ft long wire. They are probably images of 31m band stations which are usually suppressed in the r.f. stages of a more complicated receiver. A station can be received on two positions on the dial: when the local oscillator is higher than the station by the amount of the i.f. (correct), and when it is lower than the station by the same amount (incorrect). The two are separated by twice the value of the i.f. which is usually 910kHz (2 times 455) or 930kHz (2 times 465). Images of the 31m band will be found between 8·5 and 9MHz approximately.

"Has anyone succeeded in obtaining a QSL from the Voice of Chile?" enquires **Dave Jones** of Normanton, West Yorks, who sounds rather exasperated. Logging a Latin American is only the start of the trail Dave, you should try to get a QSL from some m.w. Latin Americans. Although Dave now uses a DR26 with digital readout he mentions his earlier receiver, a Grundig TR600, which he bought for £15 in 1973. It pulled in 68 countries and he heartily recommends this set to newcomers, if they can find one, as the model has gone off the market.

Roy Patrick (Derby) points out that many South Americans are now excellent signals in the 16 and 19m bands. He has heard the Voice of Chile in English at 2100 on 17 715, Radio Nacional Brazil at 2000 on 15 270, HCJB Quito Ecuador on 17 785 and 15 295 with DX Party Line at 2130 on Mondays, Thursdays and Saturdays.

Brian Davis (Bath) has "rejoined the scene" after some 20 years and he now has a National Panasonic DR28 with built-in telescopic aerial. He does his late evening DXing in real comfort in bed. If I brought all my gear into the bedroom there would be a domestic crisis! Brian is puzzled with Radio Amateurs on radiotelephony who are unreadable as though with the b.f.o. on. This is s.s.b. and you have to switch on the b.f.o. to receive them. Further information from Eric Dowdeswell.

The Bristol Pathfinders DX Club now has a new Editor/Secretary who is Philip Grainger, 26 Beattie Street, South Shields, Tyne and Wear. The club issues a newsletter every two months and the annual subscription is £1.

VHF BANDS

by Ron Ham BRS15744

Although modern technology has provided us with very fine radio equipment, DX hunting will always depend upon the user's own ability to recognise and take advantage of the unusual ionospheric and tropospheric conditions when they prevail.

Solar

On September 24, **Cmdr Henry Hatfield,** Sevenoaks, using his spectrohelioscope, observed 13 sunspot groups, two of them large, and recorded a 5-minute burst of radio noise at both 136 and 1296MHz. During the same day, **Ted Waring,** Bristol, counted 61 individual spots, so there was little surprise when, at 0300 on the 25th, the BBC World Service announced that an ionospheric disturbance was affecting their north-Atlantic signal paths. Ted also counted 59 spots on the 27th, 63 on the 29th, 53 on October 1, 31 on the 5th, 63 on the 7th, 55 on the 9th and 34 on the 13th. Both Henry and I recorded varying degrees of solar noise, at 136 and 146MHz respectively, almost daily between September 30 and October 16. Around 1150 on the 5th, we both recorded an individual burst, Fig. 1, which lasted for four minutes as did **Robin Knight** of the South East Essex Astronomical Society, at 60MHz. While Robin was recording noise at 60MHz on the 10th and 11th, I heard strong individual bursts on 50MHz at 0730 and 0920 on the 12th, with only a vertical dipole feeding my R216 receiver. The general solar noise was very strong on the 13th and during the late afternoon, **John Cooper** G8NGO, Cowfold, Sussex, also heard the noise when he turned his 2m beam toward the west and the setting sun.

The 10 Metre Band

"10 metres has really improved," writes **N. Clarke** BRS 34306, Knottingley, West Yorkshire, on October 10.

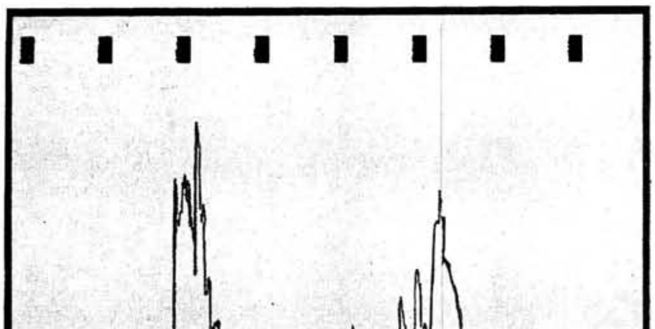


Fig. 1: Four minute solar burst recorded by the author at 146MHz at midday on October 5. The lower trace is the normal receiver noise level recorded on the 4th

"From around 1130, US stations were rolling in and remained so for the next nine hours. On favourable days, Florida beacon N4RD, 28·207MHz, has been riding above S9 for hours at a time and the Canadian beacon VE3TEN, 28·175MHz, has been S9 at times but faded out an hour or so before N4RD." Like **Alan Baker** G4GNX, Newhaven, **Ted Waring,** N. Clarke and I have heard the beacons at Bahrain A9XC, Bermuda VP9BA, Cyprus 5B4CY and Germany DL0IGI, on most days between September 20 and October 21. During one afternoon Alan had a c.w. QSO with W3LG, who was mobile at the time. On almost every day throughout the period Russian stations were very strong, and frequently so were the Australians, Japanese and north-Americans. At 1258 on the 4th, I heard a UA tell a W; "Your signal is fantastic" and the W replied with a report of 59 plus 15dB.

Harold Brodribb, St Leonards-On-Sea, Sussex, heard many harmonics of lower frequency broadcast stations between 28 and 31MHz on days when the band was wide open, "Imagine getting huge loudspeaker reception when both AR88LF and CR100 were tuned to these", writes Harold, who also reported hearing "marked round-the-world echo" on the BBC World Service transmissions in the 11m band on the 13th and 18th. During the early morning of the 16th, there were many strange noises on the band, some c.w. signals were chirpy and several s.s.b. stations were echoing. Around 0800 on the 17th there was a very strong echo on a German and a Hungarian station which stood out in a crowded band.

In his letter on October 8, **John Branegan** GM4IHJ, Saline, Fife, said that the m.u.f. was steadily climbing above 40MHz. Well, this continued John, because on several days I heard a multitude of beacons, broadcast harmonics, pagers, teleprinters and radiotelephone signals between 30 and 50MHz, above which there seemed to be a sharp cut off.

Aurora

During the late afternoon of September 18, John Branegan had c.w. contacts, via aurora, with G6GN and GW4FJK and heard tone-A signals from GM4DIJ, G4DSC, LA3WU, PE1BZD and the 2m beacons in Cornwall GB3CTC, Germany DL0PR, Northern Ireland GB3GI and Wrotham GB3VHF. John also had an auroral QSO with GM4IDR during the afternoon of the 20th and, by using the high scintillations on OSCARs 8J and 7A, located brief aurorae on October 6, 7 and 8.

Satellites

"I am still getting excellent DX on OSCAR-7B," writes John Branegan, and during the first week in October, he worked K0RZ in Boulder, Colorado, about 4350 miles and very close to 7Bs limit. "OSCAR-8 is still going well," says John. "I had five transatlantic QSOs in ten days." A weather satellite observer is now warning John when the auroral oval advances far enough south to interfere with his pictures.

DXTV

Stephen Haywood, Higham, Barnsley, is a keen s.w.l. and has now added a JVC 3050 television receiver to his station for DXTV work, **Denis Kenneally,** Co Cork, has already received pictures in Band 1, during the sporadic-E season, from stations in Austria, Germany, Iceland, Norway and Poland on a 12in Bush portable using its own telescopic aerial. "From 1700 on September 18, I received weak, unidentified, periodic bursts of video from the east on Ch. R1, lasting an hour or so," writes **Sam Faulkner,**

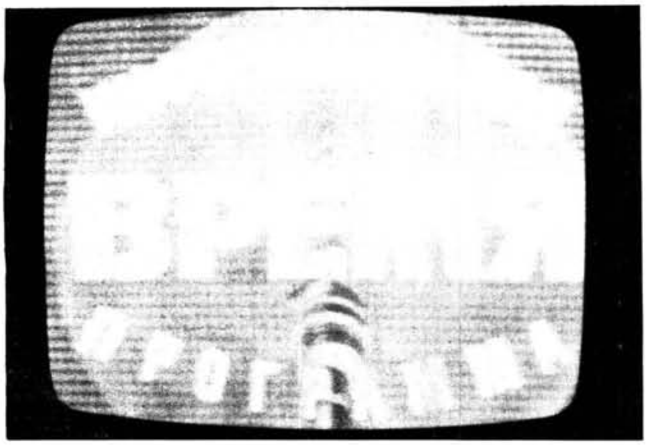


Fig. 2: Programme introduction, believed to have originated from Bulgaria, received by Sam Faulkner at 1650 on September 5 on Channel R1 49·75MHz

Burton-on-Trent. "All very tantalising," says John Branegan, who, like me, has seen many short bursts of picture on R1 during the early mornings of late September and early October. Although these bursts were brief I did catch a glimpse of a familiar Russian test card at 0639 on October 14.

"During the latter half of September, I was able to log RTE 1 (Radio Telefis Eireann) in Band III on several occasions", says Sam, and during the morning of the 29th he watched part of the Pope's visit to Ireland. Sam also sent a photograph of a DXTV signal, Fig. 2, which he received on Ch. R1 on September 5.

Band I conditions were even more tantalising during the early mornings of October 16 to 21 inclusive because there was a mixture of signals on the screen and what looked like several images on each one. Although the signals were strong, captions were out of focus, and often there were one or more wobbly black lines, also with images, down the centre of the picture. At 0825 on the 17th, I saw an announcer's face just to the left of a vertical line and an image each side of it. At 0900 on the 18th a clock appeared from the jumble, but there were too many images to see the time. This was followed by a caption, from which I could see the letters CCCP and then an announcer became predominant for about two minutes, after which the signals and their images returned to a jumble. An extra letter from John Branegan says: "A lot of co-channel interference with several stations present at once. Azimuth 070 to 080 degrees suggests origin in central Russia."

Slow Scan Television

After finding the 10m band in such good shape on September 22, Sam Faulkner, using a KW202 and Robot 400 with Hitachi 9in CCTV monitor, began monitoring 28·680MHz and up to October 12, had found some really excellent SSTV signals coming across the Atlantic. During the period, Sam logged two stations from Argentina, two from Canada, one from England and 20 from the USA, Fig. 3. On October 7, Sam received pictures from VE3JW who was operating the exhibition SSTV station at the Museum of Science and Technology in Ottawa and, apart from seeing the operator and his gear, there were pictures of some of the many people attending the museum. "I enjoy this side of the hobby very much", writes Sam, "and its rising popularity is reflected by the increasing number of new calls on the bands. Between September 15 and October 12, Sam logged signals from DL, EA, F, HB, I, JA, LA, OE, OH, OK, SM and YU on the 20m band, proving that there are plenty of SSTV enthusiasts about.

Tropospheric

Conditions on v.h.f. were greatly improved while the atmospheric pressure was above 30·0in between September 22, and October 3, reaching a maximum of 30·5in on the 28th. Around 0800 on September 24, 27, 30 and October 3, I received strong signals from the *Bristol Channel* repeater GB3BC, plus at times the Kent repeater GB3KR, and pictures from the IBA transmitter at Lichfield on Channel 8, 189MHz.

During the early evening of October 1, **Ken Smith** BRS20001, Horsham, Sussex, heard several French broadcast stations in Band II and I heard them again at 0806 on the 3rd. At 2107 on the 2nd, G4GNX worked F6FLB via the French repeater FZ2VHF, R5, Bologne. The pressure remained low until midnight on the 16th when it rocketed up from 29·9in to reach 30·4in by 1800 on the 18th and, true to form, the v.h.f. bands opened up. During the evening of the 18th, Ken Smith, using a Bush VTR 178 portable with an outside rod aerial, heard about seven French broadcast stations in Band II and I received strong signals through GB3BC, R6, GB3KR, R4, and pictures from Lichfield. Around 2240 on the 19th, Alan Baker worked DD3AW and OS7EH and at 2326 F1EWP, in Chateauraux (500km) on 2m s.s.b. At 2240 on the 20th, Alan again worked a German station, DF3PR/P, on 2m s.s.b. and during the morning of the 21st, **Graham Matthews** G8SAG, worked a GW from Horsham, Sussex, using 1 watt from a TR2300 into a 5-element quad aerial.

New VHF operators

Congratulations to **Gerry Cogger, Margaret Hill, John Trimmer** and **Chick Tutt** on passing the RAE. They now have the callsigns: G8TUQ, G8TTT, G8TMX and G8TOZ respectively. All are active on 2m and I look forward to hearing more from them in the future.

News Items

Graham Kehily G4IBQ, has worked 40 countries on 20 and 10m, using a KW2000A since he was licensed last April. Graham wants to renovate an old Hallicrafters Super Sky Rider, SX28 communications receiver and requires a manual or technical gen, any offers please to: G4IBQ, 59, Bradbourne Park Road, Sevenoaks, Kent.

Before **David Wakefield** G8RVK, Worthing, joined the RAF on October 10, he took part in the RSGB 2m contest and worked seven countries in 2½ hours including F, GJ and PA0.

Plans are well in hand for the Sussex Mobile Rally to be held at Brighton Race Course on June 1, 1980, which will include demonstration and talk-in stations on the h.f., v.h.f. and u.h.f. bands. This venture is a joint effort of the Sussex radio clubs and the officers of the organising committee are G4GNX, Chairman, G8JVE, vice-Chairman, G8TMX, Secretary and G8TOZ, Treasurer.

Alan Manning, Bonnyrigg, Midlothian, has recently joined the British Astronomical Association and is particularly interested in satellite tracking by radio and radio astronomy, and is constructing gear for 23 and 13cm.

If you know of a handicapped person who could benefit from short-wave radio as a broadcast listener, then put them in touch with Handicapped Aid Programme "UK",

Fig. 3: Slow scan TV pictures received in the 10m band from Argentina, Canada and the USA by Sam Faulkner

c/o European DX Council, PO Box 4, St Ives, Huntingdon, Cambs PE17 4FE. The idea of HAP UK is to promote the hobby of short-wave radio broadcast band listening among the physically disabled and housebound, many of whom are unaware that radio can bring the world into their home. HAP-UK also need help with local organising, giving advice and installing sets and aerials and will be pleased to send you all details.

Microwaves

A microwave round table was held at the headquarters of the Martlesham Amateur Radio Society on September 30. "There was an excellent lecture with talks on propagation, microwave feeds for dishes, and Moonbounce complete with tape recordings of echoes from the Moon," writes **John Tye** G4BYV, Dereham, Norfolk. One of the outstanding features was a 10GHz receiver which was working and receiving signals from **Mike Walters** G3JVL, in Hayling Island. The organisers plan to hold another event there next year, and hope to invite some Continental amateurs over.

Stop Press

John Branegan reports the 6 metre band wide open between 1526 and 1740 on October 25. Strong signals were heard on 50·0MHz (c.w.) and 50·1MHz (s.s.b.), including stations W2UTH, W1XM and VE2CRA. More details next month.

Simply ahead . .

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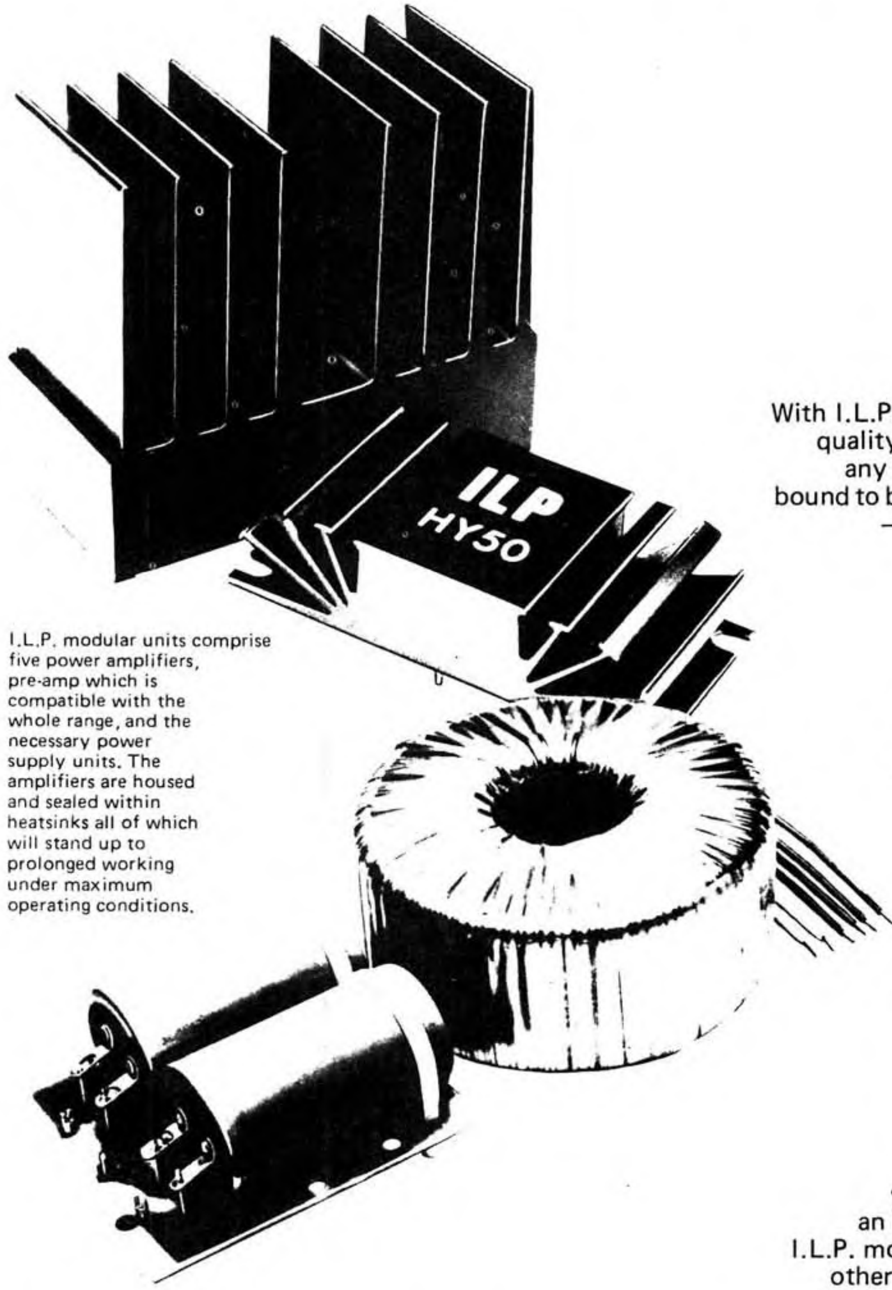

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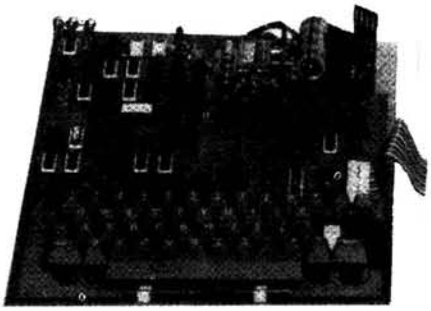

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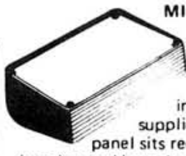

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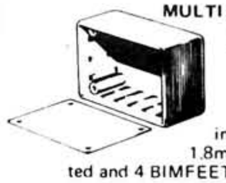

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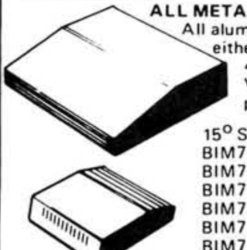

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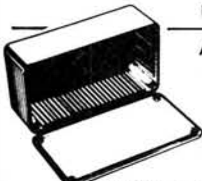

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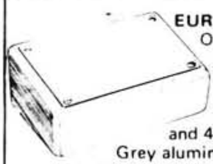
(112x62x31mm)	BIM2003/13	£1.27	BIM5003/13	£2.24	£1.70
(120x65x40mm)	BIM2004/14	£1.51	BIM5004/14	£2.81	£2.11
(150x80x50mm)	BIM2005/15	£1.72	BIM5005/15	£3.19	£2.72
(190x110x60mm)	BIM2006/16	£2.69	BIM5006/16	£4.94	£3.96

Also available in Grey Polystyrene with no slots and self-tapping screws
BIM 2007/17 (112x61x31mm) £1.06



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Orange, Blue, Black or Grey ABS body accepts full or ½ size Eurocards, with bosses in the base for direct fixing. 1.8mm wide pcb guides incorporated and 4 BIMFEET supplied. 1mm Grey aluminium lid sits flush with body top and held by 4 screws into integral brass bushes.

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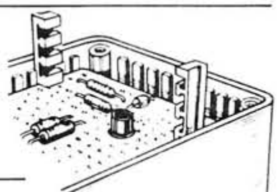

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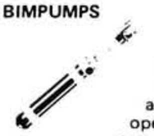

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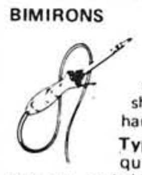

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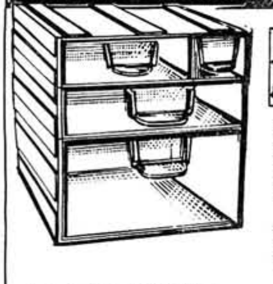

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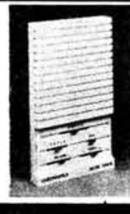

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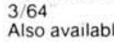

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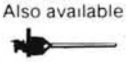

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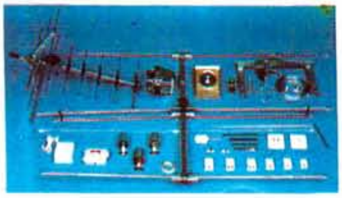

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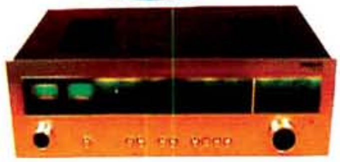

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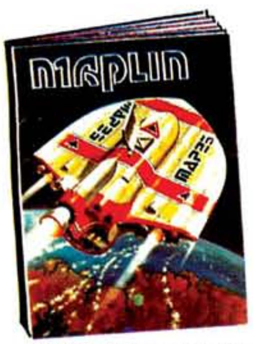

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