PRACTICAL

ELECTRONICS

APRIL 1975

30p

...FULL EXPOSURE!!

with the

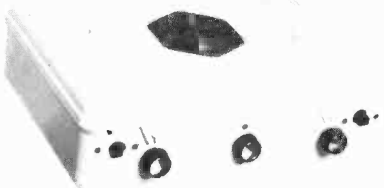
PE COMPENSATED PHOTO TIMER

other projects include:

- MUSICAL DOORBELL
- ESP DETECTOR

Part ONE of a NEW SERIES

TRANSDUCERS



NEW EDU-KIT MAJOR

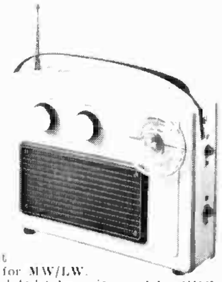
COMPLETELY SOLDERLESS ELECTRONIC CONSTRUCTION KIT
BUILD THESE PROJECTS WITHOUT SOLDERING IRON OR SOLDER

- 4 Transistor Earpiece Radio
- Signal Tracer
- Signal Injector
- Transistor Tester NPN —PNP
- 4 Transistor Push Pull Amplifier
- 5 Transistor Push Pull Amplifier
- 7 Transistor Loudspeaker Radio MW/LW.
- 5 Transistor Short Wave Radio
- Electronic Metronome
- Electronic Noise Generator
- Batteryless Crystal Radio.
- One Transistor Radio
- 2 Transistor Regenerative Radio
- 3 Transistor Regenerative Radio
- Audible Continuity Tester
- Sensitive Pre-Amplifier

Components include:
- 24 Resistors ● 21 Capacitors ● 10 Transistors ● 3½" Loudspeaker ● Earpiece ● Mica Baseboard ● 3 12-way Connectors ● 2 Volume Controls ● 2 Slider Switches ● 1 Tuning Condenser ● 3 Knobs ● Ready Wound MW/LW/SW Coils ● Ferrite Rod ● 6½ yards of wire ● 1 yard of sleeving, etc.
- Parts price list and plans 55p (free with parts)

TOTAL BUILDING COSTS
£7·23 (+8% VAT 57p) P.P. & Ins. 44p (Overseas Seamail P. & P. £2·35)

NEW ROAMER NINE

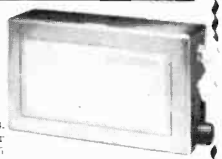


WITH V.H.F. INCLUDING AIRCRAFT

Nine Transistors. 9 Tunable wavebands as Roamer Ten. Built in ferrite rod aerial for MW/LW. Retractable chrome plated telescopic aerial for VHF and SW. Push Pull output using 600 mW transistors. 9 Transistors and 3 diodes, tuning condenser with VHF section, separate coil for aircraft, moving coil loudspeaker, volume ON/OFF and wavechange controls. Attractive all white case with red grille and carrying strap. Size 9½in × 7in × 2¼in approx. Parts price list and plans free with parts.

TOTAL BUILDING COSTS £6·95 (+8% VAT 55p) P.P. & Ins. 44p (Overseas Seamail P. & P. £2·35)

POCKET FIVE

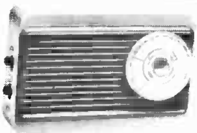


NOW WITH 3" LOUDSPEAKER

3 Tunable wavebands. MW/LW and Trawler Band. 7 stages. 5 transistors and 2 diodes, supersensitive ferrite rod aerial, attractive Black and Gold Case. Size 5½in × 1¼in × 3½in approx. Plans and parts price list free with parts.

Total Building Costs £2·50 (+8% VAT 20p) P.P. & Ins. 36p (Overseas Seamail P. & P. £1·70)

TRANSONA FIVE NOW WITH 3" LOUDSPEAKER



Wavebands, transistors and speaker as Pocket Five. Larger Case with Red Speaker Grille and Tuning Dial. Plans and parts price list free with parts.

Total Building Costs £2·75 P.P. & Ins. 36p (+8% VAT 21p) (Overseas Seamail P.&P. £1·70)

NEW EVERYDAY SERIES

Build this exciting New series of designs

EV5 5 Transistors and 2 diodes. MW/LW. Powered by 4½ volt Battery. Ferrite rod aerial, tuning condenser, volume control, and now with 3" loudspeaker. Attractive case with red speaker grille. Size 9in × 5½in × 2½in approx. Parts price list and plans free with parts.

TOTAL BUILDING COSTS £2·95 (+8% VAT 23p) P.P. & Ins. 36p (Overseas Seamail P. & P. £1·70)

EV6 Case and looks as above. 6 Transistors and 3 diodes. Powered by 9 volt Battery. Ferrite rod aerial, 3" loudspeaker, etc., MW/LW coverage. Push Pull Output. Parts price list and plans free with parts.

TOTAL BUILDING COSTS £3·60 (+8% VAT 29p) P.P. & Ins. 36p (Overseas Seamail P. & P. £1·70)

EV7 Case and looks as above. 7 transistors and 3 diodes. Six wavebands. MW/LW, Trawler Band, SW1, SW2, SW3. powered by 9 volt Battery Push Pull Output. Telescopic Aerial for Short Waves. 3" Loudspeaker. Parts price list and easy build plans free with parts.

TOTAL BUILDING COSTS £4·08 (+8% VAT 32p) P.P. & Ins. 38p (Overseas Seamail P. & P. £2·00)

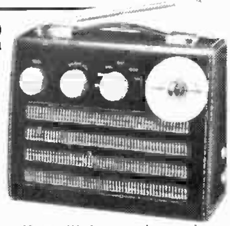
ROAMER EIGHT Mk. I

NOW WITH VARIABLE TONE CONTROL

7 TUNABLE WAVEBANDS: MW1, MW2, LW, SW1, SW2, SW3 AND TRAWLER BAND. Built-in ferrite rod aerial for MW and LW. Chrome plated telescopic aerial can be angled and rotated for peak short-wave listening. Push-pull output using 600mW transistors. Car aerial and tape record sockets. Selectivity switch. 8 transistors plus 3 diodes. Latest 4" 2 watt Ferrite Magnet loudspeaker. Air spaced ganged tuning condenser. Volume/on/off, tuning, wave change and tone controls. Attractive case in rich chestnut shade with gold blocking. Size 9in × 7in × 4in approx. Easy to follow instructions and diagrams. Parts price list and plans free with parts.

TOTAL BUILDING COSTS £6·98 (+8% VAT 56p) P.P. & Ins. 47p (Overseas Seamail P. & P. £2·50)

ROAMER TEN Mk. II



WITH VHF INCLUDING AIRCRAFT

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

Now with free earpiece and switched socket.

Latest 4" 2 watt Ferrite Magnet Loudspeaker. Built-in ferrite rod aerial for MW/LW. Chrome plated 6 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. 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 plans 50p (FREE with parts).

TOTAL BUILDING COSTS £9·50 (+8% VAT 76p) P.P. & Ins. 52p (Overseas Seamail P. & P. £2·50)

EDU-KIT

Build Radios Amplifiers, etc., from easy stage, diagrams.

Five units including master unit to construct.

Components include: Tuning Condenser: 2 Volume Controls: 2 Slider Switches: Fine tone 3" moving coil Speaker: Terminal Strip: Ferrite Rod Aerial: Battery Clips: 4 Tag Boards: 10 Transistors: 4 Diodes: Resistors: Capacitors: Three ¼in Knobs. Units once constructed are detachable from Master Unit, enabling them to be stored for future use. Ideal for Schools, Educational Authorities and all those interested in radio construction. Parts price list and plans free with parts.

TOTAL BUILDING COSTS £5·50 (+8% VAT 44p) P.P. & Ins. 40p (Overseas Seamail P. & P. £2·35)

TRANS EIGHT 8 TRANSISTORS AND 3 DIODES

6 TUNABLE WAVEBANDS, MW, LW, SW1, SW2, SW3 AND TRAWLER BAND. Sensitive ferrite rod aerial for MW and LW. Telescopic aerial for short waves. 3in speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9in × 5½in × 2¼in approx. Push-pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and plans free with parts.

TOTAL BUILDING COSTS £4·48 (+8% VAT 36p) P.P. & Ins. 40p (Overseas Seamail P. & P. £2)

ROAMER SIX

CASE AND LOOKS AS TRANS EIGHT 6 TUNABLE WAVEBANDS: MW, LW, SW1, 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, etc. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9in × 5¼in × 2¼in approx. Plans and parts price list free with parts.

TOTAL BUILDING COSTS £3·98 (+8% VAT 32p) P.P. & In. 40p (Overseas Seamail P. & P. £2·00)

RADIO EXCHANGE LTD

*Callers side entrance "Lavells" shop
*Open 10-1, 2.30-4.30, Mon.-Fri. 9-12 Sat.

To RADIO EXCHANGE CO., 61a HIGH STREET, BEDFORD MK40 1SA
Tel. 0234 52367 Reg. No. 788372

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Name ______

Address ______

PE4

PRACTICAL
ELECTRONICS

VOLUME 11 No. 4 APRIL 1975

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

Our May issue will be published on Friday, April 11, 1975

Europe's Largest Hi-Fi Retailers
LASKYS
give you the greatest choice
TMK 200 MULTIMETER KIT
Build yourself a quality 20000 opv. multimeter and save money. Complete kit with meter scale, movement and rotary range selector ready mounted in cabinet. All parts, batteries, test prods and instructions. Ranges: 0/0.6/6/30/120/600/1200V D.C. 0/6/30/120 600/1200V A.C. Current: 0/0.6/6/60/600mA. Resistance: 0/10/100K/1/10 Meg ohms. Decibels: –20 to +63db. Size: 90 x 150 x 35mm
OUR PRICE £7.95 P&P 30p.
AUDIOTRONIC Model ATM1
Top value 1,000 opv pocket multimeter. Ranges: – 0/10/50/250/1,000 volt AC and DC. DC current 0-1mA/100mA. Resistence: 0/150k ohms. Decibels: –10 to +22dB. Size 90 x 60 x 28mm. Complete with test leads.
OUR PRICE £3.25 P&P 15p
MODEL C1092
Jewel movement, attractively moulded case with edgwise ohms adjustment. Ranges: 0-3/15/150/300/1200V AC, (2500 opv). 0-6/30/300/600V DC, (5000 opv). 0-300 uA/0-300mA DC. Resistance: x 10 & x 100. –10 to +16dB. Supplied with battery test leads and data booklet. Size: 121 x 73 x 29mm.
OUR PRICE £3.95 P & P 20p
HIOKI 720X VOM
A versatile, accurate measuring instrument. 20,000 opv. 0/5/25/100/500/1000V DC. 0/10, 50/250/1000V AC. 0–50uA/250mA. 0–20k/2 Megohms.
OUR PRICE £5.97
P&P 30p
MODEL C7202EN
20,000 o.p.v. DC
10,000 o.p.v. AC
Mirror Scale.
5/25/50/250/500/1000/2500 V. DC
10/50/100/500/1000 V. AC. DC Resistance x 10, x 1000 (30Ω centre scale) DC Current 50uA/2.5mA/250mA. –20 to +68 dB
OUR PRICE £6.95 P & P 30p
MODEL PL436
20,000 opv DC.
8000 opv AC.
Mirror scale
6/3/12/30/120/600V DC. 3/30/120/600V DC. 50/600μA/60/600mA.
10/100K/1 Meg/10 Meg Ohm. –20 to 46 dB.
OUR PRICE £6.97 P&P 30p
HIOKI 730X
30,000 opv. Overload protection. 6/30/60/300/600/1200V DC. 12/60/120/600/1200V AC. 60/μA/30mA/300mA. 2K/200K/2 Meg Ohm. –10 to 63dB.
OUR PRICE £7.50
P&P 30p.
U4323 MULTIMETER
20,000opv. Simple unit with audio/IF oscillator. Suitable for general receiver tuning. Ranges: 0.5/2.5/10/50/250/500/1000V DC. 2.5/10/15/250/500/1000V AC. 0.05/0.5/5/50/500mA DC. Resistance: x 10, x 100, x 1,000, x 10,000 (50Ω. 500Ω, 5kΩ, 50kΩ centre scale) Battery operated. Size: 160 x 97 x 40mm. Supplied in carrying case complete with test leads.
OUR PRICE £8.00 P&P 30p
U435 MULTIMETER
20,000opv. Ranges:
75mV/2.5/10/25/100/250/500/1000V DC. 2.5/10/25/100/250/500/1000V AC. Current: 50uA/1/5/25/100mA/0.5/2.5A DC. 5/25/100mA/0.5/2.5A AC. Resistance: 0.3/3/30/300k ohms. Size: 205 x 110 x 84mm. Supplied complete with leads, crocodile clips and steel carrying case.
OUR PRICE £8.75 P&P 30p
MODEL C7208FM
30,000 opv DC.
15,000 opv AC.
6/3/15/60/300/600/1200 V. DC. 6/30/120/600/1200 V. AC. DC Resistance x 1, x 10, x 100, x 1000 (50Ω centre scale) DC Current 30uA/3/30/600mA. –20 to +63dB.
OUR PRICE £8.95 P & P 30p
U4324 MULTIMETER
High sensitivity, overload protected. 20,000opv. Ranges: 0.6/1.2/3/12/30/60/120/600/1200V DC. 3/6/15/60/150/300/600/900V AC. Current: 0.06/0.6/6/60/600mA/3A DC. 0.3/3/30/300mA/3A AC. Resistence: 25/500 ohms/0.5/5/50/500k ohms/5 Mohms. Decibels: –10 to +12dB. Size 167 x 98 x 63mm. Supplied complete with test leads, spare diode and instructions.
OUR PRICE £9.85 P&P 30p
U91 Clamp VOLT AMMETER
For measuring AC voltage and current without breaking circuit. Ranges: 300/600V AC. Current: 10/25/100/250/500A. Accuracy 4%. Size 283 x 94 x 36mm. Complete with carrying case, leads and fuses.
OUR PRICE £14.00 P&P 30p
U4312 MULTIMETER
extremely sturdy instrument for general electrical use. 667opv. 0/0.3/1.5/7.5/30/60/150/300/600/900V DC & 75mV. 0/0.3/1.5/7.5/30/60/150/300/600/900V AC. 0/300uA/1.5/6/15/150/60/600mA/1/1.5/6A DC. 0/1.5/6/15/60/150/600mA/1.5/6A AC. 0/200/3k/30k ohms. DC accuracy 1%. AC 1.5%. Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions.
OUR PRICE £10.75 P&P 50p
HIOKI 750X VOLT-OHM-MILLIAMETER
43 ranges: 0–0.3/0.6/1.5/3/6/12/30/60/150/300/600/1,200V DC. 0–3/6/15/30/60/120/300/600/1,200V AC. Current: 0–30/60uA/1.5/3/15/30/150/300 mA/6/12A. Resistence: 0–3/300k/3/30Mohms. Decibels: –10 to +17dB. Output: – 0–3/6/15/30/60/120/300V. Accuracy ± 3% DC, ± 4% AC. Sensitivity: 50,000 opv DC, 5,000 opv AC. 4 inch meter. Built in protection. Size: 57 x 102 x 153mm.
OUR PRICE £11.95 P&P 40p
TMK MODEL TW50K
46 ranges, mirror scale. 50k/V DC 50k/V AC.
DC Volts: 0.125/0.25/1.25/2.5/5/10/25/50/125/250/500/1000. AC Volts 1.5/3/5/10/25/50/125/250/500/1000. DC current 25/50uA/2.5/5/25/50/250/500mA/5/10A. Resistence: 10k/100k/1 Meg/10 Meg ohms. –20 to +81.5dB.
OUR PRICE £12.50 P&P 20p
MODEL C7080EN
Giant 6" mirror scale. 20,000 opv. 0/0.25/1/2.5/10/50/250/1000/5000V DC. 0/2.5/10/50/250/1000/5000V AC. 0/50uA/1/10/100/500mA/10A DC. 0/2k/200k/20 Meg. –20 to +50dB.
OUR PRICE £19.95 P&P 35p
MODEL 500
30,000 opv with overload protection. Mirror scale. 0/0.5/2.5/10/25/100/250/500/1000V DC. 0/2.5/10/25/100/250/500/1000V AC. 0/50uA/5/50/500mA. 12A DC. 0/60k/6 meg/60 megohms.
OUR PRICE £13.95 Carr. paid
HIOKI MODEL 700X
100,000opv. Overload protection. Mirror scale. 0.3/0.6/1.2/1.5/3/6/12/30/60/120/300/600/1200V DC. 1.5/3/6/12/30/60/150/300/600/1200V AC. 15/30uA/3/6/30/60/150/500mA/6/12A DC. 2k/200k/2M/20MOhms. –20 to +63dB.
OUR PRICE £14.95 P&P 30p
MODEL AS.100D VOM
100,000 opv. Mirror scale. Built-in meter protection. 0/3/12/60/120/300/600/1200V DC. 0/6/30/120/300/600V AC. 0/10μA/6/60/300mA/12 Amp. 0/2K/200K/2M/200 Meg Ohm. –20 to 17dB.
OUR PRICE £17.50 P&P 30p.
KAMODEN HM720B FET VDM
Input impedence 10 Megohms. Ranges: – 0/.25/1/2.5/10/50/1000V DC. 0/2.5/10 50/250/1000V AC. 0/25uA/2.5/25/250 mA DC. 0/5k/50k/500k/5 M 500 Megohms
OUR PRICE £21.00 P & P 40p
KAMODEN 360 MULTIMETER
High sensitivity. DC 100kohm/V AC 10kohm/V 5" mirror scale, overload protected. Ranges: 0.5/2.5/10/50/250/1000V DC. 5/10/50/250/1000V AC. Current: 0.01mA/0.5/5/50/500mA/10A. Resistance: 0.1/1/10/100 ohms/1/10/100k ohms/10/100M ohms. Decibels –20 to +62dB. Battery operated. Size: 180 x 140 x 80mm. Supplied complete with, test leads etc.
OUR PRICE £17.50 P & P 40p
Model HT100B4 MULTIMETER
Overload protected, shock proof circuits. 9.5uA Meter with mirror scale. Sensitivity 100kV. Polarity change switch. Ranges: 0.5/2.5/1-/50/250/500/1,000 Volts DC. 2.5/10/50/250/1,000 Volts AC. DC resistance 0–20/200k/2/20 Meg. ohms. DC current: – 10/250uA/2.5/25/250 mA/10A. AC current: –0–10A. –20 to +62dB. Operates from 2 x 1.5V batteries. Size: 180 x 134 x 79mm.
OUR PRICE £17.50 P&P 40p
370WTR MULTIMETER
Features AC current ranges. 20,000opv. 0/0.5/2.5/10/50/250/500/1000V DC. 0/2.5/10/50/250/500/1000V AC. 0/50uA/1/10/100 mA/1/10A DC. 0/100mA/1/10A AC. 0/5k/50k/500k/5 Meg/50 Meg. Decibels: –20 to +62dB.
OUR PRICE £19.95 P&P 30p
U4317 MULTIMETER
High sensitivity instrument for field and laboratory work. Knife edge pointer, 86mm. mirror scale. Overload protection Ranges: 100mV/0.5/2.5/10/25/50/100/250/500/1000 V DC. 0.5/2.5/10/25/50/100/250/500/1000V AC. Current: 50uA/0.5/1/5/10/50/250mA/1/5A DC. 0.25/0.5/1/5/10/50/250mA/1/5A AC. Resistance: 0.5/10/100/200 ohms/1/3/30/300k ohms. Decibels: –5 to +10dB Battery operated. Size: 210 x 115 x 90mm. Supplied in carrying case complete with leads.
OUR PRICE £17.00 P&P 40p
KAMODEN 72.200 Multitester
High sensitivity tester. 200,000 opv Overload protected. Mirror scale. Ranges: –0/.06/.3/3/30/120/600/1200V DC. 0/3/12/60/300/11200 V AC. 0/6uA/1.2mA/120mA/600mA/12A DC 0/12A AC. –20 to +63dB. 0/2k/200k/2 Meg/200 Megohms.
OUR PRICE £22.50 P&P 30p
MODEL AF.105 VOM
50,000 opv. Mirror scale. Meter protection. 0/3/3/12/60/120/300/600/1200V DC. 0/6/30/120/300/600/1200V AC. 0/30μA/6/60/300 mA. 12 Amp. 0/10K/1m/10m/100 Meg Ohms. –20 to 17dB.
OUR PRICE £12.50 P&P 30p.
TMK MODEL 117 FET ELECTRONIC VOLTMETER
Battery operated. 11 Meg Input, 26 ranges. Large 4¼" mirror scale. Size: 149 x 117 x 60mm. 0.3–12000V DC. 3–300V RMS AC. 8–800V P-P. DC current 0.12–12mA. Resistence up to 2000MOhms. Decibels: –20 to +51dB. Supplied complete with leads and instructions.
OUR PRICE £18.50 P&P 20p
TMK 100K LAB TESTER
100,000opv. 6½" scale. Buzzer short circuit check. Sensitivity 100,000 opv DC. 5k/V AC DC Volts: 0.5/2.5/10/50/250/1000V AC. 3/10/50/250/500/1000V DC. current 10/100uA/10/100/2.5/10A. Resistence: 1k/10k/100k/10 Meg/100 Meg ohms. Decibels: –10 to +49dB. Plastic case with carrying handle. Size: 190 x 172 x 99mm.
OUR PRICE £19.95 P&P 30p
LB4 TRANSISTOR TESTER
Tests PNP or NPN transistors. Audio indication. Operates on two 1.5V batteries. Complete with instructions etc.
OUR PRICE £4.50 P&P 20p
KAMODEN TT35 TRANSISTOR TESTER
High quality instrument to test reverse leak current and DC current. Amplification factor of NPN, PNP, diodes, transistors, SCR's etc. 4" square clear scale meter. Operates from internal batteries. Complete with instructions, leads carrying handle.
OUR PRICE £17.50 P & P 40p
U4341 Multimeter & Transistor Tester
27 ranges. 16,700opv. Overload protected. Ranges: 0.3/1.5/6/30/60/150/300/900V DC. 1.5/7.5/30/150/300/750V AC. Current: 0.06/0.6/6/60/600mA DC. 0.3/3/30/300mA AC. Resistance: 0.06/0.6/2/6/20/60/200k ohms/2 Mohms. Battery operated. Supplied complete with probes, leads and steel carrying case. Size: 115 x 215 x 90mm.
OUR PRICE £11.00 P&P 30p
S100TR MULTIMETER TRANSISTOR TESTER
100,000opv. Mirror scale. Overload protection. 0/0.12/0.6/3/12/30/120/600V DC. 0/6/30/120/600V AC. 0/12/600uA/12/300mA/6/12A DC 0/10k/1 Meg/100 Meg. –20 to +50dB. 0.01–0.2 MFD. Transistor tester measures Alpha, Beta and ICO. Complete with instructions, batteries and leads.
OUR PRICE £19.95 P&P 25p
SWR METER Model SWR3
Handy SWR meter for transmitter antenna alignment, with built-in field strength meter. Accuracy 5%, Impedence 52' Indicator 100uA DC. Full scale 5 section collapsible antenna. Size 145 x 50 x 60mm.
OUR PRICE £4.25 P&P 30p
C15 PULSE OSCILLOSCOPE
For display of pulsed and periodic waveforms in electronic circuits. VERT. AMP. Bandwidth: 10MHz. Sensitivity at 100kHz VRMS/mm: 0.1–25; HOR. AMP. Bandwidth: 500kHz. Sensitivity ay 100kHz VRMS/mm: 0.3–25 Preset triggered sweep 1–3000usec. Free running 20–200 kHz in nine ranges. Calibrator pips. 220 x 360 x 430mm. 115–230V AC.
OUR PRICE £44.00 Carr. paid
ALL PRICES EXCLUDE VAT
Also see following pages

SEW PANEL METERS

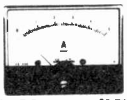
SEW PANEL METERS ARE STOCKED AT OUR 3 LISLE ST., 311 EDGWARE RD., & 152 FLEET ST., BRANCHES or order by post.

USED EXTENSIVELY BY INDUSTRY, GOVERNMENT DEPARTMENTS, EDUCATIONAL AUTHORITIES ETC.

Over 200 ranges in stock—other ranges to order. Quantity discounts available. Send for fully illustrated brochure.

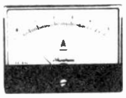
*Items with asterisk are Moving Iron type, all others are Moving Coil

CLEAR PLASTIC MODEL SD640
Size: 85 x 64mm



50uA	£3.90	10V DC	£3.75
100uA	£3.85	20V DC	£3.75
200uA	£3.80	50V DC	£3.75
500uA	£3.75	300V DC	£3.75
50-0-50uA	£3.85	15V AC	£3.85
100-0-100uA	£3.80	300V AC	£3.85
1mA	£3.75	VU Meter	£4.00
5mA	£3.75		
10mA	£3.75		
50mA	£3.75		
100mA	£3.75		
500mA	£3.75		
1A DC	£3.75		
5A DC	£3.75		
10A DC	£3.75		
5V DC	£3.75		

CLEAR PLASTIC MODEL SW100
Size: 100 x 80mm



50uA	£4.70	150V AC	£4.55
100uA	£4.60	300V AC	£4.65
500uA	£4.40	VU Meter	£5.00
50-0-50uA	£4.80		
100-0-100uA	£4.55		
1mA	£4.40		
1A DC	£4.40		
5A DC	£4.40		
20V DC	£4.40		
50V DC	£4.40		
300V DC	£4.40		

EDGWISE MODEL PE70
Size: 90 x 34mm

50uA	£4.25
100uA	£4.20
200uA	£4.15
500uA	£4.00
50-0-50uA	£4.20
100-0-100uA	£4.15
1mA	£3.95
300V AC	£4.05
VU Meter	£4.40

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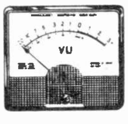
Size: 100 x 90 x 150mm including terminals

A range of high quality moving coil instruments ideal for school experiments and other bench applications. 3" mirror scale. The meter movement is easily accessible to demonstrate internal working.

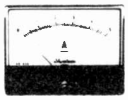
50uA	£8.70	20V DC	£7.80
100uA	£8.10	50V DC	£7.80
50-0-50uA	£8.10	300V DC	£7.80
1mA	£7.80	500mA/5A DC	£8.80
1-0-1mA	£7.80	5V/50V DC	£8.80
1A DC	£7.80	5V/15V DC	£8.80
5A DC	£7.80	1/5A DC	£8.80
5V DC	£7.80		
10V DC	£7.80		
15V DC	£7.80		

CLEAR PLASTIC MODEL MR 85P
Size: 120 x 110mm



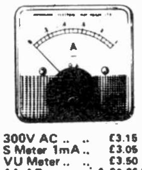
50uA	£5.60	300V DC	£5.40
100uA	£5.55	15V AC	£5.45
200uA	£5.50	300V AC	£5.45
500uA	£5.40	S Meter 1mA	£5.35
50-0-50uA	£5.55	VU Meter	£5.70
100-0-100uA	£5.50	1A AC	* £5.35 *
500-0-500uA	£5.35	5A AC	* £5.35 *
1mA	£5.35	10A AC	* £5.35 *
1-0-1mA	£5.35	20A AC	* £5.35 *
5mA	£5.35	30A AC	* £5.35 *
10mA	£5.35		
50mA	£5.35		
100mA	£5.35		
500mA	£5.35		
1A DC	£5.35		
5A DC	£5.35		
15A DC	£5.35		
30A DC	£5.55		
10V DC	£5.35		
20V DC	£5.35		
50V DC	£5.35		
150V DC	£5.35		

CLEAR PLASTIC MODEL SD830
Size: 110 x 83mm



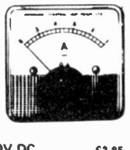
50uA	£4.40	10V DC	£4.20
100uA	£4.35	20V DC	£4.20
200uA	£4.30	50V DC	£4.20
500uA	£4.25	300V DC	£4.20
50-0-50uA	£4.35	15V AC	£4.30
100-0-100uA	£4.30	300V AC	£4.30
1mA	£4.20	VU Meter	£4.50
5mA	£4.20		
10mA	£4.20		
50mA	£4.20		
100mA	£4.20		
500mA	£4.20		
1A DC	£4.20		
5A DC	£4.20		
10A DC	£4.20		
5V DC	£4.20		

CLEAR PLASTIC MODEL MR 45P
Size: 50 x 50mm



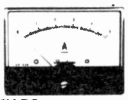
50uA	£3.30	300V AC	£3.15
100uA	£3.25	S Meter 1mA	£3.05
200uA	£3.20	VU Meter	£3.50
500uA	£3.10	1A AC	* £3.05 *
50-0-50uA	£3.25	5A AC	* £3.05 *
100-0-100uA	£3.20	10A AC	* £3.05 *
500-0-500uA	£3.05	20A AC	* £3.05 *
1mA	£3.05	30A AC	* £3.05 *
5mA	£3.05		
10mA	£3.05		
50mA	£3.05		
100mA	£3.05		
500mA	£3.05		
1A DC	£3.05		
5A DC	£3.05		
10V DC	£3.05		
20V DC	£3.05		
50V DC	£3.05		
300V DC	£3.05		
15V AC	£3.15		

CLEAR PLASTIC MODEL MR 38P
Size: 42 x 42mm



50uA	£3.20	20V DC	£2.85
100uA	£3.15	50V DC	£2.85
200uA	£3.10	100V DC	£2.85
500uA	£2.90	150V DC	£2.90
50-0-50uA	£3.15	300V DC	£2.90
100-0-100uA	£3.10	500V DC	£2.95
500-0-500uA	£2.85	750V DC	£2.95
1mA	£2.85	15V AC	£2.95
1-0-1mA	£2.85	50V AC	£2.95
2mA	£2.85	150V AC	£2.95
5mA	£2.85	300V AC	£2.95
10mA	£2.85	500V AC	£3.10
20mA	£2.85	S Meter 1mA	£2.85
50mA	£2.85	VU Meter	£3.30
100mA	£2.85		
150mA	£2.85		
200mA	£2.85		
300mA	£2.85		
500mA	£2.85		
750mA	£2.85		
1A DC	£2.85		
2A DC	£2.85		
5A DC	£2.85		
10A DC	£2.85		
3V DC	£2.85		
10V DC	£2.85		
15V DC	£2.85		

CLEAR PLASTIC MODEL SD460
Size: 59 x 46mm



50uA	£3.60	10V DC	£3.40
100uA	£3.55	20V DC	£3.40
200uA	£3.50	50V DC	£3.40
500uA	£3.45	300V DC	£3.40
50-0-50uA	£3.55	15V AC	£3.55
100-0-100uA	£3.50	300V AC	£3.55
1mA	£3.40	VU Meter	£3.75
5mA	£3.40		
10mA	£3.40		
50mA	£3.40		
100mA	£3.40		
500mA	£3.40		
1A DC	£3.40		
5A DC	£3.40		
10A DC	£3.40		
5V DC	£3.40		

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CLEAR PLASTIC MODEL MR 65P
Size: 86 x 78mm

50uA	£4.05	300V DC	£3.80
100uA	£3.95	15V AC	£3.90
200uA	£3.90	50V AC	£3.90
500uA	£3.85	150V AC	£3.90
50-0-50uA	£3.95	300V AC	£3.90
100-0-100uA	£3.90	500V AC	£4.00
500-0-500uA	£3.80	S Meter 1mA	£3.90
1mA	£3.80	VU Meter	£4.20
1-0-1mA	£3.80	1A AC	* £3.80 *
5mA	£3.80	5A AC	* £3.80 *
10mA	£3.80	10A AC	* £3.80 *
50mA	£3.80	20A AC	* £3.80 *
100mA	£3.80	30A AC	* £3.80 *
500mA	£3.80	50mA AC	* £3.80 *
1A DC	£3.80	100mA AC	* £3.60 *
5A DC	£3.80	200mA AC	* £3.80 *
10A DC	£3.80	500mA AC	* £3.80 *
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30A DC	£3.95		
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10V DC	£3.80		
15V DC	£3.80		
20V DC	£3.80		
50V DC	£3.80		
150V DC	£3.80		

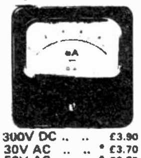
BAKELITE MODEL S80 Enlarged Window
Size: 80 x 80mm

50uA	£4.60
100uA	£4.55
500uA	£4.30
50-0-50uA	£4.55
100-0-100uA	£4.50
1mA	£4.30
1A DC	£4.30
5A DC	£4.30
20V DC	£4.30
50V DC	£4.30
300V DC	£4.30
300V AC	£4.40
VU Meter	£4.80

CLEAR PLASTIC MODEL MR 52P
Size: 60 x 60mm

50uA	£3.80	S Meter 1mA	£3.40
100uA	£3.60	VU Meter	£3.90
500uA	£3.45	1A AC	* £3.40 *
50-0-50uA	£3.60	5A AC	* £3.40 *
100-0-100uA	£3.45	10A AC	* £3.40 *
1mA	£3.40	20A AC	* £3.40 *
5mA	£3.40	30A AC	* £3.40 *
10mA	£3.40		
50mA	£3.40		
100mA	£3.40		
500mA	£3.40		
1A DC	£3.40		
5A DC	£3.40		
10V DC	£3.40		
20V DC	£3.40		
50V DC	£3.40		
300V DC	£3.40		
15V AC	£3.60		
300V AC	£3.50		

BAKELITE MODEL MR 65 Size: 80 x 80mm



25uA	£5.40	300V DC	£3.90
50uA	£4.10	30V AC	* £3.70 *
100uA	£4.05	50V AC	* £3.70 *
500uA	£3.75	150V AC	* £3.70 *
50-0-50uA	£4.05	300V AC	* £3.70 *
100-0-100uA	£4.00	500V AC	* £3.70 *
500-0-500uA	£3.70	VU Meter	£4.20
1mA	£3.70	1A AC	* £3.70 *
1-0-1mA	£3.70	5A AC	* £3.70 *
5mA	£3.70	10A AC	* £3.70 *
10mA	£3.70	20A AC	* £3.70 *
50mA	£3.70	30A AC	* £3.70 *
100mA	£3.70	50A AC	* £3.70 *
500mA	£3.70	500mA AC	* £3.70
1A DC	£3.70	50mV DC	£3.85
2A DC	£3.70	100mV DC	£3.85
5A DC	£3.70		
10A DC	£3.70		
15A DC	£3.70		
30A DC	£3.70		
50A DC	£3.90		
5V DC	£3.70		
10V DC	£3.70		
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20V DC	£3.70		
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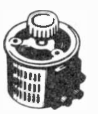

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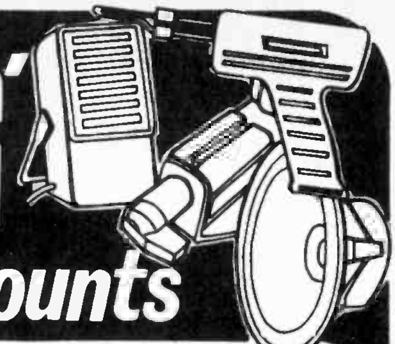

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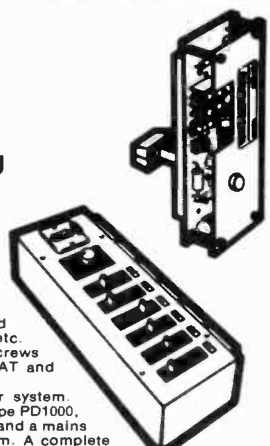

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Illustrated is the DD61 dimmer system. Contains: six 1 kW slider dimmers type PD1000, six outlet sockets, a master control and a mains on/off switch. Size 59 × 22 × 12cm. A complete system in one unit for stage or disco lighting, etc. Also available DD261 dimmer system, as above, but with 2-preset arrangement. Future systems available with 2 kW dimmers. Specials made. DD61 £97·20 inc. VAT and P. & P. DD261 £117·72 inc. VAT and P. & P.

The Dimmit range includes standard wall mounting models for home and office, etc. Professional modules for industrial heating applications, etc. Rotary and slider control versions. Ratings: 1000W; 2000W; 3000W; 110V and 240V.

Model SL800 sound to light converter. Modulates the light in time with sound. Built-in microphone. No connections to speaker required. Simple wiring—similar to dimmer. Rating 800W.

All products are guaranteed and are supplied with full instructions and applications. Full after-sales service. Technical advice given.

For full information on all modules and lighting control systems send 15p for our illustrated catalogue and price list. Callers welcome, visit our showroom for a demonstration of any of the modules or systems. Mon–Fri. 9.30 to 6.0 p.m. Sat. by arrangement.

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Sinclair Project 80

For elegant, versatile, stereo hi-fi systems designed and built by you!

Until recently, if you wanted a first-class hi-fi system you had two ways to get it.

You could buy the individual electronic components and build a system from scratch. If you were an electronics genius – fine.

Or you had to buy ready-made units. Expensive – and dull. About the only creative pleasure you'd get would be matching your amp and your speakers, or making your speaker enclosures.

So what's new?

A comprehensive hi-fi system, combining the enjoyment and satisfaction of build-it-yourself (without too much struggle)... a real value-for-money feeling... and results of the highest quality.

It's the new Sinclair Project 80.

How does Sinclair Project 80 work?

Project 80 is a comprehensive set of hi-fi modules, or sub-assemblies. Amps... pre-amps... FM tuners... stereo decoders... control units... everything you need to assemble hi-fi units. They're all designed to look alike and they're all completely compatible with each other. Simply decide on the specifications of the unit you want to build... buy the necessary modules... connect them... and house them.

No need to buy everything at once for your eventual set-up. All the modules are designed so that you can add to them as your system grows – whether or not it's based on Project 80.

This applies to refinements, like filters... to up-grading, adding a second set of amps, say, for greater output... or to real innovation, like quad. (Add a Project 80 quad decoder, a power supply, a pair of amps, and a pair of speakers – and your stereo's gone quad.)

Is it difficult to build?

Not at all. The modules are complete in themselves. All you do is connect them to your turntable... your speakers... or to each other. It's absorbing, but if you can solder wires to a 5-pin DIN plug, you can build a complete system with Project 80.

And if you're not so hot with a soldering iron? Use Project 805. Project 805 uses Project 80 modules, but provides special clip-on tagged wire connections – absolutely *no* soldering required.

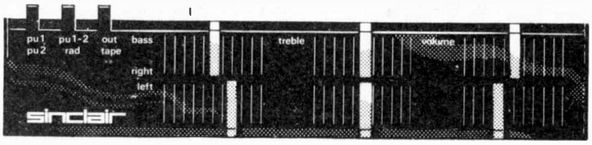
And, of course, both Project 80 and Project 805 come complete with instructions for easy, step-by-step assembly. But if you do run into problems, just call our Consumer Advisory Service who are always happy to help.

OK. Where do I go from here?

Over the page! There you'll see for yourself the exacting specifications to which Sinclair Project 80 modules are made, and you'll see some suggested systems.

As you skim the suggestions, remember all Project 80 modules are backed by the remarkable no-quibble Sinclair guarantee. Should any defect arise from normal use within a year, we'll service the modules free of charge. What could be fairer than that?

Choose the Project 80 modules that are right for you.

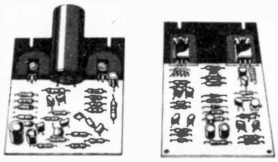


Project 80 pre-amp/control unit

The control centre of Project 80 with its distinctive white-on-matt-black styling and plastic control sliders, it's a pleasure to look at, as well as to use

Specification
(9½ in x 2 in x ¾ in.) Separate slider controls on each channel for treble, bass and volume. **Inputs:** *PU* magnetic – 3 mV (RIAA corrected), ceramic – 350 mV, *Radio* 100 mV; *Tape* 30 mV. **S/N ratio:** 60 dB. **Frequency range:** 20 Hz to 15 kHz ± 1 dB. **Outputs:** 100 mV and tape plus AB monitoring. **Press buttons** for PU, radio and tape. **Operating voltage:** 20 V – 35 V.

Price. £13.95 + VAT



Project 80 power amplifiers

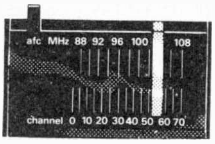
Two different amplifiers, designed to be used separately or combined, with Project 80 modules or as add-ons to existing equipment. Protected against short circuits and damage from mis-use.

Z40 Specification
(2¼ in x 3 in x ¾ in.) 8 transistors. **Input sensitivity:** 100 mV **Output:** 12 W RMS continuous into 8 Ω (35 V). **Frequency response:** 30 Hz – 100 kHz ± 3 dB. **S/N ratio:** 64 dB. **Distortion:** 0.1% at 10 W into 8 Ω at 1 kHz. **Voltage requirements:** 12 V – 35 V. **Load imp:** 4 Ω – 15 Ω; safe on open circuit. Protected against short circuit.

Price: £5.95 + VAT

Z60 Specification
(2¼ in x 3⅘ in x ¾ in.) 12 transistors. **Input sensitivity:** 100 mV – 250 mV. **Output:** 25 W RMS continuous into 8 Ω (50 V). **Frequency response:** 10 Hz to more than 200 kHz ± 3 dB. **S/N ratio:** better than 70 dB. **Distortion:** 0.02% at 10 W into 8 Ω at 1 kHz. **Voltage requirements:** 12 V – 50 V. **Load imp:** 4 Ω min; max safe on open circuit. Protected against short circuit.

Price: £7.45 + VAT

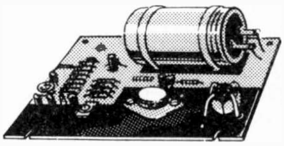


Project 80 FM tuner

Excellent reception from a tuner only 3½ in long x ¾ in deep! Styled to match Project 80 control unit

Specification
(3½ in x 2 in x ¾ in.) Tunes 87.5 MHz to 108 MHz. **Detector:** IC balanced coincidence (IC equivalent to 26 transistors) **Distortion:** 0.3% at 1 kHz for 30% modulation. **Sensitivity:** 5 µV for 30 dB signal to noise. **Output:** 100 mV for 30% modulation. **Aerial imp:** 75 Ω or 240-300 Ω. **Features:** dual Varicap tuning, 4-pole ceramic filter, switchable AFC. **Operating voltage:** 23 V – 30 V

Price: £13.95 + VAT



Power supply units

Range of power supply units to match desired specification of final system.

PZ5 Specification
Unstabilised. 30 V output. Including mains transformer.

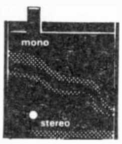
Price: £5.95 + VAT

PZ6 Specification
Stabilised. 35 V output. Including mains transformer.

Price: £8.95 + VAT

PZ8 Specification
Stabilised. Output adjustable from 20 V to 60 V approx. Re-entrant current limiting makes damage from overload or even shorting virtually impossible. Without mains transformer.

Price: £8.45 + VAT

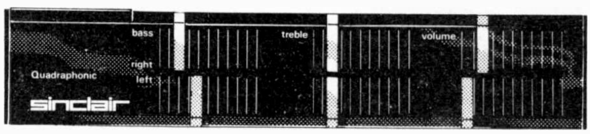


Project 80 stereo decoder

Designed for use with Project 80 FM tuner. Sold separately to keep down the price of a mono FM system, but also to make the stereo decoder available for use with existing mono FM tuners.

Specification
(1¼ in x 2 in x ¾ in.) 1 IC equivalent to 19 transistors. LED stereo indicator glows red.

Price: £8.95 + VAT

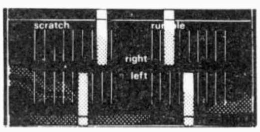


Project 80 SQ quadraphonic decoder

Combines with and exactly matches Project 80 control unit for true quadraphonics. This unit is based on the CBS SQ system and is a complete quadraphonic decoder, rear channel pre-amp and control unit.

Specification
(9½ in x 2 in x ¾ in.) Connects with tape socket on Project 80 control unit or similar facility on any stereo amplifier. Separate slider controls on each channel for treble, bass and volume. **Frequency response:** 15 Hz to 25 kHz ± 3 dB. **Distortion:** 0.1%. **S/N ratio:** 58 dB. **Rated output:** 100 mV. **Phase shift network:** 90 ± 10 100 Hz to 10 kHz. **Operating voltage:** 22 V – 35 V.

Price: £18.95 + VAT



Project 80 active filter unit

Eliminates scratch and rumble (high and low-frequency noise).

Specification
(4¼ in x 2 in x ¾ in.) Voltage gain: –0.2 dB. **Frequency response:** filter at zero: 36 Hz – 22 kHz; HF (scratch) out: variable 22 kHz to 5.5 kHz, 12 dB/octave slope; LF (rumble) out: –28 dB at 28 Hz, 9 dB/octave slope.

Price: £7.45 + VAT

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	(1) AD162
IC:	TAA435

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SN7402	0·15	0·14	0·13	SN7472	0·28	0·27	0·25
SN7403	0·15	0·14	0·13	SN7473	0·33	0·32	0·30
SN7404	0·18	0·16	0·15	SN7474	0·33	0·32	0·31
SN7405	0·18	0·16	0·15	SN7475	0·51	0·49	0·47
SN7408	0·18	0·16	0·15	SN7476	0·35	0·32	0·31
SN7410	0·15	0·14	0·13	SN7480	0·50	0·47	0·44
SN7412	0·23	0·21	0·19	SN7483	0·95	0·89	0·83
SN7413	0·33	0·32	0·31	SN7486	0·34	0·33	0·31
SN7417	0·30	0·29	0·28	SN7489	3·56	3·33	2·96
SN7420	0·15	0·14	0·13	SN7490	0·49	0·48	0·46
SN7427	0·29	0·28	0·27	SN7491	0·99	0·94	0·89
SN7430	0·15	0·14	0·13	SN7492	0·54	0·50	0·47
SN7432	0·31	0·29	0·27	SN7493	0·51	0·50	0·47
SN7437	0·31	0·29	0·27	SN7495	0·73	0·68	0·64
SN7440	0·15	0·14	0·13	SN7496	0·83	0·78	0·73
SN7442	0·70	0·68	0·64	SN74107	0·35	0·34	0·31
SN7445	0·99	0·92	0·86	SN74121	0·36	0·34	0·31
SN7447	0·98	0·96	0·87	SN74123	0·70	0·68	0·64
SN7450	0·15	0·14	0·13	SN74145	0·89	0·85	0·79
SN7451	0·15	0·14	0·13	SN74157	0·87	0·81	0·72
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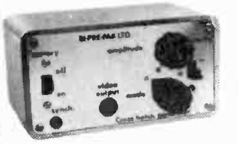

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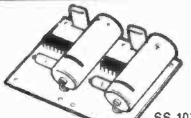
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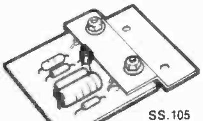
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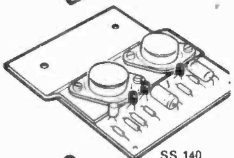
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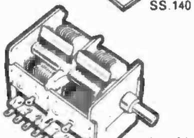
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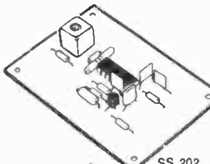
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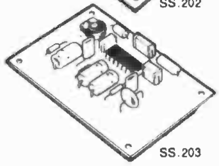
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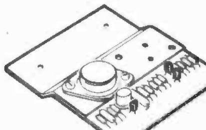
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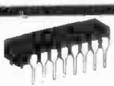

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7416	22	7485	80	74176	95
7417	22	7486	24	74177	85
7420	11	7489	1·50	74180	80
7422	22	7490	45	74181	2·50
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7437	25	74100	1·25	74193	85
7438	21	74105	60	74194	95
7440	11	74107	27	74195	80
7441	60	74121	32	74196	1·00
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377	2w Stereo amp	DIP	1·47
380	2w Audio Amp	DIP	81
380 8	.6w Audio amp	mDIP	69
381	Lo Noise Dual preamp	DIP	98
382	Lo Noise Dual preamp	DIP	98
550	Prec V Reg	DIP	44
555	Timer	mDIP	54
560	Phase Locked Loop	DIP	1·50
562	Phase Locked Loop	DIP	1·50
565	Phase Locked Loop	DIP TO-5	1·45
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AC134	16
AC137	16
AC141	20
AC141K	32
AC142	20
AC142K	28
AC151	17
AC154	22
AC155	22
AC156	22
AC157	27
AC165	22
AC166	22
AC167	22
AC168	27
AC169	16
AC176	22
AC177	27
AC178	31
AC179	31
AC180	22
AC180K	32
AC181	22
AC181K	32
AC187	24
AC187K	25
AC188	24
AC188K	25
ACY17	28
ACY18	22
ACY19	22
ACY20	22
ACY21	22
ACY22	18
ACY27	20
ACY28	21
ACY29	39
ACY30	31
ACY31	31
ACY34	23
ACY35	23
ACY36	31
ACY40	19
ACY41	20
ACY44	39
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AD140	53
AD142	53
AD143	42
AD149	55
AD161	39
AD162	39

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AF115	27
AF116	27
AF117	27
AF118	39
AF124	33
AF125	33
AF126	31
AF127	31
AF139	33
AF178	55
AF179	55
AF180	55
AF181	55
AF186	55
AF239	41
AL102	72
AL103	72
ASY26	28
ASY27	33
ASY28	28
ASY29	28
ASY50	28
ASY51	28
ASY52	28
ASY54	28
ASY55	28
ASY56	28
ASY57	28
ASY58	28
ASY73	28
ASZ21	44
BC107	9
BC108	9
BC109	9
BC113	11
BC114	17
BC115	17
BC116	17
BC117	20
BC118	11
BC119	33
BC120	88
BC125	13
BC126	20
BC132	13
BC134	20
BC135	13
BC136	17
BC137	17
BC139	44
BC140	33
BC141	33
BC142	33
BC143	33
BC145	50
BC147	11
BC148	11
BC149	13

Type	Price
BC150	20
BC151	22
BC152	19
BC153	31
BC154	33
BC157	20
BC158	13
BC159	13
BC160	50
BC161	55
BC167	13
BC168	13
BC169	13
BC170	13
BC171	16
BC172	16
BC173	16
BC174	16
BC175	24
BC177	21
BC178	21
BC179	21
BC180	27
BC181	27
BC182	16
BC182L	16
BC183	16
BC183L	16
BC184	22
BC184L	22
BC186	31
BC187	31
BC207	12
BC208	12
BC209	13
BC212L	14
BC213L	14
BC214L	18
BC225	28
BC226	39
BC301	30
BC302	27
BC303	35
BC304	40
BC440	34
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BCY30	27
BCY31	29
BCY32	33
BCY33	24
BCY34	28
BCY70	16
BCY71	22
BCY72	16
BCZ10	22
BCZ11	28
BCZ12	28
BD115	68
BD116	88
BD121	66
BD123	72
BD124	76

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BD132	66
BD133	72
BD135	44
BD136	44
BD137	50
BD138	55
BD139	61
BD140	66
BD155	88
BD175	66
BD176	66
BD177	72
BD178	72
BD179	72
BD180	77
BD185	72
BD186	72
BD187	77
BD188	77
BD189	83
BD190	83
BD195	94
BD196	94
BD197	99
BD198	99
BD199	£1·05
BD199	£1·05
BD200	£1·05
BD205	88
BD206	88
BD207	£1·05
BD208	£1·05
BDY20	£1·10
BDY20	£1·10
BF115	27
BF117	50
BF118	77
BF119	77
BF121	50
BF123	55
BF125	50
BF127	55
BF152	61
BF153	50
BF154	50
BF155	77
BF156	53
BF157	61
BF158	61
BF159	66
BF160	44
BF162	44
BF163	44
BF164	44
BF165	44
BF167	24
BF173	24
BF176	39
BF177	39
BF148	33
BF179	33

Type	Price
BF180	33
BF181	33
BF182	44
BF183	44
BF184	28
BF185	33
BF187	30
BF188	44
BF194	13
BF195	13
BF196	16
BF197	16
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BF257	50
BF258	66
BF259	94
BF262	61
BF263	61
BF270	39
BF271	33
BF272	88
BF273	39
BF274	39
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BFX29	30
BFX84	24
BFX85	33
BFX86	24
BFX87	27
BFX88	24
BFY50	22
BFY51	22
BFY52	22
BFY53	19
BSX19	17
BSX20	17
BSY25	17
BSY26	17
BSY27	17
BSY28	17
BSY29	17
BSY38	20
BSY39	20
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BSY95A	14
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OC23	54
OC24	62
OC25	42
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OC35	46
OC36	55
OC41	22
OC42	27
OC44	17
OC45	14
OC70	11
OC71	11
OC72	16
OC74	16
OC75	17
OC76	17
OC77	28
OC81	17
OC81D	17
OC82	17
OC82D	17
OC83	22
OC139	22
OC140	22
OC169	28
OC170	28
OC171	28
OC200	28
OC201	31
OC202	31
OC203	28
OC204	28
OC205	39
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ORP60	44
ORP61	44
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P397	46
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2G308	39
2G309	39
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2G339A	18
2G344	20
2G345	18
2G371	18
2G371B	13
2G373	19
2G374	19
2G377	33
2G378	18
2G381	18
2G382	18
2G401	33
2G414	33
2G417	28
2N388	39
2N388A	61
2N404	22
2N404A	31
2N524	46
2N527	54
2N598	46
2N599	50
2N696	14
2N697	15
2N698	27
2N699	39
2N706	09
2N706A	10
2N708	13
2N711	33
2N717	39
2N718	27
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2N743	22
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2N914	16
2N918	33
2N929	23
2N930	23
2N1131	22
2N1132	24
2N1302	16
2N1303	16
2N1304	19
2N1305	19
2N1306	23
2N1307	23
2N1308	26

Type	Price
2N1309	26
2N1613	22
2N1711	22
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2N1890	50
2N1893	41
2N2147	79
2N2148	63
2N2160	66
2N2192	39
2N2193	39
2N2194	39
2N2217	24
2N2218	22
2N2219	22
2N2220	24
2N2221	22
2N2222	22
2N2368	19
2N2369	16
2N2369A	16
2N2411	27
2N2412	27
2N2646	52
2N2711	23
2N2712	23
2N2714	23
2N2904	19
2N2904A	23
2N2905	23
2N2905A	23
2N2906	17
2N2906A	20
2N2907	22
2N2907A	24
2N2923	16
2N2924	16
2N2925	16
2N2926G	14
2N2926Y	12
2N2926O	11
2N2926R	11

Type	Price
2N2926B	11
2N3010	77
2N3011	16
2N3053	19
2N3054	51
2N3055	45
2N3391	16
2N3391A	18
2N3392	16
2N3393	16
2N3394	16
2N3395	19
2N3402	23
2N3403	23
2N3404	31
2N3405	46
2N3414	17
2N3415	17
2N3416	31
2N3417	31
2N3525	83
2N3614	74
2N3615	82
2N3616	82
2N3646	10
2N3702	13
2N3703	13
2N3704	14
2N3705	13
2N3706	13
2N3707	14
2N3708	09
2N3709	10
2N3710	10
2N3711	10
2N3819	31
2N3820	55
2N3821	39
2N3823	31
2N3903	31
2N3904	33
2N3905	31

Type	Price
2N3906	30
2N4058	13
2N4059	11
2N4060	13
2N4061	13
2N4062	13
2N4284	19
2N4285	19
2N4286	19
2N4287	19
2N4288	19
2N4289	19
2N4290	19
2N4291	19
2N4292	19
2N4293	19
2N5172	13
2N5294	60
2N5457	35
2N5458	35
2N5459	44
2N6121	75
2S301	55
2S301A	46
2S302	46
2S303	61
2S304	77
2S305	86
2S306	86
2S307	86
2S321	62
2S322	46
2S322A	46
2S323	62
2S324	77
2S325	77
2S326	77
2S327	77
2S701	46
40361	44
40362	50

DIODES AND RECTIFIERS

Type	Price
AA119	9
AA120	9
AA129	9
AAY30	10
AAZ13	11
BA100	11
BA116	23
BA126	24
BA148	16
BA154	13
BA155	16
BA156	15
BA173	16
BY100	17
BY101	13
BY105	19
BY114	13

Type	Price
BY124	13
BY126	16
BY127	17
BY128	17
BY130	18
BY133	23
BY164	55
BYX38/30	46
BYZ10	39
BYZ11	33
BYZ12	33
BYZ13	28
BYZ16	44
BYZ17	39
BYZ18	39
BYZ19	31

Type	Price
CG62 (OA91Eq)	6
CG651 (OA70-OA79)	7
OA5	39
OA5 short leads	23
OA10	15
OA47	8
OA70	8
OA79	8
OA81	8
OA85	10
OA90	7
OA91	7
OA95	8

BB104 Varicap back to back 0·16

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72709	0·25	0·23	0·20
72709P	0·20	0·19	0·18
72710	0·35	0·33	0·30
72741	0·30	0·29	0·28
72741C	0·28	0·27	0·26
72741P	0·30	0·29	0·28
72747	0·85	0·80	0·75
72748P	0·38	0·36	0·34
SL201C	0·59	0·45	0·40
SL701C	0·50	0·45	0·40
SL702C	0·50	0·45	0·40
TAA263	0·80	0·70	0·60
TAA293	£1·00	0·95	0·90
TAA350A	£1·85	£1·80	£1·70
μA703C	0·28	0·26	0·24
μA709C	0·20	0·19	0·18
μA711	0·35	0·33	0·30
μA712	0·35	0·33	0·30
TBA800	0·50	£1·45	£1·40
76003	£1·50	£1·45	£1·40
76023	£1·50	£1·45	£1·40
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LM380	£1·00	0·97	0·95
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NE556	0·95	0·93	0·90
ZN414			£1·20 each

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BP936	16p	15p	14p
BP944	16p	15p	14p
BP945	30p	28p	25p
BP946	15p	14p	13p
BP948	30p	28p	25p
BP951	70p	65p	60p
BP962	15p	14p	13p
BP9093	45p	43p	40p
BP9094	45p	43p	40p
BP9097	45p	43p	40p
BP9099	45p	43p	40p

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7403	0·15	0·14	0·13
7404	0·15	0·14	0·13
7405	0·15	0·14	0·13
7406	0·39	0·34	0·31
7407	0·39	0·34	0·31
7408	0·25	0·24	0·23
7409	0·25	0·24	0·23
7410	0·15	0·14	0·13
7411	0·25	0·24	0·23
7412	0·28	0·27	0·26
7413	0·32	0·31	0·30
7416	0·30	0·29	0·28
7417	0·30	0·29	0·28
7420	0·15	0·14	0·13
7422	0·30	0·29	0·28
7423	0·40	0·39	0·38
7425	0·40	0·39	0·38
7426	0·40	0·38	0·36
7427	0·40	0·38	0·36
7428	0·45	0·42	0·40
7430	0·15	0·14	0·13
7432	0·40	0·38	0·36
7433	0·42	0·40	0·38
7437	0·35	0·32	0·30
7438	0·35	0·32	0·30
7440	0·15	0·14	0·13
7441	0·74	0·71	0·64
7442	0·74	0·71	0·64
7443	£1·20	£1·15	£1·10
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7445	£1·60	£1·55	£1·50
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7450	0·15	0·14	0·13
7451	0·15	0·14	0·13
7453	0·15	0·14	0·13
7454	0·15	0·14	0·13
7460	0·15	0·14	0·13
7470	0·32	0·29	0·27
7472	0·32	0·29	0·27
7473	0·41	0·39	0·35
7474	0·41	0·39	0·35
7475	0·60	0·58	0·56
7476	0·44	0·43	0·42
7480	0·60	0·58	0·55
7481	£1·10	£1·05	£1·00
7482	0·90	0·85	0·80
7483	£1·20	£1·15	£1·05
7484	£1·00	0·97	0·95
7485	£1·60	£1·55	£1·50
7486	0·35	0·34	0·33
7489	£4·00	£3·75	£3·50
7490	0·65	0·63	0·60
7491	£1·10	£1·05	£1·00
7492	0·74	0·71	0·64
7493	0·74	0·71	0·64
7494	0·85	0·82	0·75
7495	0·85	0·82	0·75
7496	0·96	0·93	0·86
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74151	£1·10	£1·05	£1·00
74153	£1·00	0·95	0·90
74154	£1·70	£1·65	£1·60
74155	£1·20	£1·15	£1·10
74156	£1·20	£1·15	£1·10
74157	£1·00	0·95	0·90
74160	£1·40	£1·35	£1·30
74161	£1·40	£1·35	£1·30
74162	£1·40	£1·35	£1·30
74163	£1·40	£1·35	£1·30
74164	£1·80	£1·75	£1·70
74165	£1·80	£1·75	£1·70
74166	£1·60	£1·55	£1·55
74174	£1·60	£1·55	£1·50
74175	£1·10	£1·05	£1·00
74176	£1·25	£1·20	£1·15
74177	£1·25	£1·20	£1·15
74180	£1·25	£1·20	£1·15
74181	£3·95	£3·85	£3·75
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Devices may be mixed to qualify for quantity price. (TTL 74 series only) data is available for the above series of I.C.s in booklet form. Price 35p.

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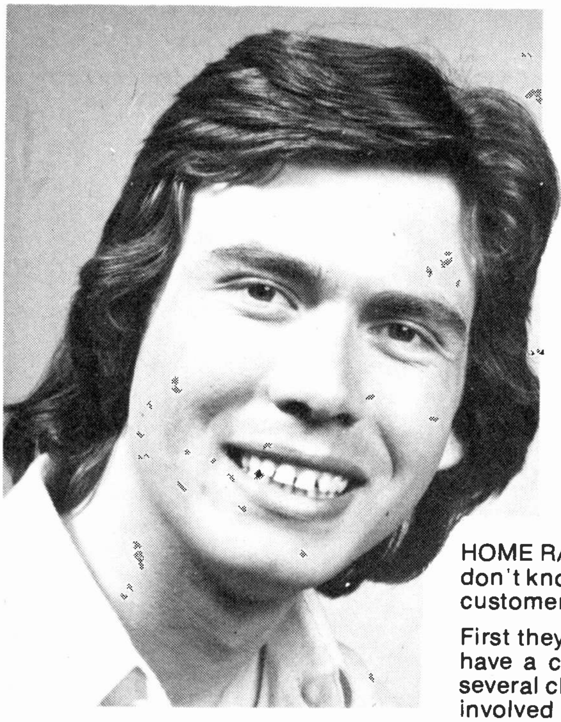

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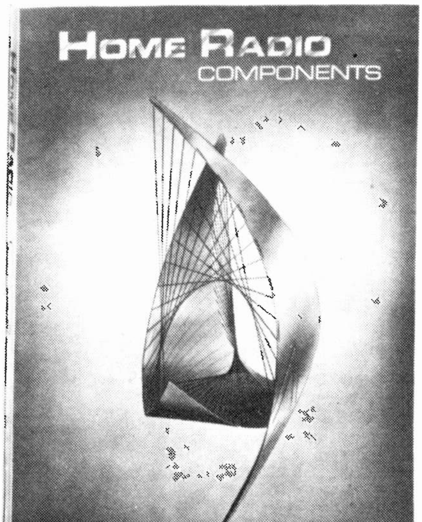

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PE

VITAL LINKS

THE very successful infiltration by electronics into miscellaneous and apparently unrelated fields is based upon the ready ability to transform different forms of energy into electrical energy, and vice versa. Without those devices embraced by the term "transducers" electronic circuitry would be limited to purely electrical or electronic functions.

Many energy transforming devices used for industrial or scientific measuring and control purposes fall clearly into the class of precision instruments. They are usually designed for specific applications in association with hydraulic, pneumatic, or mechanical systems. These kind of applications are seldom encountered by the amateur. Apart from such highly specialised transducers, there are more commonplace devices and some—like the microphone and loudspeaker—have been around for a very long time and indeed antedate the introduction of the now generally used term transducer. There are also those simple home made devices which, in comparison with their elegant commercial counterparts, seem hardly to qualify for the rather impressive title of transducer. Yet they ably perform essential energy conversion roles in some electronic system or another.

The touch plate and the moisture sensor are examples of transducers of the most rudimentary form which can be fashioned from commonplace materials and work very successfully with standard electronic circuitry. Of course far more complex and intricate devices can also be made by the amateur who is adept in mechanical matters. For example, the electrodynamic type of instrument used in the Marine Speedometer (February issue).

There is also a good variety of semiconductor devices which are used for sensing or transducing purposes. The developments in this area have been of particular value and importance to amateurs, for they have opened up additional useful applications for circuitry without introducing undue mechanical problems. One of the more recent and noteable innovations in solid state transducers is the gas or vapour detector. This device has now joined the ranks of other semiconductor devices which can sense atomic radiations, heat, light, sound and pressure. (Only taste appears to be lacking at present, but surely it can only be a matter of time before this sense is covered as well?)

As a matter of fact, this marked paralleling of human senses tempts us to indulge in a little whimsical speculation. Can we expect one day the arrival of the thought-responsive transducer, a device that will permit the control of electronic apparatus without the necessity of physical contact of any kind? Some extra-sensory perception devotees believe they really are on the track of this esoteric solution to some of life's little problems. And there has actually been a suggestion that the humble Zener diode could be a possible candidate for this post. Who knows, maybe some readers are currently engaged in pitting their wits against the undisciplined host of particles within that tiny component following the recent Probability Anomaly Detector article.

Frankly, though, we confess having doubts that any redundancy amongst orthodox transducers will result from this battle of mind over matter. So we return to wholly substantial and materialistic matters by drawing attention to the new series starting this month dealing with those important intermediaries—transducers. F.E.B.

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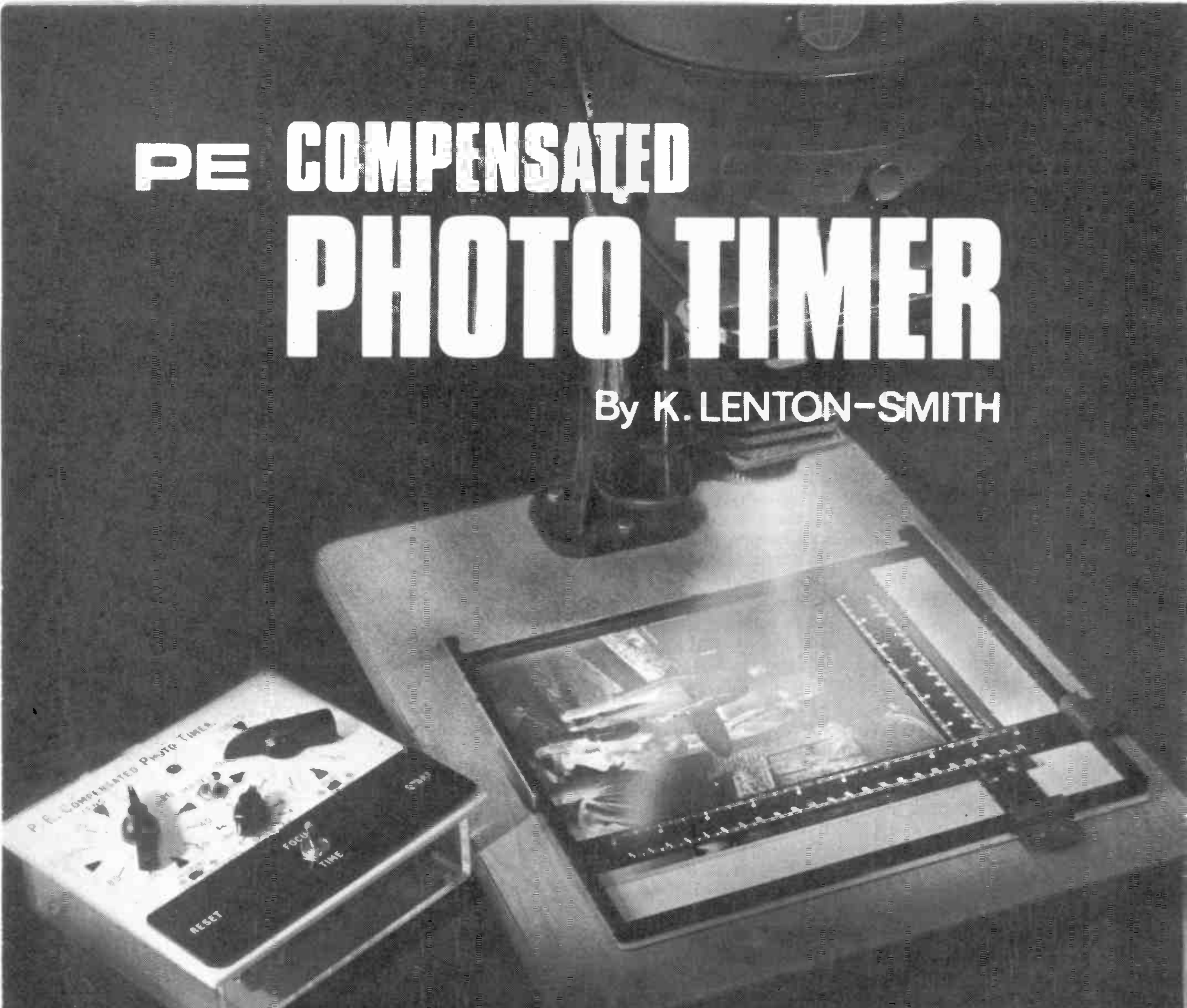
PE COMPENSATED PHOTO TIMER

By K. LENTON-SMITH



Enlarger by courtesy of Dixons of Fleet Street

THE majority of photographic interval timers lack essential refinements where precision printing is concerned. The present design was specifically evolved for advanced photography students interested in colour printing and accurate monochrome work.

Layout of the controls takes into account the probability of working in total darkness, or something closely approaching this, due to the safelighting required with panchromatic papers. Exposure intervals may be continuously adjusted between 0·1 and 121 seconds, and these may either be exact or compensated for fluctuations in the a.c. mains voltage supplying the lamp. Controls which start, reset or allow focusing are conveniently placed on a bar at the front of the instrument, for easy location in darkness. A light emitting diode pilot may be switched on or off according to whether colour blind or colour sensitive material is being used. A foot switch may be run in parallel with the start switch so that both hands are available for "dodging" the print.

The circuitry is not particularly complicated, the basic timer being quite conventional. To obtain consistent exposures it is normally necessary to use a voltage stabiliser and, if both timer and stabiliser are commercially made, the parcel can be expensive. The present design dispenses with the voltage stabiliser by altering timing periods in inverse proportion to mains supply voltage. Constructors are warned that this involves mixing low tension d.c. supply for the timing circuit with a.c. mains potentials, thus more than usual care in construction is called for.

RECIPROCITY LAW

Experienced photographers will be aware of the reciprocity law, on which all exposure measuring devices are based

$$T \times I = K$$

It expresses the fact that the product of time (T) and intensity (I) must be constant (K) for a given sensitised material (intensity being itself the product of subject brightness and the f stop used). Although it is well known that this law breaks down at extremes of shutter speeds and low light levels, it holds good over the normal ranges encountered in camera exposure. The photographer carefully measures light intensity and, with film speed (K) set, the (Reciprocity Law) calculator on the meter will compute the aperture/speed combinations for the material in question.

Having carefully measured camera exposure and accurately developed or reversed the material, the printing stage arrives. Here is where the Law goes out of the window!

Readers appreciate that there are small variations in mains voltage taking place the whole time, especially if a hospital or factory is nearby. More important, however, is that photographic high intensity enlarging lamps are slightly over-run, operating on a similar principle to the photoflood lamp. This means that their reaction to fluctuations is more highly-geared than with household lamps. When voltage alters, so does intensity (I) and, if the timer gives precise intervals, "K" is meaningless.

To compensate for intensity changes, exposure time must be reciprocal. If the intensity falls, exposure time must be extended—and vice versa. Fig. 1 shows the percentage changes in the light output from an 150W enlarging lamp as voltage is decreased, the 75W lamp following much the same pattern. A 10 per cent error in the exposure of papers such as Ektacolor 37RC will be most noticeable and really demand a reprint. Ideally, all mains supply fluctuations require compensation so that repeatable results are possible. When switched to the "Compensated" mode, this timer will give the same light dosage for a given setting of the interval switches, despite any unevenness in supply voltage.

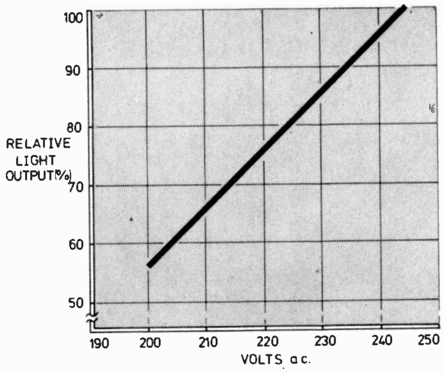


Fig. 1. Effect of mains voltage on enlarging lamps

CIRCUIT

The complete circuit is shown in Fig. 2. Pin 5 of IC1 is normally supplied with about half the rail voltage, this potential altering all intervals pro rata. When S6 is switched to "Exact", pin 5 is connected in this manner. With S6 set to "Compensated", pin 5 is supplied with an amplified version of small changes in a.c. mains voltage and thus makes the timed interval reciprocate. S3 and S2 are simple make switches, but the circuit is otherwise solid state.

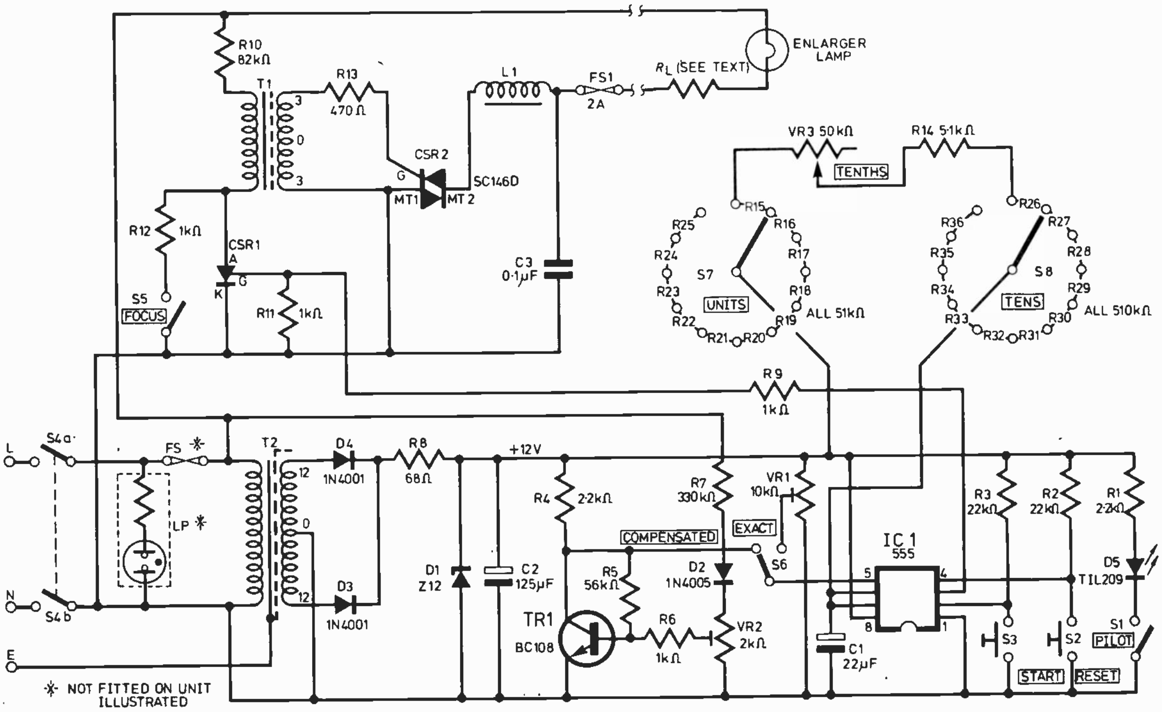
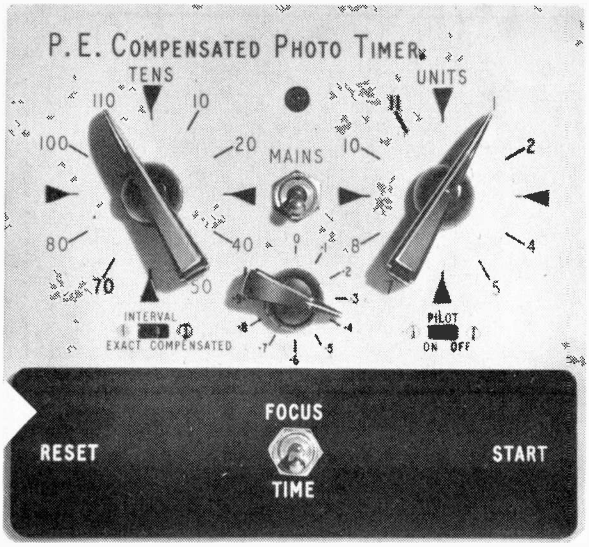


Fig. 2. Complete circuit of the timer



The completed front panel showing positioning of controls

Output from the timer i.c. is used to switch a thyristor in series with the primary winding of the transformer, whose secondary controls the gate of a triac and hence the lamp itself. Though a little more expensive than pure relay operation, this method is positive and reliable in obviating problems associated with relay points.

Supply voltage is nominally 12V, with 15V a safe upper limit. R8 may be adjusted upwards if D1 passes too much current. Reset switch S2 is connected to pin 4 of the i.c., and the start switch to pin 2. Both are held at positive potential by R3 and R2 to avoid spurious operation and are triggered by a negative going pulse when either switch is closed. The neutral side of the a.c. mains supply is ground with respect to the i.c. and its power supply. Threshold and discharge pins 6 and 7 are connected together in this application. From this point the charge on the timing capacitor C1, being fed through the timing chain, is sensed and the i.c. output switches off when the charge on C1 reaches two-thirds of the positive rail voltage. This capacitor should be either a bead tantalum or the closer tolerance tantalum specified.

RESISTOR CHAIN

Using the formula $t = 1{\cdot}1RC$, any combination of resistor and capacitor may be used to arrive at the basic 1 second unit. However, it is best to keep the value of R as low as possible to avoid the risk of leakage currents. Mathematically, these produce just over 1 second, but capacitor tolerance and the ability to adjust VR1 and VR2 make these values ideal.

As the accuracy of the finished timer depends almost entirely on C1 and the timing chain, good quality components are essential—and the extra cost not exorbitant. Resistors should not be overheated when being fitted to S7 and S8 and the associated wiring must be kept clear of other components. New switches have better contacts than old ones.

Any "stops" should be removed from rotary switches S7 and S8 so that the pointers may be turned in any direction. Timing resistors must be used in the 11 o'clock positions (though R25 may be considered superfluous) to avoid an open circuit and consequent waste of expensive material. Though it would be simple to select a set of ordinary 20 per cent resistors using a bridge or meter, 2 per cent metal oxide types are more stable in use and are thus recommended.

COMPONENTS . . .

Resistors

R1	2·2kΩ
R2, R3	22kΩ (2 off)
R4	2·2kΩ 5%
R5	56kΩ
R6	1kΩ
R7	330kΩ 5%
R8	68Ω 1W wirewound
R9	1kΩ
R10	82kΩ 1W
R11	1kΩ
R12	1kΩ
R13	470Ω
R14	5·1kΩ 5%
R15–R25	51kΩ (11 off). All metal oxide 2%
R26–R36	510kΩ (11 off). All metal oxide 2%

All ½W 10% carbon except where stated

Capacitors

C1	22μF tantalum elect. 16V
C2	125μF elec. 16V
C3	0·1μF 900V

Semiconductors

TR1	BC108
IC1	NE555V
CSR1	400V 1A Thyristor
CSR2	400V 10A Triac (Type SC146D)
D1	Z12 12V Zener diode, 600mW
D2	IN4005
D3, D4	IN4001 (2 off)
D5	TIL 209 l.e.d.

Potentiometers

VR1	10kΩ sub-minature preset
VR2	2kΩ sub-miniature preset
VR3	50kΩ linear

Switches

S1	Miniature d.p.d.t. slide switches
S2, S3	Press-to-make switches (2 off) (see text)
S4	D.p.d.t. toggle 250V
S5	S.p.s.t. toggle 250V
S6	D.p.d.t. slide switch
S7–S8	12 way rotary (2 off)

Transformers

T1	Douglas type MT238C5. Pri. 240V, Sec. 3–0–3V, 200mA
T2	Brazenose 12012/1. Pri. 240V, Sec. 12–0–12V, 100mA

Miscellaneous

1 Pointer knob 1¼in, 2 long pointer knobs 2¼in, 4 way terminal block, 16 s.w.g. aluminium for small heat sink; Case (see text), 4 rubber feet, FS1 2A fuse and holder, L1 (see text)

PHOTOGRAPHIC TIMER WIRING

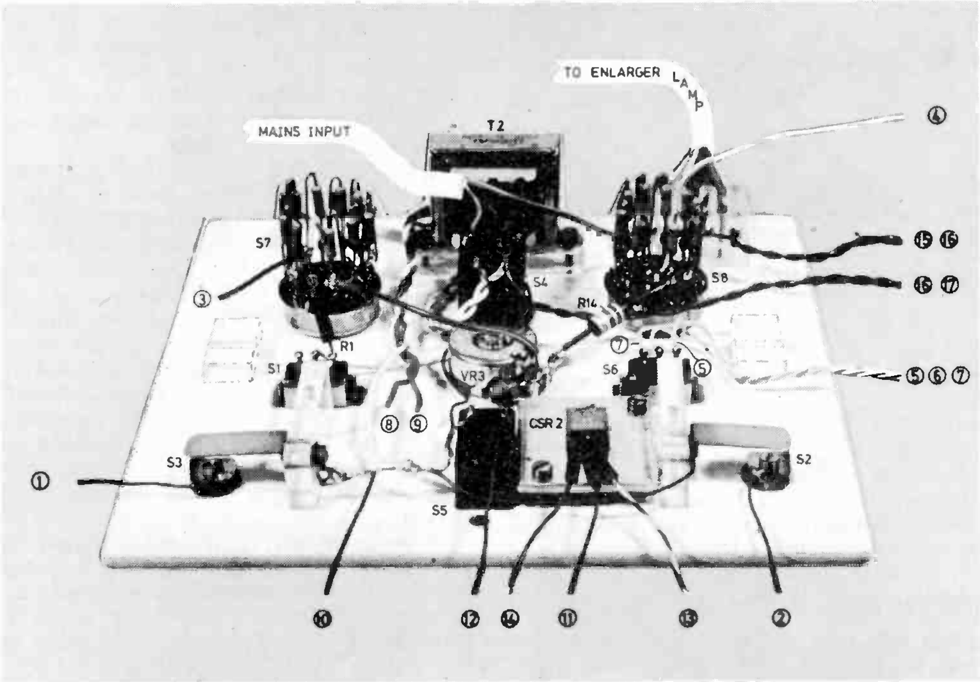


Fig. 3. Underside of control panel. Flying leads terminate at Veroboard sub-chassis (Fig. 4)

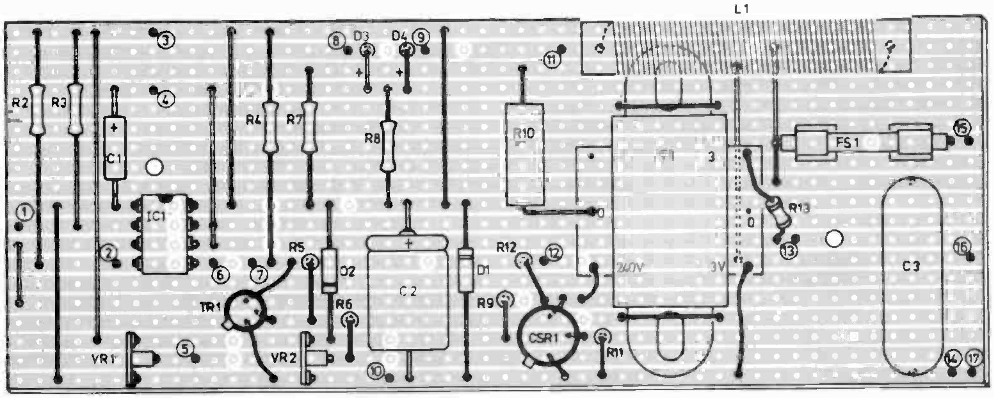
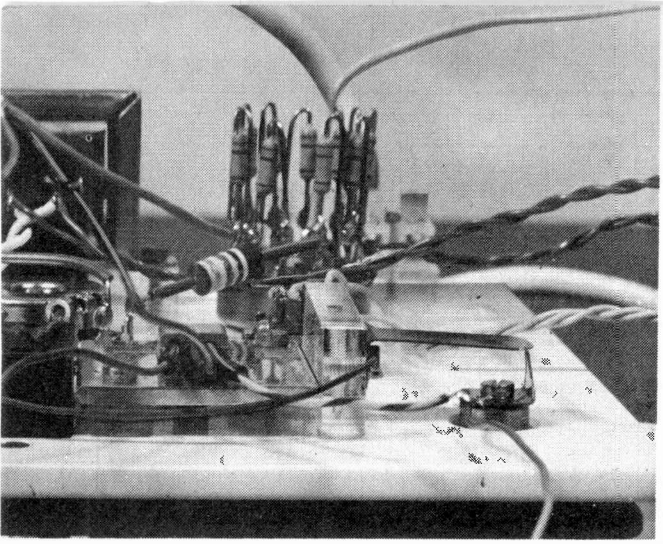


Fig. 4. Veroboard sub-chassis showing assembly and wiring



A close-up of the reset switch assembly and the $1\frac{1}{2}$in × $1\frac{1}{4}$in aluminium heat sink for CSR2

With S6 in the "Compensated" position, operation of the chip will be affected by mains voltage. R7 and VR2 form a potential divider, half rectified by D2. A small portion of this voltage is fed to the base of TR1 through R6. R5 provides automatic transistor stabilisation and the collector of TR1 reflects changes in mains voltage. A rise in voltage at the slider of VR2 will reduce collector voltage and shorten the interval, the opposite applying when voltage falls.

LAMP SWITCHING

Output from pin 3 of IC1 is fed to the gate of CSR1 through R9. The thyristor, primary winding of T1 and R10 are connected across the mains supply so that the transformer is energised by a positive signal on pin 3. The 6V secondary winding of T1 produces an a.c. signal, which is fed through R13 to the gate of the triac CSR2. The enlarger lamp is connected in series with the triac across the mains supply.

L1 and C3 form a transient suppression network which is necessary as triacs may easily be destroyed by high level pulses in the supply. In addition to fitting a 2A fuse in series with the lamp, it is advisable always to use a low resistance series limiter—because the triac could be destroyed before the fuse blows in the event of short-circuit lamp failure. It is suggested that a 5 ohm 100W wire-wound resistor (R_L) be fitted externally between timer and enlarger.

As this resistor gets hot, it is inadvisable to include it in the timer in view of the accuracy required of the timing components.

Focus switch S5 by-passes the thyristor so that the lamp may be turned on for an unlimited period.

CONSTRUCTION

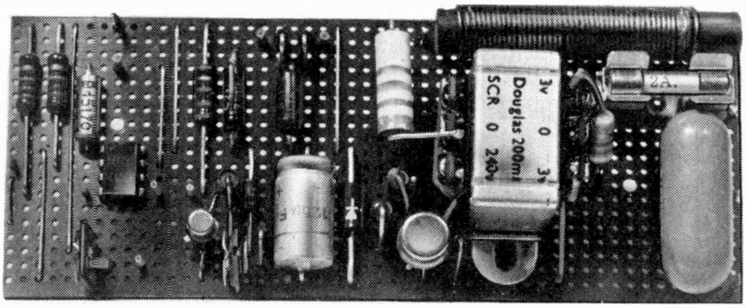
This should commence with the Veroboard sub-chassis, cutting details being shown in Fig. 4. Because some copper strips carry mains voltage and others the 12V circuits, it is necessary to be even more careful than usual that the track is cut correctly and that solder bridges are not formed inadvertently. Veropins are best used where connections are made with inflexible flying leads.

L1 consists of 50 turns of 22 s.w.g. enamelled copper wire on a short piece of $\frac{5}{16}$in ferrite rod, but anything fairly similar will suffice. After winding the coil should be warmed up with a hair-dryer and Araldite applied. This will cut down any tendency to buzz when the timer is operating.

T1 is small enough to mount with an adhesive, reinforced by copper wire loops passed over the mounting tags and soldered into the track. Some versions of the Douglas MT238 CS transformer have the tappings emerging from the underside of the coil (in the present case, they are brought out from the top) and could then be soldered into the board directly, with appropriate changes in the cutting pattern.

Timing resistors R15–R25 should be soldered round S7, bearing in mind that they progress anti-clockwise when viewed from below. Even though 2 per cent resistors are being used, it is a wise precaution to measure the total value of R15–R24 by setting S7 to junction R24/R25. R26 should be chosen to match this value and VR3 and R14 must obviously be excluded in making this match. R14 itself is a limiting resistor (which adds 1/10 second to all timing intervals) and is included to prevent damage to the i.c. if the start switch is operated with all pointers set at zero.

S7, S8, VR3 and R14 wired in series form the timing resistor chain. These may be temporarily connected to the sub-chassis by thin, flexible wires to test the basic timer circuit. With S6 bridged to the "Exact" position and 12V applied to the i.c. supply rail, the constructor can ascertain that CSR1's gate is being supplied from pin 3 of the timer. S3 and S2 will have to be jury rigged for this test and the 12V may be supplied from a battery or from T2 alone connected to mains supply.



The Veroboard sub-chassis with all components mounted in position

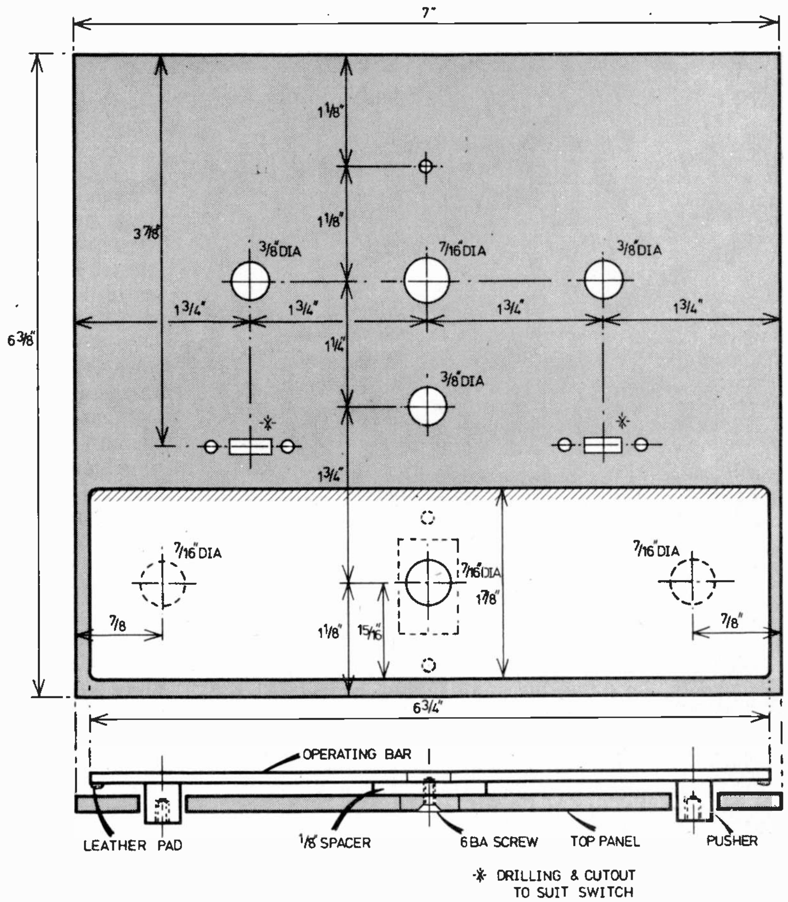


Fig. 5. Top panel dimensions and drilling details. The black Perspex operating bar shown unshaded stands proud of the panel by means of a spacer placed under the focus switch S5

CASEWORK

Fig. 5 gives top panel dimensions and drilling data, whilst Fig. 3 shows the underside of this panel and connections of its components to the sub-chassis. The majority of the hardware is attached to the underside of the panel, the sub-chassis being slung on supports which ensure that it clears the switching associated with the operating bar. The Veroboard supports are tapped with 8 B.A. threads and two paxolin washers should be placed between board and supports before finally screwing down. A large hole must be drilled in the block used to mount T2 so that the light emitting diode pilot can be fitted through the panel underneath the transformer.

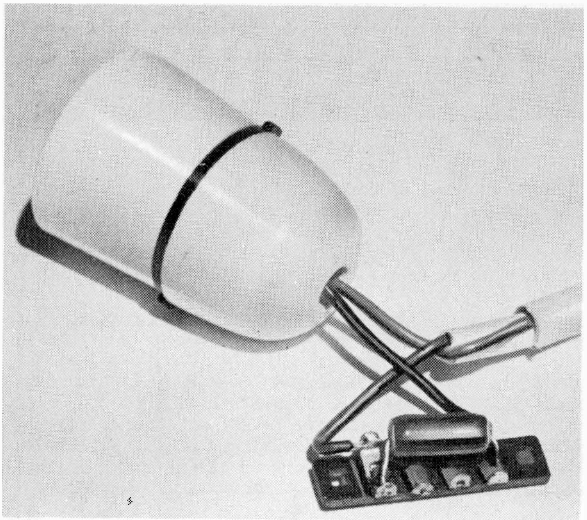
Where timers are concerned, a control panel of insulating material is to be preferred as it minimises the possibility of leakage between switches. Formica or Paxolin are suitable, but Perspex ($\frac{3}{16}$in opaque white) has been used for this timer. Apart from being a fairly good insulator, Perspex is easy to work and neat in appearance. It may be sawn with a hacksaw, roughly finished with a metal file and finally finished with wet emery and metal polish. Screwholes in the top of the panel may be minimised by attaching components T2 and the terminal block to pieces of tapped Perspex, then cementing to the underside. Holes may be tapped in the usual way, using white spirit as the lubricant and ensuring that the taper/plug is not allowed to clog.

The box covering the timer has also been made of Perspex, clear in this case, secured by screwing into tapped blocks cemented to the underside of the panel. By rubbing down sawn edges on wet emery placed on a sheet of glass, good mating of the parts of the box can be achieved when cementing together.

The panel should overlap the box itself so that the timer may be free standing on four rubber feet or flush mounted into a darkroom control panel.

OPERATING BAR

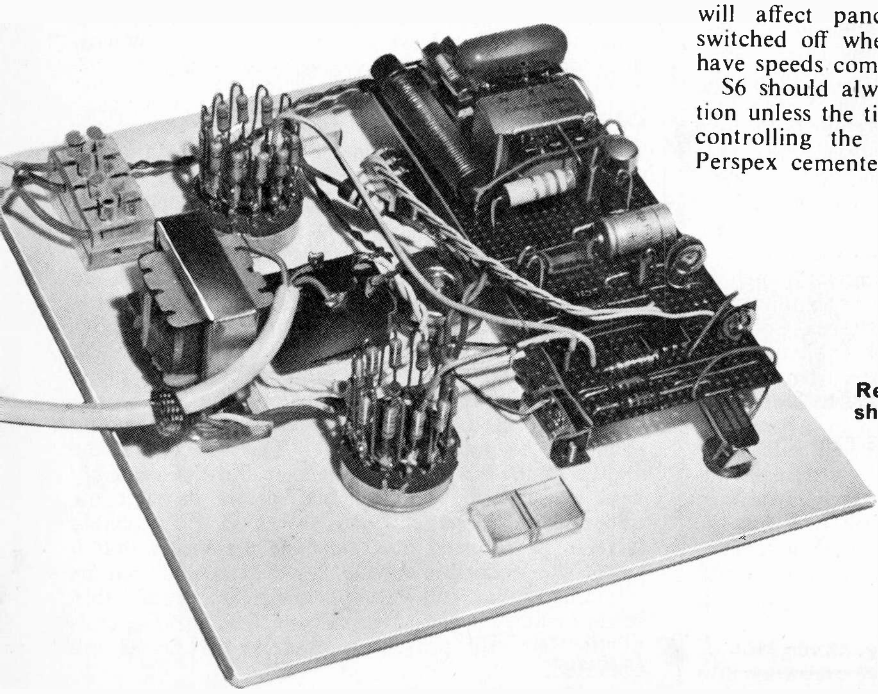
The black Perspex operating bar ($\frac{1}{8}$in thick) stands proud of the panel by means of a spacer placed under the focus switch S5. This bar is intended to flex so that pressure on either end will operate the associated switches. As one side of both S3 and S2 is at mains potential—and photographic workers are handling wet processes—these two switches are inside the timer, rather than simple contacts under the bar. "Pushers" cemented to the underside of each end of the bar protrude through holes in the panel to operate simple switches. Strips of phosphor-bronze have been used, though old relay contacts would probably be equally suitable. The spacer in the middle of the bar is cemented to it and the assembly held in place by countersunk screws through the underside of the panel. Focus switch S5 will probably have to be recessed into the panel to ensure that it clears the underside of the sub-chassis and that its retaining collar can be attached. Two small, thin leather pads on the underside of the extreme ends of the bar will prevent a click as S3 or S2 are operated.



A tag-board mounted resistor (RL) is used as a series limiter

Triac CSR2 is mounted on a small heatsink attached to the panel by small tapped blocks. As the load will not normally exceed 150W, the size is not critical; 10 or 16 s.w.g. aluminium should be used—as large as will conveniently fit between S2 and sub-chassis mounting pillar. Main terminal 2 is electrically common to the heatsink, so the triacs connections should be sleeved and the sink should not touch other components.

A short busbar connects together one side of S2 and S3, one side of S5, centre tap of the secondary winding of T2 and one lead for the pilot. When finally assembled, this busbar is connected to the common neutral line at point 10 on the Veroboard.



Rear view of completed front panel showing the range resistors

The four-way output terminal block has provision for an earth connection, though many enlargers only require two-wire connection. Earthing the column is worthwhile as static in the enlarger head is reduced and dust in the negative carrier made less problematical.

SETTING UP

Assuming the basic timer has already been tested as described, the rest of the wiring should be completed and a 75W or 150W bulb connected to the terminal block with its limiting resistor. On test, the lamp should be of normal brilliance if the stated components have been adhered to. If not, R10 or R13 may have to be reduced slightly until full-wave operation is achieved.

Preset VR1 should first be accurately set, with S6 in the "Exact" position. Set the controls to 60 seconds (VR3 and S7 being at zero) and adjust VR1 until an interval as close to this as possible results. With S6 in this mode, the timer can be used, with an audible alarm, for developing prints for the usual $1\frac{1}{2}$ or 2 minute period.

Preset VR2 is next adjusted, with S6 in the "Compensated" position. This setting should always be used for enlarging. This preset will need to be set somewhere near the "earthy" end of its track, the final setting being very critical. If the mains voltage is near to 245V, set the controls to 10 seconds and adjust VR2 minutely until this time is attained. If the mains voltage moves from this point, the timing will alter slightly—as it should. With a "Variac" transformer, it is possible to check time against voltage: the characteristic, when properly adjusted, will follow the pattern shown in Fig. 6.

USING THE TIMER

With monochrome materials, the pilot light may be switched on. The colour of the emission and value of R1 combine to produce a "safelight". As it will affect panchromatic materials, it should be switched off when using colour papers, which now have speeds comparable to bromide paper.

S6 should always be in the "Compensated" position unless the timer is used for purposes other than controlling the enlarger. Small triangles of $\frac{1}{16}$in Perspex cemented at the 0, 3, 6 and 9 position of

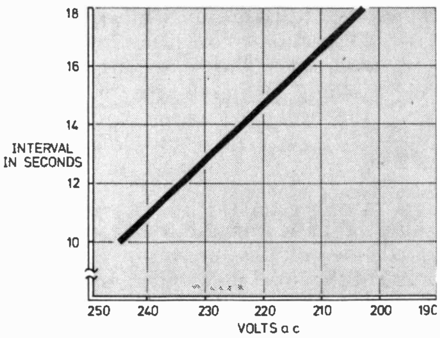


Fig. 6. Variations of a 10 second setting with changes in supply voltage produced by the timer with S6 in the compensating mode. This is close to the ideal implied in Fig. 1

S7 and S8 make it easy to set these in the dark by feel, whereas the less critical setting of VR3 can be closely estimated. In practice, the timer will be set immediately the test strip has been assessed, filtration changes made and before the lights are turned off ready for the next print to be made. It is reassuring to be able to check the setting in darkness to avoid wasting an expensive sheet of colour material!

The operating bar, carrying the most used controls, are nearest to the worker and easily operated in darkness. Positions of S3 and S2 may need to be reversed depending on the timer's position relative to the enlarger, dry bench layout and whether the user is left-handed. S3 nearest to the enlarger seems to be a natural choice. Any or all of the operating bar controls could be paralleled for foot operation, thus freeing the hands for shading and other manual control.

The timer will work comfortably at 210V or below, the author's own darkroom version having been in use during the power crisis. It will make for more consistent exposure, particularly where colour emulsions are concerned. Whilst falling mains voltage affects the colour temperature of the lamp to a small degree, the average variation will not have any practical effect, nor call for filtration changes of more than about 025Y—which can safely be ignored. Used with a filter Nomogram, this timer should enable the user to produce consistent prints of high quality with the minimum of wastage. ★

NEWS BRIEFS

Speakers In The Sun

How better to announce a new range of speakers than at a conference held in Malta? This clearly, is the view of the newly recreated Marsden Hall International company who recently held demonstrations in a luxury hotel in Malta of their latest range of quality loudspeakers.

Extending from a shelf-mounting 10W capacity unit up to a free standing 50W studio module, the range is split into two sections called respectively Annexe for powers up to 30W r.m.s. and Symphony for the two upper capacity modules of 35 and 50W rating.

The units are attractively styled in either Teak or Walnut, with detachable fronts either fabric or filter foam covered. Indeed, the foam-covered versions can be supplied in any of 26 different colours.

Of course, the critical test of a loudspeaker is not really the appearance, although this counts for a great deal in some circles, but the audio performance. Here, Marsden Hall went to some lengths to present their equipment as completely as possible.

They organised an audio demonstration of the various units in stereo pairs with the ability to switch from one pair to another at will. This allowed the listener to compare the six models one with another at ease. A selection of styles of music and types of orchestration was presented to show the ability of the equipments to cope with transients, bass and treble response, and so on.

Predictably, the larger studio units came out on top in all sections, but after all, the demonstration was given in a fairly large suite and it is under such circumstances that the full bass response can really benefit. However, all the units, including the smallest Annexe XL10 pair performed as well as one would expect, if not better.

It is quite educational to switch from a triple-driver system of 50W capacity to the smallest shelf-mounting model which uses only a six-inch base unit and a single three-inch tweeter. There is bound to be some colouration of response and a step-by-step run through the range shows this up as fairly minimal, often appearing with switching in one direction and not the other.

Prices are well in line with current ranges, running from £44·50 per pair for the smallest shelf-mounting model to £172·50 per pair for the Symphony 4522 studio units. The two smallest units are both shelf-mounting, the largest of the Annexe range can be used as a shelf-mounted or a freestanding unit whilst both the Symphony units are freestanding and can be optionally supplied with castor stands.

The prices mentioned are the recommended retail values and we understand that the units are to be available from specialist Hi-Fi dealers throughout the U.K.

The Annexe XL10 enclosure

TRANSDUCERS

Part 1 INTRODUCTION

Loa d ance Heat Light
Speed Force Load Sound istance
Force Load Sound Frequency Distance Heat

By P.R. ALLCOCK *

INTRODUCTION TO SERIES

This series of articles is intended as an introduction to the vast range of transducers that exists today. Instrumentation engineers are constantly challenged to satisfy the increasing demands made by their colleagues in other areas of specialisation and may be called upon to measure an almost infinite variety of physical phenomena.

Broadly defined, a transducer is any device by means of which energy, available in one form, may be changed to energy in another form. Energy can exist in various forms such as electrical, mechanical, acoustical and thermal and often the output energy of a transducer is in the electrical form. Devices which convert electrical power into, say, mechanical force also come within our broad definition but are often classified into a separate group known as electrical machines. Some of these devices are very important to the electronic engineer and small rotary motors, stepping motors and related devices crop up very frequently, as, for example, in equipment using tape or paper as a recording medium. Often the input energy will be in mechanical form and the first section of the transducer may then perform a conversion from say applied force to displacement.

The subsequent conversion of displacement to electrical energy would take place in a second section and could employ one of the many principles available such as: piezo electric effect, differential transformer, capacitance resistance or inductance variation, photo electric effect, magnetostriction, etc. The nature of the electrical output from the transducer depends on the principle involved in the design and may be analogue, digital, frequency modulated or some form of pulse train. In fact a transducer may be based on almost any combination of the various mechanical and electrical arrangements available.

Some examples of commonplace transducers are listed below and these will be covered in the series.

Measurement Required	Possible Transducer
Shaft rotation or position	Coded optical disc
Linear displacement	Variable resistance element
Temperature	Thermistor or variable resistance devices
Ultrasonic sound waves	Piezo-electrical material
Mechanical strain	Resistive or semiconductor strain gauge
Liquid flow	Turbine type flow-meter

IN GENERAL terms a transducer is a device which converts (or transduces) energy from one form to another. This definition is rather all-embracing since it includes devices such as electric motors, car engines and turbines whereas, at least through common usage, the term normally refers to devices of a somewhat more specialised nature.

In one category we have devices that can convert an electrical input stimulus into a mechanical output response, such as occurs in the moving coil loudspeaker, whilst in a second category we can group those devices that convert some physical quantity, property or condition to an electrical output signal as occurs for example with a pick-up cartridge.

It should be noted that transducers are not restricted to the use of an electrical signal at the input or output but such devices are by far the most common today due to the widespread use of electrical and electronic techniques in control, instrumentation, automation and measurement and the relative ease of processing or modifying such signals. For example, in many industrial processes the electrical output of a transducer is used, either directly or after processing, as a feedback signal in a servo-loop to control the output of the system in a specific manner.

In other applications a transducer might be connected to a readout device, such as a counter, tape printer or digital meter, and used to provide quantitative measurement information to an operator. Since it is not possible to control a process without measurement of one or more variables it is clear that transducers play an important part in a wide variety of modern engineering systems and measurement processes.

OPERATING PRINCIPLES

The operating principles of the majority of transducers in common use are straightforward, but in practice the utilization of these principles often involves very careful design and precision engineering in order that defects, which might otherwise limit the device accuracy, are kept to a low level. Even with careful manufacture, environmental factors such as temperature, vibration, shock and stray magnetic or electric fields, must be taken into account if the best accuracy is to be obtained.

Often several basic principles are used together to achieve the required output. The term measurand is often used to denote the quantity, condition or property which the transducer translates into the required output signal and in some cases the transducer does not respond directly to the measurand but to a related variable.

For example, transducers designed to measure acceleration are often activated by a displacement or force which is related in a known way to the acceleration.

* North Staffordshire Polytechnic

The "two-stage" principle is illustrated in Fig. 1.1. The first section translates the measurand into a displacement or stress and this in turn acts as the stimulus for the second stage which produces the requisite output. The second stage may generate the electrical output directly from the output energy of the mechanical transduction stage in which case it is known as self generating. The alternative form, which requires an external power source for excitation, is usually called a passive transducer.

TRANSDUCER CLASSIFICATION

It is an almost impossible task to classify the whole range of transducers now in use. However it is feasible to group them on the basis of their fundamental operating principles as in Table 1.1, even though they may be used in, or have evolved from, widely different applications.

Even with such grouping it may be difficult to classify a particular transducer uniquely because of overlap in the various selection parameters used. For example a thermistor might be classed as a variable resistance device or alternatively as a thermal device. Strictly speaking the thermal energy input is the measurand which can be related to temperature but two distinct modes of operation are possible.

If the electrical currents are kept sufficiently small the resistance will be dependent only on the heat input whereas if larger currents are permitted some self-heating will occur and the temperature will depend on two sources of heat.

VARIABLE RESISTANCE TRANSDUCERS

In the moving contact type, the measurand, either directly or indirectly, causes a change in the resistance of an electrical element. This change is usually caused by either a moving contact system or some physical or chemical action. The basic principle of a moving contact system is illustrated in Fig. 1.2 and here changes in liquid level are used to move a sliding contact along the resistance element BC.

TABLE 1.1

SOME ELECTRICAL PHENOMENA THAT CAN BE EMPLOYED IN TRANSDUCER OPERATION

Resistive	Electromagnetic
Capacitive	Thermo Electric (Voltaic)
Inductive	
Photo Resistive (Conductive)	Ionisation
Photo Electric (Emissive)	Electrolytic
Photo Voltaic	
Piezo Electric	Potentiometric
Piezo Resistive	Magneto Resistive

If we assume that the resistance between A and B is zero when the tank is empty the resistance R_{AB} for a liquid level of h will be $R_o \cdot h$ where R_o is the resistance change per unit height of liquid. If we assume also that R_o is constant i.e. the resistance element is perfectly uniform over its whole length L we can express the output voltage as $V_o = E\left(\frac{h}{L}\right)$ volts providing no current is drawn via the output terminals (Fig. 1.4).

In some application it may be desirable to use a resistance element that is not uniformly wound in which case the output voltage is no longer given by the above equation but by

$$V_o = E\left(\frac{R_{AB}}{R_{BC}}\right).$$

The way in which R_{AB} varies with height h determines the characteristic law of the transducer since E and R_{BC} are fixed. For example the resistance element R_{BC} could be wound on a thin wedge shaped sheet of insulating material as shown in Fig. 1.3. The resistance per unit length, R_o, is not constant for this case and will in fact increase uniformly as the slider moves from B to C as long as the resistance wire is sufficiently fine

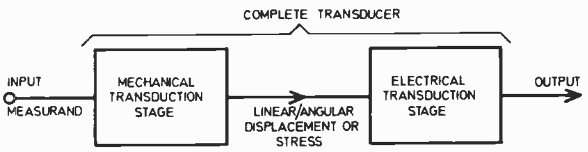


Fig. 1.1. Illustrating the "two-stage" principle of transducers

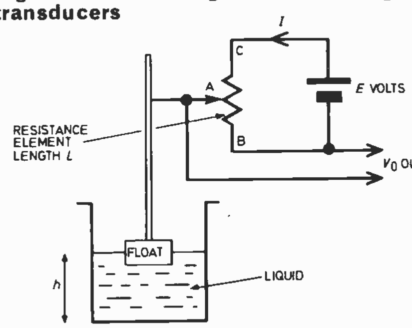


Fig. 1.2. A simple moving-contact system showing the basis of operation

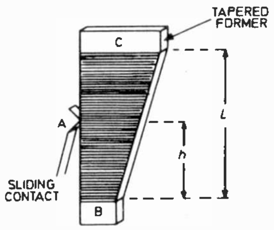


Fig. 1.3. A tapered or wedge-shaped element used in resistive transducers

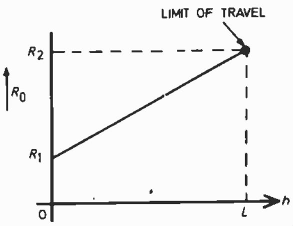


Fig. 1.4. Variation of resistance R_o with height

and the element carefully wound so that the turns cannot move as the contact passes over their surface.

For the wedge profile shown in Fig. 1.3 the variation of R_0 with height h will be as indicated in Fig. 1.5. The resistance per unit length is obviously a function of h since as the slider moves along the resistance element the length of each turn of the resistance wire increases slightly. The variation of R_0 can be written as

$$R_0 = R_1 + \frac{h}{L}(R_2 - R_1).$$

If we put $h = 0$ we find $R_0 = R_1$ and for $h = L$ (the limit of slider travel) we find $R_0 = R_2$.

To determine the resistance between AB or BC we need to add together the resistance of all the turns of wire between the two points of interest. This is achieved mathematically by integration and for the section between A and B we have

$$R_{AB} = \int_0^h R_0 dh$$

$$= hR_1 + \frac{h^2}{2L}(R_2 - R_1).$$

At full height $h = L$ and substitution in the above equation then gives $R_{BC} = L \cdot \left(\frac{R_1 + R_2}{2}\right)$ which is simply the length of the element multiplied by the average resistance per unit length.

The variation of output voltage with height for this type of element is illustrated in Fig. 1.5 which also shows, for comparison, the output of a uniformly wound element operating from the same supply voltage.

The wedge element gives the greater rate of change of output voltage providing the tank is at least half full $\left(h > \frac{L}{2}\right)$ whereas the uniform element gives the larger output voltage for all heights except $h = L$ at which level both types give the same output voltage.

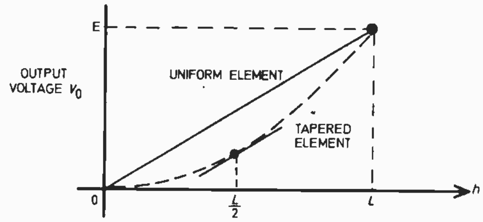


Fig. 1.5. Variation of output voltage with height

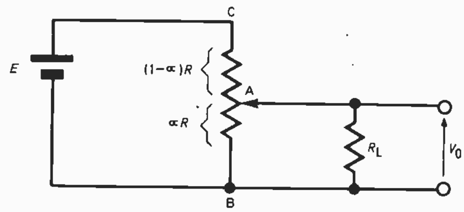


Fig. 1.6. Loading effects in transducer circuits

LAWS

The details discussed so far have shown that it is possible to control the characteristic law of the transducer by suitable choice of resistance variation with length of travel. In some applications it is the angular rotation of a shaft that activates the moving contact and in this case also it is possible, by choice of shape for the resistance wire former, to produce a given characteristic such as a sine or cosine variation of resistance against angular position.

Tapered resistance elements are sometimes used in bridge circuits to open out an otherwise cramped scale at the extremes of angular travel. The log and reverse-log audio volume controls use graded regions on the track with different resistance values per unit angle of rotation in an attempt to give a straight line piecewise approximation to the specified law.

Obviously mechanical friction has to be kept to a minimum in devices that have to operate with low forces and wear of contact and wire can limit the useful life. The wire used in some precision potentiometers is very fine to give good resolution and excessive currents can easily destroy the element, especially when the sliding contact is near to one end of the range of adjustment, due to the concentration of heat over a small region.

OUTPUT LOADING EFFECTS

No mention has been made of the loading that will occur if the transducer output is fed to a resistance which is not large relative to the element resistance. This form of loading is illustrated in Fig. 1.6 where the load on the output is represented by the inclusion of R_L. If α represents the fraction of the resistance element between A and B and R represents the total resistance of the element the circuit is simply that of a potentiometer having an upper portion of $(1 - \alpha)R$ and a lower portion of αR in parallel with R_L.

Analysis of the circuit gives the output voltage V_0 as:—

$$V_0 = \frac{\alpha E}{1 + \frac{\alpha R}{R_L}(1 - \alpha)} = \frac{\text{(Ideal Unloaded Output Voltage)}}{1 + \alpha K(1 - \alpha)}$$

where K is the ratio of transducer element-resistance to loading resistance.

For a given value of K we see that the output voltage is correct for $\alpha = 0$ and $\alpha = 1$ (i.e. $V_0 = 0$ and $V_0 = E$ at the limits of travel) but at intermediate settings of α the output is in error and will always be less than the (ideal) true output.

In any reasonable system K should be considerably less than unity in which case the output is lower than the true value by approximately $[100\alpha(1 - \alpha) K]$ per cent. The maximum error for a given K value occurs, as might be expected, when $\alpha = 0{\cdot}5$ and is of the order $25\ K$ per cent low providing K is small. For $K = 0{\cdot}1$ (i.e. $R_L = 10R$) the maximum error at mid-travel would be about 2·5 per cent low.

THERMISTORS

A thermistor is a heat-sensitive semiconductor resistor with a relatively large negative temperature coefficient of resistance, although thermistors having positive temperature coefficients are also available. A typical device will exhibit a resistance drop of about 4 per cent per degree temperature rise.

Unlike the p-n junction of a semiconductor diode or transistor, the thermistor does not depend on the effects that occur at a p-n interface and is not manufactured by doping silicon or germanium with impurities. Instead, a thermistor is made, using a sintering process, from mixtures of the oxides of metals such as manganese, nickel, cobalt, iron, copper, titanium and magnesium. Leads are attached to metallised areas on the thermistor body or connected during the controlled heating processes.

A very wide variety of shapes and sizes are now available ranging from small beads to large plates or rods.

A protective coating of epoxy or fused glass is often provided and some types are available in glass envelopes, either evacuated or gas filled. Resistance values at 25°C range from about 1 Ω to several MΩ.

Early devices were very variable in characteristic and it was difficult to match the characteristics of two similar thermistors. Fortunately improvements in manufacturing techniques have virtually eliminated the shortcomings of the early devices and thermistors are now available which are stable with time, matched and interchangeable to within a fraction of a degree over wide temperature ranges.

Thermistors now rival thermocouples in many applications since stable amplification is invariably required with thermocouples due to their low output voltage (typically of the order of 50 μV/deg C). The main advantage of the thermistor over the thermocouple is sensitivity. The output of the thermocouple is determined by the choice of the two metals and cannot be changed.

Typical thermistor bridge or potentiometer circuits can give output voltage changes of 100 mV/deg C which is some 2,000 times that of an equivalent thermocouple. The useful temperature range of thermistors is considerably less than for the thermocouple, being limited to about −100°C to +400°C whereas thermocouples can operate over a range of thousands of degrees. The thermocouple also has a more linear output since its output voltage per unit temperature change is more nearly constant.

THERMISTOR POTENTIOMETER

A simple potentiometer using a thermistor is shown in Fig. 1.7. Obviously the same current flows through both the thermistor and the fixed resistor. If the current is sufficiently small the self-heating of the thermistor will be negligible and its resistance will therefore depend on the ambient temperature. If this temperature rises the thermistor resistance will fall (assuming a negative temperature coefficient) and the current will increase. The resulting increase in voltage across the fixed resistor can be used as an indication of temperature but the voltage-temperature characteristic will not be linear.

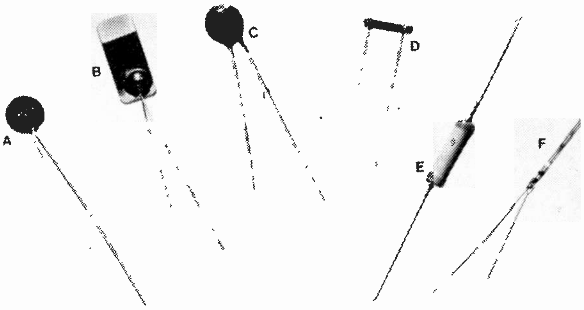
The resistance-temperature relationship for a thermistor is usually approximated by the equation

$$R = A\,e^{\beta/T}$$

where R is the resistance at temp. T^0 Kelvin, A and β are constants for the particular thermistor, T is the absolute temperature in Kelvin, and e is the base of natural logarithms, 2·7183. By taking logarithms of both sides of this equation we see that $\log_e\left(\frac{R}{A}\right) = \frac{\beta}{T}$.

This inverse relationship is sketched in Fig. 1.8.

For two temperatures T_1 and T_2 and corresponding



A selection of Mullard thermistors, (a) Diac NTC type, (b) Plate NTC type, (c) PTC type, (d) Rod NTC type, (e) Rod VDR type, (f) Bead in glass type

resistance values of R_1 and R_2 respectively we can write:

$$\frac{R_1}{R_2} = \frac{A\,e^{\beta/T_1}}{A\,e^{\beta/T_2}} = e^{\beta\left(\frac{1}{T_1} - \frac{1}{T_2}\right)}$$

which shows that the ratio of the two resistances depends only on β for given values of T_1 and T_2. The value of β usually lies in the range 2,000° to 5,500° Kelvin and is specified by the manufacturer. Also it is usual to quote a typical resistance value at some specific temperature, often 25°C. If the variables with subscript 2 are taken as the given 25°C values, then

$$R_1 = R_{25}e^{\beta\left(\frac{1}{T_1} - \frac{1}{298}\right)}$$

which allows R_1, the resistance at T_1 Kelvin, to be evaluated in terms of the resistance value at 25°C. For example if a particular thermistor has R_{25} = 1kΩ and β = 5,000 the resistance at 0°C will be

$$R = 1{,}000\left\{e^{5{,}000\left(\frac{1}{273} - \frac{1}{298}\right)}\right\}\ \Omega = 4{,}660\Omega.$$

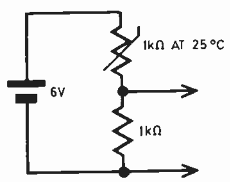


Fig. 1.7. A simple thermistor potentiometer circuit

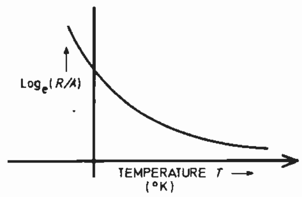


Fig. 1.8. The inverse relationship of temperature and voltage of Fig. 7

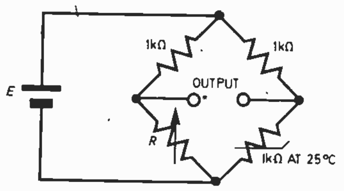


Fig. 1.9. A simple thermistor bridge circuit

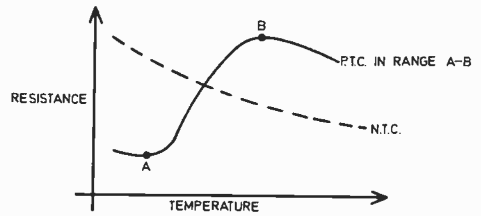


Fig. 1.10. The curves of a positive and a negative temperature coefficient thermistor

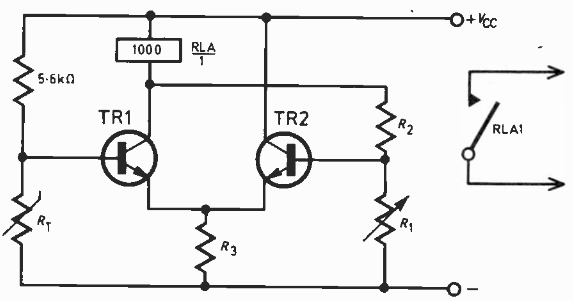


Fig. 1.11. A simple thermistor thermostat

The resistance has changed by nearly five times for a temperature change of 25 deg C.

One disadvantage of the simple circuit of Fig. 1.7 is that the output voltage (across the fixed 1kΩ) will vary with battery voltage which renders any calibration useless. This can be avoided by using a null method as shown in Fig. 1.9.

BRIDGE CIRCUITS

The bridge is balanced, by adjustment of R, to give zero output voltage. For this condition the resistance R and that of the thermistor must be equal and hence the temperature can be determined. Since the bridge circuit is always balanced when a reading is taken changes in the battery voltage have no effect on the null point providing current levels are sufficiently low to prevent self-heating.

When used at low current levels the thermistor responds to the ambient temperature as the measurand. However in some applications the most significant heating effect is due to power dissipated in the thermistor itself. As the current through the thermistor rises, from some initial low value, the voltage drop across the device rises. The onset of self heating eventually occurs and at a certain temperature the voltage stops increasing since the current increase is offset by the falling resistance.

Further increase in current (and power) causes the voltage to fall below this maximum value which is typically in the range 40° to 90°C. The temperature for maximum voltage drop depends on the β factor and ambient temperature. Another feature which is important in some applications is that of thermal time constant. An abrupt change of ambient temperature or power dissipation causes an exponential type change in the thermistor body temperature.

As mentioned earlier the temperature coefficient is large and can be shown to be equal to $-B/T^2$ per degree for negative temperature coefficient devices.

For positive temperature coefficient devices the coefficient is only positive over a finite temperature range as illustrated in Fig. 1.10 and it is usually difficult to express the resistance-temperature variation by a simple equation.

An interesting application of an n.t.c. thermistor is shown in Fig. 1.11 where the circuit behaves as a thermostat by operating the relay when the temperature falls to a predetermined level, say t_0. Resistor R_1 is set equal to the resistance of the thermistor at the specified t_0. At temperatures above t_0 the differential action of TR1 and TR2 is such that TR2 is passing current whilst TR1 is off due to the fact that the voltage across R_1 is greater than that across R_T.

As the temperature falls these two voltages become more nearly equal and eventually current starts to flow in TR1 at the expense of that in TR2. The current in TR1 flows via the relay coil and the resulting increase in voltage drop causes the base voltage of TR2 to fall. This further increases the current in TR1 and due to the regenerative action TR1 turns fully on and TR2 turns off.

The relay operates due to the flow of collector current in TR1 which aids the existing relay current that flows via R_1 and R_2. Due to the positive feedback effect the turn-on is rapid but the temperature will have to rise well above t_0 before the circuit resets itself. This effect is known as hysteresis.

Ideally R_2 should be made 4·6kΩ so that the bridge formed by the four "resistance arms" is balanced at the trigger temperature. Under these conditions the circuit is relatively insensitive to variation of supply voltage V_{CC}. R_3 determines the current levels for TR1 and TR2 once V_{CC} and R_T are fixed. A thermistor, relay and battery in series can act in the same way but operation will be very dependent on supply voltage and the switch-on instant will be less well defined.

Next month: Resistance thermometers, strain gauges, thermocouples and thermopiles.

BY FRANK W. HYDE

PHOBOS THE POTATO MOON

During the mission of *Mariner 9* to make a photographic survey of Mars, some 32 high resolution pictures were obtained of Phobos, the small Martian moon. These pictures were fortunately able to cover some 80 per cent of the satellite's surface and the first atlas of this small moon has now been published. These have been "cleaned up" using the special computer technique. The atlas was compiled by a group of scientists from Cornell, Stanford, Caltech and NASA, four very active establishments.

It is common practice, in setting up an atlas, to use a sphere on which the pictures can be placed and oriented. However, Phobos presents a special problem of its own for it is irregular in shape, more like a potato. It is thought that as the satellite has such a very small gravitational field it has not been pulled into a harmonious shape as it cooled. It is perhaps a quirk of cosmological humour that it so closely resembles the familiar potato.

Many models were tried out and T. Duxbury at Caltech finally arrived at a solution. The satellite radii are found to be 11·5, 15·5 and 9·5 kilometres. Duxbury settled on a triaxial ellipsoidal system of co-ordinates.

This reference grid was computer-fitted with the information and the results suggest that Probos is in synchronous rotation around Mars. It keeps the same face to Mars and therefore behaves as the Earth's own satellite. The longest axis points toward Mars and the intermediate one of 11·5 kilometres is in the orbital plane, the shortest axis being normal to the plane.

Phobos is very heavily cratered and the surface density is close to saturation. The initial mapping reveals some 50 craters. Seven have been given names though one is only a partial crater. This is the Kepler Ridge. Others are named Roche, Wendell, Sharpless. D'Arrest, Todd and the largest complete one, Stickney. The variations of the high to low points of the craters are as much as 20 per cent of the radius.

When compared with the Earth's Moon the feeling is that Phobos was formed as an independent unit very early in the life of the Solar System. Extensive fracturing seems to have taken place as a result of meteoritic impacts. The landscape appearance has been the result of meteor impacts. No doubt also the smallness of the body renders it liable to considerable geological change.

The structure generally suggests that Phobos is solid rock and the evidence is the manner of the cracks that can be seen. There is too little gravitation for it to be conglomerate. It is possible that the satellite is only part of a larger body that disintegrated a very long time ago.

As with all these "guestimations" alternatives are also offered. Whatever the conjectures may be there is now a good case to include a special programme to be set in operation at the time of the Mars *Viking* missions already planned.

HELIOS

In a past "Spacewatch" issue some details of a planned space probe were given. This or rather the first of two probes called *Helios* has been launched on behalf of West Germany by NASA.

The project was given the go-ahead in 1969. The probes weigh some 357 kilogrammes and will operate with a 192 day orbit. They will, at the apogee point, be within 45,000,000km of the sun, about one-third of an astronomical unit. Special thermal control will come into operation on these missions.

The first probe will steer into the ecliptic, the plane of the Earth's orbit, between Mercury and the Sun. Its final distance from the Earth will be some 300,000,000km. The primary mission will last 120 days. However, the life of the probes will be at least 18 to 20 months.

These two probes will also be supplementary, in the sense of data gathering, to that being obtained by *Explorer 47* and *50* and also that from *Pioneers 10* and *11*. The actual orbit of the probes will have a perihelion of 0·3 of an Astronomical Unit and a aphelion of about 1·0 Astronomical Unit with respect to the Sun.

The tasks set are very extensive, the instruments will investigate the magnetic field, density, speed and direction of the Solar Wind particles (electrons, alpha particles and protons). It will be possible to evaluate the spatial gradients involved in those quantities. The study of the electron plasma oscillations will be made by radio which exhibits the characteristic Type III outbursts.

Other experiments will look at the interplanetary dust, its gradients, density and direction and its exact composition. X-ray examination of the surface of the Sun will be undertaken.

ODD BODY

Helios is an unusual shape for a probe with a 16-sided central body and truncated cones top and bottom, each with 16 facets. The solar cells are disposed over the surface of the probe.

Because of the extreme temperatures involved, some 370°C, nearly 90 per cent of the Sun's radiation must be reflected. This makes very stringent demands on the probe's thermal regulation system. The solar cells may not be subjected to a greater temperature than +165°C. The interior temperature must be kept within the limits of −10°C to +20°C.

This problem is partially solved by using special SSMs, second surface mirrors, developed by NASA. They are made from fused silica and covered on the underside by a thin film of silver which is further covered by a dielectric. These cells have a high emissivity and will prevent the central body from heating up to 800°C. This is the sort of temperature to which the aerial will be subjected when extended even though the probe is revolving at 60 r.p.m.

However, the mirrors alone are not sufficient to hold off the Sun's radiation which amounts to some 22,400 watts/sq.m. A special thermal insulation system consisting of layers of spaced metallised foil is also used. The foil is held apart by nylon mesh to avoid heat bridges. Other ingenious controls consist of bimetal levers which operate the louvres to allow the experiments to be carried out. They are also used to control the inside temperature.

Control of the mission is being carried out at the Command Station at Weilheim, Germany, with a 30 metre dish built specially for these missions. Also in use for transmission of commands and the reception of data is the Planck Institute 100 metere radio telescope at Eifel.

Strictly Instrumental

by K. Lenton-Smith

IN AN earlier article in this series, we mentioned that the roots of electronic music went back some 150 years. Two Americans, C. G. Page and C. E. L. Delezenne experimented with rotary generators and their findings were published in scientific journals of the time. However, it is probably more accurate to assume that 40 years is the life-span of electronic music as both L. E. A. Bourn and Laurens Hammond perfected their respective electrostatic and electromagnetic generators in 1935.

Among other inventions in this era, the Compton Electrone and the Hammond organ were soon to make the public aware that electronic musical instruments were a practical proposition and here to stay. Dr Robert Moog's voltage-controlled circuitry (circa 1960) gave this field a new fillip: it offered another method of musical self-expression, albeit the player had to be technically inclined, patient and equipped with special recording apparatus.

IMPERSONAL

Compared with this relatively short life, conventional musical instruments have been developed over the centuries by ingenious craftsmen: they have been improved to the point of near-perfection and in the main are capable of extreme expressiveness in the hands of a skilled performer.

I was recently asked to give a lecture on "Electronic Music" to students of an eminent classical pianist. Various forms of electronic music, previously edited on stereo tape, were played to the audience, including music concrete, the classical organ and light music. A bench demonstration was carried out to show various methods of tone-generation, waveforms, tone-forming, keying and synthesiser operation. Finally, this orthodox audience was asked to express views.

"You hug a cello", commented the eminent pianist, "kiss a flute and stroke a piano. You have a quasi-erotic relationship with your instrument. Can this be so with electronic instruments? They sound too precise."

My reply was that, if you build your own instrument, you often go to bed with it! This remark was made with conviction, having built four organs over the years and burnt considerable midnight oil. Although it is literally true to say that electronic instruments certainly are "alive", his point was a valid one, as the reader will appreciate. Even so, the player can become equally attached or infatuated with his electronic instrument.

Perhaps we had invited the comment by playing tapes of both the "William Tell Overture" and part of the second movement of "Beethoven's Ninth," first by an orchestra then the Moog's imitation of it. The complexity of imitating an orchestral score on a synthesiser using multi-recording techniques is enormous, but the same performer adding line after line to his recording should be able to get timing closer than the many individual players of the concert orchestra. Indeed, the tape is often run at half speed and the parts played an octave lower than usual: when replayed at normal speed, the somewhat objectionable effect of mechanical precision is heightened.

ONE NOTE

The polyphonic synthesiser (the ability to play chords rather than single notes) is still rare, so perhaps the main objection to the instrument at present is that painstaking time and effort are involved in using it. Any solo acoustic instrument could be re-recorded in four-part harmony, provided its compass was great enough: a laborious process, but Les Paul was doing this 20 years ago with his guitar "orchestra". In its imitative capacity, at least eight tracks would be used with the synthesiser, the registration changing every few bars.

Until the polyphonic variety becomes commonplace and the cost economic, the majority of serious, non-technical musicians will give the synthesiser a wide berth. Musical readers of P.E. are probably not typical as their interests will be technical: lets face it—the constructional articles by Douglas Shaw and Alan Boothman call for a high standard of technical ability and understanding if the correct results are to be obtained.

THE TREND

Our educational system should ensure that music has full rein in years to come. At the same time, the rising number of flat-dwellers makes the ordinary piano something of a problem in their homes. So the electric piano might well become more common, albeit the 5-octave manual imposes its limitations (an 8-octave instrument would present no technical problems, but would defeat the object by taking up the same space as an upright). The harassed parent could provide budding pianists with headphones through the five-finger exercise stage—surely a selling point!

Craftsmanship is rapidly becoming scarce. The special skills required in making violins, for instance, may become both expensive and hard to find as time passes. Woodwind, brass, pianos—indeed all acoustic instruments — are craftsman-made and inflation could make these difficult to afford for future generations.

CONTROL

Although electronic components are currently in short supply, they ought to remain relatively cheap in this age of technology. So there is a strong possibility that electronic musical instruments will progressively supplement—or even supplant—acoustic instruments in classical music.

Where money is to be earned in music, it is certainly not in the serious field. Pop groups have proved that they have money (and even instruments) to burn! Many of them use synthesisers and other sophisticated equipment, but the end-product is often hideous!

If the serious music fraternity looks with trepidation to the future, it will have to come to terms with electronics and start to lay down guidelines to manufacturers for the types of electronic instrument it would like to see made. Failing this, pop groups will continue to give the impression that cacophony is the only end-result, to the detriment of electronics and good musical taste.

P.E. KIT REVIEW

SINCLAIR SCIENTIFIC CALCULATOR

BUILDING THAT COUNTS

The pocket calculator is now firmly entrenched as a part of our way of life. It appears in almost every shop window alongside stationery, toys, cassette recorders and sweets. It comes in various forms extending from the simple four-function up to the sophisticated multi-function accountant's and engineer's dream, and can be acquired in the ready-made or even the kit style.

Recently just such an instrument became available, the Sinclair Scientific, which utilises Polish notation and logarithmic and trig functions to carry out calculations currently only available in far more complex machines.

THE KIT

The Scientific kit comes carefully wrapped and packaged in a compartmented foam plastic moulding complete with all parts, very comprehensive instructions and a variety of guarantee conditions suited to those who either fail or meet problems at the constructional stage.

Assembly is certainly simple if one has had prior experience with i.c.s, soldering and plastic models, but it should be stated that the job is not one for the totally inexperienced if they also have no tools. For example, a quality miniature soldering iron is a must and miniature sidecutters and snipe-nosed pliers a very useful adjunct.

The writer found a need for a model-maker's scalpel at one stage in gaining a tight fit of the keyboard assembly in the very nicely designed outer case. A small amount of mould flash was intruding on the area to be occupied by the keyboard.

In fact assembly went ahead smoothly and without any real hitch thanks to the clear and precise instructions. Indeed these are directed to all possible purchasers and take the uninitiated right through the various problems to be met such as tools, handling calculator chips, cleanliness and so on in a very helpful manner.

The only part of the assembly which might pose problems to some concerns the keyboard and here it would be wise for any first-timer to follow the instructions very carefully. Its not that one damages the unit in the process, more that one has to do the job several times to get it right.

In fact, the case and mechanical assembly tend to appear to be somewhat flimsy on first inspection but the design is quite interesting, making use of the inherent flexibility and strength of the plastic material to give at one and the same time a strong and attractive case. The external appearance is not marred by fixings of any sort and yet it is a simple matter to take apart and reassemble the case.

The only point of serious criticism which came to light concerns the battery connectors. In the Scientific as in most of the Sinclair range made to the same standard, use is made of small plated spring clips which are soldered to the circuit board. These at one and the same time form the connectors and retainer clips for the batteries. Whilst each clip has a projection which engages in a hole in the board, this effects location rather than mechanical retention, so only the soldered joint provides the necessary strength.

Under normal desk use this is no problem, but the vagaries of pocket use over a period of three months have caused one terminal to come loose twice. The first time the soldering was questionable and the second occurred within a few days of first use anyway, so the problem appears to be removed with due attention to one's soldering.

OPERATION

In use the Scientific takes some time to acclimatise to. Unlike its four-function associates such as the Cambridge, it makes use of so-called Polish notation for the normal four-function mathematics. Thus to add A and B one enters A+ and then B+. Take B from A one enters A+ and then B−.

Equally, it requires "programming" by way of pushing one of two extra buttons in order to carry out the extra functions such as providing logs and trignometric functions.

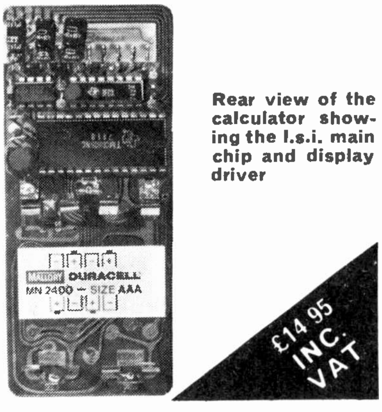
However, this is little hardship for the results obtained. The machine is sufficiently small to fit into the palm of the hand and be operable by the thumb of that hand if one wishes to show off just a little.

Clearly, at such a low cost and in such a small package, one cannot expect to get all the refinements of a £400 equipment or even, for that matter, of an £80 item. However, the Scientific gives results well in keeping with the job it is supposed to do. For example, taking the value of logs it gives. All those tried by the writer have matched four figures tables and, indeed, six figure tables most of the time. Of course, the machine only indicates to five figures, and to some this might be a disadvantage.

One or two simple tests indicate the value of the machine. Take 2^{64} up to that value and then back down again to 2, The result is 2·0001. Not bad.

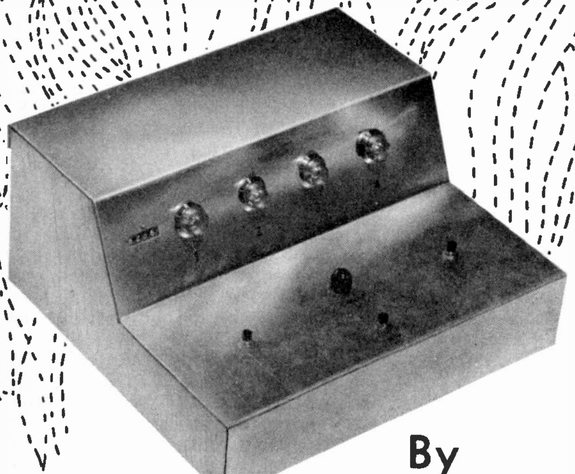
Some of the Trig functions seem, in the face of accurate tables, to leave something to be desired, and it is wisest to learn just when one ought to bring a calculation out of the machine and make suitable notes in this area.

So far any errors of note on the Scientific have been clearly traceable to the user and not the equipment and the more one uses it the easier it becomes to replace the slide rule.



Rear view of the calculator showing the l.s.i. main chip and display driver

ESP DETECTOR



By
R. K. Johnson

EXPERIMENTS to detect the existence of Extra Sensory Perception (ESP) normally involve two people: the subject being tested and an operator to turn over cards and record their symbol or value. A common problem in these experiments is a gradual reduction in performance due to boredom and lack of interest.

The electronic apparatus described here was developed so that the subject alone could test himself and so that interest could be maintained by introducing a game element into the testing by using "biofeedback".

CONTROL LAYOUT

The layout of the detector and its controls are shown in the photographs. When the SPIN button is pressed the circuitry oscillates until the button is released when the circuit freezes at either "left" or "right".

The CHOOSE lamp lights to indicate that a choice must be made between left and right. The subject then presses either the LEFT button or the RIGHT button. If he has chosen correctly, lamp LP1 lights, the CORRECT counter counts on by one digit and the TOTALS counter (at the rear) also counts on by one digit.

If he guesses wrongly, only the TOTALS counter is activated. The SPIN button is used again to spin left or right and the subject chooses again and so on. If the subject makes two successive correct guesses, then lamp LP2 lights as well as lamp LP1 (and both counters count on one).

As long as he makes more correct guesses, more lamps light until all four are illuminated and these stay illuminated so long as he guesses correctly. If he chooses the wrong button, all the lamps go out and he must begin again, trying to build up a row of lights. If required, the counters provide information for statistical analysis.

THE SYSTEM

The circuit is largely composed of cheap 74-series TTL integrated circuits. The block diagram is shown in Fig. 1 and the detailed logic in Fig. 2.

Block MV1 is an astable multivibrator which alternates high and low or "left" and "right" at about five thousand times per second.

It may be made to oscillate at a higher frequency if required by reducing the values of two capacitors C1 and C2. In any case these capacitors should have equal capacitance so that the multivibrator spends equal lengths of time in its "left" and "right" positions.

There is no possibility of the operator guessing the state of the circuit by the length of time he presses the SPIN button because the multivibrator is spinning all the time, not just when the SPIN button is pressed.

The output from the multivibrator is fed to the clock pulse input of a 7472 gated J-K flip-flop (BS1), which will not accept the pulses from MV1 unless all J and K inputs are at logic 1. (Positive logic is used throughout, i.e. logic 0 equals zero volts and logic 1 equals about +4 volts). These J, K inputs are controlled by SPIN switch S1 coupled to a "bistable latch" (L1).

The bistable latch is required to overcome problems of switch contact bounce and is formed from two of the NAND gates in a 7400 pack.

When S1 (whose wiper is earthed) is in position "a" so that input "a" is at logic 0, input "b" is at logic 1. Output C is then at logic 1 and output $\overline{C}$, at logic 0, is connected to the J, K inputs of BS1 (see Fig. 2). If SPIN switch S1 is pushed so that contact "b" is earthed, the outputs C and $\overline{C}$ of the bistable latch reverse, the J, K inputs of BS1 are then at logic 1 and the output from multivibrator MV1 is accepted into flip-flop BS1, causing the outputs (Q and $\overline{Q}$) to alternate at 5kHz.

If S1 is released so that contact "a" is earthed, output $\overline{C}$ goes to logic 0, thereby freezing flip-flop BS1 in either a "left" (Q = 1, $\overline{Q}$ = 0) or "right"

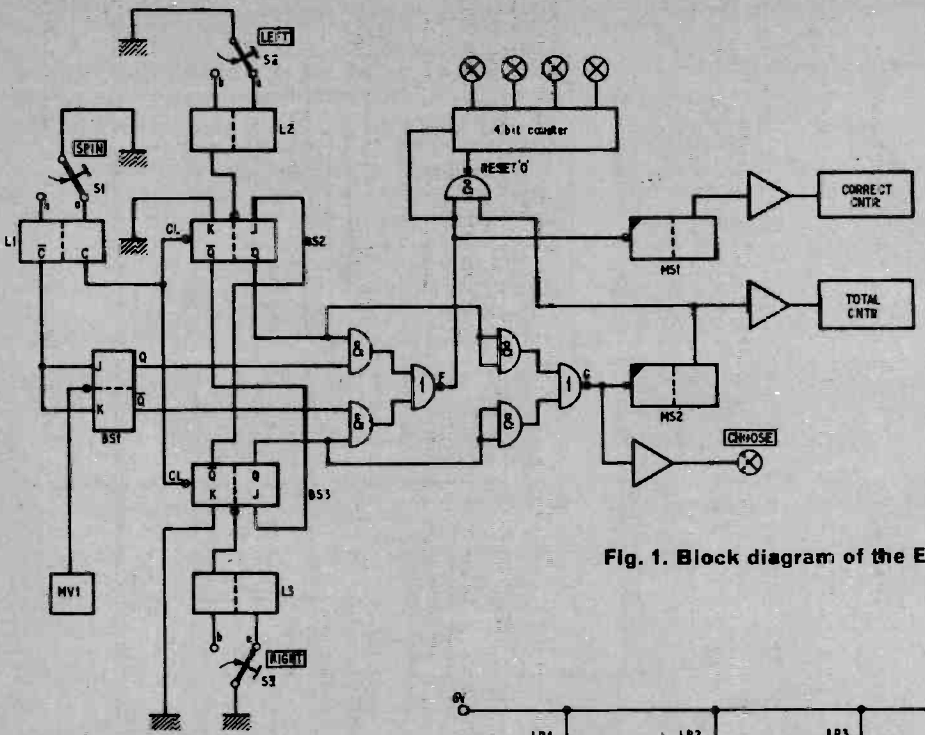


Fig. 1. Block diagram of the ESP Detector

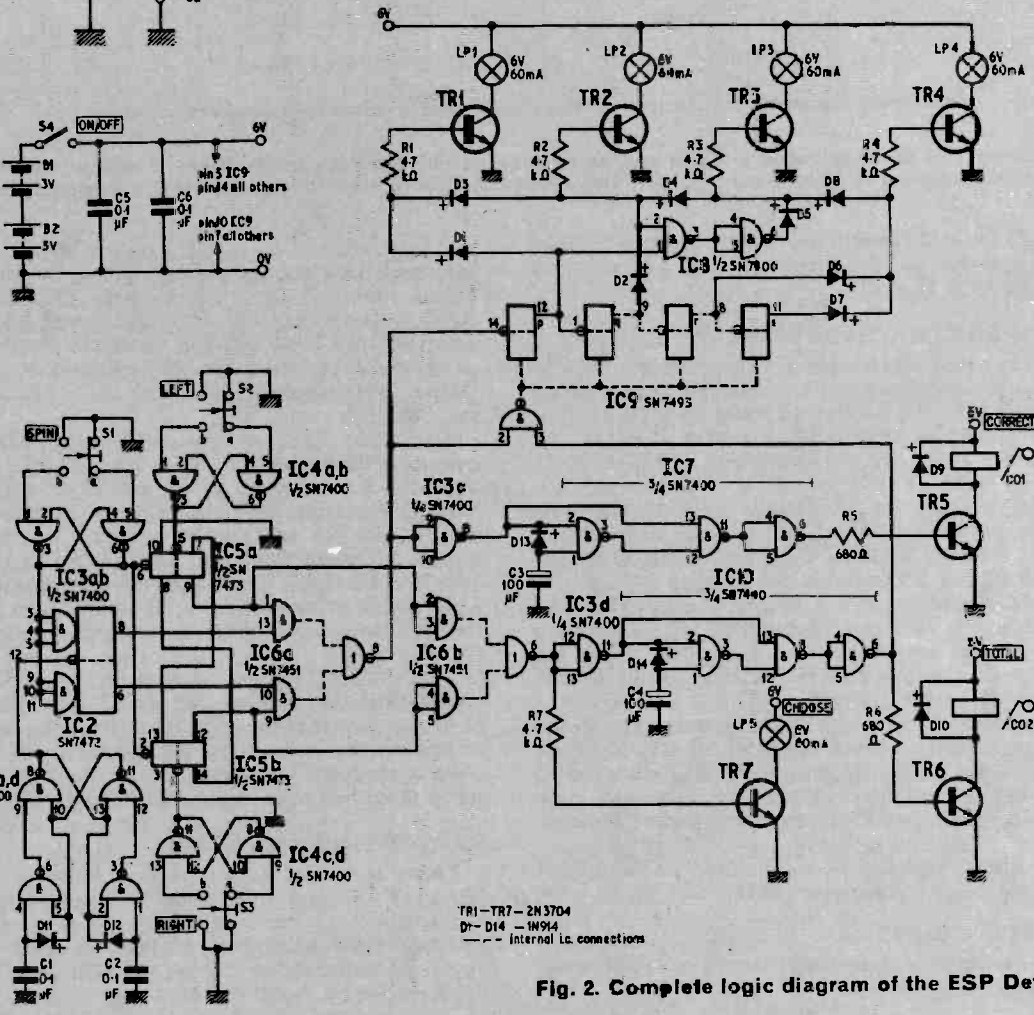


Fig. 2. Complete logic diagram of the ESP Detector

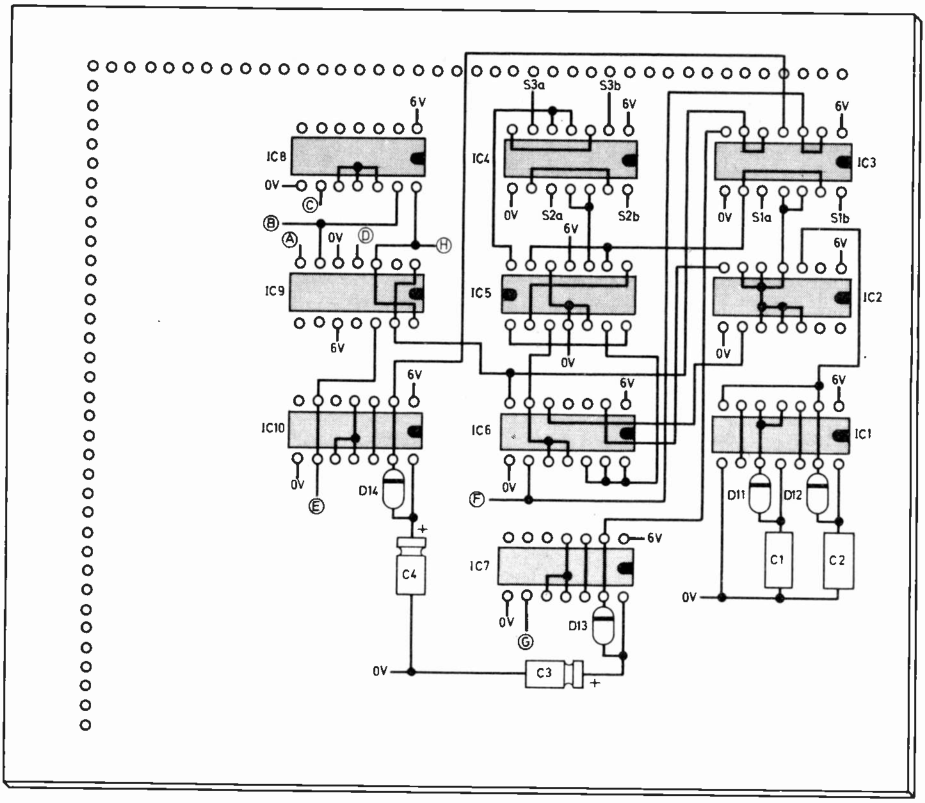


Fig. 3. Layout of the integrated circuits and associated components on the perforated board. Circled letters indicate connections to Veroboard (Fig. 4). This shows the board viewed from below (i.e. wiring side)

($Q = 0$, $\overline{Q} = 1$) condition. This condition is then to be guessed by the operator and his response compared with Q or $\overline{Q}$.

THE OPERATOR RESPONSE

The LEFT and RIGHT operator-response switches S2 and S3 are each connected to a bistable latch formed from each half of a 7400 quad NAND pack (IC4). The output from each bistable latch is fed to the clock pulse input of a JK flip-flop (BS2 or BS3), contained in pack IC5 which is a 7473 dual J-K flip-flop. Initially the Q outputs of both BS2 and BS3 are at logic 0, but after the operator's input from L1 with S2 or from L2 with S3, the Q output of either BS2 or BS3 will change to logic 1.

The Q output of BS2 with the Q output of BS1 is fed into one AND gate of one half of a 7451 dual 2-wide 2-input AND/OR/INVERT pack IC6, while the Q output of flip-flop BS3 with the $\overline{Q}$ output of BS1 is fed into the other AND gate of IC6a.

If the operator has guessed correctly (i.e. if the Q output of BS1 and the Q output of BS2 are both at logic 1, or if the Q output of BS3 and the $\overline{Q}$ output of BS1 are both at logic 1), then, and only then, will the output F change from logic 1 to logic 0.

This output F is fed to an inverter whose output is connected to a monostable (MS1).

CORRECT COUNTER

The monostable was built using a 7400 quad NAND pack.

When (after a correct guess) the signal from the inverter goes from logic 0 to logic 1, the monostable output rises to logic 1 for about 0·1 seconds. Passed through base resistor R5, this signal drives TR5 into an "on" condition for an equal length of time so that the CORRECT counter counts on one digit. Diode D9 protects TR5 from the back e.m.f. of the counter's coil.

The other half of AND/OR/INVERT pack IC6 is used to detect whether either BS2 or BS3 has been activated by switch S2 or S3 and if so, it then activates monostable MS2 (through an inverter), which drives TR6 to energise the TOTALS counter. The output G (changing from logic 1 to logic 0) also switches off TR7, to switch off the CHOOSE lamp. This lamp remains off until the circuit is reset through switch S1 when the output G again rises to logic 1.

The resetting of the activated flip-flop BS2 or BS3 (depending on whether S2 or S3 was pressed) is obtained at the same time that the SPIN switch S1 is pressed, by connecting the output from latch L1 (which changes from logic 1 to logic 0 as S1 is pressed) to the CLEAR inputs of both BS2 and BS3.

PREVENTING CHEATING

There is a further connection between the two flip-flops BS2 and BS3: the $\overline{Q}$ output of each half is connected to the J input of the other half and each K input is earthed to logic 0. This ensures that once either S2 or S3 has activated one of these flip-flops, then both flip-flops are locked and are

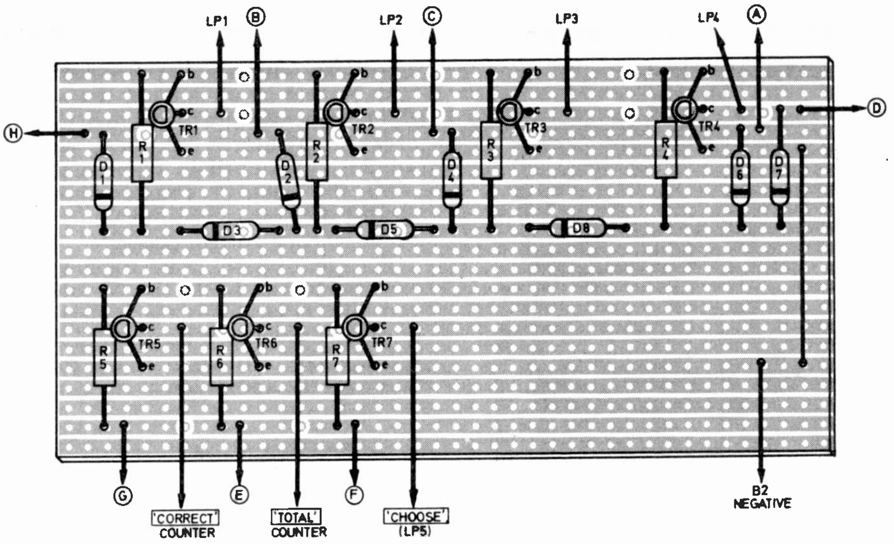


Fig. 4. Layout of the transistor circuits on the Veroboard panel

not affected by further operations of S2 and S3. This prevents the operator from trying one switch and then the other and from pressing one switch repeatedly to increase his score.

LAMP DECODING AND DRIVING

The remainder of the circuit consists of IC9 and IC8, the row of lamps LP1 to LP4 and their drivers (Fig. 2). Pack IC9 is a 7493 4-bit binary counter containing four flip-flops p, q, r, s and a NAND gated reset. The F output (which indicates correct guesses) is fed to the input of IC9. If only one pulse is fed into IC9, the output of p is at logic 1 while q, r, s are at logic 0. The p output is routed via diode D1 and R1 to TR1 which switches on lamp LP1.

If another pulse is received, p goes to logic 0 and q goes to logic 1 which is routed via diodes D2 and D3 to both TR1 and TR2 so that both lamps LP1 and LP2 light. Similarly for three pulses, both p and q are at logic 1 and their outputs are combined by gates (two of the NAND gates in 7400 pack IC8; the other two gates are not required).

Diodes D4, D5 and D3 ensure that three lamps light. For higher numbers of correct guesses (up to fifteen), the logic 1 outputs of r and s are routed via diodes D6, D7, D8, etc. so that all the lamps light. These lamps remain on so long as the two inputs to the reset are not both at logic 1. However, if the operator guesses wrongly, the output F will remain at logic 1 and the output of MS2 will rise to logic 1, thus operating the NAND reset and switching off the lamps.

While all this may seem rather complicated, the actual construction is straightforward.

CONSTRUCTION

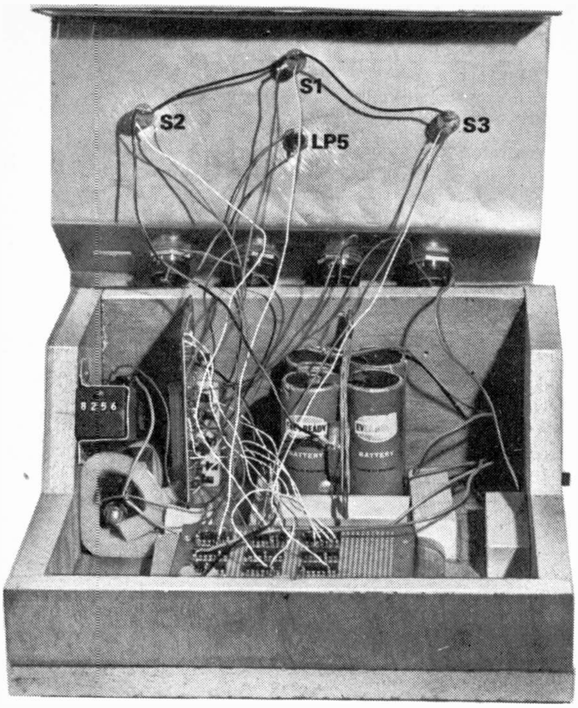
In the prototype, the ten i.c.'s IC1 to IC10, the capacitors and the diodes D11 to D14 were mounted on 0·1in matrix plain s.r.b.p. board. See Fig. 3 and the photographs. Alternatively, 0·1 matrix Veroboard may be used providing the strips are cut away so that each i.c. is isolated from the others. The connections for each of the i.c.'s (viewed from underneath) are also shown in Fig. 3.

The suggested order of construction is:

1. After labelling each i.c. from beneath the board, make the common connections between pins on the same i.c., working from Fig. 3. Use a soldering iron with a small bit and low power, touching the pins on the i.c. for the least possible length of time.
2. Make the interconnections between the i.c. soldering as before and working methodically. These connections are most easily made with colour coded wire and as each connection is made, it should be ticked off on Fig. 3.
3. Connect diodes D11 and D12 to pack IC1. Connecting pins inserted in the matrix holes are useful here.
   Similarly with diode D13 to pack IC7 and D14 to pack IC10, capacitors C1 and C2 to pack IC1, C3 to pack IC7 and C4 to pack IC10.
4. Connect the common earthed (negative) line to all the i.c.'s. This should go round all the i.c.'s like a ring main circuit.
5. Connect the common positive line round all the i.c.'s.
6. It is recommended that the supply line is decoupled every five packs by connecting capacitors C5, C6 between the positive and negative lines at two points on the board (see photograph).

All the lamp drivers and counter drivers are mounted on Veroboard. Fig. 4 shows the gaps to be cut in the copper strips and the component layout.

Rewind the coils of the two counters if they are not already six volt operating. In the prototype the counters were standard PO 4-digit non-resettable with an operating voltage of about 24V. These were dismantled to gain access to the solenoids from which all the turns of 40 s.w.g. wire were removed. The coils were then rewound with as many turns as possible (as neatly as possible) of 32 s.w.g. enamelled copper wire. The counters, when reassembled, should operate easily and firmly on 5V or less (drawing 150 to 200mA).



Photograph showing the internal layout of the ESP Detector

COMPONENTS . . .

Resistors
R1–R4 4·7kΩ (4 off)
R5, R6 680Ω (2 off)
R7 4·7kΩ
All ±10% ¼W carbon

Capacitors
C1, C2 0·1μF (2 off) (see text)
C3, C4 100μF 10V elect
C5, C6 0·1μF (2 off)

Transistors
TR1–TR7 2N3704 (7 off)

Diodes
D1–D14 1N914 *or* any general purpose silicon diodes (14 off)

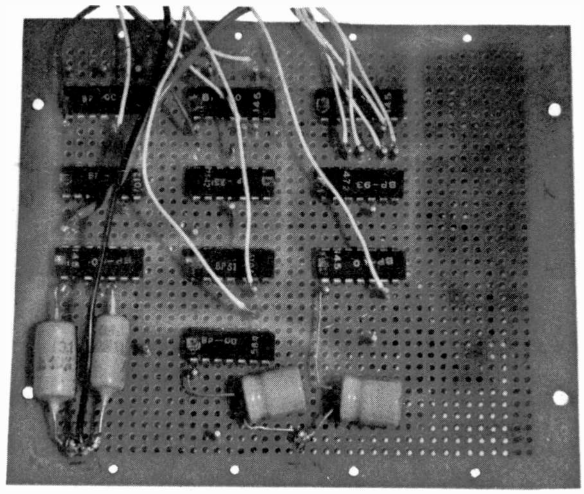
Integrated circuits
IC1, 3, 4, 7, 8, 10 SN7400N (6 off)
IC2 SN7472N
IC5 SN7473N
IC6 SN7451N
IC9 SN7493N

Miscellaneous
CO1, CO2 PO type four-digit counters (2 off) (see text)
LP1–LP5 6V 60mA lamps with 4 amber and one green holder (5 off)
B1, B2 Type 800 3V batteries (2 off)
S1–S3 Single pole changeover pushbutton
S4 Single pole on/off
0·1in matrix Veroboard 4in × 2in
0·1in matrix perforated board 12cm × 10cm
32 s.w.g. enamelled copper wire
Case to suit

THE CASE

The prototype was housed in a box made from chipboard with an aluminium fascia. The counters may be held by aluminium straps to the walls of the case. Since we are using the principle of biofeedback to reinforce learning, the TOTALS counter should be wrapped in foam rubber to reduce noise while the CORRECT counter should be held firmly against the side of the box so as to give a satisfying clunk on each correct occasion.

The i.c. board was mounted horizontally on wooden blocks while the Veroboard was mounted vertically adjacent to the batteries which were held in place by wooden blocks and an elastic band (see photograph). Rub-on lettering for CHOOSE, SPIN, etc. improves the apearance of the completed detector.



Photograph of the integrated circuit board

TESTING

On first switching on, it may happen that all five lamps light. If so, press the switches until they all go off. On then pressing the SPIN switch, the CHOOSE lamp should light and remain on when the SPIN switch is released.

Pressing the left or the right switch should have no effect but releasing it should cause the TOTALS counter to be activated. Check that this is absolutely reliable, always counting on one digit when either the left or the right switch is pressed and released after the CHOOSE lamp is lit. Releasing the left or right switch may also have the effect of activating the CORRECT counter and lamp LP1.

Check that this counter is also reliable and always counts when another lamp lights or when the completed row remains on.

If the detector has been built for interest only, no further testing is necessary. However, any statistical analysis will rely on a 50/50 chance of the spinning circuit freezing in the left or the right condition. This can be tested in two ways:

(a) by taking the output of the astable multivibrator MV1 (pin 8, IC1) to the Y-plates of a cathode ray oscilloscope and running the X-timebase at about 5kHz. The trace should show a square

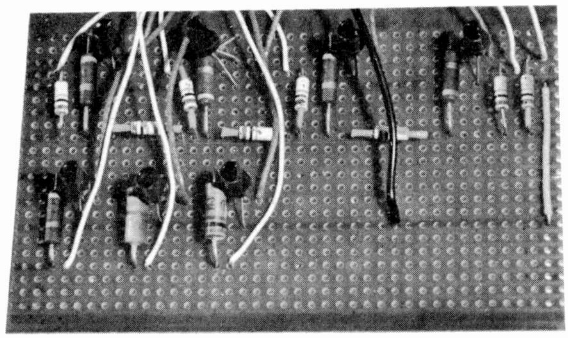
Table 1: Confidence Levels

	Excess over the mean (in standard deviations)									
	2·0	2·2	2·4	2·6	2·8	3·0	3·2	3·4	4·0	5·0
Odds (1in)	20	40	60	100	200	400	800	2,000	10,000	2,000,000
Confidence Level (%)	95·5	97·2	98·4	99·1	99·5	99·7	99·9	99·9	100	100

wave with an equal mark/space ratio. If not, it implies that the capacitors C1, C2 are not equal in value and should be changed or modified (by adding smaller capacitors in parallel with the lesser of C1 or C2) until the mark/space ratio is 1 : 1).

(b) by pressing the SPIN and (say) the RIGHT button repeatedly for a large number of times (without touching the other button) and noting the scores on the CORRECT and TOTALS counters. Over a large number of results, the CORRECT number should tend towards one half of the total number of tries. Since we are testing a random process, the CORRECT number will not be exactly one half the TOTAL number even if the probability of left/right is exactly 50/50. However, almost all runs of 100 guesses should have 50 ± 10 correct results.

If, after repeating this several times, there is a clear bias, the value of one of the capacitors should be adjusted to reduce the bias. A small remaining bias will not affect the statistics providing the subject believes there is no bias.



Photograph of the transistor panel

STATISTICAL ANALYSIS

In deciding whether a result is due to ESP or purely to random chance, it is usual to calculate the odds against the event occurring by chance.

The odds against a run of x correct answers occurring by random chance is easily calculated by $\frac{1}{2^x}$. For example, the record run in the prototype was 14 correct in a row, which by pure chance would occur $\frac{1}{2^{14}} = \frac{1}{16{,}384}$ i.e. once in 16,384 guesses.

However, calculating the odds against getting x correct answers in a session of n guesses is rather more complex. The formula is $\frac{n!}{x!\,(n-x)!\,2^n}$ where $n!$ (pronounced "factorial n") is calculated by multiplying n by all the whole numbers less than n. For example: $10! = 10 \times 9 \times 8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1 = 3{,}628{,}800$. For small values of n, with a lot of cancelling, this is straightforward. For large values of n, the calculation becomes tedious, although using Stirling's approximation the formula becomes

$$\frac{(n/2)^n}{(n-x)^{n-x}x^x} \times \sqrt{\frac{n}{6x\,(n-x)}}$$

which, although it looks more complicated, is easier to evaluate (using logs to calculate the powers).

A simpler and sufficiently accurate way to decide whether a result is sufficiently unusual to be accepted as proof of ESP is to calculate the "standard deviation" of the results from the formula:

$$\text{standard deviation} = \frac{\sqrt{n}}{2}$$

CONFIDENCE LEVEL

Table 1 can then be used to determine the "confidence level" of the experiment. In psychology and biology experiments where similar methods are used, odds of 1 in 20 (5 per cent) are normally accepted as proof, providing similar or greater odds are indicated whenever the experiment is repeated. These 5 per cent odds are usually quoted as a "95 per cent confidence level". Naturally *all* results (for a particular individual) must be included for these calculations, not just good results or sessions with high scores.

EXAMPLE

A particular subject, in nine sessions (each of 100 guesses) obtained the following scores: 49, 52, 48, 54, 57, 55, 60, 56, 52.

(a) The total number of guesses, $n = 900$.

$\therefore$ The standard deviation $= \frac{\sqrt{n}}{2} = \frac{\sqrt{900}}{2} = \frac{30}{2} = 15$

(b) The number of correct responses, $x = 483$.

The "mean" of the 900 guesses $= 900 \times \frac{1}{2} = 450$

$\therefore$ The number of correct responses exceeds the mean by 483 − 450.

$= 33$ responses

$= \frac{33}{15}$ standard deviations

$= 2·2$ standard deviations

From Table 1, an excess of 2·2 standard deviations represents a 97·2 per cent confidence level (or odds of about 1 in 40) and, if repeatable, indicates the presence of ESP in the individual who is being tested. ★

LOGIC INDICATOR PROBE

By W. H. DAVIES

THE requirement for a compact, lightweight and versatile logic tester for use with the current range of integrated circuits has long been recognised by many electronics hobbyists, particularly those who are not fortunate enough to possess an oscilloscope. The Logic Probe to be described not only fulfills this need, but has the added advantage of providing a facility for use in the field. It can be quickly assembled and the components purchased at relatively low cost.

COMPONENTS . . .

Resistors
- R1 470Ω
- R2 470Ω
- R3 33kΩ
- R4 470Ω
- All 10% $\frac{1}{8}$ watt carbon

Capacitor
- C1 2·2μF elect. 10V

Semiconductors

IC1	SN7413
IC2	9601 (Fairchild)
D1	1N4001
D2	OA200
LP1—LP3	TIL209 l.e.d.s (3 off)

Miscellaneous

Veroboard (see text) and Veropins, plastic tubing, wooden dowels, wire, miniature crocodile clips

CIRCUIT DESCRIPTION

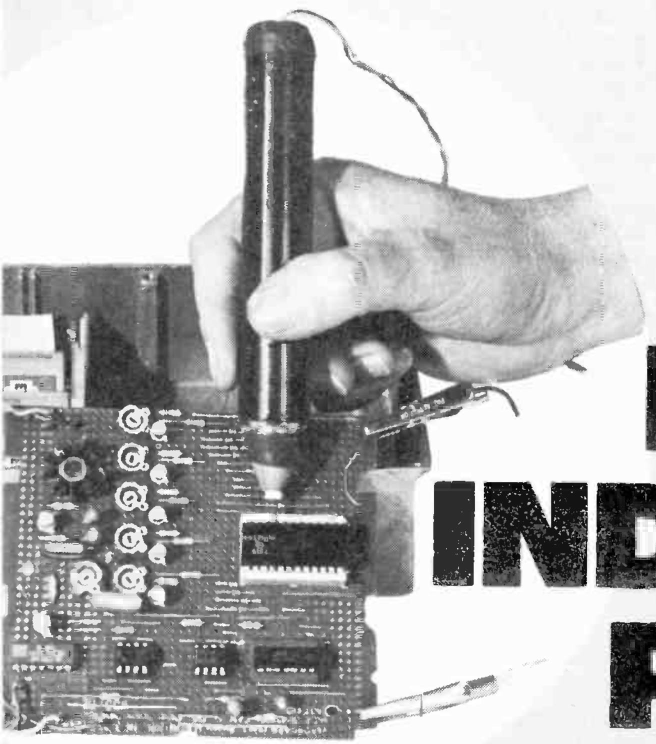
The Logic Probe is basically comprised of two readily available integrated circuits which are the SN7413 dual 4-input NAND gate (Schmitt Trigger), and the 9601 retriggerable monostable multivibrator; the various logic outputs of the integrated circuits being fed, via suitable series resistors, to light emitting diodes to provide visual indication of the logic states of the circuit under test.

The two 4-input NAND gates are connected in series as shown at Fig. 1. A steady logic 1 at the probe will produce a logic 0 at the output of the first gate, a potential difference will exist between points 'C' and 'D' on the circuit diagram and LP2 will be illuminated. A steady logic '0' at the probe will produce logic '1' at the output of the gate and a logic '0' at the output of the second gate, a potential difference will now exist between points 'A' and 'B' and LP1 will be lit.

THREE L.E.D.s LIT

In the case where the logic under test consists of a stream of d.c. pulses having an equal mark/space ratio, the monostable will trigger on the negative edge of the first pulse and LP3 will be illuminated and will remain lit for the period determined by the time constant provided by C1 and R3. Should further pulses occur during this period IC2 will retrigger. In addition LP1 and LP2 will follow the positive and negative logic, thus with a square wave all three l.e.d.s will be lit.

Consider now input logic which consists of negative going pulses where the pulse width is narrow (Fig. 2). As the d.c. state at the probe is predominantly positive (or logic '1') a predominant logic '0' will exist at the output of the first gate causing LP2 to light, also the monostable will trigger on the first negative edge and cause LP3 to light; thus, with a stream of negative going narrow pulses, LP2 and LP3 will be lit.



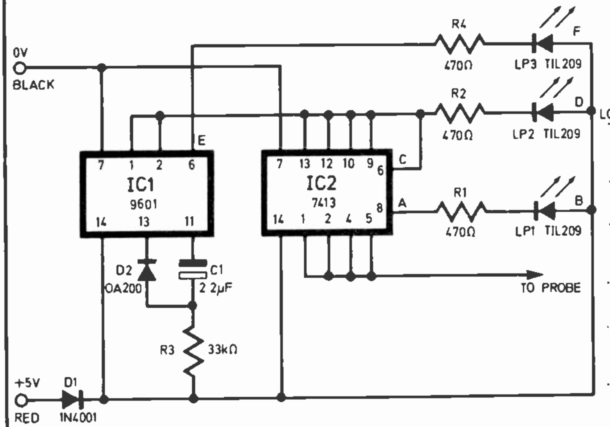


Fig. 1. Circuit of Indicator Probe

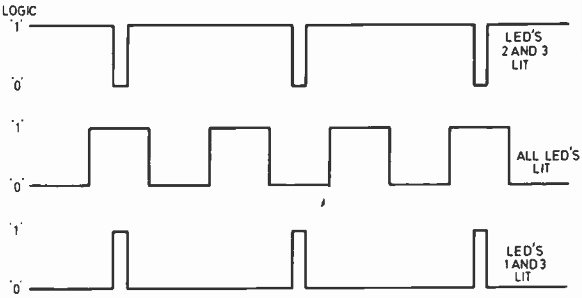
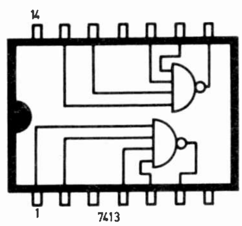


Fig. 2. Lamp switching for different pulse inputs



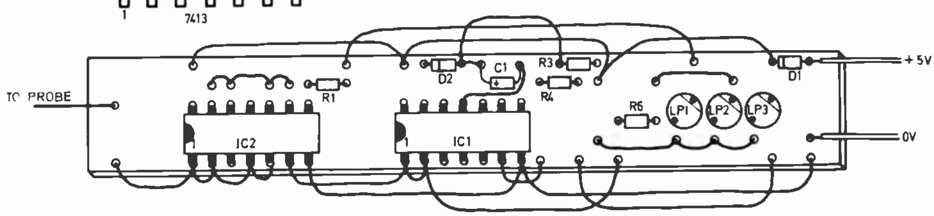


Fig. 3. Component layout and wiring details

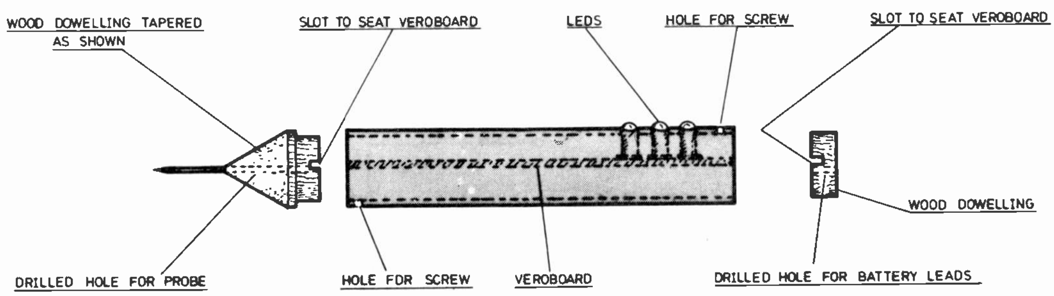
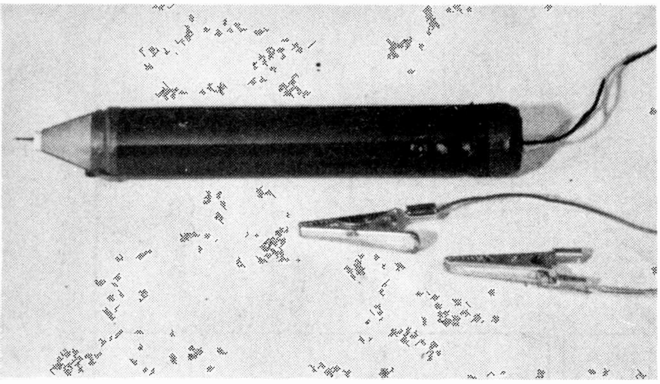


Fig. 4. Logic Probe housing details



Completed logic indicator probe showing the three light emitting diodes and the supply leads with crocodile clips attached

In the reverse case (e.g. positive going pulses) LP1 and LP3 will be lit.

In either case, where the pulse repetition rate is low—say in the order of a few hertz—all three l.e.d.'s will flash on and off.

CHOICE OF I.C.s

The 7413 was chosen because it has a defined hysteresis and is capable of responding to input pulses having slow rising edges. The Fairchild 9601 is a reliable 'one shot' and will generate a wider pulse from a narrow input pulse when used in the manner described. The probe will detect pulse widths of fractions of a micro-second. The diodes D1 and D2 are merely safety devices, D1 prevents damage to the i.c.s should the battery leads be inadvertently reversed, whilst D2 prevents a reversal of voltage reaching pin 13 of the monostable during the discharge of the electrolytic capacitor.

MATERIALS

The basic materials, excluding the electronic components, required for the construction are as follows—

(a) One 4½in length of plastic tubing having an inside diameter of ¾in (the author used plastic water piping purchased from the local building suppliers).

(b) One piece of Veroboard (0·1in matrix) 4½in in length and ¾in wide.

(c) One suitable length of wooden dowelling having a diameter of ¾in for the probe ends, an alternative would be to use suitable corks.

(d) One metal probe. This can be made from a length of 16 swg wire or a pin.

CONSTRUCTION

Layout of the components on the Veroboard is given in Fig. 3. The Veroboard should be drilled—where indicated—to break continuity of the copper strips, and the i.c.s and the probe soldered to the appropriate strips. Fig. 4 shows the Logic Probe housing. ★

A selection of readers' suggested circuits. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought. Any idea published will be awarded payment according to its merits. Why not submit YOUR IDEA?

VOLTAGE CONTROLLED DIMMER

THE circuit of Fig. 1 uses TR1 as a constant current source to charge the timing capacitor C1 at a rate determined by the applied control voltage at the base of TR1. At the correct level the charge voltage fires the unijunction TR2 to trigger CSR1 in turn via the trigger transformer T1.

In fact the timing of the circuit can be synchronised to mains waveform by using unsmoothed 15V power.

On the prototype a 0V control voltage gives full power and reduction to zero occurs at about −12V. A smaller value of control voltage could be used by increasing the value of C1.

The transformer T1 was made up from two 40-turn windings of 30 s.w.g. enamelled copper wire on a length of ferrite rod. The CSR1 can be a triac or thyristor; in the prototype it was a SC45D.

M. Lawrance,
Helston,
Cornwall

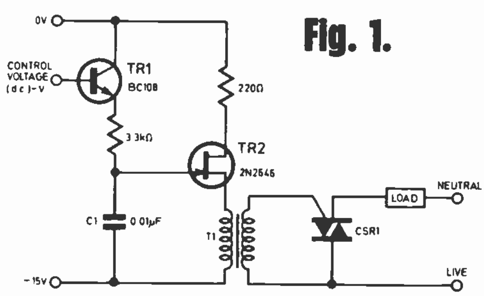


Fig. 1.

STARTING IN NEXT MONTH'S ISSUE...

The PE JOANNA

State-of-the-art piano design with additional choice of harpsichord or honky-tonk voicing. Keyboard is fully touch sensitive. Piano effect is further heightened with soft and sustain pedals. Other features include easy tuning, two speed vibrato and stool-integrated amplifier.

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PRACTICAL
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MAY 1975 ISSUE ON SALE APRIL 11, 1975

CEEFAX AND ORACLE

A PROPOSED NEW BROADCASTING SERVICE

BY J. SMITH

SECOND AND CONCLUDING PART

In the previous article (February) we described the Ceefax and Oracle system in fairly general terms. This month we are going to examine some of the more detailed provisions of the system. A complete working unit is of little interest at this stage owing to the fact that the present system is still rather tentative and experimental.

SPECIFICATION

The main technical features given in the joint BBC, IBA, BREMA specification are as follows:

1. Data pulses are transmitted during the television field-blanking interval using a bit-rate of 6·9375 megabits per second.
2. Each page consists of 24 rows of 40 characters using both upper and lower-case characters, coded using the ISO-7 code. A special top row called the page-header carries information for control and display purposes.
3. All data-words are eight bits in length; parity protection is used for the character data words while Hamming Codes are used for addressing and control purposes.
4. News flashes and sub titles are provided.
5. Every page-header will carry clock-time information to provide a display and to permit the automatic time-selection of certain pages.
6. Control characters are used to provide colouring and flashing of selected words.
7. A simple graphics facility is provided.

This list is taken from the specification which goes into considerably more detail regarding the definition of terms like "page", "magazine", etc. Readers interested in a full understanding of the system are recommended to read this publication*. In this article we shall confine our attention to the more interesting technical features of the system.

LINE ALLOCATION

Lines 17 and 18 are already allocated; they are in fact used internationally for insertion test signals. However, providing their use is restricted to this country they are available for data transmission.

Lines 13 and 14 are free, but research studies have shown that some receivers frame flyback times creep into this region. For this reason data pulses on lines 13 and 14 would be visible to some people. It is anticipated that, as the system develops, manufacturers will reduce flyback times to release these and possibly other lines to allow a better service.

RUN-IN AND FRAMING CODE

Fig. 2.1 shows how the data is fitted onto the television line scan. The clock run-in period of 16 bits is to synchronise the internal clock which determines the position of the data.

The clock run-in starts 1010 . . . for sixteen bits ending with a "0". This is followed by a framing (starting) code which identifies the start of the message. The clock run-in and starting code are the same on every line 1010101010101010 11100100.

*** Information transmission by digitally coded signals in the field-blanking interval of 625-line television systems. BBC, IBA, BREMA. Price 50p.**

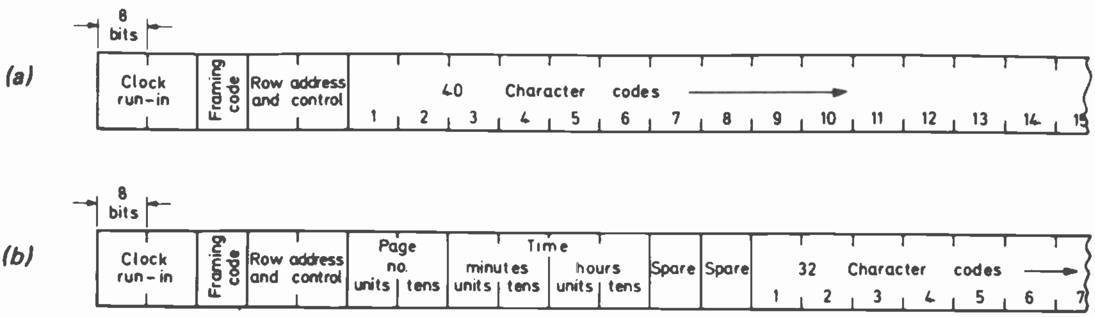

Fig. 2.1. Arrangement of data on TV lines. (a) shows a normal data line and (b) the page header line

This code has been carefully chosen for ease of recognition as it signifies the start of the data signal. From this point on, the clock, which has been previously synchronised determines the position of any eight bit character along the line scan period.

This clock is also vital when it comes to reading the data onto the TV screen because characters must be displayed in their *correct* positions along the line scan.

ROW ADDRESS GROUP

The framing or start code is followed by the row address group. It is very important to recognise the row address correctly, errors here could not only put a row in an incorrect position, but also interfere with another row. Consequently the row address is heavily protected by the Hamming Code, discussed later.

On most lines the framing code is immediately followed by the data bits, the exception being the occasional page-header line. Page-headers only occur on lines 18 or 331, but manufacturers are advised to organise receivers on a basis of code recognition, rather than line recognition, to allow for future developments.

Page-headers only occur on row 0 which must be recognised in order to deal with the page-header line correctly. The page numbers, tens and units, are also protected with the Hamming Code and must be dealt with in the appropriate manner.

PARITY CODE

The data are transmitted in blocks of eight, seven bits for the character; the eighth is a parity bit. The eight bits are transmitted in sequence the first bit being the least significant bit in binary encoded signals. Thus in binary notation we have;

Signal	1	2	3	4	5	6	7	8
Binary weight	2^0	2^1	2^2	2^3	2^4	2^5	2^6	0
	M	M	M	M	M	M	M	P

where M are the message bits and P is the parity bit.

The parity bit is "1" or "0" dependent upon odd or even message bits. The parity bit always makes an odd number of 1's. If an even number of 1's occurs, an extra (noise) pulse has been received and the signal is in error.

It is obvious that if two noise pulses occur the parity check will not reveal an error; however, some errors on the message signals can be tolerated.

HAMMING CODE

Signals protected by the Hamming Code are less liable to give errors because the Hamming Code employs four parity bits.

1	2	3	4	5	6	7	8
P	M	P	M	P	M	P	M

Again the bits are transmitted in numerical order beginning with number 1, the least significant bit. The four parity checks are carred out as follows:

Parity check A is carried out over bits 1268
Parity check B is carried out over bits 2348
Parity check C is carried out over bits 2456
Parity check D is carried out over all bits.

Table 2.1 shows the Hamming Code. A few minutes study of this code shows how the four parity checks can lead to information showing which bit is in error.

Table 2.2 shows how the various checks are used to correct some of the errors which may occur. Although Table 2.2 shows how parity bits may be complemented (1's changed to 0 or 0's changed to 1) it is only necessary to correct bits 2,4,6,8, the message bits.

Because the Hamming Code reduces the number of message bits available, four bits giving the sixteen different states shown on Table 2.1, *two blocks* of eight bits are allocated for control and row address as shown in Fig. 2.1. This arrangement gives a total of 16^2 (256) combinations of data which are protected by the Hamming Code.

Table 2.1: Hamming Code

Decimal Message Value	Bit Position Number 1	2	3	4	5	6	7	8
0	1	0	1	0	1	0	0	0
1	0	1	0	0	0	0	0	0
2	1	0	0	1	0	0	1	0
3	0	1	1	1	1	0	1	0
4	0	0	1	0	0	1	1	0
5	1	1	0	0	1	1	1	0
6	0	0	0	1	1	1	0	0
7	1	1	1	1	0	1	0	0
8	0	0	0	0	1	0	1	1
9	1	1	1	0	0	0	1	1
10	0	0	1	1	0	0	0	1
11	1	1	0	1	1	0	0	1
12	1	0	0	0	0	1	0	1
13	0	1	1	0	1	1	0	1
14	1	0	1	1	1	1	1	1
15	0	1	0	1	0	1	1	1

Bits 1, 3, 5, 7 = Protection bits
Bits 2, 4, 6, 8 = Message bits

Table 2.2: Error Correction Table

Parity Check D	C	B	A	Action
0	0	0	0	Error free reception
0	0	0	1	Reject, even order error
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	
1	0	0	0	Complement Bit 7
1	0	0	1	Complement Bit 1
1	0	1	0	Complement Bit 3
1	0	1	1	Complement Bit 8
1	1	0	0	Complement Bit 5
1	1	0	1	Complement Bit 6
1	1	1	0	Complement Bit 4
1	1	1	1	Complement Bit 2

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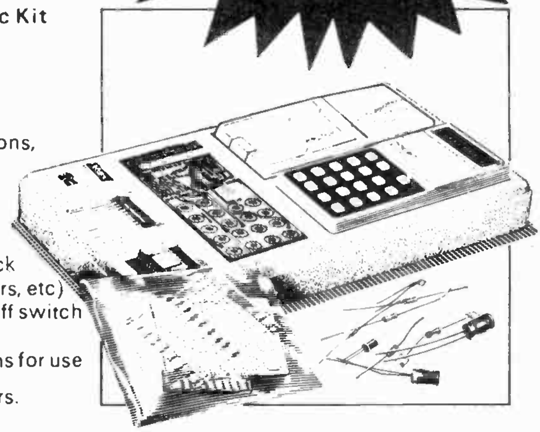

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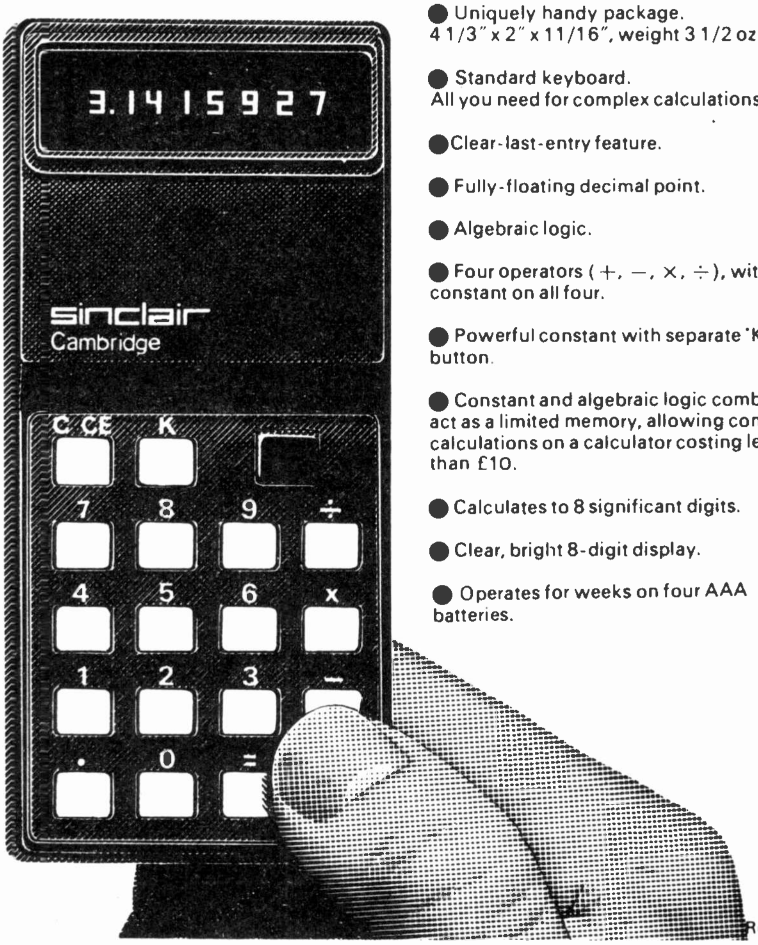

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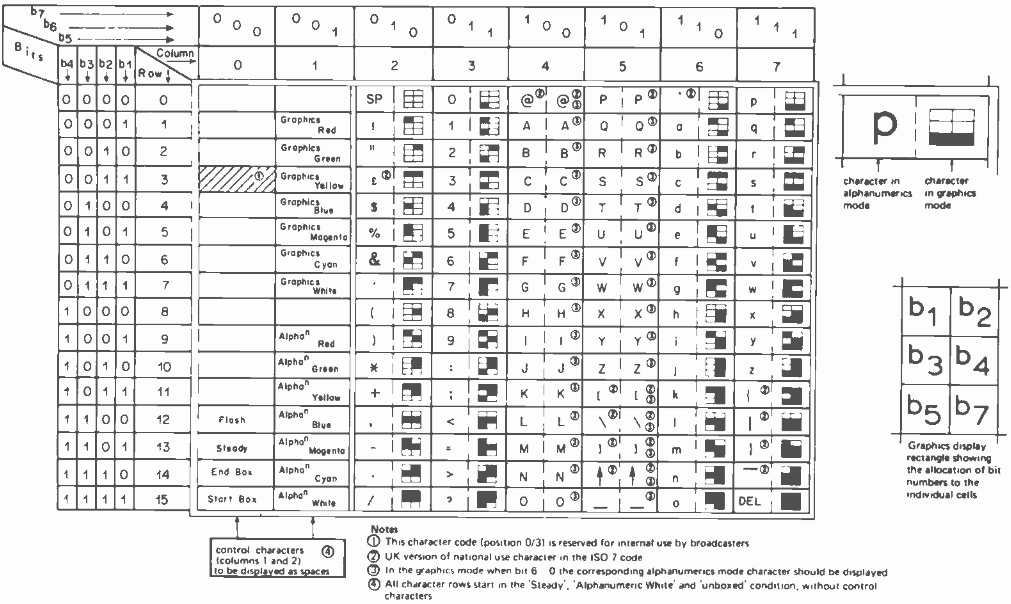


Fig. 2.2. Character code for data broadcasting. This table shows both alphanumeric and graphics information, the latter being selected by the appropriate control code in columns 1 and 2. (*Reproduced from Joint Specification*)

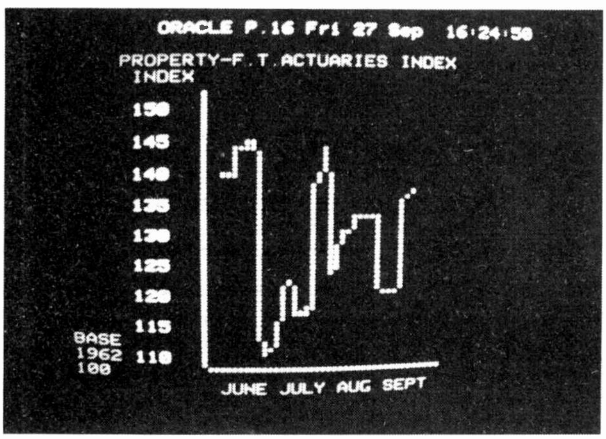
CHARACTER INFORMATION

The character information employs seven bits, 128 (2^7) different combinations. Fig. 2.2 shows how these 128 combinations are used. A matrix of 8 × 16 is used to produce 128 different characters.

Rows are identified by bits 1, 2, 3, 4, whilst columns are identified by bits 5, 6, 7. Thus if we wish to display the "£" sign we will have a code 11000100. Similarily the "&" sign would be 0110010, the parity bit being "0" in each case to give odd parity. A "?" sign on the other hand would be coded 11111101, where the parity bit is "1".

The control instructions located in columns 0 and 1 (000 and 100) are reproduced as a blank space, but following characters are produced according to the instruction given. For example, a white number 1 coded 10001100 would be *preceded* by an instruction-space code 11111000. However, if the number was to be reproduced in red it would be preceded by the instruction-space code 1001 1000. In each case the last bit is the parity bit.

An example of an ORACLE page using the graphics facility



GRAPHIC SYMBOLS

As the system has a graphics facility there are alternative graphic symbols given in each location which must be generated when called for. If instead of a red 1 the red graphic symbol was required the graphics space signal would be given. For example:

start 12345678 12345678

10011000 followed by 10001100 gives a red 1

10001001 followed by 10001100 gives red spots.

Thus the specification virtually dictates the design of the ROM unit discussed in last month's article. Before discussing the ROM organisation in more detail it will pay to re-examine how the RAM stores the transmitted data.

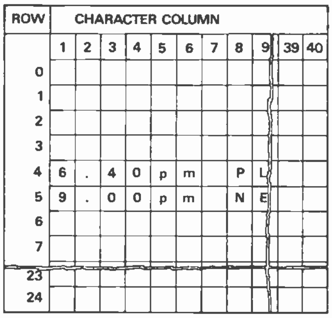
RAM ORGANISATION

The RAM can be organised in a variety of ways by receiver manufacturers, but from an operational point of view it is best to visualise a matrix 40 × 24, giving 960 locations, where each location can store seven bits of information. This then corresponds to the 40 characters and 24 rows of each page in the system.

Each row is identified by its row number (0 to 23), derived from the control and row-address group. The columns are numbered 1 to 40 and are derived from the synchronous clock.

The clock starts its division (by 40) on receipt of the framing (start) signal. Fig. 2.3 illustrates this arrangement. The row information is processed by the Hamming decoder logic which also determines if the row is "0" or not (i.e. the page header). If the row is "0", further Hamming logic is used on the next 16 characters which give the page numbers.

The synchronous clock ensures that the whole row is filled. After this nothing more happens until



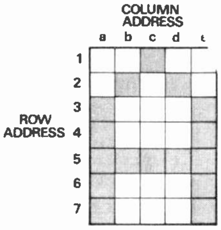


Fig. 2.3. (left) Diagram showing RAM visualisation. Each of the squares represents seven bits of data

Fig. 2.4. (right) A typical cell matrix. This particular character would be produced by the code 1000 001

An operator entering data into the ORACLE system

another line of data appears complete with its clock run-in signals, framing code and row coding, then the next row in the RAM is filled with data.

Each row of the memory may be filled at random. The transmission of each row need not be sequential and in all probability will not be. Read, write, inhibit and reset logic is also required in association with the RAM in order to fully control its function.

When filled the RAM can be visualised as the representing page of information to be written on the television screen. This idea is shown in Fig. 2.3, line 4 illustrating a programme timetable: 6.40 pm PLAY, followed by line 5, 9 pm NEWS. Of course these characters are actually stored in a seven bit binary store.

ROM ORGANISATION

The ROM unit is rather more complicated than it appears from our preliminary examination. The character must be generated over 14 lines, so each line reproduces only a small part of the character. In addition, each line reproduces a small part of **each of the 40 characters** which appear along any particular row.

The ROM unit converts the parallel coded information from the RAM board to a serial output of dot information which modulates the CRT during scan. The ROM's themselves contain character information on a 7 × 5 dot matrix

Fig. 2.4 shows cell 1000001 (capitalA) as given by the character codes in Fig. 2.2.

The sequence of operations is as follows:

1. The clock counter (synchronised with the clock run-in pulses) access the first letter stored in the RAM, in this case a capital A.
2. The ROM is addressed so that the cell containing A is activated. (Cell 1000001, Fig. 2.4.)
3. A television line scan counter has already activated the first line address input to every part of the ROM. (Line 1, Fig. 2.4.)
4. The contents of the ROM are transferred to a shift register of six bits. (The sixth bit is the space between characters.)
5. In this example the contents from line 1 of the ROM transferred to a shift register are white, white, black, white, white. (Line 1, Fig. 2.4.)
6. A 6MHz phase-locked counter shifts the information serially out of the shift register to modulate the CRT with a dot representing the top of the "A".
7. The clock counter addresses the RAM to find the next character, "B" for example.
8. The ROM cell containing "B" is addressed by the RAM (1000010 in Fig. 2.2). This cell already has its line 1 input activated.
9. The top of the "B" is transferred to the shift register and modulates the tube as described for the "A".

Proceeding thus, scan 1 moves from character to character of the row stored in the RAM, addressing the appropriate coordinates of the ROM for each character in the row. The ROM modulates the scan line with the top of each character in the row.

At the end of the row, scan line 2 on the ROM is activated to modulate the CRT with the dots required on the second line scan. The seven scan lines of character are reproduced by this means and followed by four blank lines of inter-row scan.

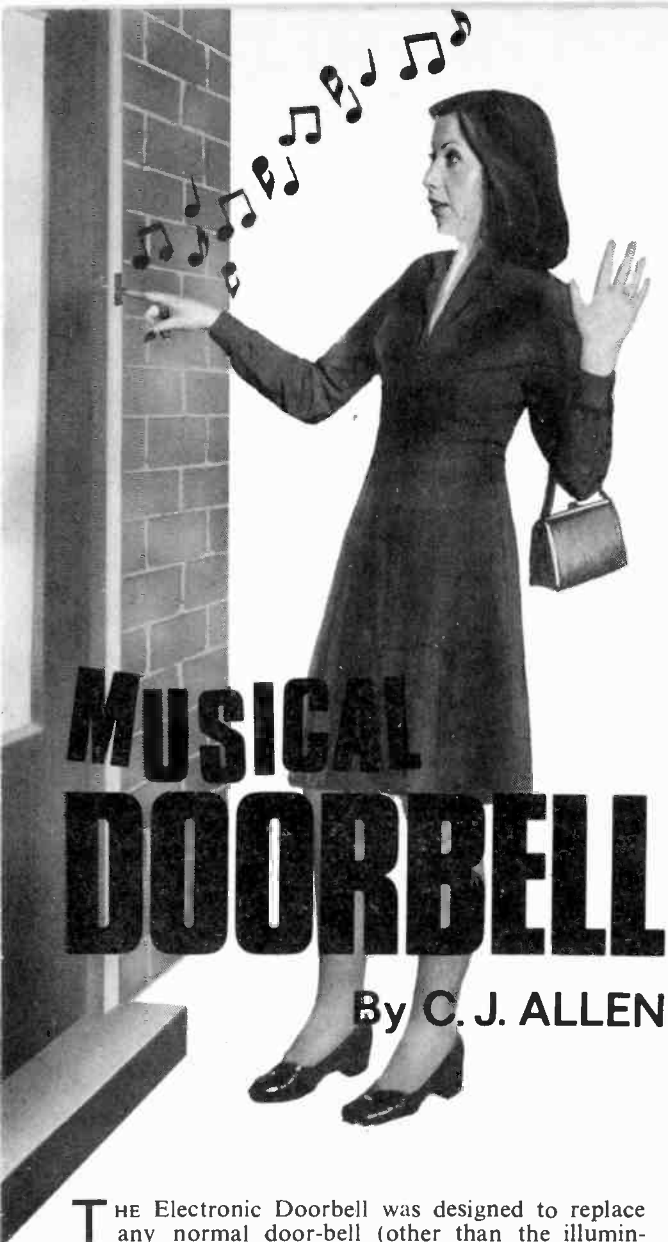
ADDITIONAL FEATURES

In the most simple systems reproduction of alphanumeric characters will be all there is to the ROM, but in more advanced receivers there will be provision for graphics and character rounding. These additional features will increase the complexity of the system considerably as will some of the other provisions of the specification.

To summarise the various systems in terms of increasing complexity, we have:

1. Alphanumeric display.
2. Upper and lower case alphanumeric characters.
3. Graphics display.
4. Flashing display.
5. News flash and sub titles superimposed on the picture.
6. Coloured displays. Red, green, yellow, blue, magenta, cyan and white.
7. Timed displays. Some data may only be transmitted once during the day. A time clock system can be incorporated to capture this signal.

We can look forward to the time when manufacturers put receivers onto the market and we can see the various ways in which they overcome the complexities of the system to provide the maximum of facilities at a minimum cost. ★



MUSICAL DOORBELL

By C. J. ALLEN

THE Electronic Doorbell was designed to replace any normal door-bell (other than the illuminated door-push type). It produces a novel sound with ample volume for an average house and a life of several months between battery changes with normal use.

OPERATION

The circuit, Fig. 1, uses an oscillator, ICI, capable of producing five different tones. The tune played includes up to fifteen time-slots of equal length, and during each of these time-slots the appropriate tone is selected, from IC1, using the pre-programmed diode matrix shown in detail in Fig. 2.

The oscillator's output is fed via a simple transistor amplifier to a loudspeaker LS1.

The time-slots are generated by a second oscillator, IC2, feeding a divide-by-sixteen binary counter, IC3, which in turn addresses a 4 to 16 line de-multiplexer. IC4.

IC4's seventeenth output is used to turn a latching relay RLA off, thereby removing power at the end of the tune.

TONE GENERATION

By now the reader should be familiar with the '555" timer and its use as an astable multi-vibrator. The frequency of IC1 may be changed by altering any of the timing components identified in Fig. 1 as R1 to 5, R11 and C1. Here the five different tones are generated by switching in one of the pre-set resistors VR1 to VR5 via the transistors TR1 to TR5. This is achieved by switching the associated transistor base towards ground (0V) potential using a diode matrix.

AUDIO AMPLIFICATION

The amplifier is a very simple class A design which in fact introduces a great deal of distortion, but as the output waveform is unimportant this is ignored. Preset VR6 acts as a volume control.

Any small loudspeaker should suffice (3Ω to 50Ω); the prototype used a 2¼in. speaker of unknown impedance removed from an old transistor radio.

CLOCK AND DE-MULTIPLEXING

This section of the circuit makes use of a second 555 timer IC2, running at about 4Hz to drive a binary counter IC3 (SN7493). The components C6 and R19 connected to IC3 set-zero input ensure that the counter is always started in the set-zero state such that the tune played starts from the chosen beginning.

The four output lines from IC3 (A, B, C and D) are then fed to a de-multiplexer IC4, which decodes the binary information into a selection of one of sixteen; that is, each of the sixteen outputs 1 to 16 is sequentially taken from logic 1 level to logic 0 for about 0·25s, only one output being at 0 at any one time.

The value for V_{Out} in the logic 1 state of an SN74154 can be as low as 2·4V. As it was felt that the transistors TR1 to TR5 would not be held fully off by these voltages, the values of resistors R1 to R10 were made lower than would appear necessary to act as pull-up resistors for the IC4 outputs, thus avoiding problems of leakage currents through the transistors.

DIODE MATRIX

As the outputs from the SN74154 are so-called "totem-pole", each has to be diode or-gated and isolated from the others. Hence the use of a diode matrix.

If desired IC4 can be replaced with the pin-compatible, open-collector output version SN74159. This removes the need for the diodes which would then be replaced with wire links. The saving in cost of the diodes, however, does not offset the extra cost of the SN74159 and for this reason it was not used in the prototype.

The matrix of Fig. 2 is for a facsimile of the beginning of the Beethoven 9th symphony. Pauses may be introduced into the music by leaving the appropriate input to the matrix open circuit. This is demonstrated in Fig. 3 which gives the matrix for playing part of "Colonel Bogey".

LATCHING RELAY

As noted, the seventeenth output from IC4 goes to logic 1 on starting the machine. This holds TR8,

MUSICAL DOORBELL CIRCUIT DETAILS

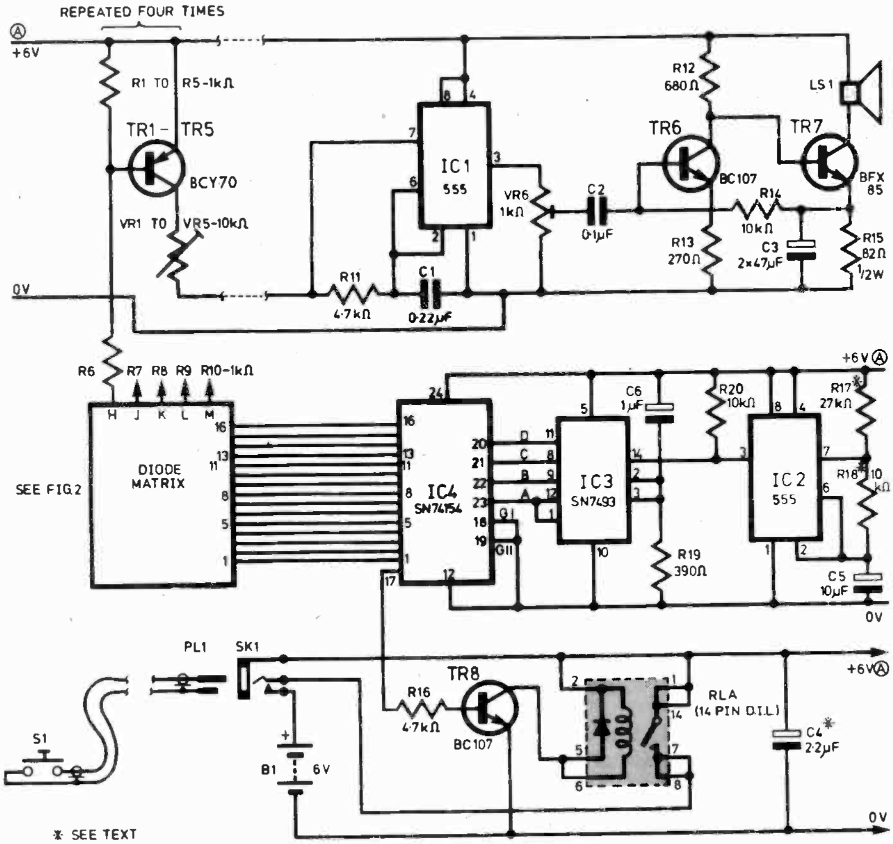


Fig. 1. General circuit diagram of the electronic doorbell

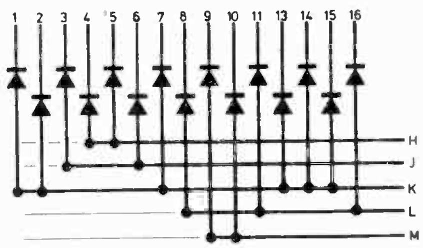


Fig. 2. The diode matrix used in the prototype to produce the first bars of the Beethoven 9th

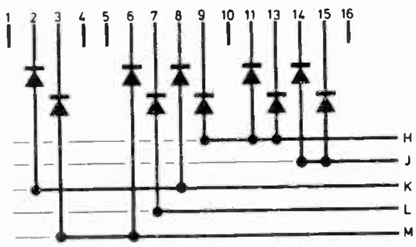
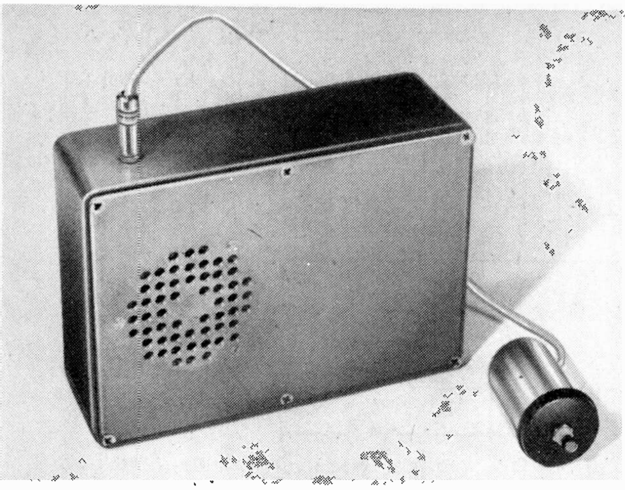


Fig. 3. Diode matrix alterations to produce Colonel Bogey



and hence the relay RLA on. Thus if the relay contacts are momentarily shorted (by the door-push) the circuit will latch and stay in that state until the tune has finished and the output of IC4 goes low, turning TR8 and the relay off. If the SN74159 is used for IC4 a 2·2kΩ resistor must be connected between this output and the +6V rail.

CONSTRUCTION

All the components, with the exception of batteries, loudspeaker and switch are soldered onto one piece of Veroboard, the size used being that made especially for mounting in a Lektrokit box. However, any piece of 0·1in Veroboard of 39 × 41 or more holes will do.

The component layout for the Beethoven's Ninth version is given in Fig. 4, whilst the alterations necessary for playing Colonel Bogey are shown in Fig. 5.

The choice of box for mounting the circuit is left to the constructor. The prototype was built in a die-cast box 6¾ × 4¾ × 2in which also contains the speaker and four HP11 batteries required to power the machine.

If this method is used it is worthwhile cutting the Veroboard to fit in the box before mounting the components as shown in the photographs and Fig. 4. Make sure none of the copper strips short to any of the many protrusions in these boxes. As can be seen from the photographs, a miniature 3½mm jack-plug and socket were used to accept the wires from the door-push; the socket used was the type with a switch on the back, bent in such a manner that it closed when the plug was inserted. This switch turns the power to the electronics off when the plug is removed.

Holes, for mounting the board on pillars, if required, may be drilled in several places if some thought is given to not breaking any used strips and care is taken not to short any strips together or to earth. Further removal of copper with a spot face cutter may be needed.

The relay RLA used is a d.i.l. packaged device with its own protection diode. Fig. 8 shows how the batteries are mounted in the prototype but constructors may wish to use different batteries or a suitable holder for their particular requirements.

TESTING AND SETTING-UP

The tone adjusting pre-sets are, for convenience, numbered in ascending order of frequency: VR1 the lowest tone used and VR5 the highest. First of all remove IC4 from its socket, set VR6 to about ⅓ of its travel clockwise, solder one end of a length of wire to earth (0V) and solder a temporary link across the terminals to the push switch. Touching the free end of the earthed wire to either end of any of the diodes should produce a tone from the speaker. By running the wire along the diodes corresponding to pins 1 to 16 respectively on IC4, the tune should be produced if the pre-sets have been correctly set. With a bit of practice and a good ear for pitch, the correct positions can soon be found.

If IC4 has been soldered in place then remove the end of the diode going to pin 1 on IC4, short

COMPONENTS . . .

Resistors

R1 to 10	1kΩ, 10 off
R11, 16	4·7kΩ, 2 off
R12	680Ω
R13	270Ω
R14, 18*, 20	10kΩ (see text ref. R18)
R15	82Ω ½W
R17*	27kΩ (see text)
R19	390Ω

All resistors ¼W, 10% or better except where specified

Potentiometers

VR1 to VR5	10kΩ miniature preset (see text ref. VR4, VR5)
VR6	1kΩ miniature reset

Capacitors

C1*	0·22μF, 100VW polyester (see text)
C1	0·1μF 100VW polyester
C3	2 × 47μF, 63VW Tant bead
C4	2·2μF, 35VW Tant bead
C5	10μF, 25VW Tant bead
C6	1μF, 35VW Tant bead

Transistors

TR1 to 5	BCY70
TR6, 8	BC107
TR7	BFX85

Diodes

D2 et al	Any general-purpose miniature silicon device such as OA200, 1N914, IS914, etc. (15 or 32 if required)

Integrated Circuits

IC1, 2	NE555, MC1455G etc. (555 chip), 2 off
IC3	SN7493
IC4	SN74154, (A. Marshall)
IC5	SN7472 (if needed, see text)
IC6	SN74154 (if needed, see text)

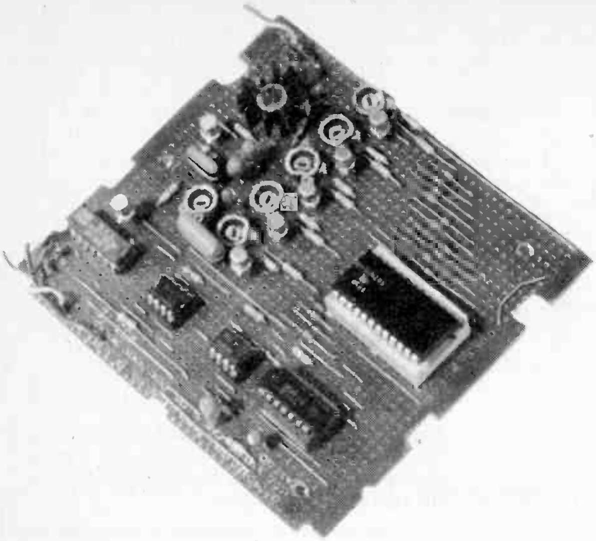
Relay

RLA	D.I.L. mounting reed relay, Chromasonic Electronics

Miscellaneous

Veroboard; suitable case; heat sink for TR7; i.c. sockets, particularly IC4 and IC6; loudspeaker, batteries or battery; wire; bell-push, etc.

* See text



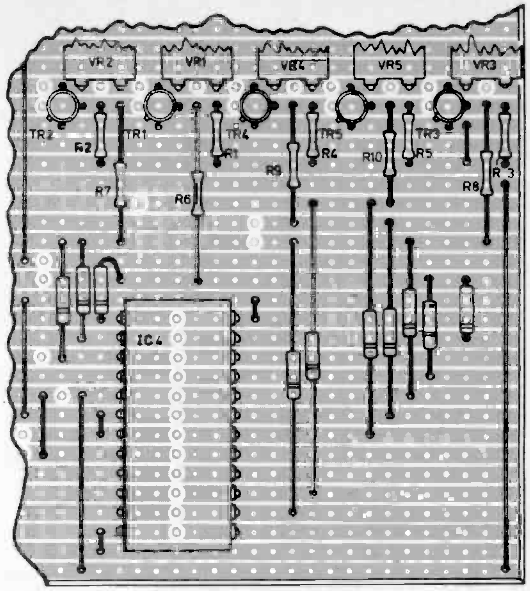


Fig. 5. Veroboard modifications for the Colonel Bogey version

out C5 to positive 6V. Now proceed with the steps from "set VR6" as above, making sure not to touch the wire on those ends of the diodes going directly to IC4 as this may be damaged. Always connect to the negative diode ends.

Remove the shorting link from the push (door) switch connections and either replace IC4, or remove the short from the capacitor and re-solder the diode. On wiring in a door switch and pressing it the doorbell should now function properly.

If the tune is played too fast or too slow this can be remedied by increasing or decreasing the value of R18. If, however, it is made to run too fast the device will not turn itself off, in which case the smoothing capacitor C4 should be reduced in value.

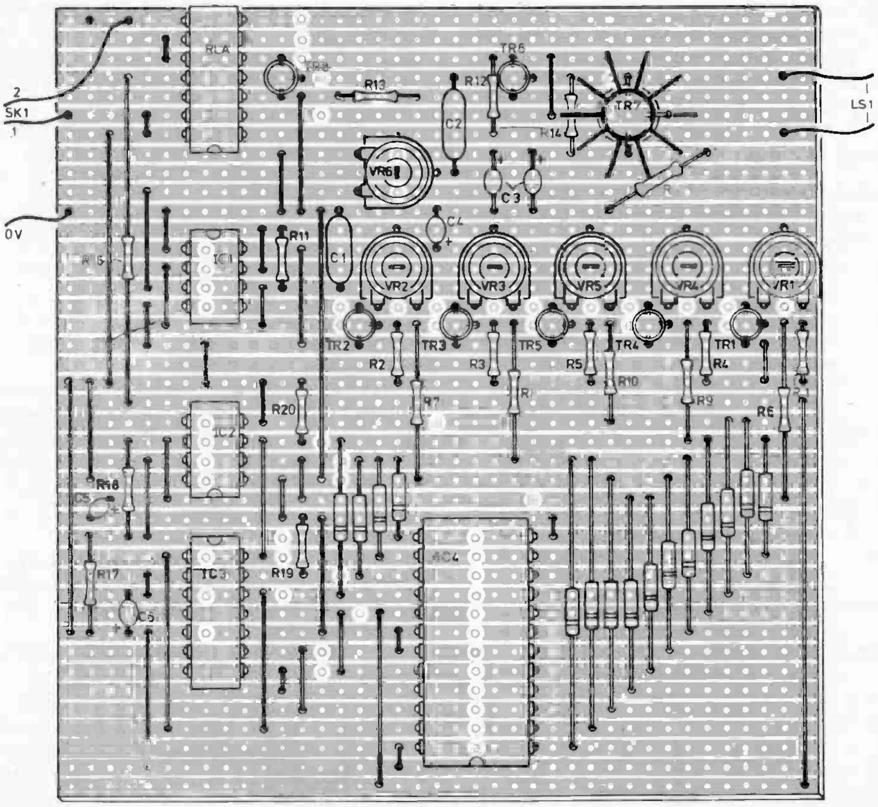


Fig. 4. Veroboard component layout and cutting details for the prototype electronic doorbell

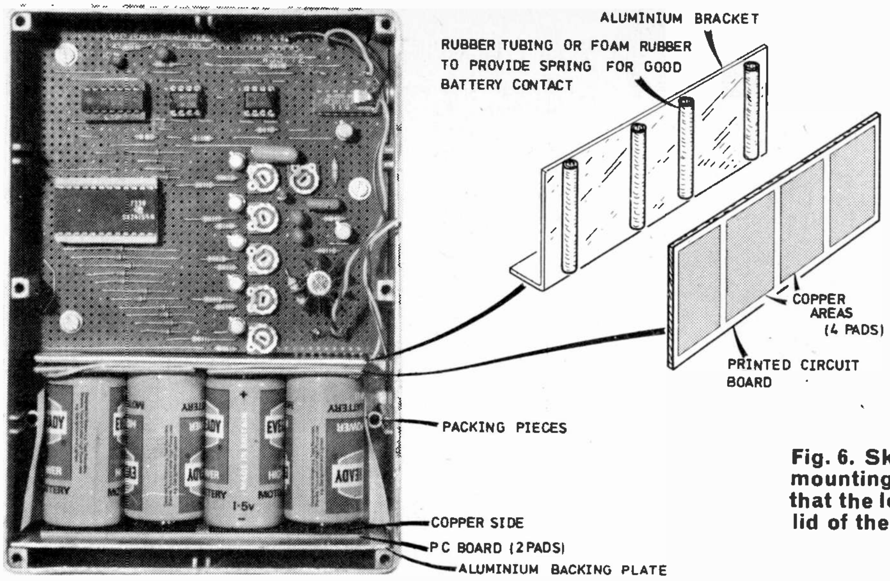


Fig. 6. Sketch of the board and battery mounting used in the prototype. Note that the loudspeaker is mounted on the lid of the diecast box.

WARNING

Do not allow any of the potentiometers VR1 to VR5 to be set fully anti-clockwise as this could damage IC1. If the Colonel Bogey version is built, note the changes marked with an asterisk in component values given in the parts list.

When the batteries start to run low the first part of the circuit to fail will be the counter IC3. This causes the device to emit a single tone that can only be stopped by removing the batteries. If you are at all tone-deaf get someone else to set the tones for you as even if it is set slightly off key it will sound very unpleasant, and can send connoisseurs of classical music mad at 100 yards.

ALTERNATIVES

The matrix could be wired on to a separate board which plugs into the main board via an edge-connector. Using this method a whole library of tunes could be built; one for each day of the week perhaps? The tunes would, of course, have to be made up of the

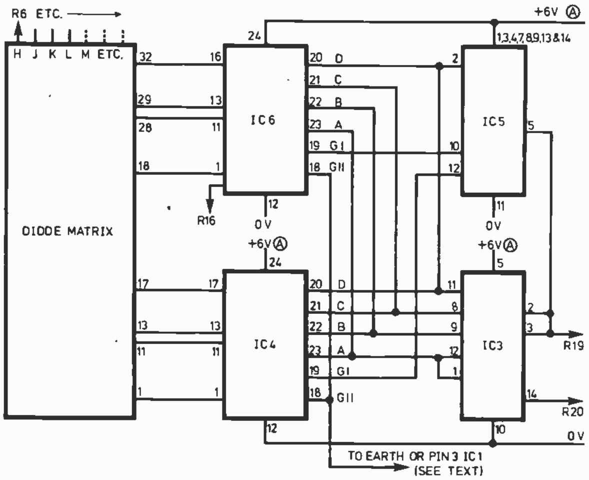


Fig. 7. Doubling the time-slot capacity to produce a longer melody requires this circuit

same five notes otherwise the pre-sets would have to be altered each time.

If this is done it becomes economical to use the SN74159 for IC4 as diodes would thus be saved.

The circuit can, if wished, be expanded to play thirty-one beats, as shown in Fig. 7. Here IC5 (SN7472) is used as a divide-by-two counter with complementary outputs such that, on starting the machine Q is low, enabling IC4 to decode the first sixteen time-slots, whilst the high $\overline{Q}$ on the second strobe input of IC6 (SN74154) dis-enables this. On IC3's sixteenth count IC5 is toggled into its other state turning off IC4 and enabling IC6 to decode the second sixteen beats.

This modification will obviously necessitate the use of a larger diode matrix, but as this can be drawn to resemble a musical scale, working out the circuit is an easy matter.

It may be found that with or without the previous modification, more than five notes are required. This can be readily achieved by the addition of an extra output line in the matrix plus an extra transistor-switched pre-set resistor for each additional note.

Both these modifications will need a larger board and a re-designed layout for their construction.

As this circuit stands, each note follows on immediately from the preceding note. To make the tune sound more realistic short pauses between notes can be introduced by gating the output of the demultiplexer with the clock pulse such that notes are produced only when the clock's output is in the "low" state.

To do this, the output of IC1 (pin 3) should be taken to one of the strobe inputs of IC6 and/or IC4 (pin 18), the latter having first been disconnected from ground.

A sensible value for the pause-to-note ratio (mark : space ratio of the clock) is 1/10. To achieve this the clock circuit must be modified by the addition of a diode between pins 6 and 7, anode to pin 7, and suitable alteration of R17 and R18. These then become 3·6kΩ and 33kΩ respectively for the Beethoven 9th tune and 4·7kΩ and 47kΩ respectively for the Colonel Bogey version. Other melodies would obviously require experimentation. ★

NEWS BRIEFS

DICE Conversion

AN AGREEMENT, signed in February, gives Marconi Communication Systems Ltd. exclusive world-wide manufacturing and marketing rights of the Digital Intercontinental Conversion Equipment (DICE) developed by engineers of the Independent Broadcasting Authority.

The latest version of DICE can convert 525-line NTSC colour pictures, as used in the U.S.A. and Japan, into the 625-line PAL or SECAM pictures used in most other parts of the world, and vice-versa. DICE is, by a comfortable margin, the world's fastest computer.

Standards conversion is essential, not only for "live" relays via satellite, but also when programme material on video tape is exchanged between countries working to different television picture standards.

A number of different types of standards converters have been developed over the years, but IBA engineers were the first to develop a unit based on digital techniques to eliminate the need for careful alignment and adjustment and to provide conversion without perceptible picture impairment.

It is claimed that DICE solves the technically complex process of conversion between systems using 30 pictures a second, as in North America and Japan, and those using 25 pictures a second, as in Europe, entirely electronically and with negligible distortion and is capable of satisfying a global demand for high quality pictures by satellite. It also allows programme companies making television recordings for world-wide sale to offer high quality pictures no matter which standard was used during production.

Another Component Source?

ANOTHER American component distributor has decided to enter the U.K. market. Cramer Electronics of Newton, Mass., is one of the largest distributors of components in the U.S. They are "broad-line" distributors offering very wide range of components with particular emphasis on the less glamorous but vitally essential non-active components and hardware items, right down to the humble grommet.

The U.K. distribution centre to be set up in the London area will be under the control of David Griffin who has been appointed Managing Director of U.K. operations and also Marketing Manager/Europe for the Newton, Mass. (U.S.) based firm.

Although Cramer Electronics is an industrial distributor, the possibility of offering a "one-off" service to individuals is not entirely ruled out. David Griffin is aware of the needs of the constructor market and has indicated his willingness to examine this particular area.

Portable Heart Monitor

IN CLOSE co-operation with Danish doctors, Simonsen & Weel have developed a new portable, battery operated combined defibrillator/memory/scope. This unit is especially designed for the resuscitation of patients suffering from acute heart diseases.

The cardio-aid is very useful to on-the-spot ambulance staff. A feature of the unit is its capability to be linked to hospital staff from the ambulance by radio link. This enables the ECG, the heart activity of a patient in electrical form, to be sent to a qualified doctor at the hospital. The doctor can then instruct the ambulance staff, via the radio link, of any emergency treatment that needs to be carried out during the journey to the hospital.

POINTS ARISING

MARINE SPEEDOMETER (*February 1975*)

The last paragraph on page 121 should read: "Ranges of 0 to 10 and 0 to 20 knots are obtained by selecting either VR2 alone or VR3 and R17 in series to replace VR2. Selection can be by S1 (VR3, R17 and S1 are not shown) or S1 can be part of S2 which thus becomes a three-pole three-way switch with 'Range 1', 'Range 2' and 'off' positions."

The Zener diodes D1 and D2 in Figs. 1 and 3 should be reversed.

Further, the co-ax outer should be connected to the battery common line in Fig. 2.

P.E. MINISONIC (*January 1975*)

In Fig. 3.12 pin 4 of IC1, MIXER 2 should be shown connected to −9V line by means of connection at column 104, tenth strip down.

In Fig. 4.6, R14 should be disconnected from pin 6 and connected to TR5 emitter. Pins 2 and 6 should be bridged with a 100pF polystyrene capacitor.

GAS DETECTOR (*September 1974*)

Some readers have experienced trouble over the starting of oscillation after setting up has been carried out. It is suggested that the setting-up procedure be altered as follows.

Connect the "dummy" load as described but set VR1 to the fully anti-clockwise position and not the opposite as originally described. This places it in the position for producing the shortest mark-space ratio.

Now adjust VR1 till the load resistors are hot but not burning to the touch. Switch off and then on again to confirm the oscillator is indeed operating.

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2N929	0·30
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2N1303	0·19
2N1304	0·24
2N1305	0·24
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2N1671C	4·32
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2N1907	5·50
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2N2219	0·24
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2N2221	0·18
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2N2905	0·24
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2N2906A	0·21

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2N2926	
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2N3053	0·25
2N3054	0·60
2N3055	0·75
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2N3391	0·23
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2N3392	0·13
2N3393	0·13
2N3394	0·13
2N3402	0·18
2N3403	0·19
2N3440	0·59
2N3441	0·59
2N3442	1·69
2N3414	0·20
2N3415	0·21
2N3416	0·34
2N3417	0·24
2N3638	0·15
2N3638A	0·15
2N3639	0·27
2N3641	0·17
2N3702	0·12
2N3703	0·13
2N3704	0·14
2N3705	0·12
2N3706	0·12
2N3707	0·13
2N3708	0·10
2N3709	0·11
2N3710	0·12
2N3711	0·11
2N3712	0·96
2N3713	1·20
2N3714	1·33
2N3715	1·50
2N3716	1·80
2N3771	2·20
2N3772	1·80
2N3773	3·20
2N3789	2·06
2N3790	2·40
2N3791	2·35
2N3792	2·69
2N3794	0·24
2N3819	0·37
2N3820	0·64
2N3823	0·78
2N3900	0·28
2N3901	0·32
2N3903	0·24
2N3904	0·27
2N3905	0·24
2N3906	0·27
2N4036	0·63
2N4037	0·42
2N4058	0·16
2N4059	0·09
2N4060	0·11

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2N5457	0·49
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2N5459	0·49
40361	0·48
40362	0·50
40363	0·88
40389	0·46
40394	0·56
40395	0·65
40406	0·44
40407	0·33
40498	0·50
40409	0·52
40410	0·52
40411	2·00
40414	3·55
40430	0·85
40583	0·23
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40603	0·53
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40636	1·10
40669	1·00
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AC113	0·16
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AC127	0·20
AC128	0·20
AC151V	0·25
AC152V	0·17
AC153	0·25
AC153K	0·33
AC154	0·20
AC176	0·23
AC176K	0·33
AC187K	0·23
AC188K	0·34
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ACY19	0·27
ACY20	0·22
ACY21	0·26
ACY28	0·20
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AD142	0·59
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AF116	0·25
AF117	0·20
AF118	0·55
AF124	0·30
AF125	0·30
AF126	0·28
AF127	0·28
AF139	0·39
AF170	0·25
AF172	0·25
AF178	0·55
AF179	0·65
AF180	0·58
AF186	0·46
AF200	0·35
AF239	0·51
AF240	0·72
AF279	0·54
AF280	0·54
AL102	1·00
AL103	0·70
BC107	0·16
BC108	0·15
BC109	0·19
BC113	0·15
BC115	0·17
BC116	0·17
BC116A	0·18
BC117	0·21
BC118	0·11
BC119	0·29
BC121	0·23
BC125	0·16
BC126	0·23
BC132	0·30
BC134	0·13
BC135	0·13
BC136	0·17
BC137	0·17
BC138	0·24
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BC141	0·29
BC142	0·23
BC143	0·25
BC145	0·21
BC147	0·12
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BC149	0·12
BC153	0·18
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BC157	0·14
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BC167B	0·13
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BC300	0·36
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BF259	0·55
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BFX89	0·45
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BFY19	0·62
BFY20	0·50
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SN7451	0·16
SN7453	0·16
SN7454	0·16
SN7460	0·16
SN7470	0·30
SN7472	0·38
SN7473	0·44
SN7474	0·48
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SN7476	0·45
SN7480	0·75
SN7481	1·25
SN7482	0·87
SN7483	1·20
SN7484	0·95
SN7485	1·58
SN7486	0·45
SN7490	0·65
SN7491	1·10
SN7492	0·75
SN7493	0·65
SN7494	0·85
SN7495	0·80
SN7496	1·00
SN74100	2.16
SN74107	0·43
SN74118	1·00
SN74119	1·92
SN74121	0·57
SN74122	0·80
SN74123	0·72
SN74141	1·00
SN74145	1·44
SN74150	1·44
SN74151	1·10
SN74153	1·09
SN74154	1·66
SN74155	1·55
SN74157	1·09
SN74160	1·58
SN74161	1·58
SN74162	1·58
SN74164	2·01
SN74165	2·01
SN74167	4·10
SN74174	1·80
SN74175	1·29
SN74176	1·44
SN64180	1·44
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50	0·24	0·32	0·60	0·62
100	0·26	0·37	0·70	0·75
200	0·30	0·41	0·75	0·80
400	0·36	0·45	0·85	1·10
600	0·40	0·52	0·95	1·25
SCR's	100V	200V	400V	600V
½A	0·43	0·44	—	
1A	0·45	0·50	0·60	—
1·2A	0·38	0·42	0·53	0·75
3A	0·47	0·53	0·60	0·90
4A	0·50	0·55	0·85	—

Construction Kits

AV7 Aerial Amps	£2·04
UHS70 Transmitter	£2·79
MUE7 Receiver for above	£3·22
EW18 Electronics dice	£6·53
EX20 Electronic Dice + Sensor	£7·79

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MARKET PLACE

Items mentioned in this feature are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned. All quoted prices are those at the time of going to press.

ARITHMETIC TUTOR

To complement their range of computer educational aids, Limrose Electronics Ltd. have recently introduced a Digital Arithmetic Tutor.

This advanced logic trainer has been designed for teaching the principles of binary arithmetic and four-bit data word manipulation to senior students who have completed a basic course in combinational and sequential logic circuits.

The tutor consists of three general purpose 4-bit shift registers, two 4-bit synchronous binary counters, one 4-bit comparator, one 4-bit adder, a carry store, one J-K master-slave flip-flop, four 2-input NAND gates, four 2-input AND gates and three logic inverters. Two manual single pulse generators and one continuous clock pulse generator are also available.

Logic states are displayed on the front panel by means of red light emitting diodes and interconnections are made using a 1mm gold-plated terminal pin and patch lead system.

The equipment is accompanied by an illustrated instruction book containing numerous computer circuits which can be constructed on the equipment. These circuits include loading and shifting of registers, 1's and 2's complements, addition and subtraction of 4-bit numbers by serial and parallel methods and multiplication and division by the shift-and-add-method. The instruction book also deals with the Octal Number System, binary fractional notation and overflow conditions in fixed point arithmetic.

Ideally suited for Universities and schools, prices of the tutor vary (approximately £150) and further information can be obtained from **Limrose Electronics Ltd., 8–10 Kingsway, Altrincham, Cheshire, WA14 1PJ.**

POCKET MULTIMETER

No bigger than a packet of cigarettes, the new ICE Microtest 80 multimeter combines several unique features in one compact and accurate instrument.

Covering 8 fields of measurement and 40 ranges, the meter has a 20,000 ohm per volt sensitivity, with 2 per cent accuracy on the a.c. and d.c. scales.

The design of the meter incorporates automatic electronic regulation for zero ohms, and the movement is protected against an overload of 1,000 times in the ohmic ranges before automatic cut-out.

The mirror scale of the meter enables clear and accurate reading. Each meter is supplied with a comprehensive instruction manual, a protective case and test leads.

A brief technical specification for the meter is as follows: volts d.c., in 6 switched ranges, 100mV to 1,000V (20kΩ/V); volts a.c., in 5 switched ranges, 1·5V to 1,000V (4kΩ/V). Current d.c., in 6 switched ranges, 50μA to 5A; current a.c., in 5 switched ranges, 250μA to 2·5A. Resistance, in 4 switched ranges, low ohms to ohms × 100. Capacitance measurements are available from 25μF to 25,000μF.

The meter is powered by a 1·35V mercury battery which, in normal usage, will last up to 3 years, and a complete range of extra accessories is available. Amongst the accessories are a temperature probe (−50 to +200°C), gaussmeter and a luxmeter probe.

The Microtest 80 multimeter is priced at £11·95 ex. VAT, with special terms for quantity purchase, and is available direct from **Electronic Brokers Ltd., 49 Pancras Road, London, NW1 2QB.**

PROFESSIONAL MICROPHONE

A professional moving coil microphone with an excellent specification and features is announced by Beyer Dynamic (GB) Ltd.

Designated type M88, it has a hypercardioid polar pattern, a frequency response of 30Hz to 20,000Hz ± 2·5dB, a high output, and is manufactured to a standard setting transient response and front-to-back ratio. This means that any two random units can be used as a stereo matched pair. Side attenuation at 120 degrees is approximately 23dB and the EIA sensitivity rating is −144dB/m.

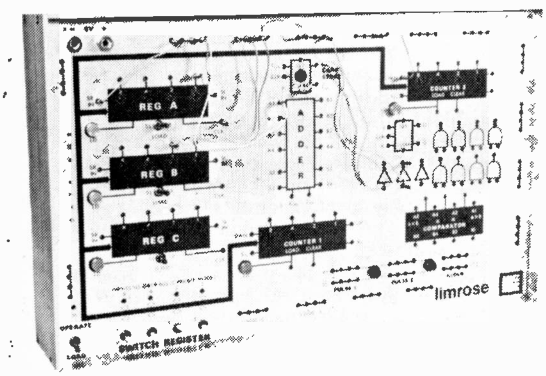
The design and features of the M88 make it ideal for both indoor and outdoor applications and it will withstand the rigours of professional usage, being completely unaffected by humidity and extreme temperatures. The rated load of the microphone is greater than 1,000 ohms and the 200 ohm low impedance balanced output is at a level of −51dB/m at 1kHz.

The microphone is available in two versions: the M88N with standard DIN connector at £81·05 plus VAT and the M88N(C) with Cannon connector at £83·35 plus VAT. Each microphone is supplied with a protective carrying case. Optional extras include windscreen, stands and cable transformer.

Further information and nearest stockists can be obtained from **Beyer Dynamic (GB) Ltd., 1 Clair Road, Haywards Heath, Sussex, RH16 3DP.**

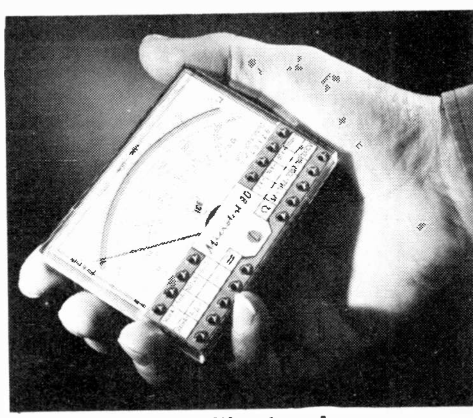
NOTE

The SEAS loudspeaker kits, mentioned last month, are only available in 8 ohm versions.



Limrose Electronics Digital Tutor

M88 Professional Microphone from Beyer Dynamic



Microtest 80 multimeter from Electronic Brokers

INDUSTRY NOTEBOOK

By Nexus

EXPORTS HOLDING FIRM

Few in the electronics industry regretted the passing of 1974 with its succession of elections, budgets, industrial unrest, inflation and general economic stress. At least 1975 promises a higher level of stability and now we are well into the first quarter of the year there are already signs that whatever the depression in the home market, mainly in entertainments products, the world is still Britain's market and that trade remains at a substantial level.

The New Year saw a flurry of activity starting with confirmation from the British Overseas Trade Board that support for exhibitions at overseas trade fairs and for outward sales missions would be greater than ever before.

Few of these exhibitions, however, were specifically for electronics companies. Their turn comes a little later in the year with a major participation in a Communications Exhibition in Moscow at the end of May as just one of the highlights in a full programme.

Quick off the mark in 1975 were Marconi-Elliott Avionics with a £1·25 million order for automatic test equipment for the US Navy and US Air Force. The equipment is for checking out head-up displays for A-7D and A-7E Corsair 2 aircraft. At the same time, sister company Marconi Communication Systems was announcing a £3 million contract for colour TV studio and OB equipment for switchover from monochrome to colour in the Egyptian TV service.

A few days later a contract worth £200,000 was announced for Marconi Mark 8 colour TV cameras for use in America.

But it's not only the truly exotic equipment that sells well. Few people are aware that Plessey, as well as being big in radar, electronic telephone exchanges and sophisticated sonar systems, have a thriving business in electronic igniters for gas stoves and boilers. In January, Plessey Windings expanded European activities by signing a contract with S.I.T., France, who will beef up markets in France, Belgium and Luxembourg.

This new agreement supplements existing arrangements in the Far East and North America. The North American breakthrough is regarded as significant because gas igniters is a cut-throat business over there. Plessey Windings is a major supplier to Caloric Corp., Pennsylvania, a principal cooker manufacturer.

Racal Group looks as vigorous as ever with Racal-Milgo high speed modems being ordered from Poland, Racal-Thermionic selling £220,000 worth of data recording equipment to French airports, and Redac Software selling computer-aided design software packages to Finland, bringing Redac customers in Scandinavia up to eight including names like Saab, Asea and Tandberg. These orders all came in early January.

Muirhead celebrated the New Year with a nice little order for 23 weather chart recorders for Kenya, Uganda and Tanzania. This brought Muirhead's export orders for this type of equipment to £325,000 in three months. Chairman Sir Raymond Brown commented that Muirhead will continue aggressive exploitation of the export potential of its products.

Smaller companies are also doing well. Membrain, for example, has installed an automatic tester for computer back-planes in West Germany. It will test over 2,000 points in less than a minute. The order was taken just before Christmas. The installation was operational by January 17. Nice work!

A heartening aspect of this brief survey is that so many of the orders, and they are only a short selection, are from countries such as the United States, France and West Germany which are themselves fully developed in the electronics industry. Another is the wide geographical spread.

WHIZZ KIDS

Gordon Pope, who led the Advance Electronics expansion programme from £800,000 turnover when he joined Advance as general manager in 1963 to today's £11 million, now rejoices in the title of Vice-President, Gould Instruments and Electronics, Europe. This follows the acquisition of Advance by Gould last October. We may expect to hear of further vigorous developments in the months ahead.

You've got to move fast to keep up with Tom Jermyn who started making transistor pads in his garage as a part-time hobby and built up Jermyn Industries to a mini-multinational operating in the USA and Europe as well as the UK. But Peter Smitham, who has become the top man in the Group, second only to Tom Jermyn, is no slouch. He leapfrogged into the top spot only a little over a year after joining Jermyn to set up Mogul Electronics as Jermyn's second component distributor company. He came to Jermyn with a fine record behind him. He was the youngest divisional manager in ITT, Europe, and has a fine academic as well as business record.

Present plans are to expand Jermyn to £20 million turnover by 1980. Latest Jermyn company is Solek Ltd., manufacturing heat pipes, a product which Jermyn Industries has been pioneering in the UK for the past two years.

And how about Clive Sinclair, well known to our hobbyist readers through his electronic kits and, more recently, through pocket calculators? Predictions in some quarters that he would overtax his capacity last year were not realised and he bounced into 1975 with yet another round of price cuts on his established calculators, some new models, and a new electronic multimeter.

On February 1 the standard Cambridge calculator came down to £12·95 (very near the £10 I was predicting in this column a year or so ago) and the Scientific came down to £19·95. His new range, announced at the same time, are equivalent to desk-top models though Sinclair prefers to call them "hand-held" indicating they will go in a brief-case, if not in the pocket. He claims to hold some 30 per cent of the calculator market in the UK, plus considerable exports with a production of some 70,000 units a month.

While majoring on calculators he is not neglecting his other product lines. His original electronic multimeter, despite its low price, was a flop. It didn't sell at all well. Nobody liked the Nixie indicators. This year's model is very superior and has an 8mm 7-segment LED readout on a front panel that looks and is highly professional although, at under £60, the instrument is at the low end of the price range. The old DM1 was not for me. But I'm now using the new DM2 very happily in my own workshop.

This year should also see Sinclair's long-awaited pocket TV set coming to the market place as well as an electronic digital watch.

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½W 1Ω to 10Ω. 5%, 1MΩ to 10MΩ: 10% E12
11Ω to 910kΩ 5% E12 and E24 **1p each**.

METAL OXIDE

½W 10Ω to 1MΩ. 2% E12 and E24 **4p each**

WIREWOUND

3W 0·22Ω, 0·27Ω, 0·33Ω, 0·47Ω 10%, 1Ω: 5% **17p each**.
1·2Ω to 270Ω 5% E12 **13p each**.
Other ranges stocked. See our catalogue for details.
E12: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and decades. E24: 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and decades.

POTENTIOMETERS

Rotary miniature carbon track ¼in spindle.
Values available: 5kΩ, 10kΩ, 25kΩ, 50kΩ, 100kΩ, 250kΩ, 500kΩ, 1MΩ, 2MΩ.
Log. Single-gang **16p**. Lin Single-gang (+ 1kΩ) **16p**.
Log. or Lin. Single-gang with switch **33p**.
Log. or Lin. Dual-gang without switch **49p**.
Slider 60mm track. Metal cased: overall length 86·15mm (knob 7p extra). Values available: 1k, 5k, 10k, 25k, 50k, 100k, 250k, 500k, 1M, 2M. Lin Single Gang **36p**. Log Single Gang **38p**. Lin or Log Dual Gang **45p**.
Presets: 0·1W vert. or hor. 100Ω, 220Ω, 470Ω, 1kΩ, 2.2kΩ, 4·7kΩ, 10kΩ, 22kΩ, 47kΩ, 100kΩ, 220kΩ, 470kΩ, 1MΩ **7p each**.

CAPACITORS

Sub-miniature
Axial lead electrolytic

Mfd	V	Price	Mfd	V	Price	Mfd	V	Price
1	63	6p	47	63	6p	330	16	14p
1·5	63	6p	68	6·3	6p	330	63	28p
2·2	63	6p	68	16	6p	470	6·3	6p
3·3	63	6p	68	63	14p	470	10	14p
4·7	63	6p	100	4	6p	470	25	16p
6·8	40	6p	100	10	6p	470	40	25p
6·8	63	6p	100	25	6p	680	6·3	14p
10	25	6p	100	40	6p	680	16	16p
10	63	6p	100	63	16p	680	25	25p
15	16	6p	150	6·3	6p	680	40	28p
15	40	6p	150	16	6p	1000	4	14p
15	63	6p	150	25	6p	1000	10	16p
22	10	6p	150	40	14p	1000	16	25p
22	25	6p	150	63	16p	1000	25	28p
22	63	6p	220	4	6p	1500	6·3	16p
33	6·3	6p	220	10	6p	1500	10	25p
33	16	6p	220	16	6p	1500	16	28p
33	40	6p	220	25	14p	2200	6·3	25p
47	4	6p	220	40	16p	2200	10	28p
47	10	6p	220	63	25p	3300	6·3	28p
47	25	6p	330	4	6p	4700	4	28p
47	40	6p	330	10	6p			

SWITCHES

Rotary adjustable stop. 1 pole, 2 to 12 way; 2 pole, 2 to 6 way; 3 pole, 2 to 4 way; 4 pole, 2 or 3 way **36p each**. Slide Sub-min DPDT **9p**. Slide min. DPDT **13p**. Push to make non-locking SPST **14p**. Push-on, push-off locking DPST 250V 4A **48p**. Rocker white DPST 250V 10A **40p**. Rotary mains DPST 250V 2A **20p**. Toggle with on/off plate DPDT 250V 1·5A **25p**.

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AC128	18p	BY127	13p
AC176	17p	BY164	49p
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BC107	10p	OA200	7p
BC108	10p	OC71	20p
BC109	13p	SC146D	88p
BC109C	15p	T1S43	28p
BC142	23p	WOO5	30p
BC143	26p	WO4	33p
BC147	10p	1N914	4p
BC148	10p	1N4001	6p
BC149	12p	1N4002	6½p
BC168C	12p	1N4003	7p
BC169C	12p	1N4004	7½p
BC178	17p	1N4005	8p
BC182L	10p	1N4006	8½p
BC183L	12p	1N4007	9p
BC184L	12p	1N4148	4p
BC212L	14p	2N1302	20p
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BD131/2MP	£1·20	2N2905	33p
		2N2926	
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BFX29	30p	2N3819	22p
BFX30	33p	2N5459	51p
BFX84	30p	7400	16p
BFX85	36p	7413	39p
BFX87	30p	7447	£1·10
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µA78M15 15V 500mA	£1·30
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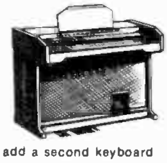

Leaflet MES51: Price **15p**, describes a fully polyphonic basic organ which can later be used as the basis of a large sophisticated instrument.
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PATENTS REVIEW...

TRANSDUCER IMPROVEMENTS

In BP1 364 669, STC Ltd. suggest some simple improvements to moving-iron transducers of the type used in some loudspeakers and telephone handsets. The basis of the technique described could be of interest to the experimenter.

Fig. 1 shows a conventional, rocking armature transducer (either a microphone or loudspeaker). A permanent magnet has pole piece members between which an armature is pivoted. The armature is coupled to a diaphragm and speech coils are wound on the pole pieces.

The passage of speech currents through the coils causes the armature to rock, or rocking of the armature induces currents through the coils. The arrangement works well until the armature is deflected too far and sticks or "freezes" against one pole of the magnet.

Diaphragm Fig. 2 shows the patented arrangement for preventing such freezing. The armature carries small magnets, one each side of its pivot point. The armature magnets lie between two end magnets and two front magnets. The polarity of the magnets is such that the armature floats freely in the central position as shown.

If currents are passed through the coil wound round the armature in such a direction as to make the left hand end of south polarity, then that end moves upwards towards the end magnet 1. Reversing the current direction causes an opposite movement, and the passage of an alternating current through the coil produces a corresponding vibration of the diaphragm. Similarly, movement of diaphragm induces currents in the coil.

Because of the repulsive forces between the magnets there can be no freezing of the armature and relatively rough-and-ready constructional techniques will provide a floating armature of low stiffness.

BP 1 364 669

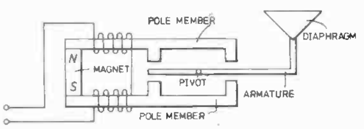

Fig. 1.

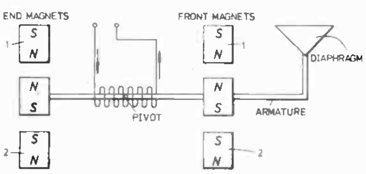

Fig. 2.

SPARK-FREE SUPPLY OF A.C.

In BP 1 366 134, Victor Products (Wallsend) Ltd., of Northumberland, claim a simple electromagnetic coupling system for supplying a.c. supplies to loads in hazardous environments, such as inflammable gas atmospheres.

The obvious risk under such situations is that a spark will be generated when a connection is made or broken. It is not new to suggest using two separable halves of a transformer to provide spark-free connection and disconnection. The primary of a transformer is provided in a wall socket and the secondary is included in a plug. When the plug is pushed into the socket the flux from the primary induces current in the secondary. The problem is ensuring that the primary does not drain current and overheat when the plug is disconnected.

The inventors show in their patent a socket with a primary winding and a plug with a secondary winding. To prevent current drain from the primary when the secondary is removed, an inductor is connected in series with the primary and a capacitor is connected in parallel with the inductor and primary. This parallel circuit is in series with a further inductor.

When the plug (sec) is coupled with the socket (pri) the circuit is tuned to the supply frequency. When the secondary is separated the inductance of the circuit decreases to cause detuning. Thus the current flowing through the primary also decreases.

As an example of component values, where the effective inductance of the primary decreases from 100mH to 10mH on removal of the secondary, a 0·16μF capacitor and a 8mH inductance was used to provide effective limiting for a supply frequency of 1kHz.

SPOT WELDING

In BP1 370 003, the Grumman Aerospace Corporation of Long Island, New York, explains how it is possible to spot weld by using a massive magnetic field. This creates a pressure on a metal workpiece and deforms it.

The Americans now suggest generating stress waves electromagnetically, to render the metal momentarily plastic. This they claim to have achieved with a device and circuit as shown in Fig. 1.

The power supply comprises a d.c. source, switch S1 and a capacitor bank. The capacitors are charged by the d.c. source when S1 is closed.

When charging is complete, switch S2 is closed to feed a high amperage current pulse of short duration to a pancake coil. The coil produces a high intensity magnetic field pulse which intersects a driver of aluminium or hardened copper. The driver acts as a one turn secondary winding of a transformer and the massive current which is induced in the driver sets up a high intensity magnetic field around it.

The electromagnetic repulsion created by the interaction of the two high intensity fields generates a stress wave in the driver, which is propagated through a focussing cone towards a tip. The combined effect of the backing mass and the stress from the tip deforms the workpiece and causes a spot weld.

The inventors claim success with voltages of between 4 and 7 kV, focusing cones of hardened steel, and a pancake coil of 18 turns of rectangular copper wire.

BP 1 370 003

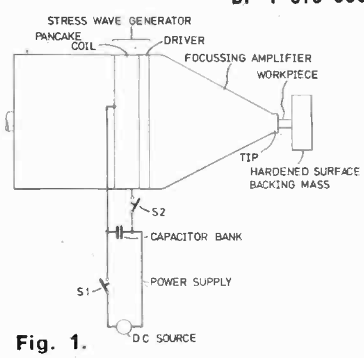

Fig. 1.

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DEPTH 3in.

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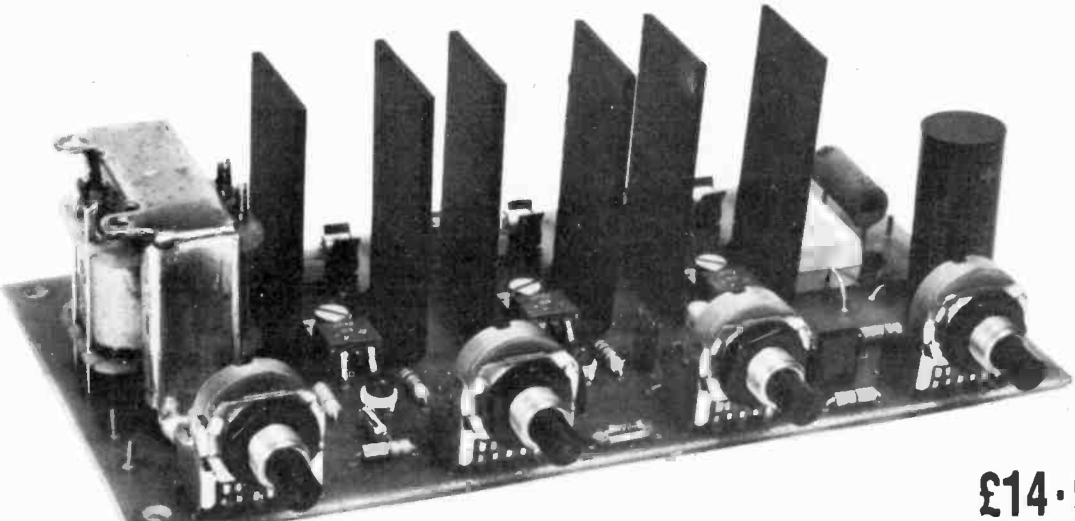

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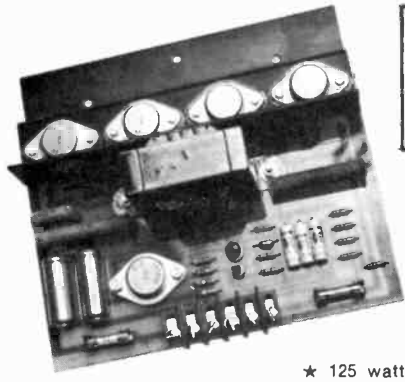

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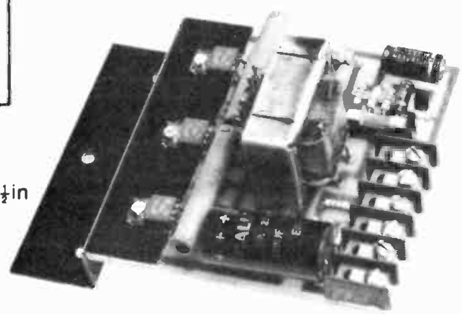

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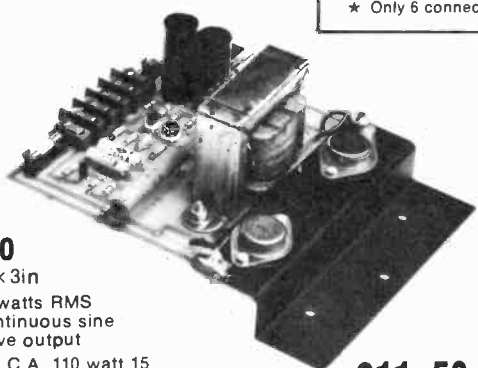

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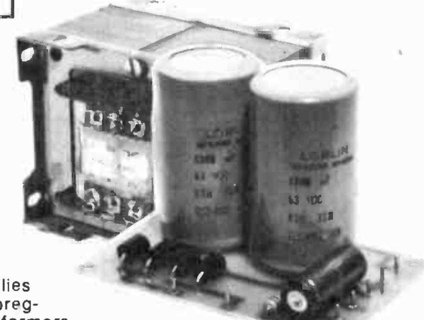

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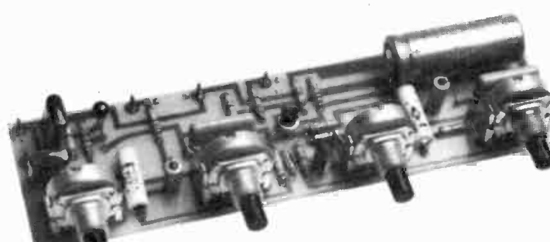

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4·7µF	63V	6½p	150µF	16V	6½p
6·8µF	63V	6½p	150µF	63V	15p
8·0µF	40V	6½p	220µF	6·4V	6½p
10µF	16V	6½p	220µF	10V	6½p
10µF	25V	6½p	220µF	16V	8p
10µF	63V	6½p	220µF	63V	21p
15µF	16V	6½p	330µF	16V	12p
15µF	63V	6½p	330µF	63V	25p
16µF	40V	6½p	470µF	6·4	9p
22µF	25V	6½p	470µF	40V	20p
22µF	63V	6½p	680µF	16V	15p
32µF	10V	6½p	680µF	40V	25p
33µF	16V	6½p	1000µF	16V	20p
33µF	40V	6½p	1000µF	25V	25p
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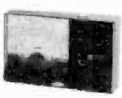

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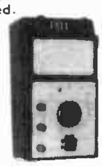

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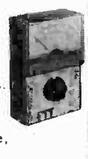

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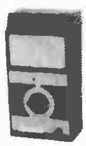

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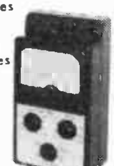

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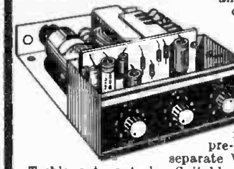
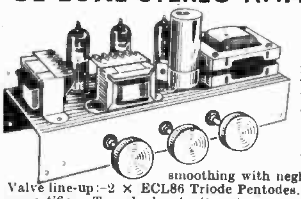
SUPERSOUND 13 HI-FI MONO AMPLIFIER



A superb solid state audio amplifier. Brand new components throughout. 5 Silicon transistors plus 2 power out-put transistors in push-pull. Full wave rectification. Output approx. 13 watts r.m.s. into 8 ohms. Frequency response 12Hz. 30KHz ±3db. Fully integrated pre-amplifier stage with separate Volume, Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3" high × 6" wide × 7½" deep. AC 200/250V. PRICE £12·50. P. & P. 50p.

DE LUXE STEREO AMPLIFIER



A.C. mains 200-240 v. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line-up:-2 × ECL86 Triode Pentodes. 1 × EZ80 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate 'Balance' control fitted at the rear of the chassis. Input sensitivity is approximately 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 11"w × 4"d. Overall height including valves 5". Ready built and tested to a high standard. £10·75. P. & P. 50p.

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 on lead.
Fitted insulated output terminals and pilot lamp indicator. Hammer finish metal case overall size 6" × 3½" × 2¼". Suitable for Transistor Radios, Tape Recorders, Amplifiers etc. etc. Ready built and tested. Price £5·20. P. & P. 35p.

VYNAIR & REXINE SPEAKERS & CABINET FABRICS app. 54 in. wide. Our price £1·30 yd. length. P. & P. 15p per yd. (min. 1 yd.). S.A.E. for samples.

HARVERSON'S SUPER MONO AMPLIFIER
A super quality gram amplifier using a double wound fully solated mains transformer, rectifier and ECL82 triode pentode valve as audio amplifier and power output stage. Impedance 3 ohms. Output approx. 3·5 watts. Volume and tone controls. Chassis size only 7in. wide × 3in. deep × 6in. high overall. AC mains 200/240v. Supplied absolutely Brand New completely wired and tested with good quality output transformer.
P. & P. 40p. BARGAIN PRICE £4·20

FEW ONLY. High grade mains transformer with grain orientated lamination. Primary 200/240. Secondary 18·5 volts at 0·6 amps and 4-6 volts at 0·3 amps. Size 2in. long × 2½in. wide × 2in. deep overall. £1·35 plus 25p P. & P.

BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. Giving 13 alternatives. Primary: 0–210–240v. Secondary combinations 0–5–10–15–20–25–30–35–40–60v. half wave at 1 amp. or 10–0–10, 20–0–20, 30–0–30v. at 2 amps fulls wave. Size 3in. long × 3½in. wide × 3in. deep. Price £2·60. P. & P. 40p.
MAINS TRANSFORMER. For transistor power supplies. Pro. 200/240v. Sec. 9–0–9 at 500 mA. £1·25. P. & P. 25p. Pri. 200/240v. Sec. 12–0–12 at 1 amp. £1·40. P. & P. 26p. Pri. 200/240v. Sec. 10–0–10 at 2 amp. £2·00. P. & P. 35p.

3 VOLT RELAY. 100 m/a single pole normally closed. 2 for 60p. P. & P. 15p.

GENERAL PURPOSE HIGH STABILITY TRANSISTOR PRE-AMPLIFIER
For P.U. Tape, Mike, Guitar, etc. and suitable for use with valve or transistor equipment. 9-18v. battery or from H.T line 200/300v. Frequency response 15Hz—25KHz. Gain 26dB. Solid encapsulation size 1¾" × 1¼" × ¾". Brand new complete with instructions. Price £1·20. P. & P. 15p.

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

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All three together £3.

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Thyristor, Triac, Diac etc. encyclopedias £1. Post Free.

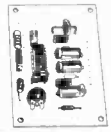
8 pole 3 way 2 bank low loss Yaxley type switches 1¼" sections. Standard spindle. 2 switches 64p + 10p P. & P.

HARVERSONIC MAINS OPERATED SOLID STATE STEREO FM TUNER

Enjoy Fabulous Stereo Radio at this Low Introductory Price!

Designed and styled to match our 10 + 10 amplifier but will suit any other standard stereo amplifier. The design incorporates the very latest circuitry techniques with high-grain, low noise IF stages. Automatic frequency control to "lock on" station and prevent drift. IC stereo decoder for maximum stereo separation. I.E.D. for stereo beacon indicator. Nominal output of tuner 100mV. Approximate size 12½in wide × 8in deep by 2½in high. Supplied ready built, fully tested and fully guaranteed (not available in kit form).
Price £23·00. Post and Packing 50p.

STEREO-DECODER SIZE 2″×3″×½″



Ready built. Pre-aligned and tested. Sens. 20-560mV for 9-16V neg. earth operation. Can be fitted to almost any FM VHF radio or tuner. Stereo beacon light can be fitted if required. Full details and instructions (inclusive of hints and tips) supplied. £5·40 plus 10p P. & P. Stereo beacon light if required 40p extra.

LATEST HI SENSITIVITY UNI-DIRECTIONAL SLIM-LINE CONDENSER MICROPHONE as used by many professionals. Very low acoustic feedback. Available Hi impedance or low impedance. State which required. £13·50. P. & P. 25p.

LATEST ACOS GP91/1SC mono compatible cartridge with t/o stylus for LP/EP/78. Universal mounting bracket. £1·46. P. & P. 15p.
CERAMIC STEREO CARTRIDGE. Universal mounting brackets and turnover stylus. 70mV per channel output. ONLY £1·75. P. & P. 15p.
SONOTONE 9TAHC COMPATIBLE STEREO CARTRIDGE T/O stylus Diamond Stereo LP and Sapphire 78. ONLY £2·27. P. & P. 10p. Also available fited with twin Diamond T/O stylus for Stereo LP. £2·76. P. & P. 15p.
LATEST RONETTE T/O STEREO/COMPATIBLE CARTRIDGE for EP/LP/Stereo 78. £1·60. P. & P. 15p.
LATEST T/O MONO COMPATIBLE CARTRIDGE for playing EP/LP/78 mono or stereo records on mono equipment. Only £1·47. P. & P. 15p.

QUALITY RECORD PLAYER AMPLIFIER MK. II
A top quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, and rectifier. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in wide × 3in deep × 6in high. Ready built and tested. PRICE £5·50. P. & P. 50p.
ALSO AVAILABLE mounted on board with output transformer and speaker. PRICE £6·70. P. & P. 60p.

HI-FI LOUDSPEAKER SYSTEM MkII

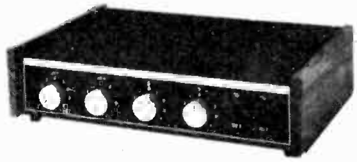
Beautifully made simulated teak finish enclosure now with most attractive slatted front. Size 16½" high × 10½" wide × 9" deep (approx.). Fitted with E.M.I. Ceramic Magnet 13" × 8" bass unit, H.F. tweeter unit and crossover. AVAILABLE IN NOMINAL 4 ohm, 8 ohm or 16 ohm impedance (state which).
OUR PRICE £9·50 each. Carr. 90p.
Cabinet Available Separately £5·00. Carr. 90p.
Also available in 8 ohms with EMI 13" × 8" bass speaker with parasitic tweeter £8·00. Carr. 75p.

LOUDSPEAKER BARGAINS
5in. 3 ohm £1·25, P. & P. 15p. 7 × 4in. 3 ohm £1·40, P. & P. 20p. 10 × 6in. 3 or 15 ohm £2·10, P. & P. 30p. E.M.I. 8 × 5in. 3 ohm with high flux magnet £1·70, P. & P. 20p. E.M.I. 13½ × 8in. with high flux ceramic magnet with parasitic tweeter 3, 8 or 15 ohm £3·50, P. & P. 30p. E.M.I. 13 × 8in 3, 8 or 15 ohm with inbuilt tweeter and crossover network £4·65, P. & P. 30p.
E.M.I. tweeter. Approx. 3½". Available 3 or 8 or 15 ohms, £1·80 + 20p, P. & P.
BRAND NEW. Bakers Loudspeakers at substantial discounts. 12in. 15w. H/D Speakers, 3, 8 or 15 ohms. State which. Current production by well-known British maker. Now with Hiflux ceramic ferrobar magnet assembly £7·50. Guitar models: 25w. £7·50. 35w. £8·50. P. & P. 45p.

"POLY PLANAR" WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER
Size 11¾" × 14⅝" × 1⅛" deep. Weight 19oz. Power handling 20W r.m.s. (40W peak). Impedance 8 ohm only. Response 40Hz–20kHz. Can be mounted on ceilings, walls, doors, under tables, etc., and used with or without baffle. Send S.A.E. for details. Only £6·60 each. P. & P. 34p.
NOW ALSO AVAILABLE 8in. 10W rms 20W peak 40Hz—20,000Hz. Overall depth 1in. Ideal for Hi-Fi or for use in cars. £4·32. P. & P. 25p.

SPECIAL BARGAIN OFFER!
Limited number of BSR C123 Auto Changer De Luxe with lightweight tubular arm and stereo cartridge. Brand new. ONLY £8·00 + p. & p. 60p.

HARVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT

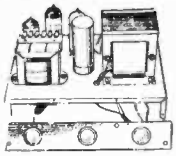


A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. Very simple to modify to suit magnetic cartridge—instructions included. Output stage for any speakers from 8 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled printed circuit board with component identification clearly marked, 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 specifications: Power output: 14 watts r.m.s. per channel into 5 ohms. Frequency response ±3dB 12–30,000 Hz Sensitivity: better than 80mV into 1MΩ. 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"w. × 8"d. × 2½"h.
Fully detailed 7 page construction manual and parts list free with kit or send 18p plus large S.A.E.

AMPLIFIER KIT	£12·96	P. & P. 30p
(Magnetic input components 33p extra)		
POWER PACK KIT	£4·32	P. & P. 40p
CABINET	£4·32	P. & P. 40p

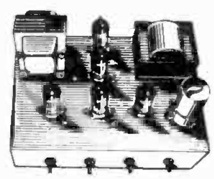
(Post Free if all units purchased at same time)
Full after sales service
Also available ready built and tested £28·08. Post Free.
Note: The above amplifier is suitable for feeding two mono sources into inputs (e.g. mike, radio, twin record decks, etc.) and will then provide mixing and fading facilities for medium powered Hi-Fi Discotheque use, etc.

3-VALVE AUDIO AMPLIFIER HA34 MK II.



Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½"w. × 4"d. × 4½"h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only £6·50. P. & P. 45p.
HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. £5·50. P. & P. 45p.

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other.
Fully shrouded section wound output transformer to match 3–15Ω speaker and 2 independent volume controls, and separate base and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 15p × SAE (Free with parts). All parts sold separately. ONLY £10·25. P. & P. 60p. Also available ready built and tested £14·00. P. & P. 70p.

HI-FI STEREO HEADPHONES

Adjustable headband with comfortable flexifoam ear-muffs. Wired and fitted with standard stereo ¼in jack plug. Frequency response 30–15,000Hz. Matching impedance 8–16 ohms. Easily converted for Mono. PRICE £3·50. P. & P. 25p.

PRICES INCLUDE VAT

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Prices and specifications correct at time of press. Subject to alteration without notice

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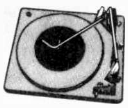
BSR HI-FI AUTOCHANGER
STEREO AND MONO



Plays 12", 10" or 7" records. Auto or Manual. A high quality unit backed by BSR reliability with 12 months' guarantee. A.C. 200/250V Size 13¼ × 11¼in. Above motor board 3¼in. below motor board 2¼in.

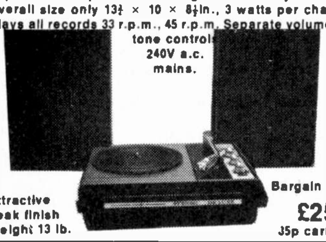
with STEREO and MONO CARTRIDGE **£7·95** Post 45p

PORTABLE PLAYER CABINET

Modern design. Rexine covered. Vynair front grille. Chrome fittings. Size 17 × 15 × 8in approx. Motor board cut for BSR or Garrard deck. **£4·50** Post 45p

COMPLETE STEREO HI-FI SYSTEM

Two full size loudspeakers 13½ × 10 × 3½in. Player unit clips to loudspeakers making it extremely compact, overall size only 13½ × 10 × 8½in., 3 watts per channel, plays all records 33 r.p.m., 45 r.p.m. Separate volume and tone controls. 240V a.c. mains.



Attractive Teak finish Weight 13 lb.

Bargain Price **£25** 35p carriage

SPECIAL OFFER!
SMITH'S CLOCKWORK 15 AMP TIME SWITCH
0–60 MINUTES **£2·20** Post 25p.

Single pole two-way. Surface mounting with fixing screws. Will replace existing wall switch to give light for return home, garage, automatic anti-burglar lights, etc. Variable knob. Turn on or off at full or intermediate settings. Brand new and fully guaranteed.

TEAKWOOD LOUDSPEAKER GRILLES will easily fit to baffle board. Size 18¼ × 10¼in—75p. 10¼ × 7¼in—45p

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RA2W Ferrite Aerial 85p	Driver Trans. LFDT4...65p
I.F. P50/2CC 470 kc/s 40p	Printed Circuit, PCA1 65p
3rd I.F. P50/3CC 40p	J.B. Tuning Gang ...£1·20
Spares Cores 3p	Weyrad Booklet 10p
P50/1AC 60p	OPT1 ....65p

Mullard Ferrite Rod 8 × ⅜in., 20p. 6 × ⁵⁄₁₆in., 20p. 3 × ⅜in. 10p

VOLUME CONTROLS
5kΩ to 2MΩ. LOG or LIN. L/S 20p. D.P. 35p. STEREO L/S 55p. D.P. 75p. Edge 5K. S.P. Transistor 25p

80 Ohm Coax 5p yd.
BRITISH AERIALITE AERAXIAL-AIR SPACED 40 yd, £2; 60 yd, £3

FRINGE LOW LOSS Ideal 625 and colour **10p yd**

8in. or 10×6in. ELAC HI-FI SPEAKER

Dual cone plasticised roll surround. Large ceramic magnet. 50–16,000 c/s. Bass resonance 55 c/s, 8 ohm impedance, 10 watts. music power.

£3·75 Post 25p

E.M.I. 13½ × 8in. SPEAKER SALE!

With twin tweeters. And crossover. 10 watt. State 3 or 8 or 15 ohm. As illustrated. Post 25p **£4·50**

With flared tweeter cone and ceramic magnet. 10 watt. Bass res. 45–60 c/s. Flux 10,000 gauss. State 3 or 8 or 15 ohm. Post 25p **£2·95**

Bookshelf Cabinet Teak finish 16 × 10 × 7in. 13in × 8in. Bass Woofer, 20 watts, £5·50 **£6·60** Post 45p

SET OF 3 MOTORS FOR COLLARO STUDIO 115 VOLT TAPE DECK
£1·50 Post 50p

BLANK ALUMINIUM CHASSIS. 18 s.w.g. 2½in. sides 6 × 4in 45p; 8 × 6in 53p; 10 × 7in 65p; 12 × 8in 85p; 14 × 9in 90p; 16 × 6in 90p; 12 × 3in 50p; 16 × 10in £1. ALUMINIUM BOXES, 3 × 3 × 3in 80p; 4 × 4 × 4in 70p; 6 × 4 × 4in 80p; 9 × 4 × 4in £1; 12 × 4 × 4in £1·30. ALUMINIUM PANELS 18 s.w.g. 6 × 4in 12p; 6 × 6in 18p; 14 × 3in 20p; 10 × 7in 24p; 12 × 5in 25p; 12 × 8in 34p; 16 × 6in 34p; 14 × 9in 40p; 12 × 12in 47p; 16 × 10in 60p.

ANOTHER R.C.S. BARGAIN!
ELAC 9 × 5in HI-FI SPEAKER TYPE 59RM
This famous unit now available, 10 watts, 8 ohm.

Price **£2·95** Post 25p

R.C.S. STABILISED POWER PACK KITS
All parts and instructions with Zener Diode, Printed Circuit, Bridge Rectifiers and Double Wound Mains Transformer Input 200/240V a.c. Output voltages available 6 or 9 or 12 or 15 or 18 or 20V d.c. at 100mA or less. PLEASE STATE VOLTAGE REQUIRED Details S.A.E. Size 3½ × 1½ × 1¼in. **£2·20** Post 25p

RCS POWER PACK KIT
12 VOLT, 750mA. Complete with printed circuit board and assembly instructions. **£2·95** Post 25p

12 VOLT 300mA KIT, £2·75. 9 VOLT 1 AMP KIT, £2·95.

R.C.S. GENERAL PURPOSE TRANSISTOR PRE-AMPLIFIER—BRITISH MADE
Ideal for Mike, Tape, P.U., Guitar, etc. Can be used with Battery 9–12V or H.T. line 200–300V d.c. operation. Size: 1½ x 1½ x ½in. Response 25 c/s to 25 kc/s. 26 dB gain. For use with valve or transistor equipment. Full instructions supplied. Details S.A.E. **£1·25** Post 20p

ELECTRO MAGNETIC PENDULUM MECHANISM
1·5V d.c. operation over 300 hours continuous on SP2 battery, fully adjustable swing and speed. Ideal displays, teaching electro magnetism or for metronome, strobe, etc. **95p** Post 20p

BRITISH FM/VHF TUNING HEART
88 to 108 M/CS British made. 2 Transistors ready aligned requires 10·7 M/CS I.F. Complete with tuning gang. Connections supplied but some technical experience essential.

Our price £3·95 Post 20p

10·7 M/CS I.F. strip £4·95 DECODER £4·95

MAINS TRANSFORMERS
ALL POST 25p each

250–0–250V 70mA, 6·3V 2A ....£2·50
250–0–250 80 mA, 6·3V 3·5A 6·3V 1A or 5V 2A ....£4·00
350–0–350 80 mA, 6·3V 3·5A, 6·3V 1A or 5V 2A ....£5·00
300–0–300V 120 mA, 6·3V 4A C.T.; 6·3V 2A ....£6·00
MINIATURE 200V 20mA, 6·3V 1A 2½ × 2½ × 2in 95p
MIDGET 220V 45 mA, 6·3V 2A 2½ × 2½ × 2in ....£1·10
HEATER TRANS. 6·3V ½ amp 85p, 3 amp ....£1·20
GENERAL PURPOSE LOW VOLTAGE. Tapped outputs at 2 amp. 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30V £4·00
1 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £4·00
2 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £6·00
3 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £7·50
5 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £9·75
3, 5, 8, 10, 13 or 5–0–5V amp. £1·50, 6–0–6V 500mA 90p, 9V 1 amp. 95p, 12V 300mA 75p, 12V 500 mA 85p, 12V 750 mA 95p, 10V, 30V, 40V, 2 amp. £2·20, 20V, 3 amp, £2. 40V, 3 amp. £2·50. 22–0–22V, 4 amp. £3. 16V, ½ amp. 95p. 16V, 2 amp. £1·85. 0, 5, 8, 10, 16V, ½ amp. £1·60
AUTO TRANSFORMERS, 115V to 230V or 230V to 115V 150W £4; 500W £7·50; 750W £15; 1000W £18.
BATTERY CHARGERS. Ready built with leads and clips 1½ amp £2; 4 amp £4; 5 amp £4·50.
FULL WAVE BRIDGE CHARGER RECTIFIERS: 6 or 12V outputs, 1½ amp 40p; 2 amp 55p; 4 amp 85p.

MAINS ISOLATING TRANSFORMER
Primary 0–110–240V. Secondary 0–240V 3A 720W Insulated terminals. Varnish impregnated. Fully enclosed in steel case with fixing feet. Famous make. (Value £19). OUR PRICE **£12** Carr. 95p Can be used as 800W auto transformers 240–110V. IDEAL FOR COLOUR T.V. OR GARDEN TOOLS.

NEW ELECTROLYTIC CONDENSERS

2/350V 14p	250/25V 14p	50 + 50/300V 50p
4/350V 14p	500/25V 20p	900/350V 95p
8/350V 22p	100 + 100/275V 65p	32 + 32/250V 20p
16/350V 25p	150 + 200/275V 70p	32 + 32/450V 60p
32/500V 50p	8 + 8/450V 22p	350 + 50/325V 85p
25/25V 10p	8 + 16/450V 25p	100 + 50 + 50/350V 85p
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100/25V 10p	32 + 32/350V ...40p	4700/63V 95p

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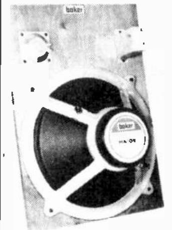
TRIMMERS 10pF, 30pF, 50pF, 5p. 100pF, 150pF, 15p. CERAMIC, 1pF to 0·01mF, 4p. Silver Mica 2 to 5000pF, 4p. PAPER 350V–0·1 7p, 0·5 13p; 1mF 150V 15p; 2mF 150V 15p. 500V–0·001 to 0·05 5p; 0·1 10p; 0·25 13p; 0·47 25p. MICRO SWITCH LEVER ACTION 20p. SUB-MIN MICRO SWITCH 25p. Single pole change over. TWIN GANG, "0-0" 208pF + 176pF £1·20; 500pF standard 75p. 365pF + 365pF with 25pF + 25pF, Slow motion drive 50p. SHORT WAVE SINGLE. 10pF, 30p, 25pF, 55p, 50pF, 55p. NEON PANEL INDICATORS 250V AC/DC. Amber 30p. RESISTORS. ⅛W, ½W, 1W, 20% 1p; 2W, 5p. 10Ω to 10M. HIGH STABILITY, ½W 2% 10 ohms to 6 meg., 10p. Ditto 5%. Preferred values 10 ohms to 10 meg., 4p. WIRE-WOUND RESISTORS 5 watt, 10 watt, 15 watt, 10 ohms to 100K 10p each. TAPE OSCILLATOR COIL Valve type 35p.

NEW MODEL "BAKER LOUDSPEAKER", 12IN 50 WATT. GROUP 50/12. 8 OR 15 OHM HIGH POWER. FULL RANGE PROFESSIONAL QUALITY. **£12·95**

BAKER MAJOR 12" £8·50



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

Module kit, 30–17,000 c/s with tweeter, crossover, baffle and instructions. **£10·95**

Please state 3 or 8 or 15 ohms.

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'Group 25'	'Group 35'	'Group 50/15'
12in. 25W **£7·75**	12in. 35W **£8·50**	15in. 50W **£16·50**
3 or 8 or 15 ohm	3 or 8 or 15 ohm	8 or 15 ohm

TEAK VENEERED HI-FI SPEAKER AND CABINETS

For 12in or 10in. dia. speaker	20 × 13 × 9in, £10·50 Post 75p
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LOUDSPEAKER CABINET WADDING 18in wide, 20p ft

GOODMANS 6½in. HI-FI WOOFER

4 ohm or 8 ohm. 10W. Large ceramic magnet. Special Cambric cone surround. Twin cone. Frequency response, 30–12,000 c/s. Ideal P.A. Columns. Hi-Fi Enclosure Systems, etc. **£4**

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The moving coil diaphragm gives a good radiation pattern to the higher frequencies and a smooth extension of total response from 1,000 c/s to 18,000 c/s. Size 3½x3½x2in deep. Rating 10W, 3 ohm. Crossover £1·25 **£1·90** Post 20p

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RICHARD ALLAN TWIN CONE LOUDSPEAKERS, 8in. diameter 4W £2·50. 10in. diameter 5W £2·95; 12in. diameter 6W £3·50. 3/8/15 ohms, please state. VALVE OUTPUT TRANS. 40p; MIKE TRANS. 50:1 40p. Mike trans. mu metal 100:1 £1·25.

Loudspeaker Volume Control 15 ohms 10W with one inch long threaded bush for wood panel mounting. ¼in spindle. 65p each, Post 15p.

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All purpose transistorised. Ideal for Groups, Disco and P.A. 4 inputs speech and music. 4 way mixing. Output 8/15 ohm. a.c. Mains. Separate treble and bass controls. Guaranteed. Details SAE. **£49** Carr. £1·00

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BARGAIN 4 CHANNEL TRANSISTOR MONO MIXER. Add musical highlights and sound effects to recordings. Will mix Microphone, records, tape and tuner with separate controls into single output. 9V. **£4·50**
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REVERSIBLE 4 POLE MOTOR

1,400 r.p.m. Reversible 42 Watt, spindle 1½"x¼", size 3¼"x3", As illustrated. With Cooling Fan. a.c. 240V. Post 25p **£2·20**

EMI TAPE MOTOR £1·85

EMI TAPE MOTORS. 240V a.c. 1,200 r.p.m. 4 pole 135mA. Spindle 0·187x0·75in. Size 3¼ × 2¼ × 2¼in (illustrated). Post 25p. 120V Model, £1.

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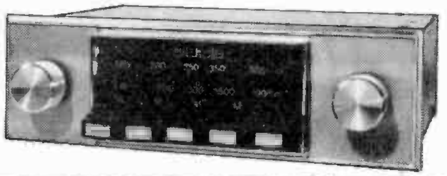
PUSH BUTTON CAR RADIO KIT* ~ The Tourist TT



NO SOLDERING REQUIRED!

NOW BUILD YOUR OWN PUSH BUTTON CAR RADIO

Easy to assemble construction kit comprising fully completed and tested printed circuit board on which no soldering is required. All connections are simple push fit type making for easy assembly. Fine tuning push button mechanism is fully built and tested to mate with printed circuit board.

TECHNICAL SPECIFICATION: (1) **Output** 4 watts R.M.S. output. For 12 volt operation on negative or positive earth. (2) **Integrated circuit** output stage, pre-built three stage IF Module. **Controls volume** manual tuning and five push buttons for station selection, illuminated tuning scale covering full, medium and long wave bands.

Size chassis 7" wide, 2" high and $4\frac{3}{4}''$ deep approx £8·00 + 90p. p & p.

Speaker including baffle and fixing strip £1.65 + 37p. p & p.

Car Aerial Recommended—fully retractable £1.37 + 32p. p & p.

The Tourist I Kit For the experienced constructor If you can solder on a printed circuit board you can build this model.
Same technical specification as Tourist TT **Price £7·00 + 90p. p & p.**

EMI SPEAKERS AT FANTASTIC REDUCTIONS

EASY BUILD SPEAKER KITS

These superb simulated teak-finished speaker kits have been specially designed by RT-VC for the cost-conscious hi-fi enthusiast who wants top quality speakers but doesn't want to spend the earth. Built to EMI's exacting specification, these new RT-VC speaker kits (350 type kit) incorporate 13" × 8" woofer, $3\frac{1}{2}''$ tweeter and matching crossover.
Easily put together with just a few basic tools. Specification (each speaker) Impedance 8 ohms. Power handling 15 watts r.m.s. (30 watts peak). Response 20–20,000 Hz. Size 20" × 11" × $9\frac{1}{2}''$ approx.
Comparable built units (EMI LE3) sold elsewhere for over £45 pair.

£18·95 pair + £4·50 p & p.

20 WATT SPEAKER SYSTEM*

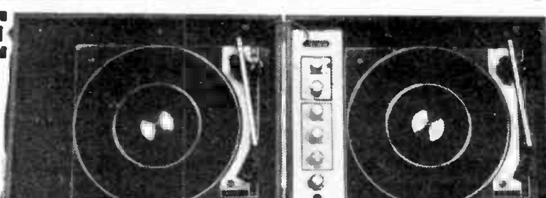
System consists of a 13" × 8" (approx) eliptical woofer unit with a 8" × 5" (approx.) mid range unit incorporating parasitic tweeter and crossover components. Circuit diagram.
Technical Specification:
Bass Unit
Flux density–100 K, speech coil–$1\frac{1}{2}''$
Cone. Triple laminated paper with P.V.C. surround.
Mid Range Unit
Flux density–33K, speech coil–1" with parasitic tweeter.
Power Handling
20 watts R.M.S., impedance–8 ohms, frequency response–20 Hz to 18,000 Hz.

OUR PRICE £7·50. Complete + £1·35 p & p.

DISCO AMPLIFIER*

Reliant Mk IV Mono Amplifier, ideal for the small disco or house parties.
Output 20 watts R.M.S. into 8 ohms (suitable for 15 ohms).
Inputs *4 electrically mixed inputs. *3 individual mixing controls.
*Separate bass and treble controls common to all 4 inputs.
*Mixer employing F.E.T. (Field Effect Transistors) *Solid State circuitry.
*Attractive styling.
INPUT SENSITIVITIES –Input – 1.) Crystal mic. guitar or moving coil mic, 2 and 10mV. (Selector switch for desired sehsitivity).
–Inputs – 2), 3), 4). Medium output equipment – ceramic cartridge, tuner, tape recorder, organs, etc. – all 250mV sensitivity. AC Mains, 240V operation. Size approx: $12\frac{1}{2}''\times6''\times3\frac{1}{2}''$. **£17·00 + £1·15 p & p.**

PORTABLE DISCO CONSOLE*



INCORPORATES: Pre-Amp with full mixing facilities, including switched input for mic with volume control, switched input for auxiliary with volume control, bass and treble controls, volume control and blend control for turntables.

Two B.S.R. single play professional series decks, fitted with crystal cartridges.

The turntables are designed and precision engineered. They combine clean modern styling with superb reproduction. Their many special features include square section aluminium tonearms, (high precision low mass design fully counterbalanced, with calibrated stylus pressure control for perfect tracking), and conveniently grouped easy to read linear controls. The turntables have viscous cueing devices which allows the tonearms to be placed or lifted at any point on the record.
The two lightweight cartridge shells have slide-in-holders to facilitate easy inspection of needles and cartridges.

TECHNICAL SPECIFICATION:
Pre-amp – Output – 200mV.
Auxiliary inputs – 200mV and 750mV into 1 meg.
Mic input – 6mV into 100K. 240 volt operation.
Turntables capacity – 7", 10" or 12" records.
Rumble, wow and flutter
Rumble Better than –35dB. Wow Better than 0.2%.
Flutter Better than 0.06% (Gaumont kalee meter).
Finish – Satin black mainplate with black turntable mat inlaid with brushed aluminium trim. Tonearm and controls in black and brushed aluminium.
Console size –
Unit Closed – $17\frac{3}{4}''\times13\frac{3}{4}''\times8\frac{3}{4}''$ (approx.)
Unit Open – $35\frac{3}{4}''\times13\frac{3}{4}''\times4\frac{3}{8}''$ (approx.)

This disco console is ideally matched for the Reliant IV and Disco 50 or any other quality amplifier.

The unit is finished in black PVC with contrasting simulated teak edging, diamond spun control knobs with matching control panel.

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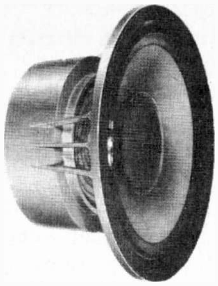

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Baker Major 12in d/cone	£8·50
Baker Regent	£7·75
Baker Superb	£14·50
Baker Auditorium 12	£12·50
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Celestion PS8 for Unilex	£3·25
Celestion G12M 8 or 15 ohm	£12·00
Celestion G12H 8 or 15 ohm	£15·00
Celestion G15C 8 or 15 ohm	£24·00
Celestion G18C 8 or 15 ohm	£33·00
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Coral 8in d/cone roll surr. 8 ohm	£3·25
EMI 13in × 8in 3, 8 or 15 ohm	£2·25
EMI 13in × 8in 150 d/c 8 ohm	£2·50
EMI 13in × 8in 450 t/tw. 3, 8 or 15 ohm	£3·75
EMI 13in × 8in type 350 8 or 15 ohm	£8·25
EMI 13in × 8in 20W bass	£8·80
EMI 6½in 93850 4 or 8 ohm	£3·00
EMI 5in 14A/7030 mid range 8 ohm	£2·50
EMI 8 × 5 d/cone, roll surr. 10W	£2·50
EMI 2½in tweeter 97492AT	£0·85
Eagle DT33 30W tweeter	£5·45
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Eagle CT10 tweeter 8 or 16 ohm	£2·55
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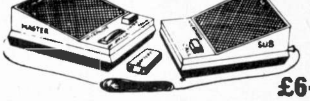

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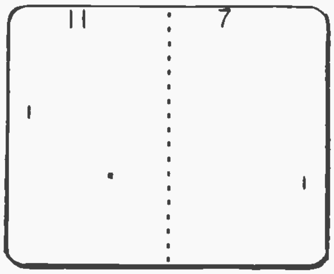

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NE566	Function Generator 8 Pin DIL	200p
NE567	PLL Tone Decoder 8 Pin DIL	250p
TBA570	AM/FM Radio receiver	160p
TBA800	5 Watt Audio Amp.	100p
TBA810	7 Watt Audio Amp.	125p
TBA820	2 Watt Audio Amp.	90p
ZN414	TRF Radio Receiver	110p
ICL8038	Voltage Controlled Osc. 14 Pin DIL	285p

Data sheets on above I.C.s 10p each.

BRIDGE RECTIFIERS

	50V	100V	400V	600V
250mA	18p	—	—	—
1 Amp	22p	24p	27p	29p
2 Amp	30p	35p	45p	48p
4 Amp	—	—	—	—
6 Amp	55p	60p	78p	—

SCR—THYRISTORS

	50V	100V	400V	600V
1 Amp	40p	45p	55p	72p
3 Amp	43p	49p	75p	100p
7 Amp	—	80p	84p	—
16 Amp	—	82p	98p	—

Other
C106D 45p, 2N3525 91p, 2N4444 165p

TRIACS

	100V	400V	500V
3 Amp	85p	95p	120p
6 Amp	88p	120p	150p
10 Amp	109p	154p	165p
16 Amp	145p	180p	200p

Other
40430 90p, 40486 85p, 40669 95p.
DIAC for use with above triacs 21p.

VOLTAGE REGULATORS

723 14 pin DIL 50p
MFC4060 70p

1 Amp	Plastic	
7805	5V	140p
7812	12V	140p
7815	15V	140p
7818	18V	140p
7824	24V	140p

AC126/7	11p	BC212	11p	OC35	48p	2N1308/9	28p	2N4060	13p
AC128	11p	BC213	10p	OC36	52p	2N1613	20p	40361	40p
AC176	11p	BC214	13p	OC41/2	15p	2N1711	0p	40362	43p
AC187	12p	BD115	55p	OC44/5	11p	2N2219	20p	**UJTS**	
AC188	11p	BD124	75p	OC70/1/2	11p	2N2221/2	20p	TIS43	25p
AD149	43p	BD131	42p	OC73	60p	2N2369	14p	2N2160	70p
AD161	36p	BD132	45p	OC81/2	12p	2N2484	30p	2N2646	35p
AD162	36p	BF115	22p	OC83/4	28p	2N2904	20p	2N4871	31p
AF114/5	13p	BF167	23p	TIP2955	70p	2N2905	18p		
AF116/7	13p	BF173	25p	TIP41A	65p	2N2926RB	8p	**FETS**	
AF139	41p	BF184	22p	TIP42A	72p	2N29260	8p	BF244	38p
AF239	44p	BF194	11p	ZTX300	12p	2N2926YG	9p	MPF102/3	31p
BC107/8	9p	BF195	12p	ZTX304	24p	2N3053	18p	MPF104/5	31p
BC109	10p	BF196	14p	ZTX500	15p	2N3054	45p	2N3819	20p
BC147/8	7p	BFR39/40	28p	ZTX504	50p	2N3055	49p	2N3820	57p
BC149	9p	BFR41	28p	2N696	15p	2N3442	140p	2N3823	60p
BC157	13p	BFX29/30	30p	2N697	13p	2N3702/3	11p	2N5457	31p
BC158	12p	BFY50/1/2	15p	2N698	30p	2N3704/5	11p	2N5458	31p
BC159	14p	BRY39	34p	2N706	12p	2N3706/7	11p	2N5459	31p
BC169C	12p	MJE340	45p	2N708	18p	2N3708/9	9p	**MOSFETS**	
BC177	18p	MJE2955	95p	2N930	18p	2N3772	161p	40603	58p
BC178	17p	MJE3055	65p	2N1131/2	18p	2N3773	220p	40673	58p
BC179	18p	MPSU06	58p	2N1302/3	17p	2N3903/4	15p	3N128	75p
BC182/3	10p	OC26	47p	2N1304/5	21p	2N3905/6	15p	3N140	85p
BC184	11p	OC28	55p	2N1306/7	28p	2N4058	15p	3N141	75p

C-MOS I.Cs

CD4001AE	37p
CD4011AE	37p
CD4012AE	37p
CD4013AE	67p
CD4016AE	90p
CD4017AE	183p
CD4023AE	37p
CD4024AE	148p
CD4025AE	37p
CD4027AE	108p
CD4030AE	82p
CD4046AE	225p
CD4047AE	154p

OPTO-ELECTRONICS
LDR ORP12 50p, ORP60 60p; Trans OCP71 85p, 2N5777 40p.

LEDS TIL209 (Red) 16p, Green/Yellow 35p.

Seven Segment Displays

Filament			
3015F	0·354in	DIL	120p
All LED			
MAN–3M	0·127in	PCB	100p
MAN–4	0·19in	DIL	180p

Reflective Bar LED

LIT 704	0·33in	DIL	100p
LIT 707	0·33in	DIL	100p
LIT 747	0·63in	DIL	210p

3 Digit Readouts

Blisdor Lens	0·127in	DIL	250p
Red Lens Filter	0·127in	DIL	185p

RECTIFIER DIODES

500mA	
BY100	15p
1 Amp	
BY126	12p
BY127	12p
1N4001	5p
1N4004	6p
1N4007	7p
1·5 Amp	
PL4004	10p
3 Amp	
PL7004	20p
6 Amp	
BYZ10	50p
BYZ11	50p
BYZ12	50p
BYZ13	50p

SIGNAL DIODES

BA100	10p
OA47	7p
OA70	8p
OA79	7p
OA81	7p
OA85	9p
OA90	6p
OA91	6p
OA95	7p
OA200	6p
OA202	7p
1N914	4p
1N916	6p
1N4148	4p

NOISE
Z1J 75p

ZENER DIODES
3·3V to 33V

400MW	9p
1·3W	18p
1·5W	27p
10W	55p

Other Diodes
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AEY11 50p

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BB104	45p
BB105	45p

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Spec.: 5 Section
Extended Length 100cm
Length under Fender 40cm
Cable Length 120cm
Supplied complete with Fixing Bracket and Control Switch. **£7·50** plus 25p P. & P.

"CRESCENT BEAT BRITE" SINGLE CHANNEL SOUND TO LIGHT UNIT
This fantastic little box approx. 4" × 3" × 2½" when connected to the output of a sound source from 1 to 100 watts produces a psychedelic light display of up to 1000 watts.
Complete with a sensitive level control the unit is fused and cannot harm your amplifier.
A Bargain at £7·50 plus 10p.

MINIATURE RELAYS

Brand new range of British made relays, size: 1¼in × 1in × ¾in.
All two changeovers with 250V 1·5A contacts and suitable for fitting on 0·1m veroboard.

Type	Volts	Current	Ohms	
27/A	12V	17M/A	700	All
21/A	12V	28M/A	430	£1·30
12/A	6V	33M/A	185	each

200/250V Mains Relay
Heavy duty contacts 2,500 ohm coil. All new and unused D.P.D.T. mains relays 50p, Carr. free. Special quantity £40 per 100 off.

MIDGET MAINS TRANSFORMER

Varnish Impregnated
Size 45mm × 36mm × 31mm

PRI 240V

Sec	3.0·3	100mA
Sec	6·0·6	100mA
Sec	9·0·9	100mA
Sec	12·0·12	100mA
Sec	20·0·20	100mA

£1·23 10p P. & P.

CRESCENT BUBBLE LIGHT SHOW

This budget system compares very favourably with more sophisticated and higher priced models.
Specification:
Projector—150W convection cooled. At 30ft the projected image is 16ft.
Motor—1 rev. per 2 min.
Liquid Wheel—6in diameter multi colour.
The motor is fitted to the projector and can only be purchased as a single unit.
The liquid wheel is our standard model and may be purchased separately.
A bargain at: Projector, £15; Wheel, £5; Total £20. Plus 75p carr.

CABLE LESS SOLDERING IRON WAHL "ISO-TIP"

- ★ Completely portable.
- ★ Solders up to 150 joints per charge.
- ★ Recharges in its own stand.
- ★ Fine tip for all types of soldering.
- ★ Only 8in long and weighs just 6 ozs.

OUR PRICE **£9·75**
(Spare bits are available)

"CRESCENT" 100 WATT R.M.S. ALL PURPOSE AMPLIFIER U.BUILD.IT

We supply the three modules for you to build this Disco-Group-P.A. amplifier into the cabinet of your choice.

★ THE POWER AMP MODULE
170W r.m.s. sq. wave 300W instantaneous peak into 8 ohm (60W into 16 ohm).

★ THE PRE-AMP MODULE
Four control pre-amp, Vol. Bass, Treble. Middle controls. Designed to drive most amplifiers using F.E.T. first stage.

★ THE POWER SUPPLY
Is supplied complete with the mains transformer. Complete fixing instructions are supplied and no technical knowledge is required to connect the three ready wired modules. A fantastic bargain. £25, carr. 75p. Send S.A.E. for further details on this or our ready built amplifiers.

12-0-12V 500M/A

240V primary transformer bargain. Approx. size: 60mm × 40mm × 50mm; fixing centres: 75mm. Our price £1·20.

18V 500M/A

240V primary. Approx. size: 60mm × 40mm × 50mm; fixing centres: 75mm. Our Price £1 each

LOW NOISE, LOW PRICE CASSETTES

Good quality tape in well made screw type cassettes. Presented in single plastic cases.
C60 31p C90 42p C120 53p
10% discount on ten or more cassettes of one type.

ABS PLASTIC BOXES

Handy boxes for construction projects. Moulded extrusion rails for P.C. or chassis panels. Fitted with 1mm front panels. 1005, 105mm × 73mm × 45mm **51p**; 1006, 150mm × 75mm × 47mm **66p**; 1007, 184mm × 124mm × 60mm **96p**; 1021, 106mm × 74mm × 45mm (sloping front) **50p**.

BARGAIN BOARDS

Components galore for the experimenter. Ex-Computer boards with resistors, capacitors and useful transistors—at least 4 transistors per board. Five boards £1.

2in. PANEL METERS

Size 59mm × 46mm

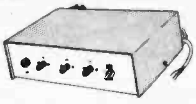
0·50µA —ME6	0·100mA—ME13
0·100µA—ME7	0·500mA—ME14
0·500µA—ME8	0·1A —ME15
0·1mA —ME9	0·50V —ME16
0·5mA —ME10	0·300V a.c.—ME17
0·10mA—ME11	S meter —ME18
0·50mA—ME12	V.U. meter—ME19

£3 each. 10p P. & P.

POWER PACKS

PP1 Switched 3-6-7½-9V 400M/A Transistor and Zener Stabilised On/Off switch and Polarity Reversal switch, in a black metal case, £5·25 each.
PP2 Switched 6-7½-9V Battery Eliminator. Approx. size 2¾in × 2¼in × 3¼in. Ideal for cassette recorders, £3·25.
PP3 Car converter. From 12V Pos. or Neg. to = 6-7½-9V. Easy to fit and transistor regulated, £3·90.

3 KILOWATTS PSYCHEDELIC LIGHT CONTROL UNIT



Three Channel: Bass, Middle, Treble. Each channel has its own sensitivity control. Just connect the input of this unit to the loudspeaker terminals of an amplifier, and connect three 250V up to 1000W lamps to the output terminals of the unit, and you produce a fascinating sound-light display. (All guaranteed.)
£18·50 plus 38p P. & P.

MINI LOUDSPEAKERS

2¼in 80 ohm, 50p; 2½in 40 ohm, 50p. Please include 5p P. & P. on each L.S.

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200 Mica, ceramic, poly, etc. £1, 15,000 £42. 15 diff. trimmers, air-spaced and compression up to 1250pF. Only £1.

8 PIN DIL 741's

FULL SPEC. OF COURSE
10+ **26p**; 25+ **23p**; 100+ **21p**; 250+ **20p.**

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Anhydrous to Mil-spec in 1lb double sealed packs. 1lb 90p; 3lb £1·80; 10lb, £4·65.

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Large quantity always available. 3lb assorted £1·60; 7lb £2·85; 56lb £15.

12 high quality panels with IC's, trimpots, power transistors, etc. £2·65.

Pack with 50 14 pin DIL DTL IC's £1·20. Pack with 20 multi-turn trimpots plus other parts £1·10. Pack with 5 1A 200V SCR's plus 60 other parts 60p.

7lb BARGAIN PARCELS

Hundreds of new components—resistors, capacitors, pots, switches plus PC boards with transistors and diodes, also loads of odds and ends. Contents always changing as new stocks arrive, £2·60.

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All mains primary. 6–0–6V at 100mA **85p**; 9–0–9 Vat 100mA **90p**; 12–0–12V at 100mA **95p**; 24–0–24V at 500mA **£2**. Ex-equip: 22½–0–22½V at 1A **£2·10**; 18V at 5A **£3·40**; 55V at 5A **£4·50**.

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6 × 5 × 3in. finned aluminium with 2 × OC29 or 2 × OC35. Only £1·20.

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G101: Mains transformer, 2A thermal cut-out, bridge rect. Will give 1·7V–10·5V output with 2 extra capacitors (provided). With data £1·30.
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G103 ex-LEC III. Contains 55V 5A transformer, 6 × 5 × 3in. heat sink with 2 × OC35, stabilizer panel, 4 × 10,000µF 63V caps, 1 × 4,700µF 100V cap, etc. £12·50.

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V996 dynamic microphone, 50k impedance, on/off switch, heavy desk stand. Very smart appearance £3·30. Crystal microphone insert 1in. dia. 35p.

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1–9 **60p**; 10–24 **50p**; 25–99 **46p**; 100+ **43p.**

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4 channel component set (excl. thyristors)	£11·49
8 channel component set (excl. thyristors)	£20·32
Power supply component set	£4·78
PCB for 4 frequency channels	£2·50
PCB for power supply and 8 lamp drivers	£1·25

P.E. SYNTHESIZER
Details in List

VOICE OPERATED FADER (P.E. Dec. 73)

For automatically reducing music volume during "talk-over"—particularly useful for Disco work, or for home-movie shows.

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P.E. GEMINI 30W STEREO AMPLIFIER

An exceptionally high quality Stereo Amplifier system, specifications for which are shown in detail in our list, together with semiconductor requirements. While stocks last.

Main Amplifier:	
Set of resistors, capacitors and presets	£5·96
Stereo printed circuit board	£1·28
Pre-Amplifier:	
Sets of resistors, capacitors, potentiometers and switches—	
Standard Tolerance Set	£10·57
Superior Tolerance Set	£16·04
Stereo PCB (as Published)	£2·20
Regulated Power Supply:	
Set of resistors, capacitors and preset	£4·58
Printed circuit board	72p

HI-FI TAPE LINK (P.E. Mar./Apr. 73)

Designed for use with reasonable quality tape decks, this high performance pre-amp includes record, playback and metering circuits.

Stereo component set (excl. panel meter)	£22·05
Mono component set (excl. panel meter)	£13·31
Power supply component set	£3·72
Stereo main PCB	£2·50
Stereo sub-assembly PCB	88p

TAPE-NOISE LIMITER

Very effective circuit for reducing the hiss found in most tape recordings.

Component set (incl. PCB)	£2·30
Regulated power supply (including PCB)	£3·71

PROJECT Q4 (P.W. Oct. 73/Jan. 74)

Multi-system Quadraphonic Decoder.

Decoder component set	£13·74
Power supply components	£3·22
Printed circuit board	£2·60

SEMICONDUCTOR TESTER (P.E. Oct. 73)

Essential test equipment for the enterprising home constructor.

Set of resistors, capacitors, semiconductors, potentiometers, makaswitches and PCB	£6·56

PHASING UNIT (P.E. Sept. 73)

A simple but effective manually controlled unit for introducing the "phasing" sound into live or recorded music.

Component set (incl. PCB)	£2·20

PHASING CONTROL UNIT (P.E. Oct. 74)

(for use with above Phasing Unit)

Component set (including PCB)	£3·50

P.E. SOUND SYNTHESISER

The well-acclaimed and highly versatile Synthesiser published in P.E. Feb. 1973 to Feb. 1974.

Component sets and printed circuit boards. List shows full details including discounts.

VOLTAGE CONTROLLED FILTER (P.E. Oct. 74)

Component set	£3·41
Printed circuit board	£1·10

RHYTHM GENERATOR (P.E. Mar./Apr. 74)

Programmable for 64,000 rhythm patterns from 8 effects circuits (high and low bongos, bass and snare drums, long and short brushes, blocks and cymbal), and with variable time signatures. See list for discount.

Tempo, Timing and Logic Circuit	
Component set (excl. switches)	£17·25
Double-sided PCB for above	£2·30
Mixer, Pre-amp and Effects Circuits	
Component set	£12·70
Printed circuit board	£2·67
Power Supply	
Component set and PCB	£5·65

ULTRASONIC TRANSMITTER-RECEIVER

A highly sensitive and long range "invisible beam" detection circuit with numerous applications. (P.E. May '72)

Component set with PCBs, but excluding transducers	£4·40

P.E. RONDO

PCB details in List

POWER SLAVES

PCB details in List.

P.E. ELECTRONIC PIANO

Details in List.

HOME INTERCOM

Details in List.

(While Stocks Last)

SOUND BENDER (P.E. May 74)

A multi-purpose sound controller, the functions of which include envelope shaper, tremolo, voice operated fader, automatic fader and frequency doubler.

Component set	£5·86
Printed circuit board	£1·44

REVERBERATION UNIT (P.W. Nov./Dec. 72)

A high-quality unit having microphone and line input pre-amps, and providing full control over reverberation level.

Component set (excl. spring unit)	£6·44
Printed circuit board	£1·40

P.E. MINISONIC
Details in list (inc. discounts)

8W AMPLIFIER (P.W. Nov. 72)

A moderately powered amplifier of more than average performance. (While stocks last.)

Main Amplifier	
Mono component set	£4·18
Stereo component set	£8·36
Pre-Amplifier	
Mono component set	£2·50
Stereo component set	£6·46
Power Supply	
Component set	£3·90

BIOLOGICAL AMPLIFIER (P.E. Jan./Feb. 73)

Multi-function circuits that, with the use of other external equipment, can serve as lie detector, alphaphone, cardiophone, etc.

Pre-Amplifier Module	
Component set and PCB	£3·48
Basic Output Circuits	
Combined component set with PCBs, for alphaphone, cardiophone, frequency meter and visual feed-back lamp driver circuits	£4·96
Audio Amplifier Module	
Type PC7	£5·50

PHOTOPRINT PROCESS CONTROL (P.E. Jan./Feb. 72)

For colour and B. & W. an indispensable dark-room unit for finding exposure, controlling enlarger timing, and stabilising mains voltage.

Component set (excl. meter)	£8·85
Printed circuit board	£1·60

ENLARGER EXPOSURE METER AND THERMOMETER (P.E. Sept. 73)

Dual-purpose dark-room unit with good accuracy.

Component set with PCB, but excluding meter	£4·00

WIND AND RAIN UNIT (P.E. Oct. 73)

A manually controlled unit for producing the above-named sounds.

Component set incl. PCB	£2·40

PCB LAYOUT AND CIRCUIT DIAGRAMS SUPPLIED WITH ALL PCBs DESIGNED BY PHONOSONICS

LIST
Send S.A.E. for free list giving fuller details of kits, PCBs, and other components.

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Add 18p to all orders

VAT
Add 8% (or current rate if different) to total order cost including P. & P.

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P. & P. will be charged extra. VAT does not currently apply. List gives fuller details including kit weights. Charge for list: Europe 10p, other countries 20p.

COLOUR CODE IDENTIFICATION SUPPLIED WITH MOST KITS AND AS PART OF LIST

Semiconductors

AC128	20p	BFY50	22p	2N3702	12p
AC176	20p	BFY51	22p	2N3703	12p
BC107	13p	BFY52	24p	2N3704	12p
BC108	13p	BSY95A	22p	2N3819	35p
BC109	13p	MJE2955	110p	2N3823E	39p
BC147	12p	MJE3055	75p	2N4060	12p
BC148	12p	NKT0033	112p	2N4871	36p
BC149	12p	OC28	60p	2N5245	51p
BC157	13p	OC71	14p	2N5777	45p
BC158	13p	OC72	14p		
BC159	13p	OC84	25p		
BC182L	12p	ORP12	60p		
BC184	12p	ZTX107	12p		
BC204	14p	ZTX503	15p		
BC209C	14p	ZTX531	23p		
BC212L	15p	2N706	13p		
BC213	15p	2N914	22p		
BC478	29p	2N1304	22p		
BCY71	22p	2N2219	27p		
BF178	40p	2N2905	27p		
		2N2907	22p		
		2N3054	66p		

Diodes

1N914	4p
1N4001	6p
1N4002	7p
1N4004	8p
1N4005	8p
1N4007	10p
OA91	7p
OA200	8p
OA202	8p
1GP7	12p
1SJ50	11p
ZIJ (ZIL)	70p

Integrated Circuits

709 8-pin DIL	40p
709 TO5	40p
723 TO5	95p
741 8-pin DIL	40p
747 14-pin DIL	115p
748 TO5	63p
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151	200	8	0	12·1 × 9·3 × 10·2	8·13	53
152	250	13	12	12·1 × 11·8 × 10·2	9·83	73
153	350	15	0	14·0 × 10·8 × 11·8	11·88	73
154	500	19	8	14·0 × 13·4 × 11·8	13·65	91
155	750	29	0	17·2 × 14·0 × 14·0	20·51	*
156	1000	38	0	17·2 × 16·6 × 14·0	29·15	*
157	1500	46	0	21·6 × 13·4 × 18·1	33·23	*
158	2000	60	0	21·6 × 15·3 × 18·1	37·07	*

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64	75	2	4	7·0 × 6·7 × 6·1	0-115-210-240	2·90	38
4	150	3	4	8·9 × 7·7 × 7·7	0-115-200-220-240	4·12	45
66	300	6	4	9·9 × 9·6 × 8·6	,, ,,	5·82	53
67	500	12	8	12·1 × 11·2 × 10·2	,, ,,	8·82	67
84	1000	19	8	14·0 × 13·4 × 14·3	,, ,,	13·68	91
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71	2	1	1	12	7·0 × 6·4 × 6·1	0-12V at 1A × 2	2·29	38
18	4	2	2	12	8·3 × 7·7 × 7·0	0-12V at 2A × 2	2·86	38
70	6	3	3	8	8·9 × 8·0 × 7·7	0-12V at 3A × 2	4·12	45
108	8	4	5	8	9·9 × 8·9 × 8·6	0-12V at 4A × 2	4·56	45
72	10	5	6	4	9·9 × 9·6 × 8·6	0-12V at 5A × 2	5·14	53
116	12	6	6	12	9·9 × 10·2 × 8·6	0-12V at 5A × 2	5·52	53
17	16	8	8	12	12·1 × 9·9 × 10·2	0-12V at 8A × 2	7·28	60
115	20	10	11	8	14·0 × 9·6 × 11·8	0-12V at 10A × 2	10·39	73
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30 VOLT RANGE

Ref. No.	Amps	Weight lb	Weight oz	Size cm.	Secondary Taps	P & P £	P & P p
112	0·5	1	4	6·1 × 5·8 × 4·8	0-12-15-20-24-30V	1·81	30
79	1·0	2	4	7·0 × 6·7 × 6·1	,, ,,	2·40	38
3	2·0	3	4	8·9 × 7·7 × 7·7	,, ,,	3·49	38
20	3·0	4	8	9·9 × 8·3 × 8·6	,, ,,	4·53	45
21	4·0	6	4	9·9 × 9·6 × 8·6	,, ,,	5·13	53
51	5·0	6	12	12·1 × 8·6 × 10·2	,, ,,	6·41	53
117	6·0	8	0	12·1 × 9·3 × 10·2	,, ,,	7·15	60
88	8·0	12	0	12·1 × 11·8 × 10·2	,, ,,	9·90	67
89	10·0	13	12	14·0 × 10·2 × 11·8	,, ,,	9·87	73

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Ref. No.	Amps.	Weight lb	Weight oz	Size cm.	Secondary Taps	P & P £	P & P p
102	0·5	1	12	7·0 × 6·4 × 6·1	0-19-25-33-40-50V	2·58	30
103	1·0	2	12	8·3 × 7·4 × 7·0	,, ,,	3·38	38
104	2·0	5	8	7·9 × 8·9 × 8·6	,, ,,	4·68	45
105	3·0	6	12	9·9 × 10·2 × 8·6	,, ,,	5·81	53
106	4·0	10	0	12·1 × 10·5 × 10·2	,, ,,	7·60	67
107	6·0	12	0	14·0 × 10·2 × 11·8	,, ,,	12·10	67
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Ref. No.	Amps.	Weight lb	Weight oz	Size cm.	Secondary Taps	P & P £	P & P p
124	0·5	2	4	7·0 × 6·7 × 6·1	0-24-30-40-48-60V	2·33	38
126	1·0	3	4	8·9 × 7·7 × 7·7	,, ,,	3·41	38
127	2·0	6	4	9·9 × 9·6 × 8·6	,, ,,	5·08	45
125	3·0	8	12	12·1 × 9·9 × 10·2	,, ,,	7·52	60
123	4·0	13	12	12·1 × 11·8 × 10·2	,, ,,	8·75	67
40	5·0	12	00	14·0 × 10·2 × 11·8	,, ,,	9·75	73
120	6·0	15	8	14·0 × 12·1 × 11·8	,, ,,	11·30	85
121	8·0	25	00	14·0 × 14·7 × 11·8	,, ,,	15·00	*
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212	1A, 1A	1	4	6·1 × 5·8 × 4·8	0-6, 0-6	1·84	30
13	100		4	3·9 × 2·6 × 2·9	9-0-9	1·41	13
235	330, 330		4	4·8 × 2·9 × 3·5	0-9, 0-9	1·56	19
207	500, 500	1	00	6·1 × 5·4 × 4·8	0-8-9, 0-8-9	1·92	30
208	1A, 1A	1	12	7·0 × 6·4 × 6·1	0-8-9, 0-8-9	3·30	38
236	200,200		4	4·8 × 2·9 × 3·5	0-15, 0-15	1·43	19
214	300, 300	1	4	6·1 × 5·8 × 4·8	0-20, 0-20	1·93	30
221	700 (d.c.)	1	8	7·0 × 6·1 × 6·1	20-12-0-12-20	2·17	38
206	1A, 1A	2	12	8·3 × 7·7 × 7·0	0-15-20, 0-15-20	3·46	38
203	500,500	2	4	8·3 × 7·0 × 7·0	0-15-27, 0-15-27	3·00	38
204	1A, 1A	3	4	8·9 × 7·7 × 7·7	0-15-27, 0-15-27	3·85	38

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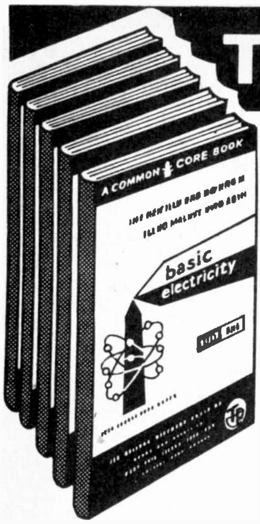

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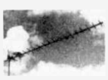

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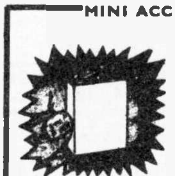

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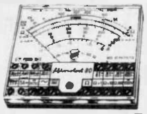

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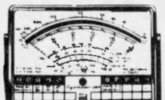

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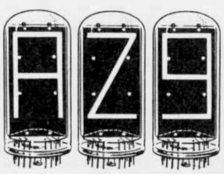

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