76 AVE

PRACTICAL

ELECTRONICS

MAY 1973

PUSHBUTTON VARICAP STEREO TUNER

FREE INSIDE... DISPLAY DEVICE IDENTICHART

PRACTICAL
ELECTRONICS
VOLUME 9 No. 5 MAY 1973

CONSTRUCTIONAL PROJECTS

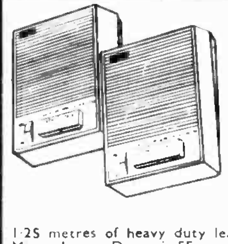
GENERAL FEATURES

NEWS AND COMMENTS

SPECIAL DATA SHEET

Our June issue will be published on Friday, May 11, 1973

gspk (sales)

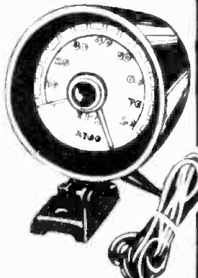


D1075 Wireless Intercom

The great merit of wireless intercoms is that separate connecting wires are not necessary providing the stations are on the same electrical mains circuit. Communication can be up to a distance of ½ of a mile providing the power lines used are on the same side of the distribution transformer, and several stations can even be operated on the same circuit. Solid state model D1075 is fully transistorised and each unit incorporates a talk-listen button with locking bar; ON/OFF volume control and a pilot light. The fawn moulded cabinets can be desk located or wall mounted and are supplied already fitted with 1·25 metres of heavy duty lead. Operating Frequency: 160kHz. Speaker/Microphone: Dynamic 55mm. Power Output: 120mW. Size: 98 × 40 × 130mm. Printed Circuit: 3 transistors, 1 diode.

£11·60

SOLID STATE TACHOMETER



Functionally styled for under or over dashboard installation, this electronic tachometer fits all 4-cycle, 4-cylinder, or 2-cycle, 2-cylinder 12V vehicles. Negative or positive earth. Calibrated white on black 0–8,000 r.p.m. in 100 r.p.m. divisions together with setable "danger" line, simple installation 2 screws, 4 wires. 80mm (3in) dia. dial, 50mm deep. On adjustable angle bracket. Sealed black crackle finish.

£6·86

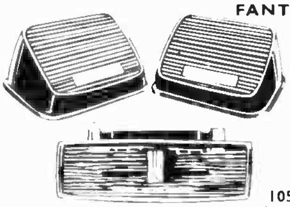
SPECIAL OFFER!

AUTO BURGLAR ALARM PLUS "POP-OUT" CIGARETTE LIGHTER

Designed for easy installation on any car (whether 6 or 12V) this device activates the horn when a theft is attempted of equipment or personal belongings. This neat unit reacts when the vehicle is disturbed or rocked and continues its warning for 15 sec. after tampering. The sensitivity of the device is adjustable and controlled by a separate ON/OFF panel which can be located wherever convenient. Supplied with connecting wires and screws in attractive bubble pack, containing installation instructions and diagrams. 150 × 65 × 20mm plus panel 65 × 45 × 20mm.

£2·10 FOR BOTH

FANTAVOX STEREO LOUDSPEAKER SYSTEM



These high quality speaker enclosures are made of tough black moulded plastic and have been designed for fitting on to almost any vehicle surface. The smart louvred fronts are silver trimmed and house heavy duty 5in (125mm) ceramic loudspeakers rated at 3/5 watts. 8 ohms impedance. Already wired with generous length connecting leads and supplied in packs of speaker pairs complete with fixing screws. Each cabinet measures 190 × 105 × 165mm. Weight: 0·55 kg.

1052 FADER CONTROL

Neat, custom-made appearance slide fader control for balance of front and rear speaker volume. Simulated wood finish panel which can be quickly fitted below car dash. Supplied with generous connecting cable and fitting screws. Will suit 4, 8, 16 ohm installations. 100 × 38 × 30mm (including knob but excluding fitting bracket).

All for £4·70

420ES MICROSCOPE

An extremely modestly priced yet efficient microscope capable of magnification up to 750 times with clear sharp images. This model is of the self-illuminating type and incorporates an easily rotable four-position turret magnifying lens with rack and pinion focusing. The crackle black metal body houses the batteries for adjustable illumination. Packed in carton with built-in carrying handle and full notes for user. A sample slide also provided. 105mm at base; 180mm high. Weight: 0·40 kg.

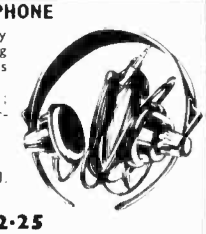
£4·95

G5555 PROFESSIONAL STEREO HEADPHONE

Lightweight materials are skilfully used in the construction of this model in black crackle moulding and kid-soft leathercloth with contrasting bright metal. Each ear pad houses a highly efficient 60mm reproducer unit and features ear muffs removable for cleaning. 10-self-coiled lead plug fitted.
Frequency Response: 20–20,000Hz. Impedance: 4–16 ohms. Sensitivity: 110dB. Power: 0·5W. Weight: 0·39kg.

£9·25

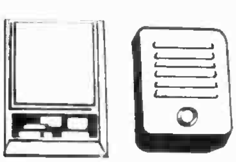
"SPRITE" LIGHTWEIGHT STEREO HEADPHONE



An outstanding achievement following lengthy development by one of the world's leading audio manufacturers, the T.T.C. "Sprite" offers the following specification:
Extreme lightness (only 150 grammes) (5oz);
Instant wearing adjustment with sliding ear-pieces and flexible headband;
Highly efficient Mylar reproducer units;
Removable, washable foam padded ear muffs;
3-metre lightweight lead with stereo plug fitted.
Frequency Response: 30–13,000Hz.
Sensitivity: 105dB. *Power*: 0·2W.
Impedance: 4–16 ohms. *Weight*: 0·15kg.

£2·25

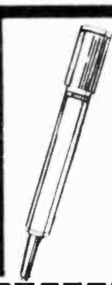
D1019 "Doorphone" with Metal Unit



Three transistor solid state two-way intercom system with specially engineered weatherproof slave unit in heavy gauge metal. Sensible design features include rain protective speaker louvres, simple push-pull button, internal socket connecting lead and removable back plate for wall and door panel mounting. Master unit in high impact white moulding has complementary silver "pinhole" grille and silver/black panels with ON/OFF volume control and push-to-talk switch. 60mm dynamic speaker/microphones are used for both units. 120mW output. 9V internal battery operation. Master unit: 77 × 40 × 105mm. Slave unit: 70 × 32 × 90mm. Supplied with battery, lead and staples.

£3·90

DF100 MICROPHONE



Bijou sized model in matt silver finish with machined capping to insert housing and supplied with unique pocket/lapel clip which also doubles as a desk support. Supplied with lavalier cord, 2 metre lead fitted 3·5mm moulded plug and packed in the latest style click-fast case manufactured from smart durable padded plastic.

Impedance: 200 ohms. Sensitivity: 82dB. Frequency: 100–9,000Hz. Size: 13mm dia. × 92mm.

£3·50

TI-C1000 MINI-METER

£2·70

This is the most compact and reliable multimeter on the market and features easy switch selection, 1,000 ohm/volt 2-jewel meter movement with zero and needle adjustment. Easy to read scale in two colours. Ranges: A.C. Voltage: 0–10V, 50V, 250V, 1,000V. D.C. Voltage: 0–10V, 50V, 250V, 1,000V. D.C. Current: 0–1–100mA. Resistance: 0–150K ohms.

Please fill in the coupon and send with 10p (refundable on ordering) for catalogue. *ALL CALLERS WELCOME*
To G.S.P.K. (Sales) Limited, Dept. P.E.,
Head Office, Hookstone Park, Harrogate, Yorkshire HG2 7BU.
Mon. to Fri. 9 a.m.–5 p.m.

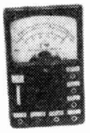
Name ....

Address ....

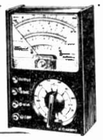
.... P.E.

MULTIMETERS *for EVERY purpose!*

Selected TEST EQUIPMENT

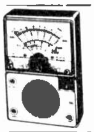


TS60 POCKET MULTIMETER
High-precision at low-cost. Ranges: D.c. 15V, 150V, 1,000V (10,000 O.P.V.). A.c. 15V, 150V, 100V (1,000 O.P.V.). D.c. Current 150mA. Resistance 100k ohms. **£1·85.** Post 15p.



MODEL 1092 Testmeter
5,000 O.P.V.
0/3/15/150/300/1,200V d.c.
0/6/30/300/300 V a.c.
0/300μA/300MA
0/10K/1 meg Ω
Decibels — 10 to + 16 dB
£2·75 each. Post 15p.

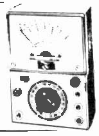
HIOKI MODEL 720X
20,000 O.P.V.
Overload protection
5/25/100/500/1,000V d.c., 10/50/250/1,000V a.c. 50μA/250mA. 20K/2 meg ohm. −5 to +62dB. **£4·97.** Post 15p.



HIOKI MODEL 730X
30,000 O.P.V. Overload protection. 6/30/60/300/600/1,200V d.c. 12/60/120/600/1,200V a.c. 60μA/30mA/300 mA. 2K/200K/2 meg. ohm. −10 to +63dB. **£6·50.** Post 15p.

MODEL TE-200 20,000 O.P.V. Mirror scale, overload protection. 0/5/25/125/1,000V d.c 0/10/50/250/1,000V a.c. 0/50μA/250mA. 0/60K/6 meg Ω. −20 to +62dB. **£3·95.** Post 15p.

MODEL 500 30,000 O.P.V. with overload protection mirror scale 0/0·5/2·5/10/20/25/100/250/500/1,000V d.c. 0/2·5/10/25/100/250/500/1,000V a.c. 0/50μA/5/50/500mA. 12 amp. d.c. 0/60/K/6 Meg./60 MegΩ. **£8·87.** Post paid.

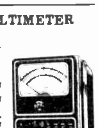


HIOKI MODEL 750X
50,000 O.P.V.
43 ranges 0-0·3 to 1,200V d.c.
0·3 to 1,200V a.c.
0-30μA/300mA.
0·3K/30 meg ohms. −10 to +17dB.
£8·97. Post 20p.

HT100B4 MULTI-METER
Features a.c. current ranges. 100,000 O.P.V. Mirror Scale. Overload protection.
0/0·5/2·5/10/50/250/500/1,000V d.c.
0/2·5/10/50/250/500/1,000V a.c.
0/10/250μA/2·5/25/250MA/10 amp. d.c.
10 amp. a.c. 0/20K/200K/2MEG/20 MEG. −20 +62dB. **£12·50.** Post. 25p.

370 WTR MULTIMETER
Features a.c. current ranges. 20,000 O.P.V.
0/0·5/2·5/10/50/250/500/1,000V d.c.
0/2·5/10/50/250/500/1,000V a.c.
0/50μA/1/10/100mA/1/10 amp. d.c.
0/100mA/1/10 amp. a.c.
0/5K/50K/500K/5MEG/50MEG. −20 +62dB. **£15.** Post 25p.

RUSSIAN 22 RANGE MULTIMETER

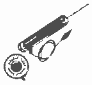


Model U437 10,000 O.P.V. A first class versatile instrument manufactured in U.S.S.R. to the highest standards. Ranges: 2·5/10/50/250/500/1,000V d.c. 2·5/10/50/250/500/1,000V a.c. D.c. current 100wA/1/10/100mA/1A. Resistance 300 ohms/3/30/300K/3mΩ. Complete with batteries, test leads, instructions and sturdy steel carrying case. OUR PRICE **£5·97.** Post 25p.

V.A.T. Information

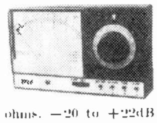
All prices quoted are subject to 10% Value Added Tax.
This must be added to the total value of goods ordered (including postage/carriage).

ROUND SCALE TYPE PENCIL TESTER MODEL TS.68



Completely portable, simple to use pocket sized tester. Ranges 0/3/30/300V a.c. and d.c. at 2,000 O.P.V. Resistance 0-20K ohms. ONLY **£1·97.** Post 13p.

LT 601 MULTI-METER



New style 20,000 O.P.V. pocket multimeter. 5/25/50/250/500/2,500V d.c. 10/50/100/500/1,000V a.c. 50μA/250A. 6K/6 meg ohms. −20 to +22dB. **£3·75.** Post 20p.

MODEL TH-12
20,000 O.P.V. Overload protection. Slide switch selector. 0/0·25/2·5/10/50/250/1,000V d.c. 0/10/50/250/1,000V a.c. 0/50μA/25/250mA d.c. 0/3K/30K/300K/3 meg. −20 to +50dB.
£4·97. Post 15p.

MODEL TE-300. 30,000 O.P.V. Mirror scale, overload protection 0/0·6/3/15/60/300/1,200V d.c. 0/6/30/120/600/1,200V a.c. 0/30μA/6mA/60mA/300mA/600mA. 0/8K/80K/800K/8, meg. ohm −20 to +63dB. **£5·97.** Post 15p.

MODEL PL436
20kΩ/V d.c. 8kΩ/V a.c. Mirror scale. 0·6/3/12/30/120/600V d.c. 3/30/120/600V a.c. 50/600μA/60/600mA. 10/100K/1 Meg/10 MegΩ. −20 to +46dB. **£6·97.** Post 12p.

TMK MODEL TW-50K 46 ranges, mirror scale, 50K/V d.c. 5K/V a.c. D.c.: Volts 0·125, 0·25, 1·25, 2·5, 5, 10, 25, 50, 125, 250, 500, 1,000V. A.c. Volts: 1·5, 3, 5, 10, 25, 50, 125, 250, 500, 1,000V. D.c. Current: 25, 50μA, 2·5, 5, 25, 50, 250, 500mA, 5, 10 amp. Resistance: 10K, 100K, 1 MEG, 10 MEG Ω. Decibels: −20 to +81·5dB. **£8·50.** Post 17p.

MODEL K228A

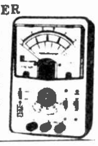
Taut band suspension. Overload protection. Polarity reversing switch. 30,000 O.P.V. 0/0·5/2·5/15/50/250/500/1,000/2,500V d.c. 0/15/50/150/500/1,000V a.c. 0/50μA/5/50/150/500mA/5A d.c. 0/3K/300K/3meg. **£8·95.** Post 20p.

HIOKI MODEL 700X
100,000 O.P.V. Overload protection. Mirror scale. 0·3/0·6/1·2/1·5/8/6/12/30/60/120/300/600/1,200V d.c. 1·5/3/6/12/30/60/150/300/600/1,200V a.c. 15/30μA/3/6/30/60/150/300mA 6/12 amp. d.c. 2K/200K/2 Meg/20 Meg ohm −20 to +63dB. **£13·50.** Post 20p.

MODEL C-7080 EN
Giant 6in mirror scale. 20,000 O.P.V. 0/0·25/1/2·5/10/50/250/1,000/5,000V d.c. 0/2·5/10/50/250/1,000/5,000V a.c. 0/50μA/1/10/100/500mA/10 amp. d.c. 0/2K/200K/20 meg. −20 to +50dB.
£13·95. Post 35p.

U4312 MULTIMETER
Extremely sturdy instrument for general electrical use, 667 O.P.V.
0/0·3/1·5/7·5/30/60/150/300/600/900V d.c. and 75mV.
0/0·3/1·5/7·5/30/60/150/300/600/900V a.c.
0/300μA/1·5/6/15/60/150/600MA/1·5/6 amp. d.c.
0/1·5/15/60/150/600MA/1·5/6 amp. a.c. 0/200Ω/3k/30kΩ. Accuracy Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions. **£9·50.** Post 25p.

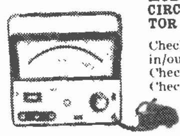
FTC-401 TRANSISTOR TESTER



Full capabilities for measuring A, B and ICO. *npn* or *pnp*. Equally adaptable for checking diodes. Supplied complete with instructions, battery and leads. **£7·50.** Post 20p.

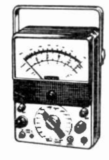
Model S-100TR MULTIMETER/TRANSISTOR TESTER. 100,000 O.P.V. mirror scale/overload protection. 0/0·12/0·6/3/12/30/120/600V d.c. 0/6/30/120/600V a.c. 0/12/600μA/12/300mA/12 amp. d.c. 0/10 K/1 MEG/100 MEG. −20 to +50dB. 0·01–2 MFD. Transistor tester measures Alpha, beta and Ico. Complete with batteries, instructions and leads. **£13·50.** Post 25p.

MODEL 449A IN CIRCUIT TRANSISTOR TESTER



Checks true a.c beta in/out. Checks Icbo. Checks diodes in/out. Checks SCR, etc. Beta H1 10 - 500 LO 2—50 Icbo 0-5000μA. 220/240V a.c. operation. **£17·50.** Post 25p.

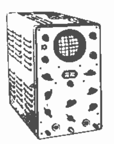
KAMODEN HM720B F.E.T. V.O.M.



Input impedance 10MΩ. Ranges: 0/0 25/1/2·5/10/50/250/1,000V d.c. 0/2·5/10/50/250/1,000V a.c. 0/25μA/2·5/25/250MA d.c. −20 to +62dB. 0/5k/50k/500k/5MΩ/500MΩ. **£14·95.** Post 30p.

MODEL L-55 FET V.O.M.

Input impedance 10 meg ohms. 0/0·3/1·2/6/30/120/600V d.c. 0/3/12/60/120/600V a.c. 0/120μA/120mA d.c. 0/1K/100K/10 meg/100 meg ohms. **£15·97.** Post 25p.



CI-5 PULSE OSCILLOSCOPE
For display of pulsed and periodic waveforms in electronic circuits VERT. AMP. Bandwidth 10MHz. Sensitivity at 100kHz V RMS/mm. 0·1-25; HOR. AMP. Bandwidth 500kHz. Sensitivity at 100kHz, V RMS/mm. 0 3-25; Pre-set triggered sweep 1-3,000μsec.; free running 20-200,000Hz in nine ranges. Calibrator pips. 220mm × 360mm × 430mm, 115-230V a.c. operation. **£39.** Carr. paid.

TO-3 PORTABLE OSCILLOSCOPE

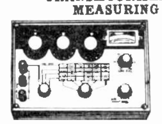
3in tube, Y amp. Sensitivity 0·1V p-p/CM. Bandwidth 1·5cps-1·5MHz. Input imp. 2 meg Ω 25pF X amp. sensitivity 0·9V. p-p/CM. Bandwidth 1·5cps-800kHz. Input imp. 2 meg Ω 20pF Time base. 5 ranges 10cps-300kHz. Synchronisation. Internal/external. Illuminated scale 140mm × 215mm × 330mm. Weight 15½lb. 220/240V a.c. Supplied brand new with handbook. **£47·50.** Carr. 50p.

RUSSIAN CI-16 DOUBLE BEAM OSCILLOSCOPE

5MHz Pass Band. Separate Y1 and Y2 amplifiers. Rectangular 5in × 4in C.R.T. Calibrated triggered sweep from 0·2μ/sec to 100 milli-sec per cm. Free running time base 50 Hz-1MHz. Built-in time base calibrator and amplitude calibrator. Supplied complete with all accessories and instruction manual. **£87.** Carr. paid.

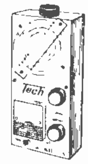
TE-16A Transistorised Signal Generator. 5 ranges 400kHz—30MHz. An inexpensive instrument for the handyman. Operates on 9V battery. Wide easy to read scale. 800kHz modulation. 5¼in × 5¼in × 3¼in. Complete with instructions and leads. **£7·97.** Post 25p.

TRANSISTORISED L.C.R. A.C. MEASURING BRIDGE



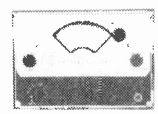
A new portable bridge offering excellent range and accuracy at low cost. Ranes: R. 1Ω–11·1 megΩ. 6 Ranges ±1%. L.1 μH — 111 HENRYS 6 Ranges ±2%. C.10pF — 1110 mFd. 6 Ranges ±2%. TURNS RATIO 1:1/1000–1:11100. 6 Ranges – 1%. Bridge voltage at 1,000cps. Operated from 9V 100μA. Meter indication. Attractive 2 tone metal case. Size 7¾in × 5in × 2in. **£20.** Post 25p

MODEL TE15 GRID DIP METER

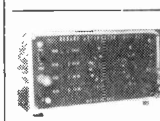


Transistorised. Operates as Grid Dip. Oscillator, Absorption Wave Meter and Oscillating Detector. Frequency range 440kHz–280MHz in 6 coils. 500μA meter. 9V battery operation. Size 180mm × 80mm × 40 mm.
£12·50. Post 20p.

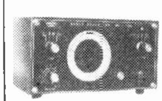
BELCO AF-5A SOLID STATE SINE SQUARE WAVE C.R. OSCILLATOR



Sine 18-200,000 Hz: Square 18-50,000 Hz. Output max. +10dB (10 K ohms) Operation internal batteries. Attractive 2-tone case 7⅜in × 5in × 2in. Price **£17·50.** Carr. 17p.



MODEL MG-100 SINE SQUARE WAVE AUDIO GENERATOR
Range 19-220,000 Hz. Sine Wave 19 - 100,000Hz. Square Wave. Output Sine or Square wave 10V. P. to P. Size 180mm × 90mm × 90mm. Operation 220/240V a.c.
£17·50. Post 37p.



MODEL AT201 DECADE ATTENUATOR
Frequency range 0-200kHz. Attenuator 0-111dB, 0·1dB step. Impedance 600 ohms. Max. Input power 30dBm. Size 180mm × 90mm × 55mm.
£12·50. Post 37p.

TE-65 VALVE VOLTMETER

28 ranges. D.c. volts 1·5–1,500V a.c. volts 1·5–1,500V. Resistance up to 1,000 megohms. 200/240V a.c. operation. Complete with probe and instructions. **£17·50.** Post 30p. Additional probes available: R.F. **£2·12**; H.V. **£2·50.**

MODEL U4311 SUB-STANDARD MULTI-RANGE VOLT AMMETER

Sensitivity 330 ohms/Volt a.c. and d.c. Accuracy 0·5% d.c. 1% a.c. Scale length 165mm. 0/300/750μA/1·5/3/7·5/15/30/75/150/300/750mA/1·5/3/7·5 amp. d.c. 0/3/7·5/15/30/75/150/300/750mA/1·5/3/7·5 amp. a.c. 0/75/150/300/750mV/1·5/3/7·5·15·30/75/150/300/750V d.c. 0/750mV/1·5/3/7·5/15/30/75/150/300/750V a.c. Automatic cut out. Supplied complete with test leads, manual and test certificates. **£49.** Post 50p.

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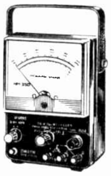
Also see opposite page and next two pages

KAMODEN 72.200 MULTITESTER

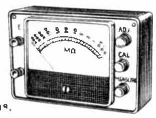
High sensitivity tester. 200,000 o.p.v. Overload protection. Mirror scale. Ranges: 0/0·06/0·3/3/30/120/600/1,200V d.c., 0/3/12/60/300/1,200V a.c. 0/6μA / 1·2mA / 120mA / 600mA / 12A d.c. 0/12A a.c. −20 to +63dB. 0/2kΩ / 200kΩ / 2MΩ / 200 MΩ. **£16·95.** Post 30p.

KAMODEN HM-350 TRANSISTOR TESTER

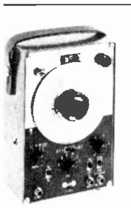


High quality instrument to test Reverse Leak current and D.C. current. Amplification factor of NPN, PNP, transistors, diodes, SCR's, etc. 4" × 4¾" clear scale meter. Operates from internal batteries. Complete with instructions, leads and carrying handle. **£12 50.** Post 30p.

KAMODEN HMG-500 INSULATION RESISTANCE TESTER



Range 0–1,000 Megohms, 500 Volt. Battery operated. Wide range clear meter 4¾" × 4". Complete with de-luxe carrying case, batteries, instructions. **£19·95.** Post 30p.



ARF-300 AF/RF SIGNAL GENERATOR

All transistorised, compact, fully portable. AF sine wave 18 Hz to 220 KHz. AF square wave 18 Hz to 100 KHz. Output sine/square 10v. P.P. RF 100 KHz to 200 MHz. Output 1v. maximum. Operation 220/240v. AC. Complete with instructions and leads. **£29·95.** Post 50p.

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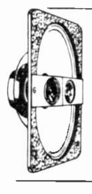

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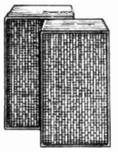

SPECIAL OFFER! STEREO SPEAKERS

Matched pair of stereo bookshelf speakers. Deluxe teak veneered finish. Size: 14½in × 9in × 7½in. 8 ohms. 8W RMS. 16W peak. Complete with DIN lead. **£12·95.** Carr. 50p.

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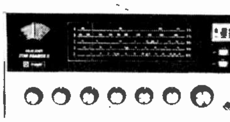
4 Bands covering 550kHz–30MHz. BFO. Built-in Speaker 220/240V a.c. Brand new with instructions. **£15·75.** Carr. 37p.

UR-1A SOLID STATE COMMUNICATION RECEIVER

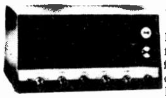
4 Bands covering 550kHz–30MHz. FET. S Meter. Variable BFO for SSB. Built-in Speaker, Bandspread. Sensitivity Control. 220/240V a.c. or 12V d.c. 12¾in × 4¾in × 7in. Brand new with instructions. **£25.** Carr. 37p.

SKYWOOD CX203 COMMUNICATION RECEIVER

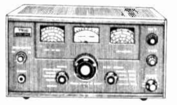


Solid state. Coverage on 5 bands 200–420 kHz and 0·55 to 30MHz. Illuminated slide rule dial. Bandspread. Aerial tuning. BFO, AVC, ANL, "S" meter. AM/CW/SSB. Integrated speaker and phone socket. Operation 220/240V a.c. or 12V d.c. Size 325 × 266 × 150 mm. Complete with instructions and circuit. **£32·50.** Carr. 50p.

LAFAYETTE HA-600 SOLID STATE RECEIVER

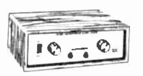


General coverage 150–400kHz, 550 kHz–30MHz. FET front end. 2 mech. filters, product detector, variable BFO, noise limiter. S Meter, Bandspread. RF Gain. 15in × 9¾in × 8½in. 18lbs. 220/240V a.c. or 12V d.c. Brand new with instructions. **£50.** Carr. 50p.



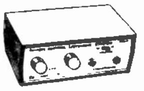
TRIO 9R59DS COMMUNICATION RECEIVER

4 band covering 550kHz–30MHz continuous and electrical bandspread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. SSB-CW. ANL. Variable BFO. S meter. Sep. bandspread dial. IF frequency 455kHz. Audio output 1·5W. Variable RF and AF gain controls 115/250V a.c. Size 7in × 13in × 10in with instruction manual. **£49 50.** Carr. paid.



HA-10 STEREO HEADPHONE AMPLIFIER

All silicon transistor amplifier operates from magnetic, ceramic or tuner inputs with twin stereo headphone outputs and separate volume controls for each channel. Operates from 9V battery. Inputs 5MV/100MV. Output 50MW. **£5·97.** Post 15p.



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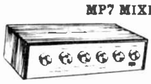
For balancing and gain selection of loudspeakers with additional facility for stereo headphone switching. 2 gain controls, speaker on-off slide switch, stereo headphone sockets. 6in × 4in × 2½in. **£2·25.** Post 15p.

MP7 MIXER PREAMPLIFIER



5 microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. 9½in × 5in × 3in. Inputs Mics: 3 × 3mV 50K: 2 × 3mV 600 ohm. Phono meg. 4mV 50K. Phono ceramic 100mV 1 meg. Output 250mV 100K. **£8·97.** Post 20p.

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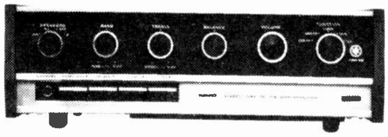

17+17W r.m.s. stereo amplifier with inputs for Magnetic and Crystal phono, Tuner, Tape, Aux and Tape Monitor. Outputs for two pairs of stereo speakers and tape. Stereo headphone socket. Full range of controls including loudness control, scratch filter, etc. Size 13in × 9¾in × 3¾in.

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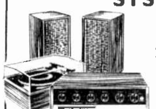
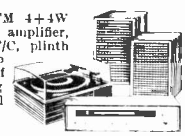


NIKKO TRM50 17+17W rms stereo amplifier, Garrard AP76 plinth and cover, Goldring G800E cartridge, pair of Linton 2 speakers and all leads.

OUR PRICE **£93·95** Carr. and Ins. £1·50

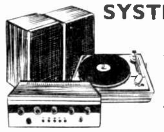
MONOTONE 6750 SYSTEM



Monotone AM/FM 4+4W stereo tuner amplifier, Garrard 2025 T/C, plinth and cover, stereo cartridge, pair of matching speakers and all leads.

OUR PRICE **£30·50** Carr. and Ins. £1

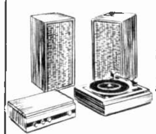
LEAK DELTA 30 SYSTEM



Leak Delta 30 stereo amplifier, Goldring GL75, plinth, cover and G800 cartridge. Pair of Leak 150 speakers and all leads.

OUR PRICE **£109·95** Carr. and Ins. £1·50

WHARFEDALE LINTON SYSTEM



Wharfedale Linton Amplifier, Linton Turntable, pair of Linton 2 speakers and all leads.

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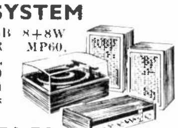
LINTON RECEIVER SYSTEM £125. Carr. and Ins. £1·50.

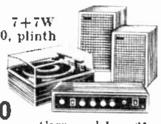
TELETON SAQ206B SYSTEM



Teleton SAQ206B 8+8W amplifier BSR MP60, plinth and cover, Goldring G800 cartridge, pair of Apollo speakers and all leads.

OUR PRICE **£51·50** Carr. and Ins. £1·50

AMSTRAD 8000 II SYSTEM



Amstrad 8000 II 7+7W amplifier. BSR MP60, plinth and cover, Goldring G800 cartridge, pair of Apollo speakers and all leads.

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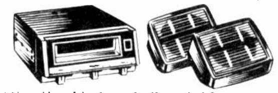
AUDIOTRONIC ACP-8 8-TRACK CAR PLAYER



Attractive black and silver finish. 12V neg. earth. Slider controls for volume, tone and balance. Channel selector button with red pilot lamp. Complete with speakers, mounting brackets and instructions.

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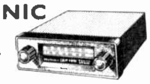

Manual tuning of Medium and Long waves. 12V pos. or neg. earth. Complete with speaker, mounting brackets and instructions.

OUR PRICE **£6·50** P. & P. 50p

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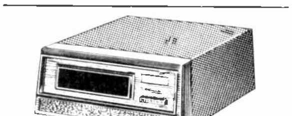

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Integrated preamps (output 125mV) to feed into any stereo amplifier. Automatic and manual programme selector. 4 pole synchronous motor. 210/240V a.c.

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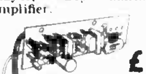

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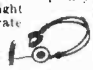

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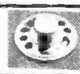
MINI LOUDSPEAKERS



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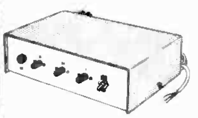

Three Channel: Bass—Middle—Treble. Each channel has its own sensitivity control. Just connect the input of this unit to the loudspeaker terminals of an amplifier, and connect three 250V up to 500W lamps to the output terminals of the unit, and you produce a fascinating sound-light display. (All guaranteed)
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A top quality speaker ideal where small size is important. Manufactured by E.M.I. for a well-known hi-fi set maker. Size: 7in × 4in. Impedance: 8 ohms. Flux: 38,000. Max. Free range: 90Hz to 12kHz. Power handling: 5W. Unbeatable. Price: **£1·60**. Free postage on this item.

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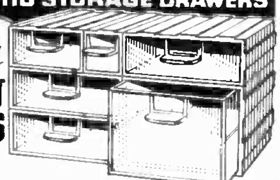

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300 Watt—**£2·97.** Kit Form **£2·42**

All plus 10p post and packing
Prices include V.A.T.

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The largest selection

NEW LOW PRICED TESTED S.C.R.'S

PIV

	50	100	200	400	600	800
	£p	£p	£p	£p	£p	£p
1A TO5	0·25½	0·27½	0·38½	0·47½	0·58½	0·69½
3A TO66	0·27½	0·36½	0·40½	0·51½	0·62½	0·77
5A TO66	0·38½	0·51½	0·54	0·61½	0·75	0·88
5A TO64	0·38½	0·51½	0·54	0·61½	0·75	0·88
7A TO48	0·51½	0·55	0·62½	0·73½	0·84½	0·99
10A TO48	0·55	0·64	0·67	0·82½	1·06½	1·32
16A TO48	0·58½	0·69½	0·82½	1·02½	1·37½	1·65
30A TO48	1·26½	1·54	1·76	1·92½	—	4·40

SIL. RECTS. TESTED

PIV	300mA DO7	750mA SO16	1A Plastic	1·5A SO16	3A SO10	10A SO10	30A SO32A
50	0·04	0·05½	0·05½	0·07½	0·15½	0·23	0·66
100	0·04	0·06½	0·05½	0·14½	0·17½	0·25½	0·82½
200	0·05½	0·10	0·06½	0·15½	0·22	0·26½	1·10
400	0·06½	0·14½	0·07½	0·22	0·30	0·40½	1·37½
600	0·07½	0·17½	0·11	0·25½	0·37½	0·49½	2·04½
800	0·11	0·18½	0·12	0·27½	0·40½	0·60½	2·20
1000	0·12	0·27½	0·15½	0·33	0·50½	0·69½	2·75
1200	—	0·36½	—	0·42	0·62½	0·82½	—

TRIACS

VBOM	2A TO-5	6A TO-66	10A TO-48
	£p	£p	£p
100V	33	55	82½
200V	55	66	99
400V	77	82½	1·21

DIACS

FOR USE WITH TRIACS
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BRAND NEW TEXAS GERM. TRANSISTORS

Coded and Guaranteed

Pak No.			EQVT
T1	8	2G3713	OC71
T2	8	D1374	OC75
T3	8	D1216	OC81D
T4	8	2G381T	OC81
T5	8	2G382T	OC82
T6	8	2G344B	OC44
T7	8	2G345B	OC45
T8	8	2G378	OC78
T9	8	2G399A	2N1302
T10	8	2G417	AF117

All 55p each pak

2N2060 NPN SIL. DUAL TRANS. CODE D1699 TEXAS. Our price **28p** each.

120 VCB NIXIE DRIVER TRANSISTOR. Sim: BSX21 & C407, 2N1893 FULLY TESTED AND CODED ND 120. 1-24 **19p** each. TO-5 N.P.N. 25 up **17p** each.

Sil. trans. suitable for P.E. Organ. Metal TO-18 Eqvt. ZTX300 5½p each. Any Quantity.

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400mW (DO-7 Case), range 2–33V, **14½p** each. 1·5W (Top-Hat), range 2–33V. **20p** each. 10W (SO-10 Stud), range 2–33V, **33p** each.

10 amp POTTED BRIDGE RECTIFIER

on heat sink.
100PIV. 99p each

NEW LINE

Plastic Encapsulated
2 Amp. BRIDGE RECTS.

50V RMS	35p each
100V RMS	40½p each
400V RMS	50½p each

Size 15mm × 6mm.

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Direct replacement for TIS43 and BEN3000 also electrically equivalent to 2N2646 Qty.: 1–24 **30p** each. 25–99 **27½p** each. 100+ **22p** each.

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ORP12 47½p
ORP60, ORP61 44p each

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		£p
20	For	0·55
50	For	1·10
100	For	1·92
500	For	8·25
1000	For	14·30

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300mW	30	0·55
40PIV(Min.)	100	1·65
Sub-Min.	500	5·50
Full Tested	1,000	9·90

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Pak No.	Description	Price
U 1	120 Glass Sub-Min. General Purpose Germanium Diodes	0·55
U 2	60 Mixed Germanium Transistors AF/RF	0·55
U 3	75 Germanium Gold Bonded Sub-Min. like OA5, OA47	0·55
U 4	40 Germanium Transistors like OC81, AC128	0·55
U 5	60 200mA Sub-Min. Silicon Diodes	0·55
U 6	30 Sil. Planar Trans. NPN like BSY95A, 2N706	0·55
U 7	16 Sil. Rectifiers TOP-HAT 750mA VLTG. RANGE up to 1000	0·55
U 8	50 Sil. Planar Diodes DO-7 Glass 250mA like OA200/202	0·55
U 9	20 Mixed Voltages, 1 Watt Zener Diodes	0·55
U10	20 BAY50 charge storage Diodes DO-7 Glass	0·55
U11	25 PNP Sil. Planar Trans. TO-5 like 2N1132, 2N2904	0·55
U12	12 Silicon Rectifiers Epoxy 500mA up to 800 PIV	0·55
U13	30 PNP-NPN Sil. Transistors OC200 & 2S 104	0·55
U14	150 Mixed Silicon and Germanium Diodes	0·55
U15	25 NPN Sil. Planar Trans. TO-5 like BFY51, 2N697	0·55
U16	10 3 Amp Silicon Rectifiers Stud Type up to 1000PIV	0·55
U17	30 Germanium PNP AF Transistors TO-5 like ACY 17-22	0·55
U18	8 6 Amp Silicon Rectifiers BYZ13 Type up to 600 PIV	0·55
U19	25 Silicon NPN Transistors like BC108	0·55
U20	12 1·5 Amp Silicon Rectifiers Top Hat up to 1000 PIV	0·55
U21	30 AF. Germanium Alloy Transistors 2G300 Series & OC71	0·55
U23	30 MADT's like MHz Series PNP Transistors	0·55
U24	20 Germanium 1 Amp Rectifiers GJM Series up to 300 PIV	0·55
U25	25 300MHz NPN Silicon Transistors 2N708, BSY27	0·55
U26	30 Fast Switching Silicon Diodes like IN914 Micro-Min.	0·55
U27	12 NPN Germanium AF Transistors TO-1 like AC127	0·50
U29	10 1 Amp SCR's TO-5 can, up to 600 PIV CRS1/25-600	1·15
U30	15 Plastic Silicon Planar Trans. NPN 2N2926	0·55
U31	20 Silicon Planar Plastic NPN Trans. Low Noise Amp 2N3707	0·55
U32	25 Zener Diodes 400mW DO-7 case 3–18 volts mixed	0·55
U33	15 Plastic Case 1 Amp Silicon Rectifiers IN4000 Series	0·55
U34	30 Silicon PNP Alloy Trans. TO-5 BCY26 2S302/4	0·55
U35	25 Silicon Planar Transistors PNP TO-18 2N2906	0·55
U36	25 Silicon Planar NPN Transistors TO-5 BFY50/51/52	0·55
U37	30 Silicon Alloy Transistors SO-2 PNP OC200, 2S322	0·55
U38	20 Fast Switching Silicon Trans. NPN 400MHz 2N3011	0·55
U39	30 RF. Germ. PNP Transistors 2N1303/5 TO-5	0·55
U40	10 Dual Transistors 6 lead TO-5 2N2060	0·55
U41	25 RF Germanium Transistors TO-5, OC45, NKT72	0·55
U42	10 VHF Germanium PNP Transistors TO-1 NKT667, AF117	0·55
U43	25 Sil. Trans. Plastic TO-18 A.F. BC113/114	0·55
U44	20 Sil. Trans. Plastic TO-5 BC115/NPN	0·55
U45	7 3A SCR. TO66 up to 600PIV	1·10

Code No's. mentioned above are given as a guide to the type of device in the pak. The devices themselves are normally unmarked.

QUALITY TESTED SEMICONDUCTORS

Pak No.		Price £p
Q 1	20 Red spot transistors *pnp*	0·55
Q 2	16 White spot R.F. transistors *pnp*	0·55
Q 3	4 OC77 type transistors	0·55
Q 4	6 Matched transistors OC44/45/81/81D	0·55
Q 5	4 OC75 transistors	0·55
Q 6	5 OC72 transistors	0·55
Q 7	4 AC128 transistors *pnp* high gain	0·55
Q 8	4 AC126 transistors *pnp*	0·55
Q 9	7 OC81 type transistors	0·55
Q10	7 OC71 type transistors	0·55
Q11	2 AC127/128 Complementary pairs *pnp/npn*	0·55
Q12	3 AF116 type transistors	0·55
Q13	3 AF117 type transistors	0·55
Q14	3 OC171 H.F. type transistors	0·55
Q15	7 2N2926 Sil. Epoxy transistors mixed colours	0·55
Q16	2 GET880 low noise Germanium transistors	0·55
Q17	5 *npn* 2 × ST.141 & 3 × ST.140	0·55
Q18	4 MADT'S 2 × MAT 100 & 2 × MAT 120	0·55
Q19	3 MADT'S 2 × MAT 101 & 1 × MAT 121	0·55
Q20	4 OC44 Germanium transistors A.F.	0·55
Q21	4 AC127 *npn* Germanium transistors	0·55
Q22	20 NKT transistors A.F. R.F. coded	0·55
Q23	10 OA202 Silicon diodes sub-min.	0·55
Q24	8 OA81 diodes	0·55
Q25	15 IN914 Silicon diodes 75PIV 75mA	0·55
Q26	8 OA95 Germanium diodes sub-min IN69	0·55
Q27	2 10A 600 PIV Silicon rectifiers IS425R	0·55
Q28	2 Silicon power rectifiers BYZ13	0·55
Q29	4 Silicon transistors 2 × 2N696, 1 × 2N697, 1 × 2N698	0·55
Q30	7 Silicon switch transistors 2N706 *npn*	0·55
Q31	6 Silicon switch transistors 2N708, *npn*	0·55
Q32	3 *pnp* Silicon transistors 2 × 2N1131, 1 × 2N1132	0·55
Q33	3 Silicon *npn* transistors 2N1711	0·55
Q34	7 Silicon *npn* transistors 2N2369, 500MHz (code P397)	0·55
Q35	3 Silicon *pnp* TO-5. 2 × 2N2904 & 1 × 2N2905	0·55
Q36	7 2N3646 TO-18 plastic 300MHz *npn*	0·55
Q37	3 2N3053 *npn* Silicon transistors	0·55
Q38	7 *pnp* transistors 4 × 2N3703, 3 × 2N3702	0·55

ELECTRONIC SLIDE-RULE

The MK Slide Rule, designed to simplify Electronic calculations features the following scales:—Conversion of Frequency and Wavelength. Calculation of L, C and fo of Tuned Circuits. Reactance and Self Inductance. Area of Circles. Volume of Cylinders. Resistance of Conductors. Weight of Conductors. Decibel Calculations. Angle Functions. Natural Logs and "e" Functions. Multiplication and Division. Squaring, Cubing and Square Roots. Conversion of kW and Hp. A must for every electronic engineer and enthusiast. Size: 2cm × 4cm. Complete with case and instructions. Price each: **£3·68½**

SILICON PHOTO TRANSISTOR. TO-18 Lens end NPN Sim. to BP×25 and P21. BRAND NEW. Full data available. Fully guaranteed.

Qty.	1-24	25-99	100 up
Price each	69p	44p	38p

F.E.T.'S

2N3819	31p	2N5458	35p
2N3820	55p	2N5459	44p
2N3821	38½p	BFW10	66p
2N3823	31p	MPF105	40½p

INTEGRATED CIRCUIT PAKS

Manufacturers' "Fall Outs" which include Functional and Part-Functional Units. These are classed as 'out-of-spec' from the maker's very rigid specifications, but are ideal for learning about I.C.'s and experimental work.

Pak No. Contents	Price	Pak No. Contents	Price	Pak No. Contents	Price
UIC00 = 12 × 7400	0·55	UIC46 = 5 × 7446	0·55	UIC86 = 5 × 7486	0·55
UIC01 = 12 × 7401	0·55	UIC47 = 5 × 7447	0·55	UIC90 = 5 × 7490	0·55
UIC02 = 12 × 7402	0·55	UIC48 = 5 × 7448	0·55	UIC91 = 5 × 7491	0·55
UIC03 = 12 × 7403	0·55	UIC50 = 12 × 7450	0·55	UIC92 = 5 × 7492	0·55
UIC04 = 12 × 7404	0·55	UIC51 = 12 × 7451	0·55	UIC93 = 5 × 7493	0·55
UIC05 = 12 × 7405	0·55	UIC53 = 12 × 7453	0·55	UIC94 = 5 × 7494	0·55
UIC06 = 8 × 7406	0·55	UIC54 = 12 × 7454	0·55	UIC95 = 5 × 7495	0·55
UIC07 = 8 × 7407	0·55	UIC60 = 12 × 7460	0·55	UIC96 = 5 × 7496	0·55
UIC10 = 12 × 7410	0·55	UIC70 = 8 × 7470	0·55	UIC100 = 5 × 74100	0·55
UIC13 = 8 × 7413	0·55	UIC72 = 8 × 7472	0·55	UIC121 = 5 × 74121	0·55
UIC20 = 12 × 7420	0·55	UIC73 = 8 × 7473	0·55	UIC141 = 5 × 74141	0·55
UIC30 = 12 × 7430	0·55	UIC74 = 8 × 7474	0·55	UIC151 = 5 × 74151	0·55
UIC40 = 12 × 7440	0·55	UIC75 = 8 × 7475	0·55	UIC154 = 5 × 74154	0·55
UIC41 = 5 × 7441	0·55	UIC76 = 8 × 7476	0·55	UIC193 = 5 × 74193	0·55
UIC42 = 5 × 7442	0·55	UIC80 = 5 × 7480	0·55	UIC199 = 5 × 74199	0·55
UIC43 = 5 × 7443	0·55	UIC81 = 5 × 7481	0·55		
UIC44 = 5 × 7444	0·55	UIC82 = 5 × 7482	0·55	UICX1 = 25 Assorted 74's	1·65
UIC45 = 5 × 7445	0·55	UIC83 = 5 × 7483	0·55		

Paks cannot be split, but 25 assorted pieces (our mix) is available as PAK UIC X1.

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GENERAL PURPOSE GERM. PNP

Coded GP100. BRAND NEW TO-3 CASE. POSS. REPLACE:—OC25-28-29-30-35-36. NKT 401-403-404-405-406-430-451-452-453. T13027-3028, 2N250A, 2N456A-457A-458A, 2N511 A & B. 2G220-222, ETC. VCBO 80V VCEO 50V IC 10A PT. 30 WATTS Hfe 30–170.

PRICE	1–24	25–99	100 up
	47p each	44p each	40p each

SILICON High Voltage 250V NPN TO-3 case. G.P. Switching & Amplifier Applications. Brand new Coded R 2400 VCBO 250/VCEO 100/IC 6A/30 Watts. HFE type 20/fT 5MHZ.
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55p	50p	44p

2N3055

115 WATT SIL POWER NPN
55p EACH

AD161/162 PNP

M/P COMP GERM TRANS.
OUR LOWEST PRICE OF 60p *PER PAIR*

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SN7401	0·16½	0·15½	0·13	SN7489	6·05	5·77½	5·50
SN7402	0·16½	0·15½	0·13	SN7490	0·73½	0·70½	0·64
SN7403	0·16½	0·15½	0·13	SN7491	1·10	1·04½	0·99
SN7404	0·16½	0·15½	0·13	SN7492	0·73½	0·70½	0·64
SN7405	0·16½	0·15½	0·13	SN7493	0·73½	0·70½	0·64
SN7406	0·38½	0·34	0·31	SN7494	0·84½	0·81½	0·75
SN7407	0·38½	0·34	0·31	SN7495	0·84½	0·81½	0·75
SN7408	0·20	0·18½	0·17½	SN7496	0·95½	0·92½	0·86
SN7409	0·20	0·18½	0·17½	SN74100	1·81½	1·76	1·70½
SN7410	0·16½	0·15½	0·13	SN74104	1·06½	1·03½	0·97
SN7411	0·27½	0·26½	0·25½	SN74105	1·06½	1·03½	0·97
SN7412	0·38½	0·34	0·31	SN74107	0·44	0·42	0·39½
SN7413	0·32	0·28½	0·26½	SN74110	0·60½	0·58½	0·55
SN7416	0·47½	0·44	0·42	SN74111	1·37½	1·26½	1·21
SN7417	0·47½	0·44	0·42	SN74118	1·10	1·04½	0·99
SN7420	0·16½	0·15½	0·13	SN74119	1·48½	1·37½	1·21
SN7422	0·55	0·53	0·49½	SN74121	0·44	0·40½	0·37½
SN7423	0·55	0·53	0·49½	SN74122	1·54	1·43	1·21
SN7425	0·55	0·53	0·49½	SN74123	3·08	2·97	2·86
SN7426	0·49½	0·46	0·44	SN74141	0·73½	0·70½	0·64
SN7427	0·49½	0·46	0·44	SN74145	1·65	1·54	1·43
SN7428	0·77	0·71½	0·66	SN74150	3·30	2·97	2·75
SN7430	0·16½	0·15½	0·13	SN74151	1·10	1·04½	0·99
SN7432	0·49½	0·46	0·44	SN74153	1·32	1·21	1·04½
SN7433	0·88	0·82½	0·77	SN74154	1·98	1·87	1·76
SN7437	0·70½	0·68	0·66	SN74155	1·54	1·43	1·32
SN7438	0·70½	0·68	0·66	SN74156	1·54	1·43	1·32
SN7440	0·16½	0·15½	0·13	SN74157	2·09	1·98	1·87
SN7441	0·73½	0·70½	0·64	SN74160	1·98	1·87	1·76
SN7442	0·73½	0·70½	0·64	SN74161	1·98	1·87	1·76
SN7443	1·43	1·37½	1·32	SN74162	4·40	4·12½	3·85
SN7444	1·43	1·37½	1·32	SN74163	4·40	4·12½	3·85
SN7445	1·98	1·94½	1·92½	SN74164	2·42	2·36½	2·31
SN7446	1·06½	1·03½	0·97	SN74165	2·47½	2·42	2·36½
SN7447	1·10	1·06½	1·04½	SN74166	3·85	3·57½	3·30
SN7448	1·10	1·06½	1·04½	SN74174	2·53	2·42	2·31
SN7450	0·16½	0·15½	0·13	SN74175	1·76	1·65	1·54
SN7451	0·16½	0·15½	0·13	SN74176	2·75	2·64	2·53
SN7453	0·16½	0·15½	0·13	SN74177	2·75	2·64	2·53
SN7454	0·16½	0·15½	0·13	SN74180	2·20	1·76	1·54
SN7460	0·16½	0·15½	0·13	SN74181	6·05	5·50	5·22½
SN7470	0·32	0·28½	0·26½	SN74182	2·20	1·98	1·76
SN7472	0·32	0·28½	0·26½	SN74184	3·85	3·57½	3·30
SN7473	0·40½	0·38½	0·35	SN74190	2·14½	2·09	2·03½
SN7474	0·40½	0·38½	0·35	SN74191	2·09	2·03½	1·98
SN7475	0·49½	0·47½	0·46	SN74192	2·14½	2·09	2·03½
SN7476	0·44	0·43	0·42½	SN74193	2·20	1·98	1·92½
SN7480	0·73½	0·70½	0·64	SN74194	2·97	2·86	2·75
SN7481	1·32	1·26½	1·21	SN74195	2·20	2·09	1·98
SN7482	0·95½	0·94½	0·93½	SN74196	1·98	1·87	1·76
SN7483	1·21	1·15½	1·04½	SN74197	1·98	1·87	1·76
SN7484	1·10	1·04½	0·99	SN74198	6·05	5·50	4·95
SN7485	3·96	3·85	3·74	SN74199	6·05	5·50	4·95

LINEAR I.C.'s—FULL SPEC.

Type No.	Price 1–24	25–99	100+
BP201C—SL201C	0·69½	0·58½	0·49½
BP710C—SL701C	0·69½	0·55	0·49½
BP702C—SL702C	0·69½	0·55	0·49½
BP702—72702	0·58½	0·49½	0·44
BP709—72709	0·39½	0·37½	0·33
BP709P—µA709C	0·39½	0·37½	0·33
BP710—72710	0·48½	0·46	0·44
BP711—µA711	0·49½	0·47½	0·44
BP741—72741	0·55	0·50	0·45
µA703C	0·31	0·28½	0·26½
TAA263	0·77	0·66	0·60½
TAA293	0·99	0·82½	0·77
TAA350	1·87	1·74	1·65
EA1000	2·89½		

ROCK BOTTOM PRICES LOGIC DTL 930 Series I.C's

Type No.	Price 1–24	25–99	100 up
BP930	0·13	0·12	0·11
BP932	0·14	0·13	0·12
BP933	0·14	0·13	0·12
BP935	0·14	0·13	0·12
BP936	0·14	0·13	0·12
BP944	0·14	0·13	0·12
BP945	0·27½	0·26½	0·24
BP946	0·13	0·12	0·11
BP948	0·27½	0·26½	0·24
BP951	0·71½	0·66	0·60½
BP962	0·13	0·12	0·11
BP9093	0·44	0·42	0·38½
BP9094	0·44	0·42	0·38½
BP9097	0·44	0·42	0·38½
BP9099	0·44	0·42	0·38½

NUMERICAL INDICATOR TUBES

MODEL	CD66	GR116	3015F Minitron
Anode Voltage (Vdc)	170min	175min	5
Cathode Current (mA)	2·3	14	8
Numerical Height (mm)	16	13	9
Tube Height (mm)	47	32	22
Tube Diameter (mm)	19	13	12 wide
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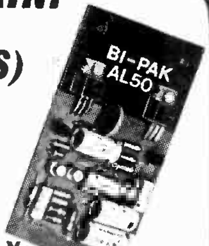

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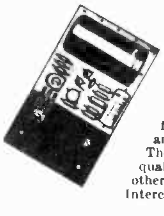

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STEREO RADIO WITHOUT TEARS

THE stereo tuner described this month has a number of interesting features which reflect some of the current approaches to domestic receiver design, as practised by set manufacturers.

In the field of domestic radio receivers, the integrated circuit has yet to make its full contribution. Various subsections of the conventional superheterodyne circuit have been designed and produced in monolithic form, but all these devices require additional discrete components in order to function. Thus the apparent labour- and material-saving advantages of i.c.s are largely nullified. The chief problem is one of inductances and capacitances. This real difficulty associated with monolithic circuits has encouraged further investigation into less conventional receiver designs where there is no dependence on LC tuned circuits. For example, the phase-locked-loop or synchronous detector receiver has been much discussed of late, as a likely future substitute for the classic superhet.

The i.c. has however made a noteworthy contribution to stereo receiver design. Single chip phase-locked decoders have been around for some time, and they represent perhaps the most highly developed integrated circuitry, with the highest component density, found at present in a sound receiver. A less exciting but important function performed by the i.c. is as a power supply regulator—a vital role in v.h.f. receivers incorporating varicapacitance diode (truly electronic) tuning.

The completely integrated high quality receiver will emerge eventually; whether as a single chip, or as a set of two or three i.c.s each covering a major portion of the system, only the i.c. and set designers and manufacturers will have a clue at this moment in time. While awaiting the inevitable, the ultimate in integration, set makers have in recent years been employing several methods. One popular approach is a different form of integration—using pre-adjusted circuit modules, containing conventional discretes. Mass production of complex receivers is thus greatly simplified and the need for critical alignment operations on the assembly line eliminated.

This approach has obvious attractions for the home constructor, especially where a complicated and highly sensitive piece of equipment such as a stereo tuner is concerned. This month's design illustrates the use of modules, i.c.s, and discrete components. Thus as a system it is interesting and instructive. It demonstrates how available circuit devices can be judiciously co-ordinated to produce a "state of the art design" for the modestly equipped home constructor.—F.E.B.

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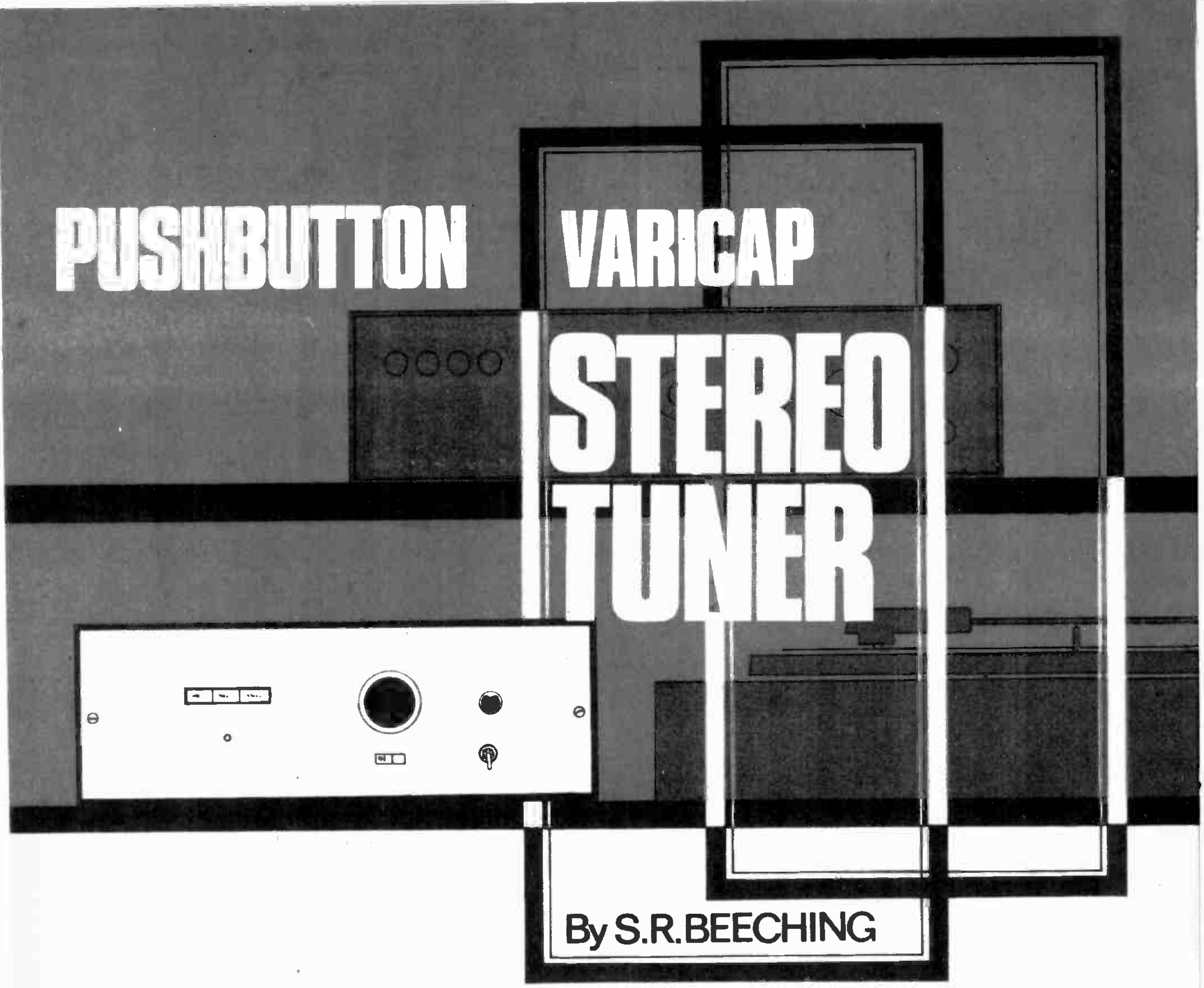
PUSHBUTTON VARICAP STEREO TUNER



By S.R.BEECHING

Up to recent times the only methods of tuning radios were either the variable capacitor or the variable inductor. Using either system the result was the same, mechanics in the form of pulleys and pointers were needed to physically move either the vanes of the capacitor or the core of the inductor. Any constructor who attempted to build such a radio faced not only these mechanical problems but also the problem of alignment, particularly difficult in v.h.f. radios.

Two new tuner modules recently produced by Mullard go a long way to overcoming all these difficulties; they are pre-aligned and the tuning is electronic, not mechanical, i.e. there are no moving parts.

VARICAP TUNING

The tuner module uses a "varicap" diode for varying the tuning frequency. A varicap diode is one which takes advantage of the fact that the width of the depletion layer in a reverse biased diode varies with the reverse voltage. Thus one is effectively changing the gap between two plates of a capacitor. The capacitances involved are small and thus at the moment varicap tuning is restricted to v.h.f. tuners.

In the Mullard LP1186 module the tuning is carried out by applying a voltage between 2 and 17 volts to its input. Because the tuning is electronic this opens up a whole field of possibilities, in particular that of remote tuning.

THE MODULES

The tuner module type LP1186 has three stages, a tuned aerial and r.f. stage, giving good image and i.f. rejection, a separate oscillator stage for good signal handling, and a mixer stage with a double-tuned i.f. output circuit. The main characteristics of this module are shown in Table 1.

The LP1185 is an f.m.-i.f. amplifier module whose main characteristics are summarised in Table 2. Both modules require a supply voltage of 9V and this is also adequate to cover the broadcast band when applied to the varicap diode.

Cover photo by courtesy of London Electricity

Only a few components are needed around the modules for decoupling and de-emphasis. Automatic frequency control (a.f.c.) is available though this may be removed by shorting to ground when tuning weak stations.

STEREO DECODER

An MC1310P integrated circuit stereo decoder is used to split the output of the LP1185 into right and left channel signals. The integrated circuit has the advantage over some of the earlier types in that it needs no coils. It has automatic stereo switching and an indicator driver capable of driving a 60mA bulb. A light emitting diode (l.e.d.) is shown in the circuit together with a resistor necessary to drop the voltage to the 1·5V needed for an l.e.d.

Table 3 gives some of the data on the i.c. stereo decoder.

CIRCUIT DIAGRAM

The full circuit diagram excluding the tuning unit and the power supply are shown in Fig. 1. The input from the aerial is fed into pin B of the tuner module. The tuning voltage is applied to pin C. Capacitor C1 is only really necessary if there is a large separation between the tuning unit and the tuner and may be omitted. A.F.C. is taken from pin F of the output module and fed back to pin D of the tuner. Switch S1 removes this a.f.c. by shorting to earth.

The signal is then fed into pin 2 of the stereo decoder. D1 is the stereo indicator lamp. VR1 is used to adjust the frequency of voltage controlled oscillator which forms part of the stereo decoder.

Components C9, R4, C10, R5 are de-emphasis components needed to compensate for the pre-emphasis of the high frequency signals which is introduced at the transmission end.

Output is taken to the DIN output socket via C11 and C12.

Table 1: SUMMARY OF THE CHARACTERISTICS OF THE LP1186 F.M. TUNER MODULE

Tuning range	87·4 to 104·5MHz
Tuning voltage	2 to 12V
Bandwidth at −3dB points	300kHz
Aerial impedance	75Ω
Power gain (f_{in} = 95MHz)	30dB
Noise factor (f_{in} = 95MHz)	6·5dB

Table 2: SUMMARY OF THE CHARACTERISTICS OF THE LP1185 F.M.-I.F. AMPLIFIER MODULE

Centre frequency	10·7MHz ± 50kHz
I.F. bandwidth at −3dB points	250kHz
Sensitivity for 40mV output	300μV (min) 60μV (max)
F.M. output at limiting (1mV input)	180mV
Signal-to-noise level with 150μV input	60dB
A.M. rejection	40dB

Table 3: SUMMARY OF THE CHARACTERISTICS OF THE MC1310P STEREO DECODER I.C.

Maximum input signal	500mV r.m.s.
Pilot capture range	±3%
Distortion	<0·3%
Maximum stereo indicator current	70mA

POWER SUPPLY

In a varicap tuner the power supply is very important as the tuning voltage must be very stable and ripple free. The power supply circuit is shown in Fig. 2.

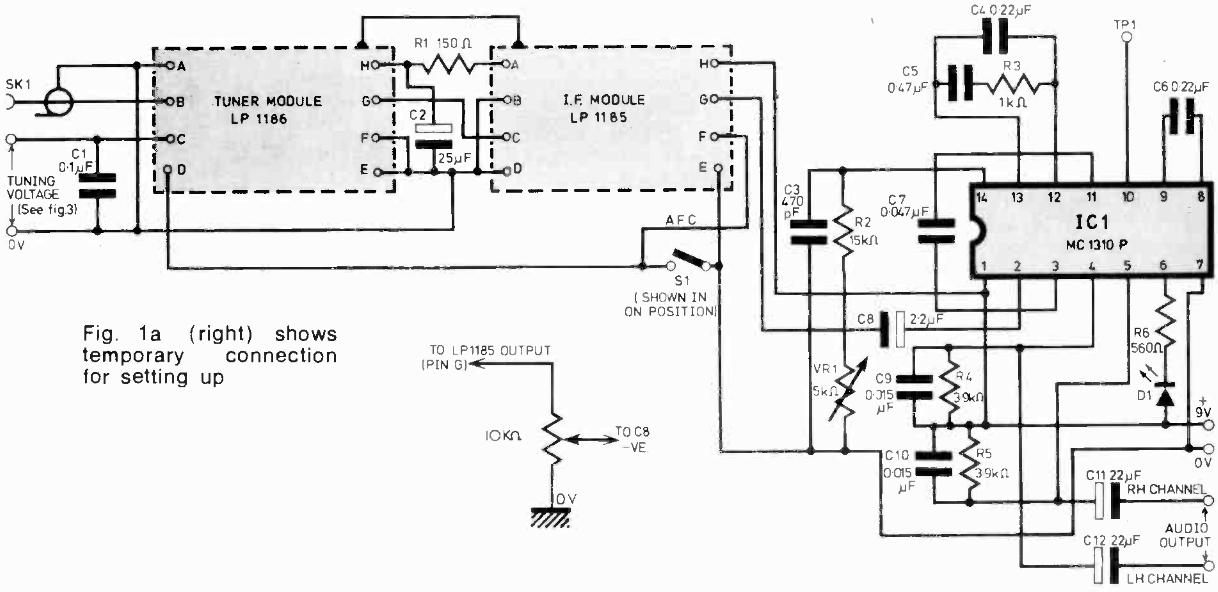


Fig. 1a (right) shows temporary connection for setting up

Fig. 1. Circuit diagram of the stereo tuner. The shaded boxes indicate ready built pre-aligned units. The tuning voltage unit is shown in Fig. 3

Photograph of the complete tuner showing the front panel layout

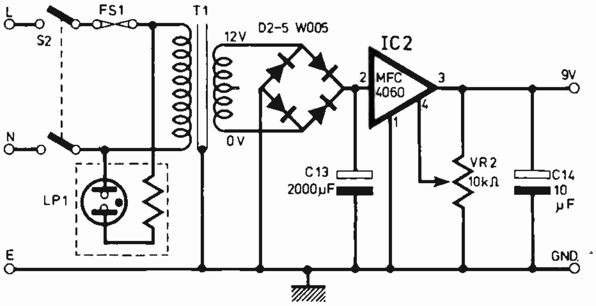


Fig. 2. Circuit diagram of the power supply unit. This not only supplies power to the modules but also provides the stabilised voltage necessary for tuning

The low voltage from the transformer is rectified by the diode bridge D2–5, smoothed by the large capacitor C13 and applied to the input of the integrated circuit regulator IC2. VR2 is used to tap off a fraction of the output voltage to feed back into the input of the i.c. Here it is compared with a reference voltage generated within the i.c. and the output is adjusted to make the two equal. Thus VR2 can be used to accurately set the output voltage.

The i.c. used will keep the output voltage to within 0·2 per cent of the nominal voltage for loads up to 100mA and within 0·03 per cent of nominal for power supply variations, provided that there is more than three volts between input and output. Because this i.c. also supplies the stereo decoder and hence the stereo indicator lamp it is best to keep the lamp current as low as possible hence the use of an l.e.d.

TUNING UNIT

As mentioned earlier, a tuning voltage of between two and nine volts will adequately cover the normal broadcast band. A suggested switching system is shown in Fig. 3. This system gives two preset stations and one manually variable setting. The number of preset stations may be extended *ad infinitum* depending only on the number of push buttons in the unit.

The circuit board shown will accommodate six preset potentiometers. Thus a six-button unit or a six-way rotary switch can be used.

Padding resistors are added at either end of the potentiometers so that fine tuning is easier, although this somewhat restricts the tuning range. Fig. 4 shows the relationship between tuning voltage and frequency and this allows calculations to be carried out on the best settings for each station. The padding resistors are mounted with the potentiometers forming small pillars.

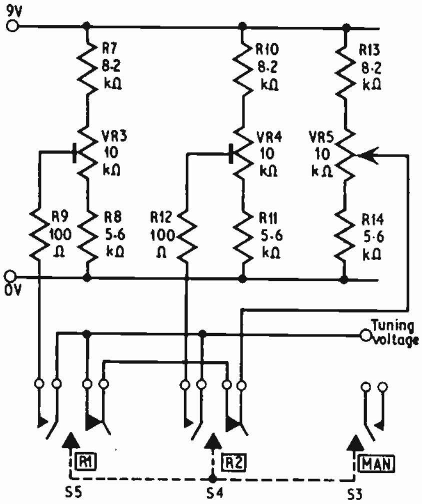


Fig. 3. A suggested tuning unit. This provides two preset voltages with a third manually variable voltage. The number of preset voltages really only depends on the size of the push button unit. There is also no reason why this tuning unit should not be mounted remote from the tuner itself. S3 is simply used to cancel the other two switches

CONSTRUCTION

Construction is simple if the printed circuit board (Fig. 5) or the layout recommended are followed. Note that the orientation of the i.c.s is critical, a small spot indicates pin 1. Assemble the power supply components first (Fig. 6). Set VR2 to midway then switch on and test the output with a voltmeter, adjusting VR2 to give a 9V output.

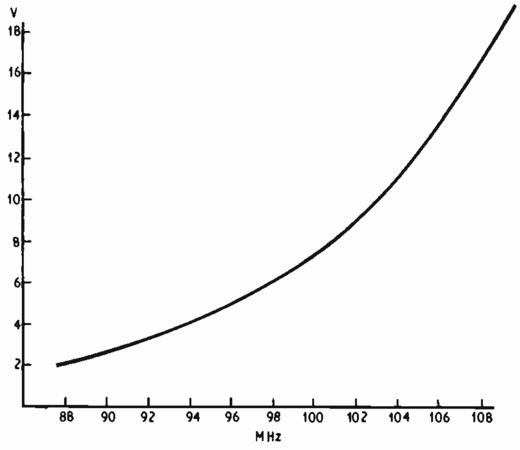


Fig. 4. Relationship between the tuning voltage and the frequency as measured in the prototype

CIRCUIT BOARD

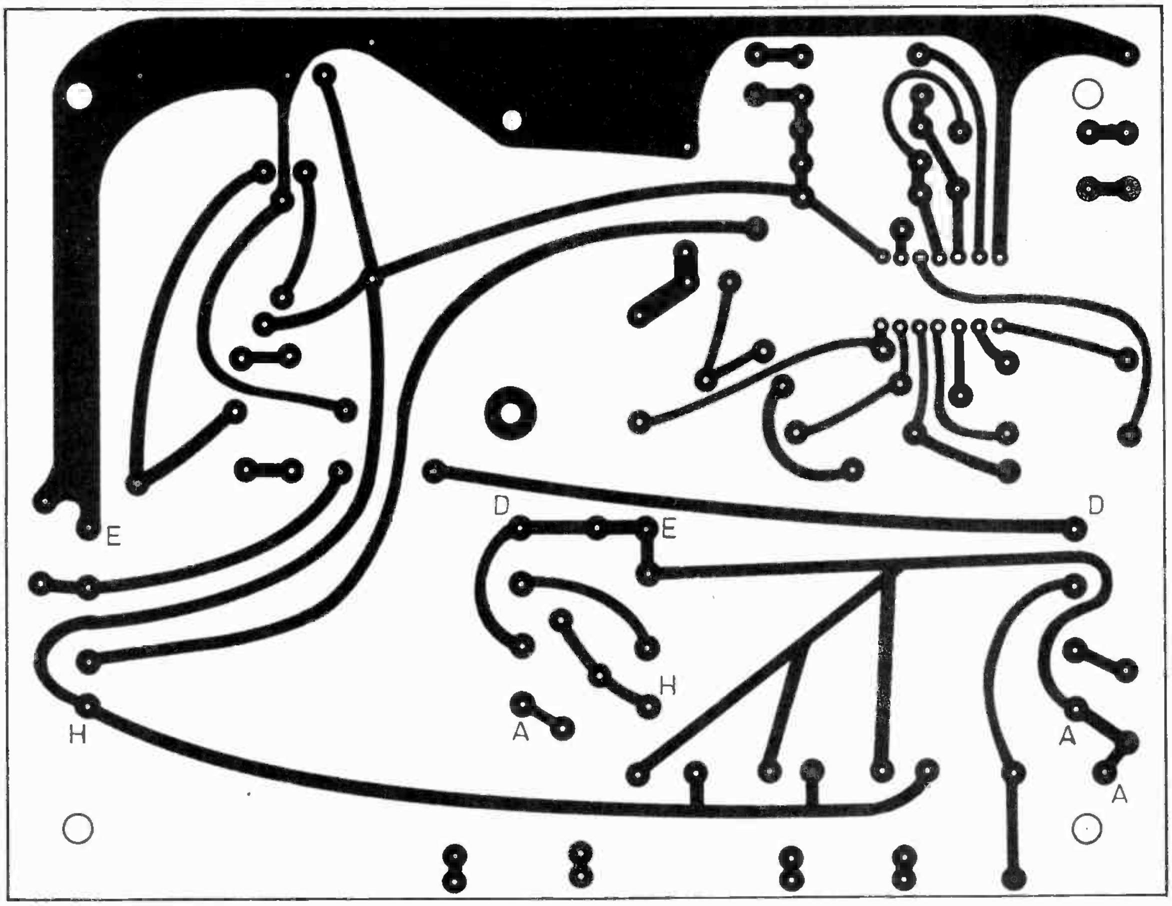


Fig. 5. The underside of the printed circuit board. The black areas indicate copper, the white areas being etched away

COMPONENTS . . .

Resistors

R1	150Ω	R4	3·9kΩ	R7	8·2kΩ	R10, R13	8·2kΩ
R2	15kΩ	R5	3·9kΩ	R8	5·6kΩ	R11, R14	5·6kΩ
R3	1kΩ	R6	560Ω	R9	100Ω	R12	100Ω

All ¼W ± 10% carbon except R2 5%

Potentiometers

- VR1 5kΩ skeleton preset
- VR2 10kΩ skeleton preset
- VR3, VR4 10kΩ skeleton preset (2 off)
- VR5 10kΩ carbon linear

Capacitors

C1	0·1μF	C8	2·2μF 64V elect.
C2	25μF 12V elect.	C9	0·015μF
C3	470pF 2%	C10	0·015μF
C4	0·22μF	C11	22μF 25V elect.
C5	0·47μF	C12	22μF 25V elect.
C6	0·22μF	C13	2,000μF 25V elect.
C7	0·047μF	C14	10μF 16V elect.

Diodes

- D1 Light emitting diode 1·5V 20mA (West Hyde)
- D2–5 W005 or any 50 p.i.v. ½A bridge rectifier

Integrated Circuits

- IC1 Motorola MC1310P
- IC2 Motorola MFC4060

Transformer

- T1 Mains primary, 12V 100mA secondary

Modules

- Tuner Module Mullard Type LP1186
- I.F. Module Mullard Type LP1185

Switches

- S1 Miniature rocker or slide on/off switch
- S2 Miniature d.p.d.t. toggle switch
- S3–5 3 way pushbutton unit, each switch cancelling the other two

Miscellaneous

- FS1 100mA fuse and fuseholder
- SK1 Coaxial socket
- SK2 5 pin 180° DIN socket, panel mounting
- LP1 Mains neon indicator with integral resistor
- PL1 Mains panel mounting plug Bulgin type P360
- 3-way tag strip, printed circuit board, case, 6BA and 8BA nuts and bolts

Printed circuit board and modules can be obtained from B & B Electronics, 64 Manners Road, Balderton, Newark, Notts.

After checking the power supply attach the other components. Note the link between the cases of the two modules. Do not attach C8 at this stage. Push button units vary as to the type of contact arrangement. If you are not sure use a continuity tester, e.g. a battery and bell or lamp to find two contacts which make when the appropriate button is pressed.

As mentioned before there is no reason why the push button units should not be mounted remote from the tuner.

SETTING UP AND TESTING

Prior to testing and final setting up, ensure that a good aerial is available and also an amplifier for monitoring. A v.h.f. aerial will be needed for low noise stereo although a v.h.f. television aerial or a length of wire will suffice for initial checks.

Before setting up is explained, some description of the stereo decoder is useful to understand what is going on. Fig. 7 shows a block diagram of the stereo decoder i.c.

The audio input is buffered and separated from the 19kHz pilot tone which is fed to two modulators which act as phase discriminators; modulator 1 is the input to the phase locking loop and modulator 2 is used as the stereo detector and indicator. Each provide an output which is proportional to the phase difference between the pilot input and the regenerated 19kHz signal (TP1). The output from modulator 1 controls the frequency of a 76kHz oscillator which is then divided by two to give a 38kHz signal necessary for decoding. The regenerated 38kHz is divided by two to give 19kHz which is fed back to the modulators, forming part of the phase locked loop.

If this regenerated 19kHz differs in phase from the 19kHz pilot then the modulator will correct the 76kHz oscillator thus locking it to the pilot tone. The resultant output from modulator 2 triggers a Schmitt trigger which switches on the stereo indicator and feeds the regenerated 38kHz to the decoder. With mono transmissions the audio comes out of the decoder outputs simultaneously, no pilot tone being present.

INTERWIRING

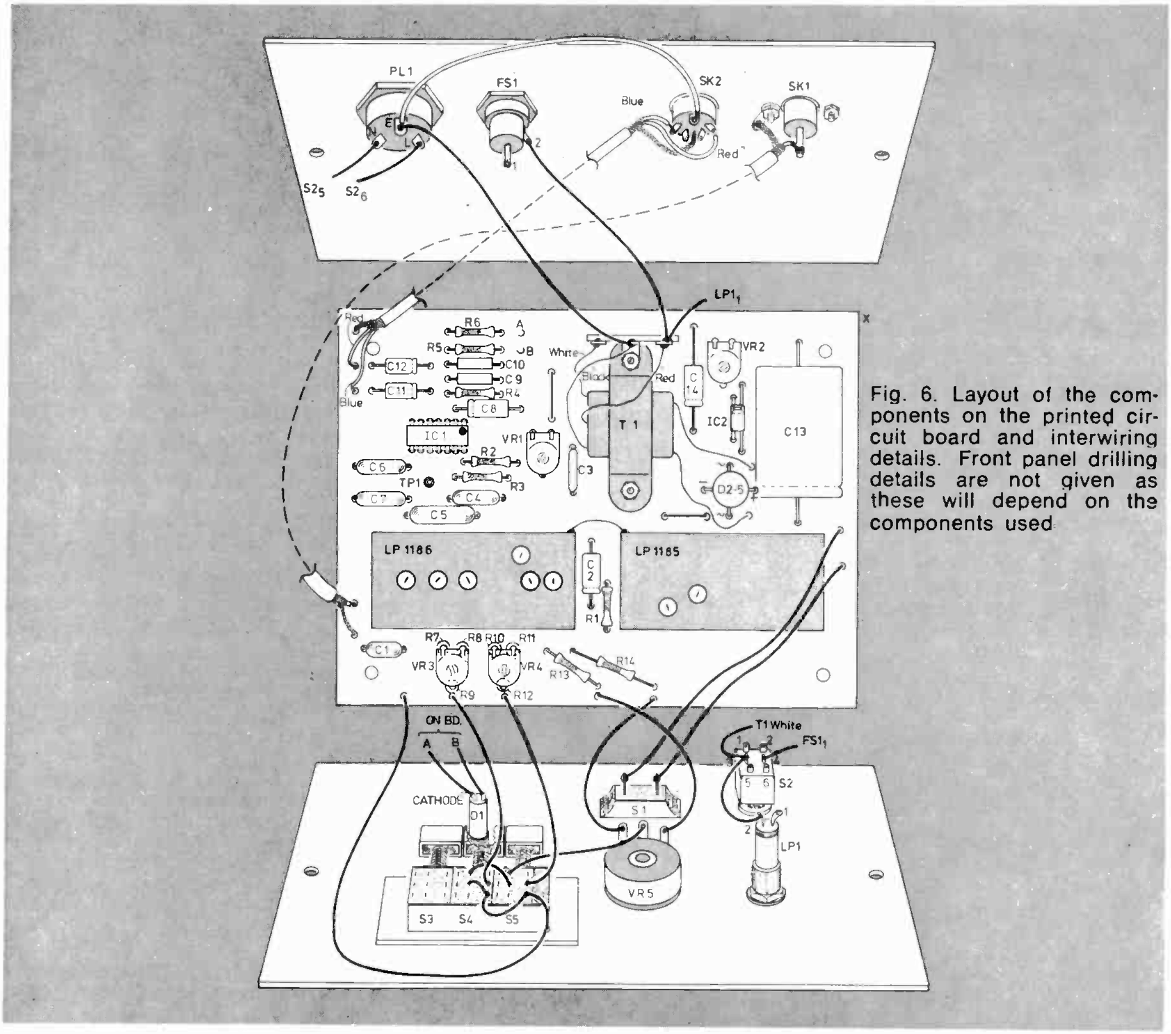


Fig. 6. Layout of the components on the printed circuit board and interwiring details. Front panel drilling details are not given as these will depend on the components used

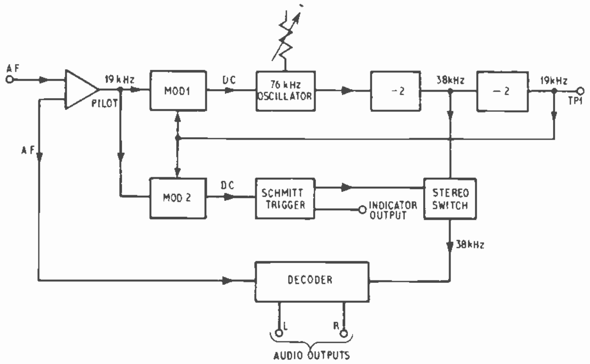


Fig. 7. Block diagram of the MC1310P stereo decoder i.c

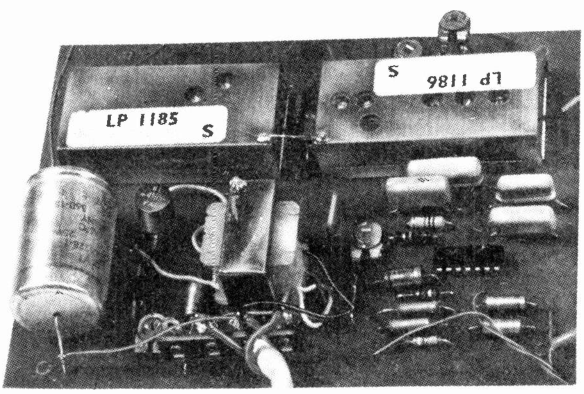
OSCILLATOR ADJUSTMENT

There are two ways to set VR1, the object being to set the oscillator to 76kHz with no pilot or input signal.

Connect the tuner to an aerial and an amplifier with C8 in position on the board, then switch on. It should be possible to tune into a station at least in mono (ignore the indicator lamp if it should come on). Switch off the a.f.c. and tune slightly away from the station, then switch back to a.f.c.; the station should pull in, if the signal is strong. Leave the a.f.c. on and tune to a known stereo broadcast. Rotate VR1 until the stereo indicator just lights and a stereo output is heard. There will probably be a good deal of background noise especially with a poor aerial.

If an oscilloscope is available monitor TP1 with the tuner locked onto a station. Remove the input signal and reset the frequency to this measured value.

An alternative method of setting up is to reduce the signal level to the decoder thus reducing the range of VR1. Connect the positive end of C8 to the board but connect a 10 kilohm potentiometer between its negative end and the LP1185 output (see Fig. 1a). Switch on and tune to a stereo broadcast then adjust this potentiometer to give maximum audio output. Adjust VR1 until the stereo indicator lights then alternately reduce the output with the potentiometer and adjust VR1 until the setting of VR1 is very sharp or critical, this being the correct setting. ★



Photograph of the internal layout of the tuner

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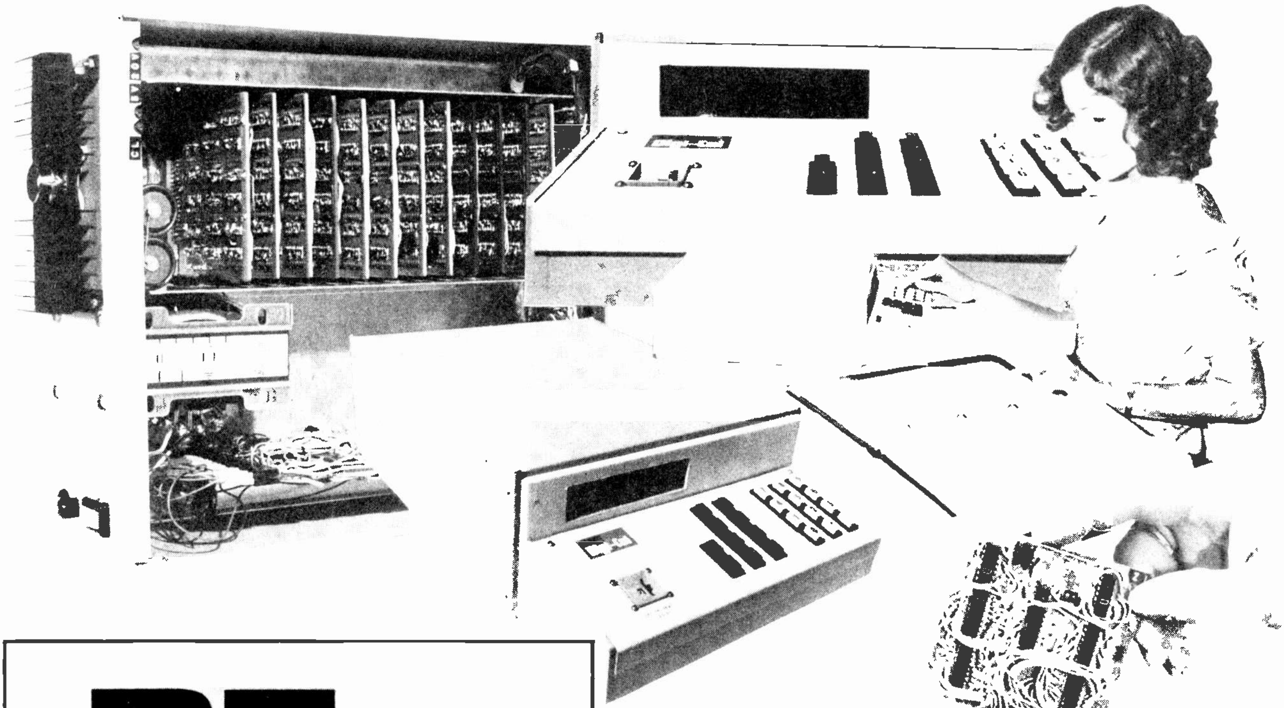


PE

By R.W.COLES

PART 11

OVERFLOW LOGIC AND OVF BOARD

THIS final part of the Digi-Cal series describes the remaining logic housed on the under-chassis overflow (OVF) board, and attempts to knit together the loose ends which have been left dangling in earlier articles. Testing and troubleshooting information is also given.

OVERFLOW (OVF) BOARD

The existence of the OVERFLOW board was established in Part 2, when it was mentioned that this board is mounted copper side uppermost under the chassis, spaced from it by two 6BA nuts on each of the supporting bolts.

The OVF identity was not given to this board in Part 2 but is used here for ease of reference, the majority of the logic housed on this board being concerned with the OVERFLOW circuitry.

The Veroboard panel itself is mounted in the copper up fashion to facilitate the use of this board as an interconnection and power bus medium in addition to its job of housing logic. This mounting method also permits the easy addition of circuitry without access to the underside of the board, the only compromise necessary being that of neatness, since the solder is "on display" together with the components.

INTERCONNECTIONS

The OVF board carries the +5V and ground line power buses, from which the other logic cards are supplied. Any other logic lines which are employed, e.g. the FUNCTION CODE A and B are also allocated a copper strip for bus use to permit a tapping to be made where required.

Programme functions are distributed from the OVF board by means of a series of terminal pins which act as distribution points, the decision as to which functions require this treatment being left to the individual constructor as layouts will undoubtedly vary.

OVERFLOW LOGIC

The OVERFLOW logic is required to detect and indicate any errors resulting from the incorrect operation of the calculator, indication being provided via the red OVF lamp on the keyboard. If this lamp comes on at all during a calculation then an improper operation has been attempted and the only course open is to depress the CLEAR key which also resets the OVF circuits.

There are several ways in which an error condition can occur, an error being a state which would result in an incorrect answer being given. Detection of these states requires a combination of three separate logic groups whose areas of responsibility are as follows:

(a) ENTRY OVERFLOW. If too many digits are entered into the E REGISTER, the most significant data can be destroyed by being shifted out of the end of the register. This condition must be detected.

(b) A REGISTER OVERFLOW. If during a multiplication sequence, the product exceeds the capacity of the A REGISTER then the CARRY STORE will stay set at the end of an addition which is an indication of OVERFLOW.

(c) ANSWER OVERFLOW. The Digi-Cal A REGISTER has a ten digit capacity although only eight digits are displayed, the other two positions in the register being for transient use during programme execution. Should either of these two positions contain other than zeros at the end of a programme sequence then an OVERFLOW has occurred.

This type of OVERFLOW can occur during ADDITION, MULTIPLICATION and when a negative answer is produced in complement form.

OVF CIRCUITS

The active circuitry of the OVF board is shown in Fig. 11.1, where it can be seen that in addition to the OVF logic proper, IC141 and IC146 perform the functions of constant store buffering and E^2 gating respectively.

Bistable BS2 of IC144 acts as the common OVF latch, which is set by an output from any of the three separate OVERFLOW detection circuits, and which controls the OVF lamp driver on the KEYBOARD logic board. The OVF latch is cleared when the CLEAR key is depressed in response to an OVF indication.

The NOR section of IC145 which is a four-wide two-input AND-OR-INVERT gate combines the inputs from three detection circuits to drive the BS2 PRESET input, an output from any of the three resulting in a SET LATCH signal.

ENTRY OVERFLOW LOGIC

IC142 and G1 of IC143 are used to detect E REGISTER overflows. The system used here to monitor the B.C.D. outputs of the most significant digit position of the register with IC142, which, in this application, can be considered as a four-input positive NOR gate with a common disable input.

The output of IC142 is gated with the E CLOCK to generate the OVF output when necessary.

Gate IC142 is in fact waiting for one or more of its inputs to go to a logic 1, indicating that the most significant digit of the E REGISTER contains other than decimal zero.

On the arrival of a further clock pulse an error output is generated to set the latch.

A problem arises here since by using the straightforward E CLOCK an error output would be produced one step too early. What is really needed is an E CLOCK "pre-pulse" which comes and goes before the register itself is clocked. At first sight this is an impossible requirement to meet; however, by using the inherent propagation delays of the gates involved, such an arrangement can be achieved.

What happens is that when a B.C.D. output other than zero appears in the most significant position of the register a 1 input to pin 9 of IC145 results.

Much later, when another number key is pressed the rising E CLOCK on IC145, pin 10 will result in an error output to pin 8, setting the latch. Even before the clock rises on pin 10, the unbuffered E CLOCK operates the common disable input connected to pins 1, 3, 5 and 9 of IC142 removing the 1 input to IC145, pin 9.

The result at the output of IC145 is an extremely narrow pulse which in practice could be too narrow to set the latch BS2. The way to stretch this pulse is to increase the propagation delay through IC142 and G1 of IC143, and this can be conveniently achieved by increasing the capacitive load on the output of IC142.

A capacitor C_x is shown on the diagram and can be added if the error output is found to be too short on test; the value used should be between 200pF and 1,000pF.

No such capacitor was necessary on the prototype.

A REGISTER OVERFLOW LOGIC

The operation of the A REGISTER detection logic is quite straightforward; in this case the task is simply to detect the presence of a stored carry at the end of ten clock pulses during a multiplication or addition.

The rising edge of the END OF TEN output from board CB triggers a monostable made up of BS1 of IC144 and G2 of IC143. The indication that the clock sequence is at an end is gated with the CARRY SENSE output from board AD, in G3.

The output of G3 is gated with an inverted FUNCTION CODE A (which is an indication of the arithmetic operation being performed) in the AND section of IC145 to produce the ERROR output at pin 8.

ANSWER OVERFLOW LOGIC

Detecting an integer in the two most significant A REGISTER positions seems on the face of it to be quite straightforward, but in practice such considerations as lack of space on the A boards to install i.c. gates, and lack of edge contacts on the A boards to allow external i.c. gates pose some problems.

The only practical solution is to construct a special gate using discrete components which operates as a positive logic NOR. This design requires only the installation of four diodes, and the utilisation of only one edge contact on each A board.

The problem of the low logic 1 levels associated with TTL outputs is overcome by clamping the emitter of TR22 of the gate to about $\frac{1}{2}V_{cc}$, and using TR23 to regenerate suitable logic levels to interface with IC145 pin 13.

Pin 1 of IC145 gates the ERROR output from the discrete component gate with what is effectively an END OF PROGRAMME signal (DISPLAY A) so that valid transient outputs from TR23 during programme execution have no effect on the OVF LATCH.

OVF BOARD

DESTINATION OF OVF TERMINATIONS

- **a** ENTER K (from keyboard)
- **b** RECALL K (from keyboard)
- **c** E^2 (from programme)
- **d** TRANSFER A to Z (from programme)
- **e** A1/25, A2/25
- **f** DISPLAY A (from programme)
- **g** AD/36
- **h** CB/35
- **i** FUNCTION CODE A (from keyboard)
- **j** ED/3
- **k** E3/32
- **l** E3/31
- **m** E3/30
- **n** E3/29
- **o** ED/4
- **p** CLEAR (from keyboard)
- **q** E1/28, E2/28, E3/28
- **r** E1/27, E2/27, E3/27
- **s** Z1/25
- **t** Z2/24
- **u** OVF (to keyboard)

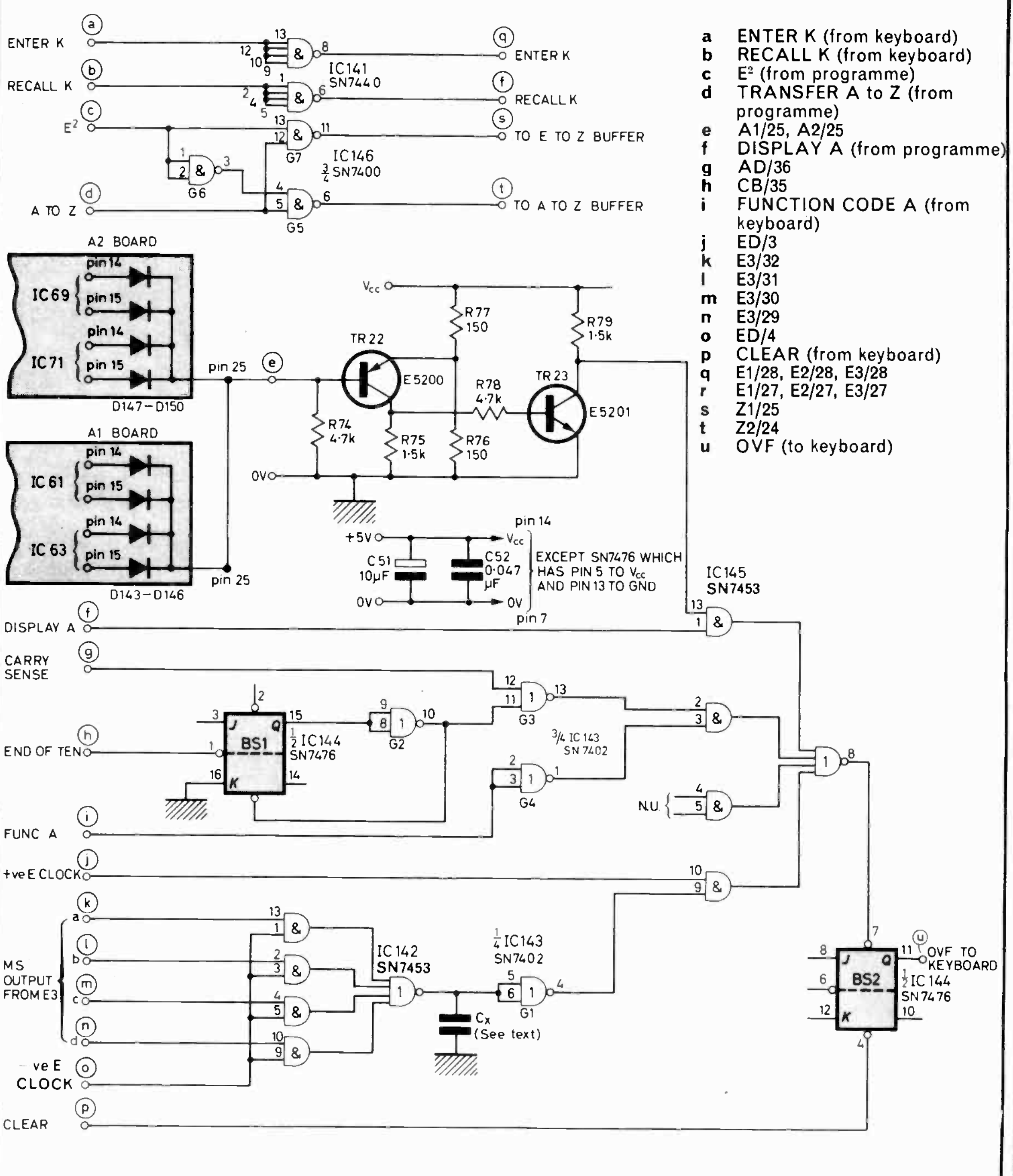


Fig. 11.1. Circuit diagram of the various units contained on the OVF board

DIVIDE OVERFLOW

No logic has been included to show that an OVERFLOW during a DIVISION operation has occurred.

Logic to fulfil this function would be simple to design and could use pins 4 and 5 of IC145 as an access to the OVF LATCH, but this was not carried out on the prototype because a divide overflow is very obvious to the operator by virtue of the fact that no answer is produced on the display.

E SQUARED GATING

It was only after the component location stage of Digi-Cal design that it was realised that the addition of a very few gates could produce an automatic E^2 facility to complement the basic arithmetic functions.

The gating required is so simple that the incorporation on the OVF board is quite straightforward.

The object of the three gates shown in Fig. 11.1 as part of IC146 is to divert the A to Z transfer command from the PROGRAMME to the E to Z buffer gate when the E^2 latch on the PROGRAMME board is set.

This simple operation causes the MULTIPLY programme to multiply the number in the E REGISTER by itself. The normal command to transfer the A REGISTER contents to the Z REGISTER is blocked and the E to Z transfer substituted, resulting in the number E being both multiplier and multiplicand.

CONSTANT STORE BUFFERS

IC141 is an SN7440 buffer gate which is interposed between the KEYBOARD outputs and the constant store to provide the drive and inversion

OVF LOGIC CONSTRUCTION

Although the E^2 logic and the constant store buffers will have to be wired up before the testing stage, it is best to leave the OVF detection logic until the calculator is operating correctly. Connecting up these circuits before proper operation is realised could lead to confusion.

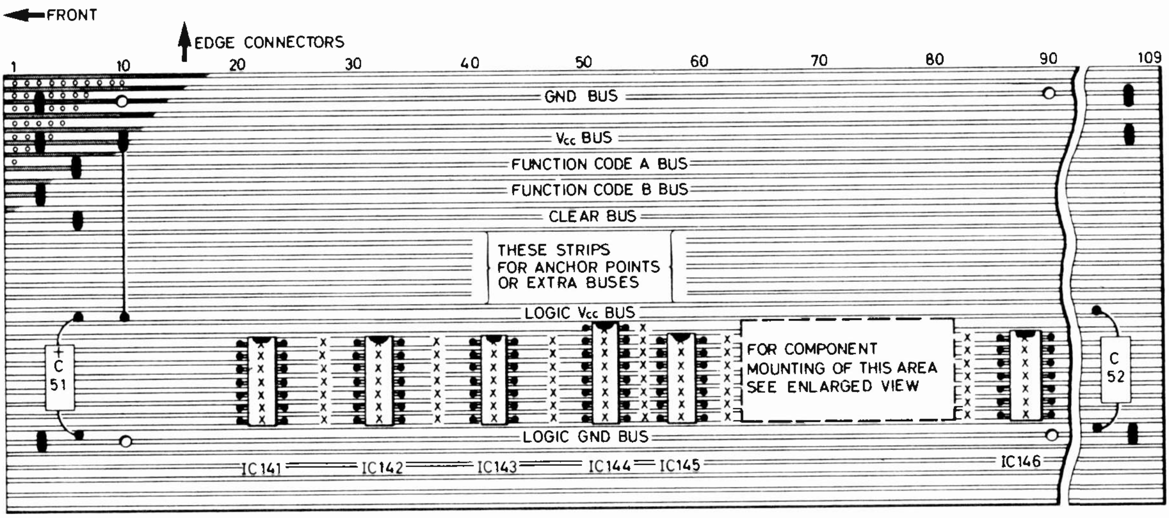
Having both the i.c.s and the wiring on the copper side of the board takes a little getting used to when soldering, but there are no special problems to look out for, and circuit tracing is really much easier. The board layout is shown in Fig. 11.2, and mounting position in Fig. 11.3.

OVERALL TESTING

It would be a very optimistic constructor indeed who wired up the whole Digi-Cal, switched on, and expected it to work perfectly first time.

There will no doubt be wiring errors, perhaps a faulty i.c. (there were three in the prototype), and a dry joint or two.

The policy of piecemeal testing suggested in previous parts will undoubtedly have eliminated most



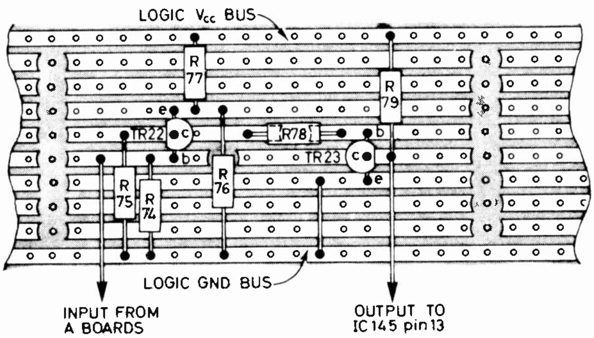


Fig. 11.2. Construction of the OVF board. Note that both the wiring and components are placed on the copper strip side of the Veroboard panel

COMPONENTS . . .

OVF BOARD

Resistors
R74 4·7kΩ
R75 1·5kΩ
R76 150Ω
R77 150Ω
R78 4·7kΩ
R79 1·5kΩ

Capacitors
C51 10μF 15V elect.
C52 0·047μF
C_x (see text)

Diodes
D143–150 West Hyde type "red" or any small silicon diode (8 off)

Transistors
TR22 E5200 } (West Hyde)
TR23 E5201 }

Integrated Circuits
IC141 SN7440
IC142 SN7453
IC143 SN7402
IC144 SN7476
IC145 SN7453
IC146 SN7400

Miscellaneous
11in × 3·6in × 0·1in matrix Veroboard panel

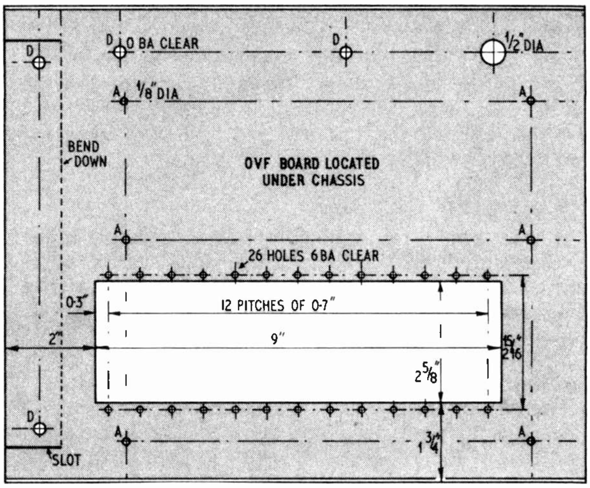


Fig. 11.3. The OVF board is mounted on the underside of the chassis in the four holes marked "A" in the main chassis plate

faults, and certainly the constructor who has reached the final testing stage, which basically involves making the programmes work as required, will be sure that all the boards are fundamentally serviceable.

The first hurdle to be cleared is the correct operation of the ADD/SUBTRACT programme and when this has been achieved (with a slow clock speed if desired) the bulk of the arithmetic section can be given a clean bill of health.

The MULTIPLY and DIVIDE programmes can then be tackeld in turn and if any problems are encountered a thorough understanding of the way the calculator should be operating will soon sort these out.

It cannot be stressed enough that after gathering evidence via a multimeter and display, the best strategy in solving a problem is to sit down with a paper and pencil and ponder the possible causes: aimless probing will get you nowhere.

CLOCK SPEED

The ultimate objective of the testing phase is to increase the clock speed to as high a rate as possible while maintaining correct operation.

In the prototype a speed of over 1MHz was obtained despite the far from ideal underchassis "bird's nest" wiring resulting from prototype modifications.

Constructors should be able to do better than this easily since all improvements have been incorporated in the published designs and any advance achieved in this respect will be rewarded by a shorter maximum multiplication time, important when operating near to the maximum capacity of the machine. ★

Corrections. We apologise for these errors which occurred during the course of Digi-Cal articles.

Part 3, Fig. 3.2. Capacitors C3, C4, C5 and C6 should be connected between +5V and GND, not as shown. The strobe outputs from IC7 are reversed, i.e. pin 12 should be strobe 8 and pin 4 should be strobe 1.

Part 4, Fig. 4.2. Switch S19 is shown twice, the K switch should be S5. S13 is shown twice, the **Decimal Point** switch should be S3. Both are shown correctly on Fig. 4.5. The diode labelled D103 on IC26 should be D101.

Part 5, Fig. 5.8. The K switch should be labelled **Recall K** output.

Part 6, Fig. 6.10. Connection from the Z1 and Z2 sockets to the E1, E2 and E3 boards show the pin numbers incorrectly. Correct destinations can be found by adding 22 to each of the pin numbers associated with the E boards, e.g. Z1/1 should go to E3/31. Also Z1/19 should go to AD/41, and Z1/20 to AD/42. Z2/19 goes to AD/39; Z2/20 to AD/40, not as shown. Z2/44 should go to Z1/42 and Z2/42.

A1/1 should go to AD/27; A1/10 to AD/31; A1/11 to AD/32.

A2/1 should go to AD/25; A2/10 to AD/29; A2/11 to AD/30.

Fig. 6.7. CP in IC77 and 78 should go to pin 3 not 2.

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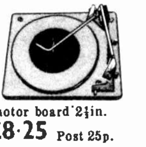

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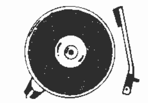

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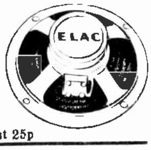

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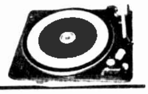

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250-0-250 80mA 6·3V 3·5A, 6·3V 1A. or 5V 2A	£2·50
350-0-350 80mA, 6·3V 3·5A, 6·3V 1A, or 5V 2A	£3
300-0-300V 120mA, 6·3V 4A C.T.; 6.3V 2A	£3·25
MINIATURE 200V, 20mA, 6·3V 1A, 2½ × 2½ × 2in	75p
MIDGET 220V 45mA, 6·3V 2A, 2¼ × 2¼ × 2in	90p
HEATER TRANS. 6·3V 3A	60p

GENERAL PURPOSE LOW VOLTAGE. Tapped outputs

at 2A, 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30V	£2·25
1A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60V	£2·25
2A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60V	£3·25
5A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60V	£8·75
3A, 5, 8, 13V	£1·00
Ditto 5A	£1·20
3A, 5, 8, 10. 13V, 5-0-5V	£1·30
Ditto 5A	£1·50

AUTO TRANSFORMERS. 115V to 230V or 230V to 115V. 150W £2·25; 500W £6·25; 750W £10; 1000W £14.
CHARGER TRANSFORMERS. Input 200/250V. for 6 or 12V, 1½A, £1·50; 2A, £1·80; 4A, £2·50.
BATTERY CHARGERS. 1½A £2; 3A £3; 4A £4; 5A £4·50.
FULL WAVE BRIDGE CHARGER RECTIFIERS: 6 or 12V outputs. 1½A 40p; 2A 55p; 4A 85p. LUCAS 2DS500 Full wave Bridge 70V, 5A 95p.

MAINS ISOLATING TRANSFORMER

Primary 0-110-240V. Secondary 0-240V. 3A. 720W. Insulated terminals. Varnish impregnated. Fully enclosed in steel case with fixing feet. Famous make. (Value £19) OUR PRICE **£10** Carr. 50p
Can be used as 800W auto transformers 240-110V.

NEW TUBULAR ELECTROLYTICS				CAN TYPES	
2/350V	14p	250/25V	14p	50+50/350V	35p
4/350V	14p	500/25V	20p	60+100/350V	58p
8/450V	14p	1000/25V	35p	32+32/250V	18p
16/450V	15p	1000/50V	47p	32+32/450V	33p
32/450V	20p	8+8/450V	18p	350+50/325V	50p
25/25V	10p	8+16/450V	20p	32+32+32/350V	43p
50/50V	10p	16+16/450V	25p	100+50+50/350V	48p
100/25V	10p	32+32/350V	25p		

LOW VOLTAGE ELECTROLYTICS.
1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 200mF 15V 10p.
500mF 12V 15p; 25V 20p; 50V 30p.
1000mF 12V 17p; 25V 35p; 50V 47p; 100V 70p.
2000mF 6V 25p; 25V 42p; 50V 57p.
2500mF 50V 62p; 3000mF 25V 47p; 50V 65p.
5000mF 6V 25p; 12V 42p; 25V 75p; 35V 85p; 50V 95p.

CERAMIC, 1pF to 0·01mF, 4p. Silver Mica 2 to 5000pF, 4p.
PAPER 350V-0·1 4p, 0·5 13p; 1mF 15p; 2mF 150V 15p. 500V-0·001 to 0·05 4p; 0·1 5p; 0·25 8p; 0·47 25p.
SILVER MICA. Close tolerance 1%. 2·2-500pF 8p; 560-2,200pF 10p; 2,700-5,600pF 20p; 6,800pF-0·01, mfd 30p each.
TWIN GANG. "0-0" 208pF+176pF, 65p; Slow motion drive 365pF+365pF with 25pF+25pF, 50p; 500pF standard 45p; single gang 500pF 75p; small 3-gang 500pF £1·60.
SHORT WAVE SINGLE. 10pF, 30p, 25pF, 55p, 50pF, 55p.
NEON PANEL INDICATORS 250V AC/DC. Amber 20p.
RESISTORS. ¼W, ½W, 1W, 20% 1p; 2W, 5p. 10Ω to 10M.
HIGH STABILITY. ½W 2% 10 ohms to 6 meg., 10p. Ditto 5%. Preferred values 10 ohms to 10 meg., 4p.
WIRE-WOUND RESISTORS 5 watt, 10 watt, 15 watt, 10 ohms to 100K 10p each; 0·5 ohm to 8·2 ohms 10p.
TAPE OSCILLATOR COIL Valve type 35p.

ALL MODELS "BAKER SPEAKERS" IN STOCK
Hi Fi Enclosure Manual containing 20 plans, designs, crossover data and cubic tables. 42p Post Free

BAKER 12in. MAJOR £10

Post 25p

30-14,500 c/s, 12in. double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 40 c/s. Rated 20W. NOTE: 3 or 8 or 15 ohms must be stated.

Module kit, 30-17,000 c/s with tweeter, crossover, baffle and instructions. **£12·50** Post 25p

BAKER "BIG-SOUND" SPEAKERS Post 25p

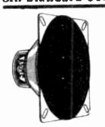
'Group 25'	'Group 35'	'Group 50'
12in. 25W **£8·80**	12in. 35W **£9·90**	15in. 50W **£22·00**
3 or 8 or 15 ohm	3 or 8 or 15 ohm	8 or 15 ohm

TEAK VENEERED HI-FI SPEAKER CABINETS.
For 12in or 10in dia. speaker 20 × 13 × 9in, £9·90. Post 25p.
For 13 × 8in or 8in speaker 16 × 10 × 9in. £5·50. Post 25p.
For 10 × 6in or 6in speaker 16 × 8 × 6in, £4·40. Post 25p.
LOUDSPEAKER CABINET WADDING 18in wide, 15p ft.

GOODMANS 6½in. HI-FI WOOFER

8 ohm. 10W. Large ceramic magnet. Special Cambric cone surround. Frequency response 30-12,000 c/s. Ideal P.A. Columns. Hi-Fi Enclosure Systems, etc. **£4**
8in Standard Cone 12W £4 50 Post 25p

ELAC CONE TWEETER



The moving coil diaphragm gives a good radiation pattern to the higher frequencies and a smooth extension of total response from 1,000 c/s to 18,000 c/s. Size 3¾ × 3¾ × 2in deep. Rating 10W, 3 ohm or 15 ohm models. **£1·90** Post 10p.
Crossover 95p

SPEAKER COVERING MATERIALS. Samples Large S.A.E.
Horn Tweeters 2-16kc/s, 10W 8 ohm or 15 ohm £1·95.
De Luxe Horn Tweeters 2-18kc/s, 15W. 15 ohm £3. TWO-WAY 3,000 c/s. CROSSOVERS 3 or 8 or 15 ohm 95p.
LOUDSPEAKERS P.M. 3 OHMS. 7x4in., £1·25; 6½in., £1·50; 8 × 5in, £1·60; 10in, £2·00; 8in, £1·75; 10 × 6in, £1·00.
SPECIAL OFFER: 80 ohm, 2¼in, 2½in; 35 ohm, 2in, 3in, 25 ohm, 2½in dia., 3in dia., 5in dia. 15 ohm, 3½in dia, 6 × 4in, 7 × 4in, 8 × 5in. **£1** EACH TYPE
3 ohm, 2½in, 2¾in, 3½in, 5in dia. 6 × 4in 8 ohms £1 50.
RICHARD ALLAN TWIN CONE LOUDSPEAKERS 8in. diameter 4W; 10in diameter 5W; 12in diameter, 6W; 3 or 8 or 15 ohm models, £2·20 each. Post 15p.
VALVE OUTPUT TRANS. 25p; MIKE TRANS. 50:1 25p.
5 WATT MULTI-RATIO, 3, 8 and 15 ohms 80p.
Mike trans. mu metal 100:1 £1·25.

MAJOR 100 WATT ALL PURPOSE TRANSISTOR AMPLIFIER

4 inputs speech and music, 4 way mixing. Response 10-30,000 c/s. Matches loudspeakers, 8 15 ohm. A.C. 200/250V. Separate Treble and Bass controls. Guaranteed. Details S.A.E. **£49** Post Free

BARGAIN AM TUNER. Medium Wave. Transistor Superhet, Ferrite aerial. 9 volt. **£4·95**

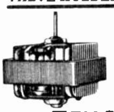
BARGAIN 4 CHANNEL TRANSISTOR MONO MIXER. Add musical highlights and sound effects to recordings. Will mix Microphone, records, tape and tuner with separate controls into single output. 9V. **£3·95**
STEREO VERSION OF ABOVE £5·95.

BARGAIN FM TUNER 88-108 Mc/s Six Transistor. 9V. Printed Circuit. Calibrated slide dial tuning. Walnut Cabinet. Size 7 × 5 × 4in. **£14·85**

BARGAIN FM TUNER as above less cabinet **£9·85**

BARGAIN 3 WATT AMPLIFIER. 4 Transistor Push-Pull Ready built, with volume control and on/off switch, 9 volt. **£4·50**

COAXIAL PLUG 10p. PANEL SOCKETS 10p. LINE 18p. OUTLET BOXES. SURFACE OR FLUSH 25p.
BALANCED TWIN RIBBON FEEDER 300 ohms. 5p yd.
JACK SOCKET Std. open-circuit 14p, closed circuit 23p; Chrome Lead-Socket 45p. Phono Plugs 5p. Phono Socket 5p.
JACK PLUGS Std. Chrome 15p; 3·5mm Chrome 12p. DIN SOCKETS Chassis 3-pin 10p; 5-pin 10. DIN SOCKETS Lead 3-pin 18p; 5-pin 15p. DIN PLUGS 3-pin 18p; 5-pin 25p.
VALVE HOLDERS, 5p; CERAMICS 8p; CANS 5p.



E.M.I. TAPE MOTORS. 120 volts A.C. each. 1,200 r.p.m. 4 pole or 2 in series 240 volts AC. Size 3¼ × 2¾ × 2¼in (illustrated). Post 25p. **£1**
E.M.I. GRAM. MOTORS. 120V or 240V a.c. 2,400 r.p.m. 2 pole 70mA. Spindle ⅛ × ⅜ in. Size 2¼ × 2¾ × 2¼in. Post 25p **£1**

RADIO COMPONENT SPECIALISTS

337 WHITEHORSE ROAD, CROYDON
Open 9-6. Wed. 9-1, Sat. 9-5 (Closed for lunch 1.15-2.30)
Illustrated Colour Brochure, Radio Books and Component Lists 10p. (Minimum posting charge 15p.) Buses 50, 68, 159. Rail Selhurst. Tel. 01-684-1665

YATES ELECTRONICS

(FLITWICK) LTD.

ELSTOW STORAGE DEPOT
KEMPSTON HARDWICK
BEDFORD

C.W.O. PLEASE. POST AND PACKING PLEASE ADD 10p TO ORDERS UNDER £2.

Catalogue which contains data sheets for most of the components listed will be sent free on request. 10p stamp appreciated.

OPEN ALL DAY SATURDAYS

ALL PRICES SUBJECT TO V.A.T.

RESISTORS

½W Iskra high stability carbon film—very low noise—capless construction.
⅓W Mullard CR25 carbon film—very small body size 7·5 x 2·5mm.
½W 2% ELECTROSIL TR5

Power watts	Tolerance	Range	Values available	Price 1–99	Price 100 +
½	5%	4·7Ω–2·2MΩ	E24	1p	0·8p
½	10%	3·3MΩ–10MΩ	E12	1p	0·8p
½	2%	10Ω–1MΩ	E24	3·5p	3p
⅓	10%	1Ω– 3·9Ω	E12	1p	0·8p
⅓	5%	4·7Ω–1MΩ	E12	1p	0·8p
4	10%	1Ω–10Ω	E12	6p	5·5p

Quantity price applies for any selection. Ignore fractions on total order.

DEVELOPMENT PACK

0·5 watt 5% Iskra resistors 5 off each value 4·7Ω to 1MΩ.
E12 pack 325 resistors **£2·40**. E24 pack 650 resistors **£4·70.**

POTENTIOMETERS

Carbon track 5kΩ to 2MΩ, log or linear (log ¼W, lin ½W).
Single, **12p.** Dual gang (stereo), **40p.** Single D.P. switch **24p.**

SKELETON PRESET POTENTIOMETERS

Linear: 100, 250, 500Ω and decades to 5MΩ. Horizontal or vertical P.C. mounting (0·1 matrix).
Sub-miniature 0·1W, **5p** each. Miniature 0·25W, **6p** each.

TRANSISTORS

AC107	15p	AF125	20p	BD132	75p	OC28	50p	2N3702	13p
AC126	12p	AF126	20p	BD133	75p	OC35	50p	2N3703	12p
AC127	12p	AF127	20p	BF115	25p	OC42	12p	2N3704	13p
AC128	12p	AF139	32p	BF173	20p	OC44	12p	2N3705	12p
AC131	12p	AF178	32p	BF177	28p	OC45	12p	2N3706	11p
AC132	12p	AF180	40p	BF178	32p	OC70	12p	2N3707	12p
AC176	12p	AF181	40p	BF179	32p	OC71	12p	2N3708	10p
AC187	22p	BC107	9p	BF180	32p	OC72	12p	2N3709	11p
AC188	22p	BC108	9p	BF181	32p	OC81	12p	2N3710	11p
AD140	50p	BC109	9p	BF194	15p	OC82D	12p	2N3711	11p
AD149	45p	BC147	13p	BF195	15p	2N2904	20p	2N4062	12p
AD161	33p	BC148	13p	BF197	15p	2N2926R	9p	40360	35p
AD162	36p	BC149	13p	BF200	32p	2N2926O	9p	40361	35p
AF114	20p	BC157	14p	BFY50	20p	2N2926Y	9p	40362	40p
AF115	20p	BC158	14p	BFY51	20p	2N2926G	10p	40408	40p
AF116	20p	BC159	14p	BFY52	20p			ZTX302	15p
AF117	20p	BC187	22p	BU105	225p	2N3054	58p	ZTX500	15p
AF117	38p	BD131	75p	OC26	45p	2N3055	60p	ZTX502	20p
AF124	22p								

ZENER DIODES

400mW 5% 3·3V to 30V, **12p.**

WIRE WOUND POTS, 3W, 10, 25, 50Ω and decades to 100kΩ, **35p.**

DIODES

RECTIFIER				SIGNAL	
BY127	1250V	1A	12p	OA85	7p
BZY10	800V	6A	25p	OA90	5p
BZY13	200V	6A	20p	OA91	5p
IN4001	50V	1A	7p	OA202	7p
IN4004	400V	1A	8p	IN4148	5p
IN4007	1000V	1A	10p	BA114	8p

BRUSHED ALUMINIUM PANELS

12in × 6in = **25p**; 12in × 2½in = **10p**; 9in × 2in = **7p**

SLIDER POTENTIOMETERS

86mm × 9mm × 16mm, length of track 59mm.
SINGLE 10K, 25K, 100K log. or lin. **40p.**
DUAL GANG, 10K + 10K etc. log. or lin. **60p.**
KNOB FOR ABOVE **12p.**
FRONT PANEL **65p.**
18 Gauge panel 12in × 4in with slots cut for use with slider pots. Grey or matt black finish complete with fixings for 4 pots.

THERMISTORS

VA1055S	15p
VA1066S	15p
VA1077	15p
R53	£1·35

THYRISTORS

2N5060 50V 0·8A **30p,** 2N5064 200V 0·8A **47p,** CRS1/40 400V 1A **25p,** 106F 50V 4A **40p,** 106D 400V 4A **55p.**

MULLARD POLYESTER CAPACITORS C296 SERIES

400V: 0·001μF, 0·0015μF, 0·0022μF, 0·0033μF, 0·0047μF, **2½p.** 0·0068μF, 0·01μF, 0·015μF, 0·022μF, 0·033μF, **3p.** 0·047μF, 0·068μF, 0·1μF, **4p.** 0·15μF, **6p.** 0·22μF, **7½p.** 0·33μF, **11p.** 0·47μF, **13p.**
160V: 0·01μF, 0·015μF, 0·022μF, 0·033μF, 0·047μF, 0·068μF, **3p.** 0·1μF **3½p.** 0·15μF **4½p.** 0·22μF, **5p.** 0·33μF, **6p.** 0·47μF, **7½p.** 0·68μF, **11p.** 1·0μF, **13p.**

MULLARD POLYESTER CAPACITORS C280 SERIES

250V P.C. mounting: 0·01μF, 0·015μF, 0·022μF, **3p.** 0·033μF, 0·047μF, 0·068μF, **3½p.** 0·1μF, **4p.** 0·15μF, 0·22μF, **5p.** 0·33μF, **6½p.** 0·47μF, **8½p.** 0·68μF, **11p.** 1·0μF, **13p.** 1·5μF, **20p.** 2·2μF, **24p.**

MYLAR FILM CAPACITORS 100V

0·001μF, 0·002μF, 0·005μF, 0·01μF, 0·02μF, **2½p.** 0·04μF, 0·05μF, 0·068μF, 0·1μF, **3½p.**

CERAMIC DISC CAPACITORS

100pF to 10,000pF, **2p** each.

ELECTROLYTIC CAPACITORS—MULLARD O15/6/7 RANGE REPLACES C426, C457 RANGES.

(μF/v) 1·0/63, 1·5/63, 2·2/63, 3·3/63, 4·7/63, 6·8/40, 10/25, 10/63, 15/16, 15/40, 15/63, 22/10, 22/25, 22/63, 33/6·3, 33/40, 47/4, 47/10, 47/25, 47/40, 47/63, 68/6·3, 68/16, 100/4, 100/10, 100/25, 100/40, 150/6·3, 150/16, 150/25, 220/4, 220/10, 220/16, 330/4, 330/10, 470/6·3, **5p** each. 68/63, 150/40, 220/25, 330/16, 470/10, 680/6·3, 1,000/4, **9p.** 100/63, 150/63, 220/40, 470/25, 680/16, 1,000/10, 1,500/6·3, **12p.** 220/63, 470/40, 680/25, 1,000/16, 1,500/10, 2,200/6·3, **15p.** 330/63, 680/40, 1,000/25, 1,500/16, 2,200/10, 3,300/6·3, 4,700/4, **18p.**

SOLID TANTALUM BEAD CAPACITORS **12p**

0·1μF	35V	2·2μF	35V	22μF	16V
0·22μF	35V	4·7μF	35V	33μF	10V
0·47μF	35V	6·8μF	25V	47μF	6·3V
1·0μF	35V	10μF	25V	100μF	3V

VEROBOARD

	0·1	0·15
2½ × 3¾	22p	16p
2½ × 5	24p	24p
3¾ × 3¾	24p	24p
3¾ × 5	27p	27p
17 × 2½	75p	57½p
17 × 3¾	100p	78p
17 × 5 (plain)	—	82p
17 × 3¾ (plain)	—	60p
17 × 2½ (plain)	—	42p
2½ × 5 (plain)	—	12p
2½ × 3¾ (plain)	—	11p
Pin insertion tool	52p	52p
Spot face cutter	42p	42p
Pkt. 50 pins	20p	20p

JACK PLUGS AND SOCKETS

Standard screened	18p	2·5mm insulated	8p
Standard insulated	12p	3·5mm insulated	8p
Stereo screened	35p	3·5mm screened	13p
Standard socket	15p	2·5mm socket	8p
Stereo socket	18p	3·5mm socket	8p

D.I.N. PLUGS AND SOCKETS

2 pin, 3 pin, 5 pin 180°, 5 pin 240°, 6 pin
Plug 12p. Socket 8p.
4 way screened cable, **15p**/metre.
6 way screened cable **22p**/metre.

BATTERY ELIMINATOR **£1·50**

9V mains power supply. Same size as PP9 battery.

LARGE (CAN) ELECTROLYTICS

1600μF	64V	74p	2500μF	64V	80p	4500μF	16V	50p
2500μF	40V	74p	2800μF	100V	£2·60	4500μF	25V	£1·68
2500μF	50V	58p	3200μF	16V	50p	5000μF	50V	£1·10

HIGH VOLTAGE TUBULAR CAPACITORS—1,000 VOLT

0·01μF	10p	0·047μF	13p	0·22μF	20p
0·022μF	12p	0·1μF	13p	0·47μF	22p

POLYSTYRENE CAPACITORS 160V 2½%

10pF to 1,000pF E12 Series Values **4p each.**

SMOKE AND COMBUSTIBLE GAS DETECTOR—GDI

The GDI is the world's first semiconductor that can convert a concentration of gas or smoke into an electrical signal. The sensor decreases its electrical resistance when it absorbs deoxidizing or combustible gases such as hydrogen, carbon monoxide, methane, propane, alcohol, North Sea gas, as well as carbon-dust containing air or smoke. This decrease is usually large enough to be utilized without amplification. Full details and circuits are supplied with each detector.
Detector GDI, **£2.** Kit of parts for detectors including GDI and P.C. board but excluding case. Mains operated detector **£5·20.** 12 or 24V battery operated audible alarm **£7·30.** As above for PP9 battery, **£6·40.**

PRINTED BOARD MARKER **97p**

Draw the planned circuit onto a copper laminate board with the P.C. Pen, allow to dry, and immerse the board in the etchant. On removal the circuit remains in high relief.

LARGE RANGE ITT/TEXAS IC's NOW IN STOCK

PRICES ARE CALCULATED ON TOTAL NUMBER ORDERED REGARDLESS OF MIX

	1–11 p	12–24 p	25–99 p	100 + p
7400	18	16	14	13
7401	18	16	14	13
7402	18	16	14	13
7403	18	16	14	13
7404	20	18	16	14
7405	20	18	16	14
7406	50	45	40	35
7407	56	50	44	38
7408	36	30	27	23
7409	36	30	27	33
7410	18	16	14	13
7411	23	21	20	18
7412	36	30	27	23
7413	34	28	26	22
7416	45	43	39	34
7420	18	16	14	13
7421	36	30	27	23
7426	32	29	23	20
7430	20	18	16	14
7432	40	36	32	28
7440	20	18	16	14
7441	80	75	70	65
7442	80	75	70	65
7443	125	120	115	115
7447	175	165	150	120
7448	185	175	170	165
7450	18	16	14	13
7451	18	16	14	13
7453	18	16	14	13
7454	18	16	14	13
7460	18	16	14	13
7470	30	28	25	24
7472	30	28	27	23
7473	40	38	36	30
7474	40	36	32	28
7475	55	52	50	49
7476	40	36	32	30
7480	100	95	90	85
7481	125	115	110	105
7482	100	96	90	85
7483	100	97	95	92
7484	120	115	110	105
7485	250	245	240	230
7486	45	42	37	33
7490	75	67	60	52
7491A	100	92	85	79
7492	75	70	65	60
7493	75	68	60	52
7494	95	90	85	80
7495	105	100	95	90
7496	100	95	90	85
74100	250	240	235	230
74118	100	82	73	64
74121	43	40	38	36
74141	100	95	90	85
74145	150	140	135	130
74150	330	280	250	220
74151	110	100	95	89
74153	120	110	105	95
74154	200	180	170	160
74155	150	120	100	86
74156	130	120	100	96
74180	155	136	112	105
74190	195	190	185	180
74191	195	190	185	180
74192	200	190	180	164
74193	200	180	170	150
74196	200	190	180	170
74197	200	195	180	170

LINEAR IC's

709	14 pin DIL	32p
741	8 pin DIL	34p
741	14 pin DIL	28p
723	14 pin DIL	95p
747	14 pin DIL	85p
748	8 pin DIL	35p
DIL socket,	14 pin and 16 pin	16p

THE EMI SCANNER

BRAIN X RAY

A NEW COMPUTERISED SYSTEM FOR DIAGNOSING BRAIN DISEASE

by K. R. HILL

THE EMI-Scanner is a computerised X-ray transverse axial tomography system using new techniques invented in the Central Research Laboratories of EMI Ltd. It has been developed by EMI in conjunction with Department of Health and Social Security after a four year research and development programme.

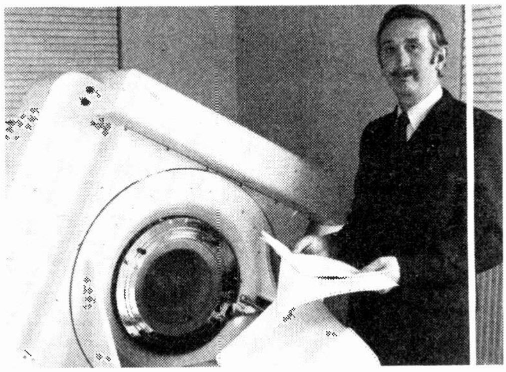
The equipment is able to produce pictures of cross sectional slices of the human brain. The basic system consists of a number of units:

1. The Scanning Unit which scans the patient with X-rays to produce a series of intensity output readings.
2. The X-ray Control Unit which controls the X-rays and the operation of the Scanning Unit.
3. The Computer Unit which stores and processes the data.
4. The Viewing Unit which displays the results on a cathode ray tube screen.
5. The X-ray generating system.

THE BASIC PROBLEM

The conventional X-ray photograph taken of the human body suffers from a serious drawback in that it is attempting to portray a three-dimensional object on a two-dimensional photographic plate. The X-ray picture indicates the X-ray intensity after it has passed through the object being examined. Typically the X-rays will have passed through bone, tissue, fat, blood, etc. and the resulting picture produced will be confused due to the superimposition of the various materials. Frequently the diagnostician is attempting to detect a small variation in the X-ray absorption of tissue (which may indicate some abnormality such as a tumour) when the area of interest is masked by a nearby bone. This situation is shown in Fig. 1.

The human brain poses a considerable problem for radiologists because it is totally enclosed in the protective bone of the skull. In an attempt to overcome some of the limitations of the conventional skull X-ray, several more sophisticated techniques have been developed such as angiography, ventriculography, and radioactive isotope brain scanning. These techniques, while giving some improvement in diagnoses, can cause considerable discomfort to the patient as well as in some cases requiring a team of highly trained staff to perform them. In addition to this the patient may need to be hospitalised after examination.



THE MACROBERT AWARD

For the invention of a new X-ray technique, Mr Godfrey Hounsfield and EMI Limited won the 1972 MacRobert Award.

This Award, often described as the Nobel Prize for engineering, consists of a Gold Medal and £25,000 prize money. It is presented annually, in recognition of the technological innovation contributing most significantly to the prestige and prosperity of the United Kingdom.

It was instituted by the MacRobert Trusts in 1968 and is administered by the council of Engineering Institutes, which is the federal body for 15 chartered engineering institutes.

This is the first time the award has been made in the field of electronics. In his citation for the Award, the Chairman of the MacRobert Award Evaluation Committee said, "One of the medical referees consulted during the evaluation stated that no comparable discovery has been made in this field since Röntgen discovered X-rays in 1895, and we agree with him.

"The EMI-Scanner system developed by Mr Hounsfield within the Central Research Laboratories of EMI is epoch-making, because it breaks away from the photographic techniques for recording X-ray pictures which in principle have remained unchanged since Röntgen's day . . .

"There is another aspect of EMI-Scanner which is remarkable. In these modern days it is rarely that one finds great developments which are the work of one man. The EMI-Scanner is different: the submission for the MacRobert Award was prepared not by the inventor, but by EMI, who stated, 'Mr Hounsfield has been the guiding expert throughout all aspects of the work. The EMI-Scanner was as much a one-man invention as anything can be these days'."

THE NEW TECHNIQUE

The EMI-Scanner offers considerable advantages to both the diagnostician and the patient.

This new system uses X-rays to produce pictures of slices of the head as shown in Fig. 2. The head of the patient rests in a rubber head cap, and a gantry, on which is mounted the X-ray tube and detectors, is able to rotate around the head to perform the scanning sequence shown in Fig. 3. With the gantry in the 0° start position, the X-ray tube and detectors move so as to make a linear pass of the head. The whole gantry then rotates 1° and the X-ray tube and detectors move back to make a further linear pass.

The gantry then rotates a further 1° and this sequence of linear passes and 1° rotations is repeated until a total rotation of 180° has been achieved. Each complete scan does in fact yield results for two contiguous slices of the head as shown in Fig. 4. The thickness of each slice can be adjusted to either 0·8cm or 1·3cm by means of collimators in the X-ray beam. The two pictures from a single patient scan are achieved by using two detectors each with its own associated data processing channel.

The X-ray detectors used are photomultipliers with sodium iodide scintillating crystals. During each linear pass of the head, 160 readings of X-ray intensity are made by each detector so that for each complete scan of 180° a total of $180 \times 160 = 28{,}800$ readings are taken. The 160 readings are controlled by means of a glass grating consisting of alternately transparent and opaque sections. This grating moves with the X-ray tube and detectors, and passes between a lamp and photodiode. The output from this photodiode controls the operation of electronic circuits which measure the output of each detector.

For each complete scan the scanning system yields a set of 28,800 readings from each of the two detectors plus an additional set of 28,800 reference readings of the X-ray intensity before passing through the patient's head. These three sets of readings are put into digital form by an analogue to digital converter and stored in the buffer section of a magnetic disc pack. This is illustrated in the block diagram of the system Fig. 5.

DATA PROCESSING

These readings of X-ray intensity now have to be used to solve many thousands of simultaneous equations so that the X-ray absorption value at each point in the slice can be calculated. This operation is performed by a mini-computer, which, by means of a specially written computer program, is able to call-up these readings from the disc store and process them. The computation, which takes about five minutes for each picture, results in 6,400 output values in digital form which are stored in the main storage section of the magnetic disc pack.

PICTURE DISPLAY

The 6,400 digital values can be called-up on command and converted into analogue form where they may be used to build up a picture on the cathode ray tube screen of the Viewing Unit. This picture consists of a matrix of 80×80 picture points, the brightness of each point representing the X-ray absorption of the tissue.

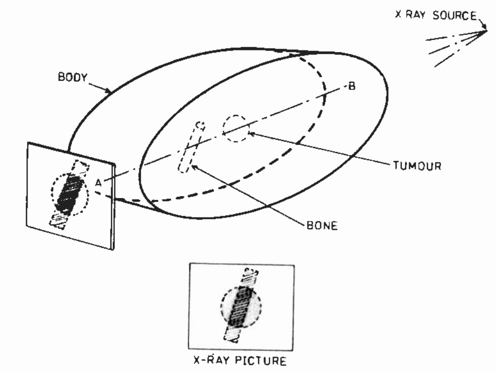


Fig. 1. Conventional X-ray technique

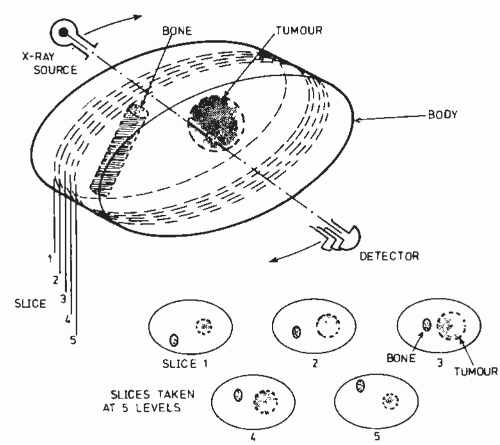


Fig. 2. Computerised transverse axial technique

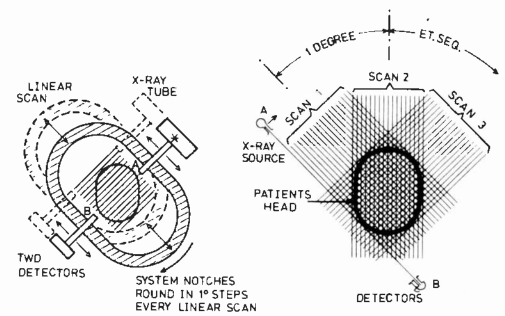


Fig. 3. Motion of scanning frame and detectors for producing two contiguous slices

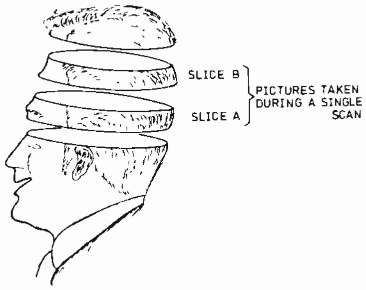


Fig. 4. Two slice planes taken during a single scan

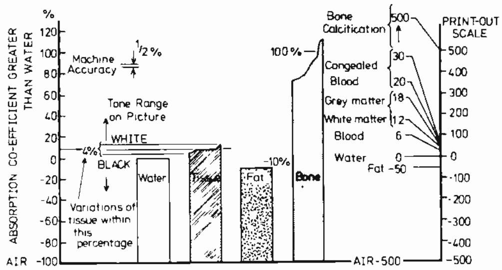


Fig. 6. X-ray absorption chart

An alternative method of displaying the results is to use a line printer which will print out the numerical values of the X-ray absorption coefficient at each point of the 80 × 80 matrix.

The chart shown in Fig. 6 illustrates the range of measurement of the system. The left-hand scale shows the percentage X-ray absorption coefficient greater or less than that of water and the vertical blocks show the coefficients for materials commonly encountered in clinical radiology, i.e. blood, tissue, bone, etc. The right-hand scale on the chart shows the scale actually used on the equipment, with dense bone at +500, water at 0 and air at −500. The system is accurate to within 2½ units on a range 0 to 500.

In order that the diagnostician can select the information which is displayed on the Viewing Unit there are two very important controls—window width and window level.

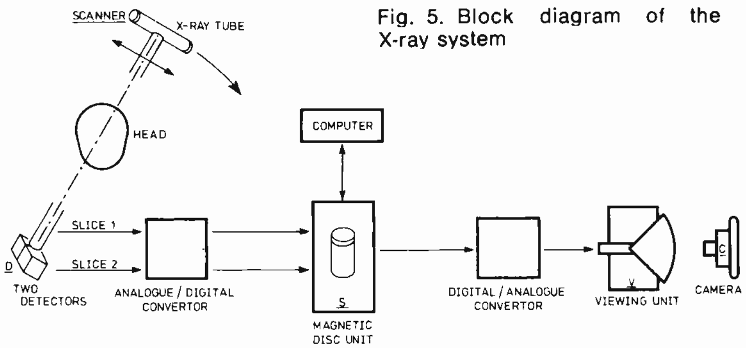
The window width control selects the range of X-ray absorption values which yields black to peak white on the cathode ray tube screen.

The window level control enables this selected band to be moved up or down the scale of absorption values. As an example with the window level control set at +15 (centre of the band) and the window width set at 20 all tissue with X-ray absorption values less than +5 would appear black and all values greater than +25 would appear white. Values between +5 and +25 would appear of different brightness values between black and peak white.

An illustration showing the effect of the window level control is shown in Fig. 8. The top left-hand picture shows the control set at −50; all values less than −60 appear black, all values greater than −40 appear white. The dark ring represents air trapped in the hair of the patient. The top centre picture shows the control set at 0 with the saline fluid-filled ventricles just beginning to show. The top right- and lower left-hand pictures show intermediate settings of the control to show detail of brain tissue at +10 to +20. The lower right-hand picture shows the control set at +50 with the white ring representing the bone of the skull. These pictures clearly show that the diagnostician can select the displayed picture to suit the material under examination.

By switching the window width control to a "measure" position, which yields 1 digit black to peak white on the display, it is possible to measure the X-ray absorption at any chosen point in the picture.

Fig. 5. Block diagram of the computerised X-ray system



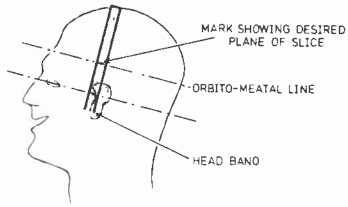


Fig. 7. Marking the slice planes on a headband

The window level control is adjusted until the point under examination is just changing from black to white. The absorption value can then be read off directly from the window level scale.

PATIENT PREPARATION

As each complete scan of the patient yields results on only two 1·3cm thick slices of the head it may be necessary to perform three or four such scans to cover the major part of the brain. If, however, it is desired to locate the examination at a certain point this is done very easily. Firstly an adhesive white tape is fixed over the head of the patient to form a head-band. This is then marked to show the orbito-meatal line, which is an imaginary line drawn between the corner of the eye and the meatus of the ear, used as a reference point. If for example the diagnostician requires to examine a slice 5cm above the orbito-meatal line, then a mark is made at this position on the head-band. This is illustrated in Fig. 7.

At this point the patient's head is inserted in the machine and the rubber head cap is collapsed onto the skull by means of water pressure to expel the air. The patient's head within the head cap is located in a plastic cone on which is printed a scale, and the mark denoting the chosen plane of slice is then read off against this scale. This reading is noted and the patient is then moved either into or out of the machine by means of a hand-wheel beneath the diagnostic table until a pointer and scale indicate the same value as the head cone reading. The patient has then been set in the machine such that a slice either side of the marked plane is examined.

A range of different plastic head cones is available in order to accommodate heads of various sizes and also to allow the head to be tilted for certain special examinations.

Each patient is normally allocated an identifying number which the radiographer can enter into the machine store before each scan by means of thumb-wheel switches on the X-ray Control Unit. This number appears on the pictures and print-outs for that scan and so gives a positive link between the patient and the result.

The computer normally processes each set of readings in serial order from the buffer store. However, should the diagnostician require the results from a certain patient quickly, then the computer can be instructed to give priority processing to a selected picture.

APPLICATIONS

As with any X-ray technique the EMI-Scanner system relies on the fact that the various structures found in the brain must have different X-ray absorption values in order that they can be differentiated. Even though the system is extremely sensitive there may be cases where the use of a contrast medium can be an advantage. Typically a small quantity of an X-ray opaque substance such as iodine can be injected intravenously into the patient.

If for instance there is a lesion which takes up the contrast medium more than the surrounding normal tissue then the diseased area will show up clearly on the picture, and, using the EMI-Scanner system, will continue to do so for several hours. The use of contrast media in this way should be compared with the technique used in angiography where the fluid is injected into the arterial system of the body and the effect lasts for only a few seconds.

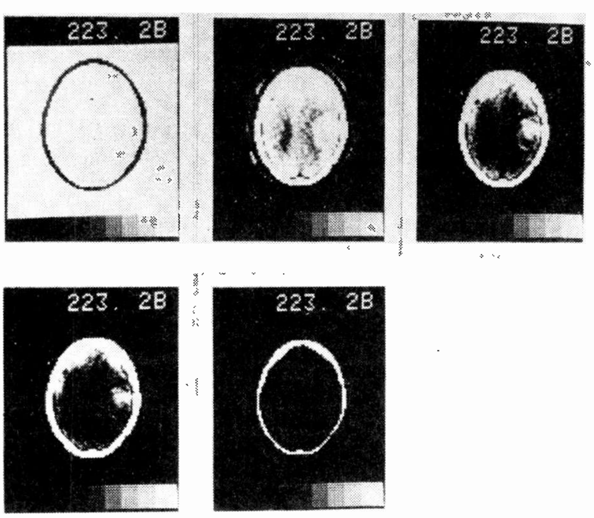
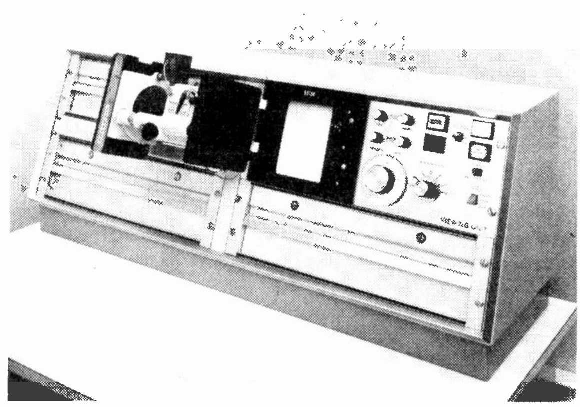


Fig. 8 (left). Effect of the "window level" control

The Viewing Unit

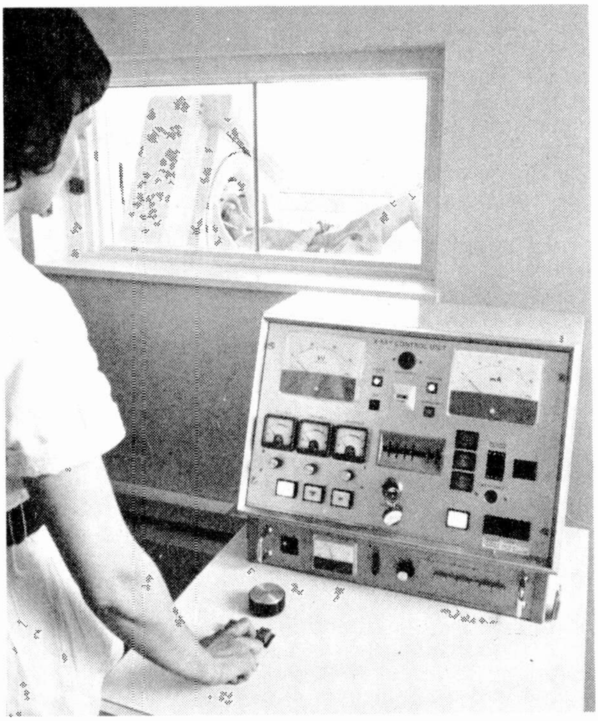


View of a patient in position on the scanning unit

TECHNICAL DETAILS

The circuit techniques used are in general of a conventional nature incorporating both discrete components and integrated circuits mounted on printed circuit boards. Both the Scanning Unit control electronics and the viewing Unit contain a large amount of logic circuitry.

The X-ray Control Unit



A feature of the system is the high degree to which the various controls are interlocked to ensure safe and correct operation by non-technical operators. As an example of this, the scanning sequence cannot be started until four conditions are satisfied:

1. That the scanning gantry is in the start position.
2. That the operator has set the patient's identifying code on the thumbwheel switches.
3. That the computer is ready to receive data into the disc buffer.
4. That the operator has removed the safety key from the Scanning Unit control panel and has inserted it in the X-ray Control Unit.

The status of these interlocks is clearly shown by means of indicating lamps so that the operator can check visually before starting the sequence.

The system for generating the X-rays is designed to give good stability and incorporates regulators for both voltage and current to the X-ray tube. Three-phase a.c. mains is converted to 100V 150Hz by a power conversion unit, which is then fed to the e.h.t. transformer. The output voltage is full wave rectified and smoothed to give an output of up to ± 70kV w.r.t. earth for the X-ray tube.

The X-ray tube is a fixed anode type, the cathode being aligned to give a line rather than a spot focus.

CONCLUSION

This system is being confidently predicted by many radiologists as one which will revolutionise the use of X-rays. The significance of this new technique has already been noted in Great Britain where its inventor, Mr G. N. Hounsfield, of the Central Research Laboratories of EMI Ltd., has recently received the MacRobert Award for outstanding innovation in engineering.

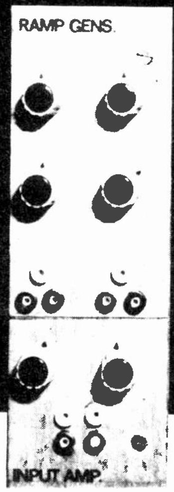
ACKNOWLEDGEMENT

The writer wishes to thank the Directors of EMI Ltd. for permission to publish this article. ★

PE Sound Synthesiser 4

RAMP GENERATORS & INPUT AMPLIFIERS

By G.D. Shaw



THIS month, the operation and construction of the ramp generators and input amplifiers will be described together with guidelines on using the various modules, so far described, in combination.

RAMP GENERATOR

The ramp generator to be described is effectively a sawtooth oscillator capable of working down to very low frequencies. At the low end of its working range the output of the device may be considered to be slowly changing d.c. and, unlike the v.c.o. which produces an output waveform swinging about zero, the output of the ramp generator is single-ended, that is, swinging from zero to about −3·5V.

The reason for this arrangement is that the ramp generator is considered essentially as a device for programming other voltage controlled modules all of which require control voltages of one polarity only. This requirement, incidentally, does not mean that alternating voltages cannot be used for programming and, as will be shown, many interesting effects can be obtained when the control voltages vary about zero.

As with the v.c.o. the principle of operation is that of the linear integrator although the circuit shown in Fig. 4.1 is very much simpler.

IC1 is the integrator which receives its positive control voltage either from VR1, an external source, or from both in combination. IC2 is a comparator which, since single ended operation is required, utilises a reference voltage set by R7-R8 and transistor TR1 to discharge the integrating capacitor C1. The reference voltage also determines the peak ramp output voltage of the circuit.

CIRCUIT OPERATION

The operation of the circuit is as follows. The divider R7/R8 provides −3·5V at the non-inverting input of IC2 and effectively biases TR1 off. Assuming that the R1 input to IC1 is open circuit, a positive voltage derived from VR1 is applied to the inverting input of IC1 via R2 and the integrator begins to ramp negatively at a rate determined essentially by R2/C1.

When the ramp output voltage applied to the inverting input of IC2 is equal to or greater than the reference voltage the comparator switches to its positive saturation state, turns on TR1, and discharges C1 via R6 and R7.

The sawtooth output waveform is taken from the junction of R4 and R5 via VR4 while a pulse output is available from the emitter of TR1. Note that this requires to be a.c. coupled if it is to be used effectively.

CONSTRUCTING THE RAMP GENERATORS

Construction of the ramp generators is perfectly straightforward, the recommended circuit board layout being shown in Fig. 4.2. Note that both ramp generators (RG1/RG2) are built on one circuit board and that power supply decoupling is not required.

The method of construction should generally follow that employed for the v.c.o. module. Components should be mounted to the front panel and prewired before the panel is secured to the circuit board support plate. Note, however, that in this case the main wiring harness from the ramp generators should leave the front panel at the top and pass over the top edge of the circuit boards while the wiring to the input amplifiers should be as short as possible and routed direct to the appropriate circuit board.

A detail of the panel component wiring and board layout is shown in Fig. 4.3. The McMurdo plug should now be prewired and mounted into the support plate.

TESTING

When assembly of one of the ramp generators has been completed make temporary connections to power supply leads and front panel controls and connect a resistor of at least 10 megohms across the integrating capacitor C1. Set VR2 and VR1 to their minimum values, VR3 to its mid-position, and switch on the power supply. Observe the integrator output on the oscilloscope and adjust VR3 for zero offset. Switch off and remove the 10 megohm resistor.

Set VR2 to its mid-position and switch on again. A sawtooth waveform of about 7Hz should now be observed. Gradually reduce the setting of VR2 until the slope of the ramp begins to show slight rippling.

RAMP GENERATORS

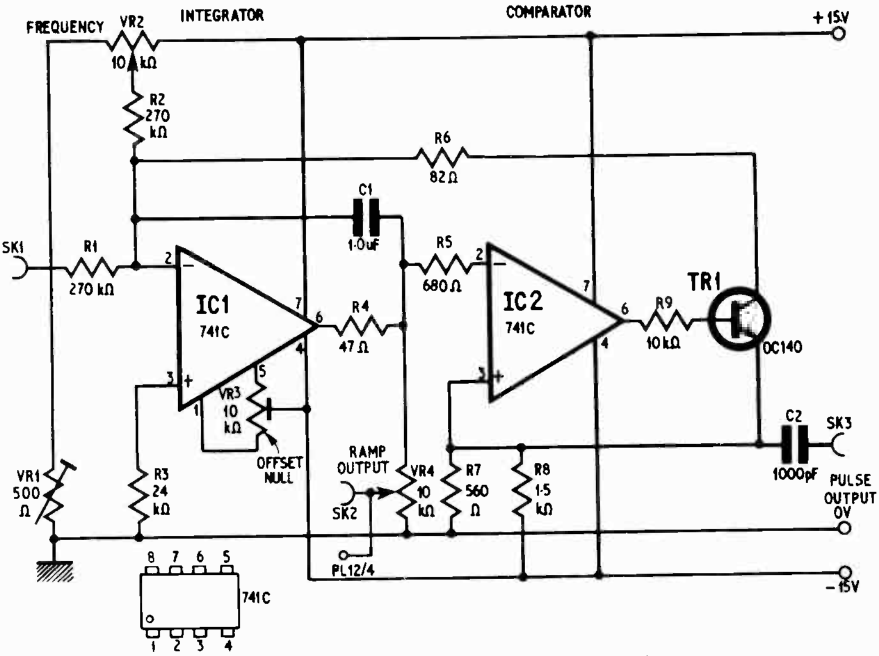


Fig. 4.1. Circuit of a ramp generator

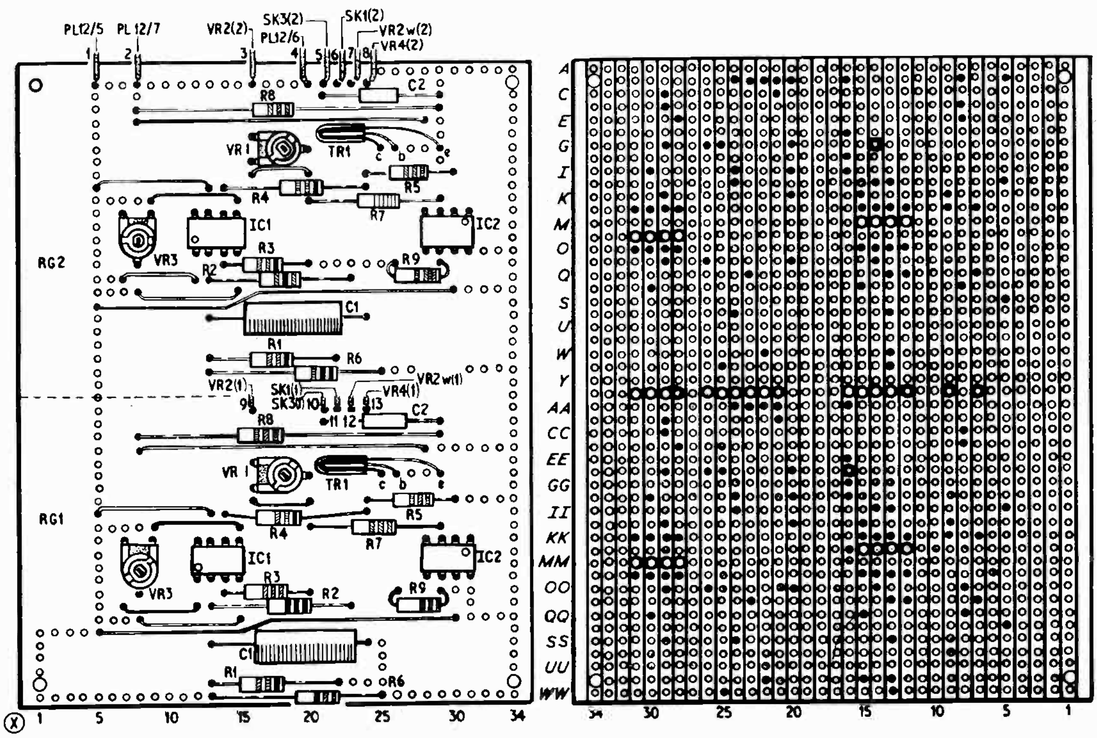


Fig. 4.2. Component layout and wiring of ramp generators

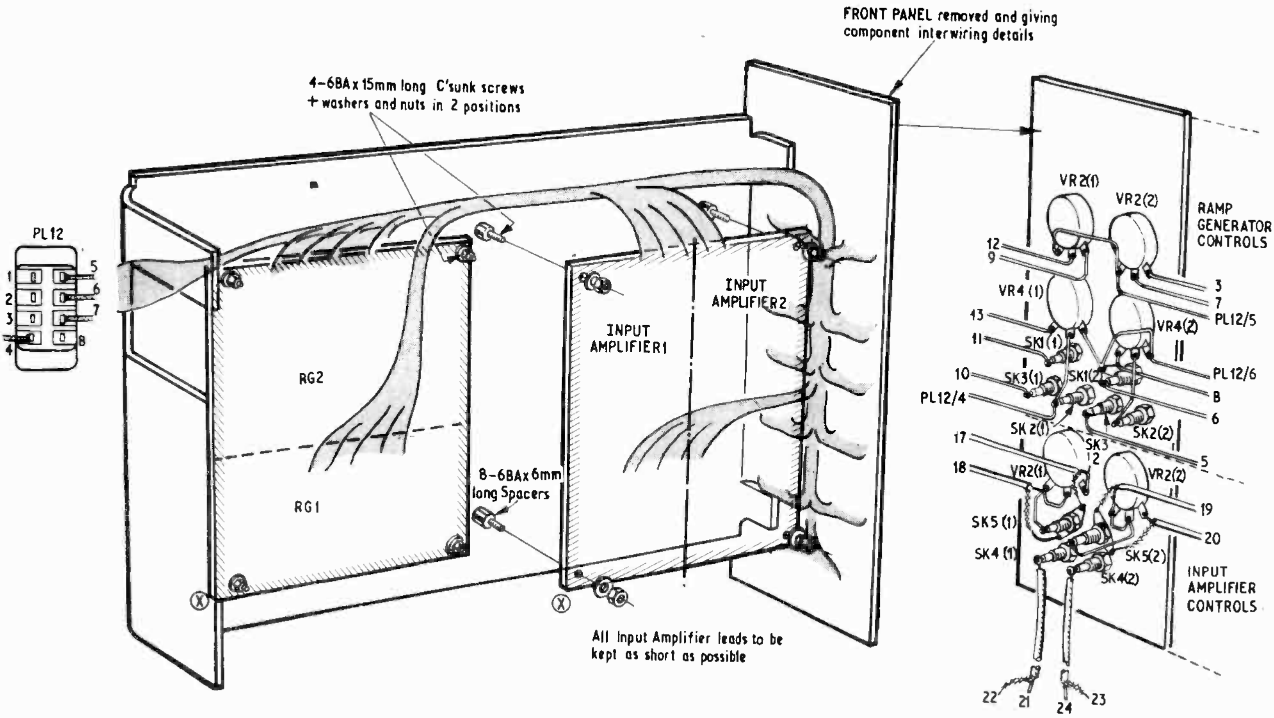


Fig. 4.3. Control panel wiring and board layout of ramp generator module. A lead should be taken from SK2(2) to PL12/8

COMPONENTS . . .

RAMP GENERATOR (2 OFF)

Resistors

R1, R2	270k Ω (2 off)
R3	24k Ω
R4	47 Ω
R5	680 Ω
R6	82 Ω
R7	560 Ω
R8	1·5k Ω
R9	10k Ω

All 2% ½ watt metal oxide

Capacitors

C1 1μF polyester 25V
C2 1,000pF polystyrene

Integrated Circuits

IC1, IC2 741C 8 pin D.I.L. (2 off)

Transistor

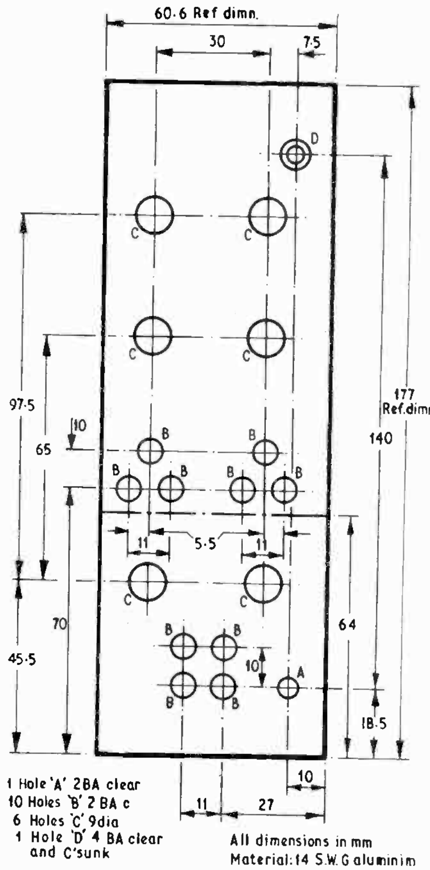
TR1 OC140

Potentiometers

VR1 500 Ω horizontal carbon preset
VR2 10k Ω miniature moulded carbon linear potentiometer
VR3 10k Ω horizontal carbon preset
VR4 10k Ω miniature moulded carbon linear potentiometer

Miscellaneous

SK1-SK3 2mm miniature sockets (3 off), 2 Elma knobs, 34 × 17 way 0·1in matrix Veroboard



INPUT AMPLIFIER

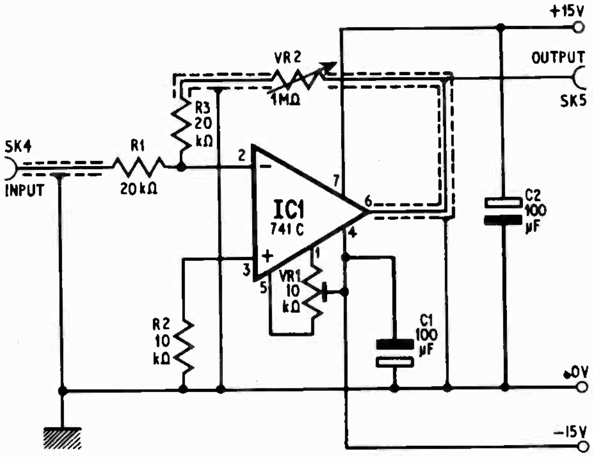


Fig. 4.4. Circuit of an input amplifier

COMPONENTS . . .

INPUT AMPLIFIERS (2 OFF)

Resistors

R1 20k Ω
R2 10k Ω
R3 20k Ω
All 2% ½ watt metal oxide

Capacitors

C1, C2 100µF elect. 25V (2 off)

Potentiometers

VR1 10k Ω horizontal linear preset
VR2 1M Ω linear miniature moulded carbon

Integrated Circuit

IC1 741C 8 pin D.I.L.

Miscellaneous

SK4, SK5 2mm miniature sockets (2 off), 34 × 17 way 0·1in matrix Veroboard, 1 Elma type knob

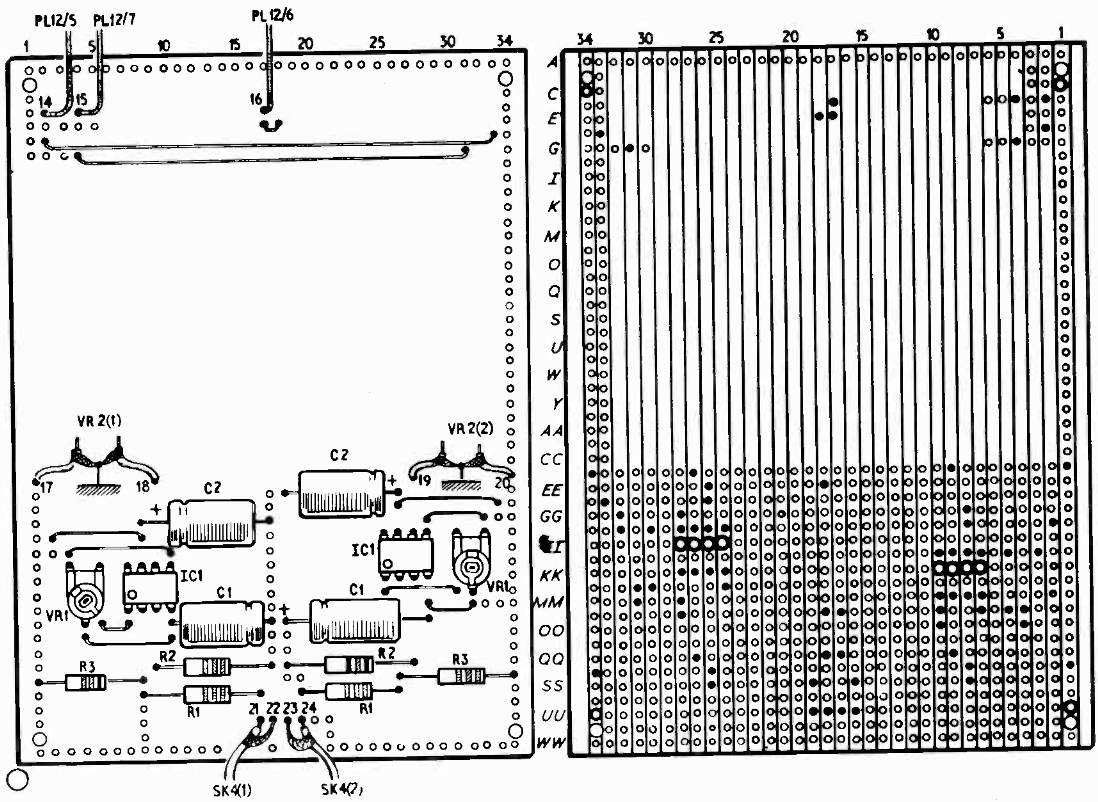


Fig. 4.5. Circuit board layout of input amplifiers

Increase the setting of VR1 until the rippling disappears and make further reductions in the setting of VR2, adjusting VR1 as necessary to keep the slope ripple free. Note that at the minimum setting of VR2 the ripple effect is at very low frequency and shows itself more as a hesitancy in the motion of the oscilloscope trace.

With careful adjustment, and the component values shown, it is possible to achieve a low frequency of 0·01Hz but it is almost impossible to remove ripple entirely at this frequency and generally it is best to set the low end of the range to 0·05Hz to ensure stability. The upper frequency limit with the 1·0μF integrating capacitor is about 15Hz.

In the prototype instrument one ramp generator was built as described and the second was built with an integrating capacitor of 0·47μF thus giving an upper frequency limit of about 30Hz with very little sacrifice to the v.l.f. end of the range. Such a procedure is recommended since the higher frequency is very useful in the production of rapidly changing, complex sound patterns.

When both ramp generators have been built and tested, mount the circuit board on the support plate in the position remote from the front panel (Fig. 4.3).

INPUT AMPLIFIERS

The input amplifier theoretical circuit is shown in Fig. 4.4 and the circuit board layout in Fig. 4.5.

Although very simple in design rather more care is required in the component layout if hum pick-up is to be avoided, this latter problem tending to occur more when the gain control VR1 is at its maximum setting. Note that screened wire is used to connect the input sockets and gain controls to the circuit board. These wires should be trimmed as closely as possible to the required length and led directly to the circuit board without being formed into a harness.

The only setting up required is the adjustment of the offsets. VR2 should be set to maximum, the input grounded and, with the power supply on, adjusted to give an output level of precisely zero.

Reference to block diagram in Part One will show that Oscillator 1 is programmed directly by Ramp Generator 1 through the medium of a prewired interconnection. Accordingly tag 4 on the ramp generator McMurdo socket (SK12) should be connected to tag 1 on the v.c.o. socket (SK8). This direct connection may be over-ridden by inserting either an open circuit or grounded jack plug into the external programming socket of the v.c.o. Alternatively a jack plug coupled to a patch cord may be used to provide programming from another source.

It is recommended that grounded jack plugs are used if precise manual control of v.c.o. frequency is required.

PROGRAMME DATA SHEET

The completion of this module provides the constructor with greater facilities for the production of programming waveforms and some quite complex sound structures. With the addition of the v.c.o. module there are now seven separate circuits and 12 controls to manipulate. There is thus a need for a method of logging control settings and interconnections so that any given sound structure may be repeated at a later date.

Details of a data sheet which will prove ideal for the purpose are given in Fig. 4.6. Control settings would normally be recorded in the circles on the front panel representation while module interconnections would be indicated by a dot in the appropriate square on the grid matrix. Data recorded in the figure relates to the production of a type of bird song which will be described in detail in a later article.

USING THE CONSTRUCTED MODULES

The provision of the input amplifiers allows waveforms from the oscillators and/or ramp generators to be mixed either additively or subtractively when used in combination with the voltage inverter. The permutation of all the possible settings of amplitude and frequency controls implies that an enormous range of sound structures may be produced and, whereas it is beyond the scope of this article to cover all the possibilities, a number of simple experiments are suggested for guidance.

Starting with the ramp generators, Fig. 4.7a shows the type of relationship which may be observed on the oscilloscope when one ramp generator is running at ten times the frequency of the other. With the output of a v.c.o. coupled to a suitable power amplifier and its frequency control at zero, application of either of the waveforms shown will cause the v.c.o. frequency to be swung from the lowermost end of the range to an upper frequency determined by the amplitude of the ramp generator waveform.

Since the upper frequency limit of the v.c.o. is dictated by the saturation level of the differential stage and since the gain of this stage is 10 then a programming waveform amplitude of about 1·4V will drive the v.c.o. to its maximum frequency.

Fig. 4.7b shows the effect of mixing the waveforms shown in Fig. 4.7a additively. To achieve this, route the outputs of the ramp generators to separate input amplifiers which have their gain controls set to zero, i.e. unity gain, and then to the inputs of the voltage inverter. Observation of the output of this latter device reveals the composite waveform.

With the ramp generator output levels adjusted so that the maximum combined level is about 1·4V route the voltage inverter to the input of the v.c.o. The result is an undulating sound the lowermost frequency of which is continuously rising at a rate set by the frequency of the slowest running ramp generator.

SUBTRACTIVE MIXING

Fig. 4.7c shows the effect of subtractive mixing of the ramp generator waveforms. Achievement of the staircase form is as follows.

Set the amplitude of the slowest ramp generator output to 1·4V and route this to the voltage inverter via an input amplifier set to unity gain. Route the second ramp generator to the voltage inverter direct. Since this now sees the inputs from the ramp generators at opposite polarities the result is subtractive mixing which, when the amplitudes are at the correct levels, produces a staircase as shown.

Application of this waveform to the v.c.o. produces a rising, arpeggio-like sound. A falling arpeggio may be produced by reversing the routing of the ramp generators with the slowest direct to the voltage inverter, and fastest to the voltage inverter via the input amplifier. In this latter case the frequency control of the v.c.o. has to be set to its maximum level since the waveform from the voltage inverter is now positive going.

SYNTHESISER PROGRAMME SHEET

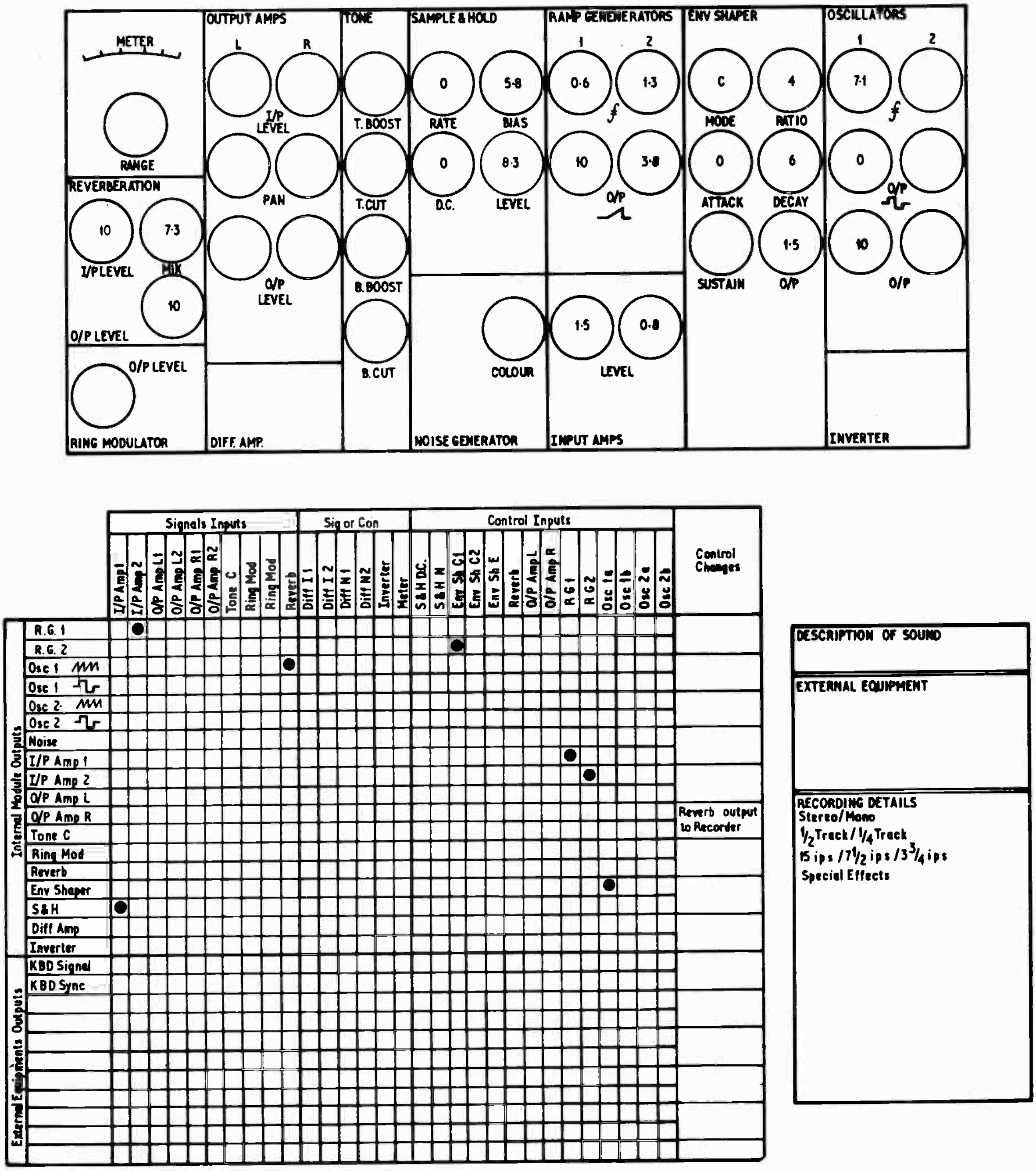


Fig. 4.6. Example of a programme data sheet

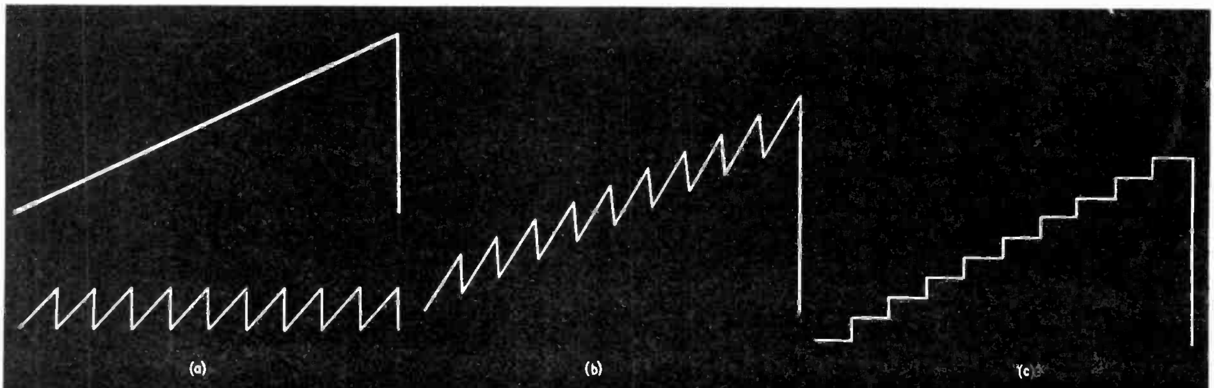


Fig. 4.7. (a) Components for additive mixing; (b) resultant through addition of components; (c) subtractive mixing produces staircase waveform

FIXING THE V.C.O. LIMITS

In these examples the v.c.o. has been programmed through its maximum working range but it is, of course, possible to achieve the same effect within very precise frequency limits. For example, suppose it is wished to provide an arpeggio rising from 130Hz to 520Hz, the frequency control of the v.c.o. is set to give the voltage required to produce 130Hz. The fact that the ramp output will, at times, be zero volts will not affect the l.f. performance limit since the v.c.o.s were originally set up with a link simulating a zero-volt programming input. Thus from Fig. 3.4 in last month's article it will be seen that the initial setting of the v.c.o. will require an input of about 24mV. Also it will be seen that a frequency of 520Hz requires an input of about 42mV and thus the output amplitude of the combined ramp generator signal will have to be (42–24)mV. In a similar manner the manipulation and adjustment of the manual and automatic voltage sources can set the programmed sequence almost anywhere in the working range of the v.c.o.

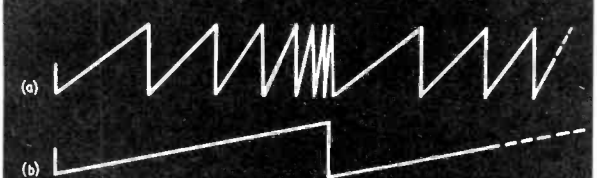


Fig. 4.8(a). Programmed ramp generator output (b) programming waveform

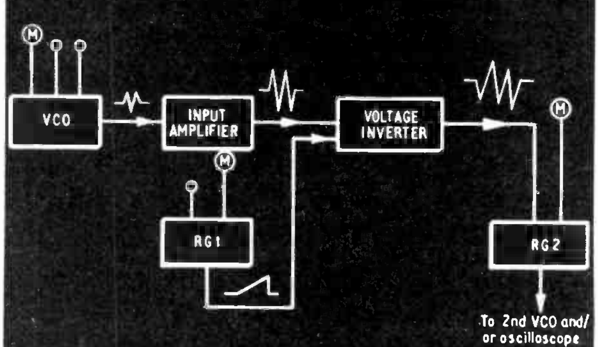


Fig. 4.9. Block diagram for ramp generator programming

PROGRAMMING THE RAMP GENERATORS

The monotonous repetition of the ramp generator output can be considerably varied by application of programming voltages to its own external control input. Fig. 4.8 illustrates the effect of applying a steadily rising voltage to the control input.

The voltage has been derived from the output of the other ramp generator running at a fairly low frequency and routed via one of the input amplifiers set to provide a peak ramp output of positive 14V. The resultant output of the programmed ramp generator consists of a series of ramps gradually increasing in frequency as the programming voltage rises to its peak, the aural effect when used to programme a v.c.o. being a kind of bounce.

For the best effect the programmed ramp generator should be running at about twenty times the frequency of the other.

An extension of the above system is shown in the block diagram Fig. 4.9. In this case one of the v.c.o.s is also providing a programming waveform which is first amplified to provide an output swing of ±7V. This is then combined, in the voltage inverter, with the output of the programming ramp generator set to its maximum output level. The voltage inverter is then routed to the programmed generator which has been set to run at about 7Hz, the overall result being a bounce which is changing its rate in a pattern depending on the relative frequencies of the programming sources.

EXPERIMENTAL COMBINATION

There are many other combinations of the programming devices all of which result in the production of characteristic sounds. The constructor is encouraged to investigate these as widely as possible noting the control settings and interconnections which produce sounds of particular interest.

It should be noted that even quite small adjustments to amplitude and frequency of programming waveforms can cause relatively great changes in the sound structure. This is particularly the case when amplitudes are adjusted in complex programming waveforms such that the waveform changes potential, i.e. crosses zero. In these cases the v.c.o. will cease to oscillate for as long as the programming waveform remains positive and thus, for a fairly rapidly changing waveform, the long term output of the v.c.o. will resemble a series of tone bursts of varying frequency.

The use of positive going programming waveforms to the v.c.o. should be investigated with care, particularly when the manual frequency control is at or near zero. The sudden application of a large positive input will cause an unpleasant click due to the increase in v.c.o. output voltage as it goes into saturation. Similarly a low potential positive input applied for a prolonged period will, on its removal, give rise to a click when the v.c.o. comes out of saturation.

USING A RECORDER

It is perhaps prudent, at this stage, to mention that a tape recorder is a most necessary adjunct to the Synthesiser if the full potential of the instrument is to be realised. This is essential because, although live performance is possible, it is somewhat limited due to the design of the keyboard which is monophonic. In order to produce complex realisations, it is necessary to employ a recorder in order that multitracking of one form or another may be used to blend or superimpose consecutive series of sound structures into a comprehensive whole.

In a similar manner many sound effects may be enhanced by the addition or superimposition of secondary sounds. This procedure can be particularly useful when complex effects such as storms, battles or woodland birdsong are being synthesised.

Quite apart from the creative aspects of using the tape recorder another important reason for its application with the Synthesiser lies in the establishment of a taped library of sounds.

Many excellent books and articles have been written on this subject but, in the field of creative recording, T. Dwyer's "Composing with Tape Recorders" (Oxford University Press 1971) contains much useful information.

NOTE:
The power supply transformer in Part 2 has 0–30, 0–30V separate secondaries. R1 and R6 should be 5·6kΩ 2% ½ watt metal oxide resistor. IC2 should be insulated from chassis with a mica washer. In Part 3, VR2 is 100kΩ.

Next month: Sample Hold and Noise Generator.

BOOK REVIEWS

ELECTRONIC MUSIC PRODUCTION

By Alan Douglas
Published by Sir Isaac Pitman & Sons Ltd
148 pages 5½in × 8½in. Price £2·75

ELECTRONIC MUSIC PRODUCTION presents a very much "up to the minute" look at the use of electronics in the production of music with special reference to the synthesiser and the applications of voltage control. The book is divided into four main sections. 1—Properties of conventional musical instruments. 2—Musical scales, temperament and tuning; concord and discord. 3—Electronic music generators. 4—Electronic music and the composer. Additionally there are two appendices which provide, in the first, a detailed specification of the Synthi 100, a highly advanced synthesiser designed for interfacing with a computer and, in the second, details of MUSYS documentation standards together with an example drawn from part of a composition programmed on the Synthi 100. Finally there is a comprehensive bibliography and index.

Electronic Music Production is a lucidly written book packed with data much of which will be new to the reader. There are plenty of clear line illustrations and circuit diagrams and there is little doubt that this book will be "required" reading for all students of electronic music—amateur and professional alike.

G.D.S.

LOGIC AND LOGIC DESIGN

By B. Girling and H. G. Moring
Published by International Textbook Company
328 pages, 9in × 6in. Price £5·80

A BASIC understanding of logic is essential for anyone interested in the design of computers and associated logic systems. This book, based on a course of lectures given at The City University, provides an excellent introduction to logic, starting from basic number and set theory. It covers the Computer Science requirements for a B.Sc. degree and each chapter concludes with a bibliography and a set of questions with solutions.

This book is very well written and concepts are explained with the aid of copious clearly drawn diagrams. The book does not deal at all with engineering considerations in logic circuit design, concentrating rather on the logical concepts involved. As well as all the standard aids to logic design many up to date references are quoted so that modern concepts can be understood.

With the increasing interest in Computer Science this book will no doubt find its way into many degree courses as the standard reference work. It is well bound and excellently printed and though the price is rather high it is good value for money.

S.R.L.

POCKET CALCULATOR KIT REVIEW

Supacal Calculator

Obtainable from S.C.S. Components Ltd., P.O. Box 26, Wembley, Middx HA0 1YY.
Price £39 (+ V.A.T.) with special £4 discount to P.E. readers.

IMMEDIATELY upon opening the box containing the SUPACAL calculator kit the decision should be made as to whether one is sufficiently equipped in terms of both tools and experience to undertake the construction of the calculator. *Should there be any doubt in this respect, it is strongly recommended that the services of a more experienced friend or colleague be recruited for this work.* The minimum tools required for building the kit are a good soldering iron of 10 to 25 watts with a bit preferably no more than a sixteenth of an inch diameter, also a pair of side cutters, a pair of long nosed pliers, and a good light.

Many solder joints have to be made in a small area and a certain degree of skill is needed to avoid short circuits and dry joints. Fine solder is provided with the kit and this greatly simplifies the construction.

COMPONENT PACKING

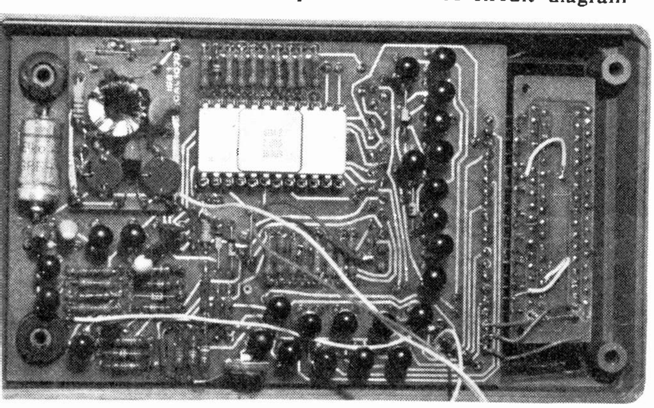
All components come in plastic bags marked with the value of the components contained, but it is as well to check these values against those required as it is always better to be safe than sorry. Because the printed circuit board has tracks both sides many solder joints have to be made on both sides of the board; this is tedious but it is essential to make good connections.

The display board and the inverter board for the 25V i.c. supply come as ready made units and this eases the constructor's task enormously. The keyboard is already fitted into the top half of the case and wiring to the main circuit board is simple, though here again solder joints have to be made top and bottom of the board.

HANDLING PRECAUTIONS

The calculator i.c. comes in a piece of protective conductive foam and the handling precautions in the instructions should be carefully followed. A socket is provided for the i.c. so the usual problems of soldering to an m.o.s. integrated circuit are overcome.

Instructions for the insertion of all components are given and these are easy to follow. A circuit diagram and point-to-point wiring diagram are also supplied. Total construction time for the SUPACAL was three and a half hours in this reviewer's case. Any difficulties will probably be caused by poor soldering and a good light is useful for checking.



The kit suppliers offer a back-up service in the form of a fixed price repair facility and this ensures a fully working calculator no matter how much of a mess you made of the construction. Once the calculator is working then all parts are guaranteed for one year.

CALCULATOR CONSTRUCTION

Now something about the calculator itself. It is housed in a strong plastics case and uses two rechargeable batteries for its power source. A ready built charger is provided with the kit; fully charged batteries give about eight hours working. There is an automatic fade-out facility which switches off the display (which consumes about half the total power) approximately ten seconds after a key has been pressed.

The keyboard uses conductive rubber contacts which give the machine an extremely light touch; in fact the switches are almost too sensitive, some care being needed not to enter a digit unintentionally.

CAPABILITY

The calculator can handle all four arithmetic operations with all calculations being in floating point, with eight digits being displayed. There is a stored constant facility which, unlike most other calculators, can be used with *all* four functions. Another advantage of this calculator is that it will not overflow. Other calculators will ignore any entries over eight digits long; the SUPACAL stores not only the eight digits entered but also stores an exponent up to 10^{79}; the true decimal point position is found by dividing by powers of ten until the point appears on the display. This enables more accurate answers to be found.

INSIDE THE POCKET CALCULATOR

How does the pocket calculator work? The "heart" is the second generation single chip MOS LSI circuit type C500 manufactured by General Instruments Microelectronics. It contains within its 4,000 active devices all the logic necessary for performing eight digit, four function plus constant and floating decimal point, calculations.

The chip contains a read-only-memory (ROM) of 2,000 bits, a random-access-memory (RAM) of 100 bits and associated control logic, dividers and timing circuits for clocking and multiplexing. The chip simply requires a 25V supply and a clock input of 50kHz to 100kHz, a keyboard, display, and circuits to drive the display and it becomes a fully operational calculator.

The display interface is by means of discrete buffer/driver transistors for segment and digit driving. The display is multiplexed, i.e. each digit is only driven for one-ninth of the time, there being nine l.e.d. digits with seven segment format.

B Y F R A N K W. H Y D E

SKYLAB EXPERIMENTS

The number of activities that have been planned for the *Skylab* project are extensive. The work periods are 28 days for the first crew and up to 56 days for the next two crews.

In some experiments the astronauts will be used to study the effect of prolonged weightlessness. So far the longest time in the weightless state has been 18 days. This was by three Russian astronauts during the *Soyus 9* flight.

One of the after effects that became noticeable after the *Soyus* flight was a curious random stumbling which each astronaut suffered but for varying times. All had returned to normal within three weeks.

As the Russians always operate the "shirt sleeve" mode as it were, the *Skylab* experiments will be comparable though, of course, the available area for movement will be greater.

There will be specific exercises which each member of *Skylab* crew will do. These, together with studies of the changes induced in muscles, bones and the blood chemistry will enable a better assessment to be made of the space-induced effects.

Each man will have a special standardised diet to follow. With a special spring balance designed for zero gravity use, the astronauts will measure and record the mass of food they eat.

The spring balance is a coil spring to which is attached the item to be measured. The oscillation of the spring is measured electronically. The period of the oscillation depends upon the mass and on the known properties of the spring. In a similar way the astronauts will check their body weight using a spring chair.

Other experiments to be carried out are the study of crystal growth of metals and alloys together with solidification properties by using an electric furnace. One special study will be that of the possibility of producing doped semiconductors of high chemical uniformity. It is thought that in zero gravity the effects of thermal convection in a gravity field will be avoided.

The changes in flammability which have been noticed in short periods of weightlessness in aircraft will also be studied. On many occasions it has been noted that flames tend to go out when the weightless condition has been reached.

EARTH RESOURCES STUDY

Because the orbit of the space station will be inclined by 50° to the equator something like 75 per cent of the earth's surface will be covered and the station will return every five days over a given area. This provides a unique opportunity to study earth resources. Some 132 experiments originating from about 24 countries will be undertaken.

Observations will be made with cameras both in the visible and the infra-red part of the spectrum, together with the microwave sweeps. The moisture in the soil, the vegetation type and its condition will be determined by comparing the photographs from different spectral areas.

The experiments are varied and the chart below gives some details.

These are but a few of the experiments agreed by NASA and there are many more suggestions involving, in some cases, on-board equipment and in others the use of data collected. NASA accepted 19 experiments from the total of 3,400 proposals sifted by the Science Teachers Association.

The results of the first period will undoubtedly influence the later programmes particularly on the effects of weightlessness.

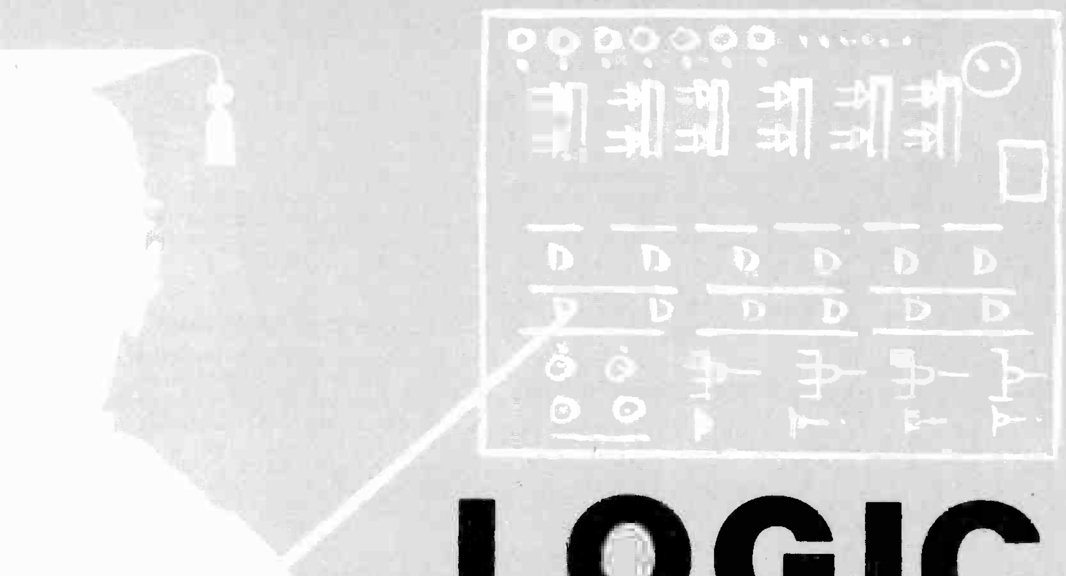
SOLAR OBSERVATION

The experiments involving solar observation are designed to both add to existing data and check the present thinking. Several of the station's telescopes are under automatic control from Earth. This has many advantages since there will be intervals between the change of crews when the station will be unmanned; continuous operation of the selected instruments is important.

The white light coronograph will measure the brightness of the corona and the polarisation. This will be done at distances varying between 1.5 and 6.0 solar radii from the Sun. The instrument has a number of sizes of occulting discs which are controllable and prevent the direct light from the Sun from reaching the objective lens. The scattered light is reduced to 10^{-10} of the mean solar radiance.

CHART 1

Experiment	*Originator*	*Observation*
Ecological	Joseph Otterman	Indentification of land in Israel suitable for wheat and date palms.
Ecological	US Department of Agriculture	Seek infestation areas by pine beetles in South Dakota.
Environment	Japan	Effect of human activities on the environment.
Astronomical	High School Students	Skylab telescopes to look for "cloud moons" thought to be 60° ahead and 60° behind the moon in its orbit.
		Inspection of solar photos for planet between Sun and Mercury.
Biological	High School Students	Radishes grown in weightless conditions to show effect of light and gravity on direction of root and shoot growth.
		Observe spider making web to detect any differences due to gravity.



LOGIC TUTOR

By G. D. Bishop and M. Hughes

To many, the fundamental principles involved in computing are a foreign language. In this article the construction of a comprehensive Logic Tutor is described. Elsewhere in this issue is the first article on using the Tutor providing an introduction to digital logic theory with practical exercises so that at the end of the series a full understanding of computing should be gained.

TUTOR FUNCTIONS

The Logic Tutor is designed to demonstrate the AND, NAND, NOR and OR gates in NAND logic form. Other circuit functions demonstrated are flip-flops, counters and shift registers.

To demonstrate logic theory it is necessary to construct a basic bread board on which exercises can be carried out. This panel can be seen in the photograph with the various symbolic functions marked upon it.

The complete tutor can be made, using entirely bought parts, for about £9. This can, of course, be reduced by judicious shopping.

LOGIC BOARD

In the prototype a 13in × 10in × 4in wooden box was used for housing the Tutor electronics, the logic board forming the lid.

The latter is drilled as in Fig. 1 using a 1·2mm drill for the terminal pin holes. Other holes should be shaped to suit the switches, lamps and digital indicator purchased but at this stage none of these components should be mounted. The logic symbols

COMPONENTS . . .

DISPLAY CIRCUITS

Resistors

R1–R11	100Ω (see text) (11 off)
R12–R17	1kΩ (6 off)
R18	47kΩ
R19–R28	470Ω (10 off)
All 10% ½ watt carbon	

Transistors

TR1–TR32	BC108 or any 300mW n.p.n. silicon planar switching transistor (32 off)

Lamps

LP1–LP10	Round M.E.S. bulbs 1·5V, 0·2A

Cold cathode tube

V1	Hivac GR2M or Mullard ZM1026

LOGIC CIRCUITS

Integrated Circuits

IC1–IC6	945 D.I.L. (6 off)
IC7–IC10	946 D.I.L. (4 off)
IC11–IC12	930 D.I.L. (2 off)
IC13	962 D.I.L.
IC14	933 D.I.L.
IC15	945 D.I.L.

Diodes

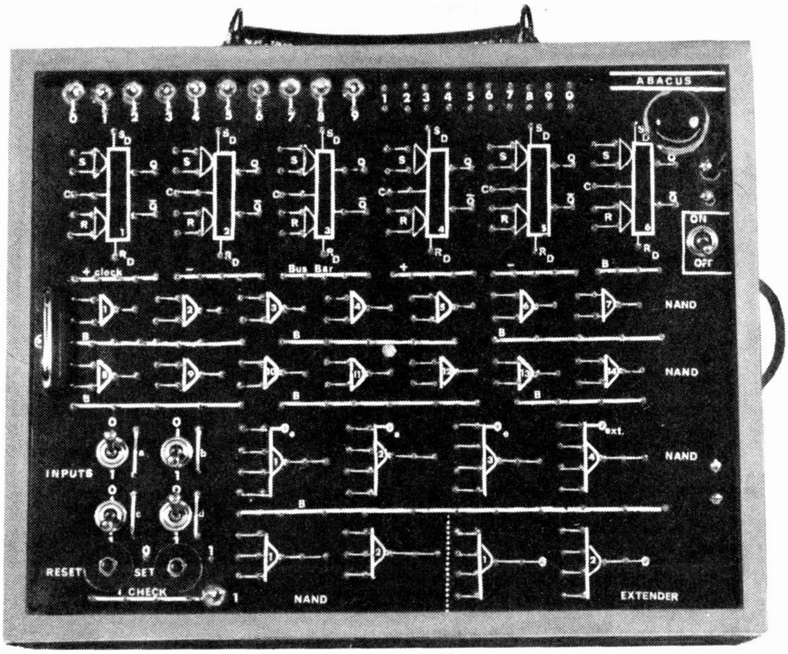
D1–D2	OA91 (2 off)

Capacitors

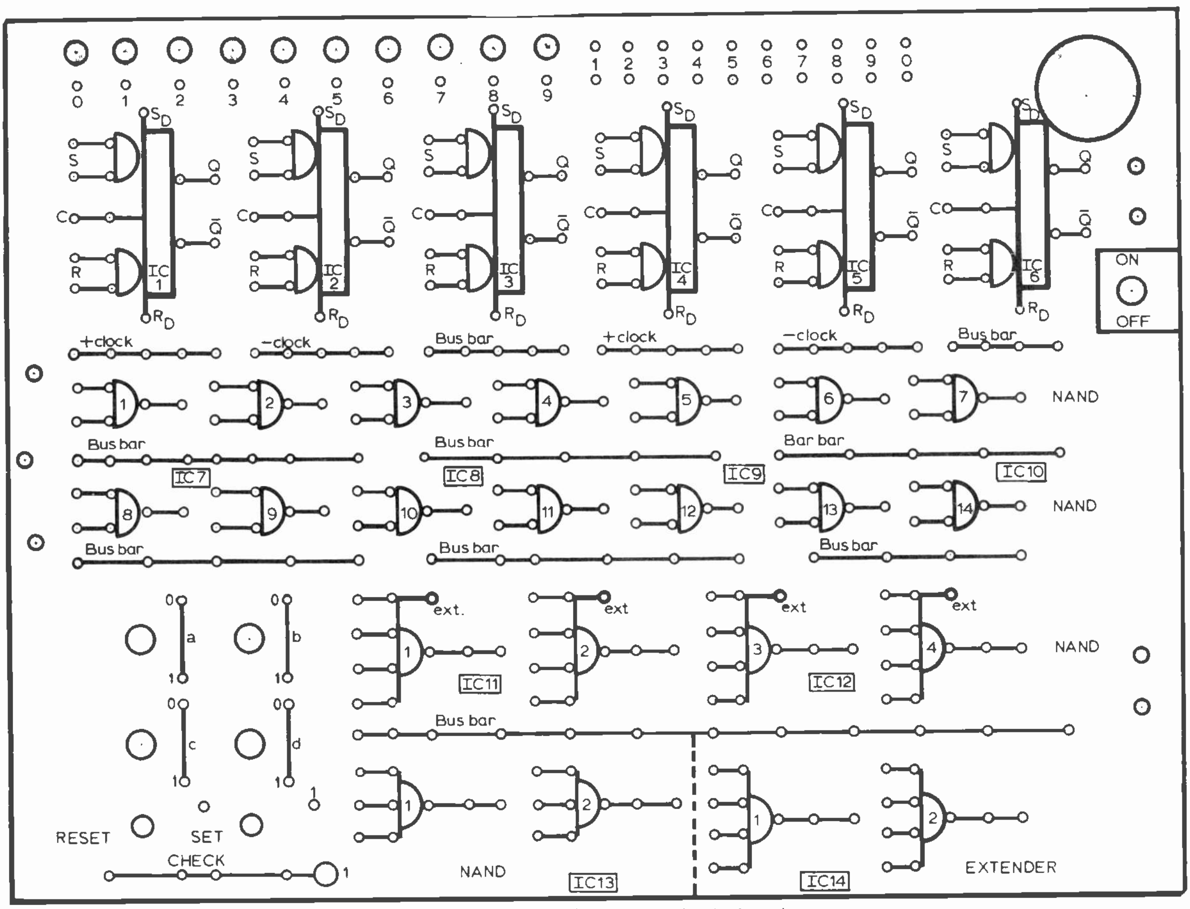
C1–C2	100μF elect. 6V (2 off)

Switches

S1	Mains on/off toggle
S2–S5	Single pole, changeover toggle (4 off)
S6–S7	Miniature push button switches
LP11	Round M.E.S. bulb 1·5V, 0·2A
D.I.P.	Veroboard 6in × 3½in



The completed Logic Tutor showing the front panel layout



All holes shown thus ◯ are to be made to suit components available

Veropins to be interwired under the board as indicated by heavy solid lines

Fig. 1. Layout of logic board showing drillings and symbols

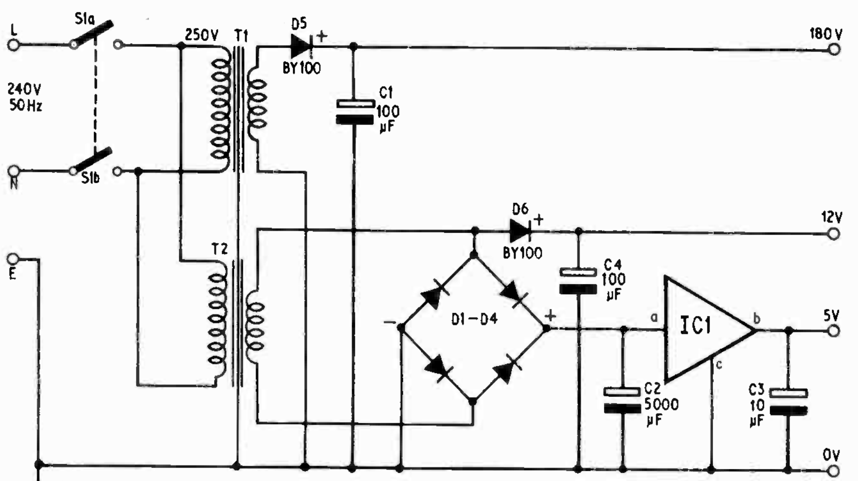
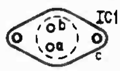
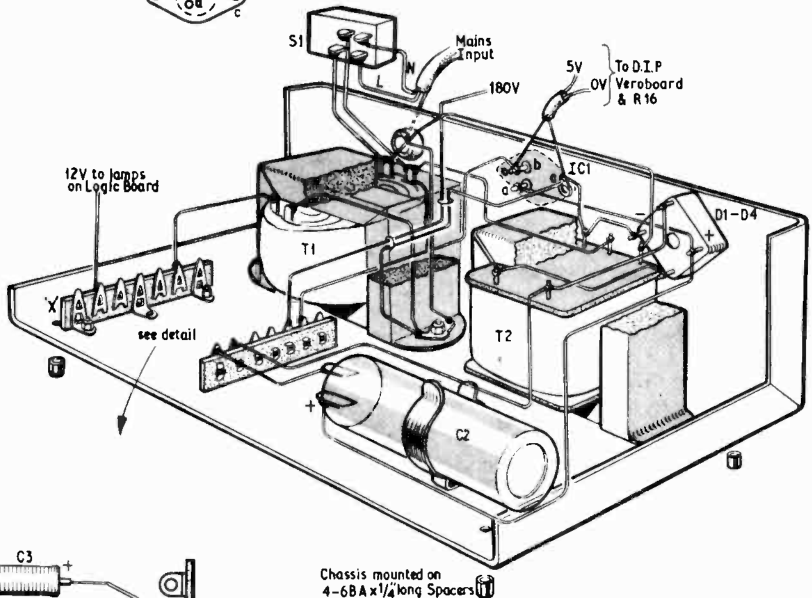


Fig. 2. Circuit diagram of power supply





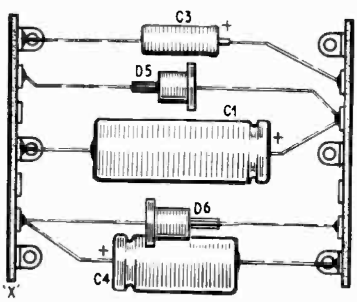


Fig. 3. Component layout and wiring for the power supply unit

COMPONENTS . . .

POWER SUPPLY UNIT

Capacitors

C1 100µF elect. 350V
C2 5,000µF elect. 15V
C3 10µF elect. 15V
C4 100µF elect. 15V

Rectifiers

D1–D4 REC41A Silicon Bridge Rectifier
D5–D6 BY100 (2 off)

Regulator

IC1 5V—600mA monolithic voltage regulator (R.S. type MVR—5V or similar)

Transformers

T1 240V primary; 150V, 10mA secondary
T2 240V primary; 9V, 1A secondary

Miscellaneous

18 s.w.g. aluminium as required, 12 way tag strip, double-sided terminal pins and pick-up tags 1·2mm diameter (R.S. types)

on the board indicate six RS/JK flip-flops, fourteen two-input NAND gates, four four-input NAND gates, two three-input NAND gates and two four-input extenders (AND). Most logic functions can be demonstrated with these.

The logic symbols are marked on the drilled board with paint or Letraset. These should be lacquered for permanent fixing after the double-sided terminal pins are pressed into the 1·2mm holes. These pins have a shoulder to facilitate insertion without risk of pushing the pin right through the board.

POWER SUPPLY

The next item to be tackled is the power supply which feeds the integrated circuits with a stabilised 5 volt, and the output displays.

To observe the logic outputs two alternative displays can be used; lamps to indicate outputs singly or a cold cathode numerical indicator. Although included this item can be dispensed with if costs are to be kept down.

The display supply requirements are 12V for the lamps and 180V for the neon indicator. The circuit diagram in Fig. 2 show how these outputs are derived.

The power supply unit is mounted on an 18 s.w.g. aluminium sub-frame as in Fig. 3, which also gives the interwiring details.

When the wiring is complete the output voltages should be checked with a meter before any loads are connected. If everything is functioning satisfactorily the sub-frame can be screwed to the base of the box.

D.I.P. MOUNTING AND WIRING

The fifteen D.I.P. integrated circuits are mounted on a D.I.P. Veroboard (Fig. 4) in the orientation shown. Pin numberings for the i.c.s are identical as indicated on the key. When the i.c.s are soldered the wire links are added.

The next job is to connect the i.c.s to the logic board. In Fig. 5 the board symbol input and output pins are related directly to the numbered i.c. pins on the Veroboard so that point-to-point wiring can be made. To illustrate this; to wire IC1 to its corresponding logic board symbol, IC1 pins are connected to the underside of the logic board at the corresponding pin numbers (Fig. 5(a)).

Next the two-input NAND gates are wired (IC7–IC10), the four-input (IC11–IC12), the three-input

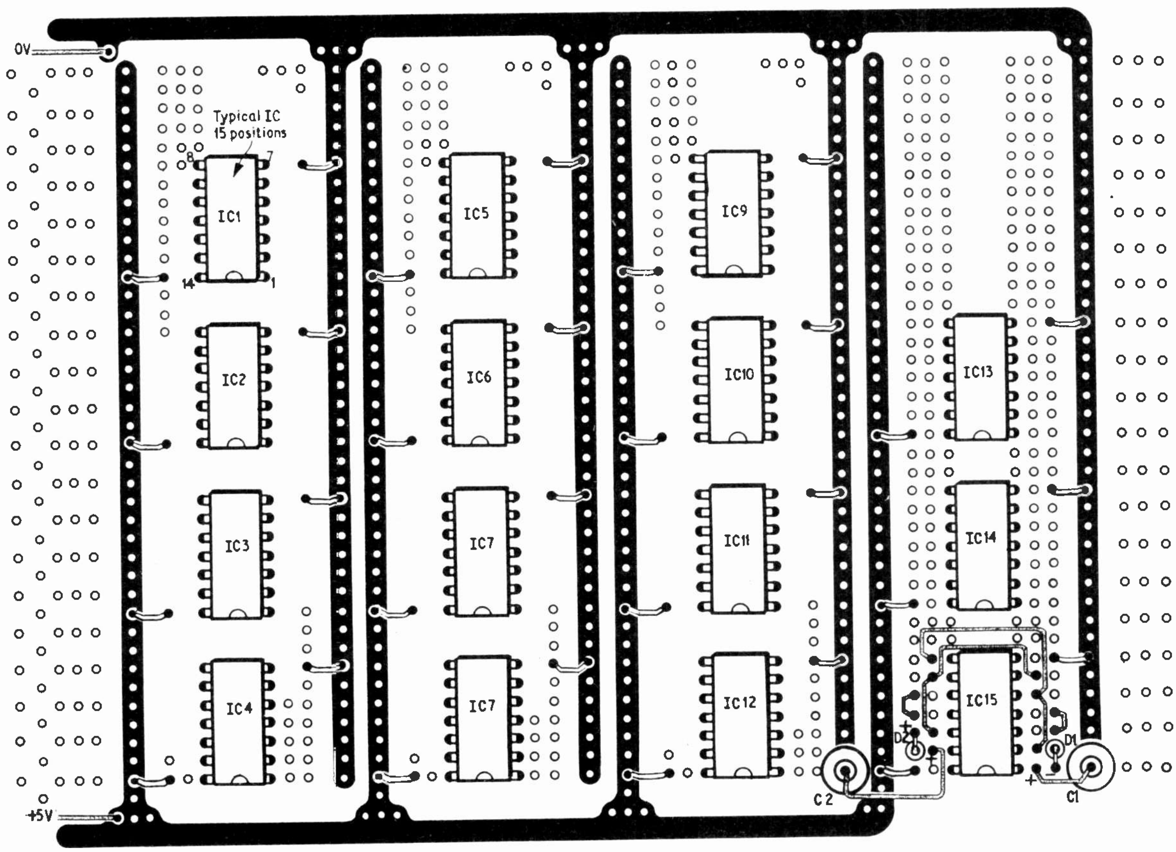


Fig. 4. Wiring and layout of the fifteen D.I.P. integrated circuits on the D.I.P. Veroboard

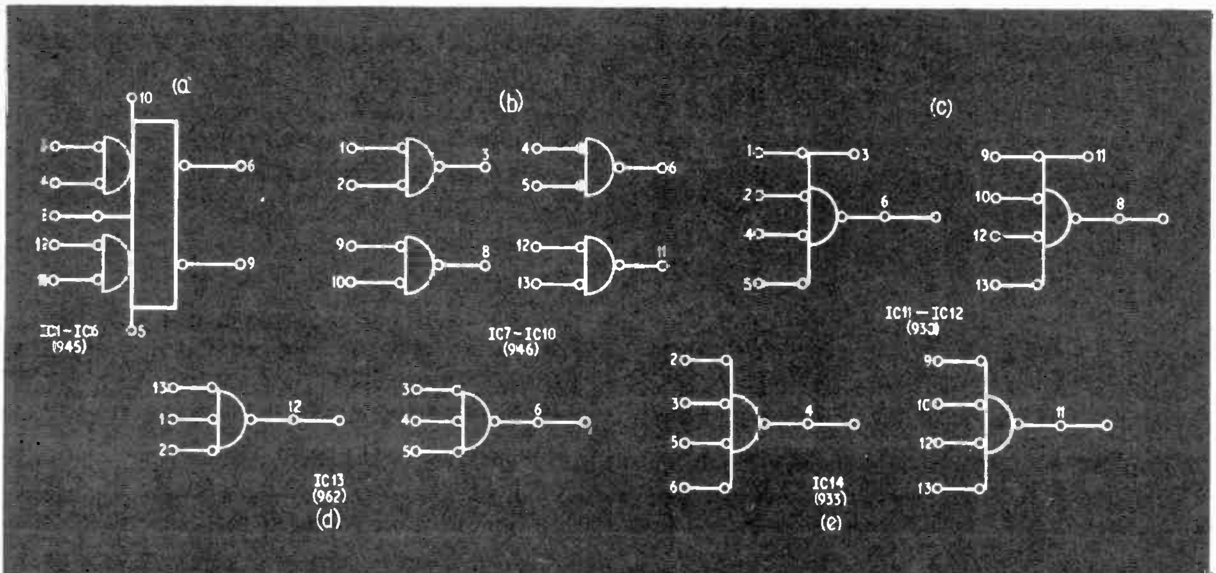


Fig. 5. Identifying the logic symbol Veropins with the i.c. pin numbering

(IC13), and finally the four-input gates (IC14) all being wired according to the relevant gate symbol of Fig. 5. The Veroboard can be fixed finally to the underside of the front panel with nuts, screws and stand off bushes.

LOGIC SWITCHES

Four switches are provided (S2–S5) for logic 0 or 1 inputs to the gates. Here, 0 corresponds to 0 volts and 1 to 5 volts as indicated in Fig. 6. A switch output is taken from either of two Veropins at the switch pole. Wiring for all four switches is given later in Fig. 10.

CLOCK GENERATOR

Most counting circuits can best be demonstrated by applying a clock input of about 2 to 4Hz. This function is provided on the logic board by a 946 i.c. connected as a free running multivibrator (Fig. 7). The timing elements include two 100μF capacitors.

Two outputs are available from this circuit, positive and negative square wave clock pulses. The pins for these are adjacent to the JK flip-flops (Fig. 1). It should be noted that the adjacent "bus-bars" alternatively marked "B" are earth returns to complete signal paths when patching leads. Wiring for the clock generator IC15 is included in Fig. 4.

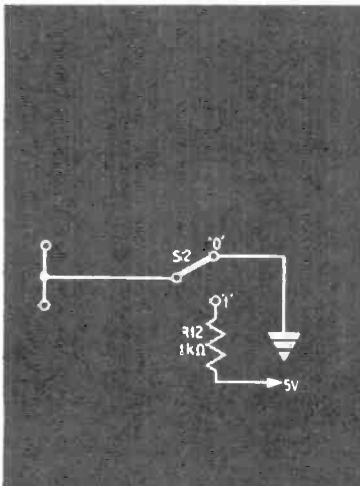


Fig. 6. Input switch circuit

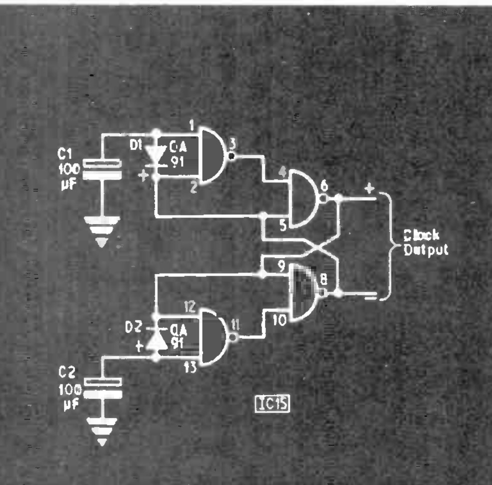


Fig. 7. Circuit diagram of the clock generator

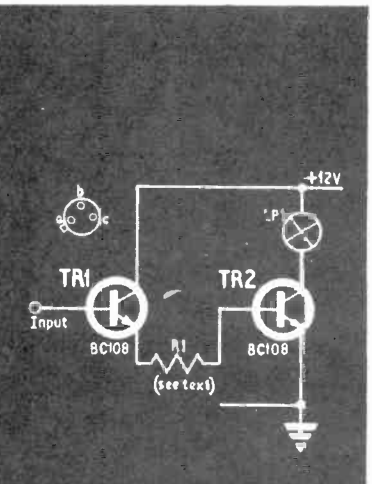
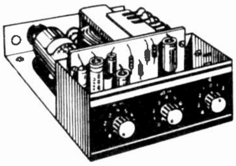


Fig. 8. Lamp driver circuit

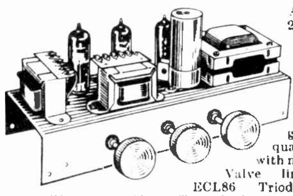
SUPERSOUND 13 HI-FI MONO AMPLIFIER



A superb solid state audio amplifier. Brand new components throughout. 5 silicon transistors plus 2 power output transistors in push-pull. Full wave rectification. Output approx. 13W r.m.s. into 8 ohm. Frequency response 12Hz—30KHz ± 3db. Fully integrated pre-amplifier stage with separate Volume, Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3in high × 6in wide × 7½in deep. A.C. 200/250V.

PRICE £10·50 P. & P. 25p.

DE LUXE STEREO AMPLIFIER



A.c. mains 200-240 volts. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up:—2 × ECL86 Triode Pentodes. 1 × EZ80 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate "balance" control fitted at the rear of the chassis. Input sensitivity is approximately 300mV for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11in. w × 4in. x. Overall height including valves 5in. Ready built and tested to a high standard. **Price £8·92.** P. & P. 45p.

NEW! POWER SUPPLY UNIT

200 240V A.C. input. Four switched fully smoothed D.C. outputs giving 6V and 7½V and 9V and 12V at 1 amp continuous (1½ amp intermittent).
Fitted insulated output terminals and pilot lamp indicator. Hammer finish metal case, overall size 6" × 3¾" × 2½". Suitable for Transistor Radios, Tape Recorders, Amplifiers, etc., etc. Ready built and tested.

PRICE £4·50 P. & P. 35p.

BLACK ANODISED 16g. ALUMINIUM HEAT SINKS. For TO3, complete with mica's and bushes. Size 2⅝in × 3in approx. **25p** pair. P. & P. 5p.

HIGH GRADE COPPER LAMINATE BOARDS. 8" × 6". 5 for **50p.** P. & P. 13p.

BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. Giving 13 alternatives. Primary: 0-210-240V. Secondary combinations: 0-5-10-15-20-25-30-35-40-60V half wave at 1 amp or 10-0-10, 20-0-20, 30-0-30V, at 2 amps full wave. Size 3inL 3½inW × 3inD. Price **£1·85.** P. & P. 30p.

BRITISH MADE SOLID STATE ALL SILICON STEREO AMPLIFIER. 15 watts rms per channel output. Fre. res. 20Hz to 20KHz. Suitable for magnetic or ceramic pickup tape mic., etc., built-in switchable scratch filter, rumble filter and loudness control. 60 m/m slider controls for base, treble and volume. 10 way push button function, selector switch. This amplifier has specification and performance usually only found in amplifiers costing twice as much. Each amplifier supplied, tested and fully guaranteed. Finished in the most attractive contemporary style teak cabinet. Size 16½in. × 8½in. × 4½in. Makers' recommended price £42·15. Our price (while stocks last) **£32·50** plus 75p p. & p. plus V.A.T. Send S.A.E. for full details of specification.

GENERAL PURPOSE HIGH STABILITY TRANSISTOR PRE-AMPLIFIER. For P.U. Tape, Mike, Guitar, etc., and suitable for use with valve or transistor equipment. 9-18V. Battery or from H.T. line 200/300V. Frequency response 15Hz-25KHz. Gain 26dB. Solid encapsulation size 1¾ × 1¼ × ⅝in. Brand new — complete with instructions. Price **88p.** P. & P. 13p.

HANDBOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES
A must for servicemen and home constructors. Including many 1000's of British, U.S.A., European and Japanese transistors. ONLY **40p.** Post 5p.

V.A.T. Prices in this advertisement (incl. P. & P.) will be subject to V.A.T. as from 1st April, 1973.

4-SPEED RECORD PLAYER BARGAINS
Mains models. All brand new in maker's packing.
LATEST B.S.R. C109/C129 4-SPEED AUTOCHANGER. With latest mono compatible cartridge **£6·97.** Carr. 50p. With stereo cartridge **£7·97.** Carr. 50p.
Garrard SP25 Mk. III with heavy precision machined die cast turntable. **£10·95.** Carr. 50p.

SPECIAL BARGAIN OFFER!

PRECISION ENGINEERED PLINTHS

Beautifully constructed in heavy gauge "Colorcoat" plastic coated steel. Resonance free. Designed to take Garrard 1025, 2000, 2025TC, 2500, 3000, 3500, 5100, SP25 II and III, SL65B, AT60, etc., or B.S.R. C109, C129, A21, etc. Black leatherette finish. Size 12½in × 14¼in × 3¼in high (approx. 7¼in high, including rigid smoked acrylic cover). P. & P. 35p. **NOW ONLY £4·50**

LATEST ACOS GP91/1SC Mono Compatible Cartridge with t/o stylus for LP/EP/78. Universal mounting bracket. **£1·50.** P. & P. 8p.
SONOTONE 9TAHC COMPATIBLE STEREO CARTRIDGE T/O stylus. Diamond Stereo LP and Sapphire 78. ONLY **£2·50.** P. & P. 10p. Also available fitted with twin Diamond T/O stylus for Stereo LP. **£3.** P. & P. 10p.
LATEST RONETTE T/O Stereo Compatible Cartridge for EP/LP/Stereo/78. **£1·63.** P. & P. 10p.
LATEST RONETTE T/O Mono Compatible Cartridge for EP/LP/78 mono or stereo records on mono equipment. **£1·50.** P. & P. 10p.

QUALITY RECORD PLAYER AMPLIFIER MK II
A top-quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, and rectifier. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. × 3 d. × 6 h. Ready built and tested. PRICE **£3·95.** P. & P. 40p. ALSO AVAILABLE mounted on board with output transformer and speaker ready to fit cabinet below. PRICE **£5·25.** P. & P. 50p.

SPECIAL OFFER!!

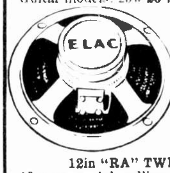
HI-FI LOUDSPEAKER SYSTEM

Beautifully made teak finish enclosure with most attractive Tygan-Vynair front. Size 16in high × 10½in wide × 6in deep. Fitted with E.M.I. Ceramic Magnet 13in × 8in bass unit, two H.F. tweeter units and crossover. Max. power handling 10W. Available 3, 8 or 15 ohm impedance.

Our Price £8·40 Carr. 65p.

CABINET AVAILABLE SEPARATELY **£4·50.** Carr. 60p.
Also available in 8 ohm with EMI 13in × 8in. bass speaker with parasitic tweeter. **£6·50.** Carr. 65p.

LOUDSPEAKER BARGAINS
5in 3 ohm **£1·05,** P. & P. 15p. 7 × 4in 3 ohm **£1 15,** P. & P. 20p. 10 × 6in 3 or 15 ohm **£1·90,** P. & P. 30p. E.M.I. 8 × 5in 3 ohm with high flux magnet **£1·62,** P. & P. 20p. E.M.I. 13¼ × 8in with high flux ceramic magnet with parasitic tweeter 3, 8, or 15 ohm **£3·20.** P. & P. 30p. E.M.I. 13 × 8in, 3 or 8 or 15 ohm with two inbuilt tweeters and crossover network **£4·20.** P. & P. 30p.
EMI CERAMIC MAGNET HEAVY DUTY TWEETER. Approx. 3½in. Available 3 or 8 or 15 ohms. **£1·25** plus 15p p. & p.
BRAND NEW. 12in 15w H/D Speakers, 3 or 15 ohm. Current production by well-known British maker. Now with Hiflux ceramic ferrobar magnet assembly **£6·75.** Guitar models: 25w **£6 75.** 35w **£8 50.** P. & P. 38p each.



SPECIAL OFFER!
LIMITED NUMBER OF BRAND NEW ELAC 10" TWIN CONE LOUDSPEAKERS. With large ceramic magnet and plasticised cone surround. 8 ohm impedance. **£2·75.** P. & P. 25p.

12in "RA" TWIN CONE LOUDSPEAKER
10 watts peak handling. 3, 8 or 15 ohm. **£2·20.** P. & P. 30p.
35 ohm SPEAKERS 3". ONLY **63p.** P. & P. 13p.
"POLY PLANAR" WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER
Size 11⅝in × 14⅜in × 1⅜in deep. Weight 19oz. Power handling 20W r.m.s. (40W peak). Impedance 8 ohm only. Response 40Hz 20kHz. Can be mounted on ceilings, walls, doors, under tables, etc., and used with or without baffle. Send S.A.E. for full details. Only **£5·95** each. P. & P. 25p.
VYNAIR & REXINE SPEAKERS & CABINET FABRICS app. 54 in. wide. Usually £1·75 yd., our price **75p** yd. length. P. & P. 15p per yd. (min. 1 yd.). S.A.E. for samples.

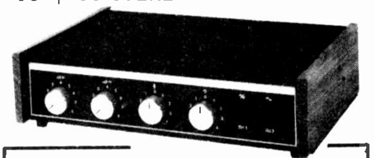
HI-FI STEREO HEADPHONES

Adjustable headband with comfortable flexifoam ear-muffs. Wired and fitted with standard stereo ¼in jack plug. Frequency response 30-15,000Hz. Matching impedance 8-16 ohms. Easily converted for mono. PRICE **£2·95.** P. & P. 15p.

HIGH IMPEDANCE CRYSTAL STICK MIKES. OUR PRICE **£1·05.** P. & P. 8p.

CENTRE ZERO MINIATURE MOVING COIL METER. 100μA for balance or tuning. Approx. size 1in 1in ⅝in. Limited number **75p.** P. & P 10p.

HARVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT

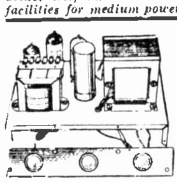


NEW FURTHER IMPROVED MODEL WITH HIGHER OUTPUT AND INCORPORATING HIGH QUALITY READY DRILLED FIBRE GLASS PRINTED CIRCUIT BOARD WITH COMPONENT IDENTIFICATION CLEARLY MARKED FOR EVEN EASIER CONSTRUCTION

A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. (Very simple to modify to suit magnetic cartridge—instructions included). Output stage for any speakers from 5 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled fibre glass printed circuit board, smart brushed anodised aluminium front panel with matching knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification: Power output 14W r.m.s. per channel into 5 ohms. Frequency response ± 3dB 12-30,000Hz. Sensitivity better than 80mV into 1MΩ. Full power bandwidth ± 3dB 12-15,000Hz. Bass boost approx. to ± 12dB. Treble cut approx. to −16dB. Negative feedback 18dB over main amp. Power requirements 35V at 1·0 amp. Overall size—12" wide × 8" deep × 2½" high.
Fully detailed 7-page construction manual and parts list free with kit or send 18p plus large S.A.E.

PRICES AMPLIFIER KIT, **£10·50** P. & P. 15p.
(Magnetic input components 30p extra)
POWER PACK KIT, **£3** P. & P. 30p.
CABINET, **£3** P. & P 30p.

(Post Free if all units purchased at same time). Full after sales service. Also available ready built and tested, **£20·50.** Post Free.
Note: The above amplifier is suitable for feeding two mono sources into inputs (e.g. mike, radio, twin record decks, etc.) and will then provide mixing and fading facilities for medium powered Hi-Fi Discotheque use, etc.



3-VALVE AUDIO AMPLIFIER HA34 MK II
Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7¼in w. × 4in. d. × 4¾in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only **£4·95.** P. & P. 35p.

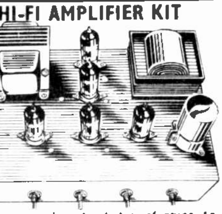
HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. **£4·10.** P. & P. 40p.

HARVERSON'S SUPER MONO AMPLIFIER

A super quality gram amplifier using a double wound fully isolated mains transformer, rectifier and ECL82 triode pentode valve as audio amplifier and power output stage. Impedance 3 ohms. Output approx 3·5 watts. Volume and tone controls. Chassis size only 7in. wide · 3in. deep · 6in. high overall. AC mains 200/240V. Supplied absolutely Brand New, completely wired and tested with good quality output transformer.

OUR ROCK BOTTOM BARGAIN PRICE £2·95 P. & P. 35p

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet **13p** (Free with parts). **All parts sold separately.** ONLY **£7 97.** P. & P. 55p. Also available ready built and tested **£10·97.** P. & P. 60p.

Open 9-5.30 Monday to Saturday
Early closing Wed. 1 p.m.
A few minutes from South Wimbledon Tube Station

HARVERSON SURPLUS CO. LTD.

Dept. PE, 170 High St., Merton, London, S.W.19 Tel. 01-540 3985

SEND STAMPED ADDRESSED ENVELOPE WITH ALL ENQUIRIES

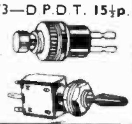
(Please write clearly)

PLEASE NOTE: P. & P. CHARGES QUOTED APPLY TO U.K. ONLY. P. & P. ON OVERSEAS ORDERS CHARGED EXTRA.

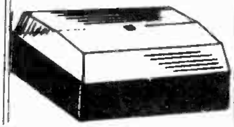
MAIL ORDERS: Some items have a postage and handling charge shown against them. Where p. & p. is not shown the charge is 13p for any selection. When both classes of goods are ordered the charge is 13p plus any p. & p. charges shown. (Overseas extra). Telephone 01-692 4412.

GARLAND BROS. LTD,
DEPTFORD BROADWAY, LONDON, SE8 4QN

SWITCHES
Standard toggle switches:
SW20—S.P.S.T. 20p; SW21—D.P.D.T. **25½p.**
Miniature toggle switches:
SW18—S.P.S.T. 51p; SW19—D.P.D.T. **64p.**
Slider switches, SW3—D.P.D.T. **15½p.**
Wafer switches (rotary)—**26½p** each
SW4—1 pole, 12 way
SW5—2 pole, 6 way
SW6—3 pole, 4 way
SW7—4 pole, 2 way
SW8—4 pole, 3 way

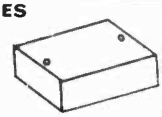


PLINTH
to suit Garrard 2025, SP25 etc. Teak finish, complete with Perspex cover. Very attractive appearance **£3·95** plus 55p p. & p.

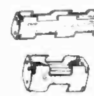


J-BEAM FM4S AERIAL
4 element, all channel aerial for stereo radio. **£6·10** plus 50p p. & p.

PLASTIC BOXES
for constructional projects. White, with lid and screws.
BP1 4½ins × 3ins × 1½ins—**37p.**
BP2 6ins × 4ins × 2½ins—**37p.**

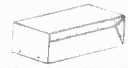


BATTERY HOLDERS
for 4 × HP7.
Long or short—**22p.**
Press studs, ready wired PP3 size—**10p**; PP9 size—**13p.**



EQUIPMENT CASES
in plain aluminium with sloping front panel.

Type	H.	W.	D.	Price	p. & p.
SF1	2in	5¾in	2½in	**50p**	13p
SF2	2in	7¾in	3½in	**66p**	17½p
SF3	2in	9¾in	4½in	**83p**	20p

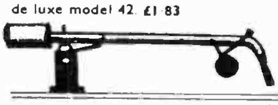


MINIATURE SPEAKERS


2½in 8 Ω
2¾in 8 Ω
2¾in 80 Ω
All at 68p each.

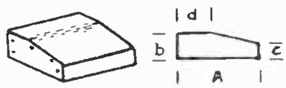
V.A.T.
Prices in this advertisement include V.A.T.

GROOV-KLEEN
de luxe model 42. **£1·83**



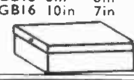
CONSOLE CASES
in plain aluminium, ideal for mixers, instruments, etc.

Type	W. in	A in	B in	C in	D in	Price	p. & p.
GB20	8	9	3½	2	3	**£1·56**	33p
GB21	10	9	3½	2	3	**£1·74**	33p
GB22	12	9	3½	2	3	**£1·89**	33p



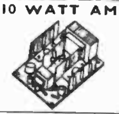
ALUMINIUM BOXES
with lids and screws

Type	L.	W.	D.	Price	p. & p.
GB7*	5½in	2¾in	1½in	**42p**	16p
GB8*	4in	4in	1½in	**42p**	16p
GB9*	4in	2¾in	1½in	**42p**	14p
GB10*	5½in	4in	1½in	**49p**	19p
GB11	4in	2½in	2in	**42p**	14p
GB12	3in	2in	1in	**36p**	15p
GB13	6in	4in	2in	**57p**	20p
GB14	7in	5in	2½in	**69p**	21p
GB15	8in	6in	3in	**89p**	29p
GB16	10in	7in	3in	**£1·00**	29p



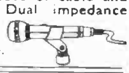
* These sizes fit standard veroboards

STEREO HEADPHONES
Eagle SE5. 8 Ω
40–16,000Hz
Complete with cable and stereo jack plug.
£3·43 Plus 24p p.&p.

10 WATT AMPLIFIER module


Input: 30mV into 10kΩ for 10W, 40 - 16,000 Hz. Output: 3-8-16Ω Power Supply 12V £4.70 plus 24p p. and p.

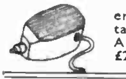
DYNAMIC MICROPHONE UD130HL
This sensitive, quality microphone is uni-directional and is complete with mute switch and 20 feet of cable and plug. 100–12,000Hz. Dual impedance 600Ω and 50kΩ.



£6·60 plus 24p p. & p.

MICROPHONE FLOOR STAND
Professional, heavy quality with folding, tripod base. Telescopic stem extends to 59ins. Chrome finish. **£6·20** plus 45p p. & p.

MICROPHONE HOLDER
with swivel (as supplied with the mic. above). Fits most tubular mics. and stands. **57p.**

TAPE ERASER


erases a whole reel of tape in seconds. 240V. A.C. Full instructions. **£2·20** plus 22p p. & p.

CATALOGUE
15p
POST FREE

SCREENED CABLES
Single for mics, audio leads, etc. 5½p yd.
Twin, as above, common screen 10p yd.
Stereo, two cores, individually screened 11p yd.
Four core with common screen 23p yd.
Four core, individually screened 30p yd.
Coiled screened leads, 20 feet long £1·05 each.

MINIATURE ELECTROLYTICS

1·0µF	63V	7p	150µF	25V	8p
1·5µF	63V	7p	150µF	40V	13p
2·2µF	63V	7p	150µF	63V	15p
3·3µF	63V	7p	220µF	4V	7p
4·7µF	63V	7p	220µF	10V	7p
6·8µF	40V	7p	220µF	16V	8p
6·8µF	63V	7p	220µF	25V	13p
10µF	25V	7p	220µF	40V	15p
10µF	63V	7p	220µF	63V	22p
15µF	16V	7p	330µF	4V	7p
15µF	40V	7p	330µF	10V	8p
15µF	63V	7p	330µF	16V	13p
22µF	10V	7p	330µF	63V	26p
22µF	25V	7p	470µF	6·3V	8p
22µF	63V	7p	470µF	10V	13p
33µF	6·3V	7p	470µF	25V	15p
33µF	16V	7p	470µF	40V	22p
33µF	40V	7p	680µF	6·3V	13p
47µF	4V	7p	680µF	16V	15p
47µF	10V	7p	680µF	25V	22p
47µF	25V	7p	680µF	40V	26p
47µF	40V	7p	1000µF	4V	13p
47µF	63V	8p	1000µF	10V	15p
68µF	6·3V	7p	1000µF	16V	22p
68µF	16V	7p	1000µF	25V	26p
68µF	63V	13p	1500µF	6·3V	15p
100µF	4V	7p	1500µF	10V	22p
100µF	10V	7p	1500µF	16V	26p
100µF	25V	7p	2200µF	6·3V	22p
100µF	40V	8p	2200µF	10V	26p
100µF	63V	15p	3300µF	6·3V	26p
150µF	6·3V	7p	4700µF	4V	26p
150µF	16V	7p			

VEROBOARD

Size	0·1 Matrix	0·15 Matrix
2½in × 3¾in	25½p	18½p
2½in × 5in	28½p	28½p
3¾in × 3¾in	28½p	28½p
3¾in × 5in	32p	35p
17in × 2½in	87p	66p
17in × 3¾in	£1·18	94p

Spot face cutter—44p
Pins, either size, pack of 36—21p
Edge connectors:
24 way, 0·1 —37½p 36 way, 0·1—48½p
24 way, 0·15—37½p 16 way, 0·15—25p

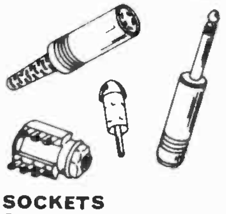
BONDED ACRYLIC FIBRE
B.A.F. wadding, 18in wide, 1in thick. The ideal lining for speaker enclosures. 33p per yard. P. & p. 1yd 14p; each extra yard 4p.

CONTROLS
Log. or Lin.
Single, less switch, 15p
Single, D.P. switch, 26p
Tandem, less switch, 44p
5kΩ, 10kΩ, 25kΩ, 50kΩ, 100kΩ, 250kΩ, 500kΩ, 1MΩ, 2MΩ

BATTERY ELIMINATORS
suitable for transistor radios and similar light current equipment. Input 240V. A.C. Output: PP6—6V D.C.; PP9—9V D.C. Price **£1·65** plus 15p p. & p.

PLUGS

Car aerial	15½p
Co-axial	10p
D.I.N. 2 pin (speaker)	11p
D.I.N. 3 pin	15p
D.I.N. 4 pin	15½p
D.I.N. 5 pin, 180°	14½p
D.I.N. 5 pin, 240°	16½p
D.I.N. 6 pin	16½p
Jack, 2½mm unscreened	10p
Jack, 2½mm screened	11p
Jack, 3½mm unscreened	9p
Jack, 3½mm screened	13p
Jack, ¼in unscreened	13p
Jack, ¼in screened	22p
Jack, stereo, unscreened	22p
Jack, stereo, screened	38p
Phono, plastic top	5½p
Phono, plated metal	13p
Wander, red or black	3½p
Banana 4mm, red or black	6½p



SOCKETS

Car aerial	9p
Co-axial, surface	9p
Co-axial, flush	10p
D.I.N. 2 pin (speaker)	11p
D.I.N. 3 pin	10p
D.I.N. 5 pin, 180°	10p
D.I.N. 5 pin, 240°	10p
Jack, 2½mm	11p
Jack, 3½mm	11p
Jack, ¼in unswitched	16½p
Jack, ¼in switched	18½p
Jack, stereo, switched	26p
Phono, single	5½p
Phono, 2 on a strip	7½p
Phono, 3 on a strip	10p
Phono, 4 on a strip	11p
Wander, single, red or black	5½p
Wander, twin strip	7½p
Banana 4mm red, or black	6½p

LINE SOCKETS

Car aerial	15½p
Co-axial	19p
D.I.N. 2 pin (speaker)	16½p
D.I.N. 3 pin	17½p
D.I.N. 5 pin, 180°	17½p
D.I.N. 5 pin, 240°	17½p
Jack, 3½mm	16½p
Jack, ¼in screened	54p
Jack, stereo, screened	37p
Phono, plated metal	15½p

TRANSFORMERS
all with 0-250 Volt primaries.
Miniature
MM6 6V, 500mA+6V, 500mA.
MM12 12V, 250mA+12V, 250mA.
MM20 20V, 150mA+20V, 150mA.
£1·42 plus 14p p. & p.
L.T.
LT1 6·3V, 1·5A—**82p** plus 20p p. & p.
LT2 6·3V, 3A—**96p** plus 28p p. & p.
LT3 12V, 1·5A—**96p** plus 28p p. & p.
LT4 12V, 3A—**£1·45** plus 33p p. & p.
LT5 9–0–9V, 0·5A—**83p** plus 23p p. & p.
LT6 12–0–12V, 1A—**£1·04** plus 29p p.&p.
Multi-tapped
MT30/2 0–12–15–20–24–30V, 2A— **£2·15** plus 33p p. & p.
MT60/1 0–5–20–30–40–60V, 1A—**£2·31** plus 33p p. & p.
MT60/2 0–5–20–30–40–60V, 2A—**£3·25** plus 37p p. & p.
Charger
CT/01 1A—**£1·16** plus 28p p. & p.
CT/02 2A—**£1·43** plus 33p p. & p.
CT/03 4A—**£1·76** plus 33p p. & p.
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Both units are complete with cables and 5 pin D.I.N. plug.

CASSETTE MICROPHONE


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1µF	450V	21p	1000µF	50V	46p
2µF	450V	22p	2000µF	25V	43p
4µF	350V	15½p	2000µF	50V	58p
8µF	450V	18½p	2500µF	25V	50p
16µF	450V	20p	2500µF	50V	66p
25µF	25V	7½p	3000µF	25V	53p
25µF	50V	11p	5000µF	25V	66p
32µF	450V	30p	5000µF	50V	£1·21
50µF	50V	11p	8–8µF	450V	20p
100µF	50V	12p	8–16µF	450V	22p
250µF	25V	15½p	16–16µF	450V	30p
250µF	50V	19p	16–32µF	450V	69p
500µF	25V	20p	32–32µF	450V	54p
500µF	50V	27½p	50–50µF	350V	42p
1000µF	25V	30p			

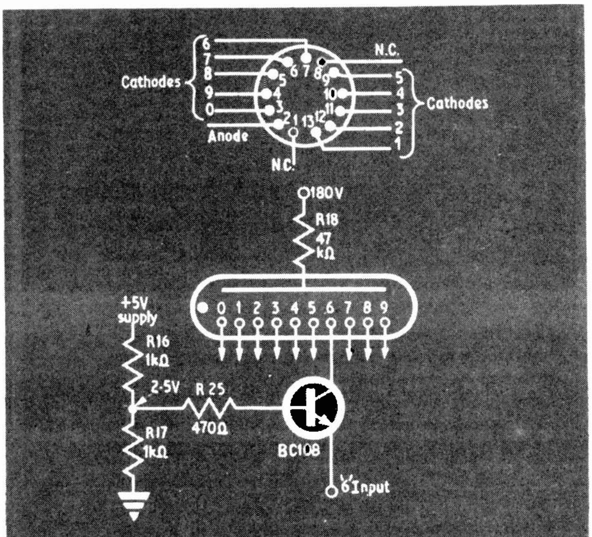


Fig. 9. Transistor switching for the cold cathode tube

Each cathode of the indicator tube is switched by a transistor (Fig. 9) the emitter of each being connected to board Veropins numbered 1–0. A wiring detail of the transistor drive circuits indicators and switches is given in Fig. 10.

WIRING THE INDICATORS

If the lamp bulbs are screw types these can be screwed into the holes provided. The cold cathode tube should be a press fit and glued finally into position.

The lamp driving circuits consist of two transistors and a resistor (Fig. 8) with the inputs connected to adjacent Veropins (0–9). The value of the series resistor may have to be tailored so that the appropriate lamp gives the required light output. The limits to be expected here are 27 ohms to 220 ohms. All drive circuitry is mounted close to each lamp base.

DISPLAY CHECKS

Connections to the indicator tube can be made with the same tags as used for terminating the patching leads, this saves the cost of a special valve base. For a rigid transistor assembly the supply lines and earth returns should be of stiff copper wire.

The first test is with the indicator which should glow as soon as its 180V supply is connected. All the numbers will glow until a particular cathode is grounded when all the current passes via one number which cancels off the others.

If this test is satisfactory connect the 5V supply to the panel and check that the indicator lamps light when the logic inputs are applied to their terminals, remembering that "off" corresponds to 0 and "on" corresponds to 1.

PATCHING LEADS

Some leads can now be terminated with tags for patching exercises. These should be of 12in, 8in, 4in and 2in lengths. More short leads will be required than long leads and it facilitates easy location of a particular length if the lengths are of one given colour.

The Logic Tutor should now be functioning and simple exercises can be performed to get the feel of the instrument. See page 438. ★

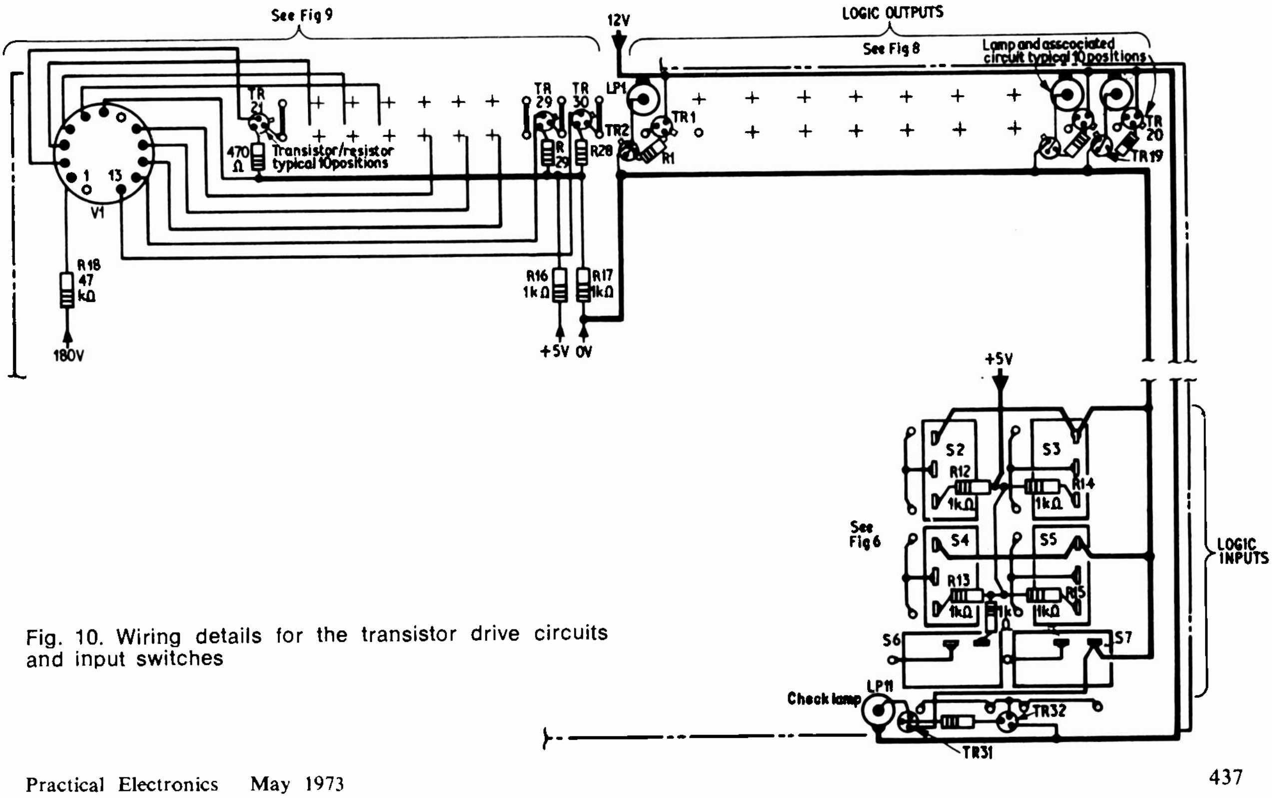
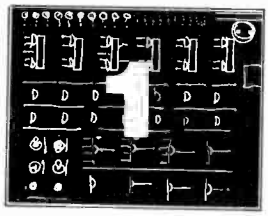


Fig. 10. Wiring details for the transistor drive circuits and input switches

LOGIC TUTOR EXPERIMENTS . .



AND and OR GATES

IN DIGITAL LOGIC there are two states, these are low and high or off and on states. In positive logic, which is the type used in the Logic Tutor, the off or low state is 0V and the on or high state 5V. These two conditions we also know as logical 0 and logical 1 respectively.

The simplest gate which allows or stops a 0 or 1 input is the AND gate formed by an arrangement of diodes as in Fig. 1.1.

TRUTH TABLES

If there is no connection to either input the output will rise to 5V since no current flows through the resistor but if either input is grounded current flows to ground thereby reducing the output to zero volts.

This is logically expressed in logic truth tables and the output sequence is expressed as A.B which is the Boolean Algebra way of representing A AND B. So in the circuit both A AND B must be 1 in order that the output is 1.

PROVING IT

To electrically check the truth table connect the four logic input switches to the inputs of EXTENDER 1 and the output of this to the CHECK lamp. Operating the switches will show that the lamp lights only when all inputs are logical 1.

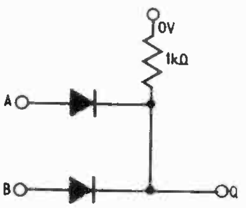
OR GATE

If the diodes of the AND gate are reversed and the supply is changed to 0V an OR gate is formed as in Fig. 1.2. In this gate the output is always 1 if any input is 1, that is, the diodes will conduct if the input goes to 5V but the output return to zero if no input is connected or the inputs are grounded.

It is not possible to demonstrate an OR gate on the tutor since it is seldom used on its own.

The OR function is normally expressed as a combination of NAND functions known as a wired OR functions which will be demonstrated in a later exercise. The OR function is written as A OR B; symbolically this is A + B.

by M. Hughes



A	B	Q
0	0	0
1	0	1
0	1	1
1	1	1

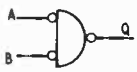
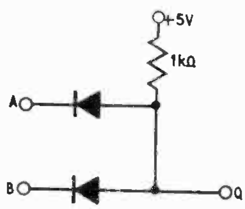


Fig. 1.1. AND gate and truth table



A	B	Q
0	0	0
1	0	0
0	1	0
1	1	1

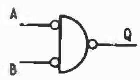


Fig. 1.2. OR gate and truth table

POINTS ARISING

HI FI TAPE LINK *(March, April 1973)*

In Components List, Page 213, R121, 220Ω was omitted. In Fig. 6 page 328, R13 adjacent to C12 should be R12. TR9 and TR109 base diagram, drain and gate connections reversed. On underside wiring collector of TR103 should go directly to R102 not via point marked TO SK2 PIN. In Table 3 TR10 collector voltage is dependent on VR5. First paragraph page 332 should read "collectors of TR10 and TR110 is 12 volts".

P.E. SYNTHESISER
See note on page 427

P.E. TRIFFID I.C. RADIO *(February 1973)*

R7 should be 4·7kΩ not 10kΩ as specified. R17 should be 10Ω not 10kΩ as in the components list. High gain transistors *must* be used for TR2 and TR3. Fig. 7. Transistor TR4 should read c.b.e. not as shown.

A.F. SIGNAL GENERATOR *(November 1972)*

VR2 should be 10kΩ not 1kΩ as shown in Fig. 1 and components list. In Fig. 3 C5 and C7 to S1 have been reversed, i.e. C5 should be where C7 is shown.

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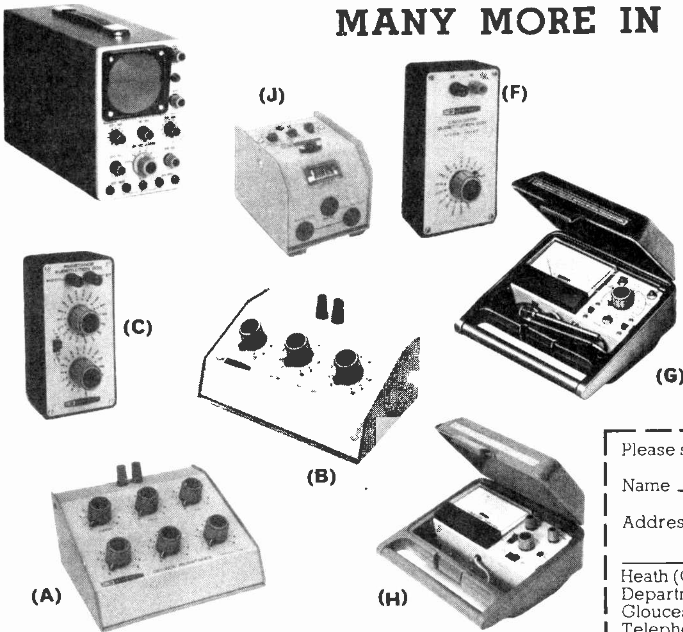

- **(A)** Decade Resistance Box, K/IN-17.
- **(B)** Decade Capacitor Box, K/IN-27.
- **(C)** Resistance Sub Box, K/IN-37.
- **(D)** Service Scope, K/OS-2.
- **(E)** Popular VVM, K/IM-18D (Not illustrated).
- **(F)** Capacitor Sub Box, K/IN-47.
- **(G)** Solid-state VVM, K/IM-17U.
- **(H)** Transistor Tester, K/IT-18.
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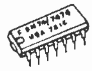
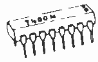
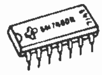

Type	1/11 p	12/24 p	25/99 p
SN7400	0·20	0·18	0·16
SN7401	0·20	0·18	0·16
SN7402	0·20	0·18	0·16
SN7403	0·20	0·18	0·16
SN7404	0·20	0·18	0·16
SN7405	0·20	0·18	0·16
SN7406	0·30	0·27	0·25
SN7407	0·30	0·27	0·25
SN7408	0·20	0·19	0·16
SN7409	0·45	0·42	0·35
SN7410	0·20	0·18	0·16
SN7411	0·23	0·22	0·20
SN7412	0·42	0·40	0·35
SN7413	0·30	0·27	0·25
SN7416	0·30	0·27	0·25
SN7417	0·30	0·27	0·25
SN7420	0·20	0·18	0·16
SN7422	0·48	0·44	0·40
SN7423	0·48	0·44	0·40
SN7425	0·48	0·40	0·35
SN7427	0·42	0·39	0·35
SN7428	0·50	0·45	0·42
SN7430	0·20	0·18	0·16
SN7432	0·42	0·39	0·35
SN7433	0·70	0·61	0·44
SN7437	0·65	0·60	0·50
SN7438	0·65	0·60	0·50
SN7440	0·20	0·18	0·16
SN7441AN	0·75	0·72	0·70
SN7442	0·75	0·72	0·70
SN7443	1·00	0·95	0·90
SN7445	2·00	1·75	1·60
SN7446	2·00	1·75	1·60
SN7447	1·75	1·60	1·45
SN7448	1·75	1·60	1·45

Type	1/11 p	12/24 p	25/99 p
SN7450	0·20	0·18	0·16
SN7451	0·20	0·18	0·16
SN7453	0·20	0·18	0·16
SN7454	0·20	0·18	0·16
SN7460	0·20	0·18	0·16
SN7470	0·30	0·27	0·25
SN7472	0·30	0·27	0·25
SN7473	0·40	0·37	0·35
SN7474	0·40	0·37	0·35
SN7475	0·55	0·52	0·50
SN7476	0·45	0·42	0·39
SN7480	0·80	0·75	0·67
SN7481	1·25	1·15	1·10
SN7482	0·87	0·80	0·70
SN7483	1·00	0·90	0·85
SN7484	0·90	0·85	0·80
SN7486	0·45	0·41	0·38
SN7490	0·75	0·70	0·65
SN7491AN	1·00	0·95	0·90
SN7492	0·75	0·70	0·65
SN7493	0·75	0·70	0·65
SN7494	0·80	0·75	0·70
SN7495	0·80	0·75	0·70
SN7496	1·00	0·97	0·95
SN7497	6·25	5·50	5·00
SN74100	2·50	2·30	2·00
SN74104	1·45	1·35	1·20
SN74105	1·45	1·35	1·20
SN74107	0·50	0·45	0·40
SN74110	0·80	0·70	0·60
SN74118	1·00	0·95	0·90
SN74119	1·90	1·78	1·65
SN74121	0·60	0·55	0·50
SN74122	1·35	1·25	1·10
SN74123	2·70	2·55	2·47
SN74141	1·00	0·95	0·90

Type	1/11 p	12/24 p	25/99 p
SN74145	1·50	1·40	1·30
SN74150	3·35	2·95	2·15
SN74151	1·10	0·95	0·90
SN74153	1·35	1·27	1·20
SN74154	2·00	1·75	1·55
SN74155	1·55	1·47	1·35
SN74156	1·55	1·47	1·35
SN74157	1·80	1·70	1·50
SN74160	2·60	2·40	2·25
SN74161	2·60	2·40	2·25
SN74162	3·40	3·25	2·70
SN74163	3·40	3·25	2·70
SN74164	2·75	2·30	2·10
SN74165	4·00	3·50	3·00
SN74166	4·00	3·50	3·00
SN74167	6·25	5·60	5·10
SN74170	4·10	3·55	3·05
SN74174	2·00	1·75	1·30
SN74175	1·35	1·27	1·15
SN74176	1·60	1·35	1·20
SN74177	1·60	1·35	1·20
SN74180	1 55	1·30	1·20
SN74181	7·00	6·00	5·50
SN74182	2·00	1·80	1·60
SN74184	2·40	2·00	1·80
SN74185A	2·40	2·00	1·80
SN74190	1·95	1·85	1·75
SN74191	1·95	1·85	1·75
SN74192	2·00	1·90	1·80
SN74193	2·00	1·90	1·80
SN74194	2·50	2·25	1·90
SN74195	1·85	1·70	1·60
SN74196	1·50	1·40	1·30
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NKT217	40p
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NKT404	50p
OA5	50p
OA10	35p
OA81	10p
OA91	7p
OA200	7p
OA202	10p
OC16	75p
OC20	95p
OC23	85p
OC25	40p
OC28	65p
OC35	50p
OC36	65p
OC42	40p
OC44	15p
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OC72	25p
OC77	45p
OC81	25p
OC83	25p
OC140	55p
OC170	25p
OC171	30p
OC200	45p
OC201	75p
OC202	80p
OC203	50p
OCP71	1·25
ORP12	50p
ORP60	40p
P346A	20p
RAS310AF	45p
RAS508AF	55p
TAA263	75p
TIL209	39p
TIP29A	50p
TIP30A	60p
TIP31A	60p
TIP32A	70p
TIP33A	1·00
TIP34A	1·50
TIP35A	2·50
TIP36A	3·00
TIP41A	75p
TIP42A	85p
TIS43	35p
V405A	25p
ZTX108	12p
ZTX300	12p
ZTX301	15p
ZTX302	18p
ZTX341	20p
ZTX500	15p
ZTX503	17p
2G301	30p
2N404	20p
2N527	35p
2N696	15p
2N697	15p
2N706	10p
2N930	20p
2N987	45p
2N1131	25p
2N1132	25p
2N1302	18p
2N1304	22p
2N1305	22p
2N1307	25p
2N1308	25p
2N1613	20p
2N1671	1·00
2N2147	75p
2N2160	59p
2N2217	25p
2N2221	20p
2N2222A	25p
2N2369A	15p
2N2906	20p
2N2926 (all cols)	10p
2N3053	20p
2N3054	50p
2N3055	55p
2N3440	75p
2N3442	1·25
2N3525	75p
2N3614	59p
2N3615	75p
2N3702	10p
2N3704	10p
2N3705	10p
2N3714	1·80
2N3771	1·75
2N3773	2·00
2N3790	2·25
2N3819	35p
2N3820	50p
2N3866	85p
2N3903	15p
2N3906	12p
2N4061	12p
2N4062	12p
2N4126	15p
2N4871	35p
2N5457	30p
2N5777	55p
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1 amp miniature		
IN4001	50	6
IN4002	100	7
IN4003	200	8
IN4004	400	8
IN4005	600	10
IN4006	800	12
IN4007	1000	15
1·5 amp miniature		
PL4001	50	8
PL4002	100	9
PL4003	200	10
PL4004	400	10
PL4005	600	12
PL4006	800	15
PL4007	1000	16

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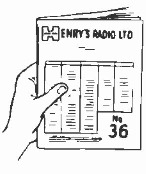

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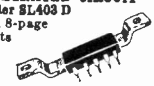

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Type	Volts P.I.V.	Price 1-11
3 AMP RANGE		
SC35A	100	75p
SC35B	200	79p
SC35D	400	85p
6 AMP RANGE (TO48)		
SC40A	100	85p
SC40B	200	90p
SC40D	400	£1·00
SC40E	500	£1·20
10 AMP RANGE (TO48)		
SC45A	100	95p
SC45B	200	£1·00
SC45D	400	£1·25
SC45E	500	£1·45
15 AMP RANGE (TO48)		
SC50A	100	£1·25
SC50B	200	£1·35
SC50D	400	£1·65
SC50E	500	£1·85

DIAC D32 25p
TRIACS— Additional Types
40430 (TO66) 85p
40669 (Plastic) £1·00
40486 (TO5) 80p


3 Amp T048


15 Amp T048

NEW BRIDGE RECTIFIERS

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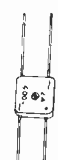
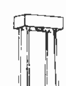
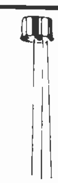
Type	Volts P.I.V.	Price 1-11
HALF AMP		
BO5/05	50	20p
BO5/10	100	25p
ONE AMP ¼ × ⅜ H TUBULAR		
B1/05	50	25p
B1/10	100	25p
B1/20	200	30p
B1/60	600	35p
ONE AMP (G.I.) TUBULAR		
W005	50	30p
W01	100	35p
W02	200	40p
W06	600	45p
TWO AMPS ⅜ H × ⅜ L × ⅜		
B2/05	50	35p
B2/100	100	40p
B2/200	200	45p
B2/600	600	50p
B2/1000	1000	60p
FOUR AMPS ⅜H × ⅜L × ⅜		
B4/100	100	60p
B4/200	200	65p
B4/400	400	70p
B4/600	600	75p
B4/800	800	£1·00
SIX AMPS ⅜H × ⅜L × ⅜		
B6/100	100	70p
B6/200	200	75p
B6/400	400	90p
B6/600	600	£1·00

SILICON CONTROLLED RECTIFIERS

Type	Volts P.I.V.	Price 1-11
ONE AMP		
CRS 1/05	50	25p
CRS 1/10	100	30p
CRS 1/20	200	30p
CRS 1/40	400	35p
CRS 1/60	600	45p
THREE AMP (TO48)		
CRS 3/05	50	30p
CRS 3/10	100	30p
CRS 3/20	200	35p
CRS 3/40	400	45p
CRS 3/60	600	55p
FIVE AMP (TO66)		
CRS 5/400	400	60p
SEVEN AMP (TO48)		
CRS 7/100	100	60p
CRS 7/200	200	65p
CRS 7/400	400	70p
CRS 7/600	600	95p
SIXTEEN AMP		
SCR 16/100	100	65p
SCR 16/200	200	70p
SCR 16/400	400	80p
SCR 16/600	600	£1 00


1 Amp T05


3 Amp T048

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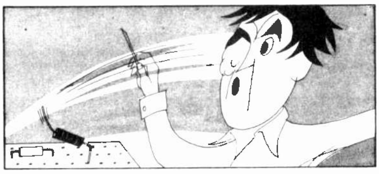
ON THE FRINGE



SHEER CUSSEDNESS

The number of times I have heard people justifiably complain about having put a screwdriver down on the floor while adjusting some piece of equipment, only to find, on going to pick it up, that the darned thing had surreptitiously "hopped it". If that didn't happen, one could lay even odds that the four screws, previously lying on your left-hand side, had somehow learned to interpret the structure of the DNA molecule enabling them to grow legs of their own.

Screwdrivers are not, however, exclusive in possessing a mind of their own, oh no. Indeed, the effect is not entirely foreign to the wrong side of hot buttered crumpets, marmalade toast, and (on occasion) the resistor that you've just soldered into position (and for which you are enduring agonies in order to prove that *you* just don't make dry joints) flying off at one end and treating both you and your starboard eye to a good "dollup" of molten solder! Soad's Law, for that is the nice way of putting what this effect has come to be known as, is almost certainly the one which equates with the belief that "If something *can* go wrong, then it *will*".

My old friend Denis has an interesting theory about the effect (also, in ancient literature, referred to as the 4th Law) and has recently put it to the test. He believes, you see, that Soad still exists somewhere, and further that he controls his meddling from either the Moon, or that other satellite which the earth is supposed to have.

The test, which you may have already proved unwittingly, is accomplished by employing a "sacrificial" circuit like the one I've shown in Fig. 1. With such an arrangement one can easily establish how far away this bloody-minded individual is.

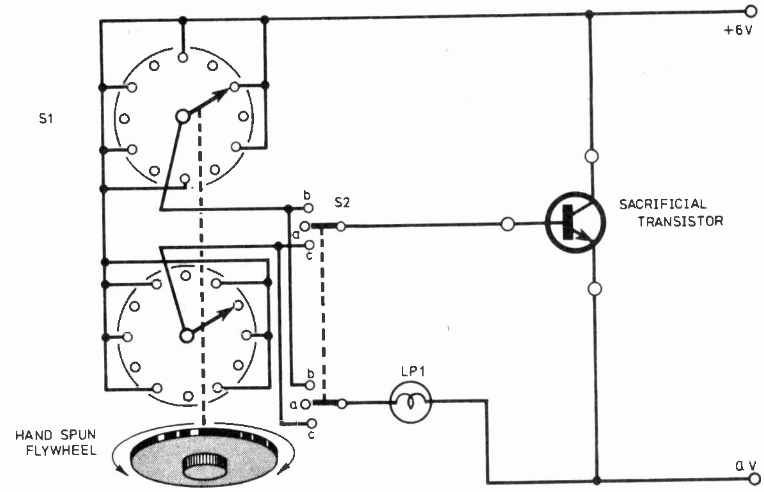


Fig. 1

First set switch S1 to position "a", then select the most expensive transistor you have, and connect it into circuit. Spin the flywheel-driven rotary switch (the normal wafer type, but with mechanical "click" and "end stops" removed). When it has come to a standstill, decide quite deliberately to yourself whether to operate switch S2 to "b" or "c". This done, now operate the switch quickly to the *opposite* position of your choice; but do it within 2·68 seconds, I implore you.

Provided the decision is made within this time, I'm told it has never been known to "do-in" a transistor. This being so, it looks certain that this ubiquitous enemy of mankind must inhabit a world about a quarter of a million miles from here, composed, for the most part, of dud transistors, brand-new screwdrivers, and fluff-covered "jam-butties".

Judging from his discussion a couple of months back, I have a shrewd suspicion that Frank Hyde knows something of the fella's co-ordinates but is not letting-on!

NEWS BRIEFS

1973 Design Council Awards

Two electronics companies feature prominently among this year's Design Council Awards for consumer goods. Sinclair Radionics win an award for the Sinclair Executive calculator and Rank Radio International win an award for the Wharfedale "Isodynamic" headphones.

The Sinclair Executive pocket calculator was launched in June 1972 and now, nine months later, sales are running at nearly £100,000 per month and profits of £300,000 are forecast for the financial year ending in April this year.

The Wharfedale Isodynamic headphones also introduce some technological advances to achieve a quality of sound previously only reached in headphones costing well over twice as much.

The Wharfedale system combines the best of the electrostatic method with the simplicity and price advantage of the electromagnetic method by using a lightweight diaphragm driven evenly all over its surface by magnetic means.

Launched in London last year, sales for the first year are expected to reach 100,000 units and in fact Wharfedale are having difficulty meeting the demand.

New Electronics Course at Keele University

Among nine new courses announced by Keele University is a new degree course in Electronics. There is great demand for honours Electronics, it being one of the major growth areas in scientific studies. There is particular interest in Electronics where it overlaps with such areas as cybernetics, information theory and "bioelectronics".

Three and four year courses will be on offer, and amongst the permissible combinations of courses over three years will be Electronics and Music.

For further information please contact the Director of Information Services or Professor D. J. E. Ingram, Department of Physics, University of Keele, Keele, Staffordshire ST5 5BG.

INDUSTRY NOTEBOOK

By Nexus

PRICE WAR CONTINUES

A phenomenon of the electronics industry is that while everything else seems to be shooting up in price, many electronic products persist in going down. This is mainly due to the nature of the beast. High technology demands big investment in R and D and, more often than not, a further major investment in production equipment. So new products tend to start their life as high cost items capitalising on improved performance. Then, as production increases, there is the so-called "learning curve" which, when mastered, gives fewer rejects and higher production rates. By this time, other firms are getting into the same market and any monopoly position that may have been attained is soon eroded. Add these factors together and you can see the reason why prices tumble.

No less an authority than Dr Ian Mackintosh, 20 years in the semiconductor business and now a leading consultant, goes as far as to suggest in a recent press interview that aggressive pricing is the key to success. Essentially, he maintains, semiconductors is a volume industry and nobody gets volume without competitive prices. He cites the 1971 price war in TTL devices as nothing new and forecasts a similar war in MOS devices.

Certainly, ready availability of devices and lowered prices are working their way through into products. Look at digital multimeters. The Solartron 4440 is billed in the advertisements as low-cost at £115. Along comes Sinclair with the DM1 at £49. Not to be left out of the act, Advance Electronics introduce the Alpha DMM8 at £55.

It wasn't all that long ago that a digital panel meter was listed at £99. Today you can get one for well under £50. Of course, the products I have mentioned are not all to the same specifications and therefore not directly comparable but the trend is there—downwards in price.

The trend is most obvious in consumer products—in radio, TV, tape recorders, pocket calculators. Look around and shop around—you can see it happening. I find it intriguing that some of my friends in manufacturing industry claim it is often cheaper to buy their employers' products through cut-price retail outlets than through their own staff shops.

The biggest shock, however, comes not through price competition between existing technologies and derivatives thereof, but when a completely new technology threatens to displace the old. Semiconductor memory manufacturers may well spend restless nights following the disclosures that IBM researchers have developed amorphous film bubble memories and got them into experimental use. Moreover, IBM say the new process cuts bubble memory costs ten-fold as well as conferring advantages such as extremenly high density packaging.

EUROCONTROL

It was quite an experience attending the signing of Eurocontrol's latest commercial contracts for the new KARLDAP air traffic control centre at Karlsruhe. The signing was between Plessey Radar, Thomson-CSF and AEG-Telefunken on the one hand, and Eurocontrol officials on the other, and covered the supply of electronic equipment to the value of over £5 million. We had full simultaneous translations of the proceedings which took place in the Eurocontrol Brussels HQ beneath the flags of the member nations.

Plessey Radar's share was worth £1·25 million. Good for Britain, of course, but what was most pleasing was to be in at a ceremony where nations and companies were working amiably together towards a common good.

ERNIE Mk. II

Having never won a penny on Premium Bonds it was interesting to visit the newly installed ERNIE Mk II at Lytham St Annes and see for myself that everything was fair and above board and that my lack of success was nothing more than bad luck.

The original ERNIE, now honourably retired, was built by the Post Office and did a marvellous job. The success of Premium Bonds has been so staggering that Old ERNIE was too sluggish to cope with the draw. It was taking ten working days to generate the prize list. New ERNIE picks out the winners of over 90,000 prizes each month in just three hours. This is remarkable when you remember that each random number generated has to be checked against a master file to see if it has been sold or not.

New ERNIE was designed by Dr Roger Harding of Plessey Telecommunications under a contract worth £250,000. Plessey has also supplied a smaller system to New Zealand who run a similar Bonds scheme. Plessey now have ERNIE on offer world-wide and could secure more orders from governments who wish to run similar savings schemes.

To-date, ERNIE has paid out 10 million winners with nearly £350 million of prizes. Average odds of winning are 10,350 to 1. Don't despair—there will be even more prizes in future.

GROWTH

Several sectors of electronics are now showing good growth. VAT has helped Pitney-Bowes in selling electronic cash registers which have calculating power and produce cash receipts showing the amount of VAT paid. Sales are well up on the forecasts. NCR is another company gearing up to get in on the electronic point-of-sale business.

Over £3·5 million is said to have been invested in getting a production line going at Dundee for the NCR 280 retail terminal and first orders have been taken in the UK. In the United States the order book is reported as being 20,000 units of which 4,500 have been installed. Dundee output is planned to match a sales forecast of over 1,000 units this year rising to over 4,000 units by 1975.

Finally, MDS Data Processing Ltd. report big European sales for the 2400 Key Display System, a key-to-disc data entry system for computers. In 14 months more than 500 systems have been ordered which, together, use 6,000 key-stations.

AEROSPACE EXPORT DRIVE

More than 100 British aerospace companies will be at Paris for this year's air show in June. Electronics companies will be well represented during what promises to be a boom exhibition despite setbacks on the Concorde programme. Last year's exports were in the region of £400 million for the industry as a whole with electronic navaids and guided missiles accounting for a big chunk.

PATENTS REVIEW...

CAR WARNING CIRCUIT

A Company which is very active in the field of patents for car safety devices is Joseph Lucas (Industries). Their latest device, BP 1 297 385, triggers an alarm if a driver attempts to leave his vehicle without removing the ignition key.

In the patent circuit, Fig. 1, the car battery has its negative terminal earthed to chassis and its positive terminal connected to one side of a car internal rooflight LP1.

The other side of the light is earthed to chassis via three separate parallel paths. One of these paths contains switch S1 which is operated by the passenger door of the vehicle and closes when the door is open. The second path contains a switch S2 which is manually controlled from within the vehicle.

The third parallel path contains a diode D1 and switch S3 in series. Switch S3 is operated by the driver's door and closes when the door is opened. Closure of any one of the switches S1, S2, S3 energises LP1.

The "live" side of switch S3 is connected to the positive battery terminal via an alarm buzzer or bell in series with a resistor R1.

An *npn* transistor TR1 has its collector-emitter path connected across the alarm and its base connected to the positive battery terminal through resistor R2 and to earth via switch S4. The switch S4 is ganged to the ignition switch and closes when the ignition key is in position.

When the car is being driven, S4 is closed and current flows through R2; no current flows through the alarm or the transistor. When the driver stops the vehicle and removes the ignition key, S4 opens. As the driver gets out of the car the act of opening his door closes S3 and TR1 is turned on by current flow through resistor R1. This short circuits the alarm, which thus cannot sound.

In the event that the driver forgets to remove his ignition key, S4 stays closed and no base current reaches the transistor when S3 closes (as the driver opens his door). In this case the alarm receives current via R1 and sounds the alarm.

The presence of the diode D1 ensures that the alarm cannot be operated when one or both of the switches S1 and S2 are operated.

BP 1 297 385

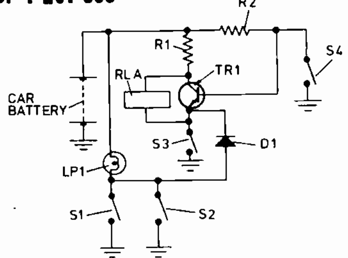


Fig. 1

BUTLER-TYPE OSCILLATOR CIRCUIT

BP 1 282 853

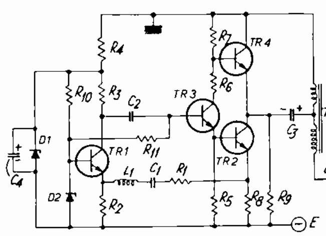


Fig. 1

International Standard Electric Corporation in BP 1 282 853 discloses a Butler-type oscillator circuit of the generally known type in which a first and second transistor have their emitters coupled by a series resonant circuit.

The first transistor has its base biased to a fixed potential and its collector coupled to the base of the second transistor to limit feedback amplitude. The output signal is in the form of a clipped sine wave so in some uses, e.g. in telephony where distortion may cause the faulty operation of receiving equipment, the clipped signal must be corrected by filtering. The filterers necessary can, however, be bulky and costly in comparison with other miniaturised components.

What ISEC suggest is a modified Butler-oscillator with three *npn* transistors TR1, TR2 and TR3 and a buffer output stage formed from an *npn* transistor TR4 mounted in emitter follower configuration.

CIRCUIT PROTECTION

Connecting a car battery into circuit the wrong way round can cause damage, e.g., in the generating and regulating circuits of the vehicle. A diode can be used to block wrong polarity currents but where the circuit carries heavy surges, the diode is at risk.

In BP 1 293 046 Pal-Magneton Narodni Podnik of Czechoslovakia describe three closely related simple ways of connecting circuits which must carry heavy currents and are sensitive to polarity.

The circuit, Fig. 1, shows a relay with its contacts RLA1 in series with a battery and the coil in series with diode D1 and switch S1. The coil, D1 and S1 are connected in parallel with the battery.

The contacts RLA1 are normally open and the diode D1 ensures that current will flow through the relay coil (when S1 is closed) only if the battery is connected with the correct polarity. Incorrect polarity will cause the diode to block current flow through the coil with the result that the contacts stay open and the polarity sensitive load is safeguarded.

The circuit in Fig. 2 shows RLA1 contacts connected as in Fig. 1 but diode D1 is used in parallel with the coil. A resistor R1 is connected in series with the coil and S1.

Again, current flows through the relay coil only if the battery is correctly connected, but in this case if the polarity is wrong the diode D1 will conduct and, in effect, put a short across the relay coil stopping it operating. The resistor R1 prevents the full short circuit current from passing through the diode when the battery is connected incorrectly.

BP 1 293 046

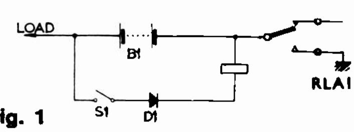


Fig. 1

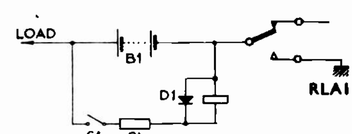


Fig. 2

BOOK REVIEWS

THE RADIO AND ELECTRONIC ENGINEER
(The Journal of the Institution of Electronic and Radio Engineers)
VOL. 43 No. 1/2 January/February 1973.

IT is unusual to review a Journal, but this particular publication is of especial and topical interest to all who are involved in any way with semiconductors. The January/February issue of the *Radio and Electronic Engineer* is almost entirely devoted to special contributions from leading British scientists and engineers who have been associated with semiconductor developments during the past 25 years. Collected together are 18 papers, each written with authority based upon intimate involvement and covering some particular aspect of the design, development, manufacture or application of discrete active devices and integrated circuits.

As a technical record of the first twenty-five years of semiconductors, including their impact and influence upon different specialised fields of application, this issue of the *Radio and Electronic Engineer* warrants a place on the bookshelf of any electronics enthusiast.

Copies may be obtained from the IERE Publications Sales Department, 9 Bedford Square, London, WC1B, price £2·00 per copy, post free.

HANDBOOK OF BASIC ELECTRONIC EQUIPMENT
By W. Oliver
Published by Foulsham Technical
102 pages, 5½in × 9in. Price £1·75

THE AUTHOR of this book will be known to all readers of Foulsham-Sams books as the man who translates American into English. The main idea behind this book seems to be that of giving readers some technical background on basic equipment but mainly information on suppliers.

However, if one is going to give technical information it is essential not to give wrong information. The note inside the front cover states that "mathematics . . . have been minimised so that the book will be easily understood by even beginners". After reading the book it makes me wonder whether Mr Oliver knows any maths! For instance, on capacitors: "the total effective capacity of capacitors in series is the sum of the individual capacitors"; or on resistors: "2K and 4K in parallel, then in series with the 3K, gives you roughly 1,333 ohms" (yes, very roughly, in actual fact 4,333 ohms); the term EMF is used where potential drop is meant; a varactor is described as a "very special kind of diode" whereas all diodes exhibit varactor action.

If one is going to present technical information, especially for beginners then one has got to be a little more accurate than this. No, I am afraid I would not recommend this book to any beginner; the suppliers addresses may be useful but as a technical work it leaves very much to be desired.

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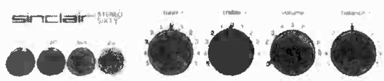
Stereo 60 Pre-amp/control unit



Designed specifically for use on Project 60 systems, the Stereo 60 is equally suitable for use with any high quality power amplifier. Since silicon epitaxial planar transistors are used throughout, a really high signal-to-noise ratio and excellent tracking between channels is achieved. Input selection is by means of press buttons, with accurate equalisation on all input channels. The Stereo 60 is particularly easy to mount.

SPECIFICATIONS—Input sensitivities: Radio – up to 3mV. Mag. p.u. 3mV correct to R.I.A.A. curve ±1dB 20 to 25,000 Hz. Ceramic p.u. – up to 3mV. Aux – up to 3mV. **Output:** 250mV. **Signal to noise ratio:** better than 70dB. **Channel matching:** within 1dB. **Tone controls:** TREBLE +12 to –12dB at 10KHz. BASS +12 to –12dB at 100Hz. **Front panel:** brushed aluminium with black knobs and controls. **Size:** 66 x 40 x 207mm.

Built, tested and guaranteed. **£9.98**

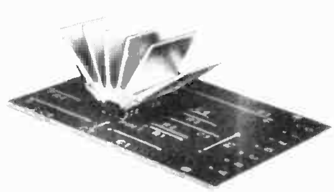
Project 60 Stereo F.M. Tuner

The phase lock loop principle was used for receiving signals from space craft because of its vastly improved signal to noise ratio. Now, Sinclair have applied the principle to an F.M. tuner with fantastically good results. Other advanced features include varicap diode tuning, printed circuit coils, an I.C. in the specially designed stero decoder and switchable squelch circuit for silent tuning between stations. In terms of high fidelity this tuner has a lower level of distortion than any other tuner we know. Stereo broadcasts are received automatically, a panel indicator lighting up as the stereo signal is tuned in. This tuner can also be used to advantage with most other high fidelity systems.

SPECIFICATIONS—Number of transistors: 16 plus 20 in I.C. **Tuning range:** 87.5 to 108MHz. **Sensitivity:** 7µV for lock-in over full deviation. **Squelch level:** Typically 20µV. **Signal to noise ratio:** >65dB. **Audio frequency response:** 10Hz – 15KHz (±1dB). **Total harmonic distortion:** 0.15% for 30% modulation. **Stereo decoder operating level:** 2µV. **Cross talk:** 40dB. **Output voltage:** 2 x 150mV R.M.S. maximum. **Operating voltage:** 25–30VDC. **Indicators:** Stereo on ; tuning. **Size:** 93 x 40 x 207mm.

Built and tested. Post free. **£25**

Super IC.12 Integrated circuit high fidelity amplifier



Having introduced Integrated Circuits to hi-fi constructors with the IC.10, the first time an IC had ever been made available for such purposes, we have followed it with an even more efficient version, the Super IC.12, a most exciting advance over our original unit. This needs very few external resistors and capacitors to make an astonishingly good high fidelity amplifier for use with pick-up, F.M. radio or small P.A. set up, etc. The free 40 page manual supplied, details many other applications which this remarkable IC make possible. It is the equivalent of a 22 transistor circuit contained within a 16 lead DIL package, and the finned heat sink is sufficient for all requirements. The Super IC.12 is compatible with Project 60 modules which would be used with the Z.50 and Z.30 amplifiers. Complete with free manual and printed circuit board.

SPECIFICATIONS

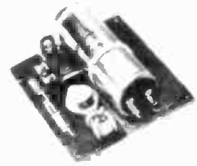
Output power: 6 watts RMS continuous (12 watts peak). 6–8Ω. **Frequency Response:** 5Hz to 100KHz ±1dB. **Total Harmonic Distortion:** Less than 1%. (Typical 0·1%) at all output powers and frequencies in the audio band (28V). **Load Impedance:** 3 to 15 ohms. **Input Impedance:** 250 Kohms nominal. **Power Gain:** 90dB (1,000,000,000 times) after feedback. **Supply Voltage:** 6 to 28V. **Quiescent current:** 8mA at 28V. **Size:** 22 × 45 × 28mm including pins and heat sink.

Manual available separately 15p post free.

With FREE printed circuit board and 40 page manual

£2.98 Post free

Power Supply Units The new PZ.8 Mk.3



The most reliable power supply unit ever made available to constructors. Brilliant circuitry makes failure from over load and even direct shorting of the output impossible. This is due to an ingenious re-entrant current limiting principle which, as far as we know has never before been available in any comparable unit outside the most expensive laboratory equipment. Ripple and residual noise have been reduced to the point of almost total elimination. This is, of course, the perfect unit for Project 60 assemblies, particularly where the new Z.50 MK.2 amplifiers are used. Nominal working voltage – 45.

PZ.8 Mk.3—£7.98
(Mains transformer, if required) £5.98
PZ.5 30v. unstabilised
(not suitable for Project 60 tuner) £4.98
PZ.6 35v. stabilised
(not suitable for IC. 12) £7.98

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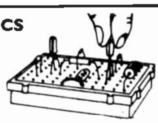

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T-DECS **£2·88**
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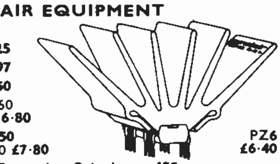

IC12 **£2**
Z50 **£4·25**
PZ5 **£3·97**
Z30 **£3·50**
Project 60 tuner **£16·80**
AFU **£4·50**
stereo 60 **£7·80**
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61	100	5	12	10·2 × 8·9 × 8·3	2·88	52
30	200	9	8	12·0 × 10·3 × 10·0	4·83	52
62	250	12	4	9·5 × 12·7 × 11·4	6·38	67
55	350	15	0	14·0 × 10·8 × 12·4	8·55	82
63	500	27	0	17·1 × 11·4 × 15·9	11·32	•
92	1000	40	0	17·8 × 17·1 × 21·6	22·70	•
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64	75	1	14	7·0 × 6·4 × 6·0	0-115-210-240	1·82	30
4	150	3	0	8·9 × 6·4 × 7·6	0-115-200-220-240	2·20	36
66	300	6	0	10·2 × 10·2 × 9·5	,, ,,	4·28	52
67	500	12	8	14·0 × 10·2 × 11·4	,, ,,	6·35	67
84	1000	16	0	11·4 × 14·0 × 14·0	,, ,,	11·54	82
93	1500	28	9	13·5 × 14·9 × 16·5	,, ,,	16·72	•
95	2000	40	0	17·8 × 16·5 × 21·6	,, ,,	21·82	•
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213	1·0	0·5	1	0	8·3 × 5·1 × 5·1	0-12V at 0·5A × 2	1·11	22
71	2	1	1	0	7·0 × 6·4 × 5·7	0-12V at 1A × 2	1·46	22
18	4	2	2	4	8·3 × 7·0 × 7·0	0-12V at 2A × 2	2·04	36
70	6	3	3	12	10·2 × 7·6 × 8·6	0-12V at 3A × 2	2·46	42
108	8	4	5	4	10·0 × 8·3 × 8·2	0-12V at 4A × 2	2·73	52
72	10	5	6	3	7·9 × 10·8 × 10·2	0-12V at 5A × 2	3·23	52
17	16	8	7	8	12·1 × 9·5 × 10·2	0-12V at 8A × 2	4·99	52
115	20	10	11	13	12·1 × 11·4 × 10·2	0-12V at 10A × 2	6·35	67
187	30	15	16	12	13·3 × 12·1 × 12·1	0-12V at 15A × 2	11·73	82
226	60	30	34	0	17·0 × 14·5 × 12·5	0-12V at 30A × 2	21·57	•

30 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	P & P £	p
112	0·5	1	4	8·3 × 3·7 × 4·9	0-12-15-20-24-30V	1·11	22
79	1·0	2	0	7·0 × 6·4 × 6·0	,, ,,	1·48	36
3	2·0	3	2	8·9 × 7·0 × 7·6	,, ,,	2·21	36
20	3·0	4	6	10·2 × 8·9 × 8·6	,, ,,	2·72	42
21	4·0	6	0	10·2 × 10·0 × 8·6	,, ,,	3·23	52
51	5·0	6	8	12·1 × 10·0 × 8·6	,, ,,	4·02	52
117	6·0	7	8	12·1 × 10·0 × 10·2	,, ,,	4·80	52
88	8·0	10	0	14·0 × 11·7 × 10·0	,, ,,	6·20	67
89	10·0	12	2	14·0 × 10·2 × 11·4	,, ,,	7·85	67

50 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	P & P £	p
102	0·5	1	11	7·0 × 7·0 × 5·7	0-19-25-33-40-50V	1·46	30
103	1·0	2	10	8·3 × 7·3 × 7·0	,, ,,	2·13	36
104	2·0	5	0	10·2 × 8·9 × 8·6	,, ,,	2·96	42
105	3·0	6	0	10·2 × 10·2 × 8·3	,, ,,	4·01	52
106	4·0	9	4	12·1 × 11·4 × 10·2	,, ,,	5·31	52
107	6·0	12	4	12·1 × 11·1 × 13·3	,, ,,	7·85	67
118	8·0	18	9	13·3 × 13·3 × 12·1	,, ,,	10·25	97
119	10·0	19	12	16·5 × 11·4 × 15·9	,, ,,	12·85	97

60 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	P & P £	p
124	0·5	2	4	8·3 × 9·5 × 6·7	0-24-30-40-48-60V	1·48	36
126	1·0	3	0	8·9 × 7·6 × 7·6	,, ,,	2·06	36
127	2·0	5	6	10·2 × 8·9 × 8·6	,, ,,	3·23	42
125	3·0	8	8	11·9 × 9·5 × 10·0	,, ,,	4·92	52
123	4·0	10	6	11·4 × 9·5 × 11·4	,, ,,	6·35	67
120	6·0	16	12	13·3 × 12·1 × 12·1	,, ,,	9·20	82
122	10·0	23	2	16·5 × 12·7 × 16·5	,, ,,	15·23	•

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5	4·0	3	11	10·2 × 7·0 × 8·3	Please note, these	2·23	42
86	6·0	5	12	10·2 × 8·9 × 8·3	units do not in-	3·37	52
146	8·0	6	4	8·9 × 10·2 × 10·2	clude rectifiers	3·84	52
50	12·5	11	14	13·3 × 10·8 × 12·1		5·72	67

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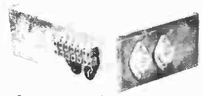
PRACTICAL ELECTRONICS "SCORPIO" ELECTRONIC IGNITION SYSTEM



This Capacitor-Discharge Electronic Ignition system was described in the November and December issues of Practical Electronics. It is suitable for incorporating in any 12V ignition system in cars, boats, go-karts, etc., of either pos. or neg. earth and up to six cylinders. The original coil, plugs, points and contact-breaker capacitor fitted in the vehicle are used. No extra or special components are required.
Helps to promote easier starting (even under sub-zero conditions), improved acceleration, better high-speed performance, quicker engine warm-up and improved fuel economy. Eliminates excessive contact-breaker point burning and the need to adjust point and spark-plug gaps with precision.
Construction of the unit can easily be completed in an evening and installation should take no longer than half an hour. A complete complement of components is supplied with each kit together with ready-drilled roller-tinned professional quality fibre-glass printed-circuit board, custom-wound transformer and fully-machined die-cast case. All components are available separately. Case size 7¼in × 4½in × 2in. approx.
Complete assembly and wiring manual **25p**, refundable on purchase of kit. Price: **£10·50** plus 50p P. & P.

PSYCHODELIC LIGHTING UNIT Mk. 3

This unit represents a natural progression from our phenomenally successful Mk. 1 and 2 Units. As before the drive voltage is derived directly from the amplifier output or across the speakers. The unit converts the audio frequency signals into a three-coloured light display; the colour depending on the frequency of the signal and the intensity on the loudness of the audio source.
The unit is constructed on professional fibre-glass printed-circuit board material and uses latest full-wave triac circuitry. There is a master-level control, together with independent sensitivity controls for each channel. The original minimum ambient light level controls have been redesigned permitting their use as faders; allowing dimming from max. to zero at the turn of a knob. R.F.I. suppression is now incorporated as standard as well as provision for D.J. "Pulse-Flash" controls. The choice of two inputs enables operation from both high and low power amplifiers. Max. power 1·5kW per channel at 240V a.c.
Complete assembly built and tested. Size 9in × 7in × 3in. Price **£25** carr. paid.

PLEASE NOTE ALL THE ABOVE PRICES ARE SUBJECT TO V.A.T. ADJUSTMENT

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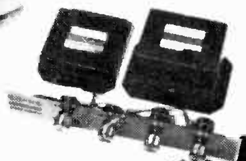
AT **£26·12** INC. VAT

It's the RT-VC system that screws together to save you pounds! Unisound comprises two superb speakers and an amplifier/record deck plinth—all beautifully finished in simulated teak. The stereo amplifier (4 watts per channel into 8 ohms) is based on the famous Mullard Unilex system brought up-to-date by RTVC using intergrated circuits. Turntable is the proven Garrard 2025TC complete with stereo cartridge and tinted acrylic cover. Speakers are big EMI Twin-cone units all ready for mounting in their elegant cabinets, which simply need screwing and glueing together. Easy step-by-step instructions. £26·12 **complete plus £1·40 packing + £1·40 post.** Diamond Stylus £1·25 extra. Stereo headphones with adaptor £4 extra. Send for leaflet.

AN RTVC EXCLUSIVE DESIGN

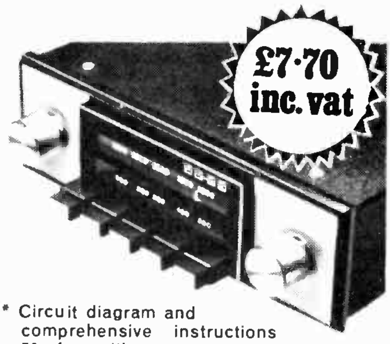


UNISOUND MODULES ONLY £6·95 + 50p. p. & p.
For the man who wants to design his own stereo—here's your chance to start, with Unisound—pre-amp, power amplifier and control panel. No soldering—just simply screw together. 4 watts per channel into 8 ohms. Inputs: 120mV (for ceramic cartridge). The heart of Unisound is high efficiency I.C. monolithic power chips which ensure **very low distortion at all power levels over the audio spectrum.**

RTVC No price in

If you can solde on printed circuit board you can build this push-butto car radio kit. It's simple—jus follow the step-by-step instructions

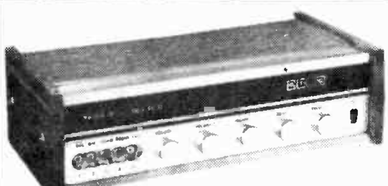
THE TOURIST PB CAR RADIO KIT
AN INCREDIBLE BUY
ONLY FROM RTVC



The Tourist PB is suitable for 12 volt working on both negative and positive earth vehicles. It covers the full medium and long wave bands. It is permeability tuned and sturdily constructed. Output is a full 2·5 watts into an 8ohms speaker. But the Tourist PB will operate into any loudspeaker from 8 to 15 ohms.
Apart from the output stage, which is an intergrated circuit, the only other electronic components that need soldering are some capacitors, resistors, etc. The kit includes a pre-built RF tuner unit, and fully modulised IF stages which are pre-aligned before despatch. As well as electronic components this kit also contains 2 diamond-spun aluminium knobs, elegant matching front panel, dial, washers, screws and wire.
The Tourist PB can be mounted in any standard size dash panel and it has an illuminated tuning scale. Chassis size is: 7" wide, 2" high and 4 13/16" deep.

* Circuit diagram and comprehensive instructions 50p free with parts.
* Fully retractable lockable car aerial £1·25 post paid.

PRICE ONLY £7·70 p. and p. 55p
Speaker with baffle and fixing strips £1·50. 25 p. & p., post free if bought with the kit. Send for leaflet.



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12W 3 ohms only version **£10·50**
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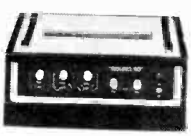
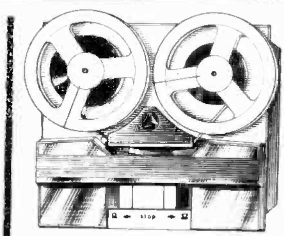


£31·35 (inc. VAT)



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£8 plus £1 p & p

crease* with VAT!

* Denotes VAT has been absorbed in the price without increase on VISCOUNT audio systems.

PRICES: SYSTEM 1

Viscount III R 101 amplifier	£24·20 + £1 p & p
2 Duo Type II speakers	£15·40 + £2·20 p & p
Garrard SP25 Mk.III with MAG. cartridge plinth & cover	£25·00 + £1·75 p & p
total	£64·60

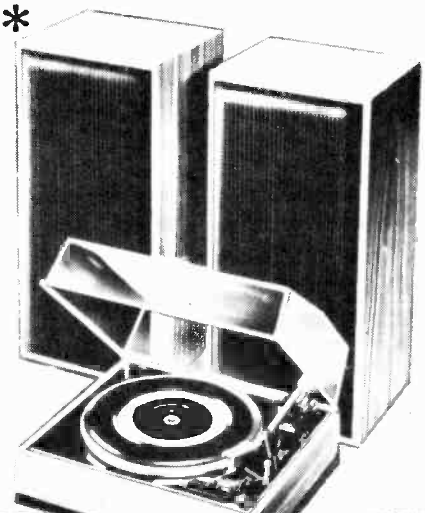
Available complete for only £52* + £3·50 p & p

PRICES: SYSTEM 2

Vicount R 101 amplifier	£24·20 + £1 p & p
2 Duo Type III speakers	£35·20 + £3·30 p & p
Garrard SP25 Mk. III with MAG. cartridge plinth & cover	£25·00 + £1·75 p & p
total	£84·40

Available complete for £69* + £4 p & p

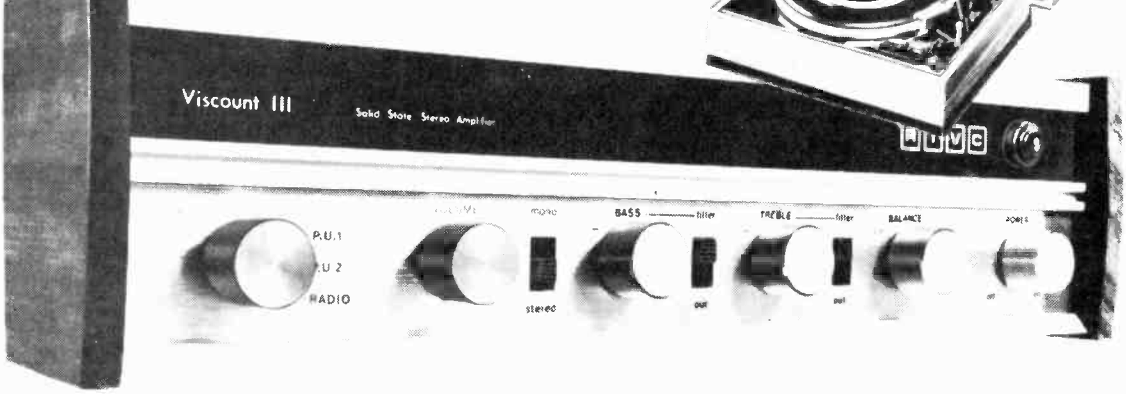
VISCOUNT III AUDIO STILL ONLY £52* COMPLETE



14 + 14w. r.m.s. 40Hz to 40kHz ± 3dB. Total distortion at 10w. at 1kHz – 0·1%. This is real value for money! We have designed 2 systems and the heart of them both is the Viscount III amplifier. A unit of great eye appeal with teak finished cabinet. FET's (Field effect, transistors) are incorporated on the input stages, just like top priced units. FET's give you more of the signal you want and almost none of the hiss you don't. Both units have output sockets for headphones and tape recorder.

For both systems we have chosen the famous Garrard SP25 Mk. III deck, with fitted magnetic cartridge, which comes complete with simulated teak plinth and tinted acrylic cover.

The exclusive Duo loudspeaker systems are incomparable for quality within their price range. Large speakers in extremely substantial cabinets. There's a choice of the Duo II's for the smaller room or the big Duo III's for real bass response.



SPEAKERS: Duo Type II Size approx. 17in. × 10¾in. × 6¾in. Drive unit 13in. x 8in. with parasitic tweeter. Max. power 10 watts ohms. Simulated Teak cabinet. £15·40 a pair (inc. VAT), £3·30 p. and p. Duo Type III Size approx. 23½in. × 11½in. × 9½in. Drive unit 13½in. 8¼in. with H.F. speaker. Max. power 20 watts. 8 ohms. Freq. range 20Hz to 20KHz. Teak veneer cabinet.

SPECIFICATION R101: 14 watts per channel into 3 to 4 ohms (suitable 3–15 ohms.) Total distortion @ 10W 1kHz @ 0·1%. P.U.1 (for ceramic cartridges) 150mV into 3 Meg. P.U.2 (for magnetic cartridges) 4mV @ 1kHz into 47K equalised within idB R.I.A.A. *Radio* 150mV into 220K. (Sensitivities given at full power). Tape out facilities: headphone socket, power out 250mW per channel. Signal-to-noise ratio: (all controls at max.)—P.U.I. and radio — 65dB, P.U.2 — 58dB. Cross talk better than — 35dB on all inputs. Size approx. 13¾in. × 9in. × 3¾in. Send S.A.E. for fully illustrated brochure. 12 month's written guarantee.

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