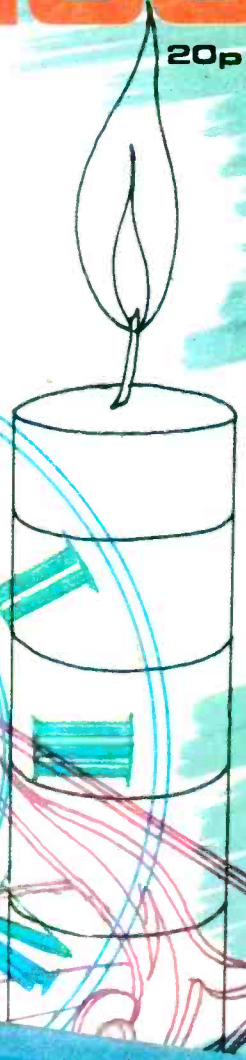
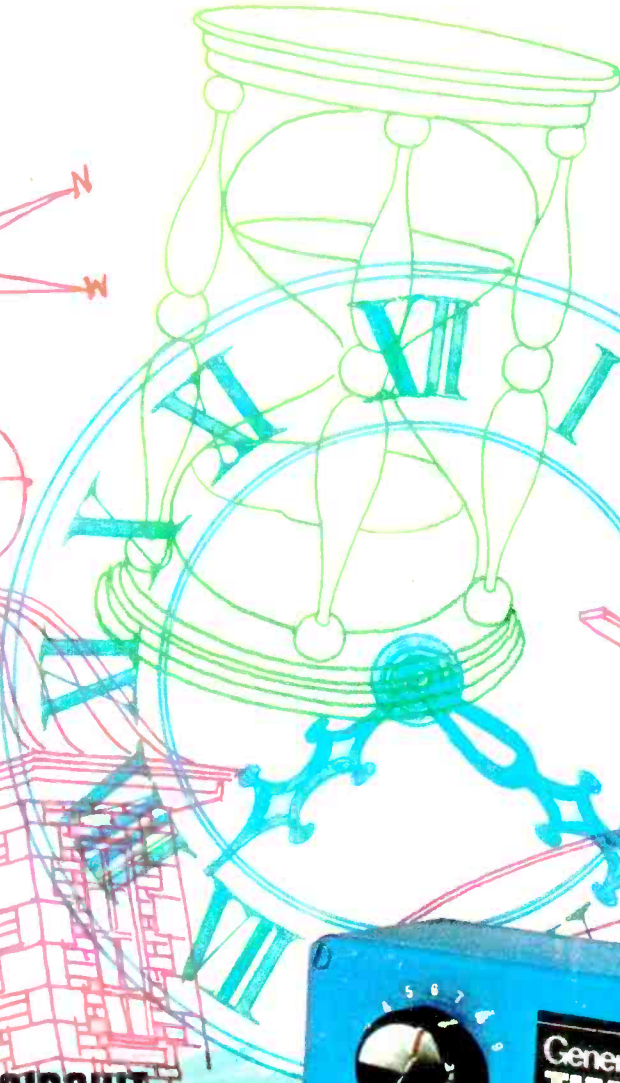
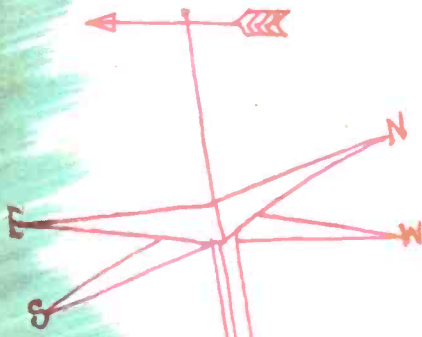


PRACTICAL

ELECTRONICS

JUNE 1973

20p



555 INTEGRATED CIRCUIT

GENERAL PURPOSE TIMER



The X25

Why two shafts?

220-240 Volts or 100-120 Volts.

Model X25

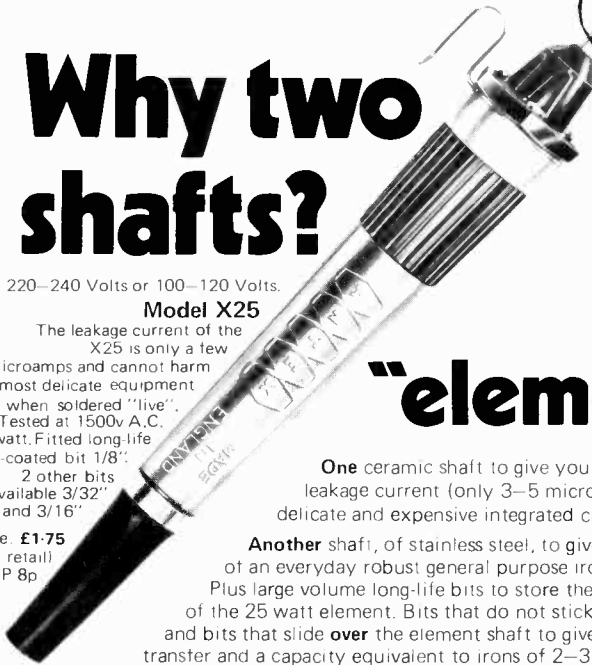
The leakage current of the X25 is only a few

microamps and cannot harm the most delicate equipment even when soldered "live".

Tested at 1500v A.C. 25 watt. Fitted long-life iron-coated bit 1/8".

2 other bits available 3/32" and 3/16"

Price: **£1-75** (rec. retail) P & P 8p



"elementary"

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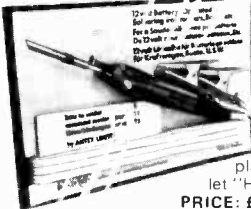
MODEL CCN

220 volts or 240 volts. The 15 watt miniature model CCN also has negligible leakage.

Test voltage 400v. A.C. Totally enclosed element in ceramic shaft.

Fitted long-life iron-coated bit 3/32". 4 other bits available 1/8", 3/16", 1/4" and 3/64".

PRICE: **£1-80** (rec. retail) OR Fitted with triple-coated, iron nickel and Chromium bit 1/8". PRICE: **£1-95** (rec. retail). P&P5p



MODEL MES.KIT

Battery-operated 12v. 25 watt iron fitted with 15" lead and 2 heavy clips for connection to car battery. Packed in strong plastic wallet with booklet "How to Solder"

PRICE: **£1-95** (rec. retail).

P&P 12p

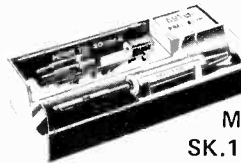
MODEL G

18 watt miniature iron, fitted with long life iron-coated bit 3/32". Voltages 240, 220 or 110.

PRICE: **£1-83** (rec. retail). P&P5p



All prices mentioned are exclusive of V.A.T.



MODEL SK.1 KIT

Contains 15 watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32", heat sink, solder, stand and "How to Solder" booklet.

PRICE: **£2-75** (rec. retail).

P&P 12p

MODEL CN

Miniature 15 watt soldering iron fitted 3/32" iron-coated bit. Many other bits available from 3/64", to 3/16". Voltages 240, 220, 110, 50 or 24.

PRICE: **£1-70** (rec. retail). P&P5p

MODEL CN2

Miniature 15 watt soldering iron fitted with nickel plated bit 3/32". Voltages 240 or 220.

PRICE: **£1-70** (rec. retail). P&P5p

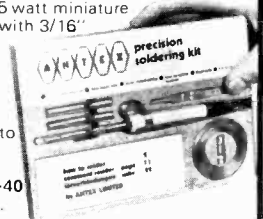
MODEL SK.2 KIT

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bit, 2 spare bits 5/32" and 3/32" heat sink, solder, and "How to Solder" booklet.

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P&P8p



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Our July issue will be published on Friday, June 8, 1973

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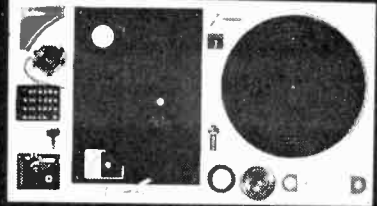
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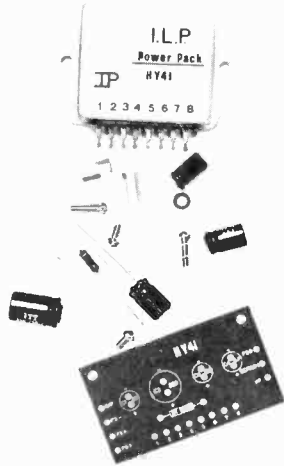
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THE HY41



The HY41 supersedes the popular HY40 introduced by ILP last year. This highly improved module achieves true High Fidelity with a dramatic reduction in distortion (typically 0.05% at 1KHz into 8 ohms!) and is electronically and mechanically compatible with the HY40.

With this important improvement the HY41 retains all of the quality characteristics found in the earlier version and P.C. board, Resistor, Capacitors, Hardware Mountings and comprehensive manual are included in the basic kit. No further components are required to construct a complete power amplifier of extremely high performance sufficiently versatile to provide power not merely for Hi-Fi but also for public address systems and industry.

The free manual gives a full circuit diagram of the HY41 and its various applications including a complete stereo amplifier.

Like its predecessor the HY41 is based on conventional and proven circuit techniques developed over recent years.

OUTPUT POWER: British Rating 40 WATTS PEAK, 20 watts R.M.S. continuous.

LOAD IMPEDANCE: 4-16 ohms.

INPUT IMPEDANCE: 30K ohms at 1KHz.

VOLTAGE GAIN: 30db at 1KHz

TOTAL HARMONIC DISTORTION: less than 0.15% (typical 0.05%) at 1KHz.

FREQUENCY RESPONSE: 5Hz-50KHz \pm 1db.

SUPPLY VOLTAGE: + 22.5volts D.C.

SUPPLY CURRENT: 0.8 amps maximum.

PRICE: inc. comprehensive manual, P.C. board, five extra components and P. & P. —

MONO: £5.39

STEREO: £10.78

UNIQUE HYBRID PRE-AMPLIFIER

The HY5 has rapidly established a position in the WORLD as the sole hybrid pre-amplifier to contain all feedback and equalization networks within an integrated pre-amplifier circuit.

Supplied with the HY5 are two stabilizing capacitors and by the addition of volume, treble and bass potentiometers it is ready for use.

Internally the HY5 provides equalization for almost every conceivable input, the desired function is achieved by use of a multi-way switch or by direct interconnection.

Two distinctive features of the HY5 are its inbuilt stabilization circuit, allowing it to be run off any unregulated power supply from 16-25 Volts and a balance circuit which, when linked by a balance control to a second HY5, forms a complete stereo pre-amplifier.

Specifically and critically designed to meet exacting Hi-Fi standards, the HY5 combines extremely low noise with a high overload capability. When used in conjunction with the HY41 and PSU45 forms a completely integrated system.

INPUTS

Magnetic Pick-up (within \pm 1db RIAA curve)

2mV, 47K Ω

Tape Replay (external components to suit head), 4mV, 47K Ω

Microphone (flat) 10mV, 47K Ω

Ceramic Pick-up (equalized and compensatable) 20-2000mV, variable.

Tuner (flat) 250mV, 100K Ω

Auxiliary 1 250mV, 47K Ω

Auxiliary 2 2-20mV, 100K Ω

OUTPUTS

Main Pre-amp output 500mV.

Direct tape output 120mV.

ACTIVE TONE CONTROLS (Baxendall)

Treble + 12db.

Bass + 12db.

INTERNAL STABILIZATION

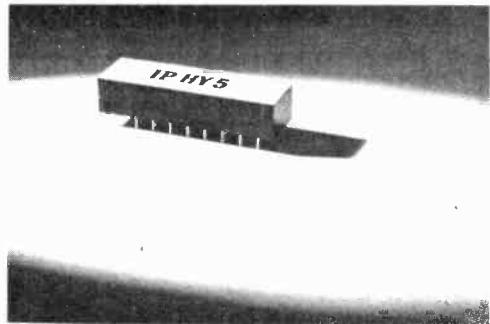
Enables the HY5 to share an unregulated supply with the Power Amplifier.

SUPPLY VOLTAGE

16-25 volts

PRICE: MONO £3.96

STEREO £7.92



SUPPLY CURRENT

6mA approx.

OVERLOAD CAPABILITY

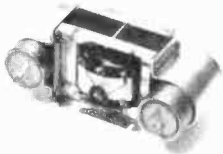
better than 26db on most sensitive input

infinite on tuner and auxl.

OUTPUT NOISE VOLTAGE: 0.5mV.

POWER SUPPLY PSU45

The versatile P.S.U.45 is designed to supply your HY41's +HY5's in stereo or mono format.



Specification

Input: 200-240 Volts.

Output: + 22.5 Volts at 2 amps.

Overall Dimensions: L. 7"; D. 3.8"; H. 3.1"

PRICE: £4.95 inc. P. & P.

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| Ref. No. | VA (Watts) | Weight lb oz | Size cm. | P & P £ |
|----------|------------|--------------|--------------------|---------|
| 07 | 20 | 1 11 | 7.0 x 6.0 x 6.5 | 1.77 30 |
| 100 | 60 | 3 8 | 8.9 x 8.0 x 7.7 | 2.62 36 |
| 61 | 100 | 5 12 | 10.2 x 8.9 x 8.3 | 2.88 52 |
| 30 | 200 | 9 8 | 12.5 x 10.3 x 10.0 | 4.83 52 |
| 62 | 250 | 12 4 | 9.5 x 12.7 x 11.4 | 6.38 67 |
| 55 | 350 | 15 0 | 14.0 x 10.8 x 12.4 | 8.55 82 |
| 63 | 500 | 27 0 | 17.1 x 11.4 x 15.9 | 12.32 * |
| 92 | 1000 | 40 0 | 17.8 x 17.1 x 21.6 | 22.70 * |
| 128 | 2000 | 63 0 | 24.1 x 21.6 x 15.2 | 37.50 * |

| Ref. No. | VA (Watts) | Weight lb oz | Size cm. | Auto Taps | P & P £ |
|----------|------------|--------------|--------------------|-------------------|----------|
| 113 | 20 | 1 11 | 7.3 x 4.3 x 4.4 | 0-115-210-240 | 0.93 22 |
| 64 | 75 | 1 14 | 7.0 x 6.4 x 6.0 | 0-115-210-240 | 1.82 30 |
| 4 | 150 | 3 0 | 8.9 x 6.4 x 7.6 | 0-115-200-220-240 | 2.20 36 |
| 66 | 300 | 6 0 | 10.2 x 10.2 x 9.5 | | 4.28 52 |
| 67 | 500 | 12 8 | 14.0 x 10.2 x 11.4 | | 6.35 67 |
| 84 | 1000 | 16 0 | 11.4 x 14.0 x 14.0 | | 11.54 82 |
| 93 | 1500 | 24 8 | 13.5 x 14.9 x 16.5 | | 16.72 * |
| 95 | 2000 | 40 0 | 17.8 x 16.5 x 21.6 | | 21.82 * |
| 73 | 3000 | 45 8 | 17.4 x 18.1 x 21.3 | | 29.70 * |

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| Ref. No. | 12V 24V | Weight lb oz | Size cm. | Secondary Windings | P & P £ |
|----------|---------|--------------|--------------------|--------------------|----------|
| 110 | 5 0-25 | 1 12 | 7.6 x 5.7 x 4.4 | 0-12V at 0.25A x 2 | 0.93 22 |
| 213 | 10 0-5 | 1 0 | 8.3 x 5.1 x 5.1 | 0-12V at 0.5A x 2 | 1.11 22 |
| 71 | 2 1 | 1 0 | 7.0 x 6.4 x 5.7 | 0-12V at 1A x 2 | 1.46 22 |
| 18 | 4 2 | 2 4 | 8.3 x 7.0 x 7.0 | 0-12V at 2A x 2 | 2.04 36 |
| 70 | 6 3 | 3 12 | 10.2 x 7.6 x 8.6 | 0-12V at 3A x 2 | 2.46 42 |
| 108 | 8 4 | 5 4 | 10.0 x 8.3 x 8.2 | 0-12V at 4A x 2 | 2.73 52 |
| 72 | 10 5 | 6 8 | 7.9 x 10.8 x 10.2 | 0-12V at 5A x 2 | 3.23 52 |
| 17 | 16 8 | 7 8 | 12.1 x 9.5 x 10.2 | 0-12V at 8A x 2 | 4.99 52 |
| 115 | 20 10 | 11 13 | 12.1 x 11.4 x 10.2 | 0-12V at 10A x 2 | 6.35 67 |
| 187 | 30 15 | 16 12 | 13.3 x 12.1 x 12.1 | 0-12V at 15A x 2 | 11.73 82 |
| 226 | 60 30 | 34 0 | 17.0 x 14.5 x 12.5 | 0-12V at 30A x 2 | 21.57 * |

| Ref. No. | Amps. | Weight lb oz | Size cm. | Secondary Taps | P & P £ |
|----------|-------|--------------|--------------------|-------------------|---------|
| 112 | 0.5 | 1 4 | 8.3 x 3.7 x 4.9 | 0-12-15-20-24-30V | 1.11 22 |
| 79 | 1.0 | 2 0 | 7.0 x 6.4 x 6.0 | | 1.48 36 |
| 3 | 2.0 | 3 2 | 8.9 x 7.0 x 7.6 | | 2.21 36 |
| 20 | 3.0 | 4 6 | 10.2 x 8.9 x 8.6 | | 2.72 42 |
| 21 | 4.0 | 6 0 | 10.2 x 10.0 x 8.6 | | 3.23 52 |
| 51 | 5.0 | 6 8 | 12.1 x 10.0 x 8.6 | | 4.02 52 |
| 117 | 6.0 | 7 8 | 12.1 x 10.0 x 10.2 | | 4.80 52 |
| 88 | 8.0 | 10 0 | 14.0 x 11.7 x 10.0 | | 6.20 67 |
| 89 | 10.0 | 12 2 | 14.0 x 10.2 x 11.4 | | 7.85 67 |

| Ref. No. | Amps. | Weight lb oz | Size cm. | Secondary Taps | P & P £ |
|----------|-------|--------------|--------------------|-------------------|----------|
| 102 | 0.5 | 1 11 | 7.0 x 7.0 x 5.7 | 0-19-25-33-40-50V | 1.46 30 |
| 103 | 1.0 | 2 10 | 8.3 x 7.3 x 7.0 | | 2.13 36 |
| 104 | 2.0 | 5 0 | 10.2 x 8.9 x 8.6 | | 2.96 42 |
| 105 | 3.0 | 6 0 | 10.2 x 10.2 x 8.3 | | 4.01 52 |
| 106 | 4.0 | 9 4 | 12.1 x 11.4 x 10.2 | | 5.31 52 |
| 107 | 6.0 | 12 4 | 12.1 x 11.1 x 13.3 | | 7.85 67 |
| 118 | 8.0 | 18 9 | 13.3 x 13.3 x 12.1 | | 10.25 97 |
| 119 | 10.0 | 19 12 | 16.5 x 11.4 x 15.9 | | 12.85 97 |

| Ref. No. | Amps. | Weight lb oz | Size cm. | Secondary Taps | P & P £ |
|----------|-------|--------------|--------------------|-------------------|---------|
| 124 | 0.5 | 2 4 | 8.3 x 9.5 x 6.7 | 0-24-30-40-48-60V | 1.48 36 |
| 126 | 1.0 | 3 0 | 8.9 x 7.6 x 7.6 | | 2.06 36 |
| 127 | 2.0 | 5 6 | 10.2 x 8.9 x 8.6 | | 3.23 42 |
| 125 | 3.0 | 8 8 | 11.9 x 9.5 x 10.0 | | 4.92 52 |
| 123 | 4.0 | 10 6 | 11.4 x 9.5 x 11.4 | | 6.35 67 |
| 120 | 6.0 | 16 12 | 13.3 x 12.1 x 12.1 | | 9.20 82 |
| 122 | 10.0 | 23 2 | 16.5 x 12.7 x 16.5 | | 15.23 * |

| Ref. No. | Amps. | Weight lb oz | Size cm. | P & P £ |
|----------|-------|--------------|--------------------|---------|
| 45 | 1.5 | 1 9 | 7.0 x 6.0 x 6.0 | 1.47 30 |
| 5 | 4.0 | 3 11 | 10.2 x 7.0 x 8.3 | 2.23 42 |
| 86 | 6.0 | 5 12 | 10.2 x 8.9 x 8.3 | 3.37 52 |
| 146 | 8.0 | 6 4 | 8.9 x 10.2 x 10.2 | 3.84 52 |
| 50 | 12.5 | 11 14 | 13.3 x 10.8 x 12.1 | 5.72 67 |

All ratings are continuous. Standard construction; open with solder tags and wax impregnation. Enclosed styles to order.

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|-------------------------------------|-------|--------------|-------------------|---------|-------------------|-----|------|
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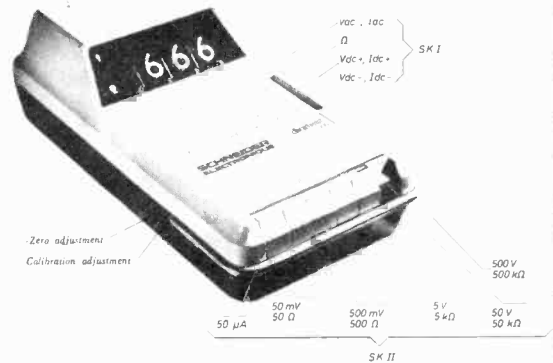
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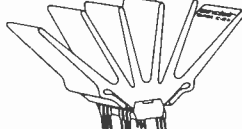
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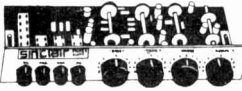


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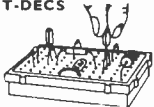
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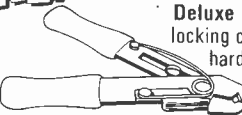
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NEW! BIB WIRE STRIPPER AND CUTTER



Deluxe Model 9 Automatic opening spring, locking catch, plastic-covered handles. Case hardened and precision ground. Adjusts to most wire sizes. Cuts and strips flex, splits plastic twin flex. 75p

Prices shown are recommended retail, excluding VAT. From Electrical and Hardware Shops. If unobtainable, send 10p p&p direct to: **Multicore Solders Ltd.**, Hemel Hempstead, Hertfordshire HP2 7EP

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"CRESCENT" BUBBLE LIGHT SHOW



A new and exciting feature for the professional disc jockey or to give the private party an electric atmosphere, a projected kaleidoscope of colour makes the music you produce more interesting and will appeal to the visual as well as the audio senses.

This budget system compares very favourably with the more sophisticated and much higher priced models. Specification: Projector, 150W, convection cooled, at 30ft the projected image = 18ft. Motor: 1rev 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, however, is our very popular standard model and may be purchased separately. A bargain: Projector with Motor ready for instant use. £15; 6in Liquid Wheel. £5 = £20 plus 75p carr.

TRI-VOLT BATTERY ELIMINATOR

Enables you to work your Transistor Radio, Amplifier or Cassette, etc., from the a.c. mains through this compact Eliminator. Just by moving a plug you can select the voltage you require, 6, 7½ or 9 volt. This means all your transistor power pack applications can be handled by this one unit. Approx. size 2½in x 2½in x 3½in. Our Price £2.75 plus 10p P. & P. Same model suitably wired for the Philips Cassette £3 plus 10p P. & P.

TRI-VOLT CAR SUPPLY

Enables you to work your Transistor Radio, Amplifier or Cassette, etc., from the 12 volt car supply. Positive or negative earth. Approx. size = 2in x 3½in x 1½in. This converter supplies 6, 7½ or 9 volts and is transistor regulated. A real money saving device for £2.50 plus 10p P. & P.

MINI LOUSPEAKERS

2½in 8 ohm, 50p; 2½in 80 ohm, 50p; 2½in 40 ohm, 50p. Please include 5p P. & P. on each L.S.

DIGITAL CLOCK KIT

24-hr. Nixie dig. clock kit. We supply: a complete set of components; a complete set of easy to follow instructions; printed circuits made to make construction as simple as possible; a cabinet and front panel to give a professional finish. All for the price of the components. £22.50 + 50p P. & P. Please send S.A.E. if you require more information.

AL20 5 WATT AUDIO AMPLIFIER

A low cost high quality 5 watt audio amplifier designed for use in stereo systems, record players and other audio equipment. Supply Voltage = 9 to 30 volts. Frequency = 50 to 25 kHz. Overall Size = 3in x 2½in x 1in approx. Full technical data and diagrams with each module. All guaranteed and a bargain at £2.63 plus 5p P. & P.

V.A.T. From 1st April, 1973, will you please include on your Total (Goods plus Postage and Packing) Value Added Tax at the Standard Stated Rate.

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6 volt 70 ohm. Single Pole Changeover = 40p plus 5p P. & P. Approx. size = 1½in x 1in x 1½in.

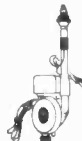
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Fused Primary 240V. Secondary 220V @ 50mA. 6.3V @ 1A. This transformer is made to a very high standard and is a small size - 2in x 2½in x 2½in. 63p plus 10p P. & P.

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WITH A MOTOR DRIVEN CAR AERIAL

Spec: 5 Section Extended Length 100cm Length under Fender 40cm Cable Length 120cm Supplied complete with Fixing Bracket and Control Switch. £6.75 P. & P.



EMI LOUSPEAKER 450

10W. 13in x 8in ± two 2-2½in tweeters and cross-over. All wired and ready for use. This ever-popular 450 in 3-8-15 ohm imp. £3.75 plus 38p P. & P. each.

7in x 4in LOUSPEAKER

A top quality speaker ideal where small size is important. Manufactured by E.M.I. for a well-known hi-fi set maker. Size: 7in x 4in. Impedance: 8 ohms. Flux: 38,000. Max. Free range: 90Hz to 12kHz. Power handling: 5W. Unbeatable. Price: £1.60. Free postage on this item.

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Top quality cassettes at unbeatable prices (complete with standard storage case): C60 28p, C90 38p, C120 48p plus 5p P. & P.

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 500W lamps to the output terminals of the unit, and you produce a fascinating sound-light display. (All guaranteed) £18.50 plus 38p P. & P.

If you require more information please send S.A.E.

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

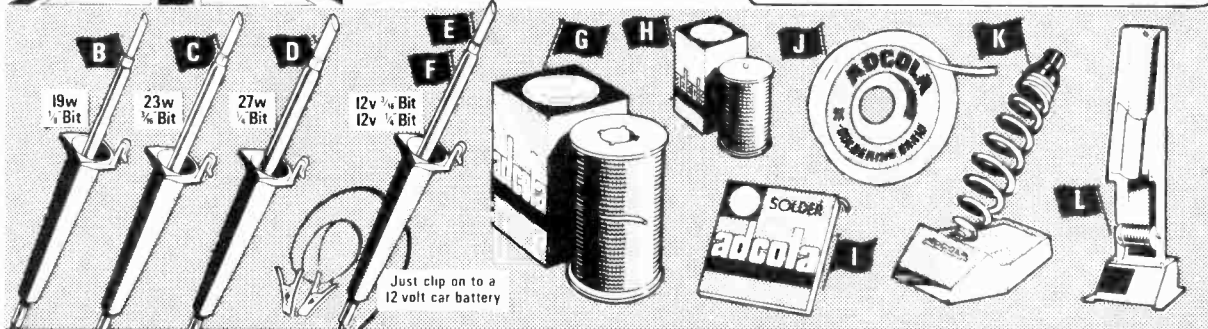
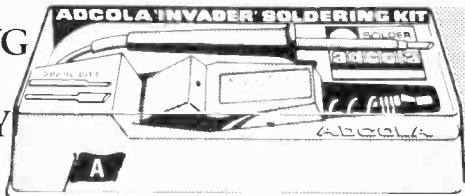
We supply the three modules for you to build this Disco-Group-P.A. amplifier into the cabinet of your choice.

- ★ THE POWER AMP MODULE TP100W 170W r.m.s. sq. wave 300W instantaneous peak into 8 ohm (60W into 16 ohm). £14.28 carr. 45p
- ★ THE PRE-AMP MODULE Four control pre-amp, Vol, Bass, Treble, Middle controls. Designed to drive most amplifiers using F.E.T. first stage. £9.96 carr. 25p
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| I SOLDER PACK | £0.065 | <input type="checkbox"/> |
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All prices include 10% V.A.T.

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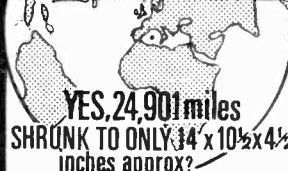


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YES, "YOU'VE GOT THE WHOLE WIDE WORLD IN YOUR HANDS"!! ALMOST UNBELIEVABLE!! Think of the year 1984 and what might be produced then—now get the fantastic **ASTRAD 17** and **SEE** for yourself that the incredible Russians have done it! **NO MORE** "COMPUTERISED" tuning, dream come true! **THIS ONE SUPERSEDES ALL EARLIER MODELS!** It will probably make your present radio seem like a "crystal set"! Complete with optional battery eliminator for both battery and mains use! We're almost giving them away at only £18.50—a mere fraction of even today's Russian miracle price! We challenge you to compare performance and value with £80 radios! Send us a cheque, or a receipt, goods test 7 days, refund if not delighted. Or call. Elegant black & chrome finish facia, set in fabulous Cabinet built case—constructed of fine Russian hardwood in beautiful Teak Veneer finish—prevents vibration, ensures purer & sweeter tone than ever! Volume controlled from a whisper to a roar that would fill a hall! Much wider band spread, for absolute "pin-point" station selection! Plus "MAGIC EYE" tuning level indicator for ultra perfect tuning sensitivity! Yes, the Russians have surpassed themselves, proving again their fantastic ability in the field of electronics and brilliantly reflecting their advanced micro-circuitry techniques in the field of spacehip and satellite communications. **Yes, EVERY WAVEBAND** instantly at your fingertips including **Standard Long, Medium, Short and Ultra Short Waves** to cover the four corners of the earth during 24 hours a day including all normal transmissions. Yes, the FM/USW, MW, SW, gets, locally, local & new stations not yet operational, and messages from all over the world! Expensive **TURRET TUNER** side control waveband selection unit (as used on expensive T.V.'s!). Every waveband clicks into position giving incredible ease of station tuning! Genuine push-pull output! ON/OFF volume and separate Treble and Bass tone controls for utter perfection of reproduction of every tone! Press-button dial illumination! Take it anywhere—runs economically on standard batteries (obtainable everywhere) or direct through battery eliminator from 220/240V AC mains supply. Internal ferrite rod aerial plus built-in "rotatable" telescopic aerial extending to 39in approx. It's also a fabulous **CAR RADIO**. Can also be used through extension amplifier, tape recorder or public address system. **SIZE 14in x 10½in x 4in** over all approx. Magnificent design made to give years of perfect service. (U.K. service facilities & spares available for years & years to come, if ever necessary!). With **WRITTEN GUARANTEE**, manual with simple operating instructions & circuit diagram. **PLUS** ultra sensitive earphone for personal listening. **ONLY £18.50** (with mains/battery eliminator £2.00 extra). **BOX, POST, ETC. 45p.** ***BUT WAIT!** for only 75p extra you get the sensational "COMPUTERISED" **WORLD TUNING GUIDE** (it enables you to time, pinpoint & get transmissions the whole world over—even a child can do it in a flash—it even lets you know when to tune into the U.K. when abroad. **NO GUESSING! NO MESSING!** **PLUS** Standard 'longlife' batteries. (Sorry—We cannot change these new radios for any earlier model purchased.) Send quickly to Uxbridge Road address, or call at either Store. But **HURRY!** **SHOPERTUNITIES SAVE YOU ££'s.**

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**THIS FANTASTIC
 EARTH SHRINKER**



**YES, 24,901 miles
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**28 TRANSISTORS
 AND DIODES!
 WAVEBANDS:
 STANDARD LONG and MEDIUM
 Plus 5 SHORT WAVEBANDS
 Plus ULTRA SHORT WAVES
 (V.H.F. AM, FM, MW,
 LW, USW.)**

BATTERY MODEL £18.50 BOX POST ETC. 45p
MAINS/BATTERY ELIMINATOR £2 extra

BRAND NEW FABULOUS ASTRAD 17
'PORTABLE RADIO & COMMUNICATIONS
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***MUST YOU PAY UP TO £80?**

FIRST TIME EVER!
***NOW AVAILABLE WITH fabulous 'COMPUTERISED' WORLD TUNING GUIDE! NO MORE GUESSWORK—INSTANT DATA at your fingertips—enables you to TUNE IN A FLASH to transmissions the world over!**

THIS OFFER ONLY FROM US!

BUY ONE FROM US! SAVE £21.60 NOW!
Fabulous BRAND NEW SOLID STATE
 This equipment's got EVERYTHING!
BATTERY/MAINS AC Combined V.H.F. AM/FM RADIO and CASSETTE TAPE RECORDER & PLAYER
 WITH REMOTE CONTROL MICROPHONE
 RECOMMENDED RETAIL PRICE £44
OUR PRICE £22.40 CARR. ETC. 39p

(Our bargain prices even absorb V.A.T.)
Shopertunities "thunder" ahead with an offer that's FANTASTIC (even by our standards). We've snapped up 500 magnificent machines. Latest sensation in the world of sound! First-class makers! Fabulous VHF, AM/FM Radio AND Cassette Tape Recorder & Player combined & it also runs off standard batteries or mains. (Simply plug in the 220/240V AC line cord.) Record and play back anything, anywhere! **RECOMMENDED RETAIL PRICE GENUINELY £44! WE OFFER AT ALMOST HALF PRICE!** Wonderful features: ★ Press-button Keyboard Control Panel or latest MASTER SWITCH CONTROL! ★ "MAGIC EYE" Visual Battery check/recording level indicator or built-in automatic Leveler! ★ Separate ON/OFF and HI-LO volume controls! ★ Heavy duty built-in speaker! ★ Earphone (for personal listening or "monitoring") and extension speaker sockets! ★ Remote control microphone! ★ Built-in swivel telescopic extension aerial (24in approx.). Magnificently made case with carry handle. (DESIGNS VARY SLIGHTLY.) Takes standard 30, 60, 90 or 120-minute Cassette Tapes, obtainable everywhere. AND the amazing built-in full circuit VHF, AM/FM Radio gives you superb clarity of tone, incredible station selection. Unique rotating Station Selector Dial—gets, locally, city and regional stations in every part of the country, plus B.C. National VHF. Picks up dozens of foreign stations. Fabulous in your car! You could pay ££'s more for a Car Radio or Car Cassette player ALONE! £22.40, carr. etc., 39p. Complete with simple instructions, remote control microphone with on/off switch and microphone stand. **WITH WRITTEN GUARANTEE.** Send quickly, after receiving goods, test 7 days, refund if not delighted. Or call. **BONUS OFFER:**—Cassette tape, standard batteries AND Microphone stand 55p extra if required.
CALLERS: ACCESS & BARCLAY CARDS ACCEPTED AT BOTH STORES

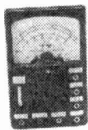
FIRST TIME EVER! SAVE £15.21!
BRAND NEW AC/DC BATTERY/MAINS
Cassette TAPE RECORDER & PLAYER
 With remote control microphone.
FIRST CLASS MAKERS
 WE COULD CHARGE UP TO £26.97!
OUR PRICE £11.76 POST ETC. 34p

(Our bargain prices even absorb V.A.T.)
THE ONE STEP FORWARD EVERYONE HAS WAITED FOR! NOW a superb de-luxe portable **BATTERY/MAINS** tape recorder and player—and incredible Shopertunities bring it to you for **ONLY £11.76!** Due to our cut price we cannot name first-class makers—but rest assured you're getting one of the BEST! Expensive "PIANO KEYBOARD" CONTROL PANEL (or latest MASTER SWITCH control) AND AUTOMATIC LEVEL CONTROL. No fiddling with awkward tape and reels, just "slap-in" a cassette and off you go! (Takes 30, 60, or 90 minute standard cassette tapes obtainable everywhere). Amazing performance ensures perfect tapings and superb reproduction! Remote control microphone. Rapid Rewind! Fast forward! Beautiful tone from a whisper to a roar! Completely self contained—record anywhere, indoors or out! Runs on standard batteries AND 220/240V AC mains. Separate jacks for remote control microphone, etc. Size 9½in x 5in x 2½in approx. Design can vary slightly. With carry handle. **WRITTEN GUARANTEE** and full instructions. (Recommended selling price £26.97!) **OUR PRICE ONLY £11.76, post, etc. 34p.** *Send quickly, after receiving goods test 7 days—refund if not delighted. Or call at either of our stores.
BONUS OFFER:—Cassette tape, standard batteries AND Microphone stand 55p extra if required.
 Order by post to Uxbridge Road address or call at either store.
 Bargains galore at both stores.—(COMMERCIAL TRAVELLERS PLEASE)
NOTE: Merchandising office at Holborn Store.)

SHOPERTUNITIES LTD.

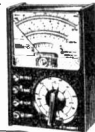
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High-precision at low-cost. Ranges: 0-15V, 150V, 1,000V (10,000 O.P.V.). A.c. 15V, 150V, 100V (1,000 O.P.V.). D.c. Current 150mA. Resistance 100k ohms. **£1.85.** Post 15p.

MODEL 1092 Testmeter
5,000 O.P.V.
0/3/15/150/300/1,200V d.c.
0/6/30/300/500 V a.c.
0/300 μ A/300mA
0/10K/1 meg Ω
Decibels - 10 to +16 dB
£2.75 each. Post 15p.



HIOKI MODEL 720X
20,000 O.P.V.
Overload protection
5/25/100/500/1,000V d.c.
10/50/250/1,000V a.c.
50 μ A/250mA, 20K/2 meg ohm.
-5 to +62dB.
£4.87. Post 15p.

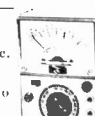
HIOKI MODEL 730X
30,000 O.P.V. Overload protection.
0/3/15/150/300/600/1,200V d.c.
12/60/120/600/1,200V a.c.
60 μ A/300mA/300 mA. 2K/200K/2 meg. ohm.
-10 to +63dB.
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MODEL TE-200 20,000 O.P.V.
Mirror scale, overload protection.
0/2/5/12/5/10/50/100V a.c.
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mirror scale 0/0-5/2-5/20/25/100/250/500/1,000V d.c.
0/2-5/10/25/100/250/500/1,000V a.c.
0/50 μ A/5/50/500mA. 12 amp. d.c.
0/60K/6 Meg./60 Meg Ω .
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HIOKI MODEL 750X
50,000 O.P.V.
43 ranges 0-0.3 to 1,200V d.c.
0-3 to 1,200V a.c.
0-30 μ A/300mA.
0-3K/30 meg ohms. -10 to +17dB.
£8.97. Post 20p.



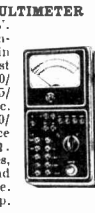
HT100B4 MULTI-METER
Features a.c. current ranges. 100,000 O.P.V.
Mirror Scale. Overload protection.
0/0-5/2-5/10/50/250/500/1,000V d.c.
0/2-5/10/50/250/500/1,000V a.c.
0/10/250 μ A/2-5/25/250MA
10 amp. d.c.
10 amp. a.c.
0/20K/200K/2MEG/20 MEG.
-20 +62dB. **£15.** Post 25p.



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

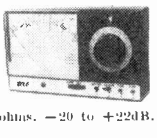


RUSSIAN 22 RANGE MULTIMETER
Model U437 10,000 O.P.V.
A first class versatile instrument manufactured in U.S.S.R. to the highest standards. Ranges: 2-5/10/50/250/500/1,000V d.c. 2-5/10/50/250/500/1,000V a.c.
D.c. current 100mA/1/10/100mA/1A. Resistance 300 ohms/3/30/300K/3m Ω . Complete with test leads, instructions and sturdy steel carrying case. OUR PRICE **£5.97.** Post 25p.



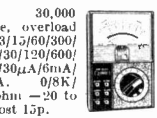
ROUND SCALE TYPE PENCIL TESTER MODEL TS.68
Completely portable, simple to use pocket sized tester. Ranges 0/3/30/300V a.c. and d.c. at 2,000 O.P.V. Resistance 0-20K ohms. **ONLY £1.97.** Post 15p.

LT 601 MULTI-METER
New style 20,000 O.P.V. pocket multimeter. 5/25/50/250/500/2,500V d.c. 10/50/100/500/1,000V a.c. 50 μ A/250A. 6K/6 meg ohms. -20 to +22dB. **£3.75.** Post 20p.



MODEL TE-12 20,000 O.P.V. Overload protection. Slide switch selector.
0/0-25/2-5/10/50/250/1,000V d.c.
0/2-5/10/50/250/1,000V a.c.
0/50 μ A/25/250MA d.c. 0/3K/30K/300K/3 meg. -20 to +50dB.
£4.97. Post 15p.

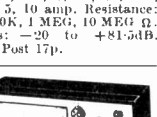
MODEL TE-300. 30,000 O.P.V. Mirror scale, overload protection
0/0-6/3/15/60/300/1,200V d.c.
0/6/30/120/600/1,200V a.c.
0/30 μ A/60mA/60mA/300mA/600mA. 0/8K/80K/800K/8 meg. ohm -20 to +63dB. **£5.97.** Post 15p.



MODEL FL438 20K Ω /V d.c. 8K Ω /V a.c. Mirror scale.
0-6/3/12/30/120/600V d.c.
3/30/120/600V a.c.
50/600 μ A/60/600mA. 10/100K/1 Meg/10 Meg Ω .
-20 to +45dB. **£6.97.** Post 12p.

TMK MODEL TW-50K 46 ranges, mirror scale, 50K/V d.c. 5K/V a.c. D.c.: Volts 0-125, 0-25, 1-25, 2-5, 5, 10, 25, 50, 125, 250, 500, 1,000V. D.c. Current: 25, 50 μ A, 2-5, 5, 25, 50, 250, 500mA, 5, 10 amp. Resistance: 10K, 100K, 1 MEG, 10 MEG Ω . Decibels: -20 to +81.5dB. **£8.50.** Post 17p.

MODEL K228A Taut band suspension. Overload protection. Polarity reversing switch. 30,000 O.P.V.
0/0-5/2-5/15/100/2,500V d.c.
0/15/50/150/500/1,000V a.c.
0/50 μ A/5/50/500MA/5A d.c.
0/3K/300K/3meg. **£8.95.** Post 20p.



HIOKI MODEL 700X 100,000 O.P.V. Overload protection. Mirror scale.
0-3/0-6/1-2/1-5/8/6/12/30/60/120/300/600/1,000V d.c.
1-5/3/6/12/30/60/150/300/600/1,200V a.c.
15/30 μ A/3/6/30/60/150/300MA
6/12 amp. d.c. 2K/200K/2 Meg/20 Meg ohm -20 to +63dB. **£13.50.** Post 20p.

MODEL C-7080 EN Giant 6in mirror scale. 20,000 O.P.V.
0/0-25/1/2-5/10/50/250/1,000/5,000V d.c.
0/2-5/10/50/250/1,000/5,000V a.c.
0/50 μ A/1/10/100/500MA/10 amp. d.c. 0/2K/200K/20 meg. -20 to +50dB. **£13.95.** Post 32p.

U4312 MULTIMETER Extremely sturdy instrument for general electrical use. 667 O.P.V.
0/0-3/1-3/7-5/30/60/150/300/600/900V d.c. and 75mV.
0/0-3/1-3/7-5/30/60/150/300/600/900V a.c.
0/300 μ A/1-5/6/15/60/150/600MA/1-5/6 amp. d.c.
0/1-5/15/60/150/600MA/1-5/6 amp. a.c. 0/200 Ω /3K/30K Ω . Accuracy Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions. **£9.50.** Post 25p.



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Full capabilities for measuring A, B and ICO. *npn* or *pnp*. Equally adaptable for checking diodes. Supplied complete with instructions, battery and leads. **£7.50.** Post 20p.



Model 100TR MULTIMETER/TRANSISTOR TESTER. 100,000 O.P.V. mirror scale/overload protection. 0/0-12/0-6/3/12/30/120/600V d.c. 0/6/30/120/600V a.c. 0/12/600 μ A/12/300mA/12 amp. d.c. 0/10 K Ω /1 MEG/100 MEG. -20 to +50dB. 0-0.1-2 MFD. Transistor tester measures Alpha, beta and Ico. Complete with batteries, instructions and leads **£13.50.** Post 25p.



MODEL 449A IN CIRCUIT TRANSISTOR TESTER
Checks true a.c. beta in/out. Checks Icho. Checks diodes in/out. Checks SCR, etc. Beta HI 10-500 LO 2-50. Icho 0-5000 μ A. 220/240V a.c. operation. **£17.50.** Post 25p.

KAMODEN HM720B F.T.V.O.M. Input impedance 10M Ω . Ranges: 0/0-25/1/2-5/10/50/250/1,000V d.c. 0/2-5/10/50/250/1,000V a.c. 0/25 μ A/2-5/25/250MA d.c. -20 to +62dB. 0/5k/50k/500k/5M Ω /500M Ω . **£14.95.** Post 30p.



MODEL L-55 FET V.O.M. Input impedance 10 meg ohms. 0/0-3/1-2/6/30/120/600V d.c. 0/3/12/60/120/600V a.c. 0/120 μ A/120mA d.c. 0/1K/100K/10 meg/100 meg ohms. **£15.97.** Post 25p.



TE-16A Transistorised Signal Generator. 5 ranges 400KHz-30MHz. An inexpensive instrument for the handyman. Operates on 9V battery. Wide easy to read scale. 800KHz modulation. 5 $\frac{1}{2}$ in x 5 $\frac{1}{2}$ in x 3 $\frac{1}{2}$ in. Complete with instructions and leads. **£7.97.** Post 25p.

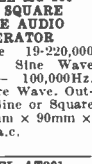
TRANSISTORISED L.C.R. A.C. MEASURING BRIDGE
A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1 Ω -11.1 meg Ω . 6 Ranges \pm 1%, L. 1 μ H - 11.1 mFH. 6 Ranges \pm 2%. C. 10pF - 111.0 nFD. 1/1000-1/1100. 6 Ranges \pm 1%. Bridge voltage at 1,000cps. Operated from 9V 100 μ A. Meter indication. Attractive 2 tone metal case. Size 7 $\frac{1}{2}$ in x 5in x 2in. **£20.** Post 25p.

MODEL TE15 GRID DIP METER
Transistorised. Operates as Grid Dip. Oscillator, Absorption Wave Meter and Oscillating Detector. Frequency range 40KHz-280MHz in 6 coils. 500 μ A meter. 9V battery operation. Size 180mm x 80mm x 40 mm. **£15.** Post 20p.

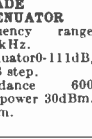


BELCO AF-5A SOLID STATE SINE SQUARE WAVE C.R. OSCILLATOR
Sine 18-200,000 Hz; Square 18-50,000 Hz. Output max. +10dB (10 K ohms) Operation internal batteries. Attractive 2-tone case. 7 $\frac{1}{2}$ in x 5in x 2in. Price **£17.50.** Carr. 17p.

MODEL MG-100 SINE SQUARE WAVE AUDIO GENERATOR
Range 19-200,000 Hz. Sine Wave 19 - 100,000Hz. Square Wave. Output Sine or Square wave 10V. P. to P. Size 180mm x 90mm x 90mm. Operation 220/240V a.c. **£17.50.** Post 37p.



MODEL AT201 DECADE ATTENUATOR
Frequency range 0-200KHz. Attenuator-0.1dB, 0-1dB step. Impedance 600 ohms. Max. Input power 30dBm. Size 180mm x 90mm x 35mm. **£12.50.** Post 37p.



TE-65 VALVE VOLTMETER
28 ranges. D.c. volts 1-5-1,500V. a.c. volts 1-5-1,500V. Resistance up to 1,000 megohms. 200/240V a.c. operation. Complete with probe and instructions. **£17.50.** Post 30p. Additional probes available: R.F. £2-12; H.V. £2-50.

MODEL U4311 SUB-STANDARD MULTI-RANGE VOLT AMMETER
Sensitivity 330 ohms/Volt a.c. and d.c. Accuracy 0.5% d.c. 1% a.c. Scale length 160mm.
0/300/750 μ A/1-5/3/7-5/15/30/75/150/300/750mA/1-5/3/7-5 amp. a.c. 0/3/7-5/15/30/75/150/300/750V a.c. Automatic cut out. Supplied complete with test leads, manual and test certificates. **£49.** Post 50p.

G. W. SMITH & CO. (RADIO) LTD.
Also see opposite page and next two pages

V.A.T. Information

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

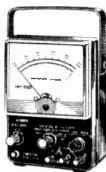
KAMODEN 72.200 MULTITESTER

High sensitivity tester. 200,000 o.p.v. Overload protection. Mirror scale. Ranges: 0/0-06/0-3/3/30/120/600/1,200V a.c. 0/3/12/60/300/1,200V a.c. 0/6μA/1/2mA/1/20mA/600mA/1/2A d.c. 0/1/2A a.c. -30 to +63dB. 0/2kΩ/200kΩ/12MΩ/200MΩ. £18-95. Post 30p.



KAMODEN HM-350 TRANSISTOR TESTER

High quality instrument to test Reverse Leak current and D.C. current. Amplification factor of XPN, PNP, transistors, diodes, SCR's, etc. 4" x 4 1/2" clear scale meter. Operates from internal batteries. Complete with instructions, leads and carrying handle. £12-50. Post 30p.



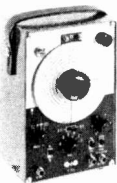
KAMODEN HMG-500 INSULATION RESISTANCE TESTER

Range 0-1,000 Megohms, 500 Volt. Battery operated. Wide range clear meter 4 1/2" x 4". Complete with deluxe carrying case, batteries, instructions. £19-95. Post 30p.



ARF-300 AF/RF SIGNAL GENERATOR

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



HAND HELD 2-WAY WALKIE TALKIES

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

2 channel £52-50 Pair. Post 50p.
3 channel £79-50 Pair. Post 50p.
2 watt.
(Note: Licence required for operation in U.K.)

HOMER INTERCOMS

Ideal for home, office, stores, factories, etc. Supplied complete with batteries, cable and free instructions.

2 Station £2-97, 3 Station £2-25, Post 15p.
4 Station £6-62. Post 17p.



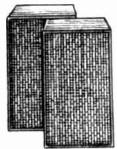
EMI LOUSPEAKERS

Model 350. 13in x 8in with single tweeter/crossover, 20-20,000Hz. 15W RMS. Available 8 or 15 ohms. £7-25 each. Post 37p.
Model 450. 13in x 8in with twin tweeter/crossover. 35-13,000Hz. 8W RMS. Available 8 or 15 ohms. £3-62 each. Post 25p.



SPECIAL OFFER! STEREO SPEAKERS

Matched pair of stereo bookshelf speakers. Deluxe teak veneered finish. Size: 14 1/2in x 9in x 7 1/2in. 8 ohms. 8W RMS. 16W peak. Complete with DIN lead. £12-95. Carr. 50p.



EA.41 REVERBERATION AMPLIFIER

Self contained, transistorised, battery operated. Simply plug in microphone, phone, guitar, etc., and output into your amplifier. Volume control, depth of reverberation control. Beautiful walnut cabinet. 7 1/2in x 3in x 4 1/2in. £5-97. Post 15p.



UNR-30 RECEIVER

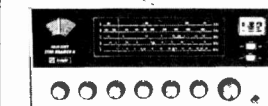
4 Bands covering 550kHz-30MHz. 'BFO. Built-in Speaker 220/240V a.c. Brand new with instructions. £15-75. Carr. 37p.



UR-1A SOLID STATE COMMUNICATION RECEIVER

4 Bands covering 550kHz-30MHz. FET. S Meter. Variable BFO for SSB. Built-in Speaker, Bandsread, Sensitivity Control. 220/240V a.c. or 12V d.c. 12 1/2in x 4 1/2in x 7 1/2in. Brand new with instructions. £25. Carr. 37p.

SKYWOOD CX203 COMMUNICATION RECEIVER



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

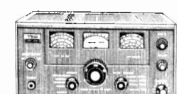
LAFAYETTE HA-600 SOLID STATE RECEIVER

General coverage 150-400kHz, 550 kHz-30MHz. FET front end. 2 mech. filters. product detector, variable BFO, noise limiter. S Meter, Bandsread. RF Gain. 10in x 9 1/2in x 8 1/2in. 18lbs. 220/240V a.c. or 12V d.c. Brand new with instructions. £50. Carr. 50p.



TRIO 9R59DS COMMUNICATION RECEIVER

4 band covering 550kHz-30MHz. continuous and electrical bandsread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. 8SB-CW. ANL. Variable BFO. S meter. Sep. bandsread dial. 1F frequency 43kHz. Audio output 1.5W. Variable RF and AF gain controls 115/250V a.c. Size 7in x 13in x 10in with instruction manual. £49 50. Carr. paid.



HA-10 STEREO HEADPHONE AMPLIFIER

All silicon transistor amplifier operates from magnetic, ceramic or tuner inputs with twin stereo headphone outputs and separate volume controls for each channel. Operates from 9V battery. Inputs 3MV/100MT. Output 50MW. £5-97. Post 15p.



1021 STEREO LISTENING STATION

For balancing and gain selection of loudspeakers with additional facility for stereo headphone switching. 2 gain controls, speaker on-off slide switch, stereo headphone sockets. 6in x 4in x 2 1/2in. £2-25. Post 15p.



MP7 MIXER PREAMPLIFIER

5 microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. 9 1/2in x 5in x 3in. Inputs Mics: 3 x 3mV 50K; 2 x 3mV 600 ohm. Phono neg. 4mV 50K. Phono ceramic 100mV 1 meg. Output 250mV 100K. £8-97. Post 20p.

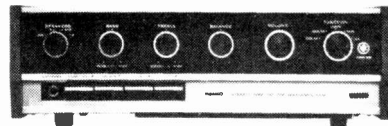


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FANTASTIC OFFER! NIKKO TRM50 STEREO AMPLIFIER



17+17W r.m.s. stereo amplifier with inputs for Magnetic and Crystal phono, Tuner, Tape, Aux and Tape Monitor. Outputs for two pairs of stereo speakers and tape. Stereo headphone socket. Full range of controls including loudness control, scratch filter, etc. Size 13in x 9 1/2in x 3 1/2in. Unrepeatable offer—limited stocks!

List price £59-50
OUR PRICE
£39-95
Carriage 60p

NIKKO TRM 50 SYSTEM



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

LEAK DELTA 30 SYSTEM



OUR PRICE **£110-50** Carr. and Ins. £1-50

TELETON SAQ206B SYSTEM



OUR PRICE **£50-95** Carr. and Ins. £1-50

AUDIOTRONIC ACP-8 8-TRACK CAR PLAYER



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

ONLY **£12-50** P. & P. 40p.

AUDIOTRONIC ACR3500 CAR RADIO



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

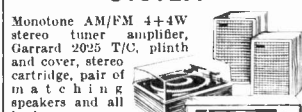
OUR PRICE **£6-50** P. & P. 50p

AUDIOTRONIC ACR. 1 PUSH BUTTON CAR RADIO

Push button tuning of one LW and five MW stations of your choice. 12V Pos. or Neg. earth. Complete with speaker, mounting brackets and instructions.

OUR PRICE **£8-95** P. & P. 50p.

MONOTONE 6750 SYSTEM



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

WHARFEDALE LINTON SYSTEM



OUR PRICE **£95-95** Carr. and Ins. £1-25

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

AMSTRAD 8000 II SYSTEM



OUR PRICE **£43-50** Carr. and Ins. £1

B.S.R. TD8S 8-TRACK STEREO TAPE PLAYER DECK



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

OUR PRICE **£12-75** Carr. 60p.

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SINCLAIR PROJECT 60 PACKAGE DEALS

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£15.95. P. & P. 37p
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 Transformer for PZ8
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 Sinclair Project 605
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All other Sinclair Products in stock: 2000 Stereo Amplifier, **£22.95**; 3000 Stereo Amplifier, **£28.95**; 2000/3000 Stereo Tuner, **£26.95**; P. & P. 50p.

★ TRANSISTORISED FM TUNER ★

6 TRANSISTOR HIGH QUALITY TUNER. SIZE ONLY 6in x 4in x 2 1/2in. 3 I.F. stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Coverage 88-108MHz. Ready built ready for use. Fantastic value for money. **£5.95**. Post 12p. Stereo multiplex adaptors **£4.97**.

TE 1018 DE-LUXE MONO HIGH IMPEDANCE HEADSET
 Sensitive, soft earpads, adjustable headband. Magnetic impedance 2,600 ohms. **£1.97**. Post 15p.

KOSS BARGAIN! SPXCO STEREO HEADPHONES
 Extremely sensitive high quality headphones. Impedance 4-16 ohms. 10-15,000Hz. Soft sponge ear cushions. 10ft coiled lead. Brand new and boxed. (List £9.50). **OUR PRICE £6.50** P. & P. 30p.

HOSIDEN DHO-28 STEREO HEADPHONES
 Wonderful value and excellent performance combined. Adjustable headband. 8 ohm impedance. 20-12,000 cps. Complete with lead and plug. **ONLY £2.37**. Post 12p.

TE-1035 STEREO HEADPHONES
 Low cost high performance stereo headphones. Foam rubber ear cups. Adjustable headband. 8 ohm impedance. 25-18,000Hz. With lead and stereo jack plug. **ONLY £1.97**. Post 12p.

BE.001 HEAD SET AND ROOM MICROPHONE
 Moving coil. Ideal for language teaching, communications. Headphone imp. 16 ohms. Microphone imp. 200 ohms. **£4.82**. Post 15p.



AKAI BARGAINS!

AA6300 AM/FM STEREO TUNER AMPLIFIER
 20 + 20 watts rms. Magnetic ceramic and tape inputs. FM 88-108 MHz. AM 535-1605 kHz. Dual stereo speaker outputs. Headphone socket. (Rec. List Price £117.46)
OUR PRICE £61.95 P. & P. 75p

AKAI AA6300 SYSTEM
 20+20 watt AM/FM stereo tuner amplifier. Garrard AP76, plinth and cover. G800 cartridge, pair of Mezzo III speakers.
OUR PRICE £132.50 Carr. & Pack. £2.00



ROTEL BARGAINS!

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 RA310 15 + 15 watt **£34.95**
 RA610 32 + 32 watt **£51.95**
 RA810 40 + 40 watt **£72.95**
 RA1210 60 + 60 watt **£89.95**
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AM/FM STEREO RECEIVERS
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 AM/FM 7 1/2 + 7 1/2 watt stereo tuner amplifier, BSR MP60, plinth and cover, G800, pair of Denton 2 speakers and all leads.
OUR PRICE £75.95 Carr. & Ins. £1.25



ROTEL BARGAIN!
RH700 STEREO PHONES
 Soft leather ear cushions. Impedance 8-16 ohm. 20-20,000Hz. 15ft coiled lead. Brand new and boxed.
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 GXC46D Dolby Deck **£84.30**
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 Improves the performance of cassette and semi-professional recorders. Reduces tape hiss by 3dB at 600Hz, 6dB at 1200Hz and 10dB for all frequencies above 3000Hz. Controls for input levels and noise reduction on record and replay. 2 meters for Dolby level. Off tape monitoring. Frequency response: 20Hz to 15kHz +1dB 19kHz -35dB. Size 15 1/2in x 9in x 3 1/2in. A.C. 200/250V.
OUR PRICE £32.50 Carr. 50p.

AUDIOTRONIC LOW NOISE TAPE CASSETTES
 Top Hi-Fi quality in library cases.

| Type | 5 | 10 | 20 |
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 SME 2000 System **£26.40**

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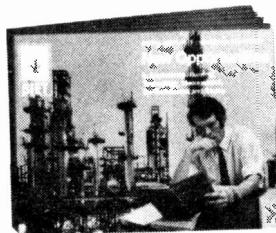
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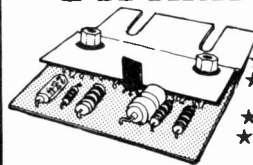
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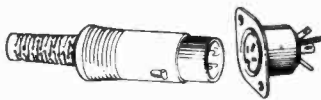
OA90, OA91, OA95, 6p each; OA200, 9p; OA202, 10p.
Other semiconductor: AC128, 17p; AF117, 35p; BFY51, 19p. Full lists and technical data will be found in Catalogue No. 6. See also amendments list.

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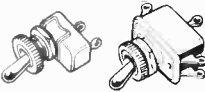
2 way LS —socket 10p, plug 12p
3 way scr.—socket 10p, plug 12p
5 way scr.—socket 11p, plug 15p

TRANSISTOR ACCESSORIES

TO3 cover, 7p; Heat sinks 1°C/W, type 6W1, undrilled, 60p.

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1011 SPST toggle, 20p; 409 DPDT toggle, 29p (these are chrome plated, 2.5A rating); 7201 sub-miniature DPDT 250V a.c./2A, 48p.

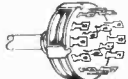


ROTARY SWITCHES

Radiospares Miniature Maka-switch (in assembly kit form). Shaft, 48p. Wafers, MBB-2P5W, 1P11W; BBM1P12W, 2P6W, 3P4W, 4P3W, 6P2W, 32p each.

WAVECHANGE SWITCHES

IP12W, 2P6W, 3P4W, 413W, 24p each.



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| Rated voltage: | 3V | 6.3V | 10V | 16V | 25V | 40V | 63V | 100V |
|------------------|--------|------|-----|-----|-----|-----|-----|------|
| Capacity μ F | 0.47 | — | — | — | — | — | 7p | 7p |
| | 1.0 | — | — | — | — | 7p | 7p | 7p |
| | 2.2 | — | — | — | 7p | 7p | 7p | 7p |
| | 4.7 | — | — | 7p | — | 7p | 7p | 7p |
| | 10 | — | — | 7p | 7p | 7p | 7p | 7p |
| | 22 | — | — | 7p | 7p | 7p | 7p | 7p |
| | 47 | 7p | — | 7p | 7p | 7p | 7p | 7p |
| | 100 | 7p | 7p | 7p | 7p | 7p | 7p | 7p |
| | 220 | 7p | 7p | 7p | 7p | 7p | 7p | 7p |
| | 470 | 7p | 7p | 7p | 7p | 7p | 7p | 7p |
| | 1,000 | 9p | 12p | 12p | 17p | 20p | 23p | 24p |
| | 2,200 | 14p | 16p | 22p | 25p | 36p | 40p | — |
| | 4,700 | 23p | 26p | 37p | 40p | — | — | — |
| | 10,000 | 37p | 40p | — | — | — | — | — |

RESISTORS - 10%, 5%, 2%

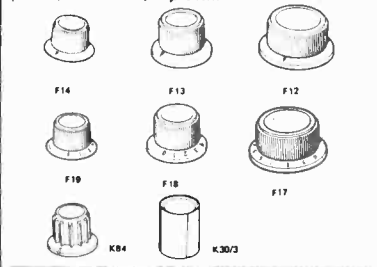
| Code | Power | Tolerance | Range | Values available | 1 to 9 | 10 to 99 | 100 up |
|------|-------|-------------------------|------------------------------|------------------|--------|----------|--------|
| C | 1/20W | 5% | 82 Ω - 220K Ω | E12 | 9 | 8 | 7.5 |
| C | 1/8W | 5% | 4.7 Ω - 470K Ω | E24 | 1 | 0.9 | 0.75 |
| C | 1/4W | 10% | 4.7 Ω - 10M Ω | E12 | 1 | 0.9 | 0.75 |
| C | 1/2W | 5% | 4.7 Ω - 10M Ω | E24 | 1.2 | 1 | 0.8 |
| C | 1W | 10% | 4.7 Ω - 10M Ω | E12 | 2.5 | 2 | 1.6 |
| MO | 1/2W | — | 10 Ω - 1M Ω | E24 | 4 | 3 | 2 |
| WW | 1W | 10% \pm 1/20 Ω | 0.22 Ω - 3.9 Ω | E12 | 7 | 7 | 6 |
| WW | 3W | 5% | 1 Ω - 10K Ω | E12 | 7 | 7 | 6 |
| WW | 7W | 5% | 1 Ω - 10K Ω | E12 | 9 | 9 | 8 |

Codes: C = carbon film, high stability, low noise. MO = metal oxide, Electrofil TR5, ultra low noise. WW = wire wound. Plessey.
Values: E12 denotes series: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades. E24 denotes series: as E12 plus 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and their decades.
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We regret that where substantial price increases have occurred in some items, they are due to increased costs of imported goods, S.A.E.

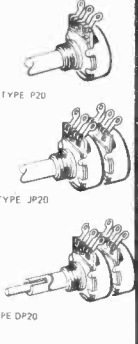
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BURIED FROM VIEW

THE irresistible march of microelectronics means that more and more circuitry is disappearing from view. Circuitry that often is highly interesting in itself is being buried, not just metaphorically but literally, within the confines of black boxes. An oft-posed question is, should the user attempt to pry the secrets of the black boxes, or should he be content to accept them quite simply at their face value like any other circuit components? The latter is probably the most sensible thing to do. Yet sometimes it is essential to have a certain amount of inside information, though there are degrees of delving, of course.

Two articles in this issue illustrate different approaches to a fairly complex i.c., in order to suit (a) the builder of a detailed project and (b) the designer or experimenter.

The article describing the General Purpose Timer gives all the information needed to build this complete instrument. The i.c. upon which the design is based is treated purely and simply as a black box. So far as the constructor is concerned it is just one of the 28 circuit components employed.

This approach is perfectly satisfactory in a constructional article where a proven design is presented for the reader to copy, right down to the final detail, circuit-wise. But should the constructor wish to modify or depart from the specified design in any way, he then obviously needs to know quite a bit more about the i.c. As indeed do all those interested in designing and experimenting for themselves.

Such requirements we have met on this occasion by a separate article which describes the technical characteristics of this i.c. and its possible applications. The device is discussed in practical terms and all relevant parameters are given that need to be taken into account when designing a system around it. Even for this purpose, this "closer look" at the i.c. need not extend to a detailed examination of the actual circuitry of the chip. A functional block diagram is perfectly adequate.

Now this brings us back to that interesting and arguable point. Is there any need to peer deeper into the anatomy of an integrated circuit?

Microcircuit manufacturing processes allow quite unusual innovations in the creation of circuit elements. For example, it is quite normal for the active *pn* junction to be employed as a maid-of-all-work, including serving in the humble role of a passive element. Not surprisingly, any normally well-recognised classic circuit configuration becomes less obvious, maybe entirely unidentifiable, to the average eye scanning the equivalent circuit diagram of some monolithic device.

The internal circuit of an integrated device is not likely to be of any practical value to the general user. Admittedly it can be of academic interest and even offer some reward as a technical brain teaser. But we imagine most users will be content for the i.c. to remain an inscrutable black box. The external discrete circuitry which these devices invariably stimulate and within the web of which they become enmeshed, singly or severally, provides enough for designer, experimenter, or constructor to concentrate upon.—F.E.B.

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THE GENERAL PURPOSE timer discussed here is based on 555 i.c. timer from Signetics which is the subject of the feature commencing on page 514. The unit is constructed in an Eddystone die-cast box of external dimensions 7.39 × 4.703 × 2.062 inches. There is enough space for a mains power pack or a battery to be included inside the box. Whilst construction of the prototype is described in detail, many variations are possible to suit individual needs.

CONTROLS

The control arrangement is shown in the photograph. The eleven-position switch S1 is used to select the first digit of the desired number of seconds, whilst the second digit is selected by the potentiometer VR1. The range switch, S2, is arranged so that the total time selected by S1 and VR1 can be multiplied by 0.1, 1 or 10.

SELECTION OF DELAY

If a time delay of 860 seconds is required, S1 is set to "80", VR1 to "6" and S2 to "×10". A delay of 1.1 seconds can be obtained by setting S1 to "10", VR1 to "1" and S2 to "×0.1". Delays of less than 1 second can be obtained by setting S1 to "0" and S2 to "×0.1". The maximum delay with this unit is about 1100 seconds (18 minutes 20 seconds).

In general the delays are accurate to a few per cent.

OPERATION

The timing period commences at the instant the START button is released after it has been pressed. The internal relay closes at this time, but automatically opens again at the end of the desired delay. It may be found that the timing starts when the START button is pressed down owing to contact bounce. This will not matter provided that the button is pushed quickly and then released.

If the START button has been pressed and one does not wish the timing operation to continue, the RESE1 button may be pressed. A fresh timing operation can then commence from the beginning when the START button is pushed again. The use of the reset facility prevents having to wait or alter the timing setting after commencing a fairly long timing operation and wishing to terminate it.

THE CIRCUIT

The circuit of the timer is shown in Fig. 1. It is essentially the same as the basic circuit of Fig. 1 of the article commencing on page 514, but some refinements have been added.

The resistance of R_A has been replaced by R1 to R11 in series with VR1. The resistor R11 is of low value and is included to prevent a fairly high current (about 60mA) from flowing to pin 2 of the 555 if S1 and VR1 should both be set for zero resistance. The resistors around S1 are each 1MΩ and their total value (as set by S1) is added to the setting of VR1.

THE TIMING CAPACITORS

The timing capacitor is selected by S2a. It cannot be emphasised too strongly that the electrolytic capacitors C1 and C2 must be good quality components which have a low leakage current. The writer would have expected electrolytic capacitors with a working voltage of about 30V to pass a lower leakage current when 12V is applied to them than similar capacitors with a working voltage rating of 15V. However, measurements of the leakage current of a number of capacitors seems to indicate that this may not be the case.

An additional range of "×100" could have been added using a 1,000μF electrolytic capacitor to give time delays of up to 11000 seconds (over 3 hours), but a capacitor selected for low leakage current would probably be required. A 4-way 2-pole switch would then be required for S2.

COMPONENTS . . .

Resistors

| | | |
|-----------|-------------------------|------------|
| R1 to R10 | 1MΩ, 5% (preferably 2%) | } All 0.5W |
| R11 | 4.7kΩ, 10% | |
| R12, R13 | 22kΩ, 10% | |

Potentiometers

| | |
|------------|---|
| VR1 | 1MΩ linear |
| VR2 to VR4 | 10kΩ, 26 turn rectilinear (RS Components Ltd.) |

Capacitors

| | |
|----|--|
| C1 | 100μF, 15 to 30V, electrolytic |
| C2 | 10μF, 15 to 30V, electrolytic |
| C3 | 1μF, 63V, polyester (WIMA or RS Components Ltd.) |

Switches

| | |
|--------|---|
| S1 | 11 way, 1 pole rotary switch |
| S2 | 3 way, 2 pole rotary switch |
| S3, S4 | Single pole push-to-make switches (RS Components Ltd.) |
| S5 | Single pole, single throw toggle switch |

Semiconductors

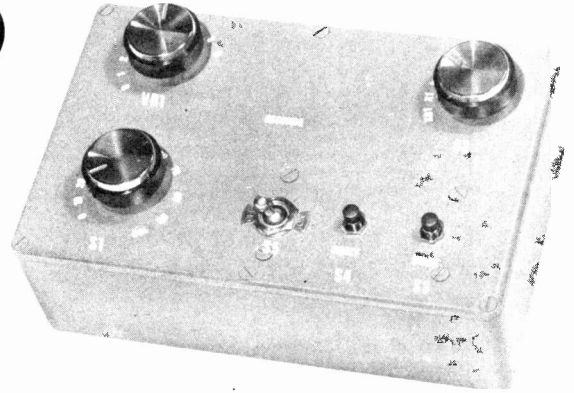
| | |
|-----|--|
| IC1 | NE555V integrated circuit (SDS Components Ltd., Gunstore Rd., Hilsea Trading Estate, Portsmouth, Hants.) |
| DI | OA47 Germanium diode |

Miscellaneous

| | |
|----------|--|
| RLA MS1B | 12V micro-switch relay (Keyswitch Relays Ltd.) |
| | 8 pin dual-in-line socket (RS Components Ltd.) |
| | Eddystone die-cast box 7.39 × 4.703 × 2.062 in external dimensions |
| | 1 Lektrokit board |
| | 4 BA bolts 1¼ to 1½ in long |
| | 12 4BA nuts |
| | 6 8BA nuts and bolts |

TIMER

By J.B. DANCE M.Sc.



Capacitors of a large value have wide tolerances. In addition they pass different leakage currents. Three trimmer potentiometers (VR2 to VR4) are therefore incorporated in the circuit so that each range can be calibrated. S2a and S2b are on the same switch wafer and select the appropriate trimmer potentiometer together with the appropriate capacitor.

CALIBRATION

Adjustment of the preset potentiometers VR2 to VR4 alters the control voltage applied to pin 5 of the 555 timer. When each potentiometer has been adjusted so that the delay is correct at one point

on each range, all of the other delay values should be approximately correct. It is best to make the final adjustments to each potentiometer at a setting near to the maximum delay for the range concerned where the timing errors are greatest. A stop watch is desirable (but by no means essential) for the accurate calibration of the x0.1 range.

The tolerance of R1 to R10 in the prototype was a nominal ± 5 per cent. The accuracy of the delays was found to be a few per cent, as would be

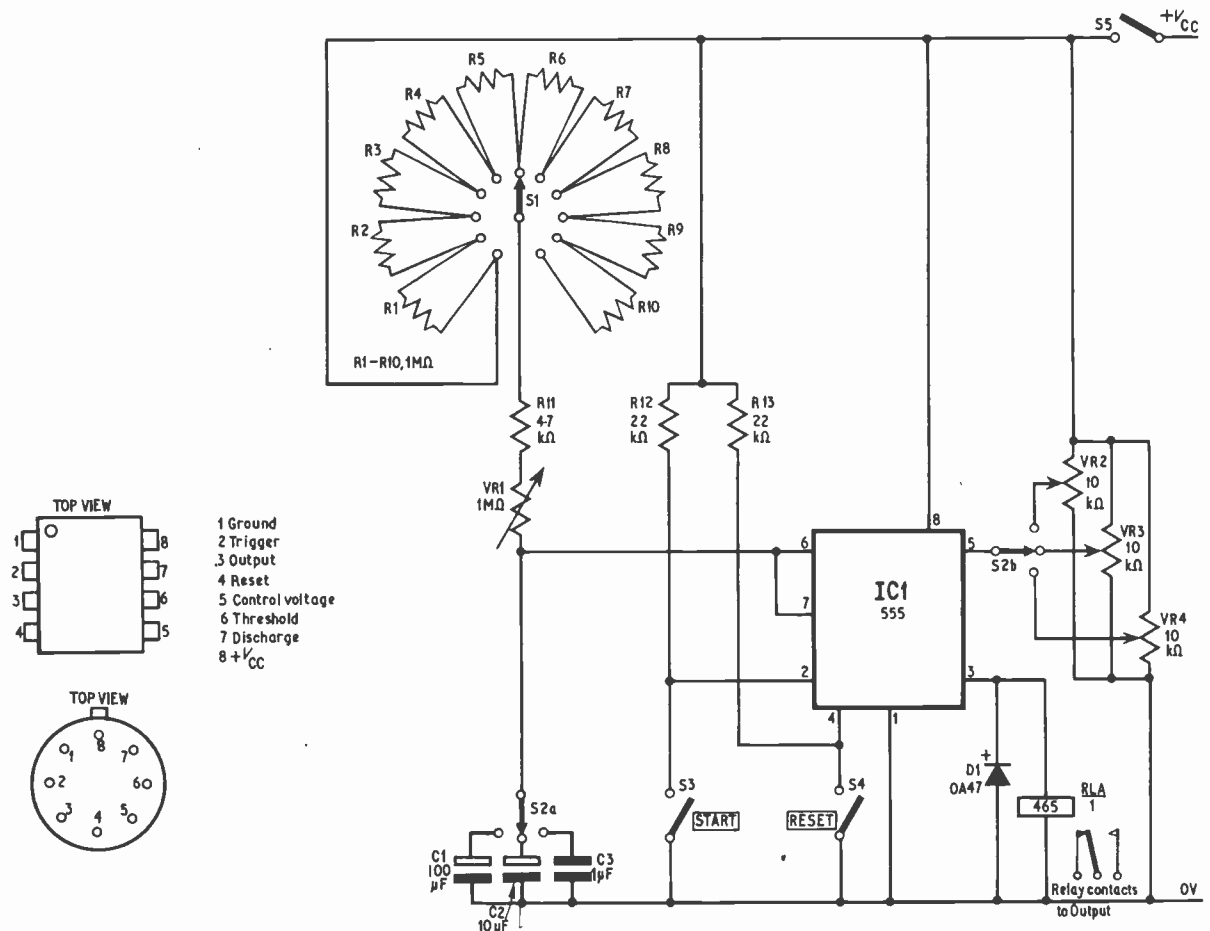


Fig. 1. Circuit diagram of the general purpose timer and the pin connections for the 555 i.c. in both DIL and TO99 case versions

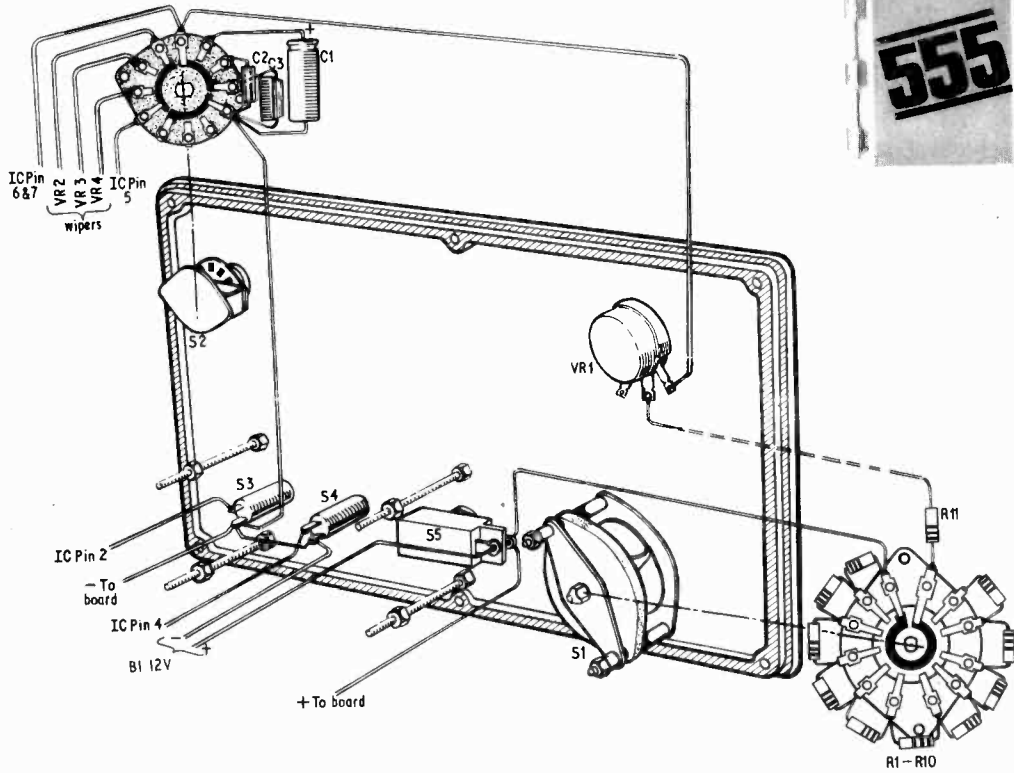
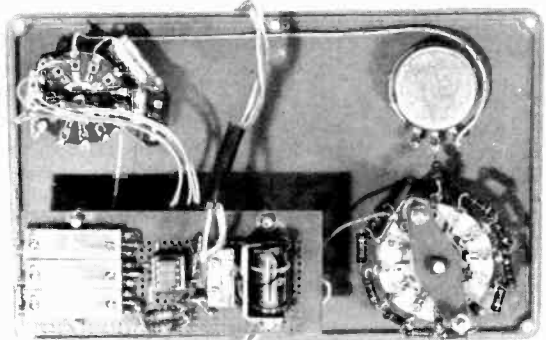


Fig. 2. The front panel layout with switch wiring detached for clarity. The top and bottom views of the circuit board showing disposition of components and interwiring is shown on the left



The completed timer with board and controls mounted in position

expected. An error of 30 seconds in 1,000 seconds is therefore reasonable. Resistors of closer tolerance should be used if it is desired that the timing delays shall be as accurate as possible.

The tolerance of the capacitors C1 to C3 can be quite wide, since the potentiometers VR2 to VR4 allow a timing adjustment of over 10:1 on each range. For example, when the time was set to 20 seconds on the x1 range, adjustment of VR3 allowed any delay between 3 and 43 seconds to be obtained with the capacitor C2 used by the writer.

The 26-turn trimming potentiometers enable a very accurate setting to be obtained. The cheaper "skeleton" preset potentiometers could be tried, but it would then be necessary to connect fixed resistors between each side of these potentiometers and the power supply lines to make their adjustment less critical.

In selecting the component values, the factor of 1.1 in equation 1 of the previous article was neglected so that component values with round whole numbers could be employed.

START AND RESET

The trigger pin 2 and the reset pin 4 are normally biased to the $+V_{cc}$ potential through R12 and R13 respectively. This prevents unwanted triggering of the START or RESET functions by spurious voltage peaks.

It is especially important that pin 2 should normally be at the $+V_{cc}$ potential, since the triggering action is extremely sensitive. It has been mentioned earlier that the circuit exhibits spurious triggering at the end of each delay period if R12 is omitted; the relay then fails to open at the end of the delay time.

THE RELAY

The relay is connected so that it is normally open and is energised only during the timing delay. This minimises the current consumption of the circuit.

The relay used is a miniature micro-switch 12V, 465 Ω relay, type MS1B which is available (through retailers) from Keyswitch Relays Ltd. The tolerance of the operating voltage is 20 per cent, so it will function with a coil operating voltage of 9.6 to 14.4V. The writer has found that a relay of this type will operate with less than 7V across the coil and the prototype circuit functions satisfactorily from a 9V battery. However, a 12V supply is ideal.

The MS1B is a printed circuit relay, but other versions are available including the totally enclosed plug-in version type MS1P. The MS1B can switch up to 5A at up to 250V in a.c. circuits; this is adequate for most purposes, since it can switch over a kilowatt at the normal mains voltage. In d.c. circuits the maximum recommended currents are 2.5A at up to 24V, 0.25A at up to 100V and 0.2A at up to 250V. Higher alternating voltages can be switched, since these voltages fall to zero many times per second and any arc which is formed is then broken.

THE DIODE

The diode in parallel with the relay coil shorts out the back e.m.f. transient voltages developed when the current ceases to flow through the coil. This prevents damage to the 555 timer.

It should be noted that either the type of diode specified or a similar gold bonded germanium diode should be used. The writer has tried a number of other types of diode in the circuit but many of these do not suppress the transient voltage across the relay coil adequately enough to prevent this pulse from re-triggering the circuit. If, therefore, another type of diode is employed and the relay does not open at the end of the delay period, re-triggering is almost certainly the cause.

CONSTRUCTION

All of the components are mounted on the lid of the die-cast box, since this provides maximum accessibility and ease of adjustment of the trimming potentiometers. The switch S1 is mounted in the position shown in Fig. 2 and the resistors R1 to R10 inclusive are mounted directly onto this switch. VR1 is mounted near to S1 with R11 mounted directly between these components.

The timing capacitors C1 to C3 mount directly onto the switch S2. The push-button switches S3 and S4 automatically open when they are released. They are mounted in line with the ON/OFF switch S5 under the circuit board containing the other components.

CIRCUIT BOARD

The circuit board used is a piece about 4 × 1.7in sawn off a Lektrokit board with holes spaced at 0.1in intervals into which metal pegs can be inserted. The board is supported by four 4BA long bolts at a little over one inch under the lid of the box clearing S3, 4 and 5.

The three trimmers VR2 to VR4 are mounted using 8BA bolts on one edge of the board where they can be easily adjusted as in Fig. 2.

An 8-pin dual-in-line i.c. socket mounts on the board, the solder on the pins holding it in position. R12 and R13 mount by the side of this socket. Care should be taken to ensure that the NE555V is always inserted with the correct orientation in this socket, since it is symmetrical and will fit in either way.

It is convenient to mount the relay on its side, cutting holes in the circuit board to accommodate any small projecting parts of the relay. In fact the wire connections to the relay can hold one side of this component to the board, the coil side being fixed by passing pieces of thin wire around the coil and tying the wire under the board.

The only component placed under the board is the diode in parallel with the relay coil. The wires connected to the board are made long enough to allow the board to be easily removed and turned over if it should require attention at any time.

USES IN PHOTOGRAPHY

The circuit is suitable for use as an enlarger timer in photography. The relay contacts are used to control the power to the enlarger lamp directly. The lamp is illuminated when the START button is released and is automatically switched off after the required time. This is much more convenient than having to estimate times or to peer at a watch in a dark room.

The circuit can also be used for timing the development of plates and films. The relay contacts are used to operate a buzzer or a small bell at the end of the required time. ★



AUTOTONE

By Renny Skagestad

THE making of music automates has been an attractive challenge to inventors for many years.

In both the mechanical and electronic versions a variety of ingenious ideas have been applied. However, in general most of the systems are complex and expensive in their realisation.

The circuit to be described has none of these drawbacks.

BLOCK DIAGRAM

A block diagram (Fig. 1) indicates the operating principles of the Autotone. Here an astable pulse generator of fixed frequency switches on and off the supply feeding a shift register of four so advancing conduction from one stage to the next in sympathy with the pulse input.

Each conducting stage in the counter is preadjusted to provide a particular bias voltage to a tone generator so that variable pitch tones are available. The sequenced tones produced are further amplified and fed to loudspeaker.

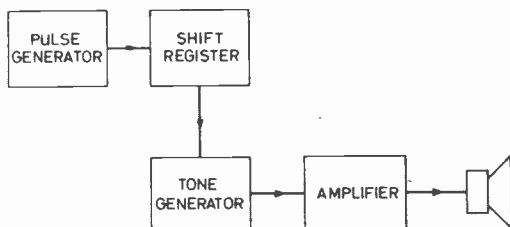


Fig. 1. Block diagram of Autotone

COMPONENTS . . .

Resistors

| | | | |
|---------|---------------------|-----|---------------|
| R1 | 47k Ω | R15 | 220 Ω |
| R2 | 33k Ω | R16 | 1k Ω |
| R3 | 33 Ω | R17 | 56k Ω |
| R4 | 6.8k Ω | R18 | 56k Ω |
| R5 | 33 Ω | R19 | 470 Ω |
| R6 | 1k Ω | R20 | 120 Ω |
| R7 | 10k Ω | R21 | 820 Ω |
| R8 | 1k Ω | R22 | 330 Ω |
| R9 | 220 Ω | R23 | 33k Ω |
| R10-R11 | 1k Ω (2 off) | R24 | 10k Ω |
| R12 | 220 Ω | R25 | 1.5k Ω |
| R13-R14 | 1k Ω (2 off) | R26 | 220 Ω |

All $\frac{1}{2}$ watt 10% carbon

Potentiometers

VR1-VR3 220k Ω vertical presets

Capacitors

| | |
|-------|---|
| C1 | 0.5 μ F to 20 μ F (see text) elect. 15V |
| C2 | 0.01 μ F elect. 9V |
| C3 | 100 μ F elect. 9V |
| C4 | 10 μ F |
| C5-C7 | 0.01 μ F (5 off) |
| C8 | 0.1 to 0.01 μ F |
| C9 | 100 μ F elect. 9V |
| C10 | 500 μ F elect. 9V |
| C11 | 100 μ F elect. 9V |
| C12 | 100 μ F elect. 9V |
| C13 | 200 μ F elect. 9V |

Diodes

D1-D9 ISJ50 (9 off)

Transistors

| | |
|-------------------------------|---------------|
| TR1, TR3, TR4, TR6, TR8, TR10 | 2S104 (6 off) |
| TR2, TR5, TR7, TR9 | OC200 (4 off) |
| TR11, TR12 | AC126 (2 off) |
| TR13, TR15, TR16 | AC128 (5 off) |
| TR14 | AC127 |

Miscellaneous

BY1-BY2 9V batteries (PP9) (2 off)
Veroboard as required, LS1, 5in 3 Ω loudspeaker

PULSE GENERATOR

The complete circuit of the Autotone for four note generation is shown in Fig. 2. This can be increased for an eight note diatonic scale or twelve note chromatic scale by adding extra stages to the ring counter.

The pulse generator is made up of transistors TR1 and TR2. When voltage is first applied C1 starts to charge through the emitter of TR1. This transistor switches on TR2 and a regenerative switching action takes place until the voltage on C1 exceeds the base voltage of TR1 when conduction ceases.

C1 now discharges through R1 until conditions are right for the conduction cycle to start again.

The pulsating voltage at TR2 emitter switches TR3 on and off which itself is in series with one of the supply rails to the ring counter so this is also switched.

SHIFT REGISTER

When power is first applied to the shift register none of the stages normally conducts. But when C4 is switched in it starts to charge thereby giving TR5 the necessary base current drive to make the stage

CIRCUIT DIAGRAM

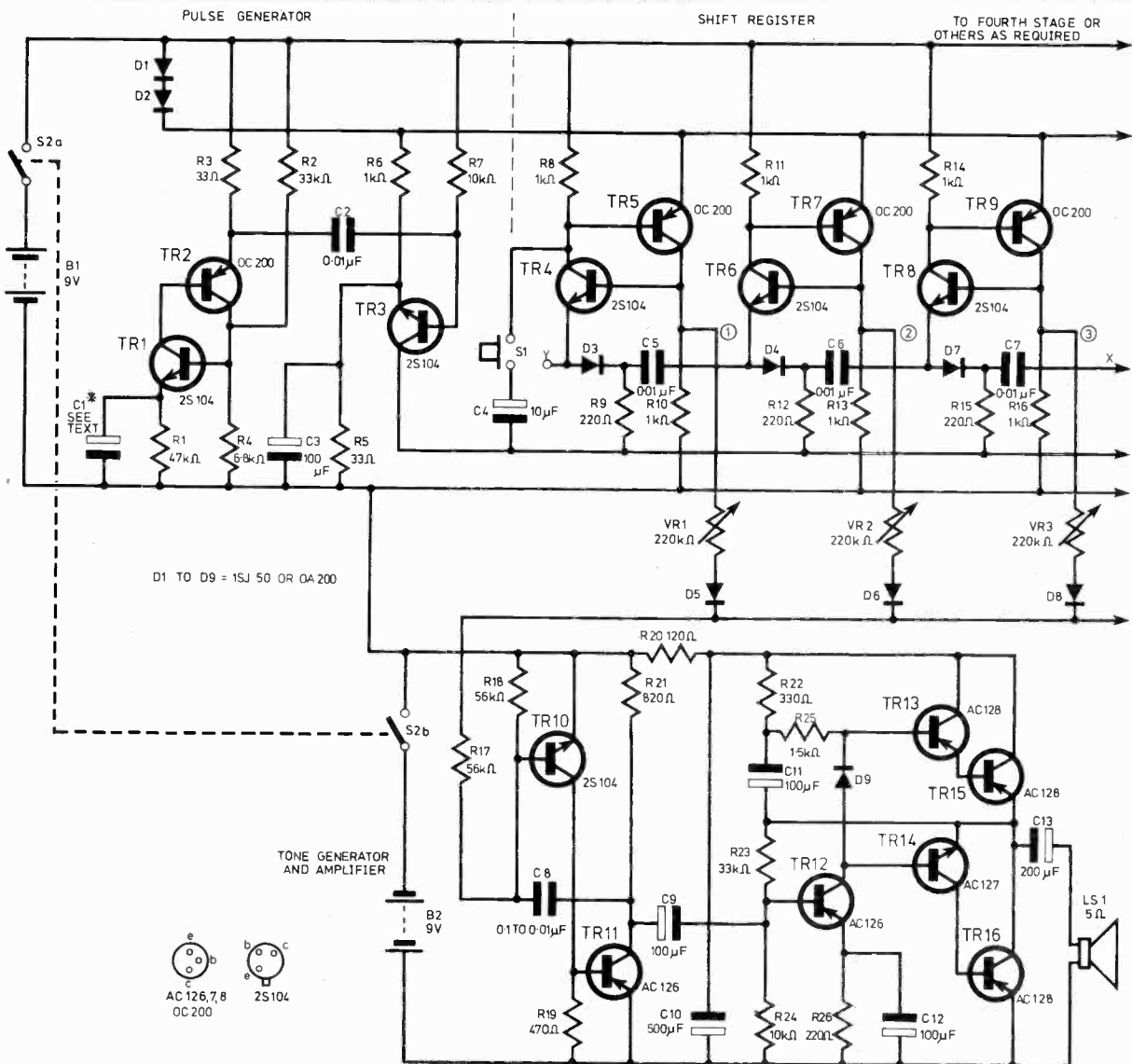


Fig. 2. Circuit diagram of Autotone. Only three stages of the shift register are shown but other identical stages can be added to as required

(TR4/TR5) conducting and an output voltage of about 8V appears at the top of R10. For this condition to exist TR3 must also be switched on.

When TR3 is pulsed off the first stage of the register ceases to conduct. However, since C5 is charged the bias conditions are correct for TR6 to conduct and hence TR7 when TR3 next switches on. This means that the 8V output now advances one stage to appear at the top of R13.

After the fourth shift, to maintain a cycling output, point X can be connected to point Y.

tone generator and amplifier

The outputs taken from the shift register via the presets (VR1-VR4) are used to give base bias to TR10. Both this and TR11 are wired as a high gain amplifier with C8 providing regenerative feedback for oscillation.

The frequency is partly determined by the base voltage at TR10 which depends in turn on the resistance of the presets with the given value of C8 this frequency can only be varied within a certain range.

WIRING DETAILS

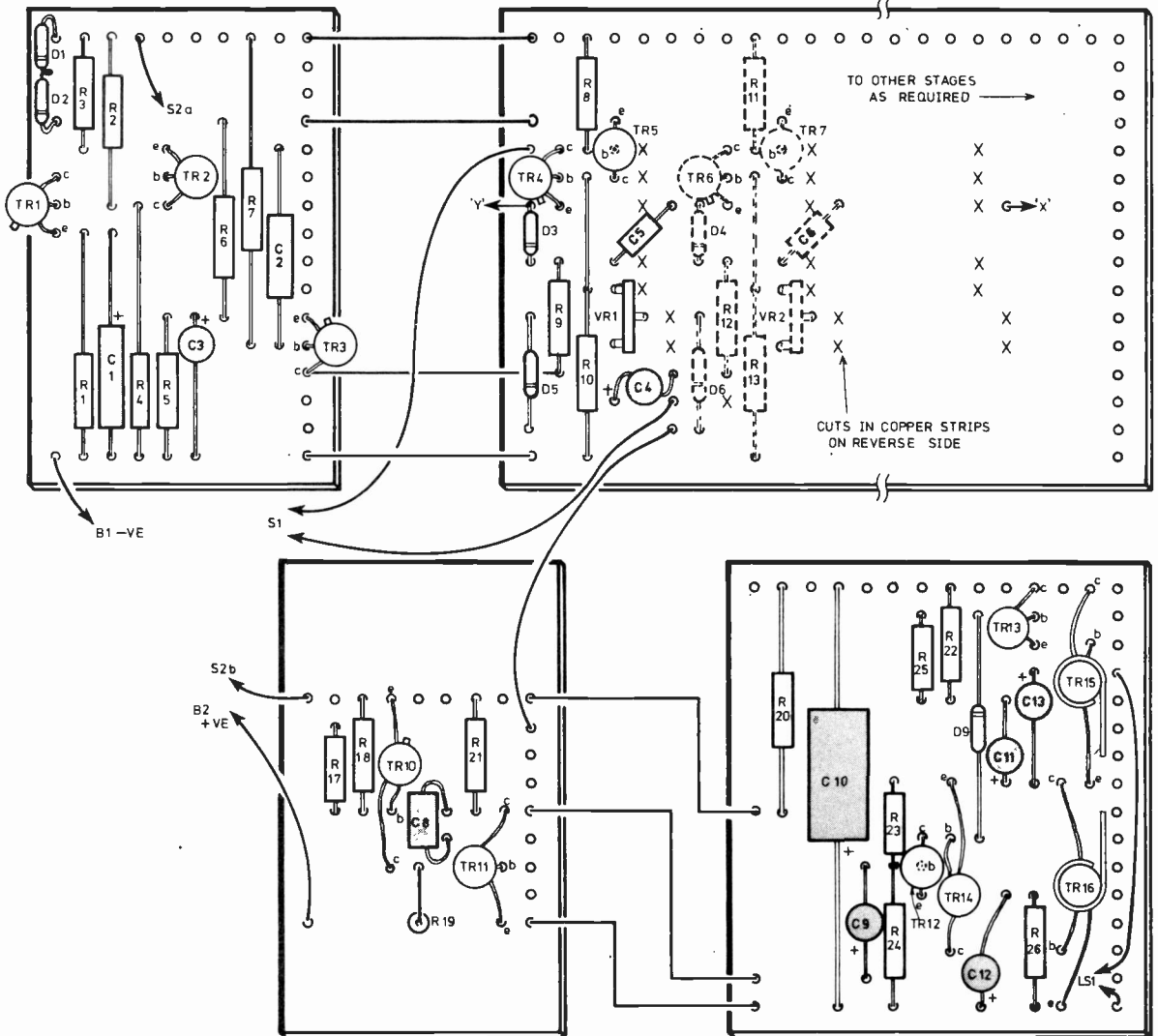
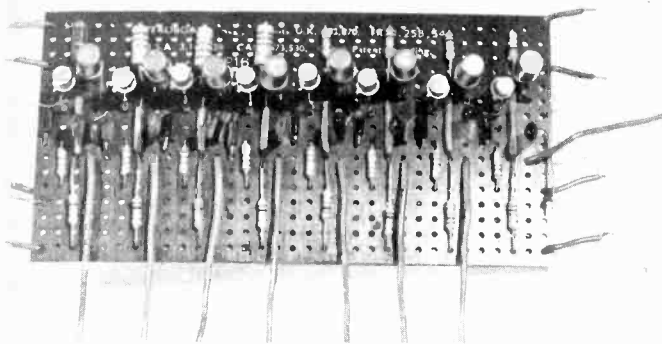


Fig. 3. Assembly and wiring details of Autotone Veroboards



Shift register board containing the eight stages for a diatonic scale. In this example the output potentiometers and diodes have been omitted and transferred to another board

To change this, values of capacitor from 0.1 to 0.1 μ F can be tried.

Tones generated are fed to a four transistor power amplifier. For experimental work the amplifier can be left out and an 80 ohm loudspeaker substituted for R21. In the circuit diagram two power supplies are used to avoid interaction.

CONSTRUCTION

The prototype unit was constructed on separate Veroboards as in Fig. 3. Of course, there is no reason why it could not be assembled on a single board, but it does make testing and servicing simpler to make the circuit elements modular.

TESTING

To test the pulse generator connect a crystal earpiece between the base of TR3 and negative line where a ticking should be heard if all is well.

By connecting a 10V meter (v.o.m.) across one of the output resistors R10, R13, etc., the action of the shift register can be checked by observing that the needle indicates about 8V at regular intervals with X and Y connected.

The tone generator can be tested by connecting a crystal earpiece across transistor TR11, and switch on. A lively oscillation should be heard.

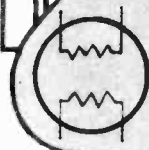
COMPOSING MELODIES

If the shift register is extended to embrace eight or twelve notes there is no need to use all the outputs as the music will become uniform and dull. The melody will be more natural when some of the outputs are left out so achieving breaks or pauses.

In order to make certain tones last longer than others, the presets of two stages may be adjusted to produce the same tone giving the effect of sustain. The speed at which the shift register advances depends upon the value of C1. This may be altered to suit the melody being composed.

If C1 is reduced to around 1 μ F a special effect is achieved which makes the Autotone suitable as an exciting doorbell alarm. ★

NEXT MONTH



Electronic NOSE

Natural gas, petrol, butane, propane, alcohol and smoke, the Electronic Nose can "smell" them all. Its uses range from a simple breathalyzer to amuse your friends, to a detector for tracing lethal concentrations of odourless gas in the bilges of boats.

This easy to construct device uses a new gas detector and incorporates an audio oscillator for easy interpretation of readings. It also uses battery power for complete portability.

Twin Power Supply

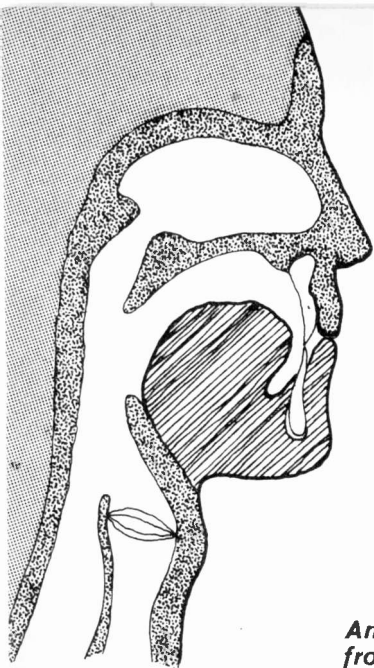
A high quality power supply unit is invaluable in the workshop for testing and evaluating equipment. This design features excellent regulation and extremely low ripple voltage. It also has a feature normally restricted to the most expensive commercial units, an accurate current limit facility, allowing current to be held constant at anything up to the maximum of one amp.

Lighting Controller Unit

A simple thyristor light control circuit provides a variety of switching actions to give effects with lighting circuits including anything from Xmas lights to discotheques. Simple in construction and operation.

PRACTICAL
ELECTRONICS

JULY ISSUE ON SALE JUNE 8, 1973



SPEECH SYNTHESIS

An account of the attempts to build a speaking machine from the eighteenth century to the present day.

By A. V. Flatman (North Staffordshire Polytechnic)

THE synthesis of speech is a subject that has pre-occupied humanity for a long time. It has been a legendary precept and mystery since the eighteenth century. Today, again, this question conserves a mysterious aspect, because speech is concerned with human activity.

Research contributions date back almost two centuries to the "talking machines" of Kempelen and Faber, who, as pioneers, established a great understanding in the acoustic structure of speech, a science that later became known as *phonetics*. It was unfortunate, however, that the early synthesisers were limited to a purely mechanical and inefficient construction.

The mid-twentieth century arrival of electronics proved to be the technology all researchers were waiting for. The tape recorder and oscilloscope made possible the acoustic spectrogram or "voice print" for analysis and synthesis of speech waveforms, whilst computer automation has effectively "untied" the operator's hands.

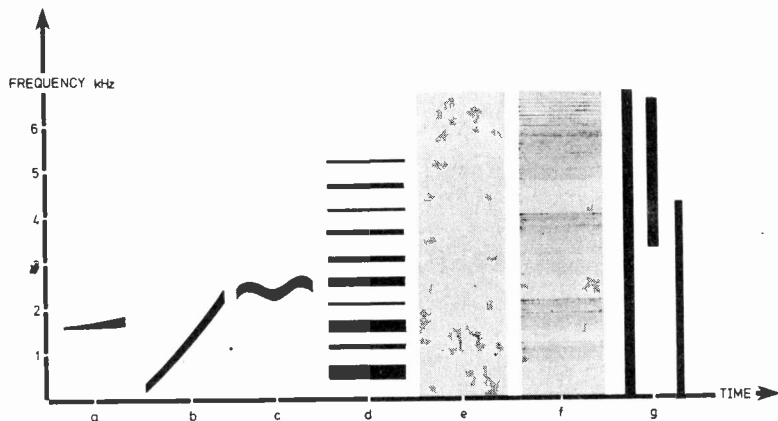
SPEECH ANALYSIS

Before the various techniques of synthesising speech are examined, we must first analyse its acoustic formation.

All acoustical signals can be represented in a *sonogram* or acoustic spectrogram; this is simply a graph of frequency plotted to a base of time, with acoustic intensity shown as line thickness. Fig. 1 gives examples of sonograms for elementary sounds.

When a complex sound enters a resonator, the harmonics near the resonant frequency will be amplified to add a certain "colour" to the sound. This frequency zone is known as a *formant*. Fig. 2 shows the effects of fixed and variable resonant frequencies on several types of acoustical signal.

English spoken in Britain can be broken down into approximately forty fundamental sound units called *phonemes*, the acoustic formation of which may be demonstrated with the aid of the human speech apparatus shown in Fig. 3.



- (a) Simple sound of increasing amplitude
- (b) Simple sound of increasing frequency
- (c) Vibrato
- (d) Harmonic sound
- (e) White noise
- (f) Coloured noise
- (g) Noise impulses

Fig. 1. Sound spectrogram for some elementary sounds

The human speech system comprises several resonant cavities which have the ability of superimposing variable formants upon the complex sounds issued from the vocal cords. One particular vocal sound, with suitable formants to produce certain yields of frequency, will acoustically represent the vowels.

Consonants, on the other hand, are a little more complex in formation. Some consonants are purely breathing noises, from the roof (sound "CH"), teeth (sound "S") or in between the teeth and lips (sound "F"); whilst others may be explosive noises produced by sudden releases, from the roof (sound "K"), teeth (sound "T") or lips (sound "P").

Spoken messages may be analysed pictorially with the aid of the acoustic spectrograph. However there are two characteristics of speech which present difficulties. Firstly, speech has a continuous appearance and is rather difficult to segment into its various phonemes. Secondly, the useful or semantic information in speech is modified somewhat by a "tone of speech" reflecting the speaker's mood.

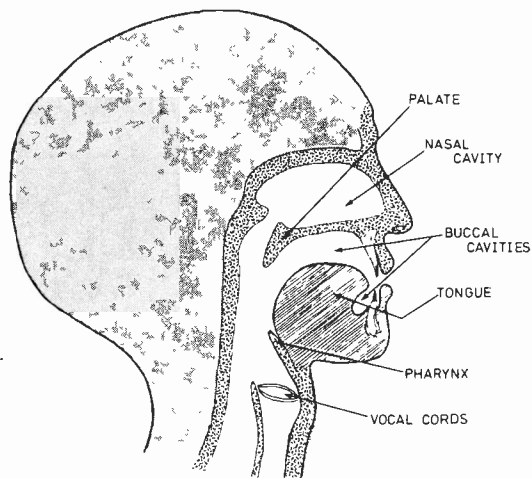


Fig. 3. Diagram of the human speech apparatus

THE KRATZENSTEIN RESONATORS

One of the earliest efforts at speech synthesis was made by Kratzenstein at the Imperial Academy of St. Petersburg in 1779. This mechanical speaking machine comprised a set of acoustic resonators somewhat similar in size and construction to the human mouth. With a vibrating reed similar to that used in the harmonica, he mimicked the vocal chords by interrupting the airstream in each of the resonators to synthesise the five vowels with tolerable accuracy.

THE KEMPELEN SPEAKING MACHINE

Kempelen's speaking machine, which was made in Vienna in 1791, is shown in Fig. 4. One can observe the relative simplicity of the results of Kempelen's research into the problems of speech synthesis. After some practice, the operator could manipulate this machine to synthesise a somewhat limited vocabulary. Whistles are used to give the "S" and "CH" sounds and a reed to give the "R" sound, whilst the rubber mouthpiece is controlled alone to generate the vowels and in conjunction with the bellows to produce a variety of explosive consonants.

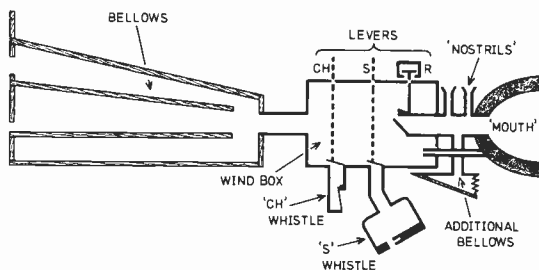
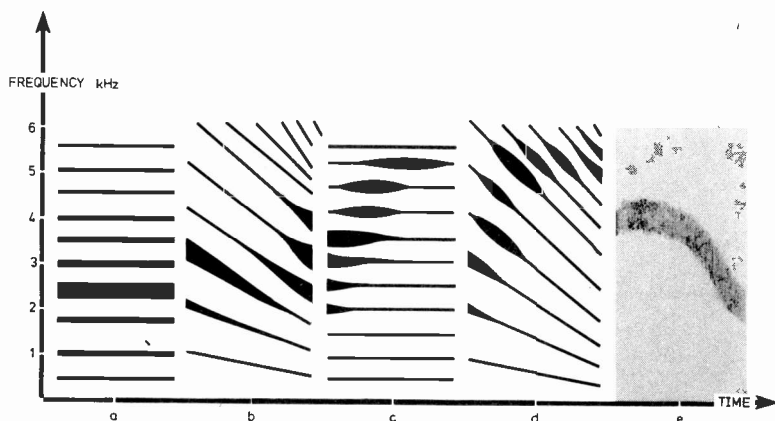


Fig. 4. Cross sectional diagram of Kempelen's speaking machine



- (a) Fixed formant on fixed spectrum
- (b) Fixed formant on variable spectrum
- (c) Variable formant on fixed spectrum
- (d) Variable formant on variable spectrum
- (e) Variable formant on continuous spectrum (noise)

Fig. 2. Some different ways of representing formants

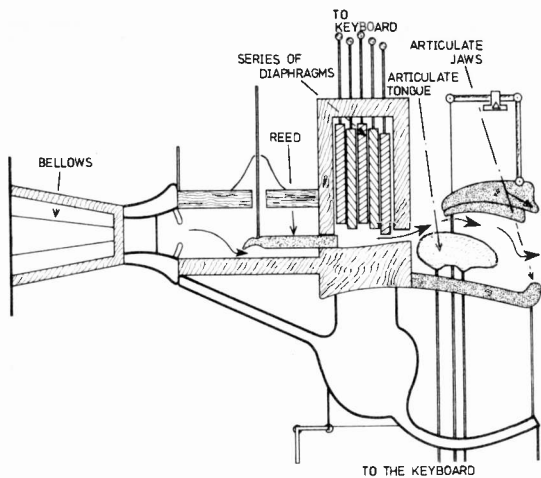


Fig. 5. Cross sectional diagram of Faber's speaking machine

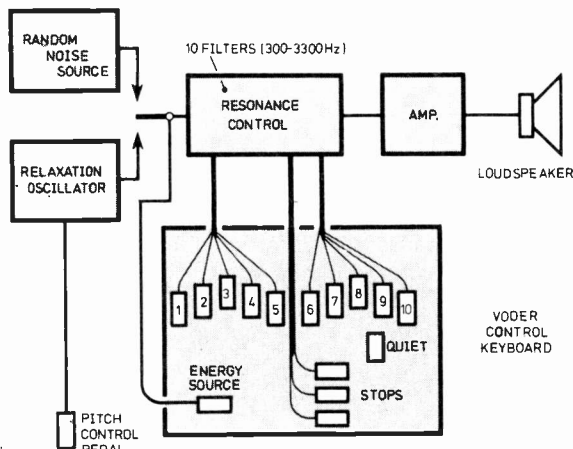


Fig. 6. Diagram showing the basic principles of the Voder

THE MACHINE OF FABER

Faber, professor of mathematics at Vienna, finished a speaking machine in 1835, which created a vast amount of interest and curiosity throughout Europe. Faber put into practice many of Kempelen's theoretical suggestions for improvement, which subsequently contributed to the success of the new machine. The strongest aspect of Faber's research was, however, his consideration of the operator in the use of a keyboard selection technique as shown in Fig. 5. For a century afterwards, many scientists attempted to expand upon the theory of Faber, unfortunately without much success.

THE VODER

The first electrical analogue speaking machine was built by Dudley in 1939. The Voder (VOICE DemonstratOR), shown in Fig. 6, comprises ten filters whose passbands are uniformly distributed between 300 and 3,300Hz. The filters are stimulated with white noise or with a signal rich in harmonics. A keyboard controls the frequency and amplitude of the stimulus as well as the filter selection. Manual operation of the machine was again rather complex, and although the phonemes were relatively accurate in reproduction, they could not be linked efficiently to synthesize continuous speech.

Nevertheless, the Voder represents a new and promising approach in speech synthesis. We will examine in sequence the four types of synthesizers which are used at present: the Vocoder; the Analogue Synthesiser; the Playback; and the Units of Verbal Response.

ELECTRONIC SPEECH SYNTHESIS

Dudley's invention of the Voder marked the beginning of several decades of intense research on both sides of the Atlantic. The new understanding of information theory demonstrated that the telephone bandwidth (300 to 3,300Hz) was exceedingly large for transmitting the semantic information of

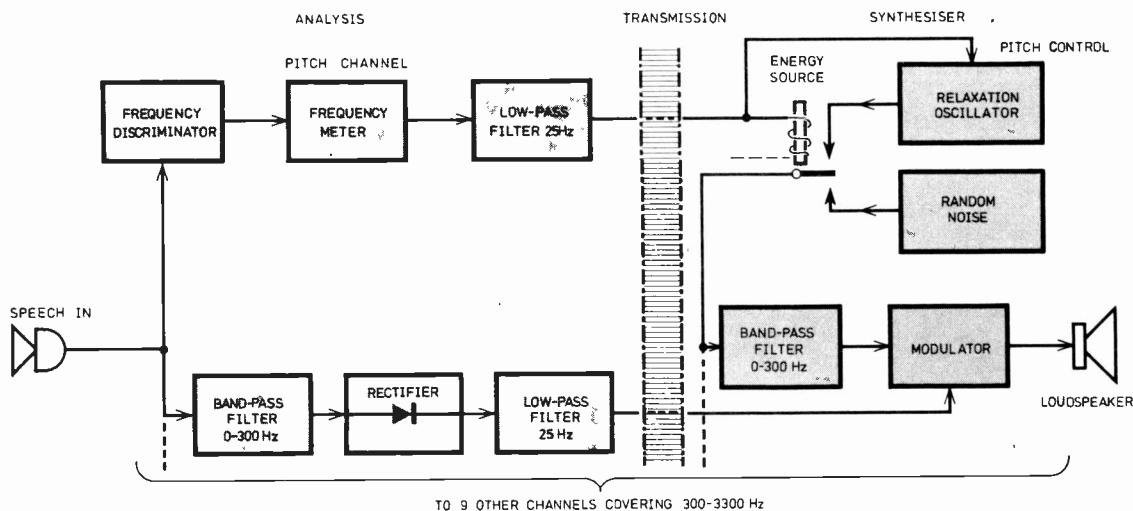
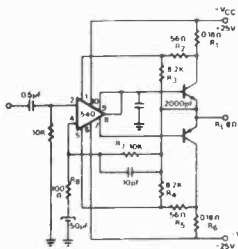


Fig. 7. Block diagram showing the principle of Dudley's Vocoder

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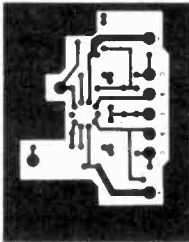


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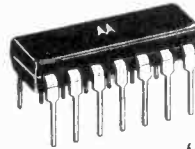
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speech. The telephone allows a data transfer rate of 20,000 binary bits per second, whilst that of the semantic content of speech rarely exceeds 100 bits per second. Speech synthesis then discovered a new field of application in communication system bandwidth reduction, by suitable phoneme encoding.

THE VOCODER

Dudley expanded upon the principle of his Voder to develop a system which greatly reduced the bandwidth of a communication channel. The Vocoder (Voice CODER) analyses incoming speech by initially splitting it into ten frequency bands by suitable filtering and then obtains the modulation "envelopes" of each band by rectifying and low-pass filtering.

Fig. 7 shows how ten separate channels are used to link the analysed or "encoded" speech to the corresponding filters in a Voder. Incoming speech pitch is sensed in a similar way and an eleventh channel is used to select the appropriate energy source in the Voder system.

The Vocoder transmission bandwidth is within 300Hz (11 channels each of 25Hz) and represents a great saving in this respect. Synthesis takes place in the established Voder system, which is now operated electronically to reproduce intelligible speech with tolerable continuity.

THE ANALOGUE SYNTHESISER

The principle of this machine consists more of simulating the function of the phonetic organs, rather than synthesis via analysis. The pharynx and buccal cavities of the human speech apparatus are firstly considered as the three damped resonators shown in Fig. 8; X, Y and Z respectively. Sound is emitted from the vocal cords into the first resonator X, then via the narrow passages to the resonators Y and Z, to result in the emergence of the combined sound, $U_n + U_m$.

Fig. 8 also shows the electrical analogue of the resonators X, Y and Z, where electrical properties of resonance; damping, etc., are matched to the properties of the acoustic resonators. The circuit will then act in a similar way to the phonetic organs if stimulated by the appropriate electrical signals, U_g .

Bell Telephone Laboratories have recently developed an extremely useful aid in the study of speech synthesis. It is a simulator in which the value of each component in the electrical analogue is controlled by a computer, at the same time a cross-section of the corresponding phonetic organ state is displayed on a screen.

Programmes have subsequently been written to electrically simulate the phonetic organs with some degree of success. Unfortunately, the rate at which the electrical circuit will deal with successive phoneme simulation is not fast enough for continuous synthesis; however, this technique appears to be very interesting for the physiological study of phonetics.

THE PLAYBACK

Acoustic engineers have demonstrated that all information in speech may be detected on the acoustic spectrogram. Conversely, speech may be reconstructed by careful manipulation of a suitable acoustic spectrogram, as seen in the playback synthesiser. The Icophone, whose principle is shown in Fig. 9, is the most recent synthesiser to use the playback technique.

The principle of the Icophone is quite simple. Opaque zones of the acoustic spectrogram represent zero speech content and allow transmission of a narrow beam of light to the corresponding photoelectric cells. Each cell, in turn, represents a spectrographic frequency zone and controls the continuity between each of the 44 oscillators and the blender. Intonation of the synthesised speech is controlled by the adjustment of each oscillator output level and the switching thresholds.

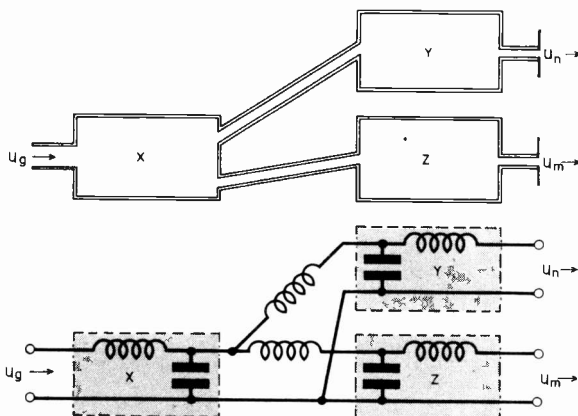


Fig. 8. Analogue synthesis of phonemes by simulation of three formants

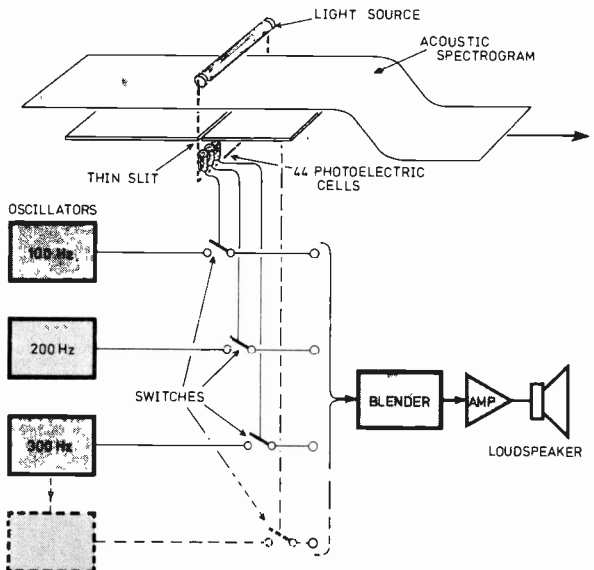


Fig. 9. Diagram showing the principle of the Icophone

Accurate feeding speeds of the acoustic spectrogram result in intelligible synthesis of phonemes and prepared speech. The ultimate and most flexible system of "real time" synthesis from a library of pre-recorded phonemes, however, proves to be somewhat inefficient due to the time taken in phoneme selection.

To overcome the inherent drawbacks of electro-mechanical synthesisers, digital computers have been used to synthesise speech by the playback principle. Semantic information of the basic library of 40 phonemes is digitised in the frequency, time and amplitude domains and held in a digital store (core-store, magnetic drum or disc).

The computer is then programmed to "empty" the contents of certain parts of the store sequentially with sub-millisecond speed, to synthesise a more efficient or continuous speech. Computer synthesis techniques have produced the most accurate subjective results to date, but unfortunately the amount of computing power required is both demanding and costly.

VERBAL RESPONSE UNITS

Certain large makers of calculating machines have commercialised some units of verbal response. These machines allow a computer to answer, in verbal form a question put by the user in coded form, using, for example, the ordinary telephone dial. This system has an immense future in some applications.

Words and phrases are prerecorded on tape and "linked" by computer programme to form a verbal output of a wide range of systems. Having a somewhat limited flexibility one would usually find this type of synthesiser performing specialised tasks of varying complexity, from the "speaking clock" to a verbal instruction generator in an aircraft flight simulator.

THE FUTURE

We have progressed from the relatively inarticulate, mechanical experiments of Kempelen and Faber to the "talking computers" of today. The recent appearance of electronics and the computer have somewhat altered the design philosophy of speech synthesisers. Dexterity, a prominent operator requirement of the past, has been replaced by the modern tool of computer programming.

Nevertheless there remains much room for improvement of today's synthesisers. Imagine the potential of an efficient, flexible, compact and inexpensive "text to speech converter"! It not only has applications in business and education, but think of the way in which it could make the lives of dumb or blind people that bit more bearable.

Speech recognition, an associated field of speech synthesis, is still relatively unconquered. The automatic recognition of speech is a much more difficult task due to the fact that a machine must cope with the enormous amount of variation in human speech, whereas synthesis of different pronunciations of words is normally not required. Obvious differences occur in accent, but considerable variety in pronunciation is present even with the same speaker. Further problems arise in recognition because the speech wave cannot easily be segmented into appropriate words or phonemes. ★



ELEMENTS OF LINEAR MICROCIRCUITS

F. D. Towers, M.B.E., M.A., B.Sc., M.I.E.R.E.

Published by Iliffe Books (Butterworth & Co. Ltd.)

108 pages, 6in × 8½in. Price £2-80

A MAJOR growth area is represented by linear microcircuits. After a late start, following the digital devices that really established the microelectronics industry, the linear form of integrated circuit is now well established and the future holds promise of ever increasing varieties of circuit for all kinds of application.

Therefore, this book is welcome. It is based on a series of articles published in *Wireless World* and provides a compact, readable digest of the subject. Because the rate of development in this field is so rapid it cannot include the very latest developments; nevertheless it is a very useful reference book. It includes practical information in the form of lists of manufacturers, component coding methods, and advice concerning the handling and use of these devices.

A chapter is devoted to each of the major categories of device, e.g. a.f. amplifiers, operational amplifiers, r.f. & i.f. amplifiers, and voltage regulators. The circuit configurations of many typical commercial devices are illustrated and described in considerable detail.

D.D.R.

ELECTRONICS—A COURSE BOOK FOR STUDENTS

G. H. Olsen, B.Sc., M.I.E.R.E., M.Inst.P.

Published by The Butterworth Group

351 pages, 6in × 8½in. Price £2-60

WITH the continuing movement of electronics into almost every other walk of life it is becoming increasingly important for students of all disciplines to be aware of the vagaries of the art. Thus any volume which eases this understanding is to be welcomed and the present document is specifically designed with this end in mind.

In fact the book is a shortened version of the successful "Electronics: A General Introduction for the Non-Specialist" and it manages to take the reader through basics right up to the complexities of integrated circuit operation without any noticeable reference to mathematics and abstruse formulae.

Included, of course, are suitable references to matters of measurement and suitable indicators, power supplies and their construction, amplifiers and oscillators.

Wherever possible the author has illustrated his text with sufficient clarity for the competent to construct many of the items discussed. Indeed, much of the equipment discussed by way of application details is culled from component manufacturers' application notes.

The author is principal lecturer in the Department of Physics and Physical Electronics at the Newcastle upon Tyne Polytechnic and he is concerned with the electronic content of C.N.A.A. degrees, organising post-graduate courses in electronics, and with consultancy in the field of electronic design.

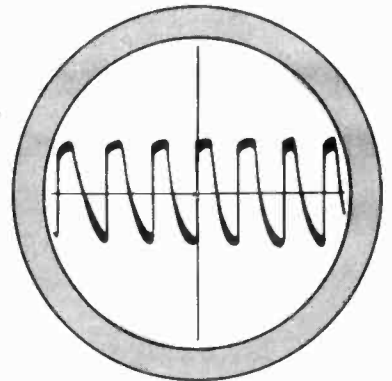
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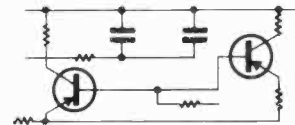
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100pF to 10,000pF, 2p each.

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2½(FV) 1/0/63, 1/5/63, 2/2/63, 3/3/63, 4/7/63, 6/8/40, 10/25, 10/63, 15/16, 15/40, 15/63, 22/10, 22/25, 22/63, 33/63, 33/40, 47/14, 47/10, 47/25, 47/40, 47/63, 68/63, 68/16, 100/4, 100/10, 100/25, 100/40, 150/63, 150/16, 150/25, 220/4, 220/10, 220/25, 220/63, 330/4, 330/10, 470/63, 5p each. 68/63, 150/40, 150/63, 1000/16, 470/10, 680/63, 1,000/4, 9p, 100/63, 150/63, 220/40, 470/25, 680/16, 1,000/10, 1,500/63, 12p, 220/63, 470/40, 680/25, 1,000/16, 1,500/10, 2,200/63, 15p, 330/63, 680/40, 1,000/25, 1,500/16, 2,200/10, 3,300/63, 4,700/4, 18p.

SOLID TANTALUM BEAD CAPACITORS

| | | | | | |
|--------|-----|-------|-----|-------|------|
| 0.1μF | 35V | 2.2μF | 35V | 22μF | 16V |
| 0.22μF | 35V | 4.7μF | 35V | 33μF | 10V |
| 0.47μF | 35V | 6.8μF | 25V | 47μF | 6.3V |
| 1.0μF | 35V | 10μF | 25V | 100μF | 3V |

VEROBOARD

| | | | | | | |
|--------------------|------|------|--------------------|-----|-----------------|-----|
| 2½ x 3½ | 0-1 | 0-15 | Standard screened | 18p | 2.5mm insulated | 8p |
| 2½ x 5 | 22p | 24p | Standard insulated | 12p | 3.5mm insulated | 8p |
| 3½ x 5 | 24p | 24p | Stereo screened | 35p | 3.5mm screened | 13p |
| 3½ x 8 | 24p | 24p | Standard socket | 15p | 2.5mm socket | 8p |
| 3½ x 8 | 27p | 27p | Stereo socket | 18p | 3.5mm socket | 8p |
| 17 x 2½ | 75p | 57p | | | | |
| 17 x 3½ | 100p | 78p | | | | |
| 17 x 5 (plain) | — | 82p | | | | |
| 17 x 5 (plain) | — | 60p | | | | |
| 17 x 2½ (plain) | — | 42p | | | | |
| 2½ x 5 (plain) | — | 13p | | | | |
| 2½ x 3½ (plain) | — | 11p | | | | |
| Pin insertion tool | 52p | 52p | | | | |
| Spot face cutter | 42p | 42p | | | | |
| Pkt. 50 pins | 20p | 20p | | | | |

JACK PLUGS AND SOCKETS

| | | | |
|--------------------|-----|-----------------|-----|
| Standard screened | 18p | 2.5mm insulated | 8p |
| Standard insulated | 12p | 3.5mm insulated | 8p |
| Stereo screened | 35p | 3.5mm screened | 13p |
| Standard socket | 15p | 2.5mm socket | 8p |
| Stereo socket | 18p | 3.5mm socket | 8p |

D.I.N. PLUGS AND SOCKETS

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

BATTERY ELIMINATOR

£1 50
9V mains power supply. Same size as PP9 battery.

LARGE (CAN) ELECTROLYTICS

| | | | | | | | | |
|--------|-----|-----|--------|------|-------|--------|-----|-------|
| 1600μF | 64V | 74p | 2500μF | 64V | 80p | 4500μF | 16V | 50p |
| 2500μF | 40V | 74p | 2800μF | 100V | £2.60 | 4500μF | 25V | £1-68 |
| 2500μF | 50V | 58p | 3200μF | 16V | 50p | 5000μF | 50V | £1-10 |

HIGH VOLTAGE TUBULAR CAPACITORS—1,000 VOLT

| | | | | | |
|---------|-----|---------|-----|--------|-----|
| 0.01μF | 10p | 0.047μF | 13p | 0.22μF | 20p |
| 0.022μF | 12p | 0.1μF | 13p | 0.47μF | 22p |

POLYSTYRENE CAPACITORS 160V 2½%

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

SMOKE AND COMBUSTIBLE GAS DETECTOR—GD1

The GD1 is the world's first semiconductor circuit that can convert a concentration of gas or smoke into an electrical signal. The sensor decreases its electrical resistance when it absorbs deoxidizing or combustible gases such as hydrogen, carbon monoxide, methane, propane, alcohol, North Sea gas, as well as carbon-dust containing air or smoke. This decrease is usually large enough to be utilized without amplification. Full details and circuits are supplied with each detector.

Detector GD1, £2. Kit of parts for detectors including GD1 and P.C. board but excluding case. Mains operated detector £5 20. 12 or 24V battery operated audible alarm £7 30. As above for PP9 battery, £6-40.

PRINTED BOARD MARKER

97p
Draw the planned circuit onto a copper laminate board with the P.C. Pen, allow to dry, and immerse the board in the etchant. On removal the circuit remains in high relief.

LARGE RANGE ITT/TEXAS IC's NOW IN STOCK

PRICES ARE CALCULATED ON TOTAL NUMBER ORDERED REGARDLESS OF MIX

| | | | | | | | | | | | | |
|------|------|-------|-------|------|-------|-----|-----|-------|-----|-----|-----|-----|
| 7400 | 1-11 | 12-24 | 25-99 | 100+ | 7448 | 170 | 165 | 74118 | 100 | 82 | 73 | 64 |
| 7400 | P | 16 | 14 | 13 | 7450 | 18 | 16 | 74121 | 43 | 40 | 38 | 36 |
| 7401 | 18 | 16 | 14 | 13 | 7451 | 18 | 16 | 74141 | 100 | 95 | 90 | 85 |
| 7402 | 18 | 16 | 14 | 13 | 7453 | 18 | 16 | 74145 | 150 | 140 | 135 | 130 |
| 7403 | 18 | 16 | 14 | 13 | 7454 | 18 | 16 | 74150 | 330 | 280 | 250 | 220 |
| 7404 | 20 | 18 | 16 | 14 | 7460 | 18 | 16 | 74151 | 110 | 100 | 95 | 89 |
| 7405 | 20 | 18 | 16 | 14 | 7470 | 30 | 28 | 74153 | 120 | 110 | 105 | 95 |
| 7406 | 50 | 45 | 40 | 35 | 7472 | 30 | 28 | 74154 | 200 | 180 | 170 | 160 |
| 7407 | 56 | 50 | 44 | 38 | 7473 | 40 | 36 | 74155 | 150 | 120 | 100 | 86 |
| 7408 | 36 | 30 | 27 | 23 | 7474 | 40 | 36 | 74156 | 130 | 120 | 100 | 96 |
| 7409 | 36 | 30 | 27 | 23 | 7475 | 55 | 52 | 74180 | 155 | 136 | 112 | 105 |
| 7410 | 18 | 16 | 14 | 13 | 7476 | 40 | 36 | 74190 | 195 | 190 | 185 | 180 |
| 7411 | 23 | 21 | 20 | 18 | 7480 | 100 | 95 | 74191 | 195 | 190 | 185 | 180 |
| 7412 | 36 | 30 | 27 | 23 | 7481 | 125 | 115 | 74192 | 200 | 190 | 180 | 164 |
| 7413 | 36 | 30 | 27 | 23 | 7482 | 100 | 96 | 74193 | 200 | 180 | 170 | 150 |
| 7416 | 45 | 43 | 39 | 34 | 7483 | 100 | 97 | 74196 | 200 | 190 | 180 | 170 |
| 7420 | 18 | 16 | 14 | 13 | 7484 | 120 | 115 | 74197 | 200 | 195 | 180 | 170 |
| 7421 | 36 | 30 | 27 | 23 | 7485 | 250 | 245 | | | | | |
| 7426 | 32 | 29 | 23 | 20 | 7486 | 45 | 42 | | | | | |
| 7430 | 20 | 18 | 16 | 14 | 7490 | 75 | 67 | | | | | |
| 7432 | 40 | 36 | 32 | 28 | 7491A | 100 | 92 | | | | | |
| 7440 | 20 | 18 | 16 | 14 | 7492 | 75 | 70 | | | | | |
| 7441 | 80 | 75 | 70 | 65 | 7493 | 75 | 68 | | | | | |
| 7442 | 80 | 75 | 70 | 65 | 7494 | 95 | 90 | | | | | |
| 7443 | 125 | 120 | 115 | 115 | 7495 | 105 | 100 | | | | | |
| 7447 | 175 | 165 | 150 | 120 | 7496 | 100 | 95 | | | | | |
| | | | | | 7497 | 100 | 95 | | | | | |
| | | | | | 74100 | 250 | 240 | | | | | |

LINEAR IC's

RINGS OF SATURN

Once again a theory has been challenged by a practical test. The original theoretical study of Saturn's rings was made by Clark-Maxwell. He gave as his opinion that these rings must be discontinuous and made up of discrete particles.

This view was accepted by astronomers and until recently the generally recognised explanation was that the particles were ice crystals or accretions of dust. This appeared to be a satisfactory conclusion since the thickness of the rings is around 1.0km, although the diameter reaches some 85,000km.

Now as a result of studies made at Goldstone, California, two researchers R. Golstein and G. Norris, have suggested that the rings consist of boulders approximately 1.0m in diameter.

They used the large Goldstone radio dish and a power of 400kW to direct a beam to the planet 700 million miles away. The beam, using a wavelength of 12.5 centimetres, calculated boulder size from the reflected signal.

This new finding represents a considerable hazard to spacecraft and it may well be that there are scattered lumps of rocks at higher and lower latitudes. The discovery prompts the thought that perhaps the rings are after all the debris of a former satellite.

The approach of the present programmed probes will be close enough to check the conclusions that have been made and possibly even photograph the rocks.

ASTEROID BELT

The safe journey of *Pioneer 10* through the asteroid belt has caused a sigh of relief from the scientists planning the missions. The knowledge that the density of the belt and the size of the particles which differs considerably from the former conjectures will enable plans for future probes to go forward with confidence.

The size of the particles in the belt were between 100 micrometres and 1.0mm. Nothing larger than 1.0mm was encountered all the way out from the earth's orbit. Even those of 1.0mm size were rare. It seems, therefore, that the belt is composed of the 17,000 to 20,000 identified asteroids and very fine dust. During the whole period of the transit through the belt *Pioneer 10* did not have one of the known asteroids in view.

COMPUTER INTEGRITY

A short time ago the possibility of a tenth planet was raised again. Observers have been unable to locate it and computation did not supply sufficient information for a search.

A new attempt at the three body problem was tackled again recently



and out of this exercise came the conclusion that residual errors, which are unavoidable in a computer analysis of data, will always predict a planet or body. It seems therefore that this situation rebuts computer integrity for problems such as this.

TECHNICAL EUTHANASIA

At the press of a switch Sir Brian Flowers FRS, Chairman of the Science Research Council put an end of the life of *Atlas 1*. This computer, the most advanced design in the world when it was installed, had come to the end of a useful life because it was old and its transistors germanium. The availability of spares and the high cost of maintenance made the euthanasia decision imperative.

The computer which dealt with the pilot data from weather satellites, retrieval of data from *UK 3*, and other space projects was designed by a team at Manchester University under Dr (now Prof.) T. Milburn. It contained a supervisory system which has only quite recently been emulated.

The work will now be taken over by a 1906A and a 370/195 which is already dealing with *UK 4* and *Essa 8*. These two computers are, of course, much faster than *Atlas 1*. The main activities of *Atlas* have been concerned with theoretical chemistry and crystallography. There is no doubt that the decision to set up the enterprise of the *Atlas* Laboratory by the Research Council was a wise one and the original investment justified by results.

ORANGE SOIL OF THE MOON

The excitement of the discovery of the orange soil on the moon, thought to be iron oxide, has now been rather dashed by the findings of the investigators. It seems that

the soil is made up of grains of glass.

It is thought that the soil has only been exposed to cosmic rays on the surface for about 8 to 10 million years. When the material was formed, which would be about 3,700 million years ago, it was buried deeply and not exposed to cosmic rays. It was thrown up later by meteoric impact and not by volcanic action of the Shorty crater even though it is of recent formation.

The orange soil is the finest grained that has been found on the moon and consists of coloured glass in droplets and fragments. Chemically the samples from the *Apollo 17* mission are the same as those from the *Apollo 11* mission which was several hundred miles away. There is, however, a difference in that the *Apollo 11* samples were not so rich in zinc.

LUNAN PROBE

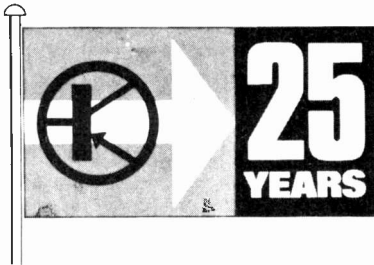
In the March issue of *Spacewatch* mention was made of the work of D. A. Lunan regarding the possibility of a probe being situated in the orbit of the Moon. This was suggested to have originated from Epsilon Boötes a star in the constellation of that name and at a distance from the Earth of approximately 105 light years. The whole matter has caused some stir and the paper was given before a large audience in Caxton Hall in March this year.

There has been a further development in this matter and America has now taken an interest in the project. Originally a project named *OSMAR* was initiated by Frank Drake and Carl Sagan in America. This was subsequently abandoned but a new project for which a very large Radio System is being set up is to be undertaken. This involves a system of aerials in a line 25 miles long.

A more modest project is being set up in this country based on Lunan's suggestions. It is called *GOLDE* (Ground Observations of Long Delayed Echoes) and is to be operated under the aegis of the British Interplanetary Society. This is a project in which the help of amateurs is required.

The principle of operation is to send a strong signal to the place where calculations show that the probe should be and time the echoes which may come back. EMI have loaned a special set of equipment to help the project, which will be in operation for a long time. From America has come an offer to participate in the programme. This is from Stanford University where a large dish is available.

The British team is lead by D. A. Lunan and A. T. Lawton who would welcome amateurs who are interested to take part in this experiment.



The Transistor and Beyond

By Prof. G. D. Sims, O.B.E., Ph.D. (Head of Dept. of Electronics, Southampton University)

AN APPRECIATION OF THE CHANGES ALREADY BROUGHT ABOUT AND AN EVALUATION OF FUTURE PROSPECTS

1973 marks the 25th anniversary of the announcement of the transistor and few in 1948 would have forecast the immeasurable impact which it was to make on the evolution of our society. Since that time "electronics" has seen the appearance of a continuous stream of new devices and "systems" for communications, data processing and control, and our pattern of living has been affected by these developments in a multitude of ways.

FROM SMALL BEGINNINGS TO A SMALLER FUTURE!

Looking back, it was clear that once the junction transistor had been produced, the day of the thermionic valve was limited, though the uptake of the new technology by U.K. industry was relatively slow. Certainly, at that time, both the educational and practical problems associated with its use were formidable, but since, there has been a steady adaptation to solid state devices in almost all low-power applications.

The new "active devices" were no longer necessarily expensive and as the new "systems" emerged, they grew in complexity, bringing new problems associated with "statistical" device and wiring failures. A solution had to be found and once planar technology had been mastered, the ultimate emergence of the microcircuit was inevitable: this, in its turn, brought still lower cost, greater reliability and, as a bonus, yet smaller size. We were now able to buy a complete amplifier, in a single can, while even more significantly logic families and complete integrated digital sub-systems, such as counters and shift registers were also available.

SYSTEMS

At this point, the revolution in basic electronic techniques took a new turn, for now quite massive systems could be envisaged, of which the control systems for the Apollo missions were perhaps the most challenging and spectacular.

In parallel with these developments new information storage techniques were emerging and "memory", whether in semiconductor or magnetic form, is now another readily purchaseable item.

Memory, together with faster digital techniques, now enables us to envisage future "super-systems"

capable of working at data processing rates which were quite inconceivable in 1948. Whereas at that time a microsecond pulse was short, now nanosecond pulses are everyday things and picosecond pulses are beginning to be considered for the communication systems of the future.

These have all been direct effects of the development of the transistor and have often diverted attention from some equally important side-effects, not the least of which was the awakening of interest in the properties of "pure" materials generally.

MATERIALS

The development of semiconductor materials, which first took us from germanium to silicon, soon turned to other materials such as gallium arsenide. This has since given us power devices at microwave frequencies and possibly, of even greater importance, useful infra-red solid state lasers. Subsequently, gallium phosphide has arrived and using much the same *pn*-junction techniques as those employed at low frequencies, we now have compact alpha numeric indicators in this material and its derivatives.

We came to realise, too, that glass could be an important material and "Ovonic" storage devices using switching properties in glass offer great potential, even though, at the moment, they remain little understood and unreliable. We had already accepted that ceramics had their uses, too, whether for substrate materials or in more esoteric combinations such as with ferroelectric glasses, whose interesting optical and piezo electric properties suggest many potential applications.

It would be no exaggeration to say that all of the major device developments which have taken place since 1948 have arisen either from the utilisation of *new materials* or from improvements in *materials technology* which enabled us to use already known materials properties more efficiently than before.

DESIGN CONSIDERATIONS

In order to exploit our devices, in the new systems, it became necessary to marshal a whole new battery of design techniques: the simplest of these were concerned with the design of logical systems, and switching theory has now become an important tool in the hands of almost all electronic engineers. Further, as systems have grown in capability, the designer has

had to find other means for carrying out the kind of routine calculations which hitherto had been his main occupations.

If a computer aided design programme could provide details of how to design a filter, or a feedback circuit, it was clearly sensible to use it rather than to waste valuable professional time on "chores".

With the bigger systems, it is seldom practicable to "bread-board" everything in the initial design stages. Thus simulation techniques, in which systems are modelled on computers, have also developed apace.

Finally, and perhaps most important, is the growing pre-occupation with systems reliability, and design for maintenance ("terotechnology"). These considerations have to be taken into account at the outset of the design process and wherever possible systematic calculations must be performed to put realistic limits on component life.

Long component life is an expensive commodity and whilst it is essential that the system is *reliable enough*, it is seldom that excessive reliability can be justified. Perfectionism is all very well but it costs money!

THE YEARS TO COME

What then of the future?

At the system level we have already spoken of the "super-system" which will provide a communicating power, exceeding by orders of magnitude that are available at the moment. This, using faster digital techniques and optical fibre waveguides, will open up the almost unlimited bandwidths available at optical frequencies and will allow many new possible applications of video systems, such as information retrieval from the local data bank or library and generally "instant-optical communication".

At the device level it is not easy at the present time to envisage a replacement for the silicon integrated circuit, though as technologies evolve, we are already seeing a noticeable movement from bi-polar techniques to MOS processes, particularly in relation to the new forms of solid state memory.

VACUUM TUBE SURVIVORS

In the area of general electronics, the cathode ray tube and imaging tubes remain apart, as almost the sole survivors of the vacuum tube era—but for how long?

We are already seeing important developments by way of self-scanned solid state silicon arrays which may soon challenge vacuum image tubes for some applications: new ideas are continually emerging in the use of new materials for image storage: new techniques also appear for writing, both with light and electron beams, either on photochromatic materials or thin films, for data recording purposes.

At the moment, notwithstanding, the cathode ray tube as a "picture tube" appears to be secure, for as yet nothing fast enough can challenge it. The same remains broadly true of "power" tubes where as yet solid state devices have made a limited impact—though undoubtedly their time will come, too!

THE ENGINEER AND TECHNICIAN

Implicit in our discussion above is the suggestion that the roles of the engineer and the technician in electronics have also changed. The subjects of fundamental importance to either remain much the same,

but the achievable level of complexity is now so great that many engineers must be less-concerned with circuit detail than with the properties and specification of the overall system and its organisation. The technician at the same time has a task which, although it may in some respects be simplified through the microcircuit, is in other ways more complicated, requiring a greater overall understanding of electronics as a whole.

EDUCATION

For those in education, the scene has been changing continually and the challenge is unrelenting. Graduate courses remain at three-years and, somehow or other, competently educated engineers must be produced in that time. As always, the education has to be mainly concerned with fundamentals and with developing, within the student, the ability to continually self-update his knowledge, in his subsequent professional life in Industry. At the same time, however, he requires an awareness of the attitudes and practices of the contemporary world and the task of balancing these needs is a delicate one.

THE VITAL AREAS

The areas above all in which more effort is needed, if the student is to cope with the changes which the future will bring, are probably the two mentioned above, viz. "Materials" and "Systems".

For the man who is going to be concerned primarily with devices, materials have assumed an importance many times greater than was appreciated 25 years ago: while for the designer of "capital goods", the systems considerations which could be overlooked when the radio set represented the ultimate challenge in complexity, are now at the forefront!

Circuit theory, of course, remains as important as ever, but, to it, we have had to add logic design and some indication of how we can check our ideas and translate them into practical terms through CAD and simulation.

Thus the education sector has had to learn and adapt rapidly, too, and it is vital that it should continue to do so, for the industry is critically dependent on an assured inflow of high quality personnel.

PROSPECT

Despite the recession, the half-million strong electronics industry of this country has been remarkably successful and will be of key importance both nationally and to the EEC, in the years to come.

Just as the development, successively, of the telephone, radio, television, and the computer have all marked stages in a revolution which has been social as well as technical, the super-systems of the future will change our habits still more. It has been, above all, the invention of the transistor which has accounted for the continually accelerating pace of this social revolution, which began, so innocently, with the invention of the thermionic valve at the turn of the century!



THIS month the module containing the Sample and Hold circuitry and Noise Generator is described together with application details.

SAMPLE AND HOLD

The Sample and Hold shown in block form in Fig. 5.1 is another programming device which is capable of producing formalised staircase waveforms (Fig. 5.2) or random staircase waveforms. In both cases the "rise" of each step in the staircase is dependent upon the amplitude of the voltage being sampled while the "tread" of each step is governed by the sampling rate set by the clock.

The clock itself consists of two separate circuit forms as shown in the theoretical circuit diagram Fig. 5.3. The first is an astable multivibrator (IC1) in which the rate of oscillation is variable between 0.25Hz and 50Hz. The circuit switches alternately between its positive and negative saturation levels so that, for 15 volt supply rails, the output voltage swing is of the order of 28 volts.

The second circuit form is a monostable multivibrator (IC2) which is triggered by the negative going steps of the astable squarewave thus producing a pulse train of the same frequency. This circuit also switches between its positive and negative saturation levels. In the stable condition the output is positive. The introduction of a negative trigger pulse at the input, C3, causes the output to switch to its negative saturation level and to remain there for a period determined by the components R12 and C4.

PRECISION GATE

Clock pulses from the monostable are used to trigger an analogue gate (IC3) which has two summing inputs. One is coupled internally to a d.c. source and the other directly to an external sample socket. The gate will only recognise negative inputs.

If the trigger input to the gate is left open circuit or is grounded the gate behaves like a unity gain inverter but only for negative going signals. A positive input signal would tend to swing the output of the gate negative, a tendency which is prevented by the bounding action of diodes D6 and D7.

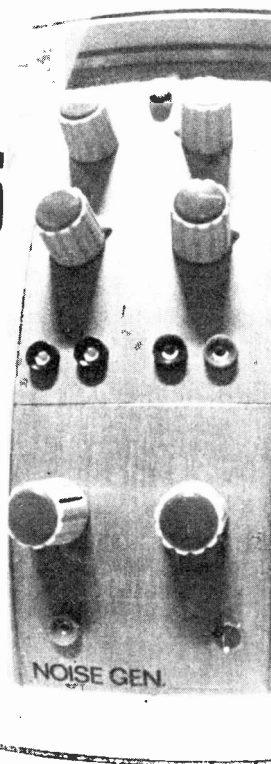
Under normal conditions overriding control of the state of the gate depends upon the polarity of the signal presented at the trigger input. As has been explained, the gate is closed, that is, passing inverted negative signals, when the trigger input is open circuit or grounded. The same situation exists when the polarity of the trigger signal is negative.

When the trigger signal is positive however the gate opens and its output is zero *provided* that the potential of the sample input is less than the potential of the trigger signal. This latter situation exists for all conditions of internal sampling where the maximum d.c. level attainable is determined by the divider R26-VR4, and for all conditions of external sampling from a single programming source.

When the d.c. and external sampling sources are combined, providing a single programming source only is used, the maximum sampling potential will never exceed 11.5V as compared to a trigger potential of 14V, and thus the closed period of the gate will never exceed 560 microseconds.

In circumstances where two or more programming sources are combined either with, or without, amplification, the situation can exist where the sample potential exceeds the trigger potential. Under these conditions the closed period of the gate is solely dependent upon the period of "high" sample potential.

PE Sound Synthesiser 5 SAMPLE-HOLD and NOISE GENERATOR By G.D. SHAW



INTEGRATOR

Output from the gate is led to the programming input of an integrator/comparator (IC4/IC5) arrangement which is basically similar to the ramp generator described in last month's article. In this case, however, the time constant of the integrator is much shorter resulting in an extremely rapid integration.

This feature is necessary in order to provide the steep rise between steps if a crisp tone change is to be achieved.

Further additions to the basic ramp generator circuit include an indicator lamp switched by TR1 which serves to indicate the "on" period of the staircase, a clamping diode D1 which serves to limit the integrator output to approximately 650 millivolts in the event that the integrator tends to go into positive saturation, and an input bias control provided by R1, VR1, R2. Input bias is required to compensate for integrator capacitor leakage during the periods of hold between samples, particularly when the sampling rate is low. It also serves to allow the Sample and Hold to be used as another Ramp Generator if required. This is achieved by disabling the trigger socket (JK1) by the insertion of an open-circuit jack plug and setting the ramp rate by adjustment of the d.c. and bias controls. Very high ramp rates may be achieved by this means.

CONSTRUCTION

The circuit board layout of the Sample and Hold is shown in Fig. 5.4. Layout is not critical although space problems may occur if relative component

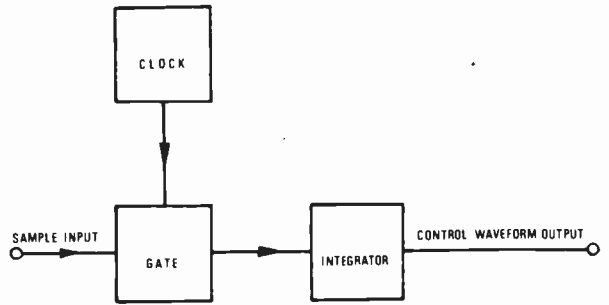


Fig. 5.1. Elements of Sample and Hold in block form

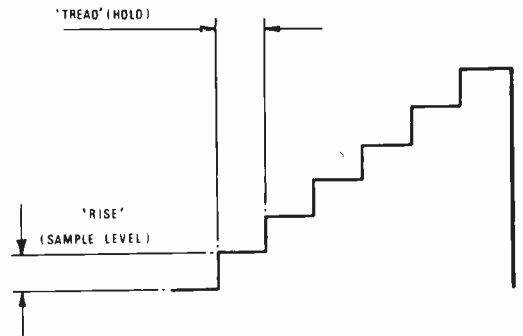


Fig. 5.2. Staircase waveform produced by Sample and Hold circuit. The rise of each step is dependent on the amplitude of the sampled voltage while the tread depends on the clock rate

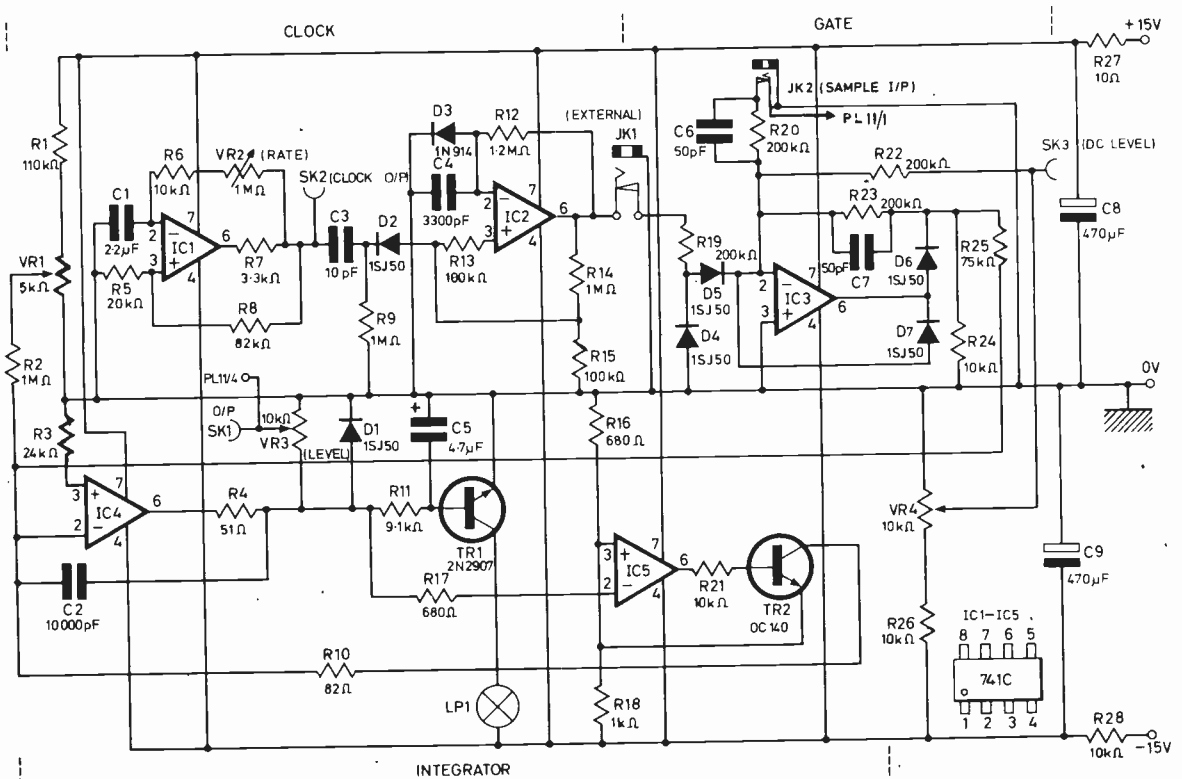


Fig. 5.3. Sample and Hold circuit

SAMPLE AND HOLD BOARD

COMPONENTS . . .

Resistors

| | |
|-------------------|-------------------|
| R1 110k Ω | R15 100k Ω |
| R2 1M Ω | R16 680 Ω |
| R3 24k Ω | R17 680 Ω |
| R4 51 Ω | R18 1k Ω |
| R5 20k Ω | R19 200k Ω |
| R6 10k Ω | R20 200k Ω |
| R7 3.3k Ω | R21 10k Ω |
| R8 82k Ω | R22 200k Ω |
| R9 1M Ω | R23 200k Ω |
| R10 82 Ω | R24 10k Ω |
| R11 9.1k Ω | R25 75k Ω |
| R12 1.2M Ω | R26 10k Ω |
| R13 100k Ω | R27 10 Ω |
| R14 1M Ω | R28 10 Ω |

All 5% $\frac{1}{2}$ watt carbon

Potentiometers

| |
|---|
| VR1 5k Ω lin. miniature moulded |
| VR2 1M Ω lin. miniature moulded |
| VR3-VR4 10k Ω lin. miniature moulded (2 off) |

Transistors

| |
|------------|
| TR1 2N2907 |
| TR2 OC140 |

Capacitors

| | |
|-------------------|--------------------|
| C1 2.2 μ F | 35V Tantalum |
| C2 10,000pF | polystyrene |
| C3 10pF | polystyrene |
| C4 3,300pF | polystyrene |
| C5 4.7 μ F | 40V tantalum |
| C6 50pF | polystyrene |
| C7 50pF | polystyrene |
| C8-C9 470 μ F | 25V elect. (2 off) |

Diodes

| |
|---------------------|
| D1 ISJ50 |
| D2 ISJ50 |
| D3 IN914 |
| D4-D7 ISJ50 (3 off) |

Integrated Circuit

| |
|----------------------|
| IC1-IC5 741C (5 off) |
|----------------------|

Miscellaneous

| |
|---------------------------------------|
| LP1-28V sub-miniature indicator lamp |
| SK1-SK3 2mm miniature sockets (3 off) |
| JK1, JK2 3.5mm jack socket (2 off) |
| 0.1in matrix Veroboards as required |

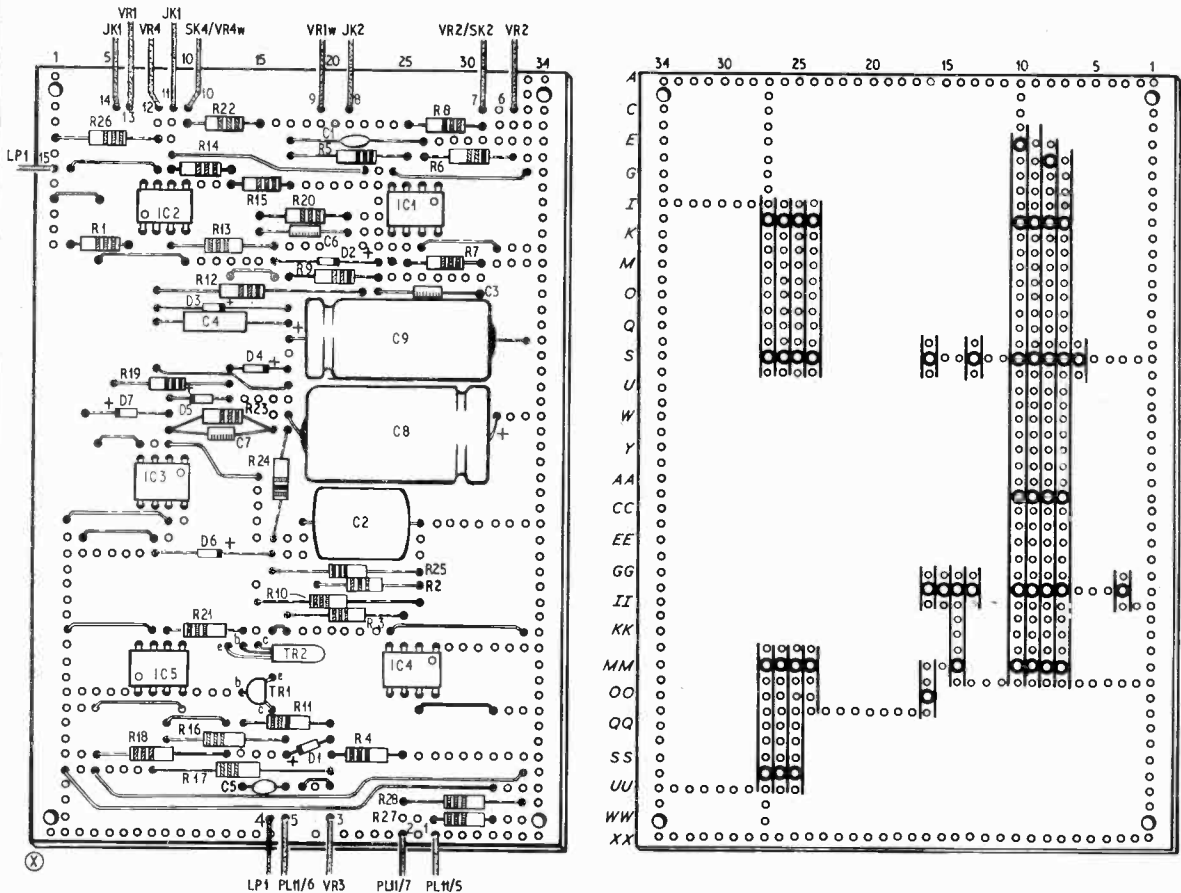


Fig. 5.4. Component layout and wiring of Sample and Hold Board

sizing differs appreciably from those shown. The power supply decoupling electrolytics present the biggest hazard as far as cramping of the board is concerned and these components should not be larger than 32mm in length by 16mm in diameter. R.S. Components Tube type are suitable and comply with the dimensions given.

EXPERIMENTAL CIRCUITS

The Sample and Hold provides the principal means by which the Synthesiser offers its most fascinating feature, that of "playing" by itself. Coupling the output to a v.c.o. and careful adjustment of the sample sources can provide a range of repetitive tone sequences the repeat period of which may be varied from a few seconds to several minutes.

Whether the sequence is truly repetitive or entirely random depends very largely on the choice of sample source. An article in the February issue of Hi-Fi News reviewed a recently issued record in which the "music" had been derived from computer stored data relating to changes in the Earth's magnetic field measured at a series of selected points.

In a similar manner existing data sources may be used to provide sample information. Crystal clocks, binary counters, ring counters, old non-erased computer tape and other digital data sources of various kinds, signal generators—even legitimate recorded music may be pressed into service, amplified, attenuated and blended together in various ways to serve the cause of random programming.

The discerning constructor will have noted that whatever the source of sample information the overall effect of the Sample and Hold is to turn this into a voltage which is progressively increasing, in steps, to a predetermined level at which point it returns to zero only to commence climbing once again. In practice the feature of a regular return to zero of the Sample and Hold output does not become obtrusive except at relatively slow sampling rates when the sample voltage shows very little variation between successive samples.

NOISE GENERATOR

White noise, defined in some circles as unwanted sound, is a very useful addition to the aural facilities provided by the synthesiser. It is a known fact that a great many sounds otherwise considered to be "pure" actually contain a relatively high noise content. The edge-tone in a wind organ is a typical example.

For imitative synthesis the addition of noise in greater or lesser degree is essential if the greatest approach to realism is to be achieved. This factor applies particularly to the synthesis of naturally occurring sounds such as rainfall, surf on the beach, storms, etc., and also to certain man-made sounds such as gunfire, explosions, train whistles, steam engines and so on.

Fig. 5.5 shows the theoretical circuit of the noise generator. The circuit is really quite simple. R5-R9; C3-C4 and D1 represent the noise generation section. The noise diode D1 is a specially selected noisy Zener marketed only by Semitron Ltd., and in the circuit configuration shown provides an output of about 75mV.

The noise bandwidth and level may be adjusted to a certain extent by varying the values of C4 and R6 respectively although it will be found, in practice, that the values shown are suitable for most purposes. C3 serves to decouple the noise diode from the inverting amplifier based around IC1.

Cost reduction can be achieved by omitting the offset adjustment preset VR3 and substituting a capacitor between the values of 0.01 and 0.1μF in the output of the operational amplifier as shown dotted.

LOW-PASS FILTER

R1, VR2 and C2 serve as a simple yet severe low-pass filter in order to provide a degree of control over the colouration of the noise. With VR2 at its minimum setting the output of the noise generator is reduced to a rough triangular waveform with a frequency in the region of 6kHz. Under these con-

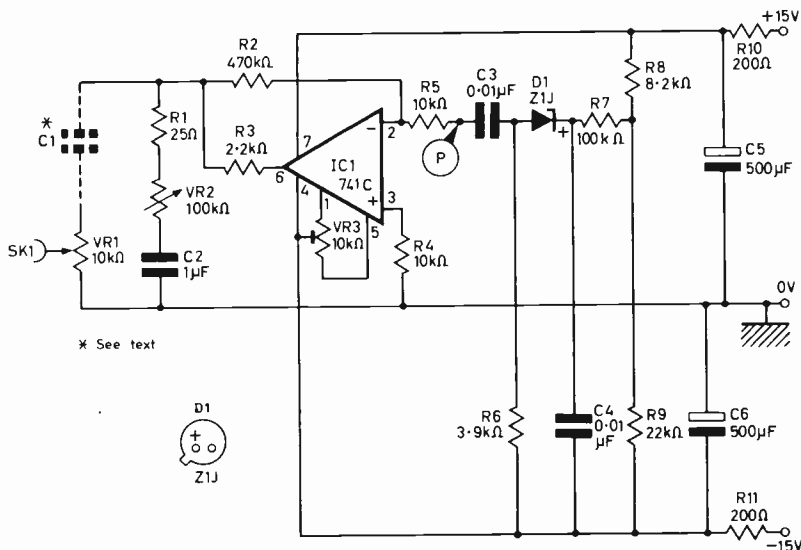


Fig. 5.5. Circuit diagram of Noise Generator

ditions the loading on the output of the operational amplifier is quite heavy and R3 is therefore included to limit the output current drain. Power supply decoupling is essential if noise is to be prevented from leaking back to the power distribution busbars.

In the circuit shown the current requirements are 2.5mA per rail and the addition of 200 ohm decoupling resistors will therefore result in a voltage drop of about 0.5V. If noise leak-through continues to be a problem these latter resistors may be increased in value quite considerably although if values over 500 ohms are used some adjustment of the values of R8 and R9 may be necessary to maintain their junction voltage at about +20V with respect to the negative rail.

Fig. 5.6 shows the circuit board layout of the noise generator. A piece of Veroboard or similar of 17 x 34 ways is suitable. Note that screened leads are used to connect this board's outputs with its associated components on the front panel. These leads should go direct to their respective components and not be bound into the wiring harness.

CONSTRUCTION

In general the construction of this module should follow the pattern adopted with those already described. The wiring harness for the Sample and Hold should pass out at the top of the front panel and down the length of the circuit board support plate to join the circuit board which is mounted adjacent to the McMurdo plug. The noise generator

circuit board should be mounted over the lower pair of supports adjacent to the base of the front panel. Details of the front panel layout and module wiring are given in Fig. 5.7.

SETTING-UP

It is recommended that setting-up and testing be established as a continuing process during construction of this module. With the noise generator, for example, it is suggested that the noise generating section consisting of R5-R9; C3-C4 and D1 be built first and tested by making temporary connections to the power supply rails and observing the output by connecting an oscilloscope between point "P" and the negative rail.

The expected output of the noise amplifier can be calculated at this stage by measuring the noise output of the diode with respect to signal ground and multiplying this by the gain of the amplifier.

In the prototype the total noise output was 3.5V maximum which is more than adequate. If the performance of this stage is satisfactory construction of the amplifying section can go forward being similarly tested on completion and before mounting the finished board into the module.

There is no actual "setting-up" to be done with the Sample and Hold and the purpose of testing is merely to establish that the circuit performs within the previously described limits.

NOISE GENERATOR BOARD

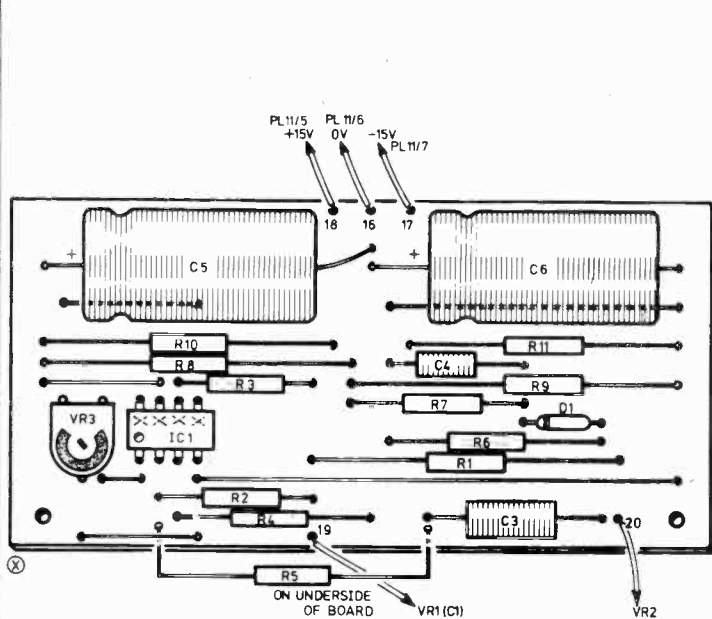


Fig. 5.6. Board layout and wiring for Noise Generator

COMPONENTS . . .

Resistors

| | | |
|----------|----------|----------|
| R1 25Ω | R5 10kΩ | R9 22kΩ |
| R2 470kΩ | R6 3.9kΩ | R10 200Ω |
| R3 2.2kΩ | R7 100kΩ | R11 200Ω |
| R4 10kΩ | R8 8.2kΩ | |

All ½ watt 5% carbon

Capacitors

| | |
|-----|------------------|
| C1* | See text |
| C2 | 1μF polyester |
| C3 | 0.01μF |
| C4 | 0.01μF |
| C5 | 500μF elect. 16V |
| C6 | 500μF elect. 16V |

Diode

D1 Z1J Zener (Semitron Ltd)

Potentiometers

| | |
|-----|------------------------------------|
| VR1 | 10kΩ lin. miniature moulded |
| VR2 | 100kΩ lin. miniature moulded |
| VR3 | 10kΩ lin. horizontal carbon preset |

Integrated Circuit

IC1 741C

Miscellaneous

| | |
|-----|-----------------------------|
| SK1 | 2mm miniature socket |
| | 0.1in Veroboard as required |

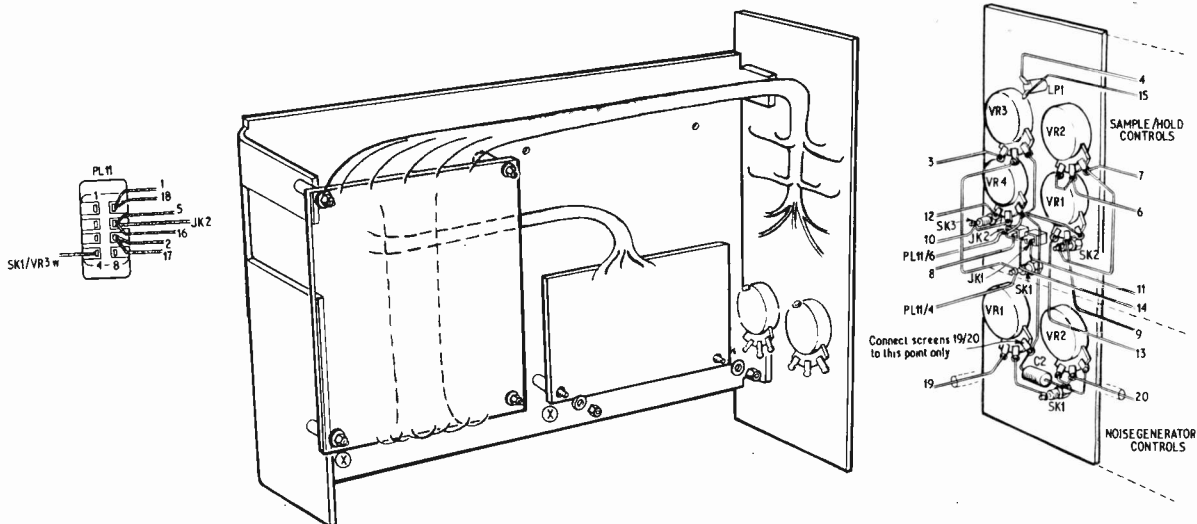


Fig. 5.7. Front panel component assembly with details of mounting and disposition of board on the module support plate. The small ringed X on the board edges indicates orientation. (See board assembly figures) For direct programming from the v.c.o. module connect SK11/4 to SK8/2

USING THE SAMPLE AND HOLD

It is best to confine initial experiments with the Sample and Hold to the formation of relatively simple staircase patterns, derived from the sampling of fixed d.c. voltages, in order to become familiarised with the effect of the adjustment of the various controls. Adjustment of the bias control, for example, can be quite critical when slow sample rates are being used and it is helpful to observe the output waveform on the oscilloscope so that drift between successive samples can be more easily balanced out.

When the Sample and Hold is programming a v.c.o. changes in "tread" voltage can be clearly discerned by ear but this becomes progressively more difficult as the sampling rate is increased. Note that it is difficult, if not impossible, to eliminate drift on the first step of a multi-step staircase due to the low charge on the integrating capacitor. This is not necessarily a disadvantage since it is possible to programme out the first step of the staircase by means of the envelope shaper which is to be described in a future article.

Progression to the sampling of varying voltages is the next logical step. Fig. 5.8 shows the effect of sampling a negative ramp having a period of about 0.1Hz. Note how the "rise" between "treads" increases in proportion to the increase in the ramp voltage. Variation in the ramp level by means of the input amplifier can cause remarkable changes in the output rhythm. A low ramp level and rapid sampling rate gives rise to an arpeggio-like sound in which the separation between the first few "treads" is barely discernible.

A high ramp level, on the other hand, causes the output of the integrator to reach its reset point fairly rapidly but since the sampling is continuing on an ever increasing ramp level the next staircase will have fewer steps and reach its reset point even more quickly. If the second reset is still well within the ramp period the third staircase will demonstrate even fewer steps while the fourth and subsequent staircases may consist of only one step, i.e. a square wave.

Variation of the sample voltage (ramp level) and sampling rate can ring the changes over a very wide range and produce some very interesting results.

SAMPLING A POSITIVE RAMP

Fig. 5.9 illustrates the effect of sampling a positive going ramp. In this case an initial condition of sampling fixed d.c. should be set and the ramp level adjusted so as not to exceed the d.c. sample voltage.

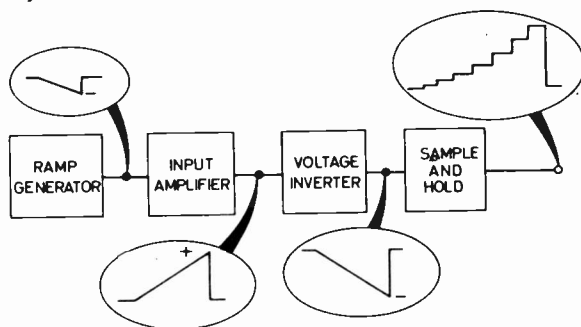


Fig. 5.8. Variable voltage programming. Note how the rise on consecutive steps at the output increase in proportion to the ramp level. Here d.c. level is zero

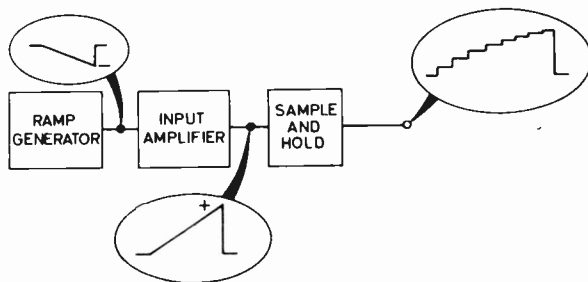


Fig. 5.9. Variable voltage programming. Here consecutive rises on the staircase output decrease with increase in ramp level. D.C. level is equal to or greater than the ramp level

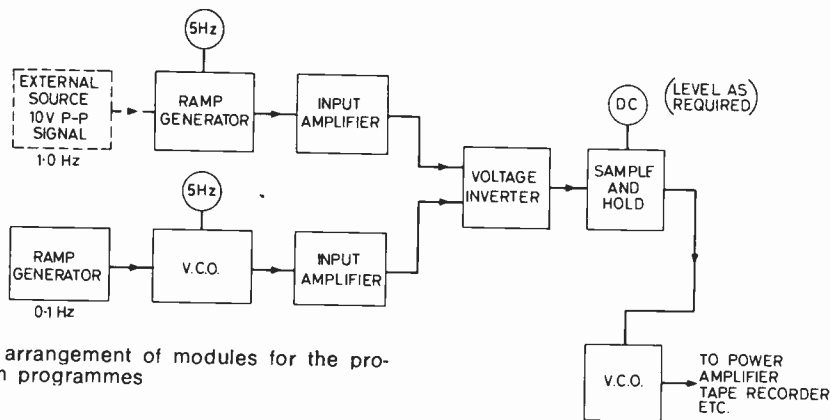


Fig. 5.10. Typical arrangement of modules for the production of random programmes

The effect of these settings is shown, i.e. a relatively large "rise" on the first few samples which gradually decreases as the ramp level rises. In other words a reversal of the situation illustrated in Fig. 5.8.

FURTHER EXPERIMENTS

Further experiments may be carried out in which the sample voltage is derived from two or more sources simultaneously and a typical arrangement is shown in Fig. 5.10.

The sample sources used need not, of course, be centred within the Synthesiser itself. Almost any

device producing a varying output voltage may be used providing that the voltage amplitude concerned is compatible with the devices used in the synthesiser.

The output from a pick-up cartridge, tape recorder or radio can be amplified to a suitable level and used as sample material. Music which has wide and fairly rapid changes in dynamic range gives the best results.

Next month: Some general views on the establishment of an experimental sound studio and the construction of the Tone Control module will be described.

SOUND '73

SOUND 73 INTERNATIONAL, organised by the Association of Public Address Engineers and held again this year at the Bloomsbury Centre, London, ran from 13 to 15 March under what can only be described as "Luxury" conditions with deep pile carpets, a warm inviting atmosphere and the sound of happy music welling up around one.

In addition to the main exhibition, the event included lectures on each day, a number of social activities, and public demonstrations of some of the available equipment.

It is as well that the environment was conducive to communications since the sheer quantity of microphones, loudspeakers, amplifiers, Discos and so on to be seen must have led many into a feeling of confusion.

To add to this, the growing availability of semi-conductor equipments and the adoption of current stylings have certainly led to a degree of similarity of gear from stand to stand.

On the lecture front the subjects covered included microphones and their circuitry; limiters and compressors, their application and use; the industrial design of PA equipment; and finally the marketing of this equipment. Of course the event is basically directed to the professional sound engineer and the manufacturer but for all that there is invariably something of interest for the casual visitor at such an event.

FROM THE PAST

An interesting contrast with the past was provided in the presence of a public address caravan once the property of Cecil Clarabut of Bedford. The van, equipped with horn speakers, a rack of amplifiers and associated microphones and 78RPM turntables, started

operating in 1927 and although the current amplifiers and other items to be seen in the van were installed in the mid 1940's the contents are no less interesting for that.

Apparently the outfit was used as recently as June of 1958 and since then it has been in store. Now it has been restored and Mr. Clarabut has donated it to the Association for Museum purposes.

Returning to a more modern theme, two points come to mind from the show. In the first place the fairly universal adoption of slider controls in tone and volume circuits. This has tended to give much of the equipment similarity of appearance which is emphasised with items like a Disco unit where the layout can be little else but symmetrical if it is to work successfully.

A second point is the tendency to place wattage ratings at 100 or 200 nowadays. Apart from the obvious dangers to the listener's hearing when faced with power at this level coming from one speaker, there seems to be the question of this type of high level being fashionable rather than necessary. One or two of the loudspeaker suppliers made this point with surprise but no doubt at the same time with a degree of pleasure at increased sales.

Whilst much of the equipment was of the type one might see in any Discotheque or audio supply house, one or two items caught the eye. For example there was a portable speaker unit intended for indoor or outdoor use mainly in PA applications.

Called the Electrovoice Sonocaster portable extension speaker, the unit uses an 8-inch transducer, can handle up to 30 watts peak and, whilst limited in frequency response to 70Hz to 13kHz, gives a very good showing in comparison to a £400 unit from the same source, Goulton Europe Ltd. Priced at between £11 and £16 (figure not yet finalised) this plastic-housed unit will no doubt collect its fair share of interest.

The latest news from the APAE is that John Robins, MD of SNS Communications Ltd., has been elected President. This year's President elect is Keith Monks of Fleet and John Weed of Uxbridge is again Treasurer.

PATENTS REVIEW...

MAGIC WIPERS

BP 1 287 752

Motorists who like the idea of triggering their windscreen wipers as if by magic should read BP 1 287 752 from Joseph Lucas Industries.

The Lucas circuit Fig. 1 shows a vehicle battery supplying power to an oscillator coupled to a transmitting aerial. Usually the aerial will be in the form of a wire loop built into the driver's seat belt. The receiver aerial, in the form of an electrode built into the vehicle dashboard, is connected to the gate of the field effect transistor TR1.

The circuit is physically and electrically constructed such that the coupling between aerials is insufficient to cause TR1 to conduct. To operate the load (e.g. the windscreen wipers) the driver touches the receiver aerial to increase capacitive coupling between the two aerials. Transistor TR1 conducts, base current reaches transistor TR2 and thereby also transistor TR3. Relay RLA then latches, due to the rectified current flow through the transistor, and "Hey Presto!" the wipers start up.

Because a self-latching relay is used it will hold the wipers working until next time the aerial is touched. A non-latching relay could of course be used for on/off touch control.

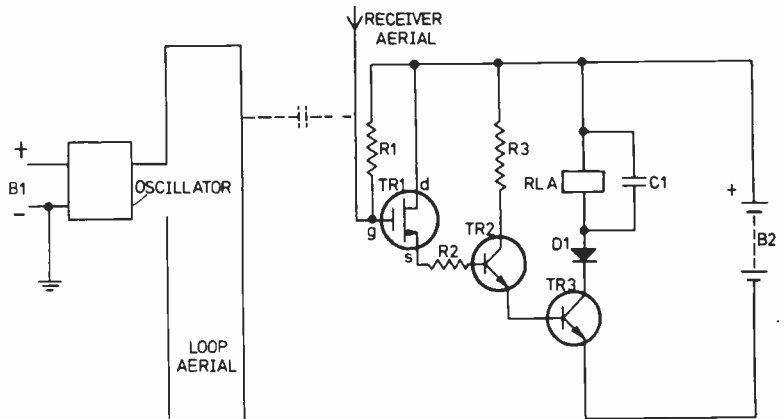


Fig. 1

then fed to an astable multivibrator (TR5, 6) which, when no reflected signal is received, is free running.

When an object is close enough to the transducers to cause the latter to receive a reflection, the multivibrator will be triggered from its original to its alternative state for a predetermined length of time, and in which state it is insensitive to any subsequent pulses. When the multivibrator reverts to its original state it will cause the transmitter to emit a train of pulses again. Simultaneously an indicator amplifier TR10 will activate a vibrator which the subject can feel.

Thus when the transducer X1 receives a reflected pulse, the multivibrator will "flip" over and control a fixed cycle of events. As

the transmitted pulse will be received back in a shorter time as the reflecting object gets closer, the repetition rate felt at the vibrator will vary with the distance of the reflecting object, i.e. the vibrator will vibrate at a frequency which increases as the object gets closer. And, of course, because the multivibrator is triggered by the first received pulse, the unit as a whole will respond only to the nearest object in its path. Transistor TR4 attenuates direct path (non reflected) pulses.

The inventor claims that with the arrangement fitted in a walking stick, the system will allow ready distinction between objects such as a telegraph pole and a building behind it.

ULTRASONIC GUIDE STICKS FOR THE BLIND

Geoffrey Mowat in BP 1 284 027 provides interesting details for the construction of a walking stick for the blind with ultrasonic guide capabilities. In his patent Mowat shows a transmitter formed from an oscillator, TR7, and amplifier, TR8, see Fig. 2. These produce ultrasonic electrical oscillations which are converted into ultrasonic sound waves by transducer X2.

No details are given of this fairly routine arrangement, but it is suggested that initially oscillation trains should be transmitted 8 times per second. The transducer X2 is directional in that it transmits only over a beamed path.

For reception a transducer X1 converts received ultrasonic soundwave pulses into electrical pulses and applies them to the receiver amplifier, TR1, 2 and 3. The amplified echo pulses are

BP 1 284 027

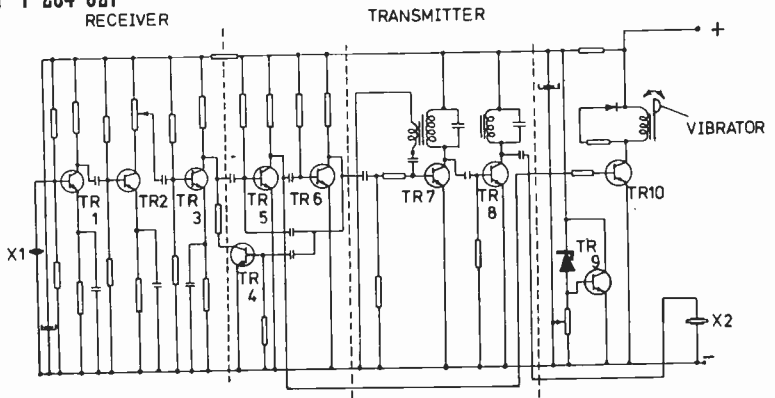


Fig. 2

The



Timer IC

By J.B. DANCE M.Sc.

SIGNETICS International Corporation has recently introduced a new economical integrated circuit, the 555, which can be employed in simple timing circuits for an extremely wide range of applications and is equally suitable for use by both the professional equipment designer and the amateur enthusiast.

The 555 devices can be employed to provide accurate time delays from microseconds to hours. The time delay is almost independent of the power supply voltage. The device can also be employed as an astable oscillator for pulse-width modulation as one of a series of timers or a frequency divider.

THE INTEGRATED CIRCUIT

The integrated circuit and its mode of operation will be described in some detail so that readers may gain an understanding of the circuit and thus be able to devise their own applications. Full constructional details of a general purpose timer appear on page 486 of this issue and show how this monolithic integrated circuit can be employed for automatically timing the exposure in photographic enlarging or as an industrial timer.

TYPES

The 555 timer is available in two types of package. An eight lead dual-in-line encapsulation with a silicon moulded body material is used for the NE555V, and the NE555T has a circular TO-99 case with eight leads. The connections to both types are shown in Fig. 2. The electrical characteristics of the two types are identical.

The SE555T is a close tolerance version of the 555 device and is available only in the circular TO-99 package at present. The connections are as in Fig. 1. The SE device can operate over the temperature range -55°C to $+125^{\circ}\text{C}$, whilst the NE types can operate only over the narrower temperature range from 0°C to 70°C . The SE555T is considerably more expensive than the NE types and it generally provides a somewhat smaller drift of the time delay with the supply voltage and with temperature.

The writer feels that the dual-in-line construction of the NE555V is rather more convenient to use than the TO-5 encapsulation and it is the cheapest type of 555.

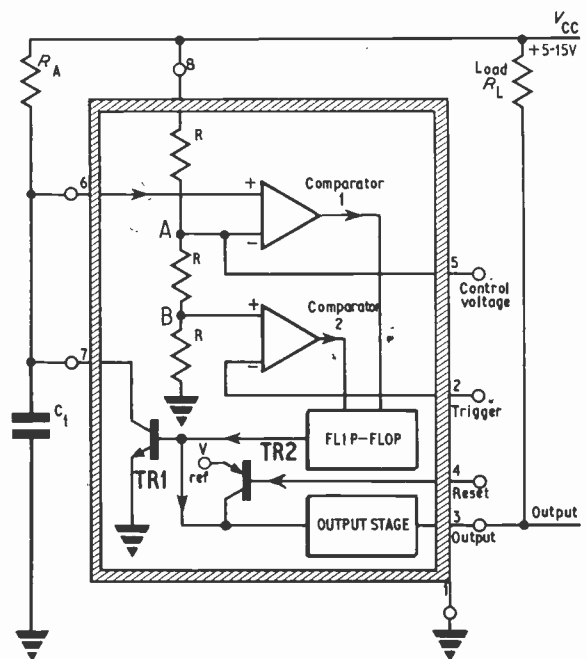


Fig. 1. General schematic of the 555 timer chip showing external circuit connections for monostable operation

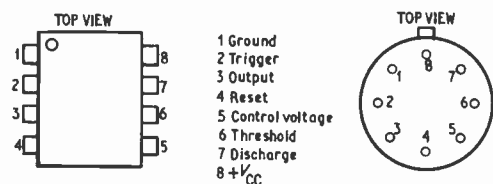


Fig. 2. Pin number connections for 8-pin DIL and TO99 can

The NE555V has therefore been used in the applications which will be described, but the NE555T or the SE555T are equally suitable.

MONOSTABLE OPERATION

In the monostable mode the timer is triggered by an input pulse or by the operation of a switch. This causes the output voltage to change for a pre-determined time (the delay) after which this voltage returns to its former value. The delay is determined by the product of the values of a capacitor and resistor connected externally to the integrated circuit.

The integrated circuit is shown connected as a monostable in Fig. 1 with the operational functions of the timer shown as blocks.

Initially the external capacitor, C_1 , is kept in a discharged state by the transistor TR1 inside the timer. This transistor is held in a fully conducting state by the bias applied to its base by the flip-flop stage.

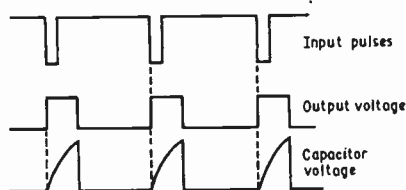


Fig. 3. Waveforms associated with the operation of the circuit of Fig. 1

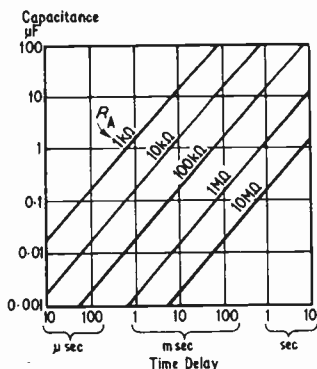


Fig. 4. Time delays obtainable with various values of C_1 and R_A

The point B is held at a potential of $V_{cc}/3$ by the potential divider containing three resistors of equal value R . When a negative-going trigger pulse causes the potential of pin 2 to fall below the value $V_{cc}/3$, comparator 2 causes the flip-flop to be switched. This results in the output voltage rising and in TR1 being cut off.

This sequence of operations may generally be started by momentarily connecting pin 2 of the timer to ground instead of applying a negative-going pulse to it. However, triggering will then normally occur at the instant the connection with ground is broken and this may introduce an appreciable error if the delay period is short.

WAVEFORMS

The voltage across C_1 now increases exponentially with a time constant $R_A C_1$ as current flows to it via R_A ; the waveforms are shown in Fig. 3. When the voltage across C_1 becomes equal to that at point A (that is, to $2V_{cc}/3$), comparator 1 of Fig. 1 resets the flip-flop. The output from the latter causes the voltage at the output (pin 3) to return rapidly to its quiescent low value. In addition, TR1 is biased so that it conducts and the capacitor C_1 is rapidly discharged.

SUPPLY VOLTAGE

If the value of the supply voltage, V_{cc} , is increased, the potential of point A and the rate of charge of the capacitor C_1 at any given point in the charging cycle are both increased in proportion. The time at which the two inputs to comparator 1 become equal (that is, the time at which the end of the delay occurs) is therefore almost unaffected by the value of V_{cc} .

RESET

Once the circuit has been triggered by a negative going pulse to pin 2, it will remain in this state until the pre-set time has elapsed, no matter whether it is triggered again during this time or not. If, however, a negative going pulse is applied to the reset terminal, pin 4, before the circuit has returned to its quiescent state, the capacitor C_1 will be discharged and the circuit will be reset.

The output is in its low voltage state during the time the reset pulse is applied to pin 4. Resetting can also be effected by momentarily connecting pin 4 to ground. The reset current is about $100\mu A$.

In applications where the reset terminal will not be used, it is advisable to connect it to the positive supply line to avoid any possibility of undesired resetting.

TIME DELAY

The time, t sec, for which the output is in its high voltage state is given by the equation:

$$t = 1.1 R_A C_1 \quad \text{Equation 1}$$

where R_A is expressed in ohms and C_1 in farads.

Equation 1 may be deduced in the following way. When a capacitor C_1 charges from a voltage V_{cc} through a resistor R_A , the voltage V across the capacitor after a time t is given by the equation:

$$V = V_{cc}(1 - e^{-t/R_A C_1})$$

In order to find the delay, t , we put $V = 2V_{cc}/3$, since this is the voltage at which the flip-flop is reset.

$$\begin{aligned} 2V_{cc}/3 &= V_{cc}(1 - e^{-t/R_A C_1}) \\ e^{-t/R_A C_1} &= 1/3 \end{aligned}$$

$$t/R_A C_1 = -\log_e(1/3) = \log_e 3 \approx 1.1$$

If one requires the output to remain in its high voltage state for one millisecond (10^{-3} s), one may choose a reasonable value of C_1 , say $0.1\mu F$ ($=10^{-7}F$), and calculate R_A using equation 1 to see if a reasonable value is obtained:

$$R_A = t/1.1C_1 = 10^{-3}/(1.1 \times 10^{-7}) \approx 9.1k\Omega$$

Similarly, if $R_A = 100k\Omega$ and $C_1 = 100\mu F$, $t = 1.1 \times 10^5 \times 10^{-4} = 11$ seconds. The chart of Fig. 4 shows the time delays obtainable for values of C_1 from $0.001\mu F$ to $100\mu F$ and for values of R_A from $1k\Omega$ to $10M\Omega$.

It should be noted that reasonable values of R_A and C_1 must be selected. A typical current of $0.1\mu\text{A}$ (maximum $0.25\mu\text{A}$) flows through R_A to pin 6 of the 555 timer. If R_A is $20\text{M}\Omega$, this current alone will produce a voltage drop of up to 5V (typically 2V). Thus this value of R_A is about the maximum which should be employed.

If R_A is chosen as $10\text{M}\Omega$ and C_1 as $10,000\mu\text{F}$, t can be calculated as about 30 hours. However, the leakage current passed by the capacitor might well be so large that a much longer delay occurs before the voltage across the capacitor reaches a value of $2V_{cc}/3$.

Apart from the fact that capacitor leakage current can affect the calculated time values, one should remember that the values marked on many capacitors are only very approximate. This is especially true in the case of electrolytic and Hi-K ceramic capacitors. The actual value may exceed the marked value by as much as 50 per cent.

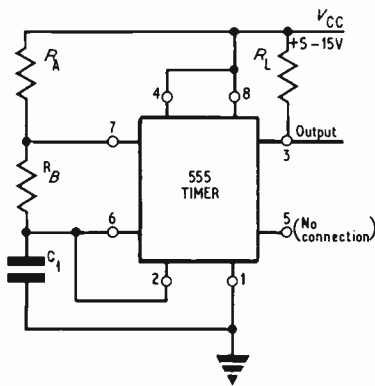


Fig. 5. Circuit of the 555 connected for astable operation

CONTROL VOLTAGE

In the previous discussion it has been assumed that pin 5 of the timer circuit has been left unconnected. However, the time delay may be changed over a range of about 10:1 by applying various control voltages to this pin. The impedance at pin 5 is a few thousand ohms. The time delay will still be independent of the value of V_{cc} if the control voltage is derived from V_{cc} by means of a potential divider so that it is proportional to V_{cc} .

OUTPUT

If one merely requires an output pulse at the end of the delay time, one may connect the output pin 3 to a resistor (perhaps $4.7\text{k}\Omega$) which is returned to the positive supply line, as in Fig. 1. The output pulses are taken directly from pin 3.

When the output voltage is high, it is near to that of V_{cc} . When it is low it is only very slightly greater than the ground potential of the negative supply line. If the output voltage is low and the current passing to pin 3 is 10mA or less, the output voltage will normally be within 0.2V of the ground potential. At output

currents of 100mA , the output voltage is usually within 2V of the potential of one of the supply lines.

An output current of up to 200mA can be obtained in either the high or low voltage states.

The output pulses rise and fall rapidly, typical rise and fall times being $0.1\mu\text{s}$. The output pulses can be used to drive a high power transistor (such as the common *npn* type 2N3055 or the somewhat smaller *npn* types 2N3054 or RCA 40250). The high power transistor can then control a high current.

RELAY OPERATION

If the delay time exceeds about 0.1 sec, a small relay connected between pin 3 of the 555 and one of the supply lines can be operated directly from the timer circuit. The relay coil should be designed so that it operates from a voltage approximately equal to V_{cc} at a current which does not exceed 200mA .

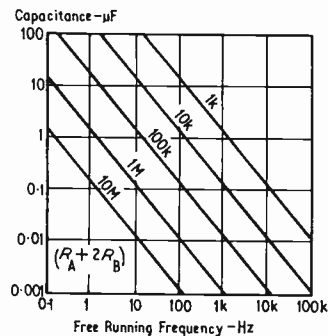


Fig. 6. Variation of frequency with component values in the astable mode

It is necessary to connect a diode across the relay so that the back e.m.f. generated when the current ceases to flow through the inductive relay coil is shorted out by the diode. This prevents possible damage to the timer circuit by the fairly high reverse transient voltage which appears across the relay coil. The diode must be connected so that it is reverse biased when the relay conducts. A fast switching diode is ideal.

TRIGGERING

The writer has found that the use of an inductive load (such as a relay) can cause the timing circuit to automatically re-trigger itself at the end of the delay time. This occurs so rapidly that the output voltage appears to stay quite constant and the relay remains closed. In the general purpose timer to be discussed, this problem is avoided by connecting pin 2 of the 555 through a resistor to the $+V_{cc}$ line.

The triggering action in the 555 is extremely sensitive. If one touches pin 2 with one's finger, triggering will occur. Even moving one's hand near to a wire connected to pin 2 is adequate to trigger the circuit by a capacitive effect. The trigger current required is only about $0.5\mu\text{A}$ for a period of $0.1\mu\text{s}$.

The NE555V & T = 4.5V → 16V but SE has up to 15V. (perhaps 18)

POWER REQUIREMENTS

The integrated circuit itself requires a current of about 3mA (maximum 6mA) from a 5V supply, increasing to about 10mA (maximum 15mA) from a 15V supply. Any current passed by the load is additional to the current shown. The absolute maximum permissible power dissipation is 0.6W, but this should not be reached if the correct voltage is applied even if the maximum permissible output current of 200mA is passed.

The NE555V and NE555T should be operated from a supply voltage of 4.5V to 15V. However, it is recommended that 15V be used as the upper limit so as to allow for supply voltage tolerances.

Variations of the delay time with the supply voltage are typically 0.01 per cent per volt and with temperature 0.005 per cent, per deg C.

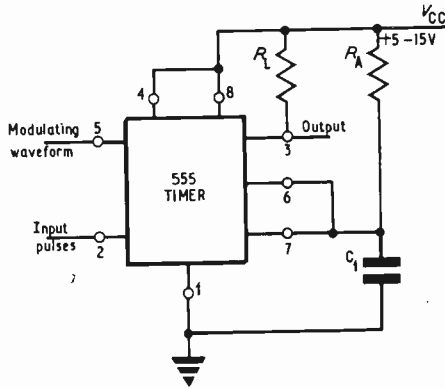


Fig. 7. Using the 555 for pulse width modulation

ASTABLE OPERATION

If a 555 timer circuit is connected as in Fig. 5, it will "free run" and operate as an astable multivibrator. The trigger pin 2 is connected to pin 6 so that when C_1 discharges the resultant negative going pulse is used to trigger a new cycle automatically.

The current required to charge the capacitor C_1 flows through R_A and R_B in series. However, when TR1 (see Fig. 1) conducts, a current from C_1 flows through R_B into pin 7. Thus the charging time is proportional to $(R_A + R_B)C_1$, but the discharging time is proportional to $R_B C_1$. The charging time cannot be made smaller than the discharging time.

TIMING

In the astable mode of operation, the capacitor C_1 charges and discharges repeatedly between the potentials $V_{cc}/3$ and $2V_{cc}/3$ provided that pin 5 is left unconnected. The charge and discharge times (and therefore the frequency of operation) are almost independent of the supply voltage, V_{cc} . The output

voltage is high during the charging time.

$$\text{Charging time} = t_c = 0.693(R_A + R_B)C_1 \quad \text{Equation 2}$$

$$\text{Discharging time} = t_d = 0.693R_B C_1 \quad \text{Equation 3}$$

$$\text{Total period} = t_c + t_d = 0.693(R_A + 2R_B)C_1 \quad \text{Equation 4}$$

$$\text{Frequency} = 1/t = 1.44/(R_A + 2R_B)C_1 \quad \text{Equation 5}$$

The variation of frequency with component values is shown in Fig. 6.

Equation 2 can be deduced using the equation $V = V_{cc}(1 - e^{-t/RC})$ for a capacitor C charging through a resistor R from a voltage source V_{cc} . One requires the time for V to increase from $V_{cc}/3$ to $2V_{cc}/3$ when charging through a resistor of value $R = R_A + R_B$. The discharging time is the time for V to decrease from $2V_{cc}/3$ to $V_{cc}/3$ when a resistor R_B is connected across the capacitor.

The charging and discharging times can be altered by the application of a control voltage to pin 5. Both of these times are affected, since an alteration of the potential of point A in Fig. 1 will affect the potential of point B .

OTHER APPLICATIONS

The astable mode of operation can be employed when a series of operations must be repeated at preset intervals many times. For example, one application occurs when one wishes to have the windscreen wipers of a car make single sweeps with a certain delay between successive sweeps. The circuit continues to operate with this delay until the timing is adjusted or until the current is switched off. Another application using the 555 in the astable mode involves the periodic switching of lights.

If a series of regularly spaced pulses is fed into pin 2 of Fig. 7, the mark/space ratio of the output from pin 3 is dependent on the instantaneous modulating voltage applied to pin 5. As the voltage at pin 5 increases, the time for which the output remains in its high voltage state increases until it becomes so long that alternate input pulses produce no output.

A number of the 555 timers can be connected in the monostable mode so that the output of the first triggers the second and the output of the second triggers the third, etc.

The operation of the first timer is started by connecting pin 2 momentarily to earth or by applying a negative pulse to it. The first 555 returns to its quiescent state after 1 sec (see equation 1) and triggers the second timer. This circuit produces an output pulse perhaps 100 sec later (owing to the higher values of R_3 and C_3) and triggers the third 555 circuit.

The output pulses from each of the timer circuits can be used to carry out any desired operation at the preset times after the first timer is started. If desired, the output from the last circuit may be used to trigger the first circuit so that output pulses continue to be generated at set intervals indefinitely.

On page 486 a general purpose timer construction article discusses the use of the 555 in practical circuitry suitable for use in, say, a darkroom timer. ★

POINTS ARISING

NOVEL BATTERY ELIMINATOR (April 1973)

To prevent the possibility of any electrical accidents the cover and base of this unit should be made up of 18 s.w.g. aluminium. Alternatively an Ever-Ready 3-way 13A adaptor can be used.

For 6V use a 6.2V 400mW Zener diode can be substituted such as the BZY88.

CAMERA SHUTTER TESTER (August 1972)

In Fig. 4; page 643, there should be a break in the copper strip between the end of R1 and the link wire which is close to VR1. The presence of this

incorrect link will probably damage the integrated circuit. Fig. 3, page 642, the reference to the integrated circuit as 7410PA should in fact read 741 operational amplifier.

GEMINI TUNER (April 1972)

The Gemini Tuner described over a year ago, in April 1972 has raised considerable interest and several hundred tuner heads have been supplied. Unfortunately these are made in Japan for an American company (thus keeping the cost down) who has now withdrawn the line because of shortage of some components and a changing product line. Both the importers and Practical Electronics have made extensive investigations to discover an alternative source or replacement product. Neither

LOGIC TUTOR EXPERIMENTS..



SOMETIMES one finds it necessary to invert logical functions—particularly when interfacing one stage of a piece of equipment to another. Logic inversion simply means that whenever we get a logical 1 we have to convert it to a level 0. The simplest way of doing this is by means of a grounded emitter amplifier stage (Fig. 2.1). Using our convention of positive logic a logical 1 on the input is represented by +5V at point A—this causes base current to flow in the transistor and hence collector current is drawn and the output at the collector Q falls to approximately zero volts, or logic level 0.

DEMONSTRATING IT

A simple application of inversion can be demonstrated on the Logic Tutor. Normally a level 1 will cause the lamps to be illuminated. Let's say we want a level 1 to extinguish a bulb; the first thing that has to be done is convert the 1 level to a 0. We have no simple transistor stages available to us on the tutor but we can simulate inversion by using one of the 2-input NAND gates. All you have to do is short both inputs together (next month's description of the NAND gate will make the reason for this clearer).

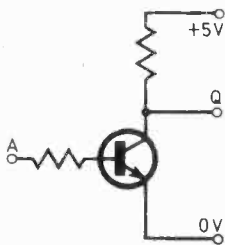


Fig. 2.1. A grounded emitter stage acts as a logic inverter

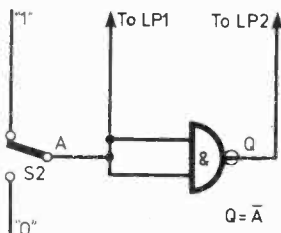


Fig. 2.2. The NAND gate with logic inputs shorted demonstrates the invert function

Connect the shorted inputs to one of the toggle switch outputs and also connect this node to one of the indicator lamps: also connect the output of the NAND to another lamp (Fig. 2.2). Set the switch to 1 and LP1 will indicate level 1 at the input but LP2 will be extinguished indicating 0. Apply a 0 on the input and you will see a 1 appear at the output.

The symbol for invert is shown in Fig. 2.3 and we say that the output Q is \bar{A} (said NOT A). The truth table is very straightforward—whatever A is, Q is the opposite.

Invert is often used in logic systems but its occurrence is sometimes disguised by the fact that it is mainly used in conjunction with AND gates to give us the NOT AND or NAND function that will be explained fully in the next issue.

by M. Hughes

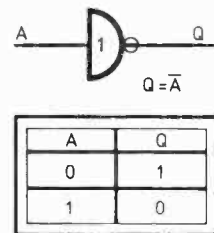


Fig. 2.3. The symbol and truth table for the invert function

In Part 1 last month the figures given should be transposed.

Electronic Music Production

Alan Douglas

The author describes the tremendous potential of electronic music which is free from the limitations of conventional instruments and notation. The three principal methods of synthesizing music electronically are discussed, with examples of the latest available equipment. Excerpts from the writings of the world's leading researchers and other previously unpublished material are also included. This practical guide will be welcomed by all working in this field.

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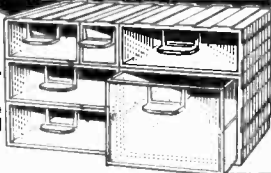
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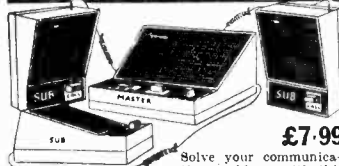
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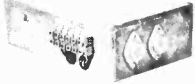


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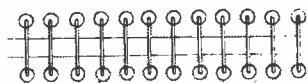
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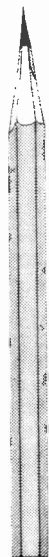
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INDUSTRY NOTEBOOK

By Nexus



FAMINE AHEAD?

It seems to be a flaw in our human character, perhaps even an immutable law, that we are unable to govern our affairs smoothly and sensibly. After the glut comes the famine—at least in professional components. Delivery times are lengthening all the while and prices are hardening and this trend is noticeable throughout Europe and the United States. The trend is that much more irritating because it is in such contrast to even a few months ago.

The Paris Components Show, still the world's biggest and best, showed a buoyancy in April unmatched since the boom year of 1969. And the London show which opens on May 21 will, according to pre-show gossip, be a much happier business event than the last, two years ago.

Some reports give lead times for deliveries of up to six months for capacitors, five months for potentiometers, up to four months for transistors.

Much of the trouble in Europe stems from the big upsurge in colour TV demand which has created an almost unprecedented call on components. And component manufacturers who burnt their commercial fingers by over-expanding production facilities and then had to cut back with heavy losses are quite naturally cautious about expanding again to meet what might only be a temporary boom period.

Component distributors in Britain who belong to the Association of Franchised Distributors of Electronic Components and therefore subscribe to an ethical standard in

their businesses, are almost as embarrassed by the present upsurge in business as when it was bad. The more sensitive of them are tormenting themselves on the ethics of switch selling (i.e. the supply of an equivalent component from a different manufacturer from that actually ordered) and such-like niceties. Another of their problems is the so-called wheeler-dealer who scours the world for job lots and then unloads them on a component-hungry market. The maxim is let the buyer beware and to trade only with reputable suppliers.

UNION CARBIDE EXPANSION

The solid tantalum capacitor was a hard-to-make sophisticated component which sold almost exclusively to the exotic space and defence market where price is secondary to performance and reliability. I was somewhat surprised, therefore, to discover on a visit to the Union Carbide plant at Aycliffe, Co. Durham, that the big expansion just completed is largely the consequence of tantalums having penetrated the consumer electronics market. Here is another company that has benefited from colour TV.

They have spent £250,000 beefing up production with new machinery and processes, much of it developed at the US production base at Greenville, South Carolina. The Aycliffe plant now turns out 2.5 million capacitors a month, a threefold expansion over one year ago. Marketing manager, Andy Thomson, was in jubilant mood explaining that the big take-off was in low-cost dipped resin types which had opened up an entirely new and still expanding market.

The Aycliffe plant opened in 1952 with 17 employees and now has 230. Watch out for further developments. In the pipeline is a new range of monolithic ceramic capacitors which is forecast to make an important contribution to Union Carbide's European operations. Ceramic and tantalum chips will be included to meet the demands of the fast-growing hybrid market.

Jogging along in the background is a little-publicised activity—the manufacture of barium getters for TV tubes and radio valves which Aycliffe workers can turn out at the rate of 120 million a year, phew!

STILL DROPPING

The huge mark-ups of some manufacturers of pocket calculators are slowly being eroded as more types come on the market,

competition increases, production problems are ironed out and the cost of expensive tooling is amortised. This is one area where prices are not hardening.

Nearly 40 models are currently on sale in London shops, most of them carrying big discounts from the "recommended" price. One British manufacturer has chopped his "recommended" price by £20, and it is generally agreed that the simpler types will ultimately become available for a little over £20.

Shrewd buyers are holding off waiting until the market bottoms and some even shrewder people have been working on how to solve complex calculations on the simpler machines which are basically only four functions, add, subtract, multiply and divide.

Square roots, cube roots and other calculations are possible by using a number of discrete stages according to extensive correspondence in the US journal "Electronics" which has printed a number of ingenious methods of expanding calculator capability without paying for it.

POCKET BREATH ANALYSER

The annual Physics Exhibition in London is not normally the best place to look for good commercial ideas. But one item I spotted this year has good commercial prospects if the price is right.

It is a pocket breath alcohol meter which uses a fuel cell developed at the University of Wales Institute of Science and Technology, Cardiff. Breathing into the cell develops a potential which is amplified and displayed on a voltmeter. Accuracy is claimed to be within 5 per cent and sensitivity is such that 0.005mg of alcohol per litre of air can be detected. Size is a modest $6 \times 10 \times 2$ cm and weight is only 60g—a truly pocket sized instrument.

I also noted that Standard Communications Laboratories are gamely pressing on with optical waveguide communications. A liquid core fibre using tetrachloroethylene as the transmission medium is said to have sufficiently low attenuation for practical use and another solution is to use a single glass fibre waveguide instead of the conventional fibre optic bundle.

The single fibre, say STL engineers, is better from all points of view from production which can be carefully monitored during extrusion through to more robust connection to the laser source and detection unit.

Wide Range

PULSE GENERATOR

By M.J. Trand

A COMPACT and lightweight source of fast pulses is frequently required for testing. Integrated circuits can meet this need and the pulse generator described here uses only TTL i.c.s as active devices with the addition of a few extra resistors and capacitors. The unit may be powered by a standard mains supply, but a battery operated version can easily be adopted without any modifications to the circuitry.

INTEGRATED CIRCUITS

As mentioned, two 74 series i.c. chips produce the rectangular shaped pulses. Type SN7404, which is a sextuple single-input inverter, uses three of its inverters as part of the oscillator section. The second circuit block, type SN74121, is a monostable multivibrator connected to provide pulses of variable widths. These two integrated circuits can be obtained for well under £1 from many electronic components distributors.

It should be mentioned at this stage that although several firms market i.c.s of the 74 series, similar

devices such as the Mullard FJH241 and FJK101 will do equally well.

CIRCUIT

The block circuit diagram of the pulse generator is shown in Fig. 1. On switching on, the output of inverter A tends to go up to a logical 1 while the output of inverter B is pulled down to a logical 0, charging the capacitor C1. The speed of this action will be governed by the time constant C_1R_1 in the circuit. The output of inverter C will then gradually go to a 1 and also transmit the transient to the input of inverter A, whose output in turn follows to a 0, and so on, thus producing an oscillatory action. The fourth inverter D in the line acts simply as a buffer stage.

The pulses are next fed to a monostable block which will vary their duration according to the value of the external time constant applied by C2 and R2.

At the last stage pulses from the monostable complementary outputs are passed on to the remaining two inverters E and F, providing simultaneous positive and negative going pulses.

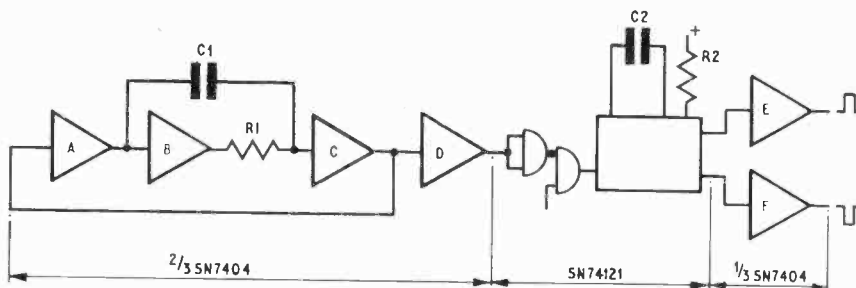


Fig. 1. Block schematic of the pulse generator with the i.c. SN7404 split for ease of illustration

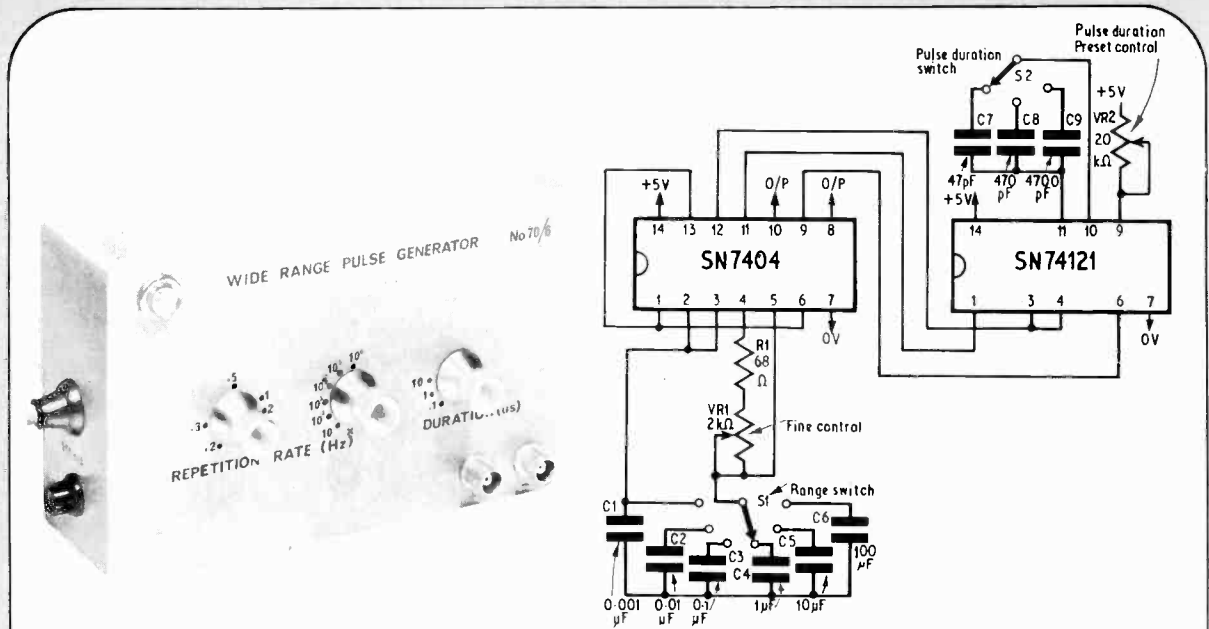


Fig. 2. Circuit diagram of the components external to the integrated circuits. VR1 is, in the final model, a 2.2k Ω linear potentiometer with an 8.2k Ω resistor connected from wiper to the end proximate R1

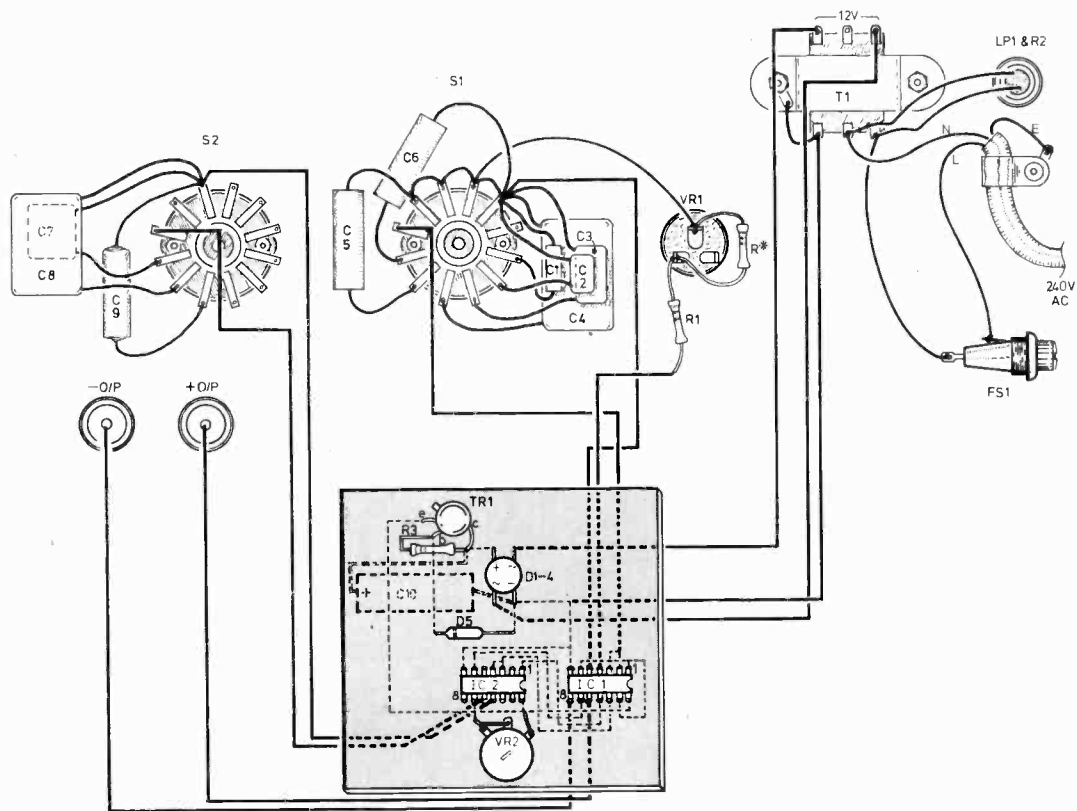


Fig. 3. Physical wiring diagram for board and mounted components

Components

GENERATOR

Resistors

R1 68Ω ($\frac{1}{4}$ W)

Potentiometers

VR1 2kΩ Lin

VR2 20kΩ Lin

Capacitors

C1 0.001μF

C2 0.01μF

C3 0.1μF

C4 1.0μF

C5 10μF

C6 100μF

C7 47pF

C8 470pF

C9 4700pF

Switches

S1 Rotary, single pole, 6-way

S2 Rotary, single pole, 3-way

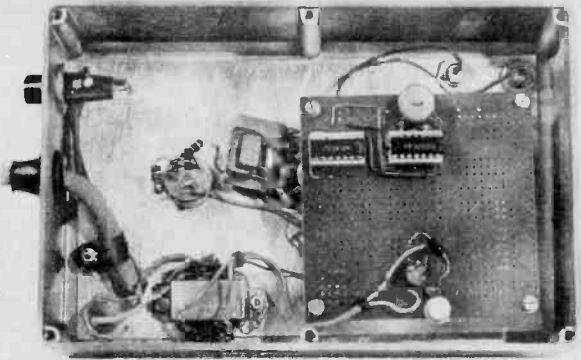
Integrated circuits

IC1 SN7404

IC2 SN74121

Miscellaneous

Die-cast box and suitable knobs



CONSTRUCTION

A circuit diagram is shown in Fig. 2, and a wiring diagram in Fig. 3. In practice the two 14-pin i.c. holders are soldered on a small piece of perforated p.c.b. as shown, keeping wiring lengths small. The value of potentiometer VR1 should not exceed 2kΩ, as this would attenuate the feedback signal and stop oscillations.

A series resistor R1 of about 80Ω increases the stability of the oscillator when VR1 is at minimum. The value of capacitors C1 to C6 can be chosen from 0.001μF to 100μF giving a frequency range from 1Hz to above 1MHz in six steps.

To fit in with the frequency range chosen, C7 to C9 can have any reasonable value between 10pF and 10,000pF giving pulse durations from 0.1μs to 10μs.

If longer pulse durations are needed at lower frequencies then larger values of capacitor can be added. When electrolytic capacitors are used connect the negative terminal to pin 11 of the monostable.

The switches S1 and S2 are ordinary single-pole rotary type.

SETTING UP

Calibration of the pulse generator, particularly VR1 the repetition rate fine control and VR2 the pulse duration preset control, can easily be done with a reference source such as the time base of commercial oscilloscope. This should be sufficiently accurate to enable a fairly precise marking of the front panel.

Pulses of 4V amplitude with a rise time of 40ns, and fall time of 20ns into about 150Ω are obtained provided stray capacitance is kept at a minimum. If necessary pulses with smaller amplitudes can be obtained using a set of plug-in attenuators.

POWER SUPPLY

A positive 5V stabilised d.c. supply is required. The diagram of such a circuit is shown in Fig. 4. The series transistor Zener diode (TR1-D5) arrangement provides sufficient stabilization against mains variations of ±10 per cent (nominal 230V a.c.). The d.c. current requirement is about 30mA.

If the instrument is to be battery operated it is recommended that the low power types of TTL be used (e.g. 74 L) in conjunction with a rechargeable battery—nickel cadmium for instance.



POWER SUPPLY

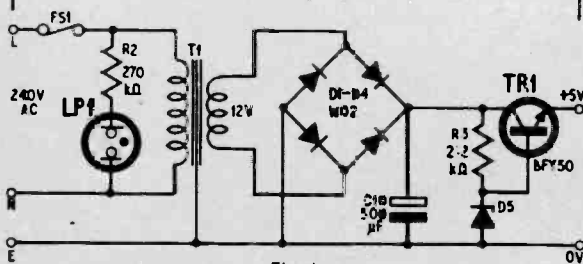


Fig. 4

Resistors

R2 270kΩ ($\frac{1}{4}$ W)

R3 2.2kΩ ($\frac{1}{4}$ W)

Capacitors

C10 500μF, 25V elect.

Diodes

D1-4 WO2 (Bridge)

D5 5.6V Zener

Transistors

TR1 BFY50

Transformer

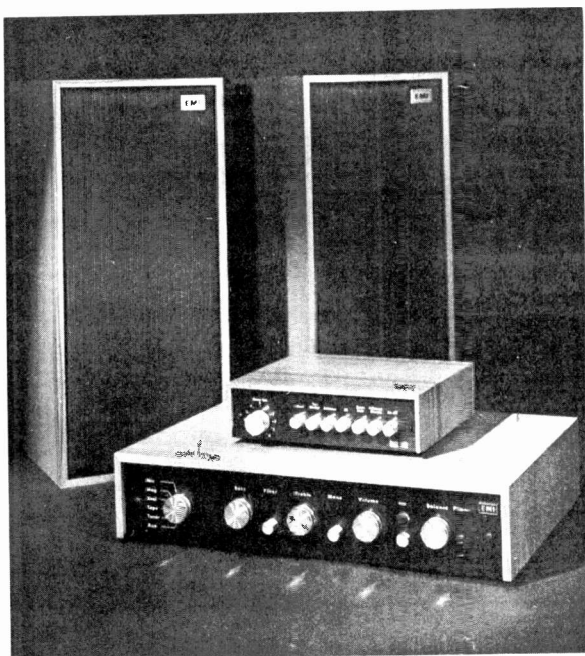
T1 12V output mains transformer

Miscellaneous

FS1 100mA fuse and panel-mounting holder

LP1 Neon indicator and panel-mounting holder

The new EMI 1515 stereo amplifier and smaller EMI SQ1500 quadraphonic decoder shown here with two LE2 15W loudspeakers forming a complete "add-on" package for converting an existing stereo system for SQ quadraphonic operation



SONEX 73



The Saba 544G stereo reel-to-reel unit illustrates the modern styling current in today's equipment

PROBABLY the main theme of this year's Sonex exhibition, Sonex 73, held at the Excelsior Hotel, London Airport, was quadraphonic or 4-channel sound. Of course, much of the exhibition and the associated lectures was concerned with the more mundane things of life like the mechanics of disc reproduction, listening room acoustics, and so on.

But, as at any gathering of Hi-Fi enthusiasts, and Sonex was certainly that, the tendency is to discuss the latest development available on the market. Currently quadraphonics falls into this category, with all the usual arguments as to benefits of different systems and methods.

Many of the exhibitors were prepared to comment on the validity of 4-channel sound but only a few offered equipment and, of course, in the small hotel rooms used by the exhibitors it was impossible to demonstrate the effects available decently.

In fact, this is one of the problems with using a hotel for an event of the nature of Sonex 73. Unlike RECMF or IEA or, for that matter any show held in a large hall-type space, not only is it difficult for the visitor to scan the field in general for his particular interest but hotel corridors have a habit of all looking the same.

Thus there is a tendency to miss items of interest and to get "lost" or disoriented. The only solution being the heavy reliance on the handbook. And we all know how impossible it is for all the information to be present there.

Of course, the hotel environment does have advantages. As the sound-making equipment was housed in separate rooms it was possible for the exhibitor to give an almost private demonstration of his gear. The usual problem of interference from stand to stand was avoided.

Really Sonex is directed to the audiophile with the desire to purchase already-built equipment, with only a scattering of items such as Richard Allan speaker kits and Connoisseur turntable products for the more practically minded. However, it is always interesting to see how the professionals do things.

LOUDSPEAKERS

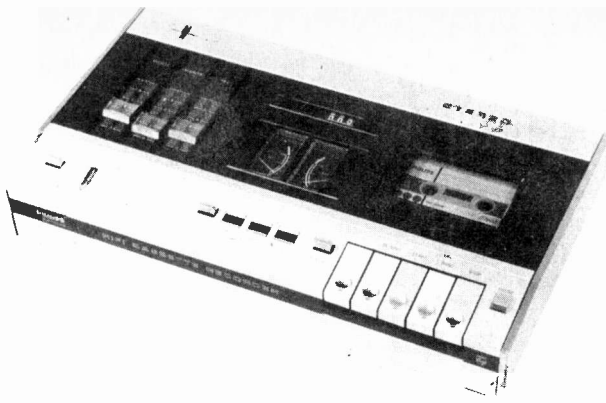
It is an accepted fact that the loudspeaker is one of the weakest links in the chain of sound reproduction and many of the exhibits showed just how far one can go with money and good intentions to put the orchestra in the sitting room. Anything up to several hundred pounds per unit can be spent. However, there must be a rational level between TV sound standards and using the dining room as a sound box for the rest of the house.

An interesting demonstration of loudspeaker performance was given by Acos using the Martin range from America. At the low price end was the Micro Dan, a prototype baby unit which is expected to sell here for about £30 plus VAT per pair. The Mini Dan, already available here at £56.28 plus VAT per pair also gave a good performance for the price. But most impressive were a pair of Laboratory Mk. 2 units and although these sell at £57.95 each plus VAT the performance was perhaps more "musical" than anything else at the show.

Of course, these comments are governed by personal hearing to a degree but when it is remembered that the Laboratory Mk 2 units include three speakers and controls to set mid and high frequency balance, allowing "tuning" of the equipment to a room, a hearing test is in the end, the only valid method left.

In fact it was commented by someone at the show that if you provided an audience with "flat" response speakers then most people would not appreciate the resulting sound at all.

Again on the subject of speakers, Richard Allan were displaying their well-known range of kits and assembled Hi-Fi units. Whilst they have not added to the kit range they were demonstrating an interesting professional/monitor unit, still in the prototype stages, called the Academy. This is physically a large item and not at all of the kittleable type. It is expected to appear on



The Philips N2510 stereo cassette unit, to DIN 45500 standards, is intended for use with Chromium Dioxide tapes

the market some time in July when the price will be settled. At the moment it is envisaged that £70 to £80 will be about right.

MADE OVERSEAS

Much of the equipment on show is made overseas. We have already mentioned American sourcing. From Norway comes the Tandberg line handled in the UK by Farnell-Tandberg Ltd. Included are a wide selection of tape and deck units, loudspeakers, separate amplifiers, tuner units and composites of various denominations. It is interesting to note the adoption by Tandberg, as almost everyone else, of a cassette deck which meets 45500 DIN requirements and includes a Dolby noise reduction system.

Japanese equipment was fairly in evidence and, as is to be expected, set a standard of appearance which some sources near home are having difficulty meeting. Again the emphasis was on 4-channel sound with specially designed controllers for remote handling of the output of each channel and special headphones designed for quadraphonics.

Of course, the Japanese exhibits included many examples of cassette units, some claiming performances equal if not superior to reel-to-reel equipments.

SIDE SHOW

Perhaps one of the problems of an event of this type is the consistency of the exhibits. Whilst not quite an "If you've seen one you've seen them all" situation, there is certainly a tendency to feel this after a matter of hours looking at the exhibits.

Thus it was somewhat of a relief to vacate the Excelsior for a while and go to see a demonstration of quadraphonics put on by EMI at a separate hotel. Intended to launch two of their latest products for the Hi-Fi market, the EM 1515 stereo amplifier and the SQ 1500 quadraphonic decoder, this side-show (as it were) took the cake as a demonstration of the abilities of quadraphonics to enhance the realism of reproduced sound.

In addition to announcing and displaying the amplifier and decoder, EMI showed a new small elliptical speaker unit which is expected to come on the market soon at about £30/pair cased.

The amplifier is to sell at £46.50 including VAT and includes a claimed performance in excess of most equipments in this mid-price area. 15 watts per channel at 0.2 per cent distortion, and the ability to control power supply to ancillary equipment are some factors of interest.

The decoder is designed to give one the ability to handle the new SQ 4-channel records in conjunction with four channels of amplification. The 1515 is suited to this and EMI are to offer a kit including the decoder and one amplifier to those already possessing a stereo unit.



NEWS BRIEFS

Advanced Motorway Communication System

A new data transmission system to control the roadside telephones on the M2 has been ordered by the Northern Ireland Ministry of Development. Designed and manufactured in Britain by AP Electronics of Chiswick, the system will be capable of replacing a 185 core cable with just two wires.

The heart of the system is a complex logic network constructed from Motorola MCMOS units. With the new system the operator will be able to dial any of the roadside telephones so that emergency situations can be handled before the less urgent breakdowns.

Underwater Detection of Aircraft Wreckage

Trials to improve the techniques for the detection of aircraft wreckage by sonar have just been carried out in Torbay. Designed to test the limitations of sonar detection, the trials covered a four-week period and the results should help in developing more effective systems.

A unique feature of the trials is the use of magnetic tape for the recording of the raw data required later for numerical analysis. More sensitive magnetic tape allows easier measurement of signal strength and hence easier differentiation between different types of wreckage.

Apart from the underwater detection of aircraft wreckage the techniques under trial could also be useful in such areas as location of ship wrecks, tracking of oil pipes and the assessment of inshore sediment accumulation.

Aircraft Tactical Simulator Takes Off

What is described as the world's most advanced simulator is now being "flown" by RAF crews after completion by the manufacturers, Marconi Space and Defence Systems. Built as the first of a number to be supplied to RAF Strike Command under a Ministry of Defence contract worth approximately £5 million, the simulator will reproduce for all 12 trainee crewmen, every operational facet of the world's most advanced anti-submarine aircraft, the Hawker-Siddeley NIMROD.

All operational equipment, including the radar, sonar, tactical navigation and weapon delivery systems, is fitted in a replica NIMROD, to reproduce actual missions, even down to engine noise and low-level buffeting.

PO Contracts for 120 Mbit/s Digital Line System

As a first step to developing a digital trunk network and preparing for new facilities, the Post Office has placed contracts with STC, GEC and Plessey to develop digital transmission systems enabling pulse code modulation (PCM) to be used on Britain's trunk network.

The decision to develop a digital system for the UK trunk network stems from the results of feasibility studies carried out for the Post Office by GEC and Plessey in 1970-71. These studies confirmed that it is technically possible to introduce a digital system using the standard 1.2/4.4mm coaxial cable already in use for multichannel frequency division multiplex transmission.

Under development contracts STC, GEC and Plessey have been commissioned to design, develop, manufacture and install systems transmitting information at a rate of 120 Mbit/s. Links between Guildford and Portsmouth, and Portsmouth and Southampton are to be set up, each system capable of transmitting up to 1,680 telephone conversations simultaneously.

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| B86 | 100 | Sil. Diodes sub. min. IN914 and IN916 types | 50p |
| B88 | 50 | Sil. Trans. NPN, PNP equiv. to OC200/1, 2N706A, BSY95A, etc. | 50p |
| H6 | 40 | 250mW. Zener Diodes DO-7 Min. Glass Type | 50p |
| H15 | 30 | Top Hat Silicon Rectifiers. 750mA. Mixed volts | 50p |
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| H20 | 20 | BY126/7 Type Silicon Recti- fiers 1 amp. plastic. Mixed volts | 50p |
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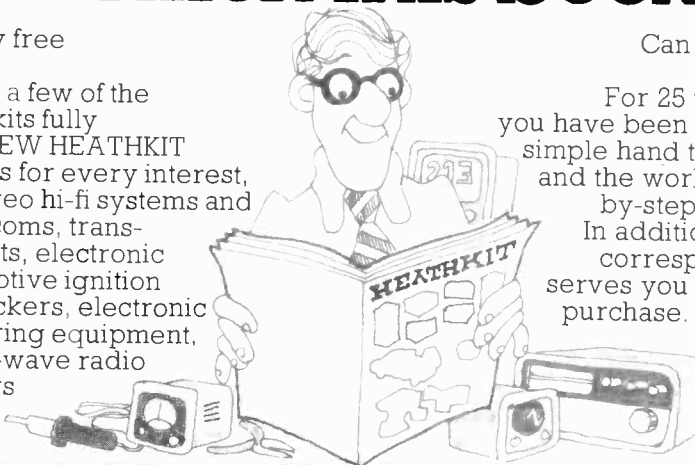
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A selection of readers' suggested circuits. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought. This is YOUR page and any idea published will be awarded payment according to its merits.

VARIABLE STABILISER FOR POWER SUPPLIES

THE need often arises for a stabilised power supply having an output which is continuously variable between two predetermined limits.

Considering the circuit in Fig. 1 and for the moment ignoring the inclusion of VR1 and VR2, it can be seen that we have a conventional stabiliser consisting of a voltage reference source, a differential amplifier TR1 and TR2, a power output stage TR3 and TR4 and a negative feedback loop provided by R5 and R6 in conjunction with the setting of VR2.

The ideal conditions for stability are as follows. The current through R3 should be equally divided between TR1 and TR2, thus implying that the base potential of TR2 should be the same as that of TR1, namely V_{ref} . From this we can deduce that

$$V_{ref} = V_0 \frac{R_5}{R_5 + R_6}$$

$$V_0 = V_{ref} \frac{R_5 + R_6}{R_5}$$

From the last equation it can be seen that there are two alternative methods of varying V_0 ; both are shown in Fig. 1. Firstly we can vary the ratio of R_5 to R_6 by means of VR2. This suffers from the disadvantage that as V_0 changes so does the loop gain, invariably to the detriment of circuit performance.

The second alternative is to vary the value of V_{ref} by means of VR1. However, examination of the circuit discloses yet another disadvantage. For low values of V_{ref} the current through TR1 is relatively low but there must be a large voltage drop across R4 thus implying a high current through TR2. The converse applies for high values of V_{ref} and it should not be difficult to see that there is only one setting of VR1 that fulfills the fundamental condition for stability.

If, however, we replace R4 with another transistor stage TR5 (Fig. 2), which receives its base bias via the collector load resistor R8 of TR1 (Fig. 2) then this problem is resolved. If for all settings of VR1, the voltage across R8 is large compared with the emitter-base voltage of TR5 and the value of R8

is roughly the same as R4, then the current flowing through these two resistors will be substantially the same.

This circuit has the inherent advantage that TR2 has for its load the intrinsic collector resistance of another transistor which, having an extremely high incremental resistance, increases the loop gain to a value of several hundreds.

Since, at high frequency the base emitter junction of a transistor can be regarded as an RC network there will be a frequency at which this circuit will oscillate, although the frequency of oscillation is difficult to predict, depending largely on component layout and the types of transistors used. Instability can be prevented by making the output the dominant time constant by means of a capacitor, the minimum value of which in the prototype was found to be around 10 μ F.

This circuit has an output which is continuously variable from 6V to 18V at currents up to 1 amp with the output transistor suitably mounted on an adequate heat sink.

J. Davies,
London W.14.

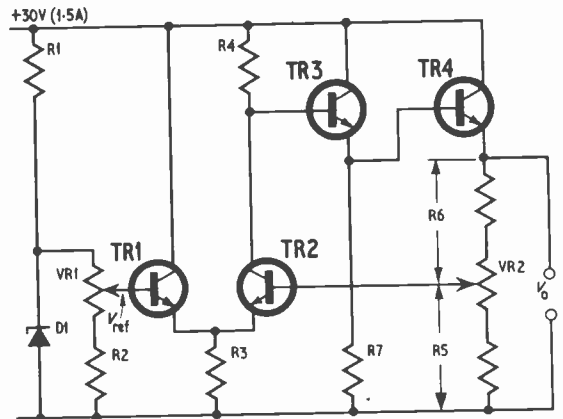


Fig. 1. Circuit for a conventional stabiliser

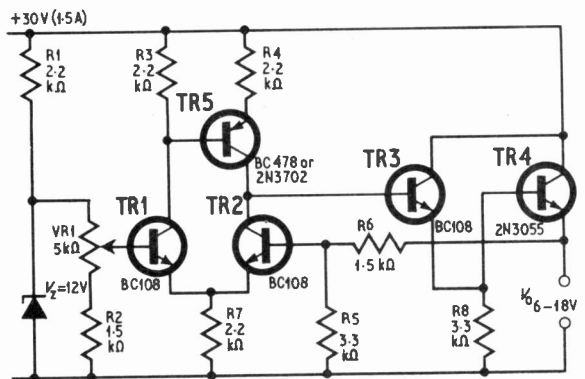


Fig. 2. Final circuit for a variable stabiliser for power supplies

LAMP STROBE



BUILT the lamp strobe (*Ingenuity Unlimited*, April 1972) but found the multivibrator in my circuit was unstable and tended to lock at mains (50Hz) frequency. This was overcome by decoupling the supply and adding two more diodes to the bridge rectifier allowed pulsating d.c. to reach the gating transistor and hence trigger the thyristor. See Fig. 1.

The speed control circuit was also modified and now gives a range of about 2–12Hz, with 10 μ F timing capacitors, which gives a good strobe effect when using several low power lamps in parallel. Coloured

15W "pigmy" bulbs are very suitable for this application, giving a fair amount of light when mounted in simple reflectors.

A "one-shot" facility was added by switching out the multivibrator and arranging for a microswitch S2 to discharge a capacitor through the gate giving one bright light pulse from the lamp for every press of the micro-switch.

Transformer T2 is a 1:1 isolating transformer consisting of about 20 turns of 36 s.w.g. enamelled copper wire wound on a ferrite core twice, preferably overlapping.

H. N. Jarman,
Tunbridge Wells.

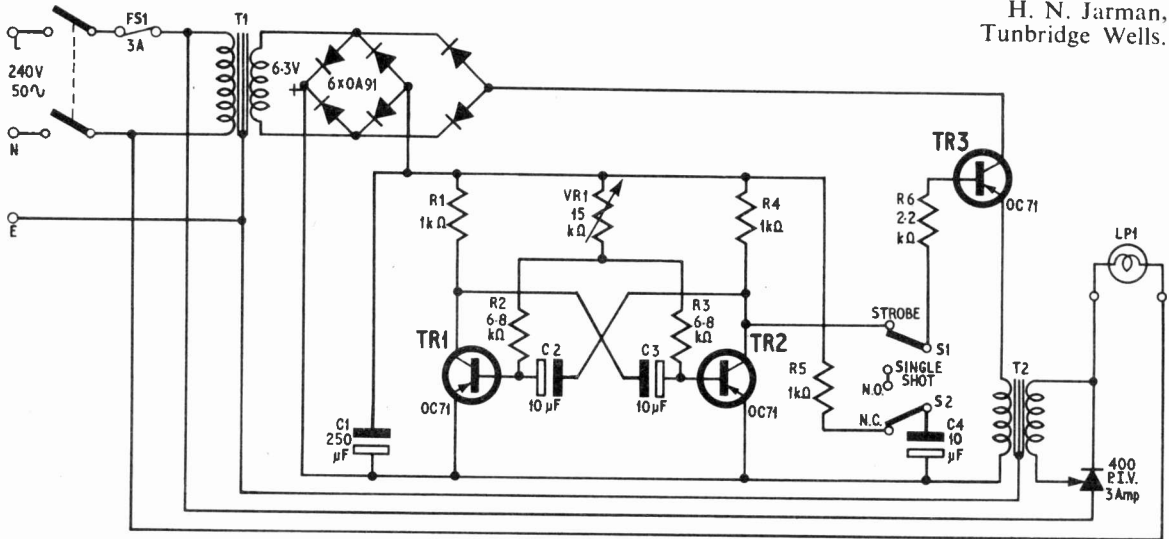


Fig. 1. Lamp strobe circuit diagram

TIMING CIRCUIT

THE main requirements of the timing circuit in Fig. 1 were that it should be cheap to build and run, while retaining reasonable accuracy.

In circuits of this kind it is usual to see a field effect transistor in the place of TR1, the main objection to a bipolar transistor being the low input resistance. In this circuit a bipolar transistor has been used for economy, the input resistance being increased by R2. Although this does not offer an input resistance comparable with that of a field effect transistor, the timing is accurate enough for many applications. The value of R2 should be found by experiment, but should not lie below 2M Ω .

When S1 is pressed TR1 will conduct, driving TR2 into saturation. This energises the relay which disconnects R1 and connects the emitter of TR2 to the power supply. C1 charges up through VR1 at a rate depending on its setting. When C1 has charged up enough, TR2 will no longer be able to hold the relay on, and the circuit will reset itself, C1 being discharged via R1.

The components specified will give a maximum timing period of a few minutes. If longer periods are required, the value of C1 can be increased.

The maximum current consumed by the prototype is about 25mA just after switching on, this value decreasing as the timing cycle progresses. The current consumed depends mainly on the relay chosen, one with a large coil resistance being most suitable.

The choice of power supply is left up to the constructor; the circuit can be run economically from a small 9V battery if desired.

P. Chappell,
Weston-Super-Mare

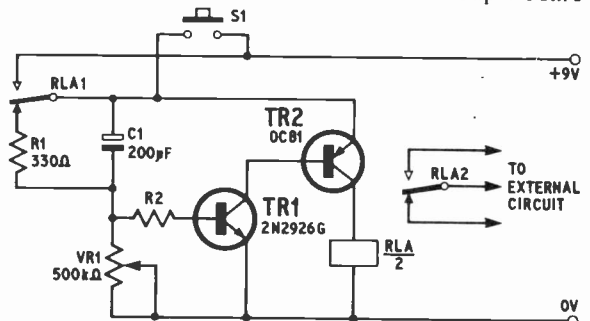


Fig. 1. Simple timing circuit

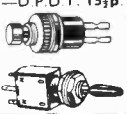
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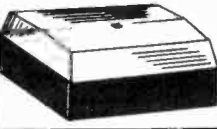


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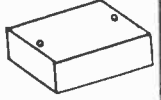
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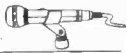
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| GB12 | 2in | 2in | 1in | 36p 15p |
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D.I.N. 6 pin 163p
Jack, 2mm unscreened 10p
Jack, 2mm screened 11p
Jack, 3mm unscreened 9p
Jack, 3mm screened 13p
Jack, ½in unscreened 13p
Jack, ½in screened 22p
Jack, stereo, unscreened 22p
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Phono, plated metal 13p
Wander, red or black 33p
Banana 4mm, red or black 63p



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Phono, 2 on a strip 7p
Phono, 3 on a strip 10p
Phono, 4 on a strip 11p
Phono, 4 on a strip 11p
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Co-axial 10p
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D.I.N. 3 pin 173p
D.I.N. 5 pin, 180° 173p
D.I.N. 5 pin, 240° 173p
Jack, 3½mm 163p
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Jack, stereo, screened 37p
Phono, plated metal 153p

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| 4-7μF | 63V | 7p | 220μF | 10V | 7p |
| 6-8μF | 40V | 7p | 220μF | 16V | 8p |
| 6-8μF | 63V | 7p | 220μF | 25V | 13p |
| 10μF | 25V | 7p | 220μF | 40V | 15p |
| 15μF | 63V | 7p | 220μF | 63V | 22p |
| 15μF | 16V | 7p | 330μF | 4V | 7p |
| 15μF | 40V | 7p | 330μF | 10V | 8p |
| 15μF | 63V | 7p | 330μF | 16V | 13p |
| 22μF | 10V | 7p | 330μF | 63V | 26p |
| 22μF | 25V | 7p | 470μF | 6-3V | 8p |
| 22μF | 63V | 7p | 470μF | 10V | 13p |
| 33μF | 6-3V | 7p | 470μF | 25V | 15p |
| 33μF | 16V | 7p | 470μF | 40V | 22p |
| 33μF | 40V | 7p | 680μF | 6-3V | 13p |
| 47μF | 4V | 7p | 680μF | 16V | 15p |
| 47μF | 10V | 7p | 680μF | 25V | 22p |
| 47μF | 25V | 7p | 680μF | 40V | 26p |
| 47μF | 40V | 7p | 1000μF | 4V | 13p |
| 47μF | 63V | 8p | 1000μF | 10V | 15p |
| 68μF | 6-3V | 7p | 1000μF | 16V | 22p |
| 68μF | 16V | 7p | 1000μF | 25V | 26p |
| 68μF | 63V | 13p | 1500μF | 6-3V | 15p |
| 100μF | 4V | 7p | 1500μF | 10V | 22p |
| 100μF | 10V | 7p | 1500μF | 16V | 26p |
| 100μF | 25V | 7p | 2200μF | 6-3V | 22p |
| 100μF | 40V | 8p | 2200μF | 10V | 26p |
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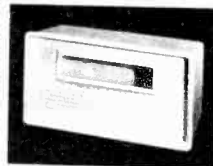
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| SN7412 | 38p | 35p | SN7443 | 1-45p | 1-37p | SN7478 | 70p | 70p | SN74110 | 81p | 72p |
| SN7413 | 32p | 29p | SN7444 | 1-43p | 1-37p | SN7478 | 87p | 85p | SN74111 | 1-37p | 1-27p |
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| 150µF | 6½p | 47µF | 6½p |
| 470µF | 11p | 100µF | 8p |
| 680µF | 13p | 150µF | 8p |
| 1500µF | 18p | 220µF | 10p |
| 2200µF | 18p | 470µF | 13p |
| 3300µF | 26p | 680µF | 20p |
| | | 1000µF | 22p |
| | | 1500µF | 26p |
| | | 2200µF | 39p |
| | | 3300µF | 68p |

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|---------|-----|---------|-----|
| 22µF | 6½p | 6.8µF | 6½p |
| 47µF | 6½p | 15µF | 6½p |
| 100µF | 6½p | 33µF | 6½p |
| 220µF | 8p | 47µF | 6½p |
| 330µF | 8p | 100µF | 11p |
| 470µF | 10p | 150µF | 12p |
| 680µF | 10p | 220µF | 15p |
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| AC142K | 22p | BC145 | 26p | BFX84 | 28p | OC72 | 14p | |
| AC141K | 20p | BC147 | 9p | BFX85 | 35p | OC81 | 14p | |
| AC176 | 15p | BC148 | 9p | BFY96 | 25p | OC83 | 22p | |
| AC187 | 13p | BC149 | 9p | BFX87 | 25p | OC84 | 25p | |
| AC187K | 20p | BC153 | 16p | BFX88 | 26p | TIP29A | 53p | |
| AC188 | 13p | BC154 | 17p | BFY50 | 21p | TIP30A | 64p | |
| AC188K | 20p | BC157 | 13p | BFY61 | 17p | TIP31A | 64p | |
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| AD161 | 28p | BC213L | 11p | MP812 | 44p | 2N1131 | 22p | |
| AD169 | 28p | BC214L | 11p | MP812 | 50p | 2N1132 | 28p | |
| AD174 | 30p | BC258 | 9p | NKT211 | 28p | 2N1613 | 22p | |
| AD174 | 30p | BC259 | 9p | NKT212 | 28p | 2N1614 | 22p | |
| AD175 | 14p | BC267 | 14p | NKT214 | 25p | 2N2904 | 40p | |
| AD176 | 14p | BC268 | 15p | NKT217 | 55p | 2N2904A | 40p | |
| AD177 | 14p | BC300 | 40p | NKT261 | 23p | 44p | BAX13 | |
| AD178 | 92p | BC301 | 32p | NKT271 | 20p | 2N2905 | 46p | |
| AD179 | 27p | BC302 | 30p | NKT274 | 20p | 2N2924 | 18p | |
| AD179 | 27p | BC303 | 30p | NKT276 | 28p | 2N2925 | 19p | |
| AD179 | 27p | BC304 | 30p | NKT278 | 28p | 2N3053 | 29p | |
| AD179 | 27p | BC304 | 40p | NKT403 | 71p | 2N3053 | 29p | |
| AL100 | 77p | BCY70 | 17p | NKT405 | 83p | 2N3054 | 55p | |
| AL102 | 77p | BCY71 | 37p | NKY603F | 9p | 2N3055 | 52p | |
| AL103 | 55p | BCY72 | 17p | 68p | 2N3405 | 44p | BAX13 | |
| ASV26 | 31p | BD123 | 60p | NKT613G | 2N3663 | 67p | OA5 | |
| ASV27 | 49p | BD124 | 50p | OC19 | 55p | 2N3702 | 9p | |
| AU109 | 9p | BD131 | 63p | NKT674 | 33p | 2N3710 | 9p | |
| AU110 | 9p | BD132 | 90p | NKT677G | 33p | 2N3704 | 9p | |
| AU111 | 77p | BD135 | 42p | 24p | 2N3705 | 9p | OA7 | |
| BC107 | 9p | BD136 | 50p | NKT713 | 32p | 2N3706 | 9p | |
| BC108 | 9p | BD141 | 41-87 | NKT773 | 27p | 2N3707 | 9p | |
| BC109 | 9p | BD142 | 50p | OC19 | 55p | 2N3708 | 9p | |
| BC113 | 15p | BF130 | 35p | OC20 | 55p | 2N3709 | 9p | |
| BC116 | 18p | BF173 | 29p | OC23 | 33p | 2N3710 | 9p | |
| BC125 | 16p | BF177 | 29p | OC25 | 28p | 2N3711 | 9p | |
| BC126 | 25p | BF178 | 29p | OC28 | 33p | 2N3794 | 17p | |
| BC132 | 16p | BF179 | 35p | OC29 | 33p | 2N3819 | 28p | |
| BC134 | 16p | BF194 | 15p | OC35 | 38p | 40361 | 50p | |
| BC135 | 16p | BF195 | 17p | OC36 | 38p | 40362 | 50p | |
| BC137 | 16p | BF244 | 27p | OC41 | 14p | 40366 | 50p | |

MULLARD POLYESTER'S

MULLARD POLYESTER CAPACITORS C280 SERIES
250V P.C. mounting: 0-01µF, 0-015µF, 0-022µF, 0-033µF, 0-047µF, 0-068µF, 4p, 0-1µF, 4½p, 0-15µF, 0-22µF, 5p, 0-33µF, 7p, 0-47µF, 8½p, 0-68µF, 12p, 1-0µF, 14p, 1-5µF, 22p, 2-2µF, 27p

MULLARD POLYESTER CAPACITORS C296 SERIES
400V: 0-001µF, 0-0015µF, 0-0022µF, 0-0033µF, 0-0047µF, 2½p, 0-0068µF, 0-01µF, 0-015µF, 0-016µF, 0-022µF, 0-033µF, 3½p, 0-047µF, 0-068µF, 0-1µF, 4½p, 0-15µF, 6½p, 0-22µF, 8½p, 0-33µF, 12p, 0-47µF, 14p.

160V: 0-01µF, 0-015µF, 0-022µF, 0-033µF, 0-047µF, 0-068µF, 8p, 0-1µF, 3½p, 0-15µF, 4½p, 0-22µF, 5½p, 0-33µF, 6½p, 0-47µF, 8½p, 0-68µF, 12p, 1-0µF, 14p.

VOLUME CONTROLS

Potentiometers
Carbon track 500 Ω to 2-2M Ω
Log or Linear
Single 13p. Dual gang (stereo) 44p
Single type with D.P. switch 13p extra.

SLIDE POTENTIOMETERS

58mm. TRACK
SINGLE GANGED, LOG or LIN 1k to 1M.
45p each
TWIN GANGED, LOG or LIN 1k to 500k.
86p each.

CARBON SKELETON PRESETS

Small high quality type (linear only).
All values 100-5 meg ohms.
-1 watt 5½p each
-2-5 watt 6½p each

VEROBOARD

| | |
|---|------------|
| 0-15 Matrix | 0-1 Matrix |
| 2½in x 3½in | 19p |
| 2½in x 5in | 28p |
| 3½in x 3½in | 28p |
| 3½in x 5in | 33p |
| 5in x 17in (plain) | 94p |
| Vero Pins (bag of 36) | 22p |
| Vero cutter, 50p; Pin insertion Tools (0-1 and 0-15 matrix) at 61p. | |

SLIDE SWITCH

SPST 11p each. D.P.D.T. 13p each.

MINIATURE NEON LAMPS

240V or 110V 1-4 5p, 5 plus 4½p each.

MINITRON DIGITAL INDICATOR TYPE 3015F

Reads 0-9 and decimals
(Data Sheet on request)
ONLY £1.50
16 DIL Socket 33p
Driven by 7447 £1.05

RECTIFIERS

| P.I.V. | 1 AMP | 1-5 AMP |
|--------|------------|------------|
| 50 | 1N4001 4p | PL4001 8p |
| 100 | 1N4002 4p | PL4002 8p |
| 200 | 1N4003 5p | PL4003 10p |
| 400 | 1N4004 6p | PL4004 10p |
| 600 | 1N4005 8p | PL4005 13p |
| 800 | 1N4006 9p | PL4006 15p |
| 1000 | 1N4007 10p | PL4007 20p |

BRIDGE RECTIFIERS

| P.I.V. | 1 AMP | 2 AMP | 5 AMP | 10 AMP |
|--------|-------|-------|--------|--------|
| 50 | 33p | 53p | £1.76p | £2.20p |
| 100 | 35p | 57p | 60p | £1.98p |
| 200 | 37p | 60p | £2.15p | £2.31p |
| 400 | 40p | 64p | £2.15p | £2.42p |
| 600 | 44p | 66p | £2.42p | £2.75p |
| 800 | 49p | | | |

AUTO—ELECTRIC CAR AERIAL

with dashboard control switch—fully extendable to 40in or fully retractable. Suitable for 12V positive or negative earth. Supplied complete with fitting instructions and ready wired dashboard switch. **£6-35 plus 25p post and insurance.**



RECORD PLAYBACK HEADS

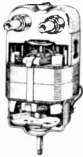
Individual prices of these are—2 track record playback heads 50p each. 4 track record playback heads 72p each. Erase heads are also available separately—2 track 17p, 4 track 28p.

I R.P.H. MOTOR

Made by the famous Smith Company. 240V 50 cycle mains working. Ideal motor to drive clock mechanisms. Price **£1-10** each or 10 for **£9-90**.

MULTISPEED MOTOR

Six speeds are available: 500, 850 and 1,100 r.p.m. and 8,000, 12,000 and 15,000 r.p.m. Shaft is 1/4in diameter and approx. 1in long. 230/240V. Its speed may be further controlled with the use of our Thyristor controller. Very powerful and useful motor, size approx. 2in dia. x 5in long. Price **87p plus 23p post and insurance.**



MAINS OPERATED CONTACTOR

220/240V 50 cycle solenoid with laminated core so very silent in operation. Closes 4 circuits each rated at 10A. Extremely well made by a German Electrical Company. Overall size 2 1/2 x 2 x 2in. **£1-65 each.**

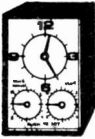


TELESCOPIC AERIAL

for portable, car radio or transmitter. Chrome plated—six sections, extends from 7 1/2 to 47in. Hole in bottom for 6BA screw. **42p. KNUCKLED MODEL FOR F.M. 55p.**

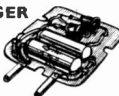
MAINS CLOCK & TIME SWITCH

Smith's main's driven clock with 15A programmable switch also notes showing how you can use this to wake up with music playing, kettle boiling or come home to a warm house, warn-off burglars, keeps pets warm, halves your heating bills etc., etc. **£2-20 +20p p. & p.**



PP3 BATTERY CHARGER

Almost 3 times the life can be obtained from PP3 battery if you re-charge it from the mains—this ready to use charger with instructions only **55p.**



IMMERSION HEATERS BY REMPLOY

Standard fitting for domestic water tanks, made by the famous Remploy Company. Complete with sealing washers suitable for 200–240V a.c. Depth into tank 1 1/2in. 2kW or 3kW. **£1-65 plus 40p each post and insurance.**



NEED A SPECIAL SWITCH?

Double Leaf Contact. Very slight pressure closes both contacts. 7p each, 10 for 83p. Plastic pushrod suitable for operating. 6p each, 10 for 54p.

THERMOSTAT

Continuously variable 30°–90°C. Has sensor bulb connected by 33in of flexible tubing. On operation a 15A 250V switch is opened and in addition a plunger moves through approx. 1in. This could be used to open valve on ventilator, etc. **£1-65 plus 23p p. & ins.**

HIGH ACCURACY THERMOSTAT

Uses differential comparator I.C. with thermistor as probe. Designer claims temperature control to within 1/10th of a degree. Complete kit with power pack **£6-25.**

NUMICATOR TUBES

For digital instruments, counters, timers, clocks, etc. HI-vac. XN. 3. Price **£1-50 each.**

12-VOLT SUB-MINIATURE MULTI-CORE CABLE

7-0076 copper cores each core. P.V.C. insulated and of different colour. P.V.C. covered overall and approx. 3/16in thick. Price **22p per yard.**

STANDARD WAVER SWITCHES

Standard size 1 1/2in wafer—silver-plated 5 amp contact, standard 1/2in spindle 2in long—with locking washer and nut

| No. of Poles | 2 way | 3 way | 4 way | 5 way | 6 way | 8 way | 9 way | 10 way | 12 way |
|--------------|-------|-------|-------|-------|-------|-------|-------|--------|--------|
| 1 pole | 44p | 44p | 44p | 44p | 44p | 44p | 44p | 44p | 44p |
| 2 poles | 44p | 44p | 44p | 44p | 44p | 44p | 44p | 44p | 44p |
| 3 poles | 44p | 44p | 44p | 44p | 44p | 44p | 44p | 44p | 44p |
| 4 poles | 44p | 44p | 44p | 44p | 44p | 44p | 44p | 44p | 44p |
| 5 poles | 44p | 44p | 44p | 44p | 44p | 44p | 44p | 44p | 44p |
| 6 poles | 44p | 44p | 44p | 44p | 44p | 44p | 44p | 44p | 44p |
| 7 poles | 77p | 77p | 77p | 77p | 77p | 77p | 77p | 77p | 77p |
| 8 poles | 77p | 77p | 77p | 77p | 77p | 77p | 77p | 77p | 77p |
| 9 poles | 77p | 77p | 77p | 77p | 77p | 77p | 77p | 77p | 77p |
| 10 poles | 77p | 77p | 77p | 77p | 77p | 77p | 77p | 77p | 77p |
| 11 poles | 77p | 77p | 77p | 77p | 77p | 77p | 77p | 77p | 77p |
| 12 poles | 77p | 77p | 77p | 77p | 77p | 77p | 77p | 77p | 77p |

THYRISTOR LIGHT DIMMER

For any lamp up to 250W. Mounted on switch plate to fit in place of standard switch. Virtually no radio interferences. Price **£2-95 plus 20p post and insurance.** Industrial model 5A with control knob but not mounted on switch plate **£3-30.**



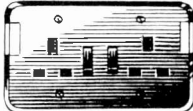
HORSTMANN "TIME AND SET" SWITCH

(A 30A Switch). Just the thing if you want to come home to a warm house without it costing you a fortune. You can delay the switch on time of your electric fires, etc. up to 14 hours from setting time or you can use the switch to give a boost on period of up to 3 hours. Equally suitable to control processing. Regular price probably around £5. Special snip price **£1-65, p. & ins. 23p.**



13 AMP TWIN GANG SOCKETS

Offered at less than wholesale price your opportunity to replace those dangerous adaptors—brown bakelite flush mounting—standard fitting. Unswitched 22p each, separately switched 33p each. Less 10% ten or more +20p postage if order under £5.



THIS MONTH'S SNIP

KETTLE ELEMENTS

Made by the famous A.E.I. Co. Complete with washers and combined fixing ring and plug shroud. Normal 2 round pin and flat pin earth connection and overload reset push button. 2 Models—1 1/2in (approx.) suitable for Swan and other similar models—1 1/2in (approx.) suitable for G.E.C. Hotpoint, etc. All quick boil 2 1/2kW elements at 240V. Price **£1-38.**

COMPUTER TAPE

2,400ft. of the Best Magnetic Tape money can buy. Some users claim good results with Video and sound. 1in, 1/2in or 3/4in wide. **£1 plus 30p post.** Spare spools and cassettes 50p. **1in Scotch tape.** Brand new. Suits most video recorders. **23 for 2,400ft.**

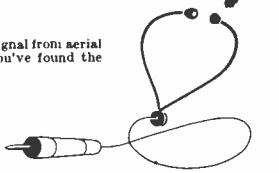


MULLARD UNILEX

This D.I.Y. Stereo Amplifier is still available complete at **£7-70** for the four Mullard Modules, or Modules can be bought separately as follows: 4 watt amplifier module (2 required) Mullard Ref. No. E.P. 9000—**£1-60 each.** Pre-amp module Mullard Ref. No. E.P. 9001, **£1-98 each.** Power module—Mullard Ref. No. E.P. 9002, **£2-33 each.** In addition and made to Mullard Specification we offer: Standard Control Unit with escutcheon, **£2-75, Knobs, Set of 4, 45p.** Unit, **£3-54** with Set of 6 Knobs, **83p.** Mullard Unilex Handbook, **25p.**

RADIO STETHOSCOPE

Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything—complete kit comprises two special transistors and all parts including probe, test lead and crystal earpiece. **£2-90—twin stethos instead of earpiece 83p extra, post and ins. 20p.**



MIGHTY MIDGET

Probably the tiniest possible radio, as described in Practical Wireless, January 73. All electronic parts **£2-20 post paid.**

DIGITAL COUNTER TIMER

Very stable and reliable crystal controlled circuit. Capable of work in excess of 15MHz. Construction simplified by use of 15 integrated circuits. Complete kit with case **£43-50** or construction data and price list **50p.**



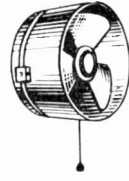
INTEGRATED CIRCUIT BARGAIN

A parcel of integrated circuits made by the famous Plessey Company. A once-in-a-lifetime offer of Micro-electronic devices well below cost of manufacture. The parcel contains 5 ICs all new and perfect, first-grade device, definitely not sub-standard or seconds. 4 of the ICs are single silicon chip GP amplifiers. The 5th is a monolithic NPN matched pair. Regular price of parcel well over **£5.** Full circuit details of the ICs are included and in addition you will receive a list of many different ICs available at bargain prices **25p upwards** with circuits and technical data of each. Complete parcel only **£1 Post paid.** **DON'T MISS THIS TERRIFIC BARGAIN.**

TERMS:—10% discount if ten of an item ordered, send postage where quoted—other items post free if order for items is over **£6** otherwise add 20p.

EXTRACTOR FAN

Cleans the air at the rate of 10,000 cubic ft per hour. Suitable for kitchens, bathrooms, factories, changing rooms, etc., it's so quiet it can hardly be heard. Compact 5 1/2in casing with 5 1/2in fan blades. Kit comprises motor, fan blades, sheet steel casing, pull switch, mains connector, and fixing brackets, **£2-75 plus 30p post and ins.**



QUICK CUPPA

Mini Immersion Heater, 350W 200/240V. Boils full cup in about two minutes. Use any socket or lamp holder. Have bedside for tea, baby's food, etc. **£1-25, post and insurance 14p.** 12V car model also available same price. Jug heater **£1-75 plus p. & p. 14p.**

MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6V, 9V, 12V for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9, and others. Kit comprises: mains transformer, rectifier, smoothing and load resistor condensers and instructions. Real snip at only **£1-10 plus 20p postage.**

TREASURE TRACER

Complete Kit (except wooden battery) to make the metal detector as the circuit in Practical Wireless, August issue. **£3-30 plus 20p post and insurance.**

WINDSCREEN WIPER CONTROL

Beat dirty roads, drizzle, fog, etc. Kit of parts to make this useful accessory with circuit details. **£2-50.**



12 VOLT 1 1/2 AMP POWER PACK

This comprises double-wound 230/240V mains transformer with full wave 2000 nfd/d rectifier and smoothing. Price **£2-20 plus post & packing.**

ONE CHIP RADIO

Ferranti's latest device ZN414—gives results better than superb. Supplied complete with technical notes and circuits. **£1-35 each, 10 for £12.**

HI-Q TUNER COMPONENTS

For experimenting with the ZN414 Kit No. 1—Plessey Tuning Condenser with built in LW switch and 3in ferrite slab and Litz wound MW coil. **72p.** Kit No. 2—Air spaced tuning condenser 6in ferrite rod, litz wound MW and LW coils, **99p.** Kit No. 3—Air spaced TC with slow motion drive 8in ferrite rod, with Litz wound LW and MW coils, **£1-10.** Kit No. 4—Permeability tuner with fast and slow motion drive and LW loading coils, **50p.**

DRY FILM LUBRICANT

In aerosol can for easy application and for putting lubricant into places where the normal oil can not reach. Home and every day use. We have purchased a large quantity of these from the Liquidator and are able to offer them to you for about half the original list price. **88p per (8oz) can or 12 cans for £8-80, 1 post and ins.** The lubricant is I.C.I. fluon L169. **PHOTO TRANSISTOR** OCP70—deal for burglar alarms and similar applications. Price **72p each.**



SOLDER GUN

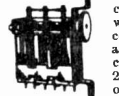
A must for every busy man, gives almost instant heat also illuminated job. **100W £2-50 plus post and ins. 20p.**

MAINS OPERATED SOLENOIDS

Model 772—small but powerful 1 1/2in pull—approx. size 1 1/2in x 1 1/2in x 1 1/2in **68p.** Model 400/1 1/2in pull. Size 2 1/2in x 2in x 1 1/2in **83p.** Model TT10 1 1/2in pull, size 3 x 2 1/2 x 2in **£1-98 plus 20p post and insurance.**

3 STAGE PERMEABILITY TUNER

Made originally for Radiomobiler car radios. This is a medium wave tuner with a frequency coverage 16kc–523kc. Aerial, RF and oscillator sections (long wave coil available) same size, only 2 1/2 x 2 x 1 1/2in. Can be used with our F.M. module and AF modules and a few inter connection components to make a complete receiver. Circuit supplied. Price **72p less 10%** for receiver.



J. BULL (ELECTRICAL) LTD.

(Dept. P.E.), 7 Park Street, Croydon CRO 1YD
Callers to 102/3 Tamworth Road, Croydon

Now available from one company are kits for many of the articles published in the Electronics, Radio and TV Journals. Examples of our range are:

SCORPIO IGNITION SYSTEMS (P.E. Nov. 1971), £9.50. This kit includes all the parts for the assembly of this popular and reliable system. The hardware and the construction data are included.

DRILL SPEED CONTROLLER (E.E. Aug. 1972). Kit consists of resistors, rectifiers, thyristor and tag board as specified in the article, price £1.15. Kit with M.K. box, switch and plate included, £2.30.

ELECTRONIC PIANO (P.E. Sept. 1972). We can supply the various sections for this article in kit form:

Power Supply, £6.60, including all semiconductors, resistors, capacitors, transformer, heat sink and hardware less P.C.B.

Preamp and Tremelo, £3.20, complete with switches, hardware and electronic components, less P.C.B.

Main Amp., £4.20, complete with IC-12, electronic components and P.C.B.

13 Pitch Boards, £39.50. Kit contains all the resistors, capacitors and semiconductors as published, but not the P.C.B.'s or the inductor.



12 Lauderdale Road, London W.9.
Telephone 01-286 0011 Telex 28479

LIGHT DIMMER. Kit contains all parts including circuit and construction data, 480 watts, fully suppressed. Price £2.10.

MUSIC MAKER ELECTRONIC ORGAN (P.W. Nov. 1972). Complete kit £4.40 or kit less resistors, P.C.B. and plastic box, £2.80. Stylus not supplied.

MIGHTY MIDGET (P.W. Jan. 1973). Kit contains all parts, less the battery, box and knob, £2.25.

TRIFFID RADIO (P.E. Feb. 1973). Kit includes all parts listed, less "tuning coil" and "miscellaneous components", £4.95. Ferrite rod and wire optional extra at 50p. P.C.B. optional extra at 65p.

We shall be offering kits for most articles published in the popular electronics magazines and will be pleased to quote prices.

Please note, prices shown do not allow for V.A.T. Please add 10% to your order.

Send for details of kits available (please enclose S.A.E.). All kits sent POST FREE within the limits of the U.K.

Please note. We reserve the right to withdraw kits without prior notification.

Electrokit

NEW COMPONENTS

Post and packaging free for orders over £1.50, include 10p P&P for each single pack under £1.50.

200 Mixed Resistors all types, 50p. 100 Mixed Modern and Miniature Resistors, 50p. 10mF 64V Electrolytic Caps, 5 for 25p; 12 for 50p. 640mF 16V Electrolytic Caps, 3 for 30p; 7 for 60p. 10mF 63V WIMA non-electrolytic, 15p each. 3200mF 10V, 15p; 3 for 30p; 5 for 60p.

SEMICONDUCTORS

Any 6 of the following, 50p, or 10p each. OC71, BFY50, 2N3702, CV8615, BSY95A, NTG885, 2N930, OA81, 2 x 1N914. (OR P60 50p).

CONSTRUCTORS' ITEMS

Subminiature Omron 12V d.c. relays mounted on CCT board, 3 for 60p, P&P 9p; mounted on CCT board with components, 2 for 60p, P&P 7p. GPO Relays, various 200Ω-7000Ω, 30p each. Uniselectors, 10 pole, 25 way, £1 each, P&P 25p. Heavy Duty Foot Pedals, 50p, P&P 20p. 6V 5 digit High Speed Counters, £1.50, 15p P&P.

DICTATING MACHINES

£2.50 each—ideal for spares, motor, power pack, record/replay, electronics with mike £3.25.

TRANSFORMERS

Mains—13V 2.5A and 15V 0.75A £1.45, 20p P&P. Mains—13V 1A 12V 0.5A, £1.25, 20p P&P. Mains—13V 5A and 24V 2A, £2, 25p. P&P. Mains—24V 100mA and 6V 100mA, 75p, 10p P&P. Power Pack—suitable to run Transistor Radio or Cassettes Recorder, 5.5V, 100mA, smoothed d.c. output £1.20, 20p P&P.

EX COMPUTER CIRCUIT BOARDS

10 Boards, 50p, 8p P&P; 25 Boards, £1, 18p P&P.
2 Boards with 2 power transistors, 1E 4 x OC28 type, 50p, 7p P&P.

LAWBAK ELECTRONICS

(HI-FI AND COMPONENTS SPECIALISTS)

18 HIGH RD., SWAYTHLING, SOUTHAMPTON

Telephone: Southampton 58479

No Half Day Closing

Discount and Credit Terms Available

AUTOMATIC EMERGENCY SUPPLY

250V 50 Hz—150 watt Inverter. Full kit of parts excluding meter. Circuit as appeared in December P.W. Complete kit—£16.95 + 80p. P. & P.

OTHER INVERTERS AVAILABLE IN KIT FORM

150 Watt—£13.50 + 60p P. & P. 75 Watt—£7.80 + 60p P. & P.
300 Watt—£17.90 + 85p P. & P. 40 Watt—£5.20 + 40p P. & P.
25 Watt—£2.60 + 20p P. & P.

All above operate from 12v. battery and give 250v.-50Hz. Output. 24 volt types are also available, alternative outputs or taps can be supplied. Transformers and/or Transistors can be supplied separately.

SPECIAL OFFER

12v. Fluorescent lights, suitable for tents, caravans, houses or secondary lighting for factories, hotels, etc. 12 inch—8 watt—£3.40 post paid. 21 inch—13 watt—£4.20 post paid. Large discounts available for quantities.

BATTERY CHARGER KIT

10 amp charge current—£5.50 + 40p P. & P.
(consists of Transformer and Rectifiers)

ASTRO ELECTRONICS

6 BARNES ROAD, CHESTERFIELD, DERBYSHIRE

STEREO IC DECODER

HIGH PERFORMANCE PHASE LOCKED LOOP (as in 'W.W.' July '72)
MOTOROLA MC1310P

EX STOCK DELIVERY

Specn. Separation: 40dB 50Hz—15kHz. Distortion: 0.3%. 1/P level: 560mV rms. O/P level: 485mV rms per channel. Input impedance: 50k. Power requirements: 8—12V (a 16mA). Will drive up to 75mA stereo 'on' lamp or LED. Simple to build.

KIT COMPRISES FIBREGLASS PCB

(Printed and tinned), Resistors, I.C., Capacitors, Preset Potm. and Instructions. Only £3.50 post free + V.A.T.

LIGHT EMITTING DIODE (Red)

Suitable as stereo 'on' indicator. For above with panel mounting clip and instructions. Only 35p + p.p. + V.A.T.

MC1310P only £2.77 + p.p. 6p + V.A.T.

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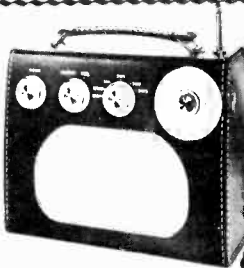
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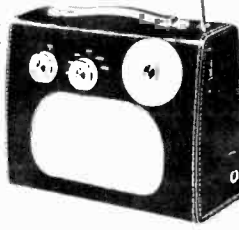


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TOTAL BUILDING COSTS

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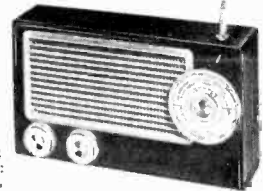
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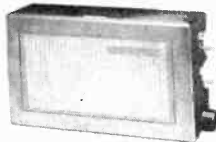
Attractive case with carrying handle. Size 9in x 7in x 4in approx. Easy to follow instructions and diagrams. Parts price list and easy build plans 25p (FREE with parts).

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P.P. & INS. 31p
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POCKET FIVE



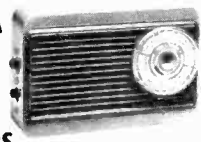
3 TUNABLE WAVEBANDS: MW, LW, TRAWLER BAND WITH EXTENDED MW BAND FOR EASIER TUNING OF LUXEMBOURG, ETC. 7 stages - 5 transistors and 2 diodes, super-sensitive ferrite rod aerial, fine tone moving coil speaker. Attractive black and gold case. Size 5 1/2in x 1 1/2in x 3 1/2in. Easy build plans and parts price list 10p (FREE with parts).

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TRANSONA FIVE



5 TRANSISTORS AND 2 DIODES

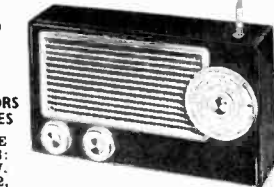
3 TUNABLE WAVE BANDS: MW, LW AND TRAWLER BAND. 7 stage - 5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, volume control, fine tone moving coil speaker. Attractive case with red speaker grille. Size 6 1/2in x 4 1/2in x 1 1/2in. Easy build plans and parts price list 10p (FREE with parts).

TOTAL BUILDING COSTS

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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 x 5 1/2in x 2 1/2in approx. Push-pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and easy build plans 25p (FREE with parts).

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| 1N93 | 0-20 | ASX26 | 0-85 | BYZ11 | 0-32 | OAZ222 | 0-45 | Z8271 | 0-18 |
| 1N85 | 0-88 | ASX27 | 0-82 | BYZ12 | 0-80 | OAZ223 | 0-45 | ZT21 | 0-85 |
| 1N85B | 0-50 | ASX28 | 0-25 | BYZ13 | 0-25 | OAZ224 | 0-45 | ZT43 | 0-85 |
| 1N266 | 0-80 | ASX29 | 0-50 | ASX29 | 0-80 | OAZ225 | 0-82 | ZTX107 | 0-15 |
| 1N645 | 0-25 | ASX30 | 0-25 | BYZ16 | 1-00 | OAZ234 | 0-28 | ZTX108 | 0-12 |
| 1N725A | 0-20 | ASX50 | 0-17 | BYZ16 | 0-62 | OAZ244 | 0-22 | ZTX304 | 0-85 |
| 1N914 | 0-07 | ASX51 | 0-40 | BYZ88C3V3 | | OAZ246 | 0-28 | ZTX300 | 0-12 |
| 1N4007 | 0-20 | ASX53 | 0-20 | | 0-15 | OAZ290 | 0-88 | ZTX300 | 0-12 |
| 18113 | 0-18 | ASX55 | 0-20 | C111 | 0-85 | OC16 | 0-80 | ZTX600 | 0-16 |
| 18130 | 0-18 | ASX82 | 0-25 | CR81/05 | 0-25 | OC18T | 0-88 | ZTX503 | 0-17 |
| 18131 | 0-18 | ASX86 | 0-28 | CR81/40 | 0-45 | OC19 | 0-87 | ZTX631 | 0-85 |
| 18202 | 0-28 | ASZ21 | 0-42 | CS4B | 2-50 | OC20 | 0-86 | | |
| 2G371 | 0-22 | ASZ23 | 0-75 | CS10H | 3-18 | OC22 | 0-50 | | |
| 2G381 | 0-25 | AUY10 | 0-98 | DD000 | 0-15 | OC23 | 0-60 | INTEGRATED | |
| 2G414 | 0-30 | AU101 | 1-50 | DD003 | 0-15 | OC24 | 0-60 | CIRCUITS | |
| 2G417 | 0-22 | BC107 | 0-10 | DD006 | 0-18 | OC25 | 0-87 | 7400 | 0-20 |
| 2N404 | 0-20 | BC108 | 0-10 | DD007 | 0-40 | OC26 | 0-25 | 7401 | 0-20 |
| 2N497 | 0-15 | BC109 | 0-10 | DD009 | 0-38 | OC28 | 0-60 | 7402 | 0-20 |
| 2N698 | 0-40 | BC113 | 0-15 | GD3 | 0-38 | OC28 | 0-60 | 7403 | 0-20 |
| 2N706 | 0-10 | BC115 | 0-20 | GD4 | 0-05 | OC29 | 0-60 | 7404 | 0-20 |
| 2N708A | 0-12 | BC116 | 0-25 | GD5 | 0-88 | OC30 | 0-40 | 7405 | 0-20 |
| 2N708 | 0-15 | BC116A | 0-80 | GD8 | 0-25 | OC35 | 0-50 | 7406 | 0-30 |
| 2N709 | 0-68 | BC118 | 0-25 | GD12 | 0-05 | OC36 | 0-60 | 7407 | 0-30 |
| 2N1091 | 0-28 | BC121 | 0-20 | GET102 | 0-80 | OC41 | 0-25 | 7408 | 0-20 |
| 2N1131 | 0-15 | BC122 | 0-25 | GET103 | 0-38 | OC41 | 0-25 | 7409 | 0-45 |
| 2N1132 | 0-25 | BC125 | 0-68 | GET113 | 0-20 | OC42 | 0-30 | 7410 | 0-20 |
| 2N1302 | 0-18 | BC126 | 0-65 | GET114 | 0-15 | OC43 | 0-40 | 7411 | 0-23 |
| 2N1303 | 0-18 | BC140 | 0-55 | GET115 | 0-45 | OC44 | 0-17 | 7412 | 0-42 |
| 2N1304 | 0-22 | BC147 | 0-15 | GET116 | 0-50 | OC44M | 0-17 | 7413 | 0-30 |
| 2N1305 | 0-22 | BC148 | 0-18 | GET120 | 0-25 | OC45 | 0-12 | 7416 | 0-30 |
| 2N1306 | 0-25 | BC149 | 0-15 | GET172 | 0-30 | OC45M | 0-18 | 7417 | 0-30 |
| 2N1307 | 0-25 | BC157 | 0-15 | GET875 | 0-25 | OC46 | 0-87 | 7420 | 0-20 |
| 2N1308 | 0-25 | BC158 | 0-12 | GET880 | 0-37 | OC67 | 0-60 | 7420 | 0-20 |
| 2N2147 | 0-75 | BC180 | 0-68 | GET881 | 0-25 | OC58 | 0-60 | 7422 | 0-48 |
| 2N2148 | 0-60 | BC189 | 0-13 | GET882 | 0-25 | OC59 | 0-85 | 7423 | 0-48 |
| 2N2160 | 0-60 | BCY31 | 0-85 | GET885 | 0-25 | OC86 | 0-50 | 7427 | 0-42 |
| 2N2218 | 0-20 | BCY32 | 0-55 | GEX44 | 0-08 | OC70 | 0-12 | 7428 | 0-50 |
| 2N2219 | 0-20 | BCY32 | 0-55 | GEX45 | 0-10 | OC71 | 0-10 | 7428 | 0-20 |
| 2N2369A | 0-15 | BCY33 | 0-25 | GEX941 | 0-15 | OC72 | 0-20 | 7430 | 0-20 |
| 2N2444 | 1-99 | BCY34 | 0-80 | GJ3M | 0-25 | OC73 | 0-80 | 7432 | 0-42 |
| 2N2613 | 0-28 | BCY38 | 0-40 | GJ4M | 0-38 | OC74 | 0-30 | 7433 | 0-70 |
| 2N2646 | 0-45 | BCY39 | 1-00 | GJ5M | 0-25 | OC75 | 0-25 | 7437 | 0-85 |
| 2N2904 | 0-20 | BCY40 | 0-50 | GJ7M | 0-37 | OC76 | 0-25 | 7440 | 0-20 |
| 2N2904A | 0-25 | BCY42 | 0-25 | HI1005 | 0-20 | OC77 | 0-40 | 7441 | 0-75 |
| 2N2906 | 0-20 | BCY70 | 0-15 | HS100A | 0-20 | OC78 | 0-20 | 7441AN | |
| 2N2907 | 0-28 | BCY71 | 0-20 | MAT100 | 0-25 | OC79 | 0-22 | 7442 | 0-75 |
| 2N2924 | 0-28 | BCZ10 | 0-35 | MAT101 | 0-30 | OC81 | 0-20 | 7450 | 0-20 |
| 2N2925 | 0-15 | BCZ11 | 0-50 | MAT120 | 0-25 | OC81D | 0-20 | 7451 | 0-20 |
| 2N2926 | 0-10 | BD121 | 0-65 | MAT121 | 0-30 | OC81M | 0-20 | 7453 | 0-20 |
| 2N3064 | 0-40 | BD123 | 0-60 | MJEG20 | 0-67 | OC81DM | 0-18 | 7454 | 0-20 |
| 2N3084 | 0-20 | BD132 | 0-75 | MJE2955 | 0-18 | OC81Z | 0-40 | 7460 | 0-20 |
| 2N3702 | 0-10 | BDY11 | 1-62 | MJE3055 | 0-87 | OC82 | 0-25 | 7470 | 0-80 |
| 2N3705 | 0-10 | BF115 | 0-25 | NKT128 | 0-35 | OC82D | 0-20 | 7472 | 0-30 |
| 2N3706 | 0-28 | BF117 | 0-20 | NKT129 | 0-30 | OC83 | 0-25 | 7473 | 0-40 |
| 2N3707 | 0-12 | BF167 | 0-25 | NKT211 | 0-25 | OC84 | 0-25 | 7474 | 0-40 |
| 2N3709 | 0-10 | BF173 | 0-25 | NKT213 | 0-25 | OC114 | 0-88 | 7475 | 0-55 |
| 2N3710 | 0-10 | BF181 | 0-25 | NKT214 | 0-15 | OC122 | 0-60 | 7478 | 0-80 |
| 2N3711 | 0-10 | BF184 | 0-20 | NKT216 | 0-37 | OC139 | 0-65 | 7480 | 0-80 |
| 2N3819 | 0-85 | BF185 | 0-20 | NKT217 | 0-35 | OC139 | 0-25 | 7482 | 0-87 |
| 2N6027 | 0-58 | BF194 | 0-17 | NKT218 | 1-13 | OC140 | 0-85 | 7483 | 1-00 |
| 2N6088 | 0-33 | BF195 | 0-15 | NKT210 | 0-38 | OC141 | 0-60 | 7484 | 0-90 |
| 28301 | 0-60 | BF196 | 0-15 | NKT222 | 0-80 | OC169 | 0-20 | 7486 | 0-45 |
| 28304 | 0-75 | BF197 | 0-15 | NKT224 | 0-22 | OC170 | 0-25 | 7489 | 0-75 |
| 28501 | 0-87 | BF881 | 0-24 | NKT231 | 0-24 | OC171 | 0-20 | 7491AN | 1-00 |
| 28702 | 0-62 | BF898 | 0-28 | NKT271 | 0-25 | OC200 | 0-40 | 7492 | 0-75 |
| AA129 | 0-20 | BFX12 | 0-20 | NKT272 | 0-25 | OC201 | 0-70 | 7493 | 0-75 |
| AAZ12 | 0-30 | BFX13 | 0-25 | NKT273 | 0-15 | OC202 | 0-80 | 7494 | 0-80 |
| AAZ13 | 0-12 | BFX29 | 0-25 | NKT274 | 0-20 | OC203 | 0-40 | 7495 | 0-80 |
| AC107 | 0-37 | BFX30 | 0-25 | NKT275 | 0-25 | OC204 | 0-40 | 7496 | 1-00 |
| AC120 | 0-20 | BFY10 | 0-20 | NKT277 | 0-20 | OC205 | 0-75 | 7497 | 0-60 |
| AC127 | 0-25 | BFX63 | 0-40 | NKT278 | 0-25 | OC206 | 0-60 | 74100 | 2-50 |
| AC128 | 0-20 | BFX84 | 0-25 | NKT301 | 0-40 | OC207 | 0-60 | 74107 | 0-50 |
| AC187 | 0-25 | BFX85 | 0-30 | NKT304 | 0-75 | OC460 | 0-20 | 74110 | 0-80 |
| AC188 | 0-25 | BFX86 | 0-25 | NKT403 | 0-75 | OC470 | 0-30 | 74111 | 1-45 |
| ACY17 | 0-30 | BFX87 | 0-25 | NKT404 | 0-55 | OC7P1 | 0-97 | 74118 | 1-00 |
| ACY18 | 0-25 | BFX88 | 0-25 | NKT678 | 0-30 | ORP12 | 0-80 | 74119 | 1-80 |
| ACY19 | 0-20 | BFY10 | 1-00 | TT113 | 0-25 | OC171 | 0-20 | 74121 | 0-60 |
| ACY20 | 0-20 | BFY11 | 1-25 | NKT773 | 0-25 | ORP61 | 0-42 | 74122 | 1-85 |
| ACY21 | 0-20 | BFY17 | 0-25 | NKT777 | 0-38 | SI9T | 0-80 | 74123 | 2-70 |
| ACY22 | 0-10 | BFY18 | 0-25 | 078B | 0-38 | SAC40 | 0-25 | 74141 | 1-00 |
| ACY27 | 0-25 | BFY19 | 0-25 | | | SFT308 | 0-88 | 74145 | 1-50 |
| ACY28 | 0-17 | BFY24 | 0-45 | 0A6 | 0-12 | ST722 | 0-88 | 74150 | 3-85 |
| ACY39 | 0-50 | BFY44 | 1-00 | 0A47 | 0-10 | ST7231 | 0-68 | 74151 | 1-10 |
| ACY40 | 0-15 | BFY50 | 0-32 | 0A70 | 0-10 | SX68 | 0-20 | 74154 | 2-00 |
| ACY41 | 0-15 | BFY51 | 0-20 | 0A71 | 0-10 | SX631 | 0-30 | 74155 | 1-55 |
| ACY44 | 0-25 | BFY62 | 0-22 | 0A73 | 0-10 | SX635 | 0-40 | 74156 | 1-55 |
| AD140 | 0-50 | BFY63 | 0-17 | 0A74 | 0-10 | SX640 | 0-50 | 74157 | 1-80 |
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| AF106 | 0-30 | BSX60 | 0-98 | 0A86 | 0-15 | SX645 | 0-40 | 74176 | 1-60 |
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| AF117 | 0-25 | BSY61 | 0-30 | OAZ200 | 0-07 | V60/201P | 0-75 | 74193 | 2-00 |
| AF118A | 0-42 | BSY85A | 0-12 | OAZ204 | 0-10 | XA101 | 0-10 | 74194 | 2-50 |
| AF119 | 0-20 | BSY87 | 0-12 | OAZ210 | 0-25 | XA102 | 0-18 | 74195 | 1-85 |
| AF124 | 0-25 | HT102/500R | | OAZ211 | 0-30 | XA151 | 0-15 | 74196 | 1-60 |
| AF125 | 0-20 | | | OAZ200 | 0-55 | XA152 | 0-15 | 74197 | 1-50 |
| AF126 | 0-17 | BTY42 | 0-92 | OAZ201 | 0-40 | XA161 | 0-25 | 74198 | 4-60 |
| AF127 | 0-17 | BTY79/100R | | OAZ202 | 0-42 | XA162 | 0-25 | 74199 | 4-80 |
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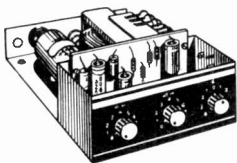
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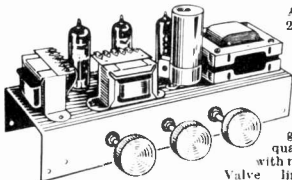


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BLACK ANODISED 16g. ALUMINIUM HEAT SINKS. For TO3, complete with nuts & bushes. Size 2 1/2in x 3in approx. 28p pair. P. & P.

HIGH GRADE COPPER LAMINATE BOARDS. 8" x 6", 3 for 55p. P. & P. 13p.

BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. Giving 13 alternatives. Primary: 0-210-240V. Secondary combinations: 0-5-10-15-20-25-30-35-40-60V half wave at 1 amp or 10-10-10, 20-20, 30-30V, at 2 amps full wave. Size 3inL x 3 1/2inW x 3inD. **Price £2.10.** P. & P. 30p.

MAINS TRANSFORMER. For transistor power supplies. Pri. 200/240V Sec. 9-0-9 at 500mA. £1. P. & P. 13p. Pri. 200/240V Sec. 12-0-12 at 1 amp. £1.10 P. & P. 13p. Pri. 200/240V Sec. 10-0-10 at 2 amp. £1.65 P. & P. 30p.

GENERAL PURPOSE HIGH STABILITY TRANSISTOR PRE-AMPLIFIER. For P.U. Tape, Mike, Guitar, etc., and suitable for use with valve or transistor equipment. 9-15V. Battery or from E.T. line 200/300V. Frequency response 15Hz-25KHz. Gain 26dB. Solid encapsulation size 1 1/2 x 1 1/2 in. Brand new - complete with instructions. Price £1. P. & P. 13p.

3 REFERENCE ENCYCLOPEDIAS FOR ELECTRONIC ENGINEERS AND DESIGNERS, covering between them, transistor characteristics, diode and transistor equivalents. Many thousands of up-to-date European types listed. Diode Equivalents 80p Transistor Equivalents 80p Transistor Characteristics £1.20 All three together **POST FREE**

HANDBOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES

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

CENTRE ZERO MINIATURE MOVING COIL METER. 100µA for balance or tuning. Approx. size 1in x 1in x 1/2in. Limited number 86p. P. & P. 10p.

Open 9-5.30 Mon. to Fri. 9-5 Sat. Early closing Wed. 1p.m. A few minutes from South Wimbledon Tube Station. **PRICES NOW INCLUDE VAT**

RECORD PLAYER BARGAINS
Mains models. All brand new in maker's packing. **LATEST B.S.R. C109/C129 AUTOCHANGER UNITS.** With latest stereo/mono compatible cartridge £7-60 plus 60p P. & P. **Garrard SP25 Mk. III** with heavy precision machined die cast turntable, £10-56. Carr. 60p.

PRECISION ENGINEERED PLINTHS
Beautifully constructed in heavy gauge "Colorcoat" plastic coated steel. Resonance free. Designed to take Garrard 1025, 2000, 2025TC, 2500, 3000, 3500, 5100, SP25 II and III, SL66B, AT60, etc., or B.S.R. C109, C129, A21, etc. Black leatherette finish. Size 12 1/2in x 14 1/2in x 3 1/2in high (approx. 7 1/2in high, including rigid smoked acrylic cover). P. & P. 35p. **Now only £4-95**

LATEST ACOG GP91/18C Mono Compatible Cartridge with t/o stylus for I.P./EP/78. Universal mounting bracket. £1-50. P. & P. 8p.

SONOTONE STANC COMPATIBLE STEREO CARTRIDGE T/O stylus. Diamond Stereo LP and Sapphire 78. **ONLY £2-30.** P. & P. 10p. Also available fitted with twin Diamond T/O stylus for Stereo LP. £2-80. P. & P. 10p.

LATEST RONETTE T/O Stereo Compatible Cartridge for EP/LP/Stereo/78. £1-63. P. & P. 10p.

LATEST RONETTE T/O Mono Compatible Cartridge for EP/LP/78 mono/stereo records on mono equipment £1-50. P. & P. 10p.

QUALITY RECORD PLAYER AMPLIFIER MK II
A top-quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, and rectifier. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. x 3 d. x 6 h. Ready built and tested. **PRICE £4-40.** P. & P. 40p. **ALSO AVAILABLE** mounted on board with output transformer and speaker. **PRICE £5-85.** P. & P. 60p.

SPECIAL OFFER!! HI-FI LOUDSPEAKER SYSTEM

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

Our Price £9.25 Carr. 70p.

CABINET AVAILABLE SEPARATELY £4.95. Carr. 65p.

Also available in 8 ohm with EMI 13in x 8in. Bass speaker with parasitic tweeter. £7.15. Carr. 70p.

HARVERSON'S SUPER MONO AMPLIFIER
A super quality gram amplifier using a double wound fully isolated mains transformer, rectifier and ECL82 triode pentode valve as audio amplifier and power output stage. Impedance 3 ohms. Output approx. 3.5 watts. Volume and tone controls. Chassis size only 7in. wide x 3in. deep 6in. high overall. A.C. mains 200/240V. Supplied absolutely Brand New, completely wired and tested with good quality output transformer.

OUR ROCK BOTTOM BARGAIN PRICE £3-30 P. & P. 35p

LOUDSPEAKER BARGAINS
5in 3 ohm £1-05. P. & P. 15p. 7 x 4in 3 ohm £1-15. P. & P. 20p. 10 x 6in 3 or 15 ohm £1-90. P. & P. 30p. E.M.I. 8 x 5in 3 ohm with high flux magnet £1-62. P. & P. 20p. E.M.I. 13 1/2 x 8in with high flux ceramic magnet with parasitic tweeter 3, 8, or 15 ohm £3-50. P. & P. 30p. E.M.I. 13 x 8in, 3, 8 or 15 ohm with two inbuilt tweeters and crossover network £4-65. P. & P. 30p. **EMI CERAMIC MAGNET HEAVY DUTY TWEETER.** approx. 3in. AV. 3 or 8 or 15 ohms. £1-25 plus 15p p. & p. **BRAND NEW.** 12in 15W Hi-Fi Speakers, 3 or 15 ohm. Current production by well-known British maker. Now with Hiflux ceramic ferrobar magnet assembly £7-50. Guitar models: 25W £7-50. 35W £9-35. P. & P. 40p each.



SPECIAL OFFER!

LIMITED NUMBER OF BRAND NEW ELAC TWIN CONE LOUDSPEAKERS. With large ceramic magnet and plasticised cone surround. 8 ohm impedance. £2-70. P. & P. 25p.

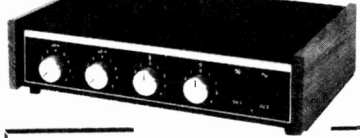
12in "RA" TWIN CONE LOUDSPEAKER
10 watts peak handling, 3, 8 or 15 ohm, £2-45. P. & P. 40p. **15 ohm SPEAKERS 3.** ONLY 70p. P. & P. 13p. **"POLY PLANAR" WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER**
Size 1 1/2in x 1 1/2in x 1 1/2in deep. Weight 19oz. Power handling 20W r.m.s. (40W peak). Impedance 8 ohm only. Response 40Hz-20KHz. Can be mounted on ceilings, walls, doors, under tables, etc., and used with or without baffle. Send S.A.E. for full details. Only £8-55 each. P. & P. 25p. **VYNAIR & REXINE SPEAKERS & CABINET FABRICS** app. 5 1/2 in. wide. Our price 85p yd. length. P. & P. 15p per yd. (min. 1 yd.). S.A.E. for samples.

HI-FI STEREO HEADPHONES

Adjustable headband with comfortable flexible ear-muffs. Wired and fitted with standard stereo 3 1/2in jack plug. Frequency response 30-15,000Hz. Matching impedance 8-16 ohms. Easily converted for mono. **PRICE £3-30.** P. & P. 15p.

HIGH IMPEDANCE CRYSTAL STICK MIXES. 01" P. & P. £1-15. P. & P. 10p.

HARVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT



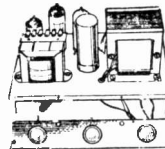
NEW FURTHER IMPROVED MODEL WITH HIGHER OUTPUT AND INCORPORATING HIGH QUALITY READY DRILLED FIBRE GLASS PRINTED CIRCUIT BOARD WITH COMPONENT IDENTIFICATION CLEARLY MARKED FOR EVEN EASIER CONSTRUCTION

A really first-class Hi-Fi Stereo Amplifier Kit. Use 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. (Very simple to modify to suit magnetic cartridge—Instructions included). Output stage for any speakers from 5 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled fibre glass printed circuit board, smart brushed anodised aluminium front panel with matching knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification: Power output 14W r.m.s. per channel into 5 ohms. Frequency response 5-30Hz 12-30,000Hz. Sensitivity better than 50mV into 1MΩ. Full power bandwidth -3dB 12-15,000Hz. Bass boost approx. to +12dB. Treble cut approx. to -16dB. Negative feedback 18dB over main amp. Power requirements 35V at 1.0 amp. Overall size—12" wide 8" deep 2 1/2" high.

Fully detailed 7-page construction manual and parts list free with kit or send 14p plus large S.A.E. **PRICES: AMPLIFIER KIT, £11.55** P. & P. 15p. (Magnetic input components 33p extra) **POWER PACK KIT, £3.30** P. & P. 35p. **CABINET, £3.30** P. & P. 35p.

(Post Free if all units purchased at same time). Full after sales service. Also available ready built and tested, £23-10. 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 permit mixing and fading facilities for medium powered Hi-Fi Diathèque use, etc.



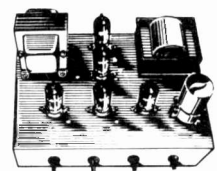
3-VALVE AUDIO AMPLIFIER HA34 MK II

Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7in. w. x 4in. d. x 4 1/2in. h. Incorporates ECC83, EL84, E280 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm wide range tone controls giving bass and treble lift and cut. Negative feedback link. Output 4 watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only **£5.50.** P. & P. 35p.

BRITISH MADE SOLID STATE ALL SILICON STEREO AMPLIFIER. 15 watts rms per channel output. Freq. res. 20Hz to 20KHz. Suitable for magnetic or ceramic pickup tape mic, etc., built-in switchable scratch filter, rumble filter and loudness control. 10 m slider controls for bass, treble and volume. 10 way push button function, selector switch. This amplifier has specification and performance usually only found in amplifiers costing twice as much. Each amplifier supplied, tested and fully guaranteed. Finished in the most attractive contemporary style teak cabinet. Size 16 1/2in. x 8 1/2in. x 4 1/2in. Makers' recommended price £46-56. Our price (while stocks last) **£35.75 plus 75p** P. & P. Send S.A.E. for full details of specification.

10 1/4 WATT HI-FI AMPLIFIER KIT

A stylishly finished monaural amplifier with an output of 10 1/4 watts from 2 EL84's in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving E280 rectifier. Simple instruction booklet 13p (free with parts). All parts sold separately. **ONLY £8.80.** P. & P. 55p. Also available ready built and tested **£12-10.** P. & P. 60p.



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Sinclair Project 60

Now—the Z.50 Mk.2

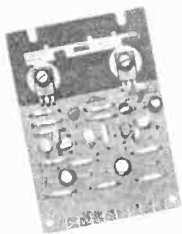
with built-in automatic transient overload protection

When originally introduced, the Sinclair Z.50 proved how it was possible to design and produce a popularly priced modular power amplifier having characteristics to challenge the world's costliest amplifiers. Many thousands of Z.50's are now giving excellent service day in, day out. But we have also learned that constructors do not always use their Z.50's ideally. That is why we have introduced modifications whereby risk of damage through mis-use, is greatly reduced and performance further enhanced. The Z.50 Mk 2 has improved thermal stability, more accurately regulated D.C. limiting to ensure more symmetrical output voltage swing and clipping and still less distortion at lower power. Z.50 Mk.2 is compatible with all other Project 60 modules, and may be incorporated to advantage in existing systems. Eleven silicon epitaxial planar transistors are now used, two more than in the original Z.50; circuitry has been re-designed, making this versatile high performance amplifier better than ever.



with free manual
£5.48

Z.30 the power amplifier for quality and economy

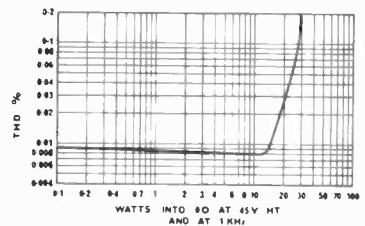


with free manual
£4.48

The Z.30 provides excellent facilities for the constructor requiring a high fidelity audio system of less power than that available from Z.50's. Using a power supply of 35 volts, Z.30 will deliver 15 watts RMS into 8 ohms, or 20 watts RMS into 3 ohms using 30 volts. Total harmonic distortion is a fantastically low 0.02% at 15 watts into 8 ohms with signal to noise ratio better than 70 dB unweighted. Input sensitivity 250mV into 100K ohms. Size 80 x 57 x 13 mm (3 1/8 x 2 1/4 x 1/2). Z.30, Z.50 and Z.50 MK 2 modules are compatible and interchangeable.

Brilliant new technical specifications

Input impedance 100 K Ω
Input (for 30w into 8 Ω) 400mV
Signal to noise ratio, referred to full o/p at 30v HT 80dB or better
Distortion 0.02% up to 20W at 8 Ω . See curve
Frequency response 10Hz to more than 200 KHz \pm 1dB
Max. supply voltage 45v (4 Ω to 8 Ω speakers) (50v 15 Ω speakers only)
Min. supply voltage 9v
Load impedance – minimum: 4 Ω at 45v HT
Load impedance – maximum: safe on open circuit



Typical Project 60 applications

| System | The Units to use | together with | Units cost |
|--|---|--|------------|
| Simple battery record player | Z.30 | Crystal P.U., 12V battery volume control, etc. | £4.48 |
| Mains powered record player | Z.30, PZ.5 | Crystal or ceramic P.U. volume control, etc. | £9.45 |
| 12W. RMS continuous sine wave stereo amp. for average needs | 2 x Z.30s, Stereo 60; PZ.5 | Crystal, ceramic or mag. P.U., F.M. Tuner, etc. | £23.90 |
| 25W. RMS continuous sine wave stereo amp. using low efficiency (high performance) speakers | 2 x Z.30s, Stereo 60; PZ.6 | High quality ceramic or magnetic P.U., F.M. Tuner, Tape Deck, etc. | £26.90 |
| 80W. (3 ohms) RMS continuous sine wave de luxe stereo amplifier. (60W. RMS into 8 ohms) | 2 x Z.50s, Stereo 60; PZ.8, mains transformer | As above | £34.88 |
| Indoor P.A. | Z.50, PZ.8, mains transformer | Mic., guitar, speakers, etc., controls | £19.43 |

F.M. Stereo Tuner (£25) & A.F.U. (£5.98) may be added as required.

Guarantee

If, within 3 months of purchasing any product direct from Sinclair Radionics Ltd., you are dissatisfied with it, your money will be refunded at once. Many Sinclair appointed Stockists also offer this same guarantee in co-operation with Sinclair Radionics Ltd.

Each Project 60 module is tested before leaving our factory and is guaranteed to work perfectly. Should any defect arise in normal use, we will service it at once and without any charge to you, if it is returned within two years from the date of purchase. Outside this period of guarantee a small charge (typically £1.00) will be made. No charge is made for postage by surface mail. Air Mail is charged at cost.

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the world's most advanced high fidelity modules

Stereo 60 Pre-amp/control unit



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

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

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

Project 60 Stereo F.M. Tuner

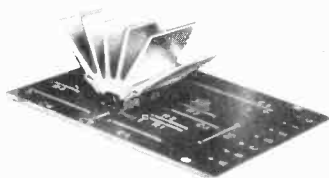


The phase lock loop principle was used for receiving signals from space craft because of its vastly improved signal to noise ratio. Now, Sinclair have applied the principle to an F.M. tuner with fantastically good results. Other advanced features include varicap diode tuning, printed circuit coils, an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

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

Built and tested. Post free. **£25**

Super IC.12 Integrated circuit high fidelity amplifier



Having introduced Integrated Circuits to hi-fi constructors with the IC.10, the first time an IC had ever been made available for such purposes, we have followed it with an even more efficient version, the Super IC.12, a most exciting advance over our original unit. This needs very few external resistors and capacitors to make an astonishingly good high fidelity amplifier for use with pick-up, F.M. radio or small P.A. set up, etc. The free 40 page manual supplied, details many other applications which this remarkable IC make possible. It is the equivalent of a 22 tran-

sistor circuit contained within a 16 lead DIL package, and the finned heat sink is sufficient for all requirements. The Super IC.12 is compatible with Project 60 modules which would be used with the Z.50 and Z.30 amplifiers. Complete with free manual and printed circuit board.

SPECIFICATIONS

Output power: 6 watts RMS continuous (12 watts peak). 6–8 Ω . **Frequency Response:** 5Hz to 100KHz ± 1 dB. **Total Harmonic Distortion:** Less than 1%. (Typical 0.1%) at all output powers and frequencies in the audio band (28V). **Load impedance:** 3 to 15 ohms. **Input Impedance:** 250 Kohms nominal. **Power Gain:** 90dB (1,000,000,000 times) after feedback. **Supply Voltage:** 6 to 28V. **Quiescent current:** 8mA at 28V. **Size:** 22 x 45 x 28mm including pins and heat sink.

Manual available separately 15p post free.

With FREE printed circuit board and 40 page manual. **£2.98** Post free

Power Supply Units The new PZ.8 Mk.3



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

PZ.8 Mk 3—£7.98

(Mains transformer, if required) £5.98

PZ.5 30v. un stabilised
(not suitable for Project 60 tuner) £4.98

PZ.6 35v. stabilised
(not suitable for IC. 12) £7.98

Project 605



the easy way to
buy and build
Project 60
without
soldering

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

Complete with comprehensive manual, post free

£29.95

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BELLING LEE INSULATED TERMINALS. Red or Black, 6 amp max. 10p pair, p.p. 4p

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FINNED ALUMINIUM HEATSINK. 9in x 1 1/2in. Drilled. 20p, p.p. 7p.

SUB-MIN. CROC. CLIPS. Red or Black, insulated 4p. Min. quantity, 6, p.p. 3p.

GARRARD MAG. TAPE DECKS: 1 1/2 p.s., 50V, solenoid operated brakes, etc. Mains voltage motors 27-50 each, p.p. 21-23.

4in PLANNAR FANS. Complete, capacitor, ex equip. 2,800 r.p.m. 23-50, p.p. 40p.

ELECTRIC MOTORS, HOOVER OR CROMPTON PARKINSON. 250V. Single phase a.c.
 1/2 h.p., 1,440 r.p.m., 23-75, p.p. 21.
 1 h.p., 1,425 r.p.m. or 2,800 r.p.m., 28-75, p.p. 21-25.
 1/2 h.p., 1,440 r.p.m., 22-25, p.p. 75p.

AUDIO CONNECTORS
 3 pin Din Plug 18p each.
 3 pin Din Plug A type, B type 18p
 2 pin Din Speaker Plug/Socket 10p
 3 pin Din Line Socket 13p
 3-5mm Jack Plug Screened 10p
 Standard Jack Plug 10p
 Screened Standard Jack Plugs 15p
 Stereo Jack Plug 18p
 Screened Stereo Jack Plug 18p

Phono Pins: Red or Black 3p each. P.p. on above items 3p.

MAINS NEONS
 Red or Green. Size: 1/2in x 1/2in x 1 1/2in. 15p, p.p. 34p.

LEVER ACTION P.O.1000 TYPE SWITCHES
 Lock 4-pole changeover, 15p, p.p. 4p. Ex equip. Lock 2-pole changeover, 10p, p.p. 4p. Ex equip.

AUDIO LEADS
 Screened Phono Leads 46in long, 15p.
 3-5mm JACK/3-5mm JACK 7in 6in long, 40p.
 3-Pin Din A Type, 3-PIN A TYPE. Approx. 5ft long, 70p.
 P.p. on above items 5p.

MULLARD & MALLORY SAEW TERMINAL CAPACITORS 4,300pF 64V, 7,100pF 40V. 50p each. 20,000 30p, 25,000 25V, 36,000 15V, 80p each, p.p. 16p.

MULLARD FULLWAVE RECTIFIERS 6-48V, 15 amp, 75p, p.p. 10p.

BELLING LEE 1.5 amp in-line rubber covered interference suppressor, 25p, p.p. 8p.

RUBBER 3 PIN 5 AMP NON-REVERSIBLE CABLE CONNECTORS, 20p, p.p. 5p.

SOLENOIDS 12 VOLT FULL ACTION 2in x 1 1/2in x 1 1/2in, 40p, p.p. 8p.

SOLENOIDS MAINS 240V A.C. pull action. 2 1/2in x 1 1/2in x 1 1/2in, 50p, p.p. 8p.

10 REED SWITCHES WITH MAGNETS. Operated by 10 push buttons 10in x 6in x 1 1/2in, 50p, p.p. 21p.

SIEMENS MINIATURE RELAY. Four pole changeover dust cover/base 48V, 2500, 50p, p.p. 5p new.

OMRON MK2 MIDGET POWER RELAY. 12V d.c. Double pole changeover. New, 70p, p.p. 5p.

STC MINIATURE RELAY 280 Ω . perapex cover. Two pole changeover 6-15V new, 35p, p.p. 5p.

GARDNER'S POTTED TRANSFORMER. 0-250V. Input: 18V 500mA, 50V 150mA, 8V 250mA output. Size: 3in x 2 1/2in x 2 1/2in, 21, p.p. 20p. Ex equip. tested.

RIPLEY TRANSFORMERS. Primary 115 and 250V, sec. 12.5-0-12.5 at 750 mA. 7V-0-7V at 1 amp. 2 1/2in x 2 1/2in x 2in. Price 21, p.p. 21p.

TELESCOPIC AERIALS
 Chromed 7in closed, 28in extended, 6 section ball jointed base, 25p, p.p. 8p new.

MULLARD 4 DM 180 INDICATORS in plastic holder/cover, ex equip., size approx. 1 1/2in x 1 1/2in x 1in. 30p, p.p. 8p.

PRINTED CIRCUIT BOARD/19 ACV 18's 10 0 A200
 Diodes: 1 reed relay: 1 AZ 218 zener aa. capacitor/ resistors. Power supply 22V, 250 mA d.c. Output 240V a.c. 21, p.p. 20p. Ex equip.

WIRING CABLE
 Size: 1-020. Various colours. 350yd, 60p, p.p. 28p.

PAINTON PLUG SOCKETS. Type 159 series. Working voltage 350V a.c./d.c. current, max. 3 amp a.c./d.c. 7 pin plug and socket, 50p, p.p. 6p. 15 pin plug and socket, 21, p.p. 6p. 31 WAY PLUG AND SOCKET, 21-50, p.p. 6p.

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A.F. SIGNAL GENERATOR (Nov. 72) S/c's, Rs, Cs, Pots, Sw's. PCB (2 1/2in x 4in) also holds Sw's, £3.15.

AUDIO MIXER (Jan. 72) Rs, Cs, Pots, PCB (1 1/2in x 2in), £1.55. (I.C. Excl.)

BIOLOGICAL AMPLIFIER (Jan./Feb. 73)—Pre-amp Set S/c's, I.c's Rs, Cs, Pots, PCB (1 1/2in x 3 1/2in), £3.70.

DOOR BELL YOELLER (Apr. 71)—S/c's, Rs, Cs, Pots, Transformer, Loudspeaker, PCB (3 1/2in x 3 1/2in), £7.70.

ELECTRONIC PIANO (Sept. 72/Jan. 73)—Details in lists.

GEMINI STEREO AMP (Nov. 70/Mar. 71) Stereo Sets and PCB's Pre-Amp—S/c's, £1.85. Rs, Cs, Pots, Maka-Sw's—with 1W 2%, M.O. Rs, £11.60 —with 1/2W 5% C.F. Rs, £9.35—with 1W 5% C.F. Rs, £8.90. PCB (3 1/2in x 10 1/2in) for kits with M.O. or 1/2W C.F. Rs. Holds pots and Maka-Sw's, £2.10. Main Amp—Rs, Cs, Pots, £5.40. PCB (3 1/2in x 5in), £1.40. PSU—Rs, Cs, Pot, £3.70. PCB (2in x 4in), 75p.

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HI-FI TAPE LINK (Mar./Apr. 73) S/c's, I.c's, Rs, Cs, Relay and PC-base, Sw's, Pots, Panel Lamp—Mono £10.80, Stereo £16.70. Power Supply £2.50. PCBs—Main Control PCB (3 1/2 x 9in) holds 2 R/C, 2P/B, 2 Meter circuits incl. relay and pot cores £1.85. Sub-assembly PCB (2 1/2in x 6 1/2in) for switch and pot associated Rs and Cs—mounts on Maka-switch 80p.

LOGICAL RADIO CONTROL (Dec. 71/Jan. 72)—Details in lists.

MODEL SERVO CONTROL (Feb./Mar. 72)—Details in lists.

MICROPHONE MIXER (Apr. 69)—S/c's, Rs, Cs, Pots, PCB (3 1/2in x 4 1/2in)—also holds pots, £4.10.

PHOTOPRINT PROCESS CONTROL (Jan./Feb. 72) Finds exposure, controls timing, stabilises mains voltage. S/c's, SCR, LDR, Rs, Cs, Pots, Relay, Keyswitch, T/former. PCB (3 1/2in x 5 1/2in) also holds pots, relay, keyswitch, £8.80.

SOUND SYNTHESIZER (Current Series)—Details in lists.

TAPE NOISE LIMITER (Feb. 72)—Mono Circuit S/c's, Rs, Cs, Pot, PCB (1 1/2in x 3in), £2.20. Regulated Power Supply (will feed 2 units) and PCB (1 1/2in x 2 1/2in), £3.20.

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ULTRASONIC TRANSMITTER-RECEIVER (May 72) Rs, Cs, Pot, S/c's, Relay, Dual PCB (2in x 5 1/2in), £3.90.

VERSATILE LIGHT EFFECTS UNIT (Jun. 72)—Single Channel Sound Controlled Light—also has built-in variable strobe. S/c's (excl. SCR), Rs, Cs, Pots, T/formers, Keyswitch, £8.85. PCB (3 1/2in x 7 1/2in) also holds Pots, Sw, T/former (T/17), £1.50.

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REVERBERATION UNIT (Practical Wireless Nov.-Dec. 72) S/c's, Rs, Cs, Slider Pots T/former, £6.80. PCB (2in x 1 1/2in) also holds sliders (compatible with publ. panel) £1.20.

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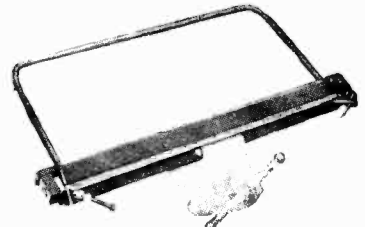
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| 2G309 | 0-50 | 2N3415 | 0-10 | 3N143 | 0-81 | AF284 | 0-54 | BCY34 | 0-85 | BFX63 | 2-48 |
| 2G345B | 0-25 | 2N3416 | 0-15 | 3N152 | 0-82 | AF288 | 0-74 | BCY38 | 0-40 | BFX68 | 0-30 |
| 2G371 | 0-15 | 2N3417 | 0-21 | 3N153 | 0-81 | AF211 | 0-55 | BCY39 | 1-05 | BFX84 | 0-24 |
| 2G374 | 0-15 | 2N3570 | 1-25 | 3N154 | 0-94 | AL102 | 0-75 | BCY40 | 0-81 | BFX85 | 0-29 |
| 2N174 | 1-40 | 2N3571 | 1-12 | 3N159 | 1-17 | AL103 | 0-70 | BCY42 | 0-15 | BFX86 | 0-24 |
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| 2N466 | 0-75 | 2N3702 | 0-10 | 3N200 | 2-49 | ASY27 | 0-38 | BCY58 | 0-21 | BFX88 | 0-25 |
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| 2N491 | 3-25 | 2N3705 | 0-14 | | | ASY29 | 0-30 | BCY66 | 0-63 | BFY10 | 0-35 |
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| 2N1638 | 0-27 | 2N3856A | 0-16 | AC126 | 0-25 | BU167B | 0-11 | BF129 | 0-27 | BSY28 | 0-15 |
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| 2N1717 | 0-17 | 2N3859 | 0-16 | BC169B | 0-13 | BF158 | 0-15 | BF158 | 0-15 | BSY31 | 0-25 |
| 2N1893 | 0-84 | 2N3859A | 0-16 | AC142K | 0-25 | BC169C | 0-13 | BF159 | 0-27 | BSY32 | 0-25 |
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| 2N2147 | 0-70 | 2N3866 | 0-70 | AC152V | 0-17 | BC171 | 0-15 | BF161 | 0-25 | BSY56 | 0-30 |
| 2N2148 | 0-60 | 2N3877 | 0-25 | AC153 | 0-22 | BC172 | 0-11 | BF162 | 0-25 | BSY65 | 0-15 |
| 2N2192 | 0-40 | 2N3877A | 0-25 | AC153K | 0-22 | BC182 | 0-10 | BF166 | 0-35 | BSY78 | 0-40 |
| 2N2192A | 0-40 | 2N3878 | 1-22 | AC154 | 0-25 | BC182L | 0-12 | BF167 | 0-18 | BSY78 | 0-40 |
| 2N2193 | 0-40 | 2N3879 | 1-91 | AC176 | 0-18 | BC183 | 0-09 | BF173 | 0-25 | BSY79 | 0-40 |
| 2N2193A | 0-42 | 2N3900 | 0-20 | AC187K | 0-20 | BC183L | 0-09 | BF177 | 0-25 | BSY95A | 0-20 |
| 2N2194 | 0-27 | 2N3900A | 0-21 | AC188K | 0-26 | BC184 | 0-11 | BF178 | 0-25 | BU104 | 1-42 |
| 2N2194A | 0-30 | 2N3901 | 0-32 | AC191 | 0-25 | BC184L | 0-11 | BF179 | 0-30 | BU105 | 2-25 |
| 2N2195 | 0-37 | 2N3903 | 0-37 | ACY18 | 0-15 | BC185 | 0-25 | BF180 | 0-35 | C111 | 0-53 |
| 2N2196A | 0-18 | 2N3904 | 0-17 | ACY19 | 0-20 | BC207 | 0-25 | BF181 | 0-32 | C40N3 | 0-55 |
| 2N2218A | 0-30 | 2N3905 | 0-21 | ACY19 | 0-20 | BC208 | 0-11 | BF182 | 0-30 | GET111 | 0-45 |
| 2N2219 | 0-37 | 2N3906 | 0-22 | ACY20 | 0-20 | BC205 | 0-10 | BF183 | 0-40 | GET114 | 0-20 |
| 2N2219A | 0-51 | 2N4036 | 0-63 | ACY21 | 0-18 | BC206 | 0-11 | BF184 | 0-17 | GET114 | 0-20 |
| 2N2220 | 0-20 | 2N4037 | 0-42 | ACY22 | 0-13 | BC207 | 0-10 | BF185 | 0-17 | GET115 | 0-50 |
| 2N2221A | 0-33 | 2N4059 | 0-09 | ACY28 | 0-18 | BC208 | 0-09 | BF194 | 0-15 | GET119 | 0-35 |
| 2N2222 | 0-31 | 2N4060 | 0-11 | ACY30 | 0-42 | BC209 | 0-10 | BF195 | 0-15 | GET120 | 0-25 |
| 2N2222A | 0-41 | 2N4061 | 0-11 | ACY40 | 0-17 | BC211 | 0-30 | BF196 | 0-15 | GET55 | 0-20 |
| 2N2368 | 0-11 | 2N4062 | 0-11 | ACY41 | 0-17 | BC212K | 0-10 | BF197 | 0-15 | GET336 | 0-20 |
| 2N2369 | 0-89 | 2N4302 | 0-25 | ACY44 | 0-31 | BC212L | 0-18 | BF198 | 0-15 | GET398 | 0-20 |
| 2N2369A | 0-17 | 2N4303 | 0-32 | AD136V | 0-66 | BC236 | 0-16 | BF199 | 0-18 | GET873 | 0-12 |
| 2N2646 | 0-50 | 2N4913 | 0-80 | AD140 | 0-50 | BC237 | 0-09 | BF200 | 0-35 | GET880 | 0-30 |
| 2N2647 | 1-20 | 2N4914 | 0-87 | AD140 | 0-50 | BC237 | 0-09 | BF242J | 0-14 | GET883 | 0-20 |
| 2N2711 | 0-16 | 2N4915 | 0-85 | AD142 | 0-50 | BC238 | 0-09 | BF237 | 0-22 | GET887 | 0-20 |
| 2N2712 | 0-12 | 2N4916 | 0-20 | AD143 | 0-45 | BC239 | 0-09 | BF238 | 0-22 | GET890 | 0-22 |
| 2N2713 | 0-17 | 2N4917 | 0-17 | AD149V | 0-66 | BC251 | 0-20 | BF244 | 0-18 | GET895 | 0-25 |
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| 2N2904 | 0-18 | 2N4919 | 0-53 | AD150 | 0-63 | BC257 | 0-09 | BF246 | 0-43 | TIP30A | 0-53 |
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| 2N2907A | 0-25 | 2N4928 | 1-80 | AF106 | 0-27 | BC302 | 0-27 | BF261 | 1-45 | TIP41A | 2-90 |
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| 2N2924 | 0-12 | 2N4930 | 2-25 | AF114 | 0-25 | BC304 | 0-43 | BF271 | 0-21 | TIP2955 | 0-98 |
| 2N2925 | 0-12 | 2N4931 | 2-70 | AF115 | 0-24 | BC307 | 0-10 | BF272 | 0-53 | TIP3055 | 0-80 |
| 2N2926 | 0-12 | 2N5172 | 0-08 | AF116 | 0-25 | BC307 | 0-10 | BF272 | 0-53 | | |
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| Yellow | 0-10 | 2N5175 | 0-28 | AF118 | 0-50 | BC307V1 | 0-10 | BF274 | 0-23 | | |
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| 2N3053 | 0-31 | 2N5245 | 0-43 | AF124 | 0-24 | BC308A | 0-09 | BF458 | 0-53 | | |
| 2N3054 | 0-49 | 2N5190 | 0-82 | AF125 | 0-25 | BC308B | 0-09 | BF459 | 0-53 | | |
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| 2N3055 | 0-40 | 2N5192 | 1-24 | AF127 | 0-20 | BC309A | 0-10 | BF821A | 2-10 | | |
| 2N3390 | 0-20 | 2N5193 | 1-01 | AF139 | 0-38 | | | | | | |

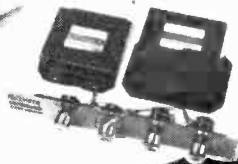
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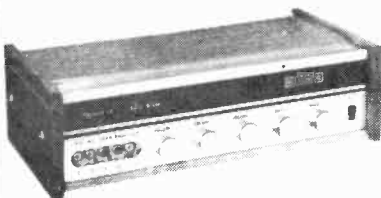
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The Tourist PB is suitable for 12 volt working on both negative and positive earth vehicles. It covers the full medium and long wave bands. It is permeability tuned and sturdily constructed. Output is a full 2.5 watts into an 8 ohms speaker. But the Tourist PB will operate into any loud-speaker from 8 to 15 ohms.

Apart from the output stage, which is an integrated circuit, the only other electronic components that need soldering are some capacitors, resistors, etc. The kit includes a pre-built RF tuner unit, and fully modulated IF stages which are pre-aligned before despatch. As well as electronic components this kit also contains 2 diamond-spun aluminium knobs, elegant matching front panel, dial, washers, screws and wire.

The Tourist PB can be mounted in any standard size dash panel and it has an illuminated tuning scale. Chassis size is: 7in wide, 2in high and 4½in deep.

RELIANT Mk IV

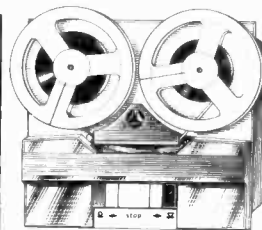


*5 Electrically Mixed inputs. *3 Individual Mixing controls. *Separate bass and treble controls common to all 5 inputs. *Mixer employing F.E.T. (Field Effect Transistors). *Solid State Circuitry. *Attractive Styling. INPUTS 1. Crystal Mic or Guitar 9mV. 2. Moving coil Mic. or Guitar 8mV. Inputs 3, 4 & 5 are suitable for a wide range of medium output equipment (Gram, Tuner, Monitor, Organ, etc.) All 250mV sensitivity. Output 20 watts into 8 ohms (suitable for 15 ohms). Size approx. 12½ x 6 x 3½ ins.

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SOUND 50

45 WATT MONO AMPLIFIER. Ideal for Disco. Output Power: 45 watts R.M.S. (Sine Wave) Frequency Response 3dB points 30Hz and 18KHz. Total Distortion: less than 2% at rated output. Signal to noise ratio: better than 60dB. Bass Control Range: 13dB at 60Hz. Treble Control Range: 12dB at 10KHz. Inputs: 4 inputs at 5mV into 470K. Each pair of inputs controlled by separate volume control. 2 inputs at 200mV into 470K. Size: 19½ x 10½ x 8ins. **£31.35** (inc. VAT) plus £1.65 p. and p.



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Suitable 3 speed tape deck, less heads. Caters up to 7ins. spools. Unused but store soiled hence no warranty. **£8.80** plus 60p packing & 50p post.

ALL PRICES INCLUDE VAT

Watts per channel RMS

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20 + 20W r.m.s. 40Hz to 40kHz ± 3dB. Total distortion at 10W at 1kHz - 0.1%. This is real value for money! We have designed 2 systems and the heart of them both is the Viscount III amplifier. A unit of great eye appeal with teak finished cabinet, FET's (Field effect, transistors) are incorporated on the input stages, just like top priced units. FET's give you more of the signal you want and almost none of the hiss you don't. Both units have output sockets for headphones and tape recorder.

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

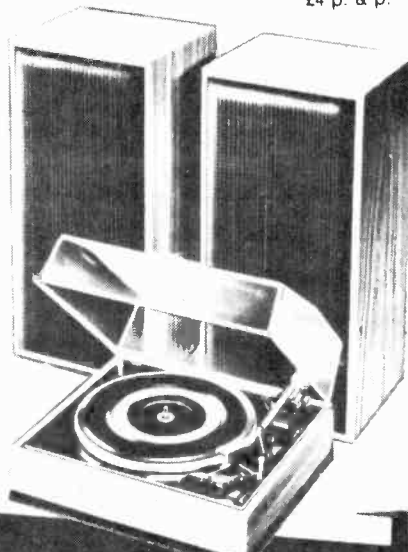
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Available complete for only **£52 +**
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| 2 Duo Type III speakers | £35.20 - £3.30 p & p |
| Garrard SP25 Mk III with MAG cartridge plinth & cover | £25.00 - £1.75 p & p |
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SPEAKERS: Duo Type II Size approx. 17in x 10½in x 6½in. Drive unit 13in x 8in with parasitic tweeter. Max. power 10 watts 8 ohms. Simulated Teak cabinet. £15.40 a pair (inc. VAT), £2.20 p. & p. Duo Type III Size approx. 23½in x 11½in x 9in. Drive unit 13in x 8in with HF speaker. Max. power 20 watts, 8 ohms. Freq. range 20Hz to 20kHz. Teak veneer cabinet. £35.20 a pair (inc. VAT) + £3.30 p.&p.

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| H8/2 | 2.2µF | 25V | 4p | H7/6 | 100µF | 25V | 5p |
| H8/2A | 3.3µF | 25V | 4p | H7/6A | 100µF | 15V | 4p |
| H8/3 | 3µF | 50V | 4p | H7/7 | 100µF | 25V | 4p |
| H8/3A | 4µF | 50V | 4p | H7/8 | 125µF | 16V | 5p |
| H8/4 | 4.7µF | 25V | 4p | H7/8A | 100µF | 35V | 5p |
| H8/4A | 5µF | 64V | 4p | H7/9 | 100µF | 63V | 6p |
| H8/5 | 5µF | 10V | 4p | H7/9A | 125µF | 4V | 4p |
| H8/5A | 5µF | 150V | 4p | H7/10 | 125µF | 25V | 6p |
| H8/6A | 10µF | 10V | 4p | H7/10A | 160µF | 2.5V | 3p |
| H8/7 | 10µF | 70V | 4p | H7/11 | 160µF | 25V | 6p |
| H8/8 | 16µF | 35V | 4p | H7/11A | 150µF | 16V | 5p |
| H8/8A | 16µF | 16V | 4p | H7/13A | 200µF | 25V | 8p |
| H8/9 | 20µF | 6V | 2p | H7/14 | 220µF | 50V | 10p |
| H8/9A | 20µF | 70V | 4p | H7/14A | 220µF | 16V | 6p |
| H8/10 | 22µF | 50V | 4p | H7/15 | 220µF | 25V | 5p |
| H8/10A | 22µF | 100V | 4p | H7/15A | 220µF | 35V | 10p |
| H8/11 | 25µF | 12V | 4p | H6/1A | 250µF | 4V | 3p |
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| H8/12A | 30µF | 10V | 4p | H6/4 | 320µF | 10V | 4p |
| H8/13A | 32µF | 50V | 4p | H6/4A | 330µF | 16V | 5p |
| H8/14 | 40µF | 15V | 3p | H6/5 | 330µF | 25V | 10p |
| H8/14A | 40µF | 16V | 4p | H6/5A | 330µF | 15V | 5p |
| H8/15 | 47µF | 50V | 4p | H6/7 | 400µF | 15V | 5p |
| H8/15A | 40µF | 35V | 4p | H6/8 | 470µF | 25V | 10p |
| H7/1 | 50µF | 6V | 3p | H6/8A | 470µF | 35V | 20p |
| H7/1A | 50µF | 10V | 4p | H6/9 | 500µF | 15V | 4p |
| H7/2 | 50µF | 50V | 4p | H6/9A | 400µF | 40V | 20p |
| H7/2A | 64µF | 25V | 2p | H6/10 | 750µF | 12V | 5p |
| H7/3A | 64µF | 25V | 4p | H6/13A | 1000µF | 25V | 16p |
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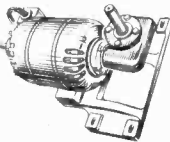


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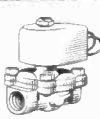


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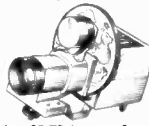
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Type 1: Three sets c/o contacts rated at 5 amps. 86p incl. P. & P. (Similar to illustration below.)
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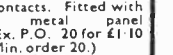
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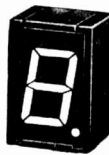
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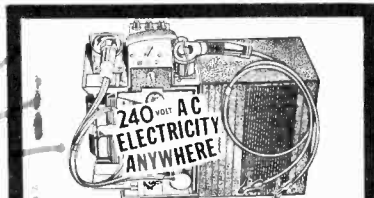
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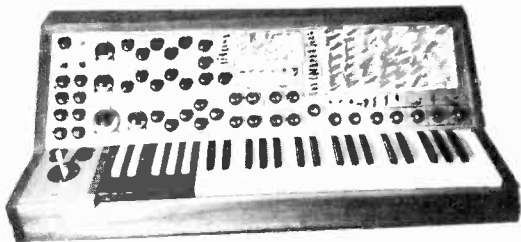
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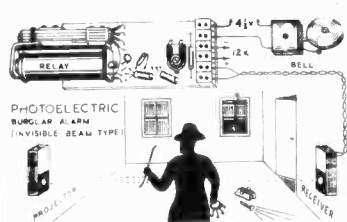
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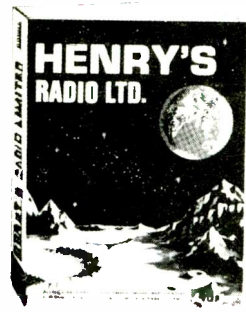
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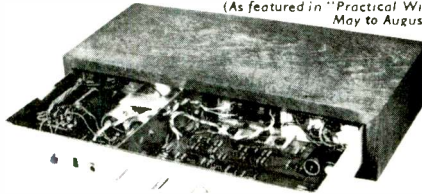


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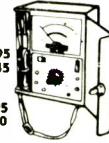
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