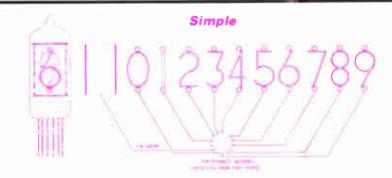




DISPLAY DEVICE ID

PRESENTED FREE WITH PRACTICAL EL





This format consists of discrete display characters. The character set takes the form of shaped wire cathodes.





Simplest bar matrix display based on a styl sed figure of eight made from seven individually illuminated bars.





Neon Manufacturer Voltage Current Brightness

Colour

Neon

Various >70V 1mA

>70V 1mA Low Orange



Manufacturer Monsanto MV2 MV1 Type Voltage 2 4 Current 50mA 50mA 500ft-L 300ft-L Brightness Colour Amber Green



Manufacturer Monsanto
Type MV5080
Voltage 1.6V
Current 20mA
Brightness 300ft-L
Colour Red



Manufacturer
Type
Voltage
Current
Brightness
Colour



Texas TIL 209 1·6V 20mA High Red







Filament Indicator

Type

Voltage



Minitron 3015F 10V (max), 5V (tvp) Luminescent Phosphor Indicator

Type



Incandescent Digital Indicator

Type



Atron DA-133

1.

Type

for

4 🖳

be a

Manufac

Voltage

Current

Brightne

Colour

Liquid C

Type

VICE IDENTICHART

ITH PRACTICAL ELECTRONICS MAY. 1973



55789

ny based on a stylised n seven individually

Hexadecimal.



This represents the hexadecimal characters for the decimal numbers 0 through to 15 on a 4 - 7 dot matrix. This kind of formal can also be achieved using a bar matrix.

Texas

TIL 207

1.65V

20mA

750ft-L

Red

Complete Alpha-numeric Matrixes



35 alpha-numeric characters available in the A.S.C.I.I. (American Standard Code for Information Interface) code are shown. The characters are made up from a 7 × 5 dot matrix.



scent Digital

Indicator

rer Texas TIL 209 1.6V 20mA High



Atron DA-133

Liquid Crystal Digital Indicator

Manufacturer

Type

Voltage

Current

Colour

Type

Brightness



RCA TA8032



Manufacturer
Type 5082-4480
Voltage 1.6V
Current 20mA
Brightness High
Colour Red

Incandescent Bulb

Type

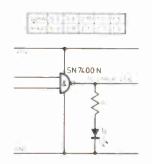
Display

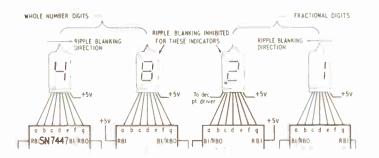


Spektra-Tek Series 2500



Using an L.E.D. to monitor the output of a TTL integrated circuit





| | Type Litronix DL34 Voltage 1.7V Current/segment 5mA Colour Red Brightness 200ft-L Character height 3.17mm Format 7-segment | Type Texas TIL 360 Voltage segment 1-65V Current 10mA Colour Red Brightness High Character height 2-54mm Format 7-segment | Type Sperry Rand SP-730 Current/segment 200µA Voltage 200V Colour Orange Brightness 225ft-L Character height 8·4mm Format 7-segment | Type Mullard ZM1250 Voltage 140V Current/each cathode 0·3mA Colour Orange Character height 9·8mm Format 7 × 5 dot matrix | Type Voltage Current Character Format |
|--|--|---|---|---|---|
| | Horizontal L.E.D. Display | Multidigit L.E.D. Display | Horizontal Neon Display | Dot Matrix Tube Assembly | 4 [|
| | Type Hewlett Packard 5082-7300 Voltage 5V Current 94mA Colour Red Character height 7-3mm Format 4 × 7 dot matrix | Digital Display with logic Type Texas TIL 306 Voltage 5V Current (total) 170mA Colour Red Brightness High Character height 6-8mm Format 7-segment Package 16 pin D.I.L. | Type Monsanto MAN 1 Voltage/segment 3·4V Current/segment 20mA Brightness 350tt-L Character height 6·8mm Format 7-segment | Alpha-Numeric L.E.D. Display Type Monsanto MAN 4 Voltage/segment 1.7V Current/segment 10mA Brightness 400ft-L Character height 4-8mm Format 7-segment Colour Red | Type Voltage/se Current/se Brightness Character Format Colour |
| | Type Mullard ZM1164, ZM1020 Voltage 170V Current 2.5mA Character height 15.5mm Package Tube Format Simple | Type Minitron 3015F Voltage 10V (max), 5V (typ) Current 13mA/bar (max) Character height 9mm Brightness 200ft-L Colour Orange Package Suit 16 pin D.1.L. socket Format 7-segment | Type Ise Itron DG12H Voltage/segment 20V Filament power 0.68W Character height 12.2mm Brightness 80ft-L Colour Green Format 7-segment | Type Atron DA-133 Voltage 3·5-5V Power 0·1-0·12W/segment Character height 12mm Brightness 5000ft-L Colour Coloured filters available Format 7-segment | Type Voltage Current Character Format Applicatio |

| | Atron DA-133 |
|------------|----------------------------|
| ge | 3 · 5-5V |
| er: | 0·1-0·12W segment |
| acter heig | ht 12mm |
| tness | 5000ft-L |
| ur | Coloured filters available |
| at | 7-segment |
| | |

a-Numeric L.E.D.

ige/segment

ent/segment

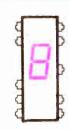
acter height

ntness

Display

| Type | RCA TA8032 |
|---------------|----------------------------|
| Voltage | 12V pulsed |
| Current | 35μ A |
| Character hei | ight 19mm |
| Format | 7-segment |
| Application | Transmissive type for back |
| | or edge lit readout |

| Туре | Spektra-Tek Series 2500 |
|------------------|----------------------------|
| Bulb voltage | 12V |
| Bulb current | 36mA |
| Character height | t 25mm |
| Brightness | Variable |
| Colour | Coloured filters available |
| Format | 7-segment |
| | |



Monsanto MAN 4

1.77

10mA

400ft-L

4·8mm

Red

7-segment

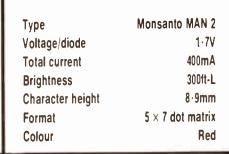


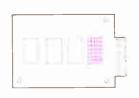
| lpha | Numeric L.E.D. Display | <u>f</u> |
|------|---------------------------|----------|
| | Display | .,,,, |

| Alpha-Numeric | L.E |
|---------------|------|
| [|)isp |
| | |

| | 00 |
|-----------------------------|--------|
| a-Numeric L.E.D. Display | 100000 |
| | |

| Туре | Monsanto MAN 3 |
|------------------|----------------|
| Voltage/segment | 1·7V |
| Current/segment | 10mA |
| Brightness | 400ft-L |
| Character height | 2·9mm |
| Format | 7-segment |
| Colour | Red |
| | |





Dot Matrix Tube Assembly

| į. | Mullard ZM1250 |
|------------------|------------------|
| ige | 140V |
| ent/each cathode | 0-3mA |
| ur | Orange |
| acter height | 9·8mm |
| ıat | 7 × 5 dot matrix |
| | |



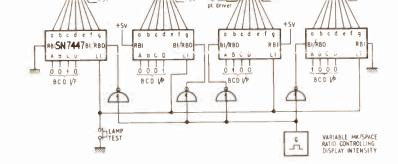
4 Digit Liquid Crystal Cells

| R.C.A. TA804 |
|--------------|
| 8-50 |
| 100μ/ |
| 15 · 2mn |
| 7-segmen |
| |



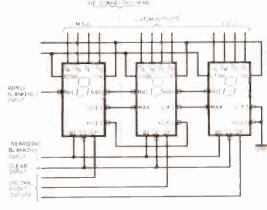
Pandicon 14 Digit Indicator Tube

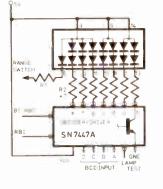
| Туре | Mullard ZM1200 |
|------------------|----------------|
| Voltage | 200V |
| Current | 8mA |
| Colour | Orange |
| Character height | 10mm |
| Format | Simple |

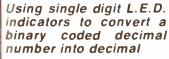


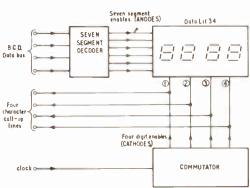
Using single digit filament indicators to give a decimal output

L.E.D. displays with integral logic greatly simplify digital circuits as shown in this circuit where three Texas devices are used to make a self-contained counter









Multidigit L.E.D. displays must be used in a time sharing or multiplex mode where only one digit at a time is activated.

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Why take the risk?

of damage to expensive transistors and integrated circuits, when soldering?

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PRICE: £1.75 (rec. retail) Suitable for production work and as a general purpose iron

Model CCN 220 volts or 240 volts

The 15 watt miniature model CCN. also has negligible leakage. Test voltage 4000v. A.C. Totally enclosed element in ceramic shaft. Fitted long-life iron-coated bit 3/32"

> 4 other bits available 1/8", 3/16" 1/4" and 1/16"

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OR Fitted with triple-coated. (iron, nickel and Chromium) bit 1/8"

PRICE: £1.95 (rec. retail)

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(Rec. retail)

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contains 15 Watt

miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32"

heat sink. solder and booklet"How to Solder'



PRICE £2.40 (Rec. retail)

MODEL MES.KIT Battery-operated 12v. 25 watt iron fitted with 15' lead and 2 heavy clips

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ELECTRONICS

VOLUME 9 No. 5 MAY 1973

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SPECIAL DATA SHEET

DISPLAY DEVICE IDENTICHART

At-a-glance information on many types of readout devices

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

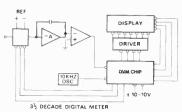
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device of the month D.V.M. chip



Now you can construct your own D.V.M. with this new G.I.

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complete D.V.M. logic for just including application notes



Compatible device M3 7 segment LED display

Also from Monsanto this display is ideal for use with D.V.M. chip.

- ° 0.125" characters * Displays all numbers plus nine letters
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- * Application notes for this unit are included in the specification on the D.V.M. chip - they are available separately, however, price: 25p.

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For six weeks only; a D.V.M. chip plus 4 digits for just £14.50 + V.A.T. Offer closes 31st May, 1973.

a superb 7 segment LED display for just



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MULTIMETER Model 200H, 20,000 ohm/voit, £4·80. 30μA, 50μA or 100μA METERS, £2:50. POTENTIOMETERS Lin or Log, 12p; with DP Switch, 24p; Dual Ganged, 36p; special offer 5K with DP switch, 16p. JB3 Junction Box. £1 20; JB11, £1 95. 500 µA TUNING METERS, 50p. CARTRIDGES: Compatible ACOS GP91-3, 90p; Stereo GP93-1, £1:15. CAPACITORS 100mF 25V, Sp; 220mF 25V, 5p; 400–200–50–16mF 300V, 30p; 0:1 500V d.c., 300V a.c., 4p. MINIATURE INDICATOR LAMPS (5 colours), 11p; 6 or 12V Bulbs for above, 4p. MAINS NEONS panel mounting (red, green, clear), 15p. HEADPHONES: High Impedance (2,000 ohm), 90p; Stereo (8 ohm), £1.95; Stereo/Mono 8/16 ohm £2:10. RECORDING TAPE, 5in LP 900ft, 45p; 52in LP 1,200ft, 60p; 7in LP 1,800ft, 81p.

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Mullard C280 Series 400V d.c., µF · 0 01, 0 015, 0 022, 3p each; 0 033, 0 047, 4p each, 250V d.c., µF · 0 068, 0 1, 0 15, 4p each; 0 22, 0 33, 5p each; 0 47, 7p; 0 68, 10p;

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|--------------------------------------|-----------------|-----------------------------------|-----------|
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|--|----------------------|--------|-----|-------|-----|---------|------------|
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| ADI61 | 30p | BC149 | 120 | OC28 | 40p | 2N2926R | 10p |
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| AFL17 | 12p | BDI32 | 60p | OC42 | 10p | 2N2926V | 9p |
| BC107 | 80 | BF194 | 15p | OC44 | 10p | 2N2926G | |
| BC108 | 80 | BFI95 | 150 | OC45 | 10p | 2N3055 | 10p 55p |
| The same of the sa | The same of the last | | | 0015 | TOP | 2143033 | 22b |

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LINEAR (C'S (DIL packaging) 709 30p DIL Sockets 8 pin 23p; 14, 16 pin all 15p.

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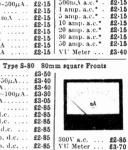
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Type PE.70. 3 17/32in. × 1 15/32in. × 2 iin. deep. £3.40 | 500µ.\ £3.05 0-0-50µA. $100\mu A \dots 100-0-100\mu A$. 1mA £2-70 300V a.c. . £2-70 £3.30 £3.20 £3.20 VII Meter ... £3.75

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50mV d.e. 100mV d.e. 30V a.e.* 50V a.e.* 150V a.e.* 300V a.e.* 500mA a.e.

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50μA.... 50-0-50μA... 100μA... 100-0-100μA.

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20V d.c. 50V d.c.

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Type ED.107. Size overall $100 \text{mm} \times 90 \text{mm}$ overall 100mm × 90mm × 108mm.

A new range of high quality moving coli instruments ideal for school experiments and other bench applications. ments and other bench applications. 3in mirror scale. The

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Model U437 10,000 O.P.V.
A first class versatile ininstrument manufactured in
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D.c. current 100wA/1/10/
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Complete with batteries
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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.

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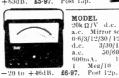
New style 20,000 O.P.V. nocket O.P.V. pocket multimeter. 5/25/ 50/250/500/2,500V d.c. 10/50/100/500/ 1,000V a.c. 50μA/



1,000V a.e. 50μA/ 250A. 6K/6 meg £3.75. Post 20μ. meg ohms. -20 to +22dB.

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| MODEL | TE-300. | O.P.V. Mirror scale, overload | protection | 0/0-6/3/15/60/300/ | 1,200V | d.e. | 0/8/30/120/600/ | a.c. | 0/80/A/60mÅ | 0/8K/ $\begin{array}{lll} 1,200V & a.c. & 0/30 \mu A/6 m A/\\ 60 m A/300 m A/600 m A. & 0/8 K/\\ 80 K/800 K/8, meg. ohm -20 to \\ +63 dB. & \textbf{\$5-97}. & Post 15 p. \end{array}$



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HIOKI MODEL 700X HIOKI MODEL 700X 100,000 O.P.V. Overhad protection. Mirror scale. o-3/0-6/1-2/1-5/8/6/12/30/60/ 1-20/300/600/1.200V d.c. 1-5/3/6/12/30/60/1-50/300/ 600/1.200V a.c. 15/304/4/3/6/30/60/1-50/300mA 6/1/2 amp. d.c. 2K/200K/ 2 Meg/20 Meg ohm -20 to 50. Post 20p.

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O . C:

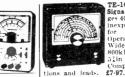
U4312 MULTIMETER U4312 MULTIMETER
Extremely sturdy instrument for general electrical use, 667 O. P.V. 0/0°3/1-5/7-5/30/60/150/300/ 600/900° d. c. and 75m.V. 0/0°3/1-5/7-5/30/60/150/300/ 600/900° x.c. 0/300µA/1-5/6/15/60/150/ 600MA/1-5/6 amp. d.c. 0/1-5/15/60/150/ acc. 0/1-5/15/60/150/ acc. 0/1-5/15/60/150/800MA/1-5/6 amp. d.c.

 $9(1\cdot5/15)69(1\cdot9)6900MA/$ $1\cdot5/6$ amp. a.c. $0/200\Omega/3$ k/30k Ω . Accuracy Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions. 29-50. Post 25p.

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ModelS-100TR MULTIMETER/TRANSISTOR

Models-100TR MULTIMETER, 100,000 O.P.V. mirror scale/overload protection. 6/0-12/6-6/3/12/30/12/0, 600V d.c. 6/6/30/12/6/60W A.c. 6/12/6/60/A/12/300W A. 12/300M A/ 12/300M A/ 12/300M A/ 12/300M A/ 12/300M To the scale of the s MFD. Transistor test measures Alpha, beta at Ico, Complete with batterie instructions and leads. £13-50. Post 25p.



MODEL 449A IN CIRCUIT TRANSIS-TOR TESTER

Checks true a.c checks title al. beta in/out. Checks lebo. Checks diodes in/out. Checks SCR, etc. Beta H1 10 - 500 LO 2lebo 0·5000μA

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KAMODEN HM720B

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MODEL L-55 FET V.O.M.

Input impedance Input impedance more observed and the second of the second



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For display of pulsed and periodic waveforms in electronic circuits VERT. AMP. Bandwidth 10MHz.

AMP. Bandwidth 19MHz.
Sensitivity at 100kHz.
V RMS/mm. 0-1-25;
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8in tube, Y amp. Sensitivity
0-1V p-p/CM. Bandwidth
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Bandwidth 1-5cps-800kHz.
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Time base. 5 ranges 10cps300kHz. Synchronisation.
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5%in × 5%in × 3%in. Complete with instruc-

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



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A new portable bridge offering excellent range and accuracy at 10w cost. Ranes: R. [10-11] meg \(\Omega\$. 6 Ranges = \frac{10}{2}^{\omega}. \text{ ClopF} = \frac{1}{1} \text{ II} \)

HENRYS 6 Ranges = \frac{20}{2}^{\omega}. \text{ TURNS RATIO} \)

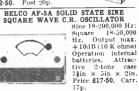
11/1000-1:11190. 6 Ranges = \frac{10}{2}^{\omega}. \text{ Bridge} \)

HENRYS 6 Ranges +2%, C.10pF ±1 1 1 0 mPd. 6 Ranges +2%, TUNNS RATIO 1:1/1000-1:11190. 6 Ranges -1%, Bridge voltage at 1,000cps. Operated from 9V 100μΑ. Meter indication. Attractive 2 tone metal case. Size 7½in × 5in × 2in. £20. metal case. Post 25p

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DECADE ATTENUATOR Frequency ra 0-200kHz.

Attenuator0-111dB, 0.1dB step. Impedance 600

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28 ranges. D.c. volts
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200/240 V r a.c. operation. Complete with
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Additional probes available: R.F. £2-12: H.V.
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d.c. 1% a.c. Scale length 163mm.
0/300/750µA|1-5/3/7-5/15/30/
75/150/300/750mA|1-5/3/7-5
amp. d.c. 0/37-5/15/30/7-5/15/7-5/15/

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KAMODEN 72.200
MULTITESTER
High sensitivity tester.
200,000 o.p.v. Overload
protection. Mirror scale.



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KAMODEN HM-350 TR. High quality instrument to test Reverse Leak current and D.C. current. Amplification factor of NPN, PNP, transistors, diodes, NCR, etc. 4">
42" clear scale meter. Operates from internal batteries. Complete with instructions, leads and carryine handle. \$12 50. Post 30p. Post 30p.



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Industrial quality in robust metal cases. Battery operation. Volume and squelch controls. Call button and press to talk button. Telescopic aerial. Complete carrying cases

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2 channel 300 mW 3 channel 2 watt.

Pair. Post 50p. Pair. Post 50p.

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Ideal for home, office, stores, fac-tories, etc. Supplied complete with bat-teries, cable and free instructions.

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Model 350, 13in x 8in with single tweeter/crossover, 20–20,000Hz, 15W RMS, Available 8 or 15 ohms, £7.25 each. Post 37t

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HKR.20



4 Bands covering 550kHz-30MHz. BFO. Built in Speaker 220/240V a.c. Brand new with instructions. £15.75. Carr. 37p.



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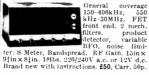
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| 2N1131 2N1132 | 0.25 | BC122 BC125 | 0.20 0.68 | + GET103 | 0.22 | 0C41 0C42 | 0.25 | 7409 | 0.45 |
| 2N1302 | | BC125 BC126 | 0.65 | GET114 | 0.15 | 0042 | 0-30 0-40 | 7410 | 0.20 |
| 2N1303 | 0.18 | + BC140 | 0-55 | GET113 GET114 GET115 | 0.45 | 0C43 0C44 | 0.17 | 7434 | 0.23 |
| 2N1304 2N1305 | 0.22 0.22 | BC147 BC148 | 0.15 | GET116 | 0.50 | OC44M | 0.17 | 7412 7413 | 0.42 0.30 |
| 2N1306 | 0.25 | BC148 BC149 | 0·13 0·15 | GET120 GET872 | 0.25 0.80 | OC45 | 0.12 | 7416 | 0.30 |
| 2N 1307 | 0.25 | BC157 BC158 | 0.15 | GET875 | 0.25 | OC45M OC46 | 0·18 0·27 | 7417 | 0.30 |
| 2N1308 | 0.25 | BC158 | 0.12 | GET880 | 0.87 | OC57 | 0.60 | 7420 7422 | 0.20 |
| 2N2147 2N2148 | 0.75 0.60 | BC160 | 0.68 | GET881 | 0.25 | OC58 OC59 | 0.60 | 7422 | 0·48 0·48 |
| 2N2160 | 0.60 | BC169 | 0.13 | GET882 | 0.25 0.25 | OC59 | 0.65 | 7425 | 0.48 |
| 2N2218 | 0.20 | BCY31 | 0.85 0.55 | GET885 GEX44 | 0.08 | OC66 OC70 | 0.50 0.12 | 7427 | 0.42 |
| 2N2219 | 0.20 | BCY32 BCY33 | 0.25 | GEX 45/1 | 0.10 | 0070 0071 | 0.12 | 7428 7430 | 0.50 0.20 |
| 2N2369A 2N2444 | 0·15 1·99 | DC 133 | 0.80 | GEX941 GJ3M | 0.18 | 0C72 0C73 | 0.20 | 7432 | 0-42 |
| 2N2613 | 0.28 | BCY38 | 0.40 | GJ4M | 0.25 0.88 | 0C73 0C74 | 0.80 0.30 | 7433 | 0.70 |
| 2N2646 | 0-45 | BCY34 BCY38 BCY39 | 1.00 | (4J5M | 0.25 | 0C75 | 0.25 | 7437 | 0.85 |
| 2N2904 2N2904A | 0.20 | | 0.60 | GJ7M | 0.87 | OC76 OC77 | 0.25 | 7438 | 0.85 |
| 2N2904A 2N2906 | 0-25 0-20 | BCY42 BCY70 BCY71 | 0.25 0.15 | H(41005 | 0.50 0.20 | OC77 | 0.40 | 7440 7441AN | 0.20 0.75 |
| 2N2907 | 0.23 | BCY71 | 0.20 | HS100A MAT100 | 0.25 | 0C78 | 0.20 0.22 | 7442 | 0.75 |
| 2N2924 | 0.23 | BCZ10 BCZ11 | 0.85 | MAT101 | 0.30 | 0C79 0C81 | 0.20 | 7450 | 0.20 |
| 2N2925 | 0.15 | BCZH | 0.50 | MAT120 MAT121 | 0.25 | OC81D | 0.20 | 7451 | 0.20 |
| 2N2926 2N3054 | 0·10 0·50 | BD121 BD123 | 0-65 0-80 | MAT121 | 0.80 | OC81M | 0.20 | 7453 7454 | 0.20 0.20 |
| 2N 3055 | 0.75 | BD124 | 0.75 | MJE520 MJE2953 | 0.87 | OC81DM OC81Z | 0·18 0·40 | 7454 7460 | 0.20 |
| 2N3702 | 0.10 | BDYII | 1.62 | MJE2955 MJE3055 | 0.87 | OC82 | 0.25 | 7470 | 0.80 |
| 2N3705 2N3706 | 0.10 | BF115 | 0.25 | NKT128 | 0.35 | OC82D | 0.20 | 7472 | 0.80 |
| 2N3707 | 0.23 0.12 | BF117 BF167 | 0.50 0.25 | NKT129 NKT211 | 0.80 0.25 | OC83 | 0.25 | 7478 7474 | 0-40 0-40 |
| 2N3709 | 0.10 | BF173 | 0.25 | NKT913 | 0.25 | OC84 OC114 | 0.25 0.88 | 7475 | 0.55 |
| 2N3710 | 0.10 | BF181 | 0-85 | NKT214 NKT216 NKT217 | 0.15 | OC122 | 0.60 | 7476 | 0-45 |
| 2N3711 2N3819 | 0.10 | BF184 BF185 | 0.20 | NKT216 | 0.37 | OC123 | 0.65 | 7480 | 0.80 |
| 2N5027 | 0.85 0.58 | BF194 | 0-20 0-17 | NKT217 | 0·35 1·13 | OC139 OC140 | 0.25 | 7482 7483 | 0·87 1·06 |
| 2N5088 | 0.88 | BF195 | 0-15 | NKT218 NKT219 NKT222 | 0.38 | 00141 | 0.85 0.60 | 7484 | 0.90 |
| 28301 | 0-50 | BF196 | 0.15 | NKT222 | 0.20 | OC141 OC169 OC170 | 0.20 | 7486 | 0-45 |
| 28304 28501 | 0-75 0-37 | BF197 BF861 | 0·15 0·28 | NKT224 NKT251 NKT271 | 0.22 0.24 | OC170 | 0.25 | 7490 7491AN | 0.75 |
| 28703 | 0.62 | BFS98 | 0.28 | NKT271 | 0.25 | OC200 | 0.80 0.40 | 7499 | 1-00 0-75 |
| AA129 | 0.20 | BFX12 | 0.20 | NKT272 NKT273 | 0.25 | OC171 OC200 OC201 | 0.70 | 7493 | 0-75 |
| AAZ12 AAZ13 | 0.80 | BFX13 BFX29 | 0.25 | NKT273 | 0.15 | OC202 OC203 | 0.80 | 7494 | 0.80 |
| ACI07 | 0·12 0·87 | BFX30 | 0-25 0-25 | NKT274 | 0.20 0.25 | OC203 OC204 | 0.40 0.40 | 7495 7496 | 0-80 1-00 |
| AC126 | 0.20 | BFX30 BFX35 | 0.98 | NKT275 NKT277 | 0.20 | OC204 | 0.75 | 7497 | 6-25 |
| AC127 | 0.25 | BFX63 | 0.50 | NKT278 | 0.25 | OC205 OC206 OC207 | 0.90 | 74100 | 2.50 |
| AC128 AC187 | 0.20 0.25 | BFX84 BFX85 | 0.25 0.30 | NKT301 NKT304 | 0-40 0-75 | OC207 | 0.90 | 74107 | 0-50 |
| AC188 | 0.25 | BFX86 | 0.25 | NKT403 | 0.75 | OC460 OC470 | 0.20 0.30 | 74110 74111 | 0-80 1-45 |
| AC188 ACY17 ACY18 | 0.80 | BFX87 BFX88 | 0.25 | NKT404 NKT678 | 0.55 | OCP71 | 0.97 | 74118 | 1.00 |
| ACY18 ACY19 | 0-25 0-25 | BFX88 BFY10 | 0.20 1.00 | NKT678 | 0.30 0.25 | ORPI2 | 0.50 | 74119 | 1.90 |
| ACY20 | 0.20 | BFV11 | 1.25 | NKT713 NKT773 | 0.25 | ORP60 ORP61 | 0-40 0-42 | 74121 74122 | 0.80 1.85 |
| ACY20 ACY21 ACY22 | 0.20 | BFY11 BFY17 | 0.25 | NKT773 NKT777 | 0.38 | SI9T | 0.80 | 74122 | 2.70 |
| ACY22 | 0.10 | BYF18 | 0.25 | 078B | 0.88 | SAC40 | 0.25 | 74141 | 1.00 |
| ACY27 ACY28 ACY39 | 0·25 0·17 | BFY19 BFY24 | 0.25 | OA6 | 0-12 | SFT308 | 0.38 | 74145 | 1.50 |
| ACY39 | 0-50 | BFY44 | 1.00 | OA47 | 0.12 | ST722 ST7231 | 0-88 0-83 | 74150 74151 | 3.35 1.10 |
| ACY40 | 0.15 | BFY50 | 0.22 | OA70 | 0.10 | SX68 | 0.20 | 74154 | 2.00 |
| ACY41 ACY44 | 0·15 0·25 | BFY51 BFY59 | 0.20 | OA71 OA73 | 0.10 | SX 631 | 0.80 | 74155 | 1.55 |
| AD140 | 0.50 | BFY53 | 0.22 | OA74 | 0·10 0·10 | 8X635 8X640 | 0.40 | 74156 | 1.55 |
| AD149 | 0.50 | BFY64 BFY90 | 0.42 | OA79 | 0.10 | SX641 | 0.50 0.55 | 74157 74170 | 1.80 4.10 |
| AD161 | 0.87 | BFY90 | 0.65 | OA81 | 0.08 | 8X642 | 0.60 | 74174 | 2.00 |
| AD 162 AF 106 | 0.87 0.80 | B8X27 B8X60 | 0.50 0.98 | OA85 OA86 | 0·12 0·15 | SX644 | 0.75 | 74175 | 1.35 |
| AF114 | 0.25 | BSX76 | 0.15 | OA90 | 0.08 | 8X645 V15/30P | 0.75 0.50 | 74176 74190 | 1.60 |
| AF115 | 0.25 | BSY26 | 0.18 | OA91 | 0-07 | V30/201P | 0.75 | 74191 | 1.95 |
| AF116 AF117 | 0-25 0-25 | BSY27 BSY51 | 0·17 0·50 | OA95 OA900 | 0-07 0-07 | V60/201 | 0.50 | 74192 | 2.00 |
| AF118 | 0.62 | BSY95A | 0-12 | OA200 OA202 | 0.10 | V60/201P XA101 | 0.75 0.10 | 74193 | 2.00 |
| AF119 | 0.20 | B8Y95 | 0.12 | OA210 | 0.25 | XA101 | 0.18 | 74194 74195 | 2.50 1.85 |
| AF124 AF125 | 0.25 | BT102/50 | | OA211 | 0.30 | X A 151 | 0-15 | 74196 | 1.50 |
| AF126 | 0.20 0.17 | BTY42 | 0.75 0.92 | OAZ200 OAZ201 | 0.55 | XA152 | 0.16 | 74197 | 1.50 |
| AF127 | 0.17 | BTY79/10 | 00R | OAZ202 | 0.42 | XA161 | 0.25 | 74198 74199 | 4-60 4-60 |
| AF139 | 0.80 | | 0.75 | OAZ203 | 0.42 | X A 162 | 0.25 | 1 1 1 (12) | 4-00 |
| AF178 AF179 | 0.55 | BTY79 40 | 10 R 1.9.6 | OAZ204 OAZ205 | 0-30 0-42 | X B101 | 0.48 | Plug in so | ckets |
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METAL CABINETS

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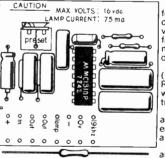
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The outputs go via a screened twin cable to the tuner inputs of your stereo amplifier.

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SPECIFICATION

Power output Freq. response Input sensitivity

120W into 8 ohm Power output 120VV into 8 onms Freq. response 20-20,000Hz ± 2dB Input sensitivity 200mV into 10K Fibreglass board Size Fibreglass board sixe 1 summer size 1 summer size

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7 transistors

100 WATTS R.M.S. 11 transistors, 6 diodes

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Freq. response Distortion Loads Quiescent current

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Size

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Better than -75 25-45V, \$A25/35 40-70V, \$A100 4½in 4in lin lin (\$A100) lin (\$A25, \$A35) 3in

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| 0.1 wa | tt 5p | 0.25 wa | att 7p | |
| 100 | 1 K 12 | 10K 12 | 100K Ω | 1 M : |
| 250 | 2.5K 12 | 25K 12 | 250K 12 | 2.51 |
| 500 | 5K 🗘 | 50K 12 | 500K 11 | 5M 9 |
| | | | | |

Capacitors

| dise ceran ·01µF 18v ·022µF 18v ·047µF 12v ceramic p 1000pf 2200pf | 5p 5p 5p | 10w voltag 0·1μF 30ν 0·22μF 6ν 0·47μF 3ν 30V 4700pf 10,000pf | 5p 5p |
|---|---|--|---|
| Ceramic - 1-8pf 2-2pf 3-3pf 3-9pf 4-7pf 5-6pf 6-8pf all 5p. eac | plate 8:2pf 10pf 12pf 15pf 18pf 22pf 27pf h | 63V (C333 33pf 39pf 47pf 56pf 68pf 82pf 100pf | 120pf 150pf 150pf 180pf 220pf 270pf 330pf |

| | Oupi | Op. | |
|--|--------|----------------------|------------------------|
| polystyrene 10pf to 10,000pf in 47 & 68. | multip | 160 V oles of 10, | 15, 22, 33, 3p each |

01μF 02μF 04μF

·068µF

| metallised p | | | 0V (C28 | |
|-----------------|--------|-------|---------|-----|
| ·01μF 3p | .068µF | 3∮p | 47μF | 8р |
| 015μF 3p | -1 μF | 4p | 68µF | 11p |
| 022uF 3p | -15µF | 4p | 1µF | 13p |
| 033uF 3p | -22µF | 5p | 1-5µF | 20p |
| 047μF 3p | 33µF | 6 ½ p | 2-2µF | 24p |
| | | | | |

| metallised | polvester | | 400V (C2 | 81) | |
|------------|-----------|----|----------|-----|--|
| 01µF 4½p | | 6p | -22µF | 10p | |
| 015µF 43p | 068µF | 6р | 33µF | 14p | |
| 022µF 44p | -1 μF | 7p | 47µF | 15p | |
| -033uF 54p | 15µF | 8р | | | |

| silvered mica | 1% | (>50pf) 500V | |
|---------------|-----|---------------|----|
| 2 · 2pf820pf | 7p | 4 · 7nF5600pf | 19 |
| 1nF-2 · 2nf | 9p | 6800pf— 01µF | 29 |
| 2 7nF-3-6nF | 16p | | |

| 2 /nr- | O . O ! I L | igh | | | |
|--------|---------------------------------|--------|----|------|-----|
| mixed | diele | etric | 60 | 00 V | |
| 01μF | 7p | .047µF | 7p | 22µF | 16p |
| 022µF | 7p | 068µF | 8p | 47µF | 24p |
| 033µF | 7p | 1 µF | 8р | 1μF | 33p |

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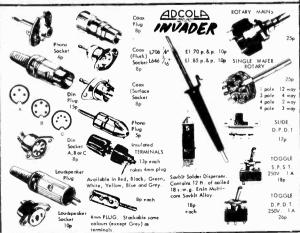
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| ١ | 2200pf | 6р | 01μF | 9p | -22µF | 22p |
| ļ | 3300pf | 6р | 022µF | 9p | 47µF | 30p |
| | 4700pf | 6р | 047µF | 12p | | |
| | Ceram | ic | | | | |
| | 12KV. | d.c. | 8KV.d. | Ç. | HI-K 750 |)V. |
| l | 10pf | 9p | 200pf | 9p | 1000pf | 5p |
| į | 15pf | 9p | 220pf | 9p | 1500pf | 5p |
| | 22pf | 9p | 250pf | 9p | 2000pf | 5p |
| | 68pf | 9p | 270pf | 9p | 3000pf | 5p |
| | 82pf | 9p | 300pf | 9p | 5000pf | 5р |
| Į | 100pf | 9p | 750V D | | 10,000pf | 5p |
| ł | 120pf | 9p | 470pf | 5p | feed- | |
| Į | 140pf | 9p | 1000pf | 5p | through | |
| ı | 150pf | 9p | 5000pf | 5p | | |
| ١ | 180pf | 9p | 10,000pf | 5p | 1000pf | 5p |
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| 1 | _ | - | _ | _ | _ | - | 6 p |
| 1.5 | - | _ | - | _ | | _ | вρ |
| 2-2 | _ | - | _ | - | | _ | 6р |
| 3.3 | _ | _ | _ | _ | _ | _ | 6р |
| 4.7 | _ | _ | - | _ | - | - | Вp |
| 6.8 | 444 | _ | _ | _ | - | 6р | 6p |
| 10 | _ | - | _ | _ | 6р | | 6p |
| 15 | _ | - | _ | 6р | _ | 6р | бр |
| 22 | _ | _ | 6р | _ | 6p | _ | 6р |
| 33 | _ | 6p | _ | 6p | | 6р | _ |
| 47 | 6 p | _ | 6 p | _ | 6p | 6р | 6р |
| 68 | _ | 6р | 1000 | бр | | _ | 10p |
| 100 | 6p | _ | 6р | _ | бp | 6p | 120 |
| 150 | | 6р | | 6р | 6р | 10p | 12p |
| 220 | 6p | _ | 6p | 6p | 10p | 12p | 18 p |
| 330 | 6p | _ | 6р | 10p | - | _ | 21p |
| 470 | _ | 6p | 10p | - | 12p | 18p | 40p |
| 680 | | 10p | _ | 12p | 18p | 21p | _ |
| 1000 | 10p | _ | 12p | 18p | 21p | 40p | 60 p |
| 1500 | _ | 120 | 18p | 21p | _ | _ | - |
| 2200 | _ | 18p | 21 p | 40p | 45p | 55p | 83p |
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| AC107 0.22 AD162 0.36½ AC113 0.22 AD161 a AC115 0.251 AD161 a AC117K 0.22 AD161 a AC117K 0.22 AD161 a AC125 0.18½ AF114 0.26½ AC127 0.18½ AF114 0.26½ AC127 0.18½ AF115 0.26½ AC127 0.18½ AF116 0.26½ AC128 0.18½ AF116 0.26½ AC132 0.15½ AF116 0.38½ AC134 0.15½ AF116 0.38½ AC137 0.15½ AF125 0.27½ AC141K 0.18½ AF126 0.31 AC141K 0.18½ AF126 0.31 AC141K 0.18½ AF126 0.31 AC142K 0.18½ AF126 0.33 AC151 0.15½ AF126 0.33 AC151 0.16½ AF129 0.33 AC151 0.16½ AF129 0.33 AC151 0.16½ AF129 0.34 AC155 0.22 AF180 0.55 AC155 0.22 AF180 0.45½ AC156 0.22 AF180 0.45½ AC165 0.22 AF180 0.45½ A | BC148 | 0.49\(\frac{1}{2}\) BF188 | $\begin{array}{cccccccccccccccccccccccccccccccccccc$ | 2N2219 |
|--|---|--|--|---|
| AC166 0-22 AL 103 0-71; AC166 0-26; ASY26 0-27; AC168 0-26; ASY26 0-27; AC168 0-26; ASY27 0-33 AC169 0-15; ASY28 0-27; AC176 0-22 ASY30 0-27; AC178 0-31 ASY31 0-27; AC180 0-18; ASY31 0-27; AC180 0-18; ASY31 0-27; AC181 0-18; ASY36 0-27; AC181 0-18; ASY36 0-27; AC181 0-18; ASY36 0-27; AC181 0-18; ASY36 0-27; AC181 0-28; AC181 0-2 | BO178 0-21 BD200 BC179 0-21 BD205 BC180 0-261 BD206 BC181 0-261 BD207 BC182 0-11 BD207 BC1832 0-11 BD102 BC1832 0-11 BP117 BC183 0-11 BP117 BC183 0-11 BP117 BC183 0-11 BP117 BC184 0-13 BF118 BC184 0-13 BF119 BC186 0-31 BF123 BC207 0-12 BF123 BC208 0-12 BF123 BC209 0-13 BF123 BC214L 0-12 BF153 BC213L 0-12 BF153 | 1.044 BFX87 0.264 0.88 BFY38 0.22 1.044 BFY30 0.22 1.044 BFY30 0.22 1.044 BFY30 0.22 1.044 BFY30 0.22 0.22 1.044 BFY30 0.23 0.264 BFX30 0.184 0.77 B8X20 0.164 0.494 B8X25 0.164 0.494 B8X26 0.164 0.494 B8X27 0.164 0.494 B8X28 0.164 0.494 B8X28 0.164 0.494 B8X28 0.164 0.494 B8X38 0.20 0.494 B8X38 0.20 0.494 B8X39 0.20 0.494 B8X39 0.20 0.495 B8X39 0.20 0.495 B8X39 0.20 | $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | 2N9924 0-161 2N3706 0-10 28034 0-77 2N9925 0-161 2N3707 0-12 28305 0-92 2N9926 (G) 2N3709 0-10 28306 0-92 2N3709 0-10 28307 0-92 2N3926 (Y) 2N3710 0-10 28321 0-61 2N2926 (Y) 2N3711 0-10 28321 0-61 2N2926 0-12 2N3817 0-10 28322 0-46 2N2926 0-11 2N3820 0-85 28323 0-81 2N2926 (B) 2N3903 0-81 28325 0-77 2N3906 0-11 2N3923 0-81 28325 0-77 2N3010 0-77 2N3905 0-31 28327 0-77 2N3010 0-77 2N3905 0-31 28327 0-77 2N3010 0-161 2N3908 0-30 28327 0-77 2N3010 0-161 2N3908 0-30 0-304 0-46 2N3003 0-181 2N4058 0-13 40362 0-491 DIODES AND RECTIFIERS |
| ACY19 0-22 BC114 0-16‡ ACY20 0-22 BC115 0-16‡ ACY21 0-22 BC116 0-16‡ ACY21 0-22 BC116 0-16‡ ACY22 0-17‡ BC117 0-16‡ ACY27 0-19‡ BC118 0-11 ACY28 0-21 BC119 0-33 ACY29 0-38‡ BC120 0-88 ACY30 0-31 BC125 0-13 ACY31 0-31 BC125 0-13 ACY36 0-23 BC134 0-20 ACY36 0-23 BC134 0-20 ACY36 0-31 BC135 0-13 ACY40 0-18‡ BC136 0-16‡ ACY44 0-38‡ BC137 0-16‡ ACY44 0-38‡ BC139 0-44 AD130 0-42 BC140 0-33 AD140 0-53 BC141 0-33 AD140 0-53 BC141 0-33 AD140 0-53 BC141 0-33 AD140 0-55 BC142 0-33 AD140 0-55 BC145 0-49‡ AD161 0-36‡ BC147 0-11 | RC225 0-27 RF156 RC226 0-38 RF157 RC230 0-28 RF157 RC230 0-28 RF159 RC231 0-28 RF159 RC231 0-28 RF159 RC232 0-33 RF160 RC233 0-24 RF162 RC234 0-27 RF162 RC271 0-20 RF163 RC271 0-20 RF163 RC271 0-27 RF167 RC271 0-27 RF177 RC271 0-27 RF177 RC271 0-66 RF178 RC272 0-714 RF179 RC273 0-66 RF180 RC274 0-66 RF180 RC275 0-66 RC275 RC275 | 0-53 BSY'15 0-14 0-80\(\frac{1}{4}\) BSY'15 2-20 0-80\(\frac{1}{4}\) BSY'15 2-20 0-86\(\frac{1}{4}\) C400 0-33 0-44 0-407 0-27\(\frac{1}{4}\) C424 0-22 0-44 0-425 0-56 0-44 0-426 0-38\(\frac{1}{4}\) C428 0-22 0-24 0-44 0-33 0-38\(\frac{1}{4}\) C444 0-33 0-38\(\frac{1}{4}\) C444 0-33 0-38\(\frac{1}{4}\) C444 0-32 0-33 MAT100 0-21 0-33 MAT100 0-21 0-33 MAT101 0-22 0-34 MAT121 0-22 0-44 MPF102 0-46\(\frac{1}{4}\) O-27\(\frac{1}{4}\) MPF102 0-46\(\frac{1}{4}\) O-40\(\frac{1}{4}\) 0-33 MPF104 0-40\(\frac{1}{4}\) | OCP71 0.47‡ 2N1302 0.15‡ ORP12 0.47‡ 2N1303 0.15‡ ORP60 0.44 2N1304 0.18‡ ORP61 0.44 2N1305 0.18‡ P346A 0.22 2N1306 0.23 ST140 0.16‡ 2N1308 0.25‡ ST141 0.16‡ 2N1309 0.25‡ T1843 0.33 2N1613 0.22 UT46 0.30 2N1711 0.22 2G301 0.21 2N1889 0.35 2G303 0.21 2N1890 0.40‡ 2G303 0.21 2N1890 0.40‡ 2G304 0.26‡ 2N2147 0.79 2G309 0.38‡ 2N2160 0.62‡ 2G309 0.38‡ 2N2160 0.626 2G339 0.22 2N193 0.38‡ 2G339 0.21 2N194 0.38‡ 2G339 0.22 2N193 0.38‡ 2G334 0.21 | $ \begin{array}{c ccccccccccccccccccccccccccccccccccc$ |

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| Pak | | | |
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| No. | Qty. | Description P | rice |
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| C 2 | 200 | Capacitors mixed values approx. (count by weight) |)-55 |
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| C 9 | 3 | Micro Switches | -55 |
| C10 | 15 | Assorted Pots & Pre-Sets | -55 |
| C11 | 5 | |)-55 |
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| C13 | 20 | Electrolytics Trans. types |)-58 |
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| C15 | 4 | Mains Toggle Switches, 2 Amp D/P |)-58 |
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| C17 | 10 | Assorted Control Knobs |)-55 |
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| | PIV | | | | | | | |
|----------|-------|-------|-------|--------|-------|-------|--|--|
| 1A TO5 | 50 | 100 | 200 | 400 | 600 | 800 | | |
| | £p | £p | £p | £p | £p | £p | | |
| | 0-251 | 0⋅271 | 0.381 | 0·47 ± | 0-58‡ | 0.691 | | |
| 3A TO66 | 0-271 | 0·361 | 0·401 | 0.51 | 0.621 | 0-77 | | |
| 5A TO66 | 0-381 | 0·511 | 0·54 | 0.61 | 0.75 | 0-88 | | |
| 5A TO64 | 0-381 | 0·511 | 0·54 | 0.61 | 0.75 | 0-88 | | |
| 7A TO48 | 0-51 | 0.55 | 0.621 | 0.731 | 0.841 | 0.99 | | |
| 10A TO48 | 0-55 | 0.64 | 0.67 | 0.821 | 1.061 | 1.32 | | |
| 16A TO48 | 0.581 | 0.691 | 0.821 | 1.021 | 1.371 | 1.65 | | |
| 30A TO48 | 1.261 | 1.54 | 1.76 | 1.921 | | 4.40 | | |

SIL. RECTS, TESTED

| PIV | 300m.A | 750m.4 | 1.A | 1.5A | 3.A | 10A | 30A |
|------|--------|--------|----------|--------|-------|-------|-------|
| | D07 | 8016 | Plast is | cSO 16 | 8010 | 8010 | 8032A |
| 50 | 0.04 | 0.051 | 0.051 | 0.071 | 0.15 | 0.23 | 0.66 |
| 100 | 0-04 | 0.061 | 0.051 | 0.141 | 0.17 | 0.251 | 0.821 |
| 200 | 0.051 | 0.10 | 0.08 | 0.151 | 0.22 | 0.081 | 1.10 |
| 400 | 0.061 | 0.141 | 0.071 | 0.22 | 0.30 | 0.401 | 1.371 |
| 600 | 0.071 | 0.17 | 0.11 | 0.251 | 0.371 | 0.401 | 2.04 |
| 800 | 0.11 | 0.18+ | 0.12 | 0.271 | 0.40 | 0.801 | 2.20 |
| 1000 | 0.12 | 0.271 | 0.151 | 0.33 | 0.504 | 0.691 | 2.75 |
| 1200 | | 0.36 | | 0.42 | 0.621 | 0.821 | |

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| T 3 | 8 | | OC81D |
| T4 | - 8 | 2G381T | OC81 |
| T5 | 8 | 2G382T | OC82 |
| T 6 | | 2G344B | OC44 |
| T7 | 8 | 2G345B | OC45 |
| T8 | 8 | 2G378 | OC78 |
| T9 | 8 | 2G399A | 2N1302 |
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\text{Full Tested} & 0.000 & 0.90 \\
\text{Sub-Min.} & 0.000 & 0.90 \\
\text{Full Tested} & 0.000 & 0.90 \\
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| U 8 | 50 Sil. Planar Diodes DO-7 Glass 250mA like OA200/20 | 2 | 0.8 | |
| U 9 | and Miles of Market and Market an | | - | |
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| UII | 25 PNP Sil. Planar Trans. TO-5 like 2N1132, 2N2904 | - :: | 0.5 | |
| U12 | 12 Silicon Rectiflers Epoxy 500mA up to 800 PIV | | 0.0 | |
| U13 | 30 PNP-NPN Sil. Transistors OC200 & 28 104 | | | |
| U14 | 110 16 - 1 000 - 1 0 | | 0.8 | |
| UIS | 25 NPN Sil. Planar Trans. TO-5 like BFY51, 2N697 | _ :- | 0.0 | |
| U16 | 10 3 Amp Silicon Rectifiers Stud Type up to 1000PtV | | 0.4 | |
| U17 | 30 Germanium PNP AF Transistors TO-5 like ACY 17-2 | | | |
| U18 | 8 6 Amp Silicon Rectifiers BYZ13 Type up to 600 PIV | | 0.5 | |
| U19 | 25 Silicon NPN Transistors like BC108 | | 0.4 | |
| 720 | 12 1 5 Amp Silicon Rectifiers Top Hat up to 1000 PIV | | | |
| 721 | 30 AF. Germanium Alloy Transistors 2G300 Series & OC | 17.1 | 0.0 | |
| J-23 | 30 MADT's like MHz Series PNP Transistors | | | |
| U24 | 20 Germanium I Amp Rectifiers GJM Series up to 300 Pl | 1.7 | 0.8 | |
| 125 | 25 300MHz NPN Silicon Transistors 2N708, BSY27 | | 0.5 | |
| 126 | 30 Fast Switching Silicon Diodes like IN914 Micro-Min. | | | |
| 27 | 12 NPN Germanium AF Transistors TO-1 like AC127 | | | |
| 129 | 10 1 Amp SCR's TO-5 can, up to 600 PIV CR81/25-600 | | 0.5 | |
| 30 | 15 Plastic Silicon Planar Trans. NPN 2N2926 | | 1.1 | |
| 31 | 20 Silicon Planes Plants NPN 2N2926 | | 0.5 | |
| 132 | 20 Silicon Planar Plastic NPN Trans. Low Noise Amp 2N 25 Zener Diodes 400mW DO-7 case 3-18 volts mixed | | _ | |
| 33 | 15 Plastic Case I Amp Silicon Rectifiers IN 4000 Series | _ :- | | |
| 134 | 30 Silicon PNP Alloy Trans. TO-5 BCY26 28302/4 | | 0.5 | |
| J35 | all officers by the second of | | 0.5 | |
| T36 | 25 Silicon Planar Transistors PNP TO-18 2N2906 25 Silicon Planar NPN Transistors TO-5 BFY50/51/52 | | 0.5 | |
| 737 | 30 Silicon Allow Transistors TO-5 BFY50/51/52 | | 0.5 | |
| 138 | 30 Silicon Alloy Transistors SO-2 PNP OC200, 28322 | | 0-8 | |
| 139 | 20 Fast Switching Silicon Trans. NPN 400MHz 2N3011 | | 0.5 | |
| 40 | 30 RF. Germ. PNP Transistors 2N1303/5 TO-5 10 Dual Transistors 6 lead TO-5 2N2060 | | 0.5 | |
| :41 | | | 0.5 | |
| 742 | 25 RF Germanium Transistors TO-5, OC45, NKT72 | | 0.5 | |
| 743 | 10 VHF Germanium PNP Transistors TO-1 NKT667, A. | | | |
| 744 | 25 Sil. Trans. Plastic TO-18 A.F. BC113/114 | | 0.6 | |
| T45 | 20 Sil. Trans. Plastic TO-5 BC115/NPN | | 0.5 | |
| 40 | 7 3A SCR. TO66 up to 600PIV | | 1.1 | |

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upn Q31 6 Silicon switch transistors 2N708,

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| 0.1 CO 5 = 1 | | 0.55 | | $= 5 \times 7448$ | 0.55 | 1 | UIC91 = . | 5×7491 | 0.55 |
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| UIC05 = 1 | 2×7405 | 0.55 | UIC53= | 12 × 7453 | 0.55 | 1 | UIC94= | 5 × 7494 | 0.55 |
| 1.1006 = 8 | × 7406 | 0.55 | UIC54= | 12×7454 | 0.55 | | $^{\circ}1C95 =$ | | 0.55 |
| UIC07 = 8 | × 7407 | 0.55 | | 12×7460 | 0.55 | | IIC96= | | 0.55 |
| UIC10 = 1: | 2×7410 | 0.55 | | 8 × 7470 | 0.55 | | | =5 × 74100 | 0.55 |
| UIC13 = 8 | ×7413 | 0.55 | | 8×7472 | 0.55 | | | = 5 × 74121 | 0.55 |
| U1C20 = 1 | 2×7420 | 0.55 | | 8×7473 | 0.55 | | | 5 × 74141 | 0.55 |
| UIC30 = 1: | | 0.55 | | 8 × 7474 | 0.55 | | | 5 × 74151 | |
| ITIC40 = 1: | | 0.55 | | 8 × 7475 | 0.55 | | | | 0.55 |
| U1C+1=5 | | 0.55 | | =8 × 7476 | 0.55 | | | 5 × 74154 | 0.55 |
| U1C42=5 | | 0.55 | | =5 × 7480 | | | | 5×74193 | 0.55 |
| U1C43≈5 | | 0.55 | | | 0.55 | Ų | TC [99 = | 5×74199 | 0.55 |
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| | | 0.55 | | 5 × 7482 | 0.55 | ι | JICXI= | 25 Assorte | d |
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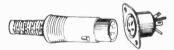
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| Capacity 11F | | | | | | | | _ |
| 0.47 | Contract | _ | _ | _ | _ | _ | 7p | 7p |
| 1.0 | _ | - | _ | _ | _ | 7p | NAME OF TAXABLE PARTY. | 7p |
| 2.2 | _ | _ | _ | _ | 7 p | _ | 7p | 7p |
| 4.7 | _ | _ | _ | 7 p | _ | 7 p | 7p | 7p |
| 10 | _ | _ | 7p | _ | 7p | 7p | 7p | 7p |
| 22 | _ | _ | 7p | 7p | _ | 7p | 7p | 8p |
| 47 | 7p | _ | 7p | 7p | 7p | 7p | 8p | 12p |
| 100 | 7p | 7p | 7p | 7p | 7p | 8p | 12p | 18p |
| 220 | 7p | 7p | 7p | 8p | 9p | 10p | 17p | 26p |
| 470 | 7p | 8p | 9p | 9p | 12p | 17p | 24p | 41p |
| 1,000 | 9p | 12p | 12p | 17p | 20p | 23p | 40p | _ |
| 2,200 | 14p | 16p | 22p | 25p | 36p | 40p | | |
| 4,700 | 23p | 26p | 37p | 40p | _ | | | _ |
| 10,000 | 37p | 40p | | _ | _ | _ | 1965-119 | _ |
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001; 0-012: 0-015: 0-018: 0-022;
002; 0-033; 0-047; 0-056; 4p each.
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| Č | 1/20W | 5% | 82 Ω −220K Ω | E12 |
| C | I/BW | 5% | 4-7 Ω –470Κ Ω | E24 |
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| C | 1/2W | 5% | 4-7 Ω –10Μ Ω | E24 |
| C | IW | 10% | 4-7 Ω=10M Ω | E12 |
| MO | 1/2W | 2% | I0 Ω −I M Ω | £24 |
| WW | IW | $10\% \pm 1/20 \Omega$ | 0-22 Ω -3-9 Ω | E 2 |
| W.M | 3₩ | 5% | 1 Ω –10Κ Ω | EI2 |
| WW | 7W | 5% | Ι Ω-10Κ Ω | E12 |
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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.

Editor F. E. BENNETT

Editorial D. BARRINGTON G. GODBOLD S. R. LEWIS B.Sc.

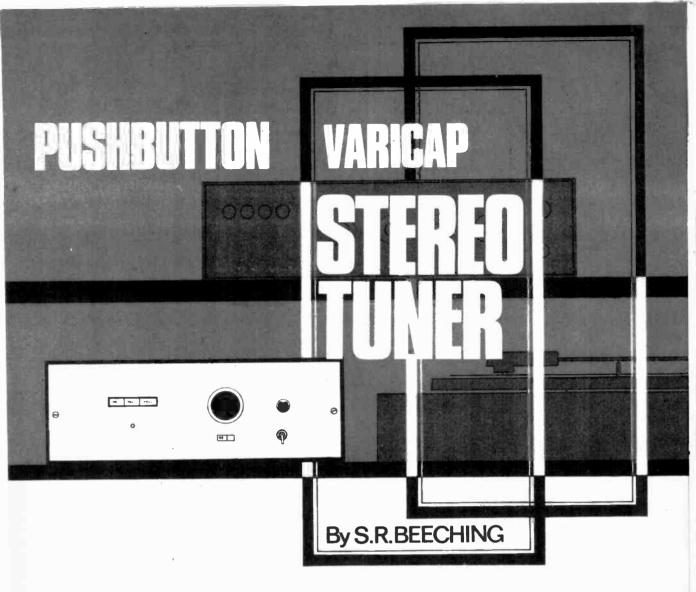
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P To recent times the only methods of tuning radios were either the variable capacitor or the variable inductor. Using either system the result was the same, mechanics in the form of pulleys and pointers were needed to physically move either the vanes 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 104.5 MHz Tuning voltage 2 to 12 V Bandwidth at -3 dB points Aerial impedance 75 Ω Power gain $(f_{in} = 95 \text{MHz})$ 30dB Noise factor $(f_{in} = 95 \text{MHz})$ 6.5dB

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

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

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

Maximum input signal
Pilot capture range
Distortion

Maximum stereo indicator
current

500mV r.m.s.
±3%
<0.3%
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.

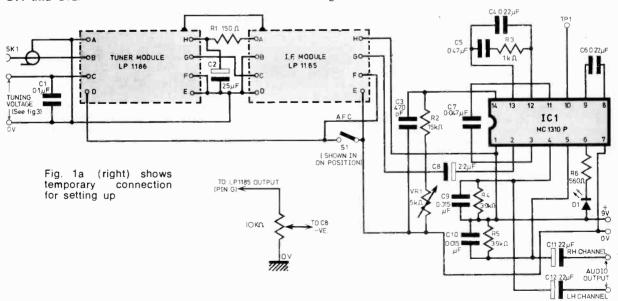


Fig. 1. Circuit diagram of the stereo tuner. The shaded boxes indicate ready built pre-aligned units. The tuning voltage unit is shown in Fig. 3



Photograph of the complete tuner showing the front panel layout

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.

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.

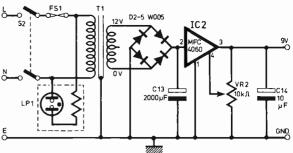


Fig. 2. Circuit diagram of the power supply unit. This not only supplies power to the modules but also provides the stabilised voltage necessary for tuning

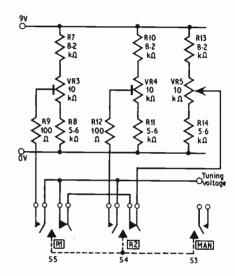


Fig. 3. A suggested tuning unit. This provides two preset voltages with a third manually variable voltage. The number of preset voltages really only depends on the size of the push button unit. There is also no reason why this tuning unit should not be mounted remote from the tuner itself. S3 is simply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

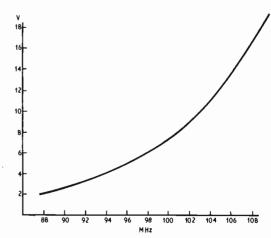
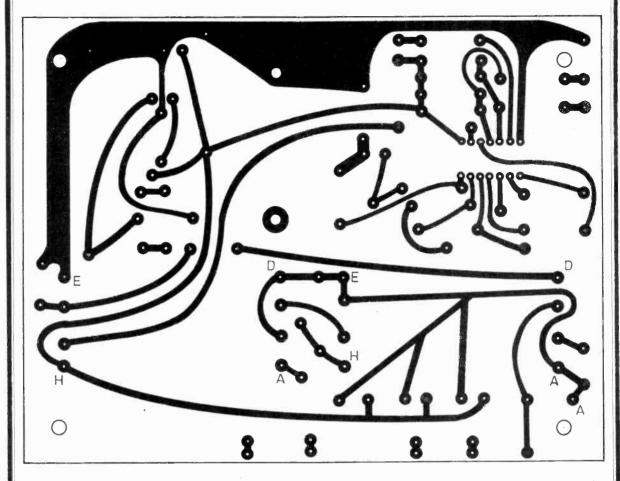


Fig. 4. Relationship between the tuning voltage and the frequency as measured in the prototype



COMPONENTS . .

| R | ۵ | 6 | i | : t | 0 | rs |
|---|---|----|---|---------------|---|----|
| п | E | Э. | н | > L | v | 13 |

R1 150 Ω R4 3.9k Ω R7 8.2k Ω R10, R13 8.2k Ω R2 $15k\Omega$ R5 $3.9k\Omega$ R8 $5.6k\Omega$ R11, R14 $5.6k\Omega$ R6 560 Ω R9 100 Ω R12 100Ω R3 $1k\Omega$ All ¼W ± 10% carbon except R2 5%

C8 2.2μ F 64V elect.

Potentiometers

 $5k\Omega$ skeleton preset VR1 $10k\Omega$ skeleton preset VR2 VR3, VR4 10kΩ skeleton preset (2 off) 10kΩ carbon linear VR5

Capacitors

0·1μF C1 25μF 12V elect. 470pF 2% C9 0.015μF C10 0.015μF C11 $22\mu F$ 25V elect. C12 $22\mu F$ 25V elect. 0.22µF C4 C5 0.47µF C13 2,000 µF 25 V elect. C6 0.22µF C14 10µF 16V elect. 0.047µF C7

Diodes

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

Integrated Circuits

ICT Motorola MC1310P IC2 Motorola MFC4060

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

Transformer

T1 Mains primary, 12V 100mA secondary

Modules

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

Switches

Miniature rocker or slide on/off switch S1 Miniature d.p.d.t. toggle switch S2

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 tues.

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.

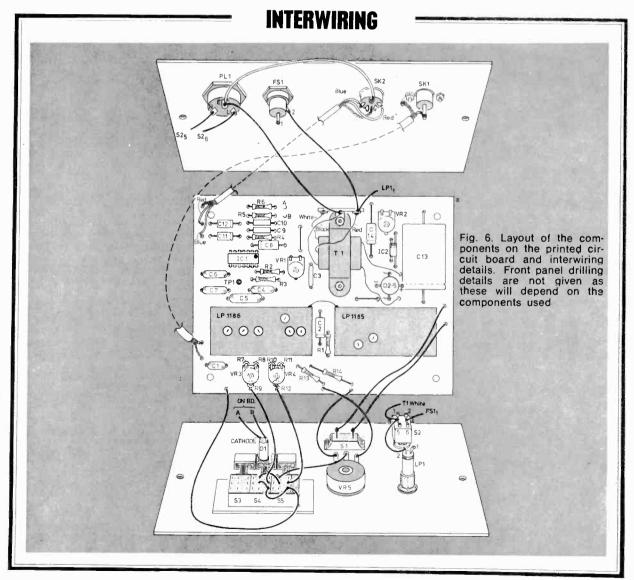
Before setting up is explained, some description of the stereo decoder is useful to understand what is going on. Fig. 7 shows a block diagram of the

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.



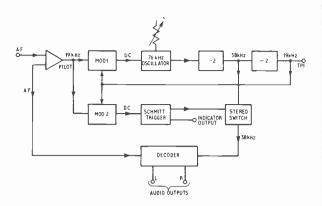


Fig. 7. Block diagram of the MC1310P stereo decoder i.c

OSCILLATOR ADJUSTMENT

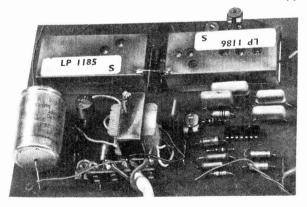
There are two ways to set VRI, the object being to set the oscillator to 76kHz with no pilot or input signal.

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 VRI 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

Practical Electronics May 1973

*j*eneral Purp

A new Integrated Circuit, the 555, provides the main circuit elements of a timing unit suited to application in the home, darkroom, workshop or factory. Covering delay times from milliseconds to hours, the 555 may in addition be used for pulse modulation or as an oscillator or in other applications. The device in its various guises is discussed in detail so that the constructor may design his own circuits. In addition, this issue includes a constructional feature on a timer using the 555.

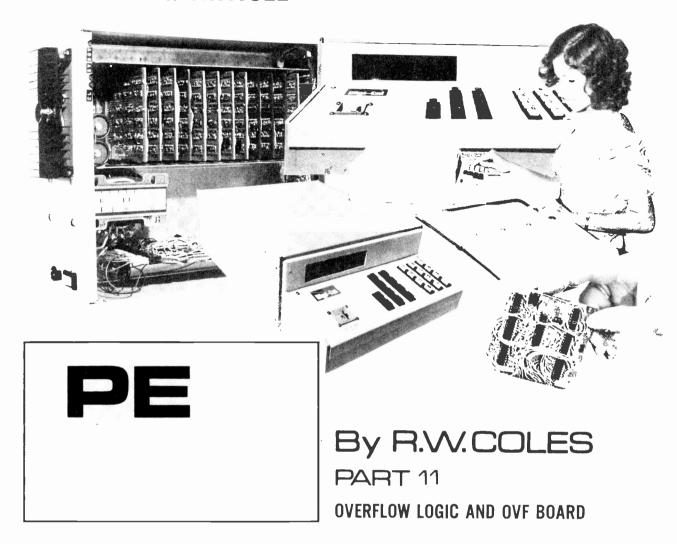
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The June Issue is on sale May 12 1973

TRONIC

CONCLUDING ARTICLE



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 OVE 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 OVER-

FLOW.

(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 execu-tion. 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 E2 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 REGIS-TER 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

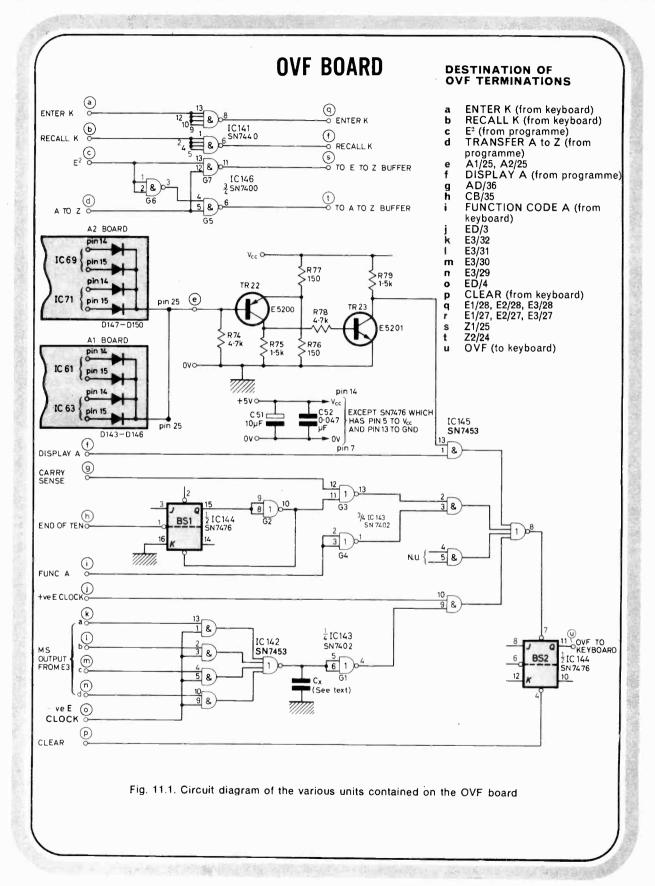
Detecting an integer in the two most significant A REGISTER positions seems on the face of it to be quite straightforward, but in practice such considerations as lack of space on the A boards to install i.c. gates, and lack of edge contacts on the A boards to allow external i.c. gates pose some problems.

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.



DIVIDE OVERFLOW

No logic has been included to show that an OVER-FLOW 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 E² 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 E² 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.

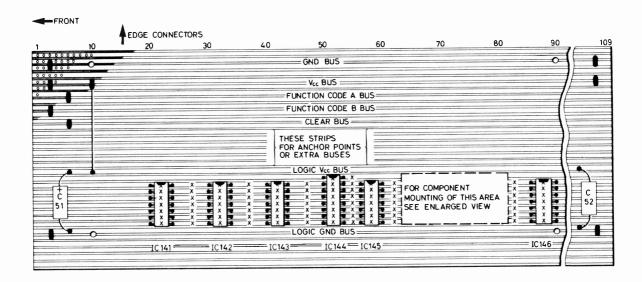
Having both the i.c.s and the wiring on the copper side of the board takes a little getting used to when soldering, but there are no special problems to look out for, and circuit tracing is really much easier. The board layout is shown in Fig. 11.2, and mounting position in Fig. 11.3.

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



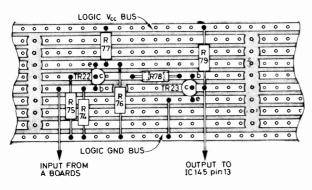


Fig. 11.2. Construction of the OVF board. Note that both the wiring and components are placed on the copper strip side of the Veroboard panel

COMPONENTS . . . OVF BOARD Resistors R74 4.7kΩ R75 1.5kΩ **R76** 150 Ω R77 150Ω R78 4.7k Ω R79 1.5kΩ Capacitors C51 10µF 15V elect. C52 0.047µF (see text) Diodes D143-150 West Hyde type "red" or any small silicon diode (8 off) Transistors TR22 E5200 (West Hyde) Integrated Circuits IC141 SN7440 IC142 SN7453 IC143 SN7402 IC144 SN7476 IC145 SN7453 IC146 SN7400 Miscellaneous

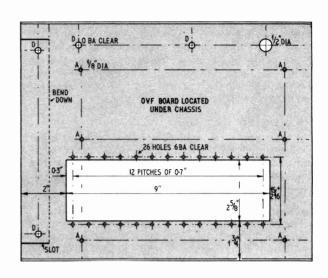


Fig. 11.3. The OVF board is mounted on the underside of the chassis in the four holes marked "A" in the main chassis plate

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.

11in × 3.6in × 0.1in matrix Veroboard panel

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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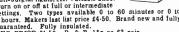
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| ZENE 400mW | | ODES -3 V to 30 V | √, I 2 p, | WIR 50Ω | E WC | OUND I | OTS, | , 3₩, 35 p. | ١٥. | 25. |
|----------------|------------|----------------------|------------------|---------------|-------------|------------------|------|-----------------------|-----|-----|
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| DIODE | S | | | | |
|--------|-------|----|-----|--------|----|
| RECTIF | IER | | | SIGNAL | |
| BY127 | 1250V | IA | 12p | OA85 | 7p |
| BZYIO | 800∨ | 6A | 25p | OA90 | 5p |
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| IN4001 | 50V | IA | 7p | OA202 | 7p |
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0.22μF, 5p. 0.33μF, 6p. 0.47μF, 7½p. 0.68μF, 11p. 1.0μF, 13p.
0.22μF, 5p. 0.33μF, 6p. 0.47μF, 0.015μF, 0.022μF, 3p. 0.033μF, 0.047μF, 0.068μF,
3p. 0.1μF, 4p. 0.15μF, 0.022μF, 5p. 0.33μF, 6½p. 0.47μF, 8½p. 0.68μF, 11p. 1.0μF, 13p.
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| 7404 | 20 | 18 | 16 | 14 | 7470 | 30 | 28 | 25 27 | 24 | 74153 | 120 | 110 | 105 | 95 |
| 7405 | 20 | 18 | 16 | 14 | 7472 | 30 | 28 | 27 | 2.3 | 74154 | 200 | 180 | 170 | 160 |
| 7406 | 50 | 45 | 40 | 35 | 7473 | 40 | 38 | 36 32 | 30 | 74155 | 150 | 120 | 100 | 86 |
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| 7409 | 36 | 30 | 27 | 33 | 7476 | 40 | 36 | 32 | 30 | 74190 | 195 | 190 | 185 | 180 |
| 7410 | 18 | 16 | 14 | 13 | 7480 | 100 | 95 | 90 | 85 | 74191 | 195 | 190 | 185 | 180 |
| 7411 | 23 | 21 | 20 | 18 | 7481 | 125 | 115 | 110 | 105 | 74192 | 200 | 190 | 180 | 164 |
| 7412 | 36 | 30 | 27 | 23 | 7482 | 100 | 96 | 90 | 85 | 74193 | 200 | 180 | 170 | 150 |
| 7413 | 34 | 28 | 26 | 22 | 7483 | 100 | 97 | 95 | 92 | 74196 | 200 | 190 | 180 | 170 |
| 7416 | 45 | 43 | 39 | 34 | 7484 | 120 | 115 | 110 | 105 | 74197 | 200 | 195 | 180 | 170 |
| 7420 | 18 | 16 | 14 | 13 | 7485 | 250 | 245 | 240 | 230 | | | | | |
| 7421 | 36 | 30 | 27 | 23 20 | 7486 | 45 | 42 | 37 | 33 | 100000000000000000000000000000000000000 | 127,123 | | | |
| 7426 7430 | 32 20 | 29 | 23 | 20 | 7490 | 75 | 67 | 60 | 52 | 1 | | INEARIO | - | - 3 |
| | | 18 | 16 | 14 | 7491A | 100 | 92 | 85 | 79 | 709 | | 14 pin DIL | | 32p |
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| 7442 | 80 | 75 75 | 70 70 | 65 | 7494 | 95 | 90 | 85 | 80 | 723 | | 14 pin DIL | | 95p |
| 7443 | 125 | 120 | 115 | 65 | 7495 | 105 | 100 | 95 | 90 | 747 | | 14 pin DIL | | 85p |
| 7447 | 175 | 165 | 150 | 115 | 7496 | 100 | 95 | 90 | 85 | 748 | | 8 pin DIL | | 35p |
| // | 1/3 | 103 | 130 | 120 | 74100 | 250 | 240 | 235 | 230 | DIL socket | | 14 pin and | 16 pin | 16p |

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.

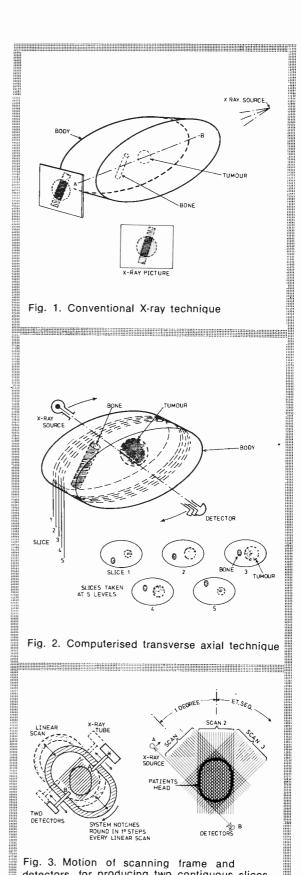
For each complete scan the scanning system yields a set of 28,800 readings from each of the two detectors plus an additional set of 28,800 reference readings of the X-ray intensity before passing through the patient's head. These three sets of readings are put into digital form by an analogue to digital 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 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.



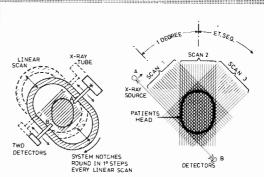
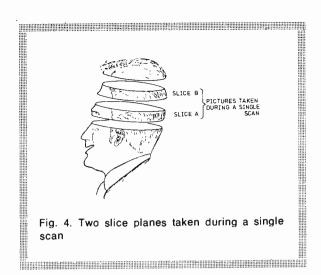


Fig. 3. Motion of scanning frame and detectors for producing two contiguous slices detectors for producing two configuous sinces



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 $2\frac{1}{2}$ 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.

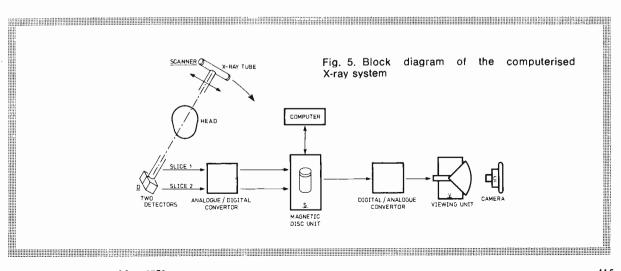
The window width control selects the range of X-ray absorption values which yields black to peak white on the cathode ray tube screen.

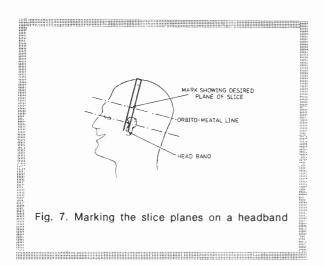
The window level control enables this selected band to be moved up or down the scale of absorption values. As an example with the window level

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 rightand 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 I digit black to peak white on the display, it is possible to measure the X-ray absorption at any chosen point in the picture.





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 orbitomeatal 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 thumbwheel 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.

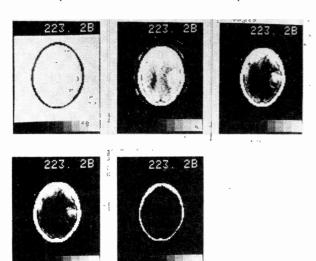
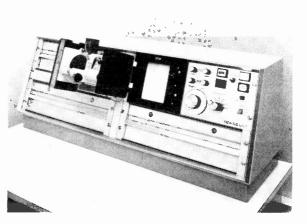


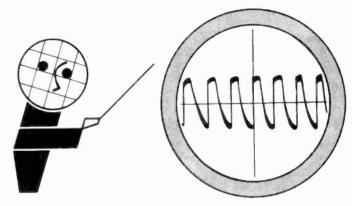
Fig. 8 (left). Effect of the "window level" control The Viewing Unit



electronics really mastered

... practical ... visual ... exciting!

no previous knowledge no unnecessary theory no "maths"





RAPY

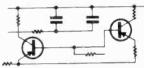
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View of a patient in position on the scanning unit

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



Practical Electronics May 1973

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 ± 70 kV 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

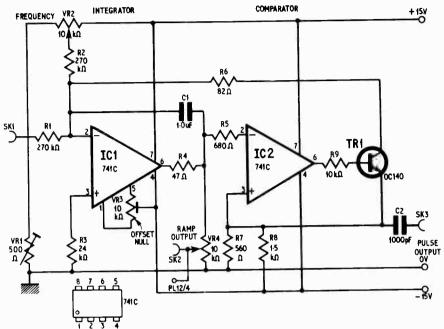


Fig. 4.1. Circuit of a ramp generator

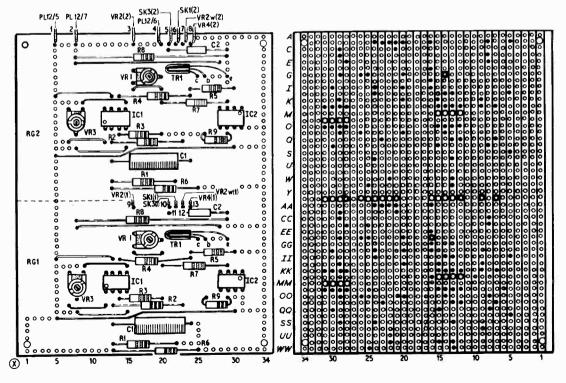


Fig. 4.2. Component layout and wiring of ramp generators

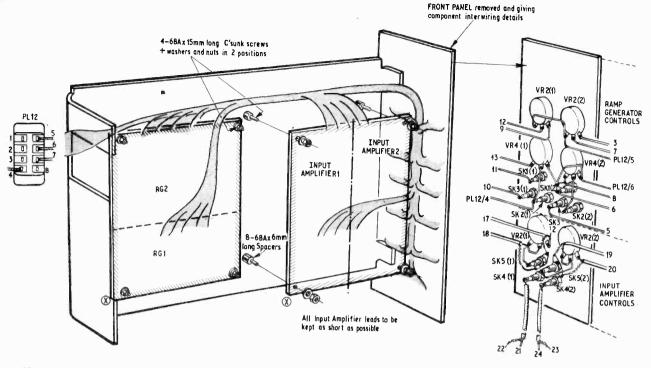
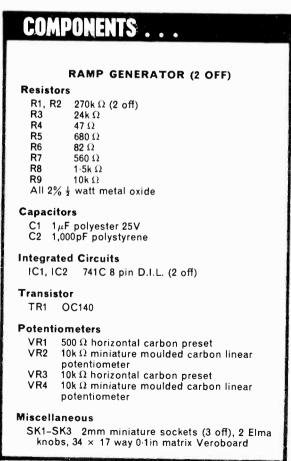
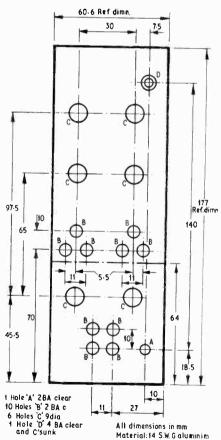


Fig. 4.3. Control panel wiring and board layout of ramp generator module. A lead should be taken from SK2(2) to PL12/8





INPUT AMPLIFIER

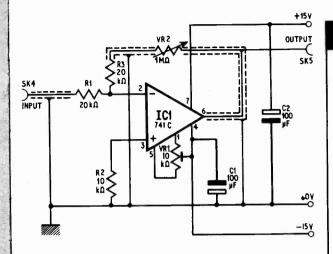


Fig. 4.4. Circuit of an input amplifier

COMPONENTS

INPUT AMPLIFIERS (2 OFF)

Resistors

 $\begin{array}{ccc} \textbf{R1} & \textbf{20k} \ \Omega \\ \textbf{R2} & \textbf{10k} \ \Omega \\ \textbf{R3} & \textbf{20k} \ \Omega \end{array}$

All 2% ½ watt metal oxide

Capacitors

C1, C2 100µF elect. 25V (2 off)

Potentiometers

 $\begin{array}{ll} \text{VR1} & \text{10k}\; \Omega \; \text{horizontal linear preset} \\ \text{VR2} & \text{1M}\; \Omega \; \text{linear miniature moulded carbon} \end{array}$

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

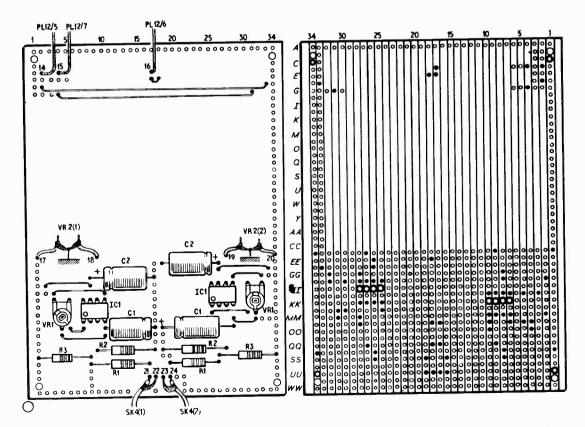


Fig. 4.5. Circuit board layout of input amplifiers

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 1.0 µF 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 0.47 µF 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

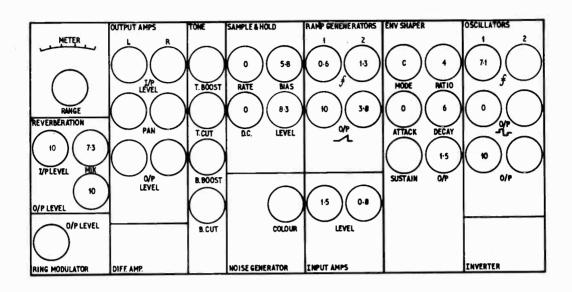
Fig. 4.7c shows the effect of subtractive mixing of the ramp generator waveforms. Achievement of the staircase form is as follows.

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.

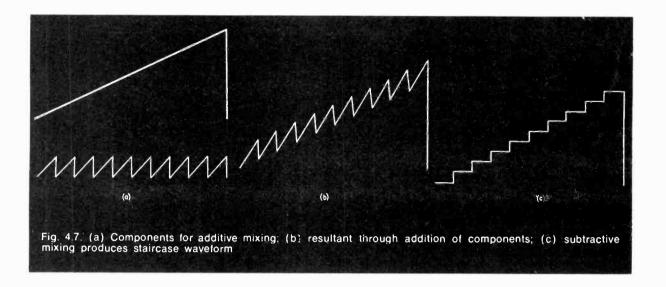
SYNTHESISER PROGRAMME SHEET



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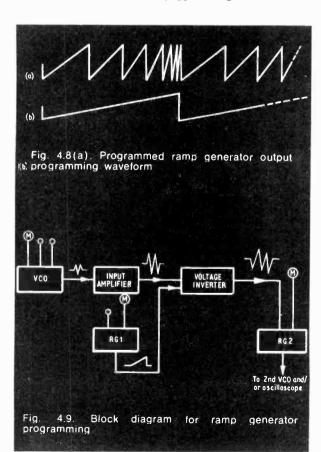
| DESCRIPTION OF SOUND | |
|--|--|
| EXTERNAL EQUIPMENT | |
| RECORDING DETAILS Stereo/Mono Y ₂ Track/Y ₄ Track 15 ips /7 ¹ / ₂ ips /3 ³ / ₄ ips Special Effects | |

Fig. 4.6. Example of a programme data sheet



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 zerovolt 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.

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 $\pm 7V$. 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 $5.6k\Omega$ 2% $\frac{1}{2}$ watt metal oxide resistor. IC2 should be insulated from chassis with a mica washer. In Part 3, VR2 is $100k\Omega$.

Next month: Sample Hold and Noise Generator.



ELECTRONIC MUSIC PRODUCTION

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

LECTRONIC 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 profes-

sional 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.

MMEDIATELY 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 he 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

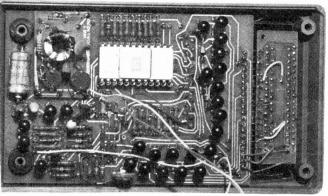
All components come in plastic bags marked with the value of the components contained, but it is as well to check these values against those required as it is always better to be safe than sorry. Because the printed circuit board has tracks both sides many solder joints have to be made on both sides 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 fadeout 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 1079; 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 the display interface is by means of discrete the display interface.

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 I.e.d. digits

with seven segment format.



SKYLAB EXPERIMENTS

The number of activities that have been planned for the *Skylah* 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 *Skylah* 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.

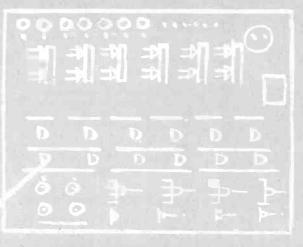
The results of the first period will undoubtedly influence the later programmes particularly on the effects of weightlessness.

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. |



G. D. Bishop and M. Hughes

o 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 $13in \times 10in \times 4in$ 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

100 Ω (see text) (11 off) R1-R11

R12-R17 1kΩ (6 off)

R18 47KQ

R19-R28 470Ω (10 off)

All 10% 1 watt carbon

Transistors

TR1-TR32 EC108 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 GF2M or Mullard ZM1026

LOGIC CIRCUITS **Integrated Circuits**

IC1-IC6 945 D.I.L. (6 off)

946 D.I.L. (4 off) IC7-IC10

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 CA91 (2 off)

Capacitors C1-C2 100 µF elect. 6V (2 off)

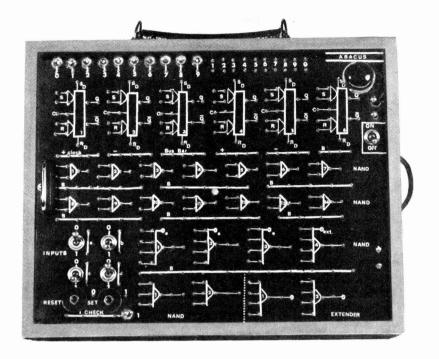
Switches Mains on/off toggle S1

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 ≈ 31in



The completed Logic Tutor showing the front panel layout

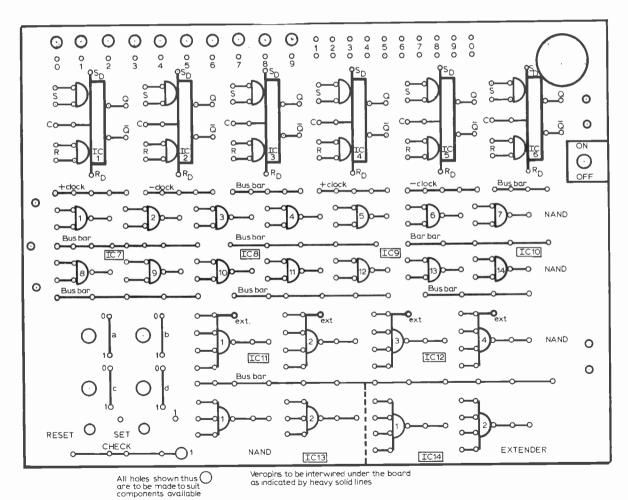
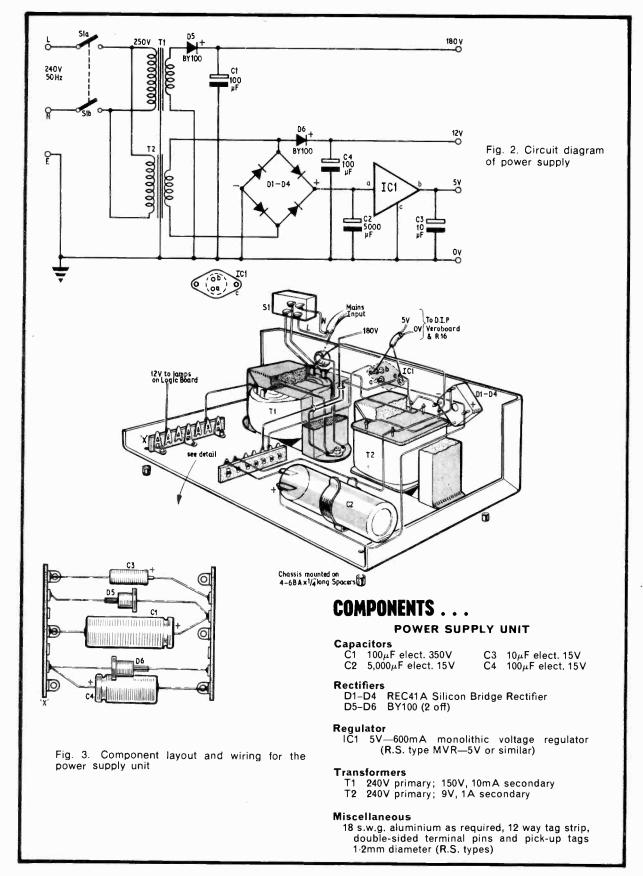


Fig. 1. Layout of logic board showing drillings and symbols



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 fourinput 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, ICI 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

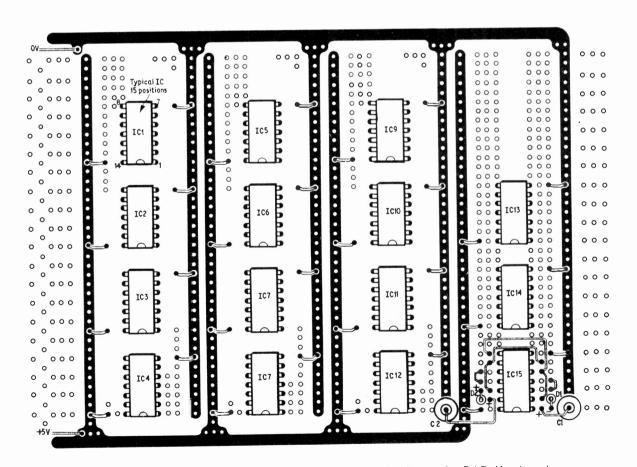
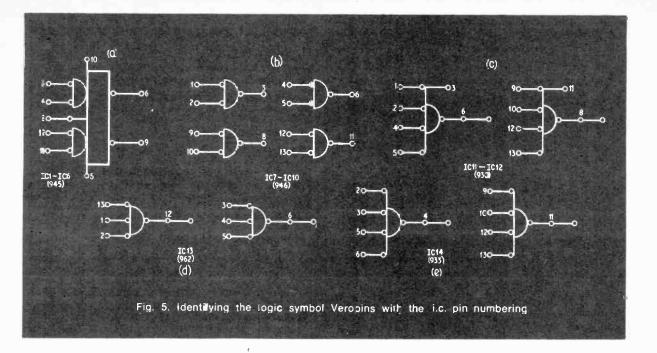


Fig. 4. Wiring and layout of the fifteen D.I.P. integrated circuits on the D.I.P. Veroboard



(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.

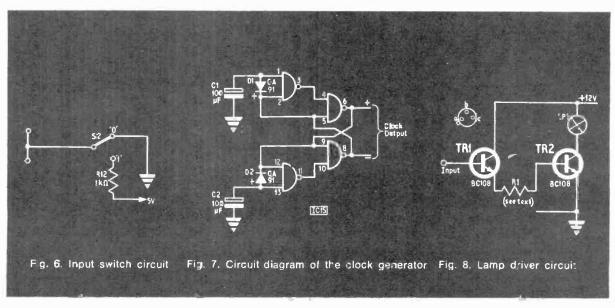
LOGIC SWITCHES

Four switches are provided (S2-\$5) 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.



SUPERSOUND 13 HI-FI MONO AMPLIFIER

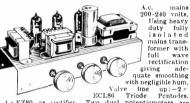


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DE LUXE STEREO AMPLIFIER



giving aquate smoothing with negligible hum.

ECLS6 Triode Pentodes.

I × EZS0 as tectifier. 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 300m/v 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 Ilin. w 4 in. x. Overall height including valves 5 in. 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 $6^\circ \sim 34^\circ \times 24^\circ$. Suitable for Transistor Radios, Tape Recorders, Amplifiers, etc., ctc. Ready built and tested.

PRICE £4:50 P. & 35p.

BLACK ANODISED 16g, ALUMINIUM HEAT SINKS. For TO3, complete with mice's and bushes. Size 24in × 3in approx. 25p pair. P. & P. 5p.

HIGH GRADE COPPER LAMINATE BOARDS. 8" × 6".

BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. 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 have at 1 amp or 10-0-10, 20-0-20, 30-0-30V, at 2 amps full wave.

Size 3inl. 3½inW × 3inl). Price £1-85. full wave, 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 ceranic pickup tape mic., etc., bullt-in switchable scratch filter, rumble filter and louthness control. 60 m m stider 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. Finishe in the most attractive contemporary style teak cabinet. Size 164 in. × 84 in. Makers' recommended price 242-15. Our price (while stocks last) 232-50 plus 75p p. & p. plus V.A.T. Send S.A.E. for full details of specification. specification.

GENERAL PURPOSE HIGH STABILITY TRANSISTOR PRE-AMPLIFIER. For P.U. Tape, Mike of Quitar, etc., and suitable for use with valve or transistor equipment. 9-18V. Battery or from H.T. line 200/3030V. Frequency response 15Hz-25KHz. Gain 26dB. Solid encapsulation size 11 x 11 fin. Brand new—complete with instructions. Price 85p. P. & P. 13p.

HANDBOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES

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 AUTOCRANGER.
With latest mono compatible cartridge 28-97. Carr. 50p.
With stereo cartridge 27-97. Carr. 50p.
Garrard SPS5 Mk. III with heavy precision machined die
cast turntable. \$10-95. Carr. 50p.

SPECIAL BARGAIN OFFER! PRECISION ENGINEERED PLINTHS

PRECISION ENGINEERED PLINTHS
Reautifully constructed in heavy gauge "Colorcoat"
plastic coated steel. Resonance free. Designed to take
Garrard 1025, 2000, 2025TC, 2500, 3000, 3300, 5100,
SP25 II and III, SL65B, A760, etc., or B.S.R. C109,
C129, A21, etc. Black leatherette finish. Size 124 in x
144 in x 34 in high (approx. 74 in high, including rigid
smoked acrylic cover). NOW ONLY \$4.50

LATEST ACOS GP91/18C Mono Compatible Cartridge with tio stylus for LP/EP/78. Universal mounting bracket. £1-50, P. & P. 8b.

SONOTONE STAHC COMPATIBLE STEREO CARTRIDGE SONOTONE STAHC COMPATIBLE STEREO CARTEIDGE T/O stylus. Diamond Stereo LP and Sapphier 78. ONLY \$2.50. P. & P. 10p. Also available fitted with twin Diamond T/O stylus for Stereo LP. 28. 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 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 QUALITY RECORD PLAYER AMPLIFIER MK II A top-quality record player amplifier employing heavy duty double wound mains transformer, ECC83, ELS4, and rectifier. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker, Size 7in, w. v. 3d. v. 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-Vvnair front. Size 16in high x10jin widex 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 24.50. Carr. 60p.
Also available in 8 ohm with EMI 13in×8in. bass speaker with parasitic tweeter. 26.50. Carr. 65p.

LOUDSPEAKER BARGAINS

5in 3 ohn: £1-05, P. & P. 19p, 7. × 4in 3 ohn: £1-15, P. & P. 20p. 10 × 6in 3 or 15 ohn: £1-80, P. & P. 30p. E.M.I. 8×5in 3 ohn with high flux magnet £1-62, P. & P. 20p. E.M.I. 13½ × 8in with high flux ceramic magnet with parasitic tweeter 3, 8, or 15 ohn: £3-20, P. & P. 30p. E.M.I. 13×8in, 3 or 8 or 15 ohn with two inbuilt tweeters and crossover network £4-20, P. & P. 30p.

EMI CERAMIC MAGNET HEAVY DUTY TWEETER. Approx. 3in. Available 3 or 8 or 15 ohms. 21-25 plus

BRAND NEW. 12in 15w H/D Speakers, 3 or 15 ohm, Current production by well-known British maker. Now with Hillux ceramic ferrobar magnet assembly 28.75. Guitar models: 25w 26.75, 35w 28.50. P. & P. 38p cach.

SPECIAL OFFER! LIMITED NUMBER OF BRANEW ELAC 10° TWIN CO

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.

18in "RA" TWIN CONE LOUDSPEAKER
10 watts peak handling: 3, 8 or 15 ohn, 22 20, P. & P. 30p.
35 ohm SPEAKERS 3' ONLY 83p. P. & P. 130p.
"POLY PLANAR" WAFER-TYPE, WIDE RANGE
ELECTRO-DYNAMIC SPEAKER
Size 114in x 14 in x 13, in deep. Weight 190z.
Power handling: 20% r.u.s. (40% peak). Impedance
8 ohn 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
\$2.595 each. P. & P. 25p.
VYNAIR & REXINE SPEAKERS & CABINET FABRICS
app. 54 in, wide. Usually £175 yd., our price 75p yd.

app. 54 in. wide. Usually £1.75 yd., our price 75p yd. length. P. & P. 15p per yd. (min. I yd.), S.A.E. for

HI-FI STEREO HEADPHONES

Adjustable headband with comfortable flexifloam ear-muffs. Wired and fitted with standard stereo jin jack plug. Frequency responses 30-15,000Hz. Matching impedance 8-16 ohms. Easily converted for mono. PRICE 29 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 lin lin - In. Limited number 75p. P. & P. 10p.

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

10 + 10 STEREO AMPLIFIER KIT

HARVERSONIC SUPER SOUND



NEW FURTHER IMPROVED MODEL WITH HIGHER OUTPUT AND INCORPORATING HIGHER OUTPUT READY DRILLED PIBRE GLASS PRINTED CRECUT BOARD WITH COMPONENT IDENTIFICATION CLEARLY MARKED FOR EVEN EASIER CONSTRUCTION NEW FURTHER IMPROVED MODEL WITH

A really first-class Hi-Fi Stereo Amplifier Kit. I'ses 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 cartridges. (Very simple to modify to suit magnetic cartridges. (Very simple tomiculed). 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 12–30,000 Hz. Sensitivity better than 80mV into IM Ω. Full power bandwidth ± 3dB 12–15,000 Hz. 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 × 22* Bigh.

Negative feedback folds both manning. To the texture ments 35V at 1-0 aimp. Overall size—12° wide ×8° deep ~ 24° 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, 220-50. Post Free.

Note: The above amplifier is suitable for feeding two mono sources into inputs (e.g. mike, radio, tein record decks, etc.) and will then provide mixing and fading facilities for medium powered Hi Fi Discotheque was, etc.

3-VALVE AUDIO



actilities for medium powered Hi-Fi Discotheque use, etc.

3-VALVE AUDIO

AMPLIFIER HA34 MK II
Designed for Hi-Fi reproduction of records. A.C. Mans operation. Ready built on opiated heavy gauge metal chassis, size Tifn w. 4 fm. d. Alim. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer and output transformer matched for 3 obm speaker. Separate volume control and now with improved wide range four controls. Guite medium power with the controls. Complete with knobs, valves, etc., wired and tested for only \$4.95. P. & F. 35p.

HSL "FOUR" AMPLIFIER KIT, Similar in appearance to

HSL "FOUR" AMPLIFIER KIT, Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. 24-10. P. & P. 40p.

HARVERSON'S SUPER MONO AMPLIFIER

HARVERSON'S SUPER MONO AMPLIFIER
A super quality gram amplifier using a double wound fully
isolated manus transformer, rectifier and ECL82 triode
pentode valve as audio amplifier and power output stage,
Impedance 3 ohms. Output approx 35 watts. Volume
and tone controls. Chassis size only 7in. wide - 3in. deep
in. 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.
25n.

£2.95 P. & P. BARGAIN PRICE

10'14 WATT HI-FI AMPLIFIER KIT

A stylishly finished monaural amplifier with an output of 14 watts from 2 ELS is in push-pull Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and grain allow records and announcements to follow each other Fully shrouded service.



to follow each other Pully shrouded section would output transformer to match 3-15 Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving cool lift and cut. Valve line up 2 ELF4s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 13p (Free with parts), All parts sold separately, ONLY \$2.9P, P. & P. 55p. Also available ready built and tested \$10.97, P. & P. 60p.

(Please write clearly)

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

Open 9-5.30 Monday

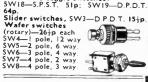
to Saturday

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, SEE 4QN

SWITCHES

Standard toggle switches: SW20—S.P.S.T. 20p; SW21—D.P.D.T. 25†p. Miniature toggle switches: 5W18—S.P.S.T. 51p: SW19—D.P.D.T.



PLINTH

to suit Garrard 2025, SP25 etc. Teak finish, complete with Perspex cover. Very attractive appearance. 43.95 plus 55p p. & p.



J-BEAM FM4S AERIAL

4 element, all channel aerial for stereo radio, £6·10 plus 50pp, & p.



BATTERY HOLDERS

for 4 x HP7. Long or short—22p.

Press studs, ready wired PP3 size— 10p; PP9 size—13p.

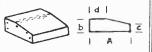




CONSOLE CASES

n plain aluminium, ideal for mixers, instruments, etc.

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



PLASTIC BOXES

for constructional projects. White projects. White, with lid and screws. BP1 4½ins x 3ins x 1½ins—37p. BP2 6ins x 4ins x 21 ins-37p.



EQUIPMENT CASES

in plain aluminium with sloping front panel.

Type H. W. D. Price p. & p. SFI 2in 5½ in 2½ in 50p 13p 5F2 2in 7½ in 3½ in 66p 17½ p. SF3 2in 9½ in 4½ in 83p 20p D. 2⅓in 3⅓in 4½in Price p. & p. 50p 13p 66p 177p 83p 20p 7₹in 7≹in 9≩in



| ALOMINION BOYES | | | | | | | | | | |
|-----------------|----------------|---------|-------|----------|-----------------|----|--|--|--|--|
| | ids and | d screv | ٧s | | | | | | | |
| Type | L. | W. | D. | Price | p. & | р. | | | | |
| G87* | 5±in | 2∄in | 1+in | 42p | 16 _D | • | | | | |
| GB8* | 4in | 4in | I∄in | 42p | 16p | | | | | |
| GB9* | 4in | 2}in | l∳in | 42p | 14p | | | | | |
| GB10 | '5 <u></u> ‡in | 4in | I ∮in | 49p | 19p | | | | | |
| GBII | 4in | 2∮in | 2in | 42p | 14p | | | | | |
| GB12 | 3in | 2in | lin | 36p | 15p | | | | | |
| GB13 | 6in | 4in | 2in | 57 p | 20p | | | | | |
| | 7 in | 5in | 2+in | 69p | 21p | | | | | |
| GB15 | 8in | 6in | 3in | 89p | 29 _D | | | | | |
| GBI6 | 10in | 7in | 3in | £1 00 | 29p | | | | | |
| | | - | | These si | zes fi | t | | | | |
| 1 | - | _ | i | standa | rd | | | | | |
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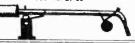
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 $2 \pm in = 8 \Omega$ $2 \pm in = 8 \Omega$ $2 \pm in = 80 \Omega$ All at 68p each.

GROOV-KLEEN

de luxe model 42. £1-83



STEREO HEADPHONES

DYNAMIC MICROPHONE

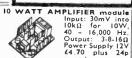
MICROPHONE HOLDER

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

UD130HL



Deter



advertisement include V.A.T.

Prices in

MICROPHONE

Professional. heavy quality with folding, tripod base. Telescopic stem extends to 59 ins. Chrome finish.

This sensitive, quality microphone is uni-directional and is complete with mute switch and 20 feet of cable and plug. 100-12,000 Hz. Dual impedance 600Ω and $50k\Omega$.

with swivel (as supplied with the mic. above). Fits most tubular mics, and stands. 57p. 66 20 plus 45p p. & p.

CATALOGUE

15p **POST FREE**

TAPE ERASER

£6.60 plus 24p p. & p.



erases a whole reel of tape in seconds. 240V. A.C. Full instructions. £2.20 plus 22p p. & p.

SCREENED CABLES

Single for mics, audio leads, etc. 5†p yd.
Twin, as above, common screen 10p yd.
Twin, as wo cores, individually screened 1†p yd.
Four core with common screen 23p yd.
Four core, individually screened 30p yd.
Coiled screened leads, 20 feet long £1·05 each.

PLUGS

| Car aerial |
|--------------------------|
| Co-axial |
| D.I.N. 2 pin (speaker) |
| D.I.N. 3 pin |
| D.I.N. 4 pin |
| D.I.N. 5 pin, 180° |
| D.I.N. 5 pin, 240° |
| D.I.N. 6 pin |
| lack, 21mm unscreened |
| Jack, 2+mm screened |
| Jack, 3½mm unscreened |
| Jack, 3∮mm screened |
| Jack, ‡in unscreened |
| Jack, ‡in screened |
| Jack, stereo, unscreened |
| Jack, stereo, screened |
| Phono, plastic top |
| Phono, plated metal |
| Wander, red or black |
| Banana 4mm, red or black |
| panana amm, red or black |

LINE SOCKETS Car aerial

Co-axial
D.I.N. 2 pin (speaker)
D.I.N. 3 pin
D.I.N. 5 pin, 180°
D.I.N. 5 pin, 240°
D.I.N. 5 pin, 240° Jack, 3 mm Jack, 4 in screened Jack, stereo, screened Phono, plated metal



| | SOCKETS | |
|---|------------------------|-------|
| • | Car aerial | 9: |
| | Co-axial, surface | 9 |
| | Co-axial, flush | 10 |
| | D.I.N. 2 pin (speaker) | H |
| | D.I.N. 3 pin | 10 |
| | D.I.N. 5 pin, 180° | 10 |
| | D.I.N. 5 pin, 240° | 100 |
| | Jack, 2+mm | 116 |
| | Jack, 34mm | 115 |
| | Jack, ±in unswitched | 164 |
| | Jack, din switched | 18 p |
| | Jack, stereo, switched | 26p |
| | Phono, single | 5 t p |
| | Phono, 2 on a strip | 740 |
| | Phono, 3 on a strip | lóp |
| | Phono, 4 on a strip | Hip |
| | | |

MINIATURE FLOOR STAND ELECTROLYTICS

| ı | 1:0#F 63V | 7p | 150 <i>u</i> F | 25 V | 8р |
|---|------------|-----|----------------|---------------|-----|
| 1 | 1 5µF 63V | 7p | 150µF | 40V | 13p |
| Į | 2 2µF 63V | 7p | 150µF | 63V | 15p |
| ı | 3-3µF 63V | 7p | 220µF | 4V | 7p |
| ı | 4 7µF 63V | 7p | 220µF | IÓV | 7p |
| ł | 6 8µF 40V | 7p | 220µF | 167 | 8p |
| ļ | 6 8µF 63V | 7p | 220µF | 25 V | 13p |
| l | 10µF 25V | 7p | 220µF | 40V | 15p |
| ı | 10µF 63V | 7p | 220µF | 63V | 22p |
| ı | 15#F 16V | Źρ | 330µF | 47 | 7p |
| ŀ | 15µF 40V | 7p | 330µF | 100 | 8p |
| | 15µF 63V | 7p | 330μF | 167 | |
| | 22µF 10V | /P | 330µF | | 13p |
| i | 22µF 25V | 7p | 330μF 470μF | 63V 6 · 3V | 26p |
| i | 22µF 63V | 7p | 470 | 100 | 8p |
| | 33µF 6·3V | 7 p | 470µF | 25 | 13p |
| | | 7p | 470µF | | 15p |
| ı | 33µF 16V | 7p | 470µF | 40V | 22p |
| 1 | 33µF 40V | 7p | 680µF | 6 · 3V | 13p |
| | 47,1F 4V | 7p | 680µF | 16V | 15p |
| Ì | 47µF 10V | 7p | 680µF | 25V | 22p |
| ı | 47µF 25V | 7p | 680µF | 40V | 26p |
| ľ | 47µF 40V | 7 p | 1000µF | 4V | 13p |
| ŀ | 47μF 63V | 8p | 1000µF | 100 | 15p |
| i | 68µF 6⋅3V | 7p | 1000µF | 16V | 22p |
| ı | 68μF 16V | 7p | 1000µF | 25V | 26p |
| ı | 68µF 63V | 13p | | 6-3V | 15p |
| ľ | 100μF 4V | 7p | 1500µF | 107 | 22p |
| | 100µF 10V | 7p | 1500µF | 16V | 26p |
| | 100µF 25V | 7p | | 6 · 3 V | 22p |
| | 100µF 40V | 8p | 2200µF | 107 | 26p |
| | 100µF 63V | 15p | | 6 · 3 V | 26p |
| | 150µF 6⋅3V | 7p | 4700µF | 4٧ | 26p |
| | 150µF 16V | 7p | | | |
| | | | | | |

TRANSFORMERS

all with 0-250 Volt primaries.

MINISTURE
MM6 6V, 500mA+6V, 500mA,
MM12 12V, 250mA+12V, 250mA,
MM20 20V, 150mA+20V, 150mA,
61-42 plus 14p p. & p.

L.T. LTI 6-3V, I-5A—82p plus 20p p. & p. LT2 6-3V, 3A—96p plus 28p p. & p. LT3 12V, I-5A—96p plus 28p p. & p. LT4 12V, 3A—41-45 plus 33p p. & p. LT4 12V, 3A—41-45 plus 33p p. & p. LT6 12-0-12V, IA—41-04 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.

| Secondaries 0-5-11-16 | Sep | Secondaries 0-5-11-16 | Secondaries 0-5-11-16

VEROBOARD

| | Size | Matrix | Matrix | | |
|---|-------------------------|----------|-------------|--|--|
| | 2±in x 3±in | 25+p | 18+p | | |
| | 2-in x 5in | 28∔p | 28+p | | |
| | 3∄in x 3∄in | 28 tp | 28∮p | | |
| Ų | 3∄in x 5in | 32 p | 35p | | |
| ı | I7in x 2+in | 87 p | 66 p | | |
| J | 17in x 31in | £1-18 | 94p | | |
| 1 | Spot face cutter- 44p | | - пр | | |
| ŀ | Pins, either size, pack | | | | |
| ı | Edge connectors: | 0.50 Z.p | | | |
| ł | 24 way, 0 1 -37 p | 36 way | 0·I—48∮p | | |
| ı | 24 way, 0 · 15—37 p | 16 way | 0 15-25 p | | |
| ł | | IV Way | , о 15—25 р | | |
| 1 | | | | | |

BONDED ACRYLIC FIBRE

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

CONTROLS

CON : NC-L Log, or Lin. Single, less switch, 15p Single, D.P. switch, 26p Tandem, less switch, 44p 5kΩ, 10kΩ, 25kΩ, 50kΩ, 100kΩ, 250kΩ, 500kΩ,

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 (5p.p. & p.

CASSETTE OWNERS!

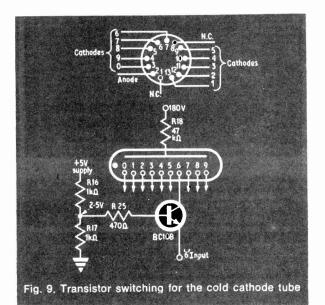
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| IμF | 450V | 21p | 1000µF | 50 V | 46p |
|----------|------|-------|----------|-------|---------|
| 2μ F | 450V | 22p | 2000 uF | 25 V | 43p |
| 4µF | 350V | 15+p | 2000uF | 50 V | 58p |
| 8µF | 450V | 18.ip | 2500µF | 25 V | 50p |
| 16µF | 450V | 20p | 2500µF | 50 V | 66p |
| 25μF | 25V | 7-jp | 3000µF | 25V | 53p |
| 25 uF | 50 V | lĺp | 5000 uF | 25 V | 66p |
| 32µF | 450V | 30p | 5000 uF | 50V | 61 - 21 |
| 50µF | 50V | Hp | 8-8µF | 450V | 20p |
| 100µF | 50 V | 12p | 8-164F | 450 V | 220 |
| 250µF | 25∨ | 15∜p | 16-16µF | 450V | 30p |
| 250uF | 50V | 19p | 16-32 uF | 450 V | 69p |
| 500µF | 25V | 20p | 32-32µF | 450 V | 540 |
| 500µF | 50V | 27↓p | 50-50uF | 350 V | 42p |
| 1000uF | 25 V | 3Óp | ос оод. | 330 1 | чар |



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.

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.

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.

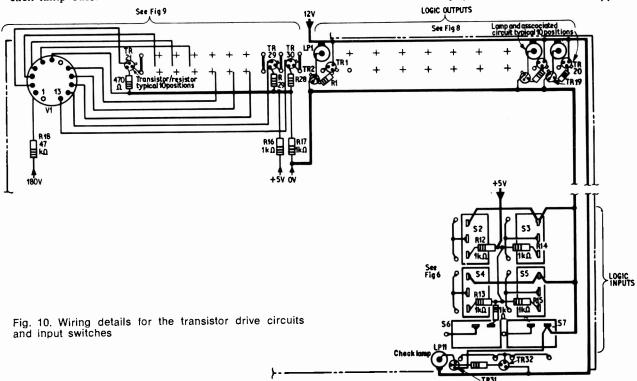
The first test is with the indicator which should glow as soon as its 180V supply is connected. All the numbers will glow until a particular cathode is grounded when all the current passes via one number which cancels off the others.

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.

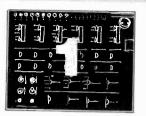
PATCHING LEADS

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.



LOGIC TUTOR EXPERIMENTS...



AND and OR GATES

N 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 I in order that the output is I.

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

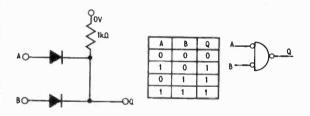


Fig. 1.1. AND gate and truth table

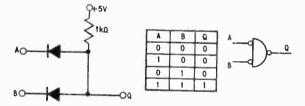


Fig. 1.2. OR gate and truth table

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 $4\cdot 7k\Omega$ not $10k\Omega$ as specified. R17 should be 10Ω not $10k\Omega$ 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 $10 \mathrm{k}\Omega$ not $1 \mathrm{k}\Omega$ 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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| 8N7405 | | 8N7470 0.80 0.27 0.25 | 8N74154 2.00 1.75 1.65 |
| BN7406 | | 8N7472 0 80 0 27 0 25 | 8N74155 1.55 1.47 1.85 |
| 8N7407 | | 8N7473 0.40 0.87 0.86 | 8N74156 1 55 1 47 1 85 |
| BN7408 | | BN7474 0-40 0-87 0-85 | 8N74157 1 80 1 70 1 50 8N74160 2 60 2 40 2 25 |
| BN7409 | | BN7475 0-55 0-52 0-50 | 8N74161 2:60 2:40 2:25 |
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| BN7411 | | 8N7480 0 80 0 75 0 67 | BN74163 8-40 8-25 2-70 |
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| BN7413 | | BN7482 0-87 0-80 0-70 | 8N74165 4 00 8 50 8 00 |
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| SN7428 | | 8N7494 0-80 0-75 0-70 | 8N74180 1 55 1 80 1 20 |
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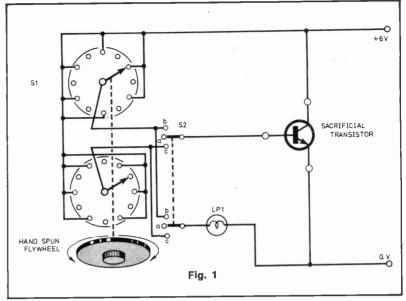
Gerry Brown . . .



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.

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.

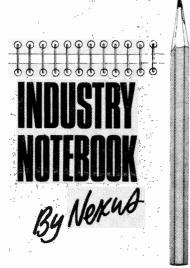
New Electronics Course at Keele University

A MONG 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.



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 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 fore-casts 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 aroundyou 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. 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-ofsale 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 kev-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.

Build yourself a TRANSISTOR RAD

ROAMER 10 WITH VHF INCLUDING AIRCRAFT

10 TRANSISTORS. 9 TUNABLE WAVEBANDS, MW1, MW2, LW, SW1, SW2, SW3, TRAWLER BAND, VHF AND LOCAL STATIONS ALSO AIRCRAFT BAND.

Built-in ferrite rod aerial for MW/LW. Retractable, chrome plated 7 section telescopic aerial, can be angled and rotated for peak short wave and VHF listening. Push-pull output using 600mW transistors. Car Aerial and tape record sockets. 10 transistors plus 3 diodes. Fine tone moving coil speaker. Ganged tuning condenser with VHF section. Separate coil for Aircraft Band. Volume/on/off, wave change and tone controls Attractive case in black with silver blocking. Size 9in × 7in × 4in.

Easy to follow instructions and diagrams. Parts price list and easy build plans 30p (FREE with parts). Earpiece with plug and switched socket for private listening 33p extra

TOTAL BUILDING COSTS

P.P. & INS. 52p (OVERSEAS P. & P. £1-05)



ROAMER **EIGHT**

Mk. I

NOW WITH VARIABLE TONE CONTROL

TUNBBLE WAVEBANDS: MWI, MW2, LW, SWI. SW2, SW3 AND TRAWLER BAND. Built-in ferrite rod aerial for MW and LW. Retractable chrome plated telescopic aerial for short waves. Push-pull output using 600mW transistors. Car aerial and tape record sockets. Selectivity switch. 8 transistors puls 3-dodes. Fine tone moving coil speaker. Air spaced ganged tuning condenser. Volume/on/off, tuning, wave change and tone controls. Attractive case in rich cheatnut shade with gold blocking. Size 9in x 7 in x 4 in approx. Easy to follow instructions and diagrans. Parts price list and easy build plans 25p (FREE with parts). Earpiece with plus and switched socket for private listening 33p extra.

TOTAL BUILDING COSTS £7.68 P. P. & INS. 47p (OVERSEAS P. & P. £1.05)

ROAMER **SEVEN** Mk. IV

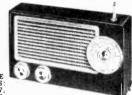
WAVEBANDS: MW1, MW2, LW. SW1, SW2, SW3 AND TRAWLER

BAND. Extra medium waveband provides easier tuning of Radio Luxembourg, etc. Built-in ferrite rod aerial for Mu and L.W. Retractable 4 section 24th chrome plated telescopic aerial for SW. Socket for car aerial. Powerful push-pull output. 7 transistors and 2 dioies, including nicero-alloy k.F. transistors. Fine tone moving including micro-alloy R.F. transistors. Fine to the flowing coil speaker. Air spaced ganged tuning condenser. Volume.on/off, tuning and wave change controls. Attractive case with carrying bandle. Size 9in × 7in × 4in approx. Easy to follow instructions and diagrams. Parts price list and easy build plans 25p (PREF with parts). Earpiece with plug and switched socket for private bistening 30p extra.

TOTAL BUILDING COSTS £6.58 P. P. & INS. 47p (OVERSEAS P. & P. £1.05)

ROAMER

SIX



TUNABLE

6 TUNABLE
WAVEBANDS:
MW. LW.
SWI. SW2.
TRAWLER
BAND PLUS AN EXTRA MW BAND FOR EASIER
TUNING OF LUXEMBOURG, ETC. Sensitive ferrite
rod aerial and telescopic aerial for short waves. 3in
speaker, 8 stages 6 transistors and 2 diodes including
nicro-alloy R.F. transistors, etc. Attractive black
case with red grille, dial and black knobs with
polished metal inserts. Size 9in × 24 im × 27 im approx.
Easy build plans and parts price list 25p (FREE with
parts).

TOTAL BUILDING COSTS £4.38 P. P. & INS. 31p (OVERSEAS P. & P. £1.05)

POCKET FIVE



8 TUNABLE WAVE-BANDS: MW, LW.
TRAWLER BAND
WITH EXTENDED
MW BAND FOR EASIER TUNING OF LUXEM-BOURG, ETC. 7 stages -5 transistors and 2 diodes.
supersensitive ferrite rold aerial, fine tone moving college.
Attractive black and gold casc. Size 6/in×
1/in × 3/in. Easy build plans and parts price list
10p (FREE with parts).

TOTAL BUILDING COSTS **£2.50** P. P. & INS. 24p (OVERSEAS P. & P. 65p)

TRANSONA **FIVE**



3 TUNABLE WAVE BANDS: MW, LW AND TRAWLER BAND, 7 stage 5 transistors and 2 diodes, ferritored acrial, tuning condenser, volume control, fine ton moving coil speaker. Attractive case with recommon control of the c

TOTAL BUILDING COSTS £2.75 P. P. & INS. 25p (OVERSEAS P. & P. 65p)

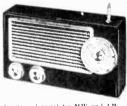
TRANS EIGHT

8 TRANSISTORS AND 3 DIODES

TUNABLE AVEBANDS:

6 TUNABLE WAVEBANDS: MW. LW. 8WI. SWJ. SW2. SW3 LW. SW2. SW3 LW. SW3. TRAWLER BAND. Sonsitive fertite rod aerial for MW and LW. BAND. Sonsitive fertite rod aerial for MW peaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grifle, thal and black kinds with polished metal inserts. Size 9in x 2/jin x 2/jin approx. Push-pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and easy build plans 25p (FREE with parts).

TOTAL BUILDING COSTS **£4.95** P. P. & INS. 33p (OVERSEAS P. & P. £1.05)



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May 1973 Practical Electronics

P.E. 53

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| | 6 3 VC | LT | Σοσομί | 456 | | |
| | 33 µF 68 µF 150 µF 470 µF 680 µF 1500 µF 2200 µF 3300 µF | 6½p 6½p 6½p 11p 13p 18p 18p 26p | 25 VO 10 μF 22 μF 47 μF 100 μF 150 μF 220 μF 470 μF 680 μF | 6 ½ P 6 ½ P 6 ½ P 8 P 8 P 10 P 13 P 20 P | 63 VC ΙμΕ 2·2μΕ 4·7μΕ |)LT 6½ 6½ 6½ |
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| | 22μF 47μF 100μF 220μF 330μF | 6½p 6½p 6½p 8p 10p | 2200μF 5000μF | 39p 68p | 10μF 22μF 68μF 100μF 150μF | 6½ 6½ 10 11 |
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| | 1500μF 2200μF | 20p 24p | 15μF 33μF | 6 ½ p 6 ½ p | 470μF 1000μF | 26 44 |
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TO99

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308 A

| AC107 16p | BC138 36p | BF260 29p | OC44 14p | Diodes | 2 | 250V P.C. moun |
|-------------------------|------------------------|--------------------------|--------------------------|----------|------------|------------------|
| AC126 14p | BC142 33p | BF329 18p | OC45 14p | Rectifie | | 0.15µF, 0.22µF, |
| AC127 13p | BC143 33p | BF330 18p | OC70 23p | | 1.20 | ,,,, |
| AC128 13p | BC144 30p | BF390 37p | OC71 14p | 1N914 | 8р | MULLARD |
| AC142K 22p | BC145 26p | BFX84 28p | OC72 14p | 1N916 | 8 p | 400V: 0.001µF, |
| AC141K 20p | BC147 9p | BFX85 85p | OC81 14p | 1N4148 | 8p | 0.022µF, 0.033µ |
| AC176 15p | BC148 9p | BFX86 22p | OC83 22p | 1844 | 10p | 12p. 0.47µF, 14 |
| AC187 18p | BC149 9p | BFX87 28p | OC84 28p | | 22p | 160V: 0.01µF, |
| AC187K 20p | BC153 16p | BFX88 26p | T1P29A 53p | 18113 | 17p | 0.22 µF, 5 p. 0. |
| AC188 13p | BC154 17p | BFY50 21p | TIP30A 64p | 18120 | 17p | |
| AC188K 20p | BC157 13p | BFY51 17p | TIP31A 64p | | 15p | VOLUME (|
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| AD162 29p AD M/P 50p | BC214L 11p BC258 9p | MP8123 50p | 2N1132 28p | | 25p | Small high qua |
| AF114 14p | | NKT211 28p | 2N1613 22p | BA115 | 8p | All valves 100- |
| AF115 14p | | NKT212 28p | 2N1711 26p | | 14 p | -1 watt |
| AF116 14p | BC267 14p BC268 15p | NKT214 25p | 2N2904 40p | BA145 | 22p 14p | -2.5 watt |
| AF117 14p | BC300 40p | NKT217 55p NKT261 23p | 2N2904A | | | |
| AF118 92p | BC301 32p | | 44p | | 14p 14p | VEROBOA |
| AF124 27p | BC302 30p | NKT271 20p NKT274 20p | 2N2905 46p 2N2924 18p | | 19p | |
| AF139 39p | BC303 50p | NKT275 25p | | BAY31 | 90 | 21 in × 31 in |
| AF239 41p | BC304 40p | NKT40371p | | | 19p | 21in × 5in |
| AL100 77p | BCY70 17p | NKT405 83p | | | 16p | 3%in × 3%in |
| AL102 66p | BCY71 87p | NK Y603F | 2N3054 55p 2N3055 52p | | | 3∰in × 5in |
| AL103 55p | BCY72 17p | 66p | 2N3405 44p | | 19p | bin × 17in (pla |
| ASY26 31p | BD123 66p | NKT613G | 2N3663 57p | | 24p | Vero Pins (bag |
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| AU110 £1.10 | BD132 90p | NKT677G | 2N3704 9p | | 24p | SLIDE SWI |
| AU111 77p | BD135 42p | 24p | 2N3705 9p | OA47 | 9p | SPST 11p each. |
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| BC116 16p | BF173 29p | OC23 33p | 2N3710 9p | OA81 | 9p | INDICATO |
| BC125 16p | BF177 28p | OC25 28p | 2N3711 9p | | 11p | |
| BC126 25p | BF178 29p | OC28 33p | 2N3794 17p | | | Reads 0-9 an |
| BC132 16p | BF179 35p | OC29 33p | 2N3819 28p | OA90 | 8p | (Data Sheet o |
| BC134 16p | BF194 15p | OC35 38p | 40361 50p | OA91 | 8p | ONLY £1 5 |
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| 17p | 0.22μF, 5 p. 0.33μF, | ο 22με, | υ υσσμε, | | |
| 17p | 0.22ДР, Бфр. 0.33ДР, | 0 p. υ 4 / μ.r | , of p. 0.0 | | |
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| 11p | STRATE GARGED I | OG or LIN | 1 lk to 17 | | |
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PATENTS BEVIEW...

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

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

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

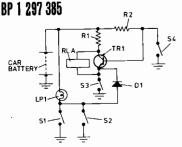


Fig. 1

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, \$4 stays closed and no base current reaches the transistor when \$3 closes (as the driver opens his door). In this case the alarm receives current via \$1 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.

BUTLER-TYPE OSCILLATOR CIRCUIT

BP 1 282 853

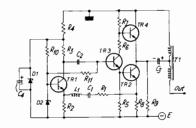


Fig. 1

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

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.

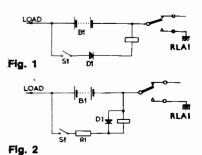
The circuit, Fig. 1, shows a relay with its contacts RLA1 in series with a battery and the coil in series with diode D1 and switch S1. The coil, D1 and S1 are connected in parallel with the battery.

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





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THE RADIO AND ELECTRONIC ENGINEER

(The Journal of the Institution of Electronic and Radio Engineers)

VOL. 43 No. 1/2 January/February 1973.

T 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, $5\frac{1}{2}$ in \times 9in. Price £1.75

HE 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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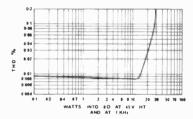
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30v HT 80dB or better Distortion 0.02% up to 20W at 8Ω . See curve Frequency response 10Hz to more than $200~\text{KHz}\pm1dB$ Max. supply voltage $45v~(4\Omega$ to 8Ω speakers) $(50v~15\Omega$ speakers only) Min. supply voltage 9v

Load impedance – minimum: 4Ω at 45v HT Load impedance – maximum: safe on open circuit

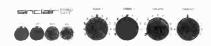


Typical Project 60 applications

| System | The Units to use | together with | Units cost |
|---|---|--|------------|
| Simple battery record player | Z.30 | Crystal P.U., 12V battery volume control, etc. | £4.48 |
| Mains powered record player | Z.30, PZ.5 | Crystal or ceramic P.U. volume control, etc. | €9.45 |
| 12W. RMS continuous sine wave stereo amp. for average needs | 2 x Z.30s, Stereo 60 ; PZ.5 | Crystal, ceramic or mag. P.U., F.M. Tuner, etc | £23.90 |
| 25W. RMS continuous sine wave stereo amp. using low efficiency (high performance) speakers | 2 x Z.30s, Stereo 60; PZ.6 | High quality ceramic or magnetic P.Ü., F.M. Tuner, Tape Deck, etc. | £26,90 |
| 80W. (3 ohms) RMS continuous sine wave de luxe stereo amplifier. (60W. RMS into 8 ohms) | 2 x Z.50s, Stereo 60; PZ.8, mains transformer | As above | £34.88 |
| Indoor P.A. | Z.50, PZ.8, mains transformer | Mic., guitar, speakers, etc., controls | £19.43 |

the world's most advanced high fidelity modules

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 207 mm.

Built, tested and guaranteed.

£9.98

Project 60 Stereo F.M. Tuner



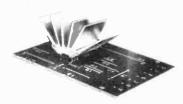
The phase lock loop principle was used for receiving signals from space craft because of its vastly improved signal to noise ratio. Now, Sinclair have applied the principle to an F.M. tuner with fantastically good results. Other advanced features include varicap diode tuning, printed circuit coils, an 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: $16 \, \text{plus} \, 20 \, \text{in} \, 1\, \text{C}$. Tuning range: $87.5 \, \text{to} \, 108 \, \text{MHz}$. Sensitivity: $7 \, \mu \text{V}$ for lock-in over full deviation. Squelch level: Typically $20 \, \mu \text{V}$. Signal to noise ratio: $> 65 \, \text{dB}$. Audio frequency response: $10 \, \text{Hz} = 15 \, \text{KHz} \, (\pm 1 \, \text{dB})$. Total harmonic distortion: $0.15 \, \text{\%}$ for $30 \, \text{\%}$ modulation. Stereo decoder operating level: $2 \, \mu \text{V}$. Cross talk: $40 \, \text{dB}$. Output voltage: $2 \, \text{x} \, 150 \, \text{mV}$ R.M.S. maximum Operating voltage: $25 \, \text{-} 30 \, \text{VDC}$. Indicators: Stereo on; tuning. Size: $93 \, \text{x} \, 40 \, \text{x} \, 207 \, \text{mm}$.

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 the 22 transactions of the control of the control of the control of the 22 transactions.

sistor 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). 6-80. 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 heatsink.

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 2.50 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

Project 605





Project 605 in one pack contains: one PZ.5, two Z 30's, one Stereo 60 and one Masterlink, which has input sockets and output components grouped on a single module and all necessary leads cut to length and fitted with clips to plug straight on to the modules thus eliminating all soldering.

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high fidelity stereo amplifier

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IC RADIO CHIP TBA651
As featured in July Practical Wireless IC of the month feature. Contains RF Amp, oscillator, mixer, IF Amps, detector, voltage stabiliser and wide range AGC circuitry. With data £2.10.

SINCLAIR EQUIPMENT

IC12 £2 Z50 £4-25 PZ5 £3.97 Z30 £3-50 Project 60 tuner £16.80 AFU £4-50 stereo 60 £7-80

Sinclair Executive Calculator, £55 New Sinclair Digital Multimeter, £44. System 2000 Amplifier, £22.

DELUXE KIT FOR THE ICI2
Includes all parts for the printed circuit and volume, bass and treble controls needed to complete the mono version £1-45. Stereo version with balance control \$1-30.

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-THIS MONTH'S SNIP-

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Designed to operate transistor sets and ampli-phers. Adjustable output 6v., 9v., 12 voite for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9, and others. Kit comprises: mains transformer rectifier, smoothing and load resistor condensers and instructions. Real snip only £1.

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Almost 3 times the life can be obtained from PP3 battery if you re-charge it from the mains— this ready to use charger with instructions only



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PROGRAMMER
Learn in your sleep:
Have radio playing and kettle boiling as you awake—switch on lights to ward of intruders—have a warm house to come home to. All these and many other things you can do if you invest in an electrical programmer. Clock by famious maker with 15 amp. on/off switch. Switch-on time can be set anywhere to stay on up to 6 hours. Independent 60 minute memory jogger. A beautiful unit. Price \$1.95 + 20p p. & p. or with glass front chrome bezel 75p extra.

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mounting by two 6B.A. serews. Size
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Sub Miniature Slide Switch. DPDT 19mm
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Primary 200-250 Voits Secondary 240 Voits Centre
Tapped (120V) and Earth Shielded
ALSO AVAILABLE WITH 115/120V SEC. WINDING PAP Ref. VA Weight No. (Wotts) Ib oz 07 20 I II 100 60 3 8 61 100 5 I2 30 200 9 8

Size cm.

| No. | (Wotts) | 16 | οz | | 4: | Þ | | | |
|---|---|------------------------------------|------------------------------------|--|---|----------------|--|--|--|
| 07 | 20 | - 1 | 11 | 7·0 × 6·0 × 6·5 | 1.77 🔨 | 10 | | | |
| 100 | 60 | 3 | 8 | 8.9 × 8.0 × 7.7 | 2.62 | 16 | | | |
| 61 | 100 | 5 | 12 | 10·2 × 8·9 × 8·3 | 2.88 | 12 | | | |
| 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 | 7 | | | |
| 55 | 350 | 15 | Ó | 14·0 × 10·8 × 12·4 | | 12 | | | |
| 63 | 500 | 27 | | 17-1 × 11-4 × 15-9 | 11.32 | | | | |
| 92 | 1000 | 40 | | 17·8 × 17·1 × 21·6 | 22.70 | | | | |
| 128 | 2000 | 63 | ŏ | 24·1 × 21·6 × 15·2 | 37.50 | ٠ | | | |
| | | | - | | | | | | |
| AUTO SERIES (NOT ISOLATED) | | | | | | | | | |
| | | | | | | _ | | | |
| Ref. | VA | W | eigh | | P & | ρ | | | |
| No. | VA (Watts | W | eigh | | 4 | | | | |
| No. | (Watts | W | eigh | 7-3 × 4-3 × 4-4 0-115-210-240 | 0.93 2 | 2 | | | |
| No. | (Watts | W) 1b | oz oz | t Size cm. Auto Tops | 0.93 2 | Þ | | | |
| No. | (Watts | s) 1b | oz | 7-3 × 4-3 × 4-4 0-115-210-240 | 0·93 2 1·82 3 | 2 | | | |
| No. 113 64 4 66 | (Watts 20 75 150 300 | W: 1b 1 1 3 6 | oz II I4 | 7-3 × 4-3 × 4-4 0-115-210-240 7-0 × 6-4 × 6-0 0-115-210-240 8-9 × 6-4 × 7-6 0-115-200-220-240 | 0.93 2 1.82 3 2.20 3 | 2 | | | |
| No. 113 64 4 | (Watts 20 75 150 | W 1b 1 1 3 | oz | 7-3 × 4-3 × 4-4 0-115-210-240 7-0 × 6-4 × 6-0 0-115-210-240 8-9 × 6-4 × 7-6 0-115-200-220-240 10-2 × 10- | 0-93 2 1-82 3 2-20 3 4-28 5 | P 2 10 16 | | | |
| No. 113 64 4 66 67 84 | (Watts 20 75 150 300 | W: 1b 1 1 3 6 | 02 11 14 0 | 7:3 × 4:3 × 4:4 0.115-210-240 7:0 × 6.4 × 6:0 0.115-210-240 8.9 × 6:4 × 7:6 0.115-200-220-240 10:2 × 10:2 × 9:5 14:0 × 10:2 × 11:4 | 0-93 2 1-82 3 2-20 3 4-28 5 6-35 6 | P 20 6 2 | | | |
| No. 113 64 4 66 67 | (Watts 20 75 150 300 500 | W: 3) 1b 3 6 | 02 11 14 0 0 8 | 7.3 × 4.3 × 4.4 0-115-210-240 7.0 × 6.4 × 6.0 0-115-210-240 8.9 × 6.4 × 7.6 0-115-200-220-240 10.2 × 10.2 × 9.5 | 0-93 2 1-82 3 2-20 3 4-28 5 6-35 6 11-54 8 | P 2 10 16 2 7 | | | |
| No. 113 64 4 66 67 84 | (Watts 20 75 150 300 500 1000 | Wi s) 1b 13 6 12 16 | 02 11 14 0 0 8 0 | 7:3× 4:3× 4:4 0.115-210-240 7:0× 6:4× 6:0 0.115-210-240 8:9× 6:4× 7:6 0.115-200-220-240 10:2× 10:2× 9:5 14:0× 10:2× 11:4 | 0-93 2 1-82 3 2-20 3 4-28 5 6-35 6 11-54 8 | P 2 0 6 2 7 12 | | | |

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PRIMARY 200-250 VOLTS 12 AND/OR 24 VOLT RANGE Ref. Amps., Weight Size cm. Secondary Windings P&F

| Ma (31/ 341/ | ** | | | |
|--------------|-------|--|-------------------|----------|
| No. 12V 24V | lb oz | | | E P |
| 1110-5 0-25 | 12 | | 0-12V at 0:25A ×2 | 0.93 22 |
| 2131-0 0-5 | 0 | | 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 B | 7 8 | 12·1 > 9·5 × 10·2 | 0-12V at 8A × 2 | 4.99 52 |
| 115 20 10 | 11 13 | $12 \cdot 1 \times 11 \cdot 4 \times 10 \cdot 2$ | 0-12V at 10A × 2 | 6-35 67 |
| 187 30 15 | 16 12 | $-13.3 \times 12.1 \times 12.1$ | 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 * |
| | | 3/ | VOLT BANGE | |

| Ref. | Amps. | We | ight | Si | ze cm. | | Secondari | y Taps | . P | & P |
|------|-------|----|------|--------|--------|-----|-----------|-----------|------|-----|
| No. | | IЬ | oz | | | | | | € | Þ |
| 112 | 0.5 | | 4 | 8-3 × | 3.7 × | 4.9 | 0-12-15-2 | 10-24-30V | 4-11 | 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 × | | | | ** | 2.72 | 42 |
| 21 | 4.0 | 6 | ŏ | 10.2 × | | | | ** | | 52 |
| 51 | 5.0 | 6 | ě. | 12·1 × | | | ** | | 4.02 | 52 |
| HĨŻ | 6.0 | 7 | ě | 12-1 × | | | | | 4.80 | 52 |
| 88 | 8.0 | 10 | ŏ | 14.0 × | | | | | 6.20 | 67 |
| 89 | 10.0 | 12 | ž | 14.0 × | | | | | 7.85 | 67 |
| • | | | - | | | | | - " | | Ψ, |
| | | | | | | 50 | VOLT | RANGE | | |

| Ref. | Amps. Weight | | | Weight Size cm. | | | Secondo | Ρ. | & P | | |
|------|--------------|-----|----|-----------------|----------|------|-----------|----------|-------|----|--|
| No. | | 16 | oz | | | | | | €. | Þ | |
| 102 | 0.5 | - 1 | 11 | 7-0 × | 7.0 × | 5.7 | 0-19-25-3 | 3-40-50V | 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 | ō | 10.2 × | 10-2 × | 8.3 | | | 4.01 | 52 | |
| 106 | 4-0 | ġ | 4 | | 11:4 × I | | | | 5-31 | 52 | |
| 107 | 6-0 | 12 | 4 | 12·1 × | Hilx | 13-3 | | | 7.85 | 67 | |
| 118 | 8.0 | 18 | 9 | | 13-3 × | | | | 10-25 | | |
| 119 | 10.0 | 19 | 12 | | 11-4 × I | | | ** | 12-85 | | |
| | | | | | | | | 2.2 | | | |

60 VOLT RANGE

| Ref. | Amps. | | eight | Si | Size cm. | | Secondary Taps | | P & | | |
|------|-------|----|-------|--------|----------|------|----------------|-----------|-------|----|--|
| No. | | 16 | OZ | | | | | | £ | D | |
| 124 | 0.5 | 2 | 4 | 8·3 × | 9-5 × | 6.7 | 0-24-30-4 | 10-48-60V | 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 x | 8.6 | | | 3.23 | 42 | |
| 125 | 3.0 | 8 | 8 | 11.9 x | 9.5 x | 10.0 | | | 4.92 | 52 | |
| 123 | 4.0 | 10 | 6 | 11-4 x | 9.5 x | 11:4 | | | | 67 | |
| 120 | 6-0 | 16 | 12 | 13-3 × | 12·1 × | 12-1 | | | 9.20 | 82 | |
| 122 | 10.0 | 23 | 2 | 16.5 × | | | | | 15-23 | | |
| | | | - | | , | | *1 | 1.1 | | | |

| | LE | AD A | ACID BA | TTER | Y CH | IARGI | ER TYPE | s | |
|------|--------|--------|-----------|--------|--------|----------|------------|----------|------|
| Ref. | Amps. | Weig | ht S | ze cm. | | | | P | & P |
| No. | | Ib oz | | | | | | € | P |
| 45 | 1.5 | 1 9 | | 6-0 × | | | | 1 - 47 | 30 |
| 5 | 4.0 | 3 11 | | 7·0 × | | Please | note, thes | e 2.23 | 42 |
| 86 | 6.0 | 5 12 | 10-2 × | 0.9 × | 8.3 | units | do not in | - 3.37 | 52 |
| 146 | 8.0 | 6 4 | | | | clude | rectifiers | 3.84 | 52 |
| 50 | 12.5 | 410-14 | I 13⋅3 × | 10-8 × | 12-1 | | | 5.72 | 67 |
| | | | | | | | on: open v | rith sol | lder |
| tags | and wa | x imp | regnation | Encl | osed s | tyles to | order. | | |

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| AF116 25p E | BEY50 15n LIC709C/8 | A APRIOCETIM | 42p 2N1302 | 17p 7450 | 20 p | Analieaus, Ciear enca | ,551ation, 5% Tole | wile, 100 VOIL | Price |
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| BB105 32p B BC107 10p B | BZY88C3V3 13p MFC9020 BZY88C3V6 13p MJE371 | £2:12 (IC Amp.) | £1 50 2N2369 75p 2N2369 A | 17p 7493 17p 7494 | 75p £1:13 | Pack No. Thread | Length | Quantity P | ack Price |
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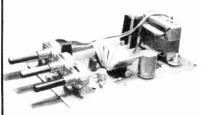
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