

PRACTICAL

ELECTRONICS

NOVEMBER 1973

20p

10p

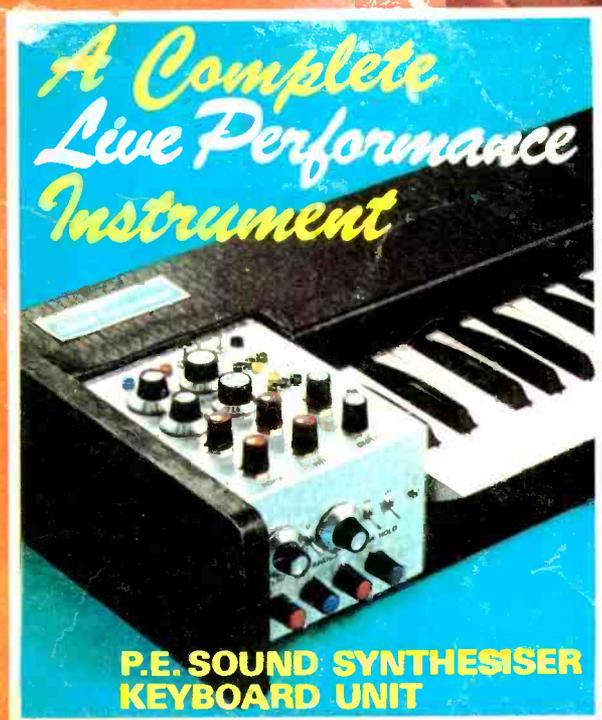
FREE INSIDE! VEROBOARD

SUITABLE FOR THE CONSTRUCTION
OF ANY OF THE 4 PROJECTS
FEATURED IN OUR

8 PAGE 8 SUPPLEMENT

- LIGHT-OPERATED DEVICE
- WAA WAA
- DIODE THERMOMETER
- TOUCH SWITCH

STAGE LIGHTING DIMMER



is this the price you pay?

Probably if you're still using an ordinary soldering iron Ordinary soldering irons can cause damage to transistors and integrated circuits - damage which wastes time and costs money. Now, with the unique ANTEX X25 and CCN low leakage soldering irons no harm can come to the most delicate equipment, even when soldered 'Live'.
(You could be making quite a saving).
All prices include V.A.T. at 10%



MODEL X25

220-240 Volts or 100-120 Volts.

The leakage current of the NEW X25 is only a few microamps and cannot harm the most delicate equipment even when soldered "live". Tested at 1500v. A.C.

This 25 watt iron with its truly remarkable heat-capacity will easily "out-solder" any conventionally-made 40 and 60 watt soldering irons, due to its unique construction advantages.

Fitted long-life iron-coated bit 1/8", 2 other bits available 3/32" and 3/16". Totally enclosed element ceramic and steel shaft. Bits do not "freeze" and can easily be removed.

PRICE: £1.93 (rec. retail). P & P 8p.

Suitable for production work and as a general purpose iron.



MODEL CCN

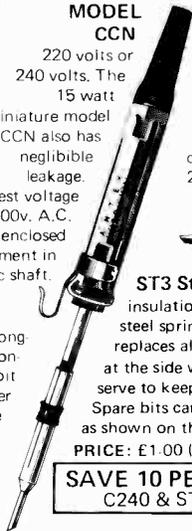
220 volts or 240 volts. The 15 watt

miniature model CCN also has negligible leakage.

Test voltage 4000v. A.C. Totally enclosed element in ceramic shaft.

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

PRICE: £2.15 (rec. retail). P & P 5p.



MODEL G - 18 watt miniature iron, fitted with long life iron-coated bit 3/32". Voltages 240, 220 or 110. **PRICE: £2.15** (rec. retail). P & P 5p.

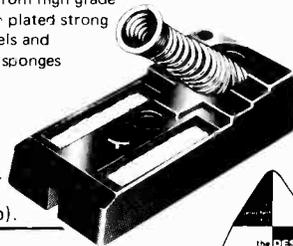


MODEL C - Miniature 15 watt soldering iron fitted 3/32" iron-coated bit. Many other bits available from 3/64" to 3/16". Voltages 240, 220, 110, 50 or 24. **PRICE: £1.93** (rec. retail). P & P 5p.

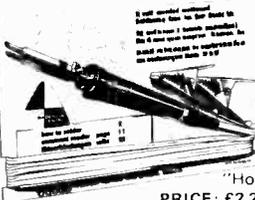


ST3 Stand - This stand is made from high grade insulation material with a chromium plated strong steel spring. It is suitable for all models and replaces all previous stands. The two sponges at the side which are easily replaceable, serve to keep the soldering bits clean. Spare bits can be accommodated as shown on the illustration.

PRICE: £1.00 (P & P 8p).



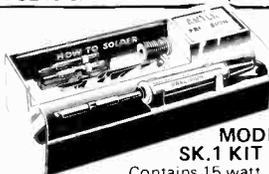
SAVE 10 PENCE X25 & ST3 or C240 & ST3 for £2.83 (P & P 13p).



MODEL MLX 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: £2.27 (rec. retail). P & P 12p



MODEL SK.1 KIT

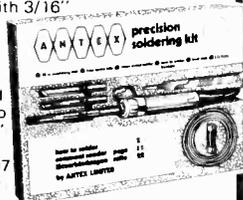
Contains 15 watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32", heat sink, solder, stand and "How to Solder" booklet.

PRICE: £3.25 (rec. retail). P&P12p

MODEL SK.2 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: £2.97 (rec. retail) P & P 8p.



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ADDRESS

PRACTICAL ELECTRONICS

VOLUME 9 No. 11 NOVEMBER 1973

CONSTRUCTIONAL PROJECTS

- STAGE LIGHTING DIMMER** *by R. Liffen*
A four channel system for controlling 13kW of lighting 950
- P.E. RONDO QUADRAPHONIC SOUND SYSTEM—3** *by R. A. Cole*
Power supplies and main chassis details 956
- P.E. SYNTHESISER—10** *by G. D. Shaw*
Keyboard unit—Log Law Oscillators 964
- SEMICONDUCTOR TESTER—2** *by J. H. Perkin*
General purpose discrete semiconductor tester 982

GENERAL FEATURES

- LOGIC EXPERIMENTS—7** *by M. J. Hughes*
The half adder 963
- AUTOMATED MAIL** *by F. J. Morris*
Survey of electronics in the postal service 973
- NEW DEVICES . . . APPLICATIONS**
A four digit calculator using an LSI MOS integrated circuit 980
- PHASE LOCKED LOOPS—2** *by J. B. Dance*
Phase locked loops in f.m. and a.m. demodulators, and frequency synthesisers 989
- INGENUITY UNLIMITED**
P.S.U. protection—Servo amplifier—Car lights monitor 995

NEWS AND COMMENT

- EDITORIAL—Take Your Pick** 949
- SPACEWATCH** *by Frank W. Hyde*
Black Holes—Comet Kohoutek—Mars Vehicles 955
- ON THE FRINGE** *by Gerry Brown*
The more unusual aspects of electronics 960
- INDUSTRY NOTEBOOK** *by Nexus*
What's happening inside industry 986

SPECIAL SUPPLEMENT—AUTUMN QUICKIES

DIODE THERMOMETER—WAA WAA—OPTOELECTRONICS—TOUCH SWITCH

FREE INSIDE THIS ISSUE: VEROBOARD PRINTED WIRING BOARD

Our December issue will be published on Friday, November 9, 1973

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Exciting...the Stereo 21!

Can you really get sound quality like this **FOR LESS THAN £19?** YES, YOU CAN! WITH THE NEW

STEREO 21

Until now, richly satisfying sound has always cost a richly satisfying price. *But not any more!* For an almost unbelievable **£18.45**, you can have Stereo 21—audio for the connoisseur! Whatever your taste in music, you can hear it on STEREO 21 the way its composers heard it in their dreams! Beethoven or Mahler... Ellington or Jellyroll Morton... Das Nibelung or Jesus Christ Superstar... Carols from King's College Chapel or the return of a Beatle... everything from a prettily fluting baroque organ to the newest pop group at full throttle—STEREO 21 does them all justice!



And have you ever seen a handsomer audio installation? Compact enough to go in a university student's bedroom-study, elegant enough for the suavest penthouse pad in Town, STEREO 21 offers you all the pride of possession as well as a thrilling musical experience!

Top-quality amplifier, BSR turntable, matching speakers. Deck and speaker cabinets you simply wrap round and glue to build. Screw in the amplifier and connect up (all push fit no soldering whatsoever), so simple literally anyone can do it. Except for glue and panel pins all parts supplied including full instructions—all for £18.45 (plus the cost of post and packing if you buy by mail), and—to round it all off—a money refund if not satisfied if your pleasure in STEREO 21 is not complete!

Just think—in only a few days you could be giving your ears the treat of a lifetime—AND introducing your envious friends to STEREO 21!

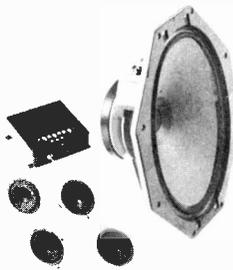
Personal shoppers and mail order price
£18.45 INCLUDING VAT plus £1.50 p. & p.

Diamond stylus, if required, £1.37 extra
Suitable pair of stereo headphones with individual lever controls, if required £3.85.

EMI SPEAKERS AT UNBELIEVABLE PRICES

950 Kit. Five matched speakers and crossover unit for handling up to 45 watts, from 20 to 20,000 Hz. Huge—19in x 14in (approx.) high efficiency 16, 500-gauss bass unit built on a heavy diecast frame. The four 10,000 gauss tweeters, each 3½in dia. approx., are fed by the crossover with a critically adjusted signal for maximum fidelity. Impedance at 1 kHz is 8 ohms. Bass coil 2in others 0.5in. Recommended list price £44.

OUR PRICE £25.00 + £1.50 p. & p



15in 14A/780. Bass unit on a rigid diecast chassis. Superior cone material handles up to 50 watts RMS, and is treated to give a smooth frequency response. Resonance 30 Hz. Flux 360,000 Maxwells. Impedance at 1 kHz is 8 ohms. 3in voice coil.

Recommended retail price £40.80.

OUR PRICE £18.70 + £1.50 p. & p.

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Mail orders to Acton. Terms C.W.O. All enquiries Stamped Addressed Envelope. Goods not despatched outside U.K.



RTVC VISCOUNT III

a boost in the output.

VISCOUNT III now gives you an imposing 20 watts per channel—and the price quoted is actually INCLUSIVE OF VAT!

The money's important, of course, but not nearly so important as *value for money!* And that's something you get in abundance with VISCOUNT III. We design it... we make it... we sell it direct to you—passing on all the economies that come from cutting out middle-men! That's the only way you can get so much quality for so little money!

The unique VISCOUNT III amplifier, plus the magnificent Garrard SP25 Mk III deck, plus the magnificent Duo Type III matched speakers (or Duo Type II for a small room) give you an audio installation that will prove unbeatable for listening pleasure! On the brushed aluminium front panel of the amplifier you'll find all the facilities you need—volume, bass, treble and balance controls, plus switches for mono/stereo, on/off function and bass and treble filters. Plus headphone socket on the back. And the teak finish will harmonise and enhance virtually any style of interior decor!

The heart-stopping timbre of Tom Jones at his most virile... the last lingering harmonics of a solo performance by Heifetz or Menuhin... the pathos and the panache of Liza Minelli... the majestic sonorities of the brass band and the elfin subtleties of the virtuoso clavichordist—hear every nuance with a fidelity that you have *never* experienced before!

Come and hear VISCOUNT III! If it's inconvenient to travel, buy by post in the confidence that you won't be disappointed (and with a 24-carat Money-Back Guarantee to give you extra reassurance). Don't settle for second-best!

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 £14.00 a pair, £2.20 p. & p. Duo Type III Size approx. 23½in x 11½in x 9½in. Drive unit 13½in x 8½in with HF speaker. Max. power 20 watts, 8 ohms. Freq. range 20Hz to 20kHz. Teak veneer cabinet. £32.00 a pair + £3.30 p. & p.

PRICES: SYSTEM 1

Viscount III R 102 amplifier	£24.20 + £1 p. & p.
2 Duo Type II speakers	£14.00 + £2.20 p. & p.
Garrard SP25 Mk. III with	
MAG. cartridge plinth & cover	£18.00 + £1.75 p. & p.
total	£56.20

Available complete for only £49.00 - £3.50 p. & p.

PRICES: SYSTEM 2

Viscount R 102 amplifier	£24.20 + £1 p. & p.
2 Duo Type III speakers	£32.00 + £3.30 p. & p.
Garrard SP25 Mk III with	
MAG. cartridge plinth & cover	£18.00 + £1.75 p. & p.
total	£74.20

Available complete for £65.00 + £4 p. & p.

STILL ONLY **£49** COMPLETE



THE TOURIST PUSH-BUTTON CAR RADIO KIT £6.60

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 loudspeaker from 8 to 15 ohms.

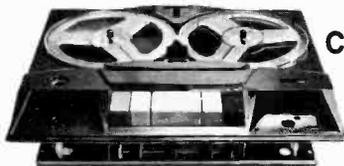
Apart from the output stage, which is an integrated circuit, the only other electronic components that need soldering are some capacitors, resistors, etc. The kit includes a pre-built RF tuner unit, and fully modularised IF stages which are pre-aligned before despatch. As well as electronic components 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.
* Circuit diagram and comprehensive instructions 55p free with parts.
* Fully retractable and lockable car aerial £1.37 post paid.

CAR RADIO KIT £6.60 p. & p. 55p

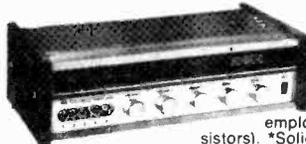
Speaker with baffle and fixing strips £1.65. 23p p. & p., post free if bought with the kit. Send stamped addressed envelope for leaflet.

If you can solder on printed circuit board, you can build this push-button car radio kit. It's simple—just follow the step-by-step instructions.



PE TAPE LINK CONSTRUCTORS

Suitable 3 speed tape deck, **less heads.** Caters up to 5½ins. spools. 240V AC mains. Unused but store soiled hence no warranty. £1 p. & p. **£4.00**



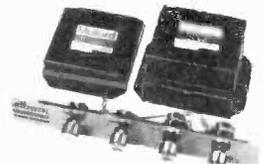
RELIANT Mk IV £13.50

*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.
£13.50 p. & p. 60p.

UNISOUND MODULES

ONLY £7.64 + 55p p. & p.

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



IN-CAR ENTERTAINMENT AT HOME

With this elegant stereo 8 track add on unit, audio enthusiasts now have the opportunity to extend their systems to include the playing of 8 track cartridges. Simply select your channel, by push button, four digital lamps indicate channel selected. Mains operated.



The Viscount III, the fabulous Stereo 21 and the Unisound Modules will all accept this unit, **£10.60p. & p. 80p** simply connect up.

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SPECIAL 40 MHz SCOPE—SOLARTRON CD1212 ONLY £50. Has to be a snag. There are no plug-in Y amps available.

TB—100 nanosecs per cm to 5 secs per cm in 24 calibrated ranges. 20 nanosecs per cm with times 5 expansion. Sin flat faced tube. Trace locator. 0.2 microsec signal delay. Built-in calibrator 1kHz square wave. 200 micro volts to 100 volts in 18 calibrated ranges. Tube sensitivity 3 V/cm. Main Frame Y Amp boosts this to better than 200 MV per cm at 40 MHz, 240V 50 Hz input. Complete with full manual including plug-in circuits. Come and see one working or Carriage £1.50. **MAKE YOUR SINGLE BEAM SCOPE INTO A DOUBLE WITH OUR NEW LOW PRICED SOLID STATE SWITCH.** 2 Hz to 8 MHz. Hook up a 9 volt battery and connect to your scope and have two traces for ONLY £5.50. P. & P. 25p. (Not cased, not calibrated.)

NEW WIDE RANGE WOBBLATOR

5 MHz to 150 MHz up to 15 MHz sweep width. Only 3 controls, preset RF level, sweep width and frequency. Ideal for I/O-7 or TV IF alignment, filters, receivers. Can be used with any general purpose scope. Full instructions supplied. Connect 6.3V A.C. and use within minutes of receiving. All this for ONLY £5.75p. P. & P. 25p. (Not cased, not calibrated.)

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SINE and SQUARE GENERATOR. Four ranges. Independent amplitude controls, thermistor stabilised. Ready to use, 9V supply required. £7.85 each. P. & P. 25p (Not cased, not calibrated.)

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COMPONENT PACK consisting of 5 pots, various, brand new; 250 resistors $\frac{1}{2}$ and $\frac{1}{4}$ watt, many high stabs, etc. Fine value at 50p. P. & P. 17p.

P.C.B. PACKS 5 & D. Quantity 2sqft —no tiny pieces. 50p plus P. & P. 20p. **FIBRE GLASS** as above £1 plus P. & P. 20p.

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POTS—10 different values. Brand new—50p. P. & P. 17p.

TRIMMER PACK. 2 Twin 50/200pF ceramic 2 Twin 10/60pF ceramic; 2 min. strip with 4 preset 5/20pF on each; 3 air spaced preset 30/100pF on ceramic base. ALL BRAND NEW, 25p the lot. P. & P. 10p.

FLAT FACED 4" Twin Beam Tube, type CV2193. Green trace. Brand new £4 each. P. & P. 37p.

LIGHT EMITTING DIODES (Red) from Hewlett-Packard. Brand New 38p each. Holder 1p each. Information 5p.

PHOTOCELL equ. OCP71, 13p each.

PHOTO RESISTOR type Clare 703 Two for 50p.

MODERN TELEPHONES type 706. Two-tone grey, £3.75 each. The same but black, £2.75 each. P. & P. 25p each.

Also **TOPAZ YELLOW** £4.50 each. P. & P. 25p.

IDEAL EXTENSION Telephones with standard GPO type dial, bell and lead coding. £1.75 each. P. & P. 25p.

DELIVERED TO YOUR DOOR 1 cwt of Electronic Scrap chassis, boards, etc. No Rubbish. FOR ONLY £3.50.

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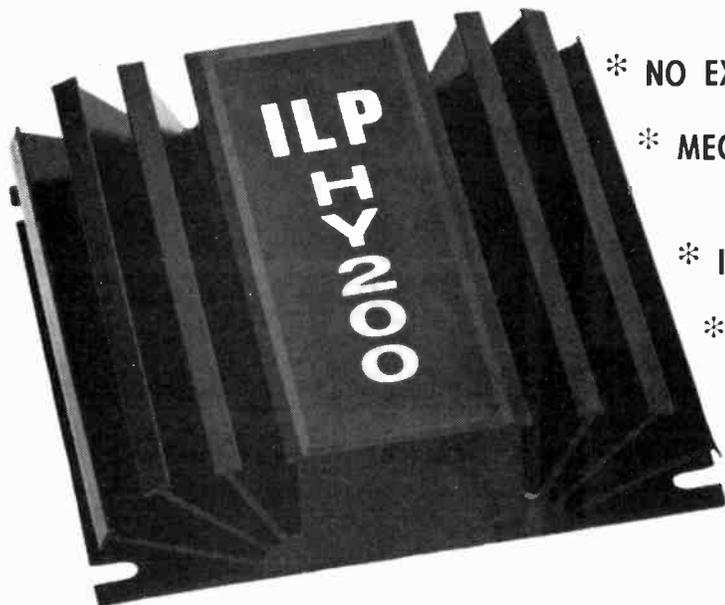
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- * ATTRACTIVE APPEARANCE
- * LOW COST
- * BRITISH BUILT

With the development of the HY200, ILP bring you the first **COMPLETE** Hybrid Power Amplifier.

COMPLETE: because the HY200 uses no external components!

COMPLETE: because the HY200 is its own heatsink!

By the use of integrated circuit technique, using 27 transistors, the HY200 achieves total component integration. The use of specially developed high thermally conductive alloy and encapsulant is responsible for its compact size and robust nature.

The module is protected by the generous design of the output circuit, incorporating 25amp transistors. A fuse in the speaker line completes protection.

Only 5 connections are provided, input, output, power lines and earth.

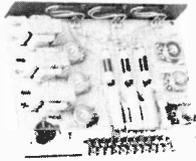
OUTPUT POWER: 100 watts RMS; 200 watts peak music power. **INPUT IMPEDANCE:** 10k Ω . **INPUT SENSITIVITY:** 0Dbm (0.775volt RMS). **LOAD IMPEDANCE:** 4-16 Ω . **TOTAL HARMONIC DISTORTION:** less than 0.1% at 100 watts, typically 0.05%. **SIGNAL : NOISE:** better than 75Db relative to 100 watts. **FREQUENCY RESPONSE:** 10Hz-50KHz \pm 1Db. **SUPPLY VOLTAGE:** \pm 45volts. **APPLICATIONS:** P.A., Disco, Groups, Hi-Fi, Industrial. **PRICE:** £14.90 inc. VAT & P&P. Trade applications welcomed.

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Please note we reserve the right to substitute at our discretion updated versions of advertised designs where applicable.

Mk III Sound to Light Unit Chassis Version



The audio drive voltage is derived directly from the amplifier output or across the speaker load. The unit converts the audio-frequency signals into a three-coloured light display when used with coloured flood lamps or similar; the colour depending on the frequency of the signal and the intensity on the loudness of the audio source. Max. power 1.5kW per channel at 240V a.c. Complete assembly built and tested. Size: 9in x 7in x 3in. Price £27.50.

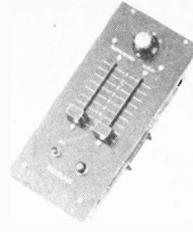
MN3 3 Channel I.C. Mixer Kit



Three channel I.C. audio mixer kit MN3 is specially designed for the home constructor or educational project. Suitable for use in domestic audio, discotheque and simple p.a. applications. The MN3 mixer kit has the following features: Advanced design using 5 ICs; Slider fader level controls mounted directly to p.c. board; Full range Bass and Treble controls; Uses top grade components with fibreglass ready-drilled and tinned printed circuit board and the unit may be operated from twin 9V batteries (PP3) if required.

As optional extras, an attractive ready-punched facia panel and control knobs are available. The unit is available as a ready built mixer with facia. Size: 9.5in x 4.8in x 1.5in (with facia). Construction manual available separately at 25p. Kit Price £11.

STL/I Single Channel Sound to Light Unit



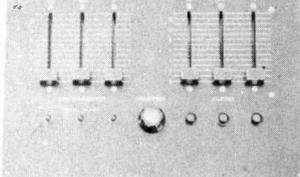
Single channel "Sound to Light" unit with 60mm slider fader controls for audio trigger level and background load dimmer. This unit is switchable for response to High, Mid. and Low frequency audio signals, selected by facia control. A D.J. "pulse-flash" push button is fitted for manual flashing of the lamp load together with neon load indicator. Maximum Load: 1kW at 240V a.c. Size: 8in x 3.6in x 3in. Price £14.30.

Practical Electronics "Scorpio" Electronic Ignition System Kit



This Capacitor-Discharge Electronic Ignition system was described in the November and December issues of Practical Electronics. It is suitable for incorporating in any 12V ignition system in cars, boats, go-karts, etc. Case size: 7.25in x 4.5in x 2in approx. Complete assembly and wiring manual 25p. Price £12.10.

STL/3 Sound to Light Unit



The performance of this unit is similar to the Mk III chassis version above, but is provided with an attractive black anodised facia panel and designed to mount directly into equipment desks or cabinets. High, Mid. and Low frequency channel sensitivity controls employ 60mm slider faders for present-day attractive appearance and ease of use. Size: 11in x 8.5in x 4in. Price £42.35.

AUDIO EFFECTS

CREATE "PHASE" EFFECT ON YOUR RECORDS-TAPES, ETC., UNIQUE CIRCUITRY ENABLES YOU TO CREATE PHASE EFFECT AT THE TURN OF A KNOB. OPERATES FROM 9V BATTERY (not supplied). COMPLETE KIT OF COMPONENTS WITH PRINTED CIRCUIT BOARD AND FULL INSTRUCTIONS. KIT PRICE £2.86.

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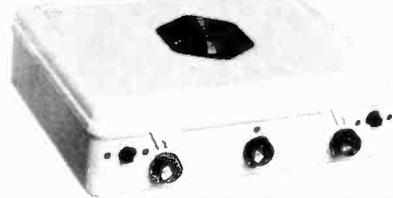
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NEW ROAMER NINE

WITH V.H.F. INCLUDING AIRCRAFT

Nine Transistors, 9 Tunable wavebands as Roamer Ten. Built in ferrite rod aerial for MW/LW.

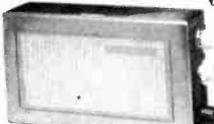
Retractable chrome plated telescopic aerial for VHF and SW. Push Pull output using 600mW transistors. 9 Transistors and 3 diodes, tuning condenser with VHF section, separate coil for aircraft, moving coil loudspeaker, volume ON/OFF and wavechange. Attractive all white case with red grille and carrying strap. Size 9 1/2in x 7in x 2 1/2in approx. Parts price list and plans 30p (FREE with parts).

TOTAL BUILDING COSTS **£6-95** P.P. & INS. 44p
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POCKET FIVE

3 Tunable wavebands, MW/LW and Trawler Band, 7 stages, 5 transistors and 2 diodes, supersensitive ferrite rod aerial, moving coil loudspeaker, attractive Black and Gold Case. Size 5 1/2in x 1 1/2in x 2 1/2in approx. Plans and parts price list 15p (FREE with parts).



Total Building Costs **£2-28**
(+10% VAT 25p) P.P. & Ins. 24p (OVERSEAS P. P. £1-25)



Total Building Costs **£2-50** P.P. & Ins. 25p
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Wavebands, transistors and speaker as Pocket Five. Larger Case with Red Speaker Grille and Tuning Dial. Plans and parts price list 16p (FREE with parts).

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 plans 25p (FREE with parts).

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TOTAL BUILDING COSTS **£3-98** P.P. & IN. 31p
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Build this exciting New series of designs

EV5 5 Transistors and 2 diodes. MW/LW. Powered by 4 1/2 volt Battery. Ferrite rod aerial, tuning condenser, volume control, and loudspeaker. Attractive case with red speaker grille. Size 9in x 4 1/2in x 2 1/2in approx. Parts price list and plans 15p (FREE with parts).

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EV6 Case and looks as above. 6 Transistors and 3 diodes. Powered by 9 volt Battery. Ferrite rod aerial, loudspeaker, etc. MW/LW coverage. Push Pull Output. Parts price list and plans 15p (FREE with parts).

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EV7 Case and looks as above. 7 transistors and 3 diodes. Six wavebands. MW/LW, Trawler Band, SW1, SW2, SW3, powered by 9 volt Battery Push Pull Output. Telescopic Aerial for Short Waves. Parts price list and easy build plans 20p. Free with parts.

TOTAL BUILDING COSTS **£4-08** P.P. & INS. 31p
(+10% VAT 40p) (OVERSEAS P. & P. £1-85p)

ROAMER EIGHT Mk. I

NOW WITH VARIABLE TONE CONTROL

7 TUNABLE WAVEBANDS: MW1, MW2, LW, SW1, SW2, SW3 AND TRAWLER BAND. Built-in ferrite rod aerial for MW and LW. Retractable chrome plated telescopic aerial for short waves. Push-pull output using 600mW transistors. Car aerial and tape record sockets. Selectivity switch, 8 transistors plus 3 diodes. Fine tone moving coil speaker. Air spaced ganged tuning condenser. Volume/on/off, tuning, wave change and tone controls. Attractive case in rich chestnut shade with gold blocking. Size 9in x 7in x 4in approx. Easy to follow instructions and diagrams. Parts price list and plans 25p (FREE with parts).

TOTAL BUILDING COSTS **£6-98** P.P. & INS. 47p
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ROAMER TEN WITH VHF INCLUDING AIRCRAFT

10 TRANSISTORS, 9 TUNABLE WAVE BANDS, MW1, MW2, LW, SW1, SW2, SW3, TRAWLER BAND, VHF AND LOCAL STATIONS. ALSO AIRCRAFT BAND. Latest 4 1/2 watt Ferrite Magnet Loudspeaker. Built-in ferrite rod aerial for MW/LW. Retractable, chrome plated 7 section telescopic aerial, can be angled and rotated for peak short wave and VHF listening. Push-pull output using 600mW transistors. Car Aerial and tape record sockets. 10 transistors plus 3 diodes. Fine tone moving coil speaker. Ganged tuning condenser with VHF section. Separate coil for Aircraft Band. Volume/on/off, wave change and tone controls. Attractive case in black with silver blocking. Size 9in x 7in x 4in. Easy to follow instructions and diagrams. Parts price list and plans 30p (FREE with parts).

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Components include: Tuning Condenser; 2 Volume Controls; 2 Slider Switches; Fine tone moving coil Speaker; Terminal Strip; Ferrite Rod Aerial; 2 Plugs and Sockets; Battery Clips; 4 Tag Boards; 10 Transistors; 4 Diodes; Resistors; Capacitors; Three 1/2in Knobs. Units once constructed are detachable from Master Unit, enabling them to be stored for future use. Ideal for Schools, Educational Authorities and all those interested in radio construction. Parts price list and plans 25p (FREE with parts).

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2 1/2in x 5in	26p	23p	13p	—
3 1/2in x 5in	26p	23p	—	—
3 1/2in x 5in	30p	30p	19p	—
17in x 2 1/2in	74p	55p	47p	10p
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17in x 5in	—	—	82p	10p

DIP Breadboard, 4.15in x 6.15in, 110p.
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8 pin 13p	16 pin 17p
14 pin 15p	24 pin 26p
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DIP10 2 for SL403D
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10DN400 4 4Y-1 4



46p 35p



46p 35p

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P.I.V	1 amp	R.M.S	2 amp
100V	20p	50V	35p
200V	22p	100V	40p
600V	25p	200V	45p
1000V	38p	400V	50p

RECTIFIERS

P.I.V	1 amp	3 amp
50	1N4001 61p	1N5400 15p
100	1N4002 71p	1N5401 16p
200	1N4003 9p	1N5402 17p
400	1N4004 9p	1N5404 22p
600	1N4005 11p	1N5406 26p
800	1N4006 13p	1N5407 30p
1000	1N4007 16p	1N5408 33p

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Rating	Type	Tolerance	Range	Price Each
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1/4 watt	Carbon Film	±5%	E24 Series 51Ω to 330KΩ	1p
1/4 watt	Metal Oxide Film	±2%	E24 Series 10Ω to 1MΩ	41p
1/4 watt	'Cermet' Thick Film	±2%	E12 Series 56Ω to 150KΩ	8p
1/4 watt	Carbon Film	±5%	E24 Series 10Ω to 10MΩ	11p
1/4 watt	Carbon Composition	±0.5Ω	2.2Ω, 2.7Ω, 3.3Ω, 3.9Ω, 4.7Ω	41p
1 watt	Carbon Composition	±0.5Ω	5.6Ω, 6.8Ω, 8.2Ω	51p
1 watt	Carbon Film	±10%	E12 Series 10Ω to 10MΩ	3p
2 watt	Carbon Film	±5%	E12 Series 10Ω to 10MΩ	6p
2 1/2 watt	Wire Wound	±5%	E12 Series 0.22Ω to 0.47Ω	10p
2 1/2 watt	Wire Wound	±10%	E12 Series 1Ω to 270Ω	10p
5 watt	Wire Wound	±5%	E12 Series 0.5Ω to 8.2KΩ	10p
10 watt	Wire Wound	±5%	E12 Series 0.5Ω to 6.8KΩ	11p
10 watt	Wire Wound	±5%	10KΩ, 15KΩ, 20KΩ, 25KΩ, 33KΩ	17p
15 watt	Wire Wound	±5%	10Ω to 6.8KΩ	13p

DISCOUNTS: 10% on any 100 or more mixed value or wattage. 25% on any 100 or more same value and same wattage.

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1.8pF to 0.022μF, 5p.

CERAMIC DISC—LOW VOLTAGE—
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5p; 0.2μF, 6p.

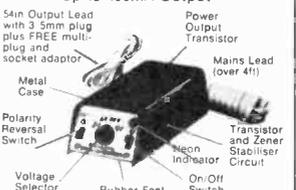
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0.033μF, 0.047μF, 3p; 0.068μF,
4p; 0.1μF, 0.15μF, 4p; 0.22μF,
5p; 0.33μF, 7p; 0.47μF, 9p; 0.68μF,
12p; 1.0μF, 14p; 1.5μF, 22p;
2.2μF, 26p.

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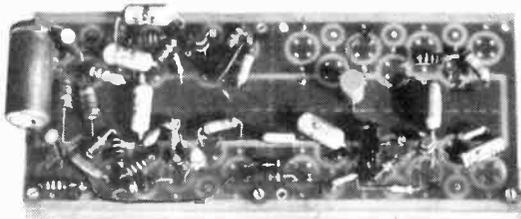
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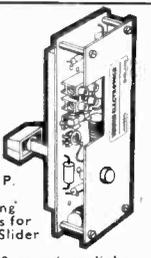
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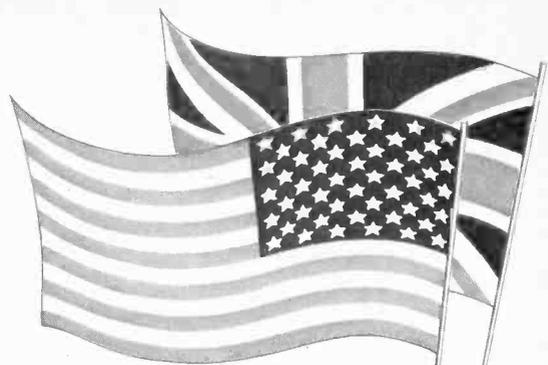


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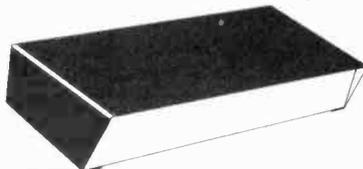


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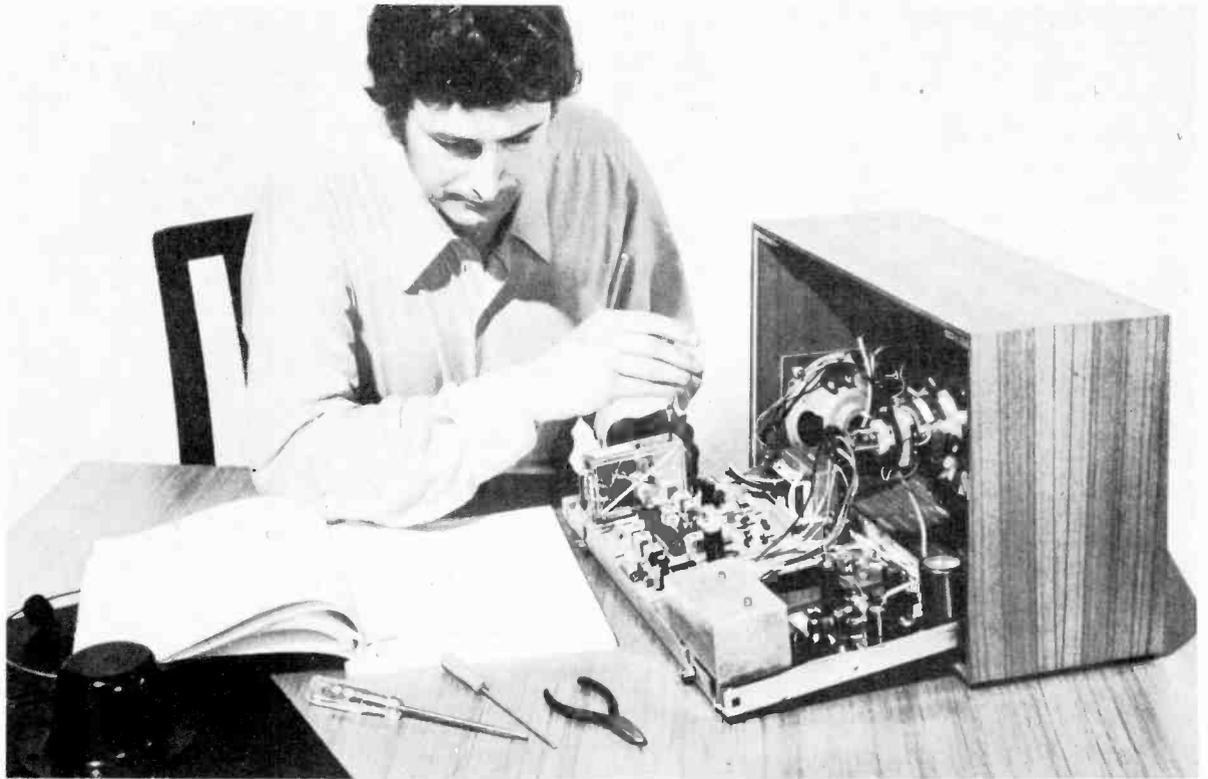
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SN74231	37 37 37	SN74182N	1-44 1-44 1-28
SN74251	37 37 37	SN74183N	1-72 1-72 1-51
SN74271	37 37 37	SN74185N	1-18 1-18 1-08
SN74281	48 43 37	SN74188N	6-48 6-48 5-87
SN74301	20 18 16	SN74190N	2-80 2-80 2-01
SN74321	27 37 32	SN74191N	2-80 2-80 2-01
SN74331	48 43 38	SN74192N	2-80 2-80 2-01
SN7433AN	57 57 50	SN74193N	2-80 2-80 2-01
SN74371	48 43 37	SN74194N	1-72 1-72 1-51
SN74381	57 57 50	SN74195N	1-18 1-18 1-08
SN74401	20 18 16	SN74196N	1-58 1-58 1-38
SN7441AN	55 79 73	SN74197N	1-58 1-58 1-38
SN74421	85 79 78	SN74198N	2-18 2-18 2-02
SN74431	1-60 1-27	SN74199N	2-88 2-88 2-82
SN74441	1-60 1-27		
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AC128	20 BCY32	35 BY213	35 OC45	18 ZTX300	14 2N3714
AC187	20 BCY39	1-00 C106D	55 OC72	15 ZTX302	18 2N3771
ACY17	35 BCY55	2-50 GET111	55 OC77	25 ZTX500	15 2N3773
ACY39	65 BCY70	15 GET115	75 OC77	55 ZG301	40 2N3779
AD149	50 BCY71	20 GET880	55 OC81	28 2N697	15 2N3819
AD161	39 BCY72	13 LM309K	1-87 OC83	25 2N706	10 2N3866
AD162	39 BCY74	80 MAT121	25 OC140	65 2N930	20 2N3903
AF111	20 BF112	45 ME440	1-06 1-06	92 2N160	45 2N4062
AF118	50 BF115	22 MJE520	65 OC200	55 2N1132	25 2N4126
AF139	30 BF180	33 MJE3055	75 OC202	90 2N1304	22 2N4871
AF186	40 BF194	13 MPF105	46 OCP71	1-00 2N1613	20 2N5457
AF239	44 BFY13	25 NKT217	45 ORP12	55 2N1671	1-00 2S001
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BA115	10 BFX88	22 OAS	60 P346A	26 2N1660	65 2S035
BA213	20 BFY13	50 OJ1	10 TL209	25 2N2926	10 4Z050
BC107	12 BFY51	20 OA200	9 TIF29A	49 2N3053	20 40361
BC108	12 BFY64	45 OA202	10 TIF30A	58 2N3054	45 40362
BC109	12 BFY90	75 OC16	85 TIP31A	61 2N3055	45 40408
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3 AMP

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1 x pin tubular

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B2/20	200V	45p
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1 x pin tubular

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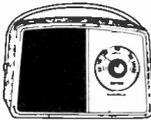
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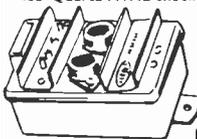
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120 12VW amplifier	3-88
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130 Mono control unit	3-52
605 Power supply for 115	3-88
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615 Power supply for 2 x 120	4-85
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275 Mic. preamplifier	5-83
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570 LF generator 10Hz—1mHz	12-60
575 Sq. wave generator 20Hz—20kHz	12-87
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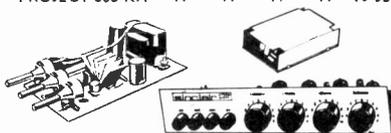
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IN85	0-88	AFZ27	0-20	BYZ12	0-40	OAZ211	0-40	ZT21	0-25
IN263	0-60	AFZ28	0-20	BYZ13	0-35	OAZ222	0-45	ZT43	0-25
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IN914	0-05	AFZ51	0-40		0-10	OAZ242	0-22	ZTX304	0-24
IN4007	0-12	AFZ53	0-20	BZY88C3V3		OAZ244	0-25	ZTX500	0-16
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18131	0-13	AFZ56	0-20	C111	0-55	OAZ290	0-22		
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2N697	0-15	AC106	0-12	DD006	0-18	OC24	1-10	7402	0-20
2N698	0-30	BC109	0-12	DD007	0-40	OC25	0-40	7403	0-20
2N706	0-10	BC113	0-16	DD008	0-38	OC26	0-25	7404	0-20
2N706A	0-12	BC115	0-20	GD3	0-38	OC28	0-65	7405	0-20
2N708	0-15	BC116	0-20	GD4	0-10	OC29	0-65	7406	0-20
2N709	0-40	BC116A	0-23	GD5	0-38	OC30	0-40	7407	0-40
2N1091	0-55	BC118	0-15	GD8	0-25	OC35	0-55	7408	0-20
2N1131	0-25	BC121	0-20	GD12	0-10	OC36	0-65	7409	0-20
2N1132	0-25	BC122	0-20	GD12	0-10	OC36	0-65	7410	0-20
2N1302	0-18	BC125	0-68	GET103	0-40	OC42	0-40	7411	0-22
2N1303	0-18	BC126	0-65	GET113	0-35	OC43	0-70	7412	0-22
2N1304	0-22	BC140	0-55	GET114	0-30	OC44	0-18	7413	0-20
2N1305	0-22	BC147	0-12	GET115	0-75	OC44M	0-17	7415	0-20
2N1306	0-22	BC148	0-10	GET116	0-65	OC45	0-18	7416	0-20
2N1307	0-22	BC149	0-12	GET120	0-60	OC49M	0-18	7417	0-20
2N1308	0-22	BC147	0-14	GET122	0-40	OC49	0-27	7422	0-28
2N1309	0-22	BC158	0-12	GET875	0-50	OC57	0-60	7423	0-40
2N219	0-75	BC160	0-68	GET880	0-55	OC58	0-60	7425	0-27
2N148	0-40	BC169	0-14	GET881	0-25	OC59	0-60	7427	0-37
2N2160	0-61	BCY31	0-45	GET882	0-35	OC66	0-60	7428	0-43
2N2218	0-23	BCY32	0-25	GET885	0-35	OC70	0-18	7430	0-20
2N2219	0-25	BCY33	0-25	GET885	0-35	OC71	0-15	7432	0-37
2N2369A	0-16	BCY33	0-25	GET885	0-35	OC71	0-15	7433	0-43
2N2444	1-09	BCY38	0-55	GET941	0-45	OC73	0-60	7437	0-48
2N2813	0-22	BCY39	1-00	GJ3M	0-50	OC74	0-20	7438	0-48
2N2846	0-50	BCY40	0-80	GJ4M	0-38	OC75	0-20	7440	0-20
2N2904	0-20	BCY42	0-80	GJ5M	0-25	OC76	0-20	7441AN	0-22
2N2904A	0-25	BCY70	0-15	GJ7M	0-50	OC77	0-55	7442	0-25
2N2908	0-20	BCY71	0-20	HG1005	0-50	OC78	0-25	7451	0-20
2N2924	0-22	BCY71	0-20	HG100A	0-60	OC79	0-30	7452	0-20
2N2925	0-15	BCZ11	0-65	MAT100	0-20	OC81	0-28	7453	0-20
2N2926	0-10	BD121	1-00	MAT101	0-25	OC81D	0-28	7454	0-20
2N3054	0-45	BD123	1-00	MAT120	0-20	OC81M	0-20	7460	0-20
2N3055	0-45	BD124	1-00	MAT121	0-25	OC81DM	0-18	7470	0-22
2N3702	0-11	BDY11	1-45	MJES20	0-65	OC81Z	0-45	7472	0-22
2N3705	0-12	BF115	0-22	MJES255	1-10	OC82	0-22	7473	0-44
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2N3707	0-11	BF167	0-23	NKT128	0-45	OC83	0-25	7475	0-59
2N3709	0-10	BF173	0-25	NKT129	0-30	OC84	0-25	7476	0-45
2N3710	0-11	BF181	0-23	NKT211	0-25	OC114	0-38	7480	0-80
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2N5088	0-22	BF195	0-13	NKT217	0-45	OC140	0-65	7486	0-50
2S801	0-59	BF196	0-15	NKT218	1-13	OC141	0-80	7490	0-75
2S804	1-15	BF197	0-15	NKT219	0-33	OC169	0-20	741AN	1-10
2S801	0-87	BF961	0-25	NKT222	0-30	OC170	0-25	7492	0-72
2S703	1-00	BF989	0-25	NKT224	0-25	OC200	0-55	7493	0-75
AA129	0-20	BFX12	0-25	NKT251	0-24	OC201	0-55	7494	0-85
AAZ13	0-10	BFX13	0-25	NKT271	0-20	OC201	0-50	7495	0-85
AC107	0-85	BFX20	0-28	NKT272	0-20	OC202	0-90	7496	1-00
AC126	0-25	BFX35	0-60	NKT273	0-20	OC203	0-55	7497	4-32
AC127	0-25	BFX63	0-98	NKT274	0-20	OC204	0-65	74100	2-16
AC128	0-20	BFX84	0-25	NKT275	0-25	OC205	1-00	74101	0-61
AC187	0-20	BFX86	0-25	NKT276	0-25	OC207	1-00	74110	0-57
AC188	0-20	BFX86	0-25	NKT277	0-25	OC207	1-00	74111	0-86
AC197	0-35	BFX87	0-25	NKT304	0-75	OC470	0-30	74118	1-00
AC198	0-27	BFX88	0-22	NKT403	0-70	OC71	1-00	74119	1-92
AC199	0-27	BFY10	1-00	NKT404	0-60	ORP12	0-55	74121	0-57
AC200	0-22	BFY11	1-25	NKT678	0-30	ORP60	0-45	74122	0-80
AC21	0-22	BFY17	0-25	NKT713	0-30	ORP61	0-45	74123	1-44
AC22	0-18	BFY18	0-45	NKT773	0-25	S1PT	0-30	74145	1-44
AC227	0-25	BFY19	0-55	NKT777	0-45	ORP61	0-45	74150	2-30
AC228	0-25	BFY24	0-45	07B	0-38	SFT308	0-38	74151	1-15
AC239	0-65	BFY44	1-00	OA6	0-12	ST722	0-38	74154	2-30
AC240	0-22	BFY50	0-20	OA47	0-08	ST7231	0-63	74155	1-15
AC241	0-22	BFY51	0-20	OA70	0-10	SX681	0-20	74157	1-09
AC244	0-38	BFY52	0-20	OA71	0-10	SX681	0-45	74170	2-88
AD140	0-40	BFY53	0-17	OA72	0-10	SX681	0-45	74171	1-80
AD149	0-50	BFY64	0-45	OA74	0-15	SX640	0-75	74174	2-98
AD161	0-39	BFY90	0-75	OA79	0-10	SX641	0-75	74175	1-29
AD162	0-39	B8X27	0-60	OA81	0-10	SX642	0-60	74176	1-44
AF106	0-30	B8X60	0-98	OA85	0-15	SX644	0-85	74180	2-30
AF114	0-25	B8Y26	0-18	OA86	0-15	SX645	0-85	74191	2-30
AF115	0-25	B8Y26	0-18	OA86	0-15	SX645	0-85	74192	2-30
AF119	0-20	BSY27	0-18	OA91	0-07	V30/201P	0-75	74193	2-30
AF117	0-20	BSY51	0-60	OA90	0-07	V60/201P	0-75	74193	2-30
AF118	0-60	BSY95A	0-12	OA200	0-08	V60/201P	0-75	74194	1-72
AF119	0-20	BSY95	0-12	OA202	0-10	XA101	0-10	74195	1-44
AF124	0-30	BT102/500R	1-10	OA210	0-25	XA102	0-18	74196	1-58
AF125	0-40	BTY42	0-92	OA211	0-20	XA151	0-15	74197	1-58
AF126	0-30	BTY79/100R	0-75	OA200	0-45	XA152	0-15	74197	1-58
AF127	0-30	BTY79/100R	0-75	OA201	0-45	XA161	0-25	74198	3-16
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<p>NEW! NEW! NEW! NEW!</p> <p>An aerosol spray providing a convenient means of producing any number of copies of a printed circuit both simply and quickly.</p> <p>Method Spray copper laminate board with light sensitive spray. Cover with transparent film upon which circuit has been drawn. Expose to light (No need to use ultra-violet.) Spray with developer, rinse and etch in normal manner.</p> <p>Light sensitive aerosol spray £1 Developer and Etchant 50p (plus postage)</p>		<p>SILICON P.N.P.</p> <table border="1"> <thead> <tr> <th></th> <th>Voltage</th> <th>Frequency</th> <th>Price</th> </tr> </thead> <tbody> <tr><td>BCY71</td><td>45</td><td>200MHz</td><td>12p</td></tr> <tr><td>BFS92</td><td>100</td><td>70MHz</td><td>20p</td></tr> <tr><td>BFS95</td><td>40</td><td>70MHz</td><td>17p</td></tr> <tr><td>BFX12</td><td>25</td><td>210MHz</td><td>10p</td></tr> <tr><td>2N2906</td><td>60</td><td>200MHz</td><td>15p</td></tr> <tr><td>2N3702</td><td>40</td><td>100MHz</td><td>11p</td></tr> <tr><td>2N3703</td><td>50</td><td>100MHz</td><td>12p</td></tr> </tbody> </table>			Voltage	Frequency	Price	BCY71	45	200MHz	12p	BFS92	100	70MHz	20p	BFS95	40	70MHz	17p	BFX12	25	210MHz	10p	2N2906	60	200MHz	15p	2N3702	40	100MHz	11p	2N3703	50	100MHz	12p	<table border="1"> <tbody> <tr><td>AF124</td><td>20</td><td>75MHz</td><td>20p</td></tr> <tr><td>AFY19</td><td>32</td><td>350MHz</td><td>20p</td></tr> <tr><td>ASY32</td><td>25</td><td>5MHz</td><td>20p</td></tr> <tr><td>ASZ21</td><td>15</td><td>450MHz</td><td>20p</td></tr> <tr><td>GET113</td><td>32</td><td>—</td><td>10p</td></tr> <tr><td>GET120</td><td>32</td><td>2 watts</td><td>10p</td></tr> <tr><td>OC123</td><td>50</td><td>1MHz</td><td>10p</td></tr> <tr><td>OCP70</td><td>Light-sensitive</td><td>—</td><td>20p</td></tr> <tr><td>2N1307</td><td>30</td><td>10MHz</td><td>15p</td></tr> <tr><td>2N1309</td><td>30</td><td>15MHz</td><td>15p</td></tr> <tr><td>2N443</td><td>60</td><td>150 watts</td><td>10p</td></tr> </tbody> </table>		AF124	20	75MHz	20p	AFY19	32	350MHz	20p	ASY32	25	5MHz	20p	ASZ21	15	450MHz	20p	GET113	32	—	10p	GET120	32	2 watts	10p	OC123	50	1MHz	10p	OCP70	Light-sensitive	—	20p	2N1307	30	10MHz	15p	2N1309	30	15MHz	15p	2N443	60	150 watts	10p	<table border="1"> <tbody> <tr><td>BXY27</td><td>Varactor Diode. "S" Band.</td><td>£1</td></tr> <tr><td></td><td>Cut-off, 70 GHz</td><td></td></tr> <tr><td>BXY28</td><td>Varactor Diode. Cut-off, 100GHz</td><td>£1</td></tr> <tr><td>BXY32</td><td>Frequency Multiplier. "X" Band, 150GHz</td><td>£1</td></tr> <tr><td>BXY35A/C</td><td>Frequency Multiplier. "X" Band, 25GHz</td><td>£1</td></tr> <tr><td>BXY36C/D</td><td>Frequency Multiplier. "X" Band, 75GHz</td><td>£1</td></tr> <tr><td>BXY37C/D</td><td>Frequency Multiplier. "X" Band, 100GHz</td><td>£1</td></tr> <tr><td>BXY38C/E</td><td>Frequency Multiplier. "X" Band, 120GHz</td><td>£1</td></tr> <tr><td>BXY39C/D</td><td>Frequency Multiplier. "X" Band, 150GHz</td><td>£1</td></tr> <tr><td>BXY40D/E</td><td>Frequency Multiplier. "X" Band, 180GHz</td><td>£1</td></tr> <tr><td>BXY41C/D/E</td><td>Frequency Multiplier. "X" Band, 200 GHz</td><td>£1</td></tr> <tr><td>CV7777</td><td>(AAY51) Microwave Mixer Diode, 18GHz</td><td>£2</td></tr> <tr><td>CAY10</td><td>Microwave Detector Diode, 250GHz</td><td>£5</td></tr> <tr><td>AEY13</td><td>Microwave Tunnel Diode, 6GHz</td><td>£5</td></tr> <tr><td>AEY16</td><td>Microwave Tunnel Diode, 10GHz</td><td>£10</td></tr> <tr><td>AEY17</td><td>Microwave Detector, 18 GHz</td><td>£3</td></tr> <tr><td>AEY31A</td><td>Microwave Detector, 18 GHz</td><td>£3</td></tr> <tr><td>BAW95</td><td>Schottky Barrier Diode, 12GHz</td><td>50p</td></tr> </tbody> </table>		BXY27	Varactor Diode. "S" Band.	£1		Cut-off, 70 GHz		BXY28	Varactor Diode. Cut-off, 100GHz	£1	BXY32	Frequency Multiplier. "X" Band, 150GHz	£1	BXY35A/C	Frequency Multiplier. "X" Band, 25GHz	£1	BXY36C/D	Frequency Multiplier. "X" Band, 75GHz	£1	BXY37C/D	Frequency Multiplier. "X" Band, 100GHz	£1	BXY38C/E	Frequency Multiplier. "X" Band, 120GHz	£1	BXY39C/D	Frequency Multiplier. "X" Band, 150GHz	£1	BXY40D/E	Frequency Multiplier. "X" Band, 180GHz	£1	BXY41C/D/E	Frequency Multiplier. "X" Band, 200 GHz	£1	CV7777	(AAY51) Microwave Mixer Diode, 18GHz	£2	CAY10	Microwave Detector Diode, 250GHz	£5	AEY13	Microwave Tunnel Diode, 6GHz	£5	AEY16	Microwave Tunnel Diode, 10GHz	£10	AEY17	Microwave Detector, 18 GHz	£3	AEY31A	Microwave Detector, 18 GHz	£3	BAW95	Schottky Barrier Diode, 12GHz	50p			
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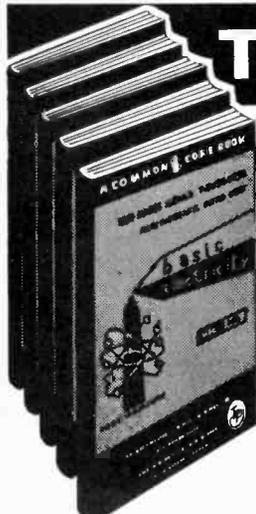
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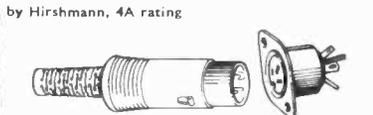
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	10	—	—	—	7p	8p	7p	8p
	22	—	—	7p	7p	7p	7p	9p
	47	7p	—	8p	8p	8p	7p	9p
	100	8p	7p	7p	7p	7p	9p	12p
	220	7p	8p	8p	8p	9p	10p	17p
	470	8p	9p	9p	10p	12p	17p	24p
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C	1/8W	5%	4.7 Ω -470K Ω	E24	1	0.9	0.75 nett
C	1/4W	5%	4.7 Ω -10M Ω	E12	1	0.9	0.75 nett
C	1/2W	5%	4.7 Ω -10M Ω	E24	1.2	1	0.95 nett
C	1W	5%	4.7 Ω -10M Ω	E12	2.5	2	1.6 nett
MO	1/2W	2%	10 Ω -1M Ω	E24	4	3	2 nett
WW	1W	10%	1/20 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

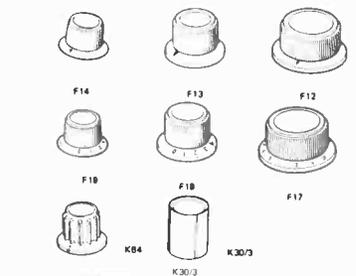
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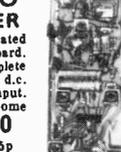
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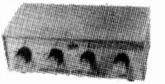
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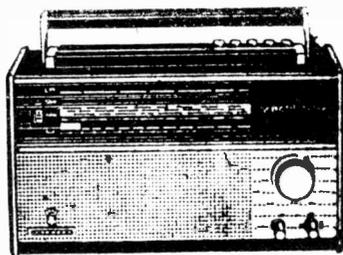
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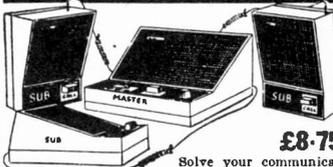
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52 For model X25 1" 37p

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PS 42 Jack Stereo Switched 0-26

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PS 45 Car Aerial 0-09

PS 46 Co-Axial Surface 0-09

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The E12 Range of Carbon Film Resistors, ¼ watt available in PAKS of 50 pieces, assorted into the following groups:—

R1 50 Mixed 100 ohms-820 ohms 40p

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R3 50 Mixed 10K ohms-82K ohms 40p

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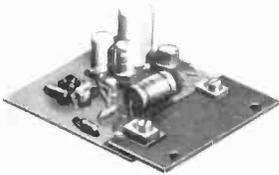
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C60, 32p; C90, 41p; C120, 52p

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AL10/AL20/AL30 AUDIO AMPLIFIER MODULES



The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S.

The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the car and at home.

Parameter	Conditions	Performance
HARMONIC DISTORTION	Po = 3 WATTS f = 1KHz	0.26%
LOAD IMPEDANCE	-	8-16 Ω
INPUT IMPEDANCE	f = 1KHz	100 kΩ
FREQUENCY RESPONSE -3dB	Po = 2 WATTS	50 Hz-25KHz
SENSITIVITY for RATED O/P	Vs=25V. R1=8Ω f=1KHz	75mV. RMS
DIMENSIONS	-	3" x 2 1/2" = 1"

The above table relates to the AL10, AL20 and AL30 modules. The following table outlines the differences in their working conditions.

Parameter	AL10	AL20	AL30
Maximum Supply Voltage	25	30	30
Power out for 2% T.H.D. (RL = 8Ω f = 1KHz)	3 watts RMS Min.	5 watts RMS Min.	10 watts RMS Min.

AUDIO AMPLIFIER MODULES

AL 10. 3 watts	£2-10
AL 20. 5 watts	£2-50
AL 30. 10 watts	£3-01

POWER SUPPLIES

PS 12. (Use with AL10 & AL20)	85p
SPM 80. (Use with also AL30 & AL50)	£3-25
FRONT PANELS PA 12 with Knobs	£1-00

PRE-AMPLIFIERS

PA 12. (Use with AL10 & AL20)	£4-85
PA 100. (Use with AL30 & AL50)	£13-15

TRANSFORMERS

T481 (Use with AL10 & AL20)	£1-38 P & P 15p
T638 (Use with AL20)	£1-93 P & P 15p
BMT80 (Use with AL30 & AL50)	£2-16 P & P 25p

PA12 PRE-AMPLIFIER SPECIFICATION

The PA12 pre-amplifier has been designed to match into most budget stereo systems. It is compatible with the AL 10, AL 20 and AL 30 audio power amplifiers and it can be supplied from their associated power supplies. There are two stereo inputs, one has been designed for use with ceramic cartridges while the auxiliary input will suit most magnetic cartridges. Full details are given in the specification table. The four controls are, from left to right: Volume and on/off switch, balance, bass and treble. Size 152mm x 84mm x 36mm.

Frequency response—
20Hz-50KHz (-3dB)
Bass control—
± 12dB at 60Hz
± 14dB at 14KHz
Treble control—
1 Meg. ohm
Sensitivity 300mV
*Input 1. Impedance
± 30 K ohms
Sensitivity 4mV

EA1000 AUDIO AMP MODULE 5 WATTS R.M.S.

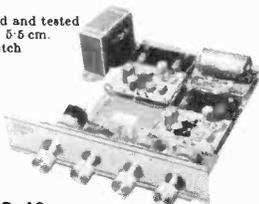
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SPECIAL OFFER £2 each while stores last

The STEREO 20

The "Stereo 20" amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm x 14 cm x 5.5 cm. This compact unit comes complete with on/off switch volume control, balance, bass and treble controls, Transformer, Power supply and Power amps. Attractively printed front panel and matching control knobs. The "Stereo 20" has been designed to fit into most turntable plinths without interfering with the mechanism or, alternatively, into a separate cabinet. Output power 20w peak. Input 1 (Cer.) 300mV into 1M. Freq. res. 25Hz-25KHz. Input 2 (Aux.) 4mV into 30K. Harmonic distortion. Bass control ± 12dB at 60Hz typically 0.26% at 1 watt. Treble con. ± 14dB at 14kHz.

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50W pk 25w (RMS)

0.1% DISTORTION!
HI-FI AUDIO AMPLIFIER

THE AL50

★ Frequency Response 15Hz to 100,000—1dB.

★ Load—3, 4, 8 or 16 ohms.

★ Distortion—better than .1% at 1KHz.

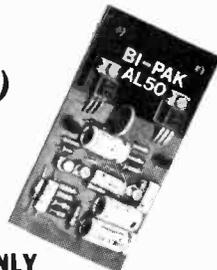
★ Signal to noise ratio 80dB.

ONLY
£3-58 each

★ Supply voltage 10-35 Volts.

★ Overall size 63mm 105mm x 13mm.

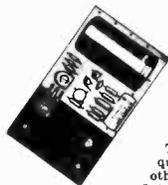
Tailor made to the most stringent specifications using top quality components and incorporating the latest solid state circuitry and AL50 was conceived to fill the need for all your A.F. amplification needs.
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STABILISED POWER MODULE SPM80

AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1.5 amps at 35 volts. Size: 63mm x 105mm x 30mm.

These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including—Disc Systems, Public Address, Intercom Units, etc. Handbook available 10p
PRICE £3-25



TRANSFORMER BMT80 £2-15 p. & p. 28p

STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages. Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.

SPECIFICATION

Frequency Response	20Hz-20KHz ± 1dB
Harmonic Distortion	better than 0.1%
Inputs: 1. Tape Head	1.25 mV into 50K Ω
2. Radio, Tuner	35 mV into 50K Ω
3. Magnetic P.U.	1.5 mV into 50K Ω
All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ± 1dB. from 20Hz to 20KHz.	
Bass Control	± 15dB at 20Hz
Treble Control	± 15dB at 20KHz
Filters: Rumble (High Pass)	100Hz
Scratch (Low Pass)	8KHz
Signal/Noise Ratio	better than -65dB
Input overload	+ 26dB
Supply	+ 35 volts at 20mA
Dimensions	292mm x 82mm x 35mm

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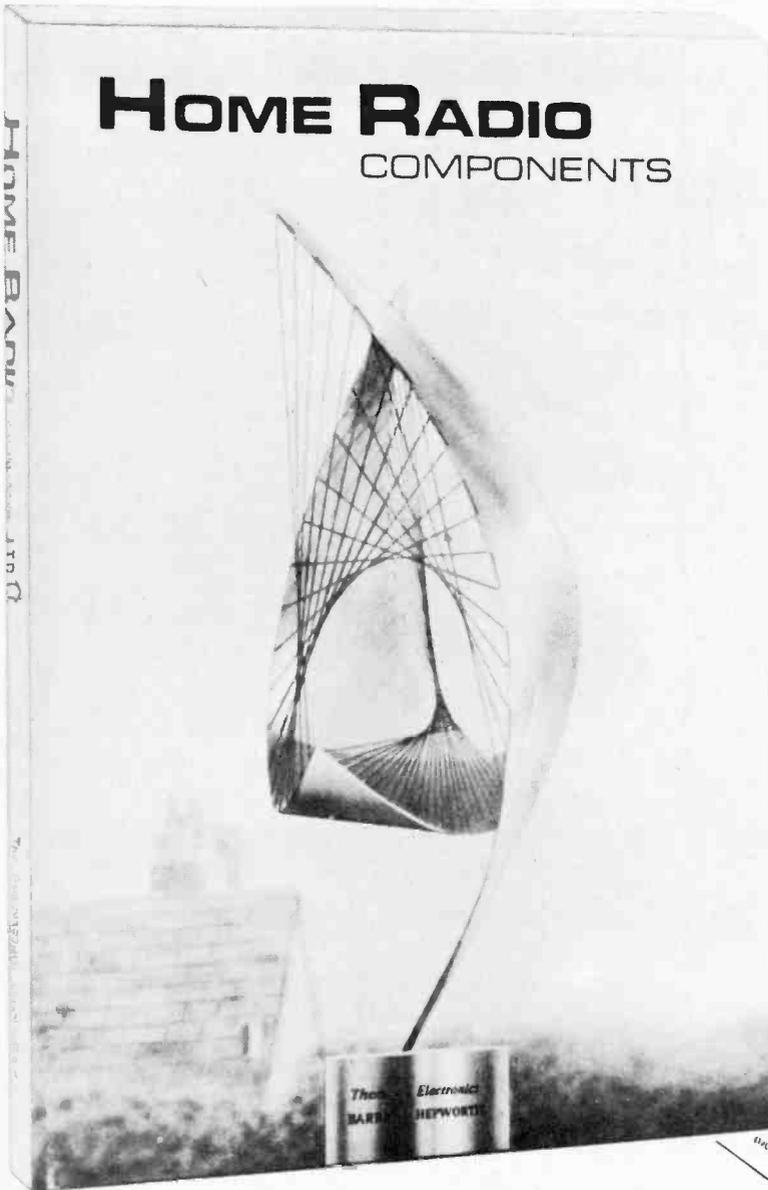
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TAKE YOUR PICK

THE tendency towards larger and more ambitious projects is a perfectly natural development in the wake of technological advancement. Not everyone wants to become involved in building the more complex project, that is true. But this expansive side of home construction should be welcomed by all the genuine enthusiasts, since it provides an opportunity for amateurs to keep up to date with the latest developments and techniques and to make practical use of them as and when they feel so inclined.

It is worth considering, also, the beneficial effect on the retail components market arising from the demand generated by some larger projects. Such demands encourage suppliers to hold a wide variety of stocks and to seek out lines in components they might not otherwise contemplate handling. A healthy and venturesome retail trade is to the advantage of everyone who purchases components, whether in large or small quantities.

The needs and interests of constructors vary widely, but so far as generalisation can go, it seems reasonable to suppose that out of the whole, a majority of constructors confine their activities to the more simple kind of project. New-comers undoubtedly start this way too, although many will in due course feel the compulsion to pursue their hobby to greater heights. Our recognition of the need for small simple designs is reflected in this month's special supplement. This contains details of four uncomplicated but useful and highly adaptable circuits, any of which can be assembled on the piece of printed wiring board presented free with this issue of Practical Electronics.

Returning now to larger projects, it may be recalled that the virtues of modular construction were discussed here last February when the P.E. Sound Synthesiser made its debut. With the synthesiser main unit now completed, this month's article in the series introduces the complementary keyboard unit.

It will interest many readers to learn that over the past 12 months the complete synthesiser has been handled by a number of professional musicians, and its unique creative possibilities—both as a composing machine and as a live performance instrument—have been established and enthused upon. Moreover, it has been confirmed that the keyboard unit on its own does constitute a valuable and versatile instrument for live performance. For example, it will meet the needs of many musical groups, being able to provide novel avant-garde accompaniment.

This feasibility is another bonus or "spin off" from the modular approach. It confirms the importance of considering both the *whole* and the *parts*, where many large and ambitious projects are concerned.

F.E.B.

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FOUR CHANNELS OF INDEPENDENT CONTROL . . .

THIS Stage Lighting Dimmer was built to the specific requirements of an amateur revue company. It consists of four independent channels each capable of dimming 13 amps (3250 watts) of incandescent (not fluorescent) lighting. The number of channels may be increased as necessary providing the current capability of the input is uprated.

SYSTEM DESCRIPTION

Each of the four dimmable channels is controlled by a linear slider fader. Any channel can be switched to a Master Fader which is a double unit made up of two stereo slider potentiometers. The Master has control over all channels simultaneously when required.

Each channel has a mimic light next to the fader control which gives a visible representation of the relative brilliance of the lights plugged into that channel.

A preset potentiometer in each channel allows the cutoff point of each channel to be adjusted for different wattage lamps with differing thermal capacities.

Interference suppression is included and the dimmers are mounted in an earthed box to reduce radiation.

The output to each channel is fed *via* a 13 amp switched socket and input from the mains is taken *via* a 60 amp fused switch which can act as a "Master Blackout" control when it is necessary to cut out all the lamps in the fastest possible time.

CIRCUIT OPERATION

Each of the four channels uses an identical circuit which uses a triac to control the current through the lamps. The basis of this circuit is shown in Fig. 1.

A triac is a four layer semiconductor device with three terminals. It will only conduct when a voltage is applied to the gate (g) terminal and will then continue conducting in either direction even when the gate voltage is removed. It will cease to conduct when the current through it drops below a threshold level known as the holding current.

The circuit shown in Fig. 1 varies the average current through the lamps by controlling the point in the mains cycle at which the triac is triggered into conduction. This method of control is known as phase control.



STAGE LIGHTING

EACH CAPABLE OF DIMMING $3\frac{1}{4}$ kW OF LIGHTING

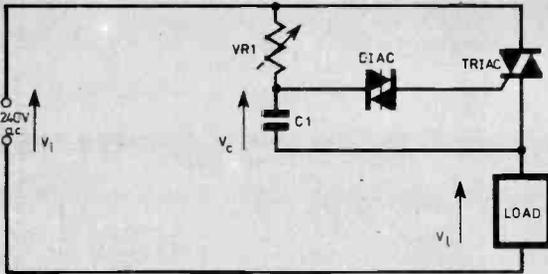


Fig. 1. The basic phase control triac circuit. The waveforms in different parts of the circuit are shown right

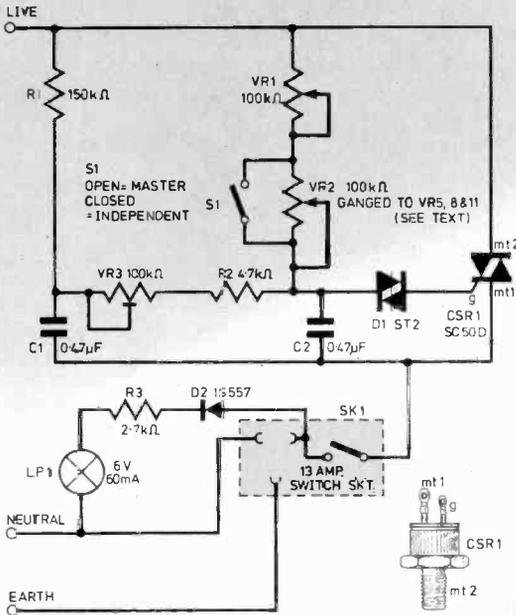
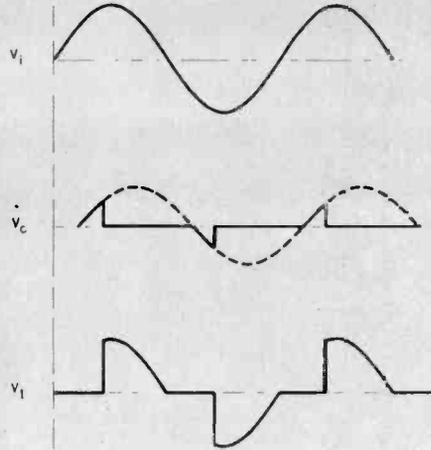


Fig. 2. The circuit of one of the control channels of the Stage Lighting Dimmer. Four identical channels are used in the unit

Referring to Fig. 1, capacitor C1 and variable resistor VR1 form a phase shift circuit which alters the phase of the signal at their junction with respect to the applied mains voltage.

The diac in series with the triac gate is a four-layer device which presents a high impedance until the voltage across it exceeds a value known as the breakdown voltage (about 30 volts) when it presents a low impedance. When the breakdown voltage is reached the capacitor C1 discharges into the gate of the triac causing it to conduct. Typical waveforms are also shown in Fig. 1.

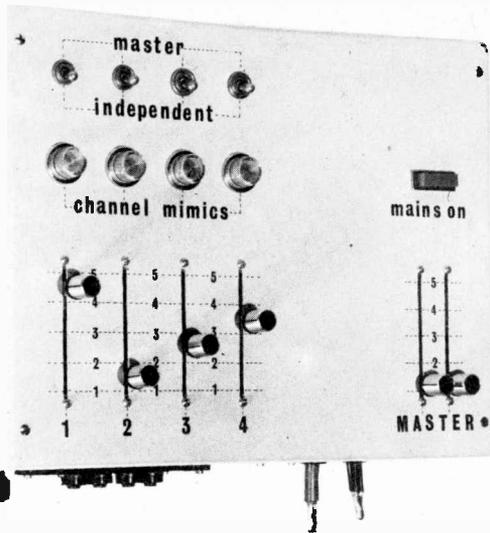
COMPLETE CIRCUIT

In the actual circuit used, shown in Fig. 2, VR1 is the Channel Fader and VR2 is one section of the Master Fader which can be over-riden by S1 to give independent control. VR1 and C2 form the phase control network and R1 and C1 are additions to provide smooth control at low light levels.

The current supplied by R1 and C1 is determined by VR3 in series with R2. VR3 can be used to

DIMMER

By R. Liffen



Photograph showing the layout of the components on the front panel and the output sockets mounted on the side of the case. Another two sockets are similarly fixed the other side

preset the extinguishing point of the lamp when the Channel Fader is fully down. There are two modes of use for VR3: it may be used to fully extinguish a lamp which would otherwise "sing" (due to the filament vibrating in the presence of small residual spiky current; alternatively it may be set so that the filament glows dull red, which enables a big lamp to be taken to full brightness quickly.

MIMIC CIRCUIT

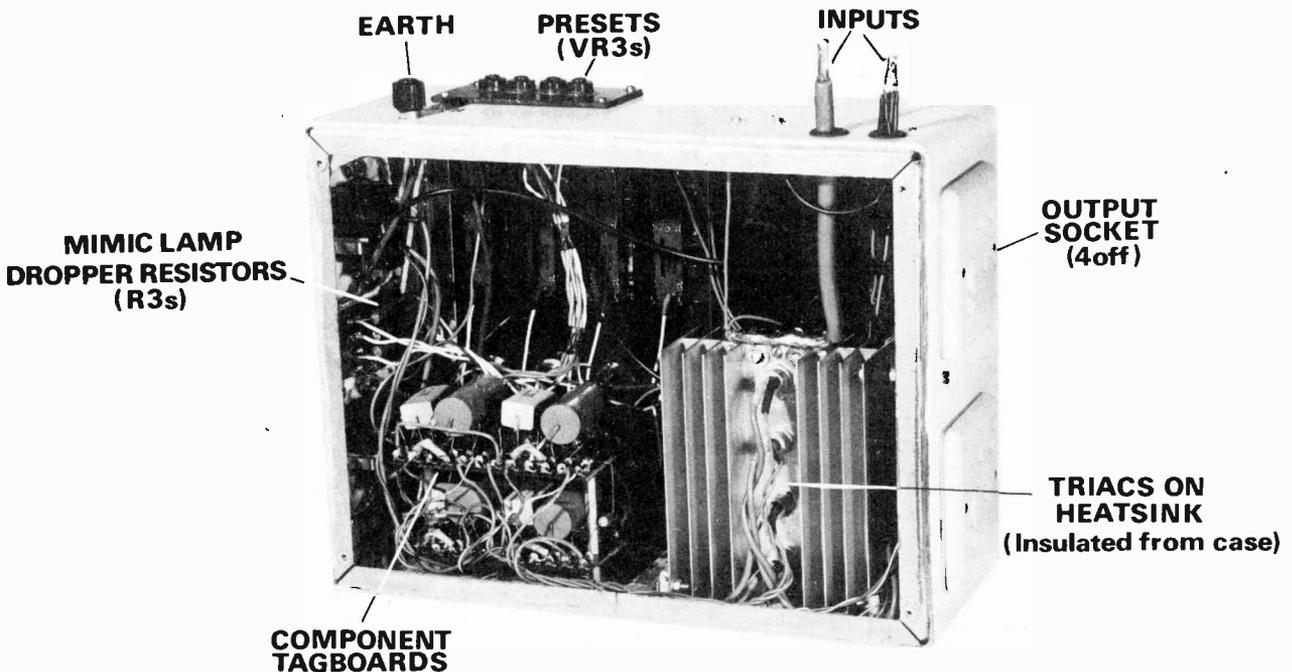
Components D2, R3 and LP1 form a "mimic" circuit to give a visual indication of the lamp brightness. D2 and R3 simply reduce the mains voltage down to six volts. The four resistors (R3 and its counterparts) dissipate nearly 10 watts each and must be placed in a well ventilated position.

Note the special connection between the switch-board 13 amp socket and D2. This is necessary because with no lighting load plugged in, the leakage through the triac will give a glow in the mimic lamp which can be disturbing to the lighting operator. With no lamp plugged in, the channel should be switched off at the socket.

The point to connect D2 will be found as a copper rivet head on the rear of the socket and should be verified with an ohmmeter.

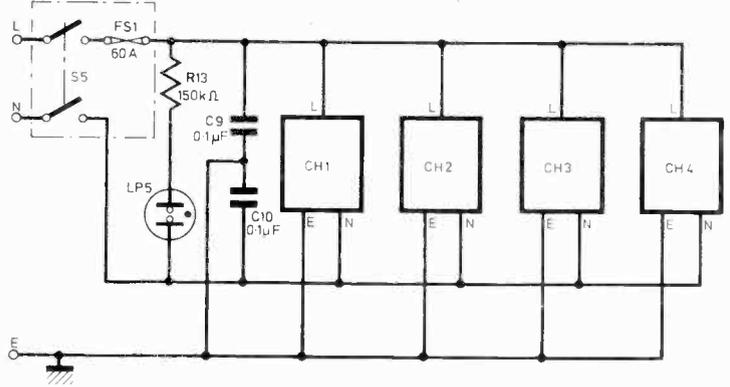
LOAD CONNECTION

The load is connected on the neutral side of the triac. This reduces the risk of electric shock from



Photograph showing the arrangement of the triac heatsink, the presets, the tagboards and the input connections within the case. *The heatsink must not touch the earthed case*

Fig. 3. Block diagram showing the four circuits of Fig. 2 interconnected and the extra components needed to complete the unit



defective lamps, since the lamp is at neutral rather than live when faded down. It also enables all the triacs to be mounted on a heatsink without insulating washers although this has the disadvantage that the heatsink is live and must therefore be insulated from the case.

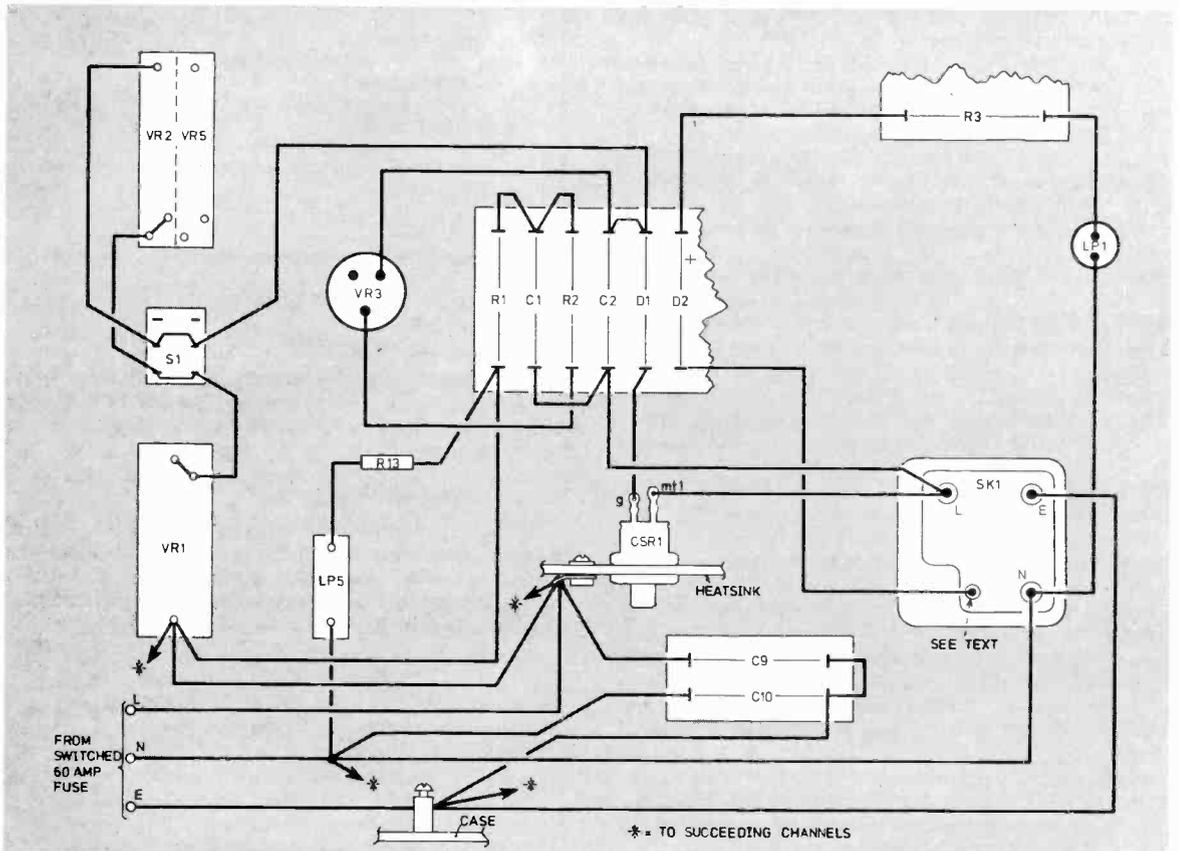
The triac, though a bi-directional device, operates best with the main terminal 2 (mt2) live with respect to mtl. For the SC50D mt2 is the threaded stud.

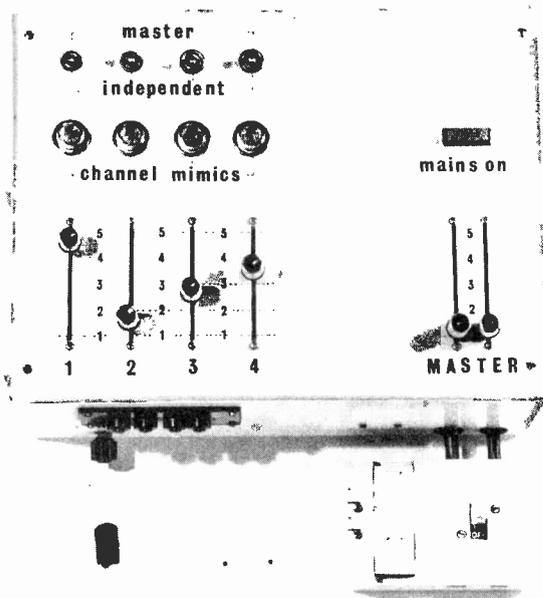
Interference suppression is obtained using two capacitors (C9 and C10) connected between the supply lines as shown in Fig. 3. Also seen on Fig. 3 is the mains indicator neon and the 60 amp fused switch.

CONSTRUCTION

The dimmer was designed to be mounted on a wall so the control box and the switched fuse were

Fig. 4. Layout of the components on the tagboard and interwiring for one of the four channels. Components should be mounted on the front panel, the case and the tagboards, and then interwiring should be done using this diagram and Fig. 3 as a guide. Wires which carry the current to the lamps should be heavy duty to reduce heating effects.





Photograph showing the completed unit and 60 amp switched fuse mounted on the backing board

fitted on a wooden panel fitted with mounting brackets (see photograph). The metal box used for the prototype is not generally available but any aluminium or steel box of sufficient size (13in × 10in × 5in) can be used.

The four triacs are mounted on a large heatsink which is connected to the live input via the switched fuse. A smear of heat-conducting grease should be applied before the triacs are bolted in position.

All the small components are mounted on two tagboards as shown in Fig. 4. The only exceptions are the four mimic lamp resistors (R3 etc.) which are mounted on a separate tagboard in a ventilated position.

The m.e.s. lampholders must be of the type which have both lamp terminals insulated from the case as neither must touch the case which is earthed.

The four preset potentiometers (VR3 etc.) are mounted on the outside of the case so that they are easily adjusted.

The output sockets are mounted two on either side of the case. The tagboards are mounted on pillars.

Plastic brackets are used to support the heatsink without it touching the case. Make sure that the lid of the case does not touch it when fitted.

Vents must be cut in the case to allow air to circulate if none are present.

Front panel layout is not critical, the photographs showing the prototype layout. Note that the two stereo sliders which form the Master Fader should be mounted as close as possible to each other so that they may be moved together. They may be physically joined with a metal bracket if this is desired.

Cables capable of carrying the 60 amp input current must be used for connection to the unit. A heavy duty earth cable should be connected to the case using a screw terminal.

COMPONENTS . . .

Resistors

- R1 150k Ω
 - R2 4.7k Ω
 - R3 2.7k Ω
- } $\frac{1}{2}$ watt carbon
10W wirewound

Potentiometers

- VR1 100k Ω linear slider
- VR2 100k Ω + 100k Ω linear stereo slider (each channel uses half of one)

Capacitors

- C1, C2 0.47 μ F 400V (2 off)

Semiconductors

- D1 Diac type ST2 (Henry's Radio)
- D2 1S557, BY100 or any 400V 1A diode
- CSR1 SC50D 400V 15A Triac (Henry's)

Miscellaneous

- LP1 6V 60mA m.e.s. lamp and holder
- SK1 13A switched mains socket (MK2957) + mounting plate MK2200 21L
- S1 Mains on/off switch

The components above are required for each of the four channels, i.e. four of each (except VR2) are required. The components below are required to complete the unit

Resistor

- R13 150k Ω (not needed if included with neon)

Capacitors

- C9, C10 0.1 μ F 1000V (2 off)

Miscellaneous

- LP5 Mains neon indicator
- S5 M.E.M. 60A switch/fuse
- 12 way tagboards (2 off)
- 4 way tagboard
- Screw terminal, 6in × 6in × 2in finned heatsink, plastic brackets, 16mm copper double insulated (p.v.c./p.v.c.)

PRACTICAL POINTS

To reduce the interference effects of the unit it should be used on a supply separate from that being used by any microphone or musical instrument amplifiers, i.e. the 60 amp cables to the input should be taken to the nearest low impedance mains supply, the local "main feeder."

Ordinary household ring main circuits will not handle the unit on full load. In the case of a house or small hall the connections should be made direct to the fuse box, having first checked that the incoming mains can supply 13kW.

Footlights present a special problem since they are often close to stage microphone cables. If possible use footlight feeder cable which has an earth screen totally enclosing the conductors.

The slots in the box for the faders was made using a Monodex metal cutter.

A heavy duty soldering iron is necessary for soldering the 60 amp cables.

Total cost of the unit was approximately £35. ★



BY FRANK W. HYDE

BLACK HOLES

There are many enquiries about "black holes" and not surprisingly they are mostly of the form "What is a black hole?"

The term "hole" is the main difficulty, just as it was with solid state devices. Perhaps this is because usually a hole is some space which is at an angle to a surface.

Since the situation is one of concentration of matter and energy it is better to use the word concentration. The new name then is a "black concentration" and in this case it means that energy and matter is not radiating outwards but is concentrated away from the observer. It is, therefore, a black condition.

Proceeding from there, imagine that the Sun in following its life course goes through the process of normal star evolution and death. It will expand to many times its present size to become a Red Giant. In expanding it will cool down and as the fuel of it becomes consumed the gravitational forces will cause it to contract to about one per cent of its volume. This will mean that it will become very hot again. It will then acquire a new name, that of White Dwarf. Its brightness will have increased and so will its density so that a cubic inch would weigh many tons.

However, by the nature of the process there is a limit to the compression and in the case of the Sun it will probably remain as a White Dwarf, gradually cooling down.

GRAVITATIONAL COLLAPSE

In the case of stars more massive than the Sun the energy produced during the life cycle may be such as to make the stage from Red Giant to White Dwarf much more

concentrated. In this case a state of gravitational collapse may occur and a "black concentration" will take place.

Not only does this effect apply to the star itself but also to the surrounding media. In this condition it is possible that other concentrations of matter nearby are sucked into the area.

The advent of gravitational collapse is likely to arise after the transition from Red Giant to White Dwarf. This could be because the White Dwarf stage is not a halting point as it were, and the energy of the shrinking from Red Giant may over-run the White Dwarf point. In this case the enormous energies will build up to a catastrophic explosion and a supernova would be the result. This will appear as an extremely bright object and parts of the original star will be flung out at fantastic speeds of the order of hundreds of miles a second. There will be left a small highly concentrated mass, the neutron star. This is the Pulsar according to the accepted current theory.

Sometimes the energy is so great that the situation is not ended at this point and the collapse goes beyond the neutron star point. It is here that the condition of the "black hole" is reached.

It is not easy to accept the implications of this manner of events. It would mean that no light or radiation of any kind comes out of this concentration.

The gravitational field is so great that in the comparatively short distance involved (if the Sun became a "black hole" it would be only two miles in diameter) matter in moving inwards from the "surface" would stretch out from the observer. In fact, there would persist for some time an image of the original matter and this would not appear to change for a very long time. In effect there would be a reversal of all the conditions that are regarded as normal.

NEW LOOK

At this point it is time to ask whether physicists have to take a new look at the whole situation. It would seem that there are no universal laws, but rather that the laws depend upon conditions as they are found. This is not merely a matter of reality but also of profound philosophical implications. It may be that other views will be expressed and that this interpretation is in itself rejected.

There is still no direct evidence, for the existence of the "black hole" but work which is going on at the moment may help to clear up the matter. It is hoped that there will be sufficient data shortly to report on the progress of a new project aimed at providing new evidence.

COMET KOHOUTEK

The comet Kohoutek, which is likely to make a sensational appearance and will be visible to the naked eye for four months or so, will be at its peak in December when it will be visible in full daylight. It will be visible to the naked eye from about the first of November.

There was not time for the organisation of a probe to intercept this comet though in other fields the early warning of its advent is useful. Professional gatherings have been held to set up a study programme and to avoid unnecessary duplication of observations.

Studies will be made in infra-red and observations in the 50-100 micrometre wavelengths will be made from a jet plane. It may well be that a programme will be set for observations from *Skylab*.

It so happens that a number of dispersed observations from automatic satellites and a probe will be able to provide useful data. Satellites *OSO-3* and *OSO-7* will be able to make photographic observations and *Mariner 10* will be able to monitor the inter-planetary medium as it proceeds on its journey to Venus and Mercury.

All these study programmes will help to practice different techniques which can be used for the special observations of Halley's comet which is due in 1986.

LIGHTS IN THE SKY

Three years ago a search for fluorescent pulses, induced by X-ray photons, was made. During this observation the fast atmospheric pulsations of light were discovered. Since this discovery there have been observations which threw more light on these effects.

At Ankara H. Ögelman has made observations with baselines of 175 and 3,300 kilometres. The results of this work are being correlated, but first results seem to indicate that these FAP's, as they are called, appear from discrete directions and are more frequent than was supposed.

The energies are being measured and later results will appear in this column.

MARS VEHICLES

Considerable re-design may be necessary for the manned vehicles to Mars because of the high radiation levels that might be normally encountered.

This conclusion arises from the examination of the materials of the *Apollo* spacecraft after returning from the Moon. The extent of the radiation has supplied the solution and it is thought a re-arrangement of the present design will be possible to overcome this hazard.

POWER SUPPLY BOARD

COMPONENTS . . .

POWER SUPPLY

Resistors

R32 1.5k Ω
 R33 470 Ω
 R34 470 Ω
 R35 39 Ω
 R36 33 Ω
 All $\frac{1}{4}$ W 10%.

Capacitors

C19 3,500 μ F 40VW
 C20 3,500 μ F 40VW
 C21 1,000 μ F 16VW
 C22 1,000 μ F 16VW
 C23 1,000 μ F 35VW
 C24 1,000 μ F 25VW
 C25 1,000 μ F 25VW
 C26 1,000 μ F 25VW
 All elect.

Semiconductors

D1 to 8 BK32
 (2 in parallel) Semicron.
 D9 to 12 B40 C1000
 Semicron.
 D13 24V Zener.
 D14 & 15 15V 10% Zener.
 D16 20V Zener.
 D17 18V Zener.
 All Zeners are 400mW
 TR6 TIP29

Transformer

T1 Primary 240V a.c.
 Secondaries
 1, 20-0-20V a.c., 4A.
 2, 24V a.c. $\frac{1}{2}$ A.

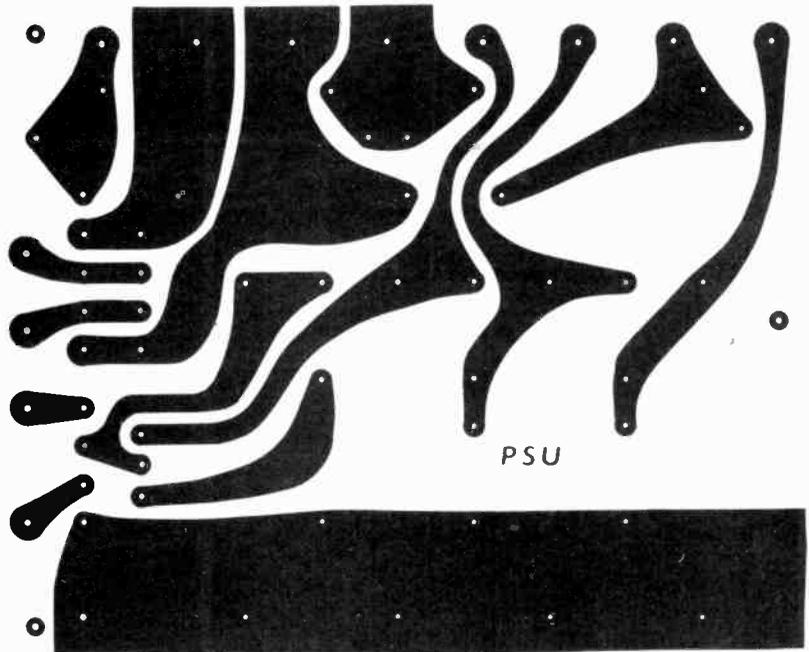


Fig. 3.2. Circuit board master for the Rondo power supply

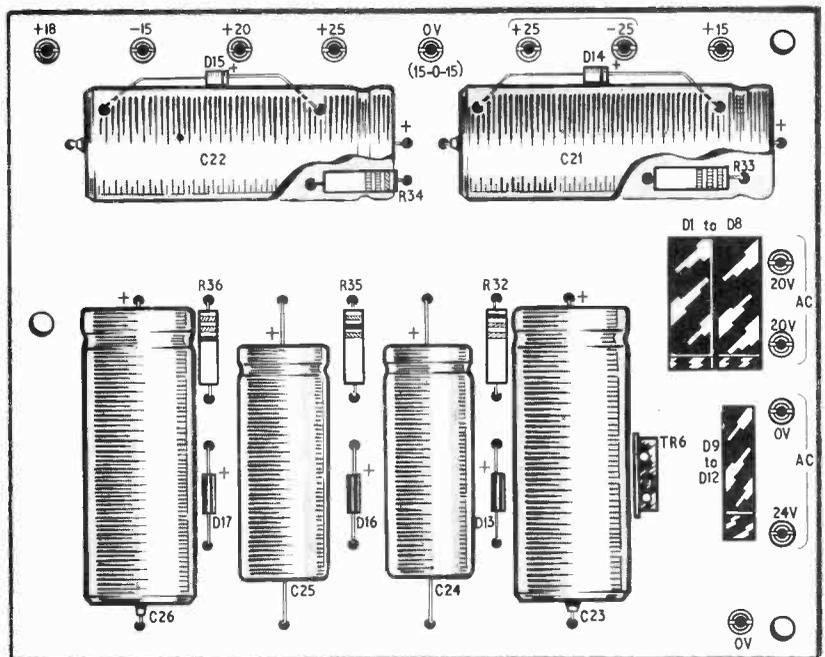


Fig. 3.3. Component layout for the power supply board viewed from the component side

MAIN CHASSIS DETAILS

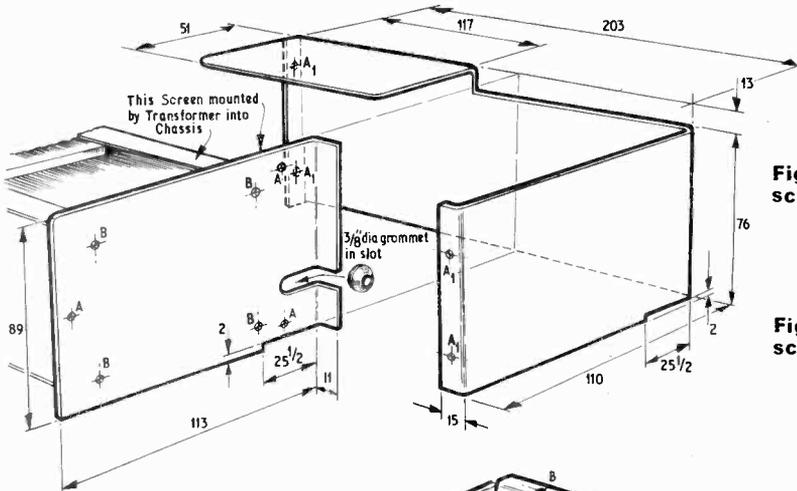


Fig. 3.5. Transformer screen metalwork details

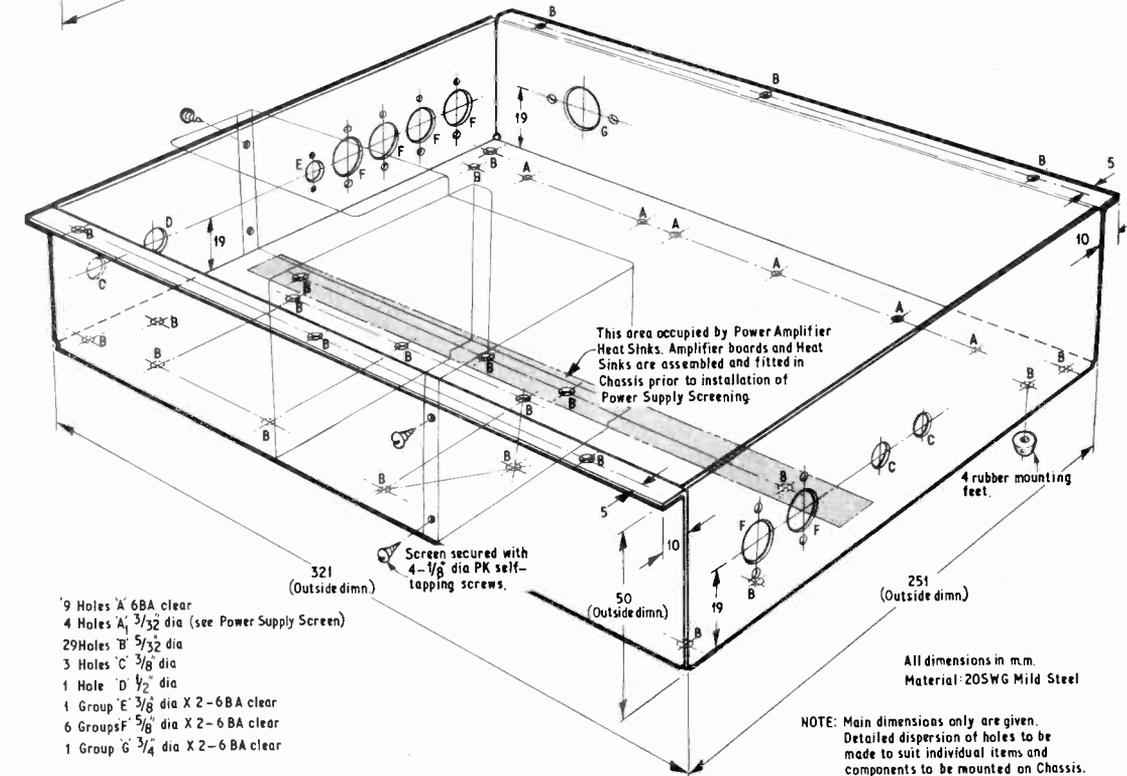


Fig. 3.6. Power supply screen metalwork details

Fig. 3.4. Main supporting chassis metalwork shown in general detail in the fabricated form and with external critical dimensions for simplicity. There should be no reinforcement where the sides meet, as the sides must be able to be pressed inwards when the wooden sleeve is fitted

POWER AMPLIFIERS SUPPLY

The dual rail supply is, as shown in Fig. 3.1, derived from a 20-0-20V transformer T1 winding with a 4A capacity rectified by two bridge rectifiers D1-D8 in parallel. The expedient of using two smaller (at lower cost) unmatched, bridge rectifiers in parallel is open to criticism because of "current hogging". That is, that the rectifier with the lower impedance will have a higher current flow. The rectifiers have been chosen so that, under all operating conditions, there are no detrimental effects due to this phenomenon.

The transformer centre tap is taken direct to the junction of two 3,500 μ F main smoothing capacitors C19, C20, joined negative to positive, and the rectified d.c. supply to the free positive and negative terminals of these capacitors respectively. The d.c. voltage, after rectification, is around +25 to -25V. (The centre zero is at earth potential.) The supplies to the main power amplifier output stages are taken direct from the main smoothing capacitors.

OTHER BOARD SUPPLIES

All the 748's are fed from ± 15 V d.c. rails obtained by dropping through resistors R33, R34 from the ± 25 V supplies smoothed by two 1,000 μ F capacitors C21, C22. As these rails do not have to be at precisely 15V but the i.c.s have to be protected against exceeding a maximum rating of 18V, they are "clamped" to 15V by two Zener diodes (D14 and D15).

The positive rail and negative earth supply is obtained from a separate winding on the transformer T1. This winding is 24V a.c. at 250mA and is rectified by a 1A bridge rectifier, D9 to D12, smoothed and then regulated by a series regulator circuit TR6, R32 and D13 to 24V d.c. and smoothed again.

From this point is taken the supply to the varicap diodes of the f.m. tuner.

A further ladder of droppers, Zeners and smoothing capacitors produces 20V d.c. to the SQ decoder, 18V d.c. to the a.m. tuner, f.m. tuner head transistors, i.f. stages and the stereo multiplex decoder. The values of the ladder are chosen so that either the a.m. or f.m. tuner may be on, or both tuners off, without disturbing the voltages of the other supplies significantly.

The components C26 and C27 and resistor R37, together with D18 are associated with the tuner unit (yet to be described) and in fact appear on that unit's board. They are shown here merely for completeness.

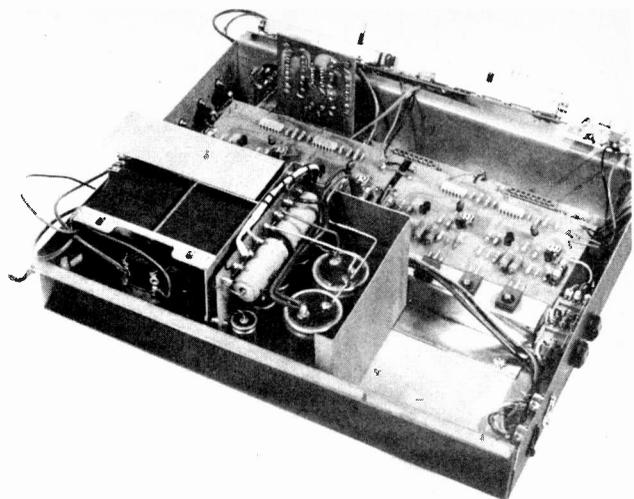
CONSTRUCTION

The power supply p.c.b. master negative is shown in Fig. 3.2 which indicates the simplicity of the circuit in practice.

The component layout appears in Fig. 3.3 which is self explanatory. Capacitors C19 and C20 are too large for board mounting and are in fact clamped in the main chassis.

MAIN CHASSIS

The main chassis member is a rectangular box-form which in fact sits on its back in the final assembly. Thus it is used as a trough with components mounted within it rather than in the more conventional manner.



General view of the "trough" form of the main chassis for the Rondo showing the orientation of the power amplifiers and power supply with some of the general wiring in place. Plug and socket holes are not sized as this will depend on items selected

The chassis is shown in the bent-up form in Fig. 3.4. The material used for the prototype was 20 s.w.g. mild steel plate but of course this may present some difficulties to constructors since it is not easy to bend. Thus it is possible to use 16 s.w.g. "half-hard" aluminium sheet which is somewhat easier to bend or, indeed, to fabricate the structure from flat sheets cut to size. For this reason only the major dimensions have been given as it is felt that each constructor will probably adopt his own style of construction.

It should be added that the chassis, in the prototype design, contains all the various parts of the system and supports the outer wooden case and fascia which is in the form of a sleeve which slips over the unit and is fastened to the chassis.

PLUGS AND SOCKETS

As individual constructors may wish to vary the types and sizes of plugs and sockets used the positioning shown is open to variation to suit though of course major shifting of components is not advised as this can create feedback paths for which the equipment is not designed.

CHASSIS SCREENS

The power supply includes the mains transformer, board and main smoothing capacitors and the whole is placed behind a shield to cut down hum pick-up at the pre-amplifier and elsewhere.

Two screens are used, as illustrated in Fig. 3.5 and 6. The smaller acts as a support for the power supply p.c.b. and is fastened to the transformer using 4BA screws. The p.c.b. is then attached to the screen using 6BA screws and $\frac{1}{8}$ in spacers.

The larger screen is assembled later in the sequence and is held in place using self-tapping screws.

Note that the transistors in the power amplifier last month should be type MJE3055K

Next month we will finalise the mechanical assembly details and discuss the unit interwiring

Gerry Brown . . .

ON THE FRINGE



DOGGED RESISTANCE

Honestly, the trouble to which people go in order to maintain their various equilibria.

The latest in this mania for status quo manipulation appeared in a letter to a professional U.S. magazine. This, in fact, took the form of a reply to an earlier piece of correspondence which complained about noise from a barking dog, and which simply requested "Help! Widget wanted to drive the Mutts Nuts."

Help, if this is what it could be referred to, appeared a month later as a package deal comprising a 20kHz oscillator and (twenty watt!) amplifier combo driving a hi-fi tweeter horn. The suggestion was, that by continuous use, although no human would be able to hear the thing, poor ole' Fido would make such an awful din that his ever-loving owner, thinking he'd gone out of his tiny mind, would be just itching the next day to have him put down!

Now no one could accuse me of holding any torches for the canine community, nevertheless, I cannot help feeling that this is a singularly pernicious use of electronics.—One couldn't help noticing that the correspondent had asked to have his name withheld!

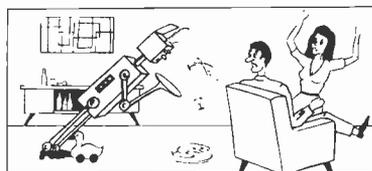
LSI or AU PAIR?

The number of times we have to hear about the feasibility of robot "flunkies" in the home, and how extraordinarily easy it's all going to be once they're installed. All you need is a handful of super-LSI chips, and you'll never look back! No doubt, the electronics represent no

insurmountable problem, but how practical would something like this be, even assuming the mechanical aspects could be solved?

The variety of jobs that can be performed by automated equipment is already overwhelming; what with tumble driers, telephone answerers, record players, etc., it might even be questionable whether a place *exists* for robots in the true sense of the word. Yet, I read, just last week, that Dr George Müller of Systems Development Corporation, California, reckons that a computerised set-up of this sort would be a viable proposition within, say, ten years.

Once written, I suppose, executive programmes having the same general format could be hard-wired into the devices prior to despatch. The "crunch" might come when the new owner needed to programme the confounded thing for the sundry tasks around the home.



Imagine trying to write a programme for accomplishing the "simple" job of pouring drinks. You would need to tell it to "come out of your storage cupboard", "turn left after three feet", "continue for nine feet seven inches" (at this point you might be wondering whether it only understood metric), "stop", "move right arm slowly towards cupboard right-hand handle", "grip handle gently and rotate it 180 degrees counter-clockwise" (supposing that the catch didn't release until 181 degrees?).

"Carefully open door 120 degrees, then release handle", "lower arm, and scan inside cupboard for port bottle (does robot think I mean the bottle on the left?)", "if located, remove the cork in this bottle and pour a quantity of liquid from the bottle into each of the glasses situated below the bottle rack", "ensure that each glass is only filled to the $\frac{3}{4}$ mark", etc., etc.

With such a system, one need only forget about junior's toy duck, 'plum in the middle' of the automaton's path, to give it a full-blown seizure!

A machine able to rely on learning techniques might prove to be a better proposition, always provided you could tolerate the broken glass, wine-sodden carpets, and the bill from the psychiatrist while it got the hang of things!

MAINSTREAM

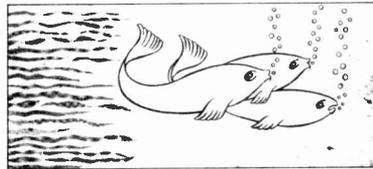
By nature (I'm told) the trout is a lazy sort of fellow; loves to bask himself in the sun, and only makes a sudden dart across the current if, in his myopic way, he fancies he's seen a fly somewhere on the surface. In this life, though, there is rarely anything that escapes exploitation and the trout represents a typical case in point.

Recently, you see, the waterworks at Boran sur Oise, near Paris, have overcome some difficulties associated with the monitoring of pollution levels by recruiting the aid of this delicious member of the aquaticeae. Seemingly, ordinary detection/warning systems in this application are insufficiently sensitive; as a corollary, the waterboard's laboratory have "roped-in" three good-sized brown trout to do the job instead.

Each animal is located in a glass-sided tank fed from normal supply water and running at a rate consistent with typical river current. Normally, the trout orientates himself up-stream; however, if conditions cause the water to be slightly polluted, he'll about-turn to face downstream.

By fitting up each of the fish with tiny electrodes, an alarm can be triggered whenever all three fish do a simultaneous "flip round". Individuals turning-tail are ignored by logic ANDING circuits to avoid false alarms.

Several days of this treatment do not appear to upset these creatures, in spite of the fact that if any of them stop swimming they are given an electric shock into the bargain. Since these animals are required to work in a sterile environment one wonders what technical arrangements have been made to feed 'em too!



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Anyone who can supply the undermentioned are asked to communicate directly with the reader.

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November 1969, February to April 1970
Mr. S. R. Dunning, 103 Glebe Road, Deanshanger, Wolverton, Bucks.

July to October 1972
Mr. J. Y. T. Lee, 20 Wong Chuk Hand Road, 2nd Floor, Aberdeen, Hong Kong.

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Mr. D. Lawrence, 8 Stringers Drive, Rodborough, Stroud, Glos.

May 1972
Mr. J. Hoppe, Murraymead, Bracknells Lane, Hartley Wintney, Basingstoke, Hants.

October, November 1972
Mr. L. Davis, 27 Highfield Avenue, Burntwood, Nr. Walsall, Staffs.

May 1969 to March 1970
T. Hall, 60 Archers Road, Marlborough Estate, Takajuna 10, Auckland, New Zealand.

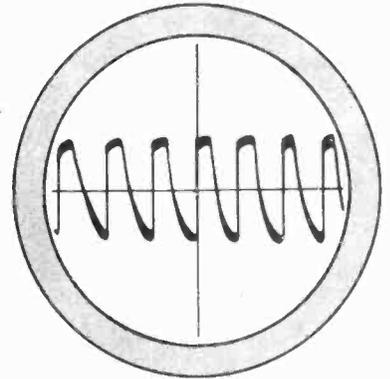
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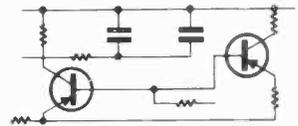
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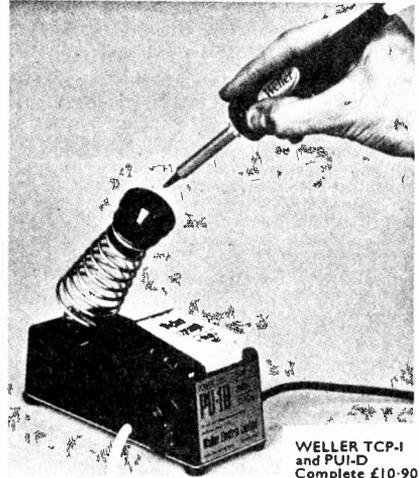
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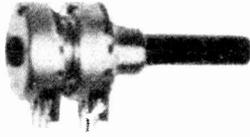
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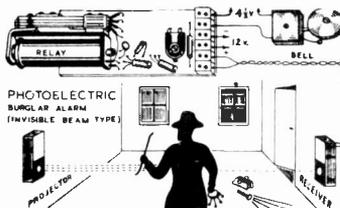
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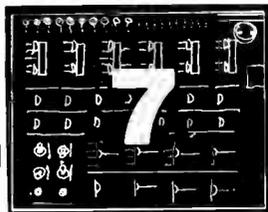
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LOGIC TUTOR

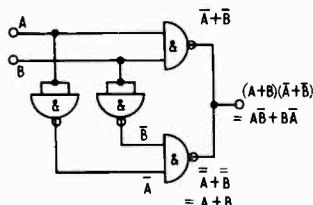
EXPERIMENTS...

THE HALF ADDER



by M. J. Hughes

THE circuit we left you to puzzle over last month was another form of the EXCLUSIVE OR gate. The Boolean expressions for the various nodes are shown in Fig. 1. The outputs of the two gates that are WIRED OR'd together would have been $\bar{A} + \bar{B}$ and $A + B$ respectively without the link between them but as soon as the link is made these two functions become AND'ed together and then it is a simple matter of Boolean manipulation to show that the output function is EXCLUSIVE OR.



Exclusive OR truth table

A	B	AB+BA
0	0	0
1	0	1
0	1	1
1	1	0

0+0=0
1+0=1
0+1=1
1+1=0 (carry 1)

Binary Addition

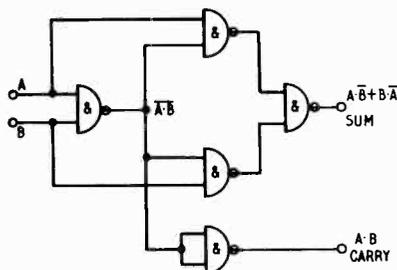
It is necessary to understand the basic principle of adding together two binary integers. The rules are very simple—in fact exactly the same as in conventional denary arithmetic except that whenever you get a sum greater than 1 you must carry over a digit into the next column. Let's take the simple case of adding two single digit numbers together. We'll call the digits A and B to differentiate between them and show the sum and carry—when necessary—in the following simple table. Note that we are carrying out pure addition here and in this instance + means plus and not OR

Digit A	Digit B	Sum
0	+	0 = 0
1	+	0 = 1
0	+	1 = 1
1	+	1 = 0 (carry 1 over)

In this list of sums we have used every permutation of the two numbers. Compare the arithmetic with the truth table for the EXCLUSIVE OR gate shown in Fig. 2. If we used electrical signals to represent the numbers we wanted to add together and could accept an electrical signal as an answer you can see that the output of an EXCLUSIVE OR gate gives us a true representation of the sum of the two binary integers. It does not, however, give us the carry digit when we want to add 1 and 1. In addition we only need a carry when we have 1 AND 1 so it is a simple matter to provide this output from the same pair of inputs by introducing an AND function.

Fig. 1. Answer to last month's problem. The circuit is an EXCLUSIVE OR

Fig. 2. Comparison of binary addition with EXCLUSIVE OR truth table



A	B	SUM	CARRY
0	0	0	0
1	0	1	0
0	1	1	0
1	1	0	1

Fig. 3. A half adder is an EXCLUSIVE OR plus an AND function of the inputs

Fig. 3 shows how this can be done by taking the $\bar{A}B$ function—generated at the centre node of the EXCLUSIVE OR—and inverting it. You can see that the truth table for the circuit shown in Fig. 3 is an exact replica of the answers we would wish to get when carrying out a binary addition. The circuit is called a half adder. As is often the case there are various ways of designing half adders—you now know at least three ways of making the EXCLUSIVE OR function so try making some more half adders yourself on the Logic Tutor.

You might query why this is called a half adder. The reason is that when we come to add together two multidigit numbers (see Fig. 4) our current circuit is quite capable of dealing with the least significant column (i) but when we come on to the other columns we have to be able to add together the respective digits of numbers A and B but also have to be able to add in any carry over that was generated in the previous (lesser significance) column. Thus to add multidigit numbers together we must have a circuit that can handle three inputs.

A circuit that will do this is called the full adder and we shall deal with this next month.

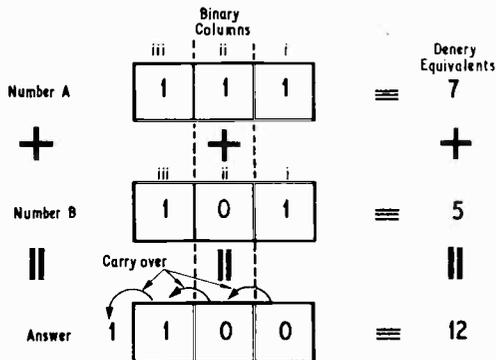


Fig. 4. When carrying out addition of two multidigit numbers a half adder is capable of dealing with column (i) but when it comes to column (ii) there must be provision for three inputs, digit (ii) of A + digit (ii) of B + possible carry over from column (i). The same applies to all higher power columns

PE Sound Synthesiser 10

KEYBOARD

With these added units the keyboard becomes a unique musical instrument . . .



WHEN the Sound Synthesiser was originally presented for publication it was the intention that it should be classed as a general purpose instrument which could be exploited in the widest possible number of ways and yet retain a basic simplicity of design and ease of construction. During the course of the series however many readers have commented that the musical capabilities of the instrument have been severely restricted by the lack of logarithmic v.c.o.s and thus the oscillator to be described in this article has been included in the keyboard unit in the hope that it will put matters right.

Prospective constructors should note that although the logarithmic v.c.o. is based on the linear v.c.o. which was described in Part 3, the parameters of operation are quite different and the setting-up is rather more critical if it is desired to operate the device within the limitations of a precise range of control voltages.

Although limited to about 11 octaves range with the design values given, it is possible to adjust the operating points to cover a much wider bandwidth. The prototype has operated quite happily from less than 1Hz to greater than 150kHz with a control voltage swing of about 11V and there is no reason to suppose that it could not reach 1MHz, or greater, if the integrator output voltage were to be reduced and a faster comparator employed. As a result it is possible that the oscillator may be suitable for a number of applications outside the sphere of sound synthesis.

The v.c.o. is shown in block schematic form in Fig. 10.1. The control voltage to the oscillator is modified in a differential input summer and then applied to a constant current generator housed in a "transistor oven". The output of the current generator is then led to an integrator/comparator stage through the medium of a current switch which is controlled jointly by the comparator and inverter. The triangular wave output is led to a waveform shaping circuit which provides a sine wave having a very low harmonic content.

DESIGN CONSIDERATIONS

It was decided that the best way of providing a log law performance to the basic v.c.o. outlined in Part 3 of the series was to utilise the entirely predictable logarithmic relationship between the base/emitter voltage (V_{be}) and collector current (I_c) of a bipolar transistor.

Start Here !

This month we start detailing the operation and construction of the keyboard unit for the synthesiser. Regular readers of P.E. who may have been put off by the apparent complexity and/or cost of the synthesiser project as a whole may be interested to learn that the facilities offered by the keyboard unit are such as to allow the instrument to be classed as a music synthesiser in its own right, and at an overall cost of less than £80. Main features of the instrument are as follows:

Two tracking oscillators featuring a variable logarithmic law which allows compatibility with a wide range of control voltages and provides square, triangular and high purity sine wave outputs.

A novel "floating" divider system which greatly simplifies tuning the instrument and by means of which the compass of the keyboard can be swung, in tune, from a low frequency of about 6Hz to a high frequency greater than 27kHz. The divider features a switchable "span" facility.

Two modulation amplifiers by means of which the oscillators may frequency modulate one another either separately or at the same time.

Two analogue memory circuits which retain the last programmed divider voltage to either oscillator. Separate portamento controls are incorporated in the hold circuits giving six values of delay from instantaneous to one second.

Two simplified envelope shapers incorporating voltage controlled amplifiers each having a variable Attack and Decay characteristic and featuring a switched percussive attack.

A simple two channel, fixed gain mixer.

Finally, the keyboard divider system incorporates a link switch which allows the two oscillators to be programmed independently by the lower 18 and upper 31 keys respectively. This particular feature greatly improves the "live performance" possibilities. An independent p.s.u. is included.

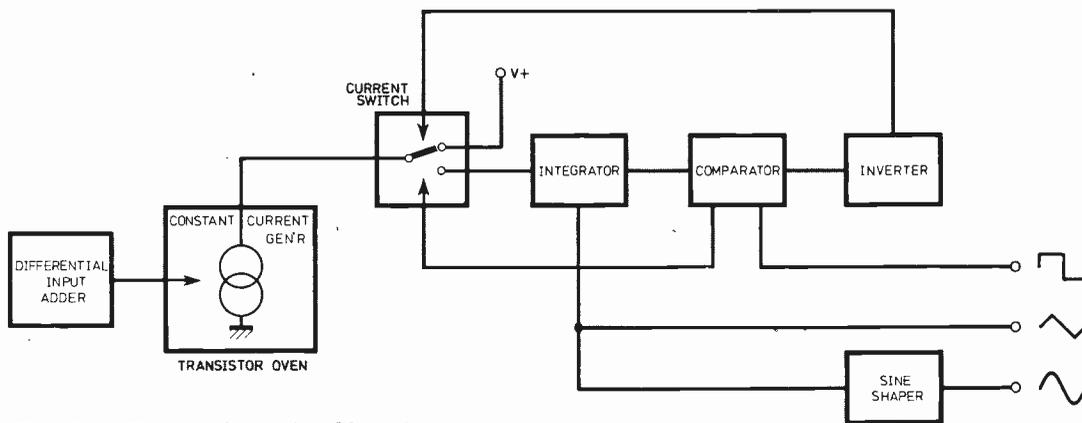


Fig. 10.1. Block schematic of logarithmic v.c.o.

Although the current generator could be almost any discrete transistor the effect of ambient temperature variations would be such as to cause the current demand to vary quite widely and thus adversely affect the "tune" of the oscillator. Consequently it was decided to make use of the inherently close thermal and electrical matching between transistors mounted in a monolithic integrated circuit — the ML3046P and CA3046 both having been tried in the prototype. Extremely close thermal stability is ensured by employing two of the transistors in the array as a heater and sensor respectively and terming the whole arrangement as a "transistor oven."

Fig. 10.2a shows a detailed arrangement of the "oven" while Fig. 10.2b shows the pin connections for the 3046 device. Fig. 10.3 illustrates how the V_{be} of transistors on the array will vary over a wide range of temperatures and provides a guide as to the actual temperature of the chip when the V_{be} of the sensing transistor is known.

In Fig. 10.2a Q1 serves as the heating element while Q2 is used to sense the temperature of the chip. The V_{be} of Q2 is compared with a reference

voltage set up by R3, VR1 and R4. The reference voltage will correspond to a temperature which is considerably higher than ambient and will thus be at a lower value than $Q2V_{be}$ when power is first applied. Thus the comparator will switch positive and turn on Q1. As the temperature of the chip rises $Q2V_{be}$ will fall to a point where it is equal to or less than the reference voltage at which time the comparator will switch negative and turn off Q1.

The criteria determining the value of R1 are as follows:—

1. The temperature of the chip must be set considerably above normal ambient conditions (say 40 degrees to 45 degrees Centigrade).
2. The combined power dissipation of Q1 and Q2 must exceed, by a wide margin, the combined power dissipation of the remaining transistors in the array.
3. The current switching of Q1 must not be so violent as to impart a significant jitter to the oscillator waveform.

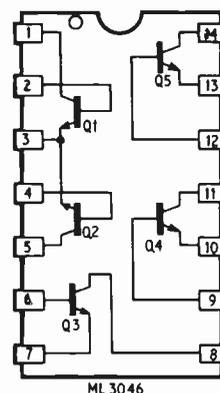
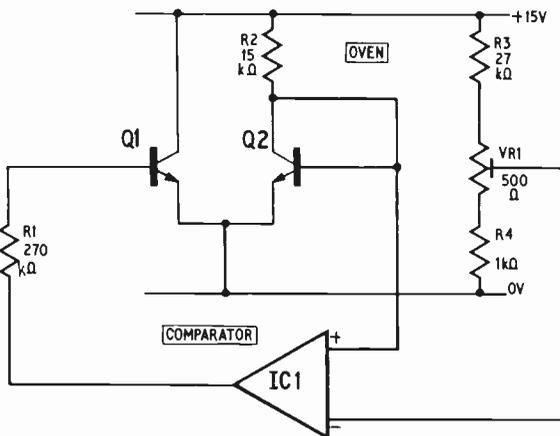


Fig. 10.2(a). Detailed arrangement of the transistor oven; (b) pin connections of the ML3046 and CA3046. Note that pin 13 must be connected to the most negative point in circuit

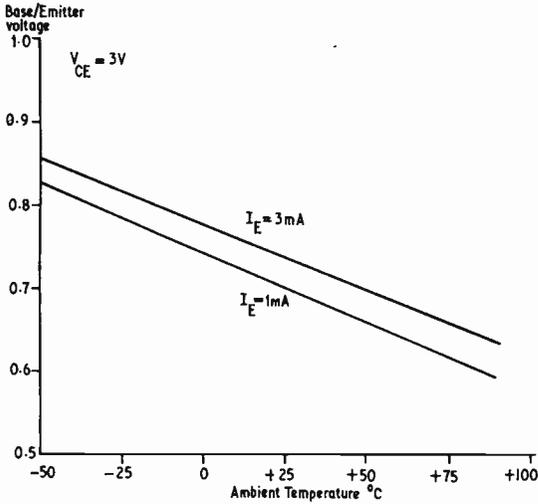


Fig. 10.3. Showing the change in V_{be} for variations in ambient temperature for the ML3046 and CA3046

In practice the value of R_1 which gives the closest approach to the above criteria is 270 kilohms. With this value it is possible to set $Q_2 V_{be}$ to 680mV, that is approximately 45 degrees Centigrade while the combined dissipation of Q_1 and Q_2 is about 90mW as opposed to the combined dissipation of Q_4 and Q_5 (the current generators) of about 1.4mW. Detailed setting-up instructions for the "oven" are given later in this article.

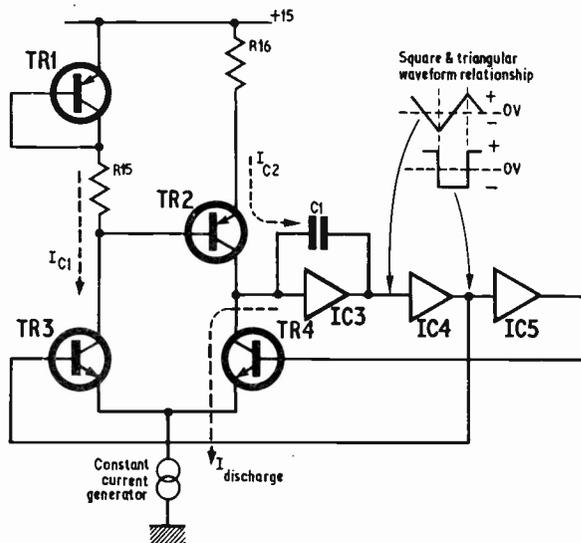


Fig. 10.4. Simplified layout of oscillator section showing operation of current switch

CURRENT SWITCH

Having thus established a thermally stable current generator it now remains to couple this to the input of the v.c.o. In the linear version of the v.c.o. a diode bridge was employed which was switched entirely by the action of the comparator. While this system could no doubt still operate satisfactorily a rather more sophisticated version has been adopted which utilises transistors in place of diodes. The so-called current switch is illustrated in Fig. 10.4. Assuming that the output of IC4 is positive to start with, the operation of the current switch is as follows.

With IC4 positive, the output of IC5 is negative and thus TR3 and TR4 are on and off respectively. With TR3 on the current generator demand will cause a drain across R_{15} and thus make the base of TR1 more negative than its emitter. TR1 will then turn on in proportion to the demand of the current generator and a current flow I_{c1} is established through TR1, R_{15} and TR3. I_{c1} will set up a p.d. across R_{15} which will have the effect of biasing on TR2 and establishing a second current flow, I_{c2} through R_{16} and TR2.

This latter current flow is entirely dependent upon the demand of the current generator which is varying the p.d. across R_{15} and thus TR2 may be said to track the demand of the current generator. The closer the matching of R_{15}/R_{16} and TR1 and TR2, the better will be the tracking and the better the symmetry of the integrator output waveform. Thermal stability is not a problem with TR1 and TR2 since the arrangement gives an equal and opposite reaction between these transistors for any variation in temperature.

I_{c2} causes the integrator to ramp negatively and at a predetermined negative level IC4 will switch negative and IC5 positive. Thus TR3 and TR4 are now off and on respectively and since TR3 is off so also is TR2 and the current generator now discharges C_1 via TR4 at a constant rate. The integrator will thus ramp positively until the switching point of IC4 is reached at which time the cycle repeats.

SINE WAVE SHAPER

The sine wave shaper used in the v.c.o. has been adapted from a design by D. T. Smith which appeared in *Wireless World* (Feb. 1973). Fig. 10.5 shows a detail of the circuit together with the waveforms presented at various points when the circuit is producing a sine wave having a low harmonic content.

The sine-shaper utilises the non-linear characteristics of a field-effect transistor in order to produce the desired output waveform and thus the operating points are quite critical. R_{20} , R_{21} and $D_{5,6}$ provide a network which allows the gate to track the input signal and apply the necessary degree of "pinch-off" as the source signal approaches its maximum on both positive and negative half-cycles. Since the gain of the f.e.t. is changing continuously relative to the input signal the device may be considered to be operating in the ohmic region as a voltage variable resistor.

In Fig. 10.5 VR_5 controls the d.c. offset of the input waveform and it is necessary to compensate for slight asymmetries which could be introduced in

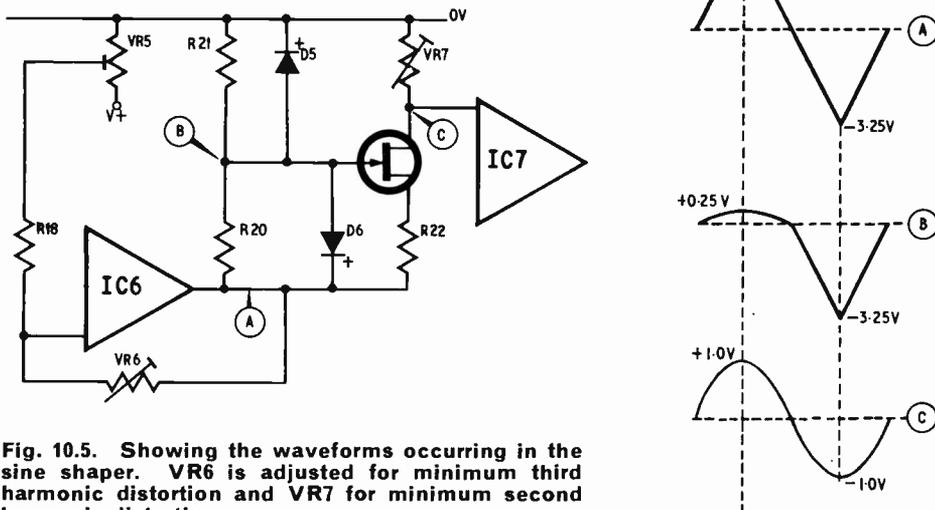


Fig. 10.5. Showing the waveforms occurring in the sine shaper. VR6 is adjusted for minimum third harmonic distortion and VR7 for minimum second harmonic distortion

the oscillator section. Over adjustment of VR5 in either direction can provide an alternative output waveform rich in harmonics.

VR6 sets the input signal level to the network. Too low a setting and the output waveform will be triangular while too much gain will give a waveform which is virtually a rounded off trapezoid. Careful adjustment of VR6 enables third harmonic distortion on the output to be reduced to a minimum.

VR7 controls the output amplitude of the signal. Too great a setting and the sine wave will become peaky while too low a setting will result in a squat, flattened out, waveform. Thus VR7 may be considered to control the second harmonic level and should be adjusted to minimise this characteristic.

BUILDING THE OSCILLATORS

The theoretical circuit of the complete oscillator module is shown in Fig. 10.6 while the recommended circuit board layout is shown in Fig. 10.7. It is strongly urged that construction of the module follows the guidelines suggested otherwise the interdependence of some of the controls is likely to make the final setting-up something of a nightmare.

Construction should start with assembly of the transistor oven, differential input summers and current generators. R1 should be 470 kilohm and left with fairly long leads to facilitate exchange during the final setting-up. Position the temperature control, preset VR1 to the R3 end of its travel to ensure that the comparator goes negative and thus turns off Q1 when power is applied. R10 should then be temporarily linked to the 0V rail and a decision taken as to the fate of R11. This resistor is optional in that it may be utilised to provide a third controlling input to the v.c.o. or it may be omitted at this stage without affecting anything. However, if it is decided to include R11 for the purpose of possible future additions to the circuitry it is important to remember that its presence could possibly compromise the setting-up of the oscillator if certain precautions are not taken.

If a third programming signal is to arrive at the oscillator from a low impedance source such as the output of another operational amplifier it is important that R11 also be temporarily linked to the 0V rail. Alternatively R11 may be left open circuit with the idea of using it only for the provision of occasional programming signals during which the tuning of the oscillator will have to be adjusted by means of VR4. In the setting-up instructions which follow R11 is open circuit.

SETTING UP

Since only one current generator can be set-up at a time the base of the second one (Q5) should be temporarily linked to the -15V rail to reduce the possibility of accidents. Set VR3 so that its value is 530 ohms. Note that if the positive lead of the ohmmeter is coupled to the -15V rail for this measurement the reading will not be compromised by the forward conduction of Q4. Set VR2 to the R6 end of its travel to ensure the minimum forward bias of Q4.

Set VR4 to its minimum setting and connect a milliammeter between the collector of Q4 and the 0V rail as shown in Fig. 10.8. As a safety precaution set the milliammeter to the 25mA range to start with. If the wiring up has been correctly carried out the milliammeter will show no reading when power is applied. On the other hand if the base of Q4 is incorrectly biased towards the positive region Q4 will pass a large current on switch-on which, besides possibly destroying the transistor, could also damage the meter.

Apply power and if no meter movement is observed reset to the 1mA range. Again there should be no obvious reading. Adjust VR2 towards the R5 end until the pointer of the meter makes a definite upward movement. At this point swing VR4 carefully over its full range and observe the maximum current drawn through Q4. The actual figure can vary quite widely at this stage and will probably be in the region 0.25-0.75mA.

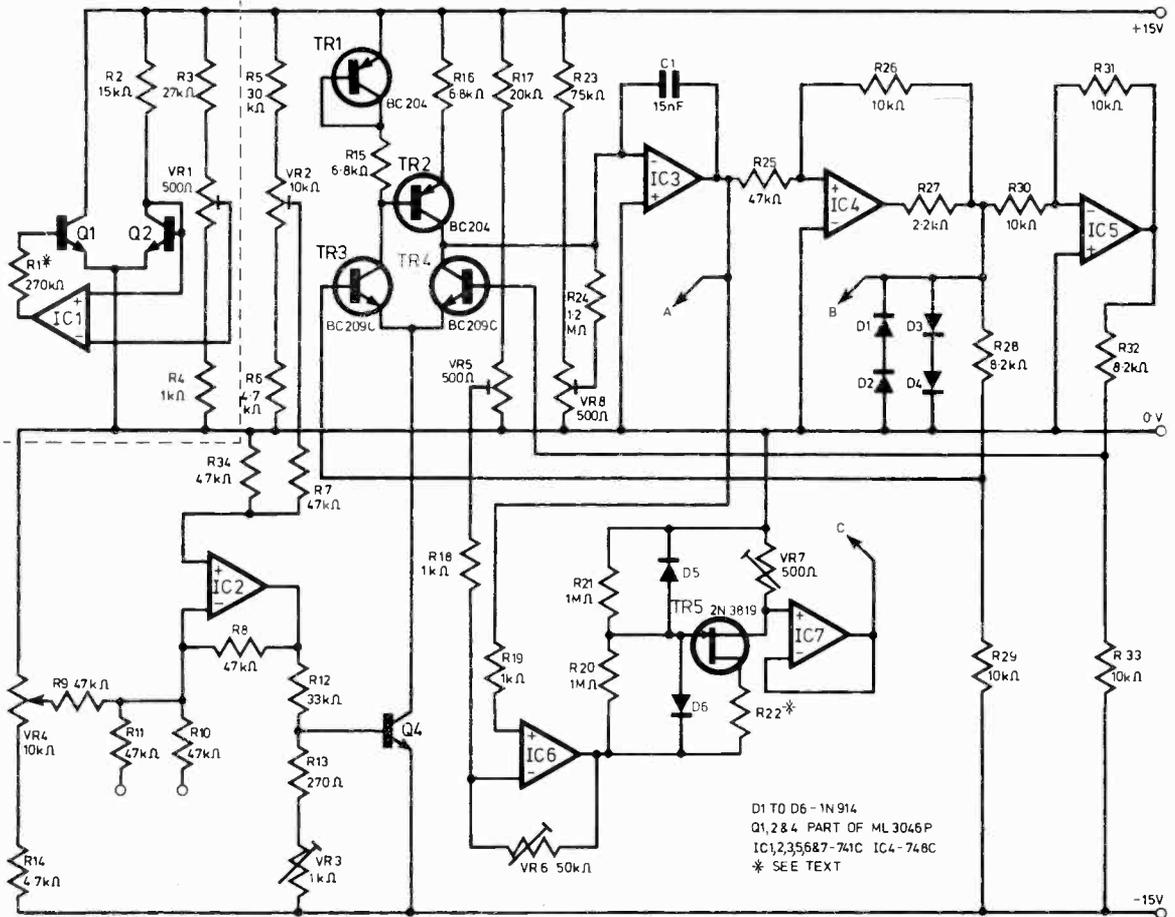


Fig. 10.6. Circuit of complete oscillator module. Points A, B and C are coupled to waveform selector switch

Set VR4 so that the meter is reading 0.2mA and place a slightly moistened finger on IC8—the transistor array. The meter reading should be seen to increase quite rapidly. Having made the above adjustments switch off and remove the meter from the collector circuit of Q4. Without disturbing the setting of any of the potentiometers temporarily link Q4 collector of the 0V rail. The same adjustments should now be made to the circuitry around Q5—having first removed the base/negative rail link.

In this case, however, leave the meter in circuit for the next stage of setting-up which entails fixing the thermal working points of the transistor oven.

Couple the oscilloscope to the output of the comparator IC1 which, at this point, will be about -14V. Carefully adjust VR1 until the comparator switches to +14V. At this time two things will start to happen. The first is that the meter will show a progressive increase in reading which, if the adjustment of VR1 has been made with care, should not exceed 1mA. The second is that within a second or so of the comparator switching positive the oscilloscope trace, which starts as a straight line, will begin to display a varying waveform.

At first the oscillation will zero about a point

approximately 12V positive, but, as the chip temperature stabilises, the zero point will move down to about +6V to +9V. Monitor the base emitter voltage of Q2 which should be in the region 650mV to 680mV.

LOW LOAD POINT

At this time all four connected transistors are contributing towards the heating on the chip. Q1 with its 470 kilohms base resistor will be passing about 3mA and contributing about 45mW, Q2 in passing 1mA will be contributing about 15mW whilst Q4 and Q5 will be contributing about 6mW jointly. These latter devices, however, are passing considerably more current than they will be required to do when coupled to their respective oscillators and running at high frequency. It is therefore necessary to establish a low load set point to ensure that the oven maintains the same temperature over the full working range of the oscillators.

On both Q4 and Q5 reduce VR4 to its setting and readjust VR2 hard over towards R6—in other words reduce the forward bias on the transistors to the absolute minimum. These adjustments will cause

VOLTAGE CONTROLLED OSCILLATORS

COMPONENTS . . .

LOGARITHMIC V.C.O.s. (2 required)

Resistors

- R1* 270k Ω (see text)
- R2* 15k Ω
- R3* 27k Ω
- R4* 1k Ω
- R5 30k Ω 2% metal oxide
- R6 4.7k Ω 2% metal oxide
- R7-R11 47k Ω (5 off) 2% metal oxide
- R12 33k Ω 2% metal oxide
- R13 270 Ω 2% metal oxide
- R14 4.7k Ω 2% metal oxide
- R15-R16 6.8k Ω 2% metal oxide
- R17 20k Ω
- R18-R19 1k Ω (2 off)
- R20-R21 1M Ω (2 off)
- R22 See text
- R23 75k Ω
- R24 1.2M Ω
- R25 47k Ω 2% metal oxide
- R26 75k Ω 2% metal oxide
- R27 2.2k Ω
- R28 8.2k Ω
- R29-R31 10k Ω (3 off)
- R32 8.2k Ω
- R33 10k Ω
- R34 47k Ω 2% metal oxide

Capacitor

- C1 15nF

Potentiometers

- VR1* 500 Ω cermet preset
- VR2 10k Ω cermet preset
- VR3 1k Ω cermet preset
- VR4 10k Ω midjet moulded carbon
- VR5 500 Ω cermet preset
- VR6 50k Ω cermet preset
- VR7 500 Ω cermet preset (see text)
- VR8 500 Ω cermet preset

Integrated Circuits

- IC1* 741C
- IC2, IC3, IC5, IC6, IC7 741C (5 off)
- IC8* ML3046P (Q1, Q2, Q4, Q5)
- IC4 748C

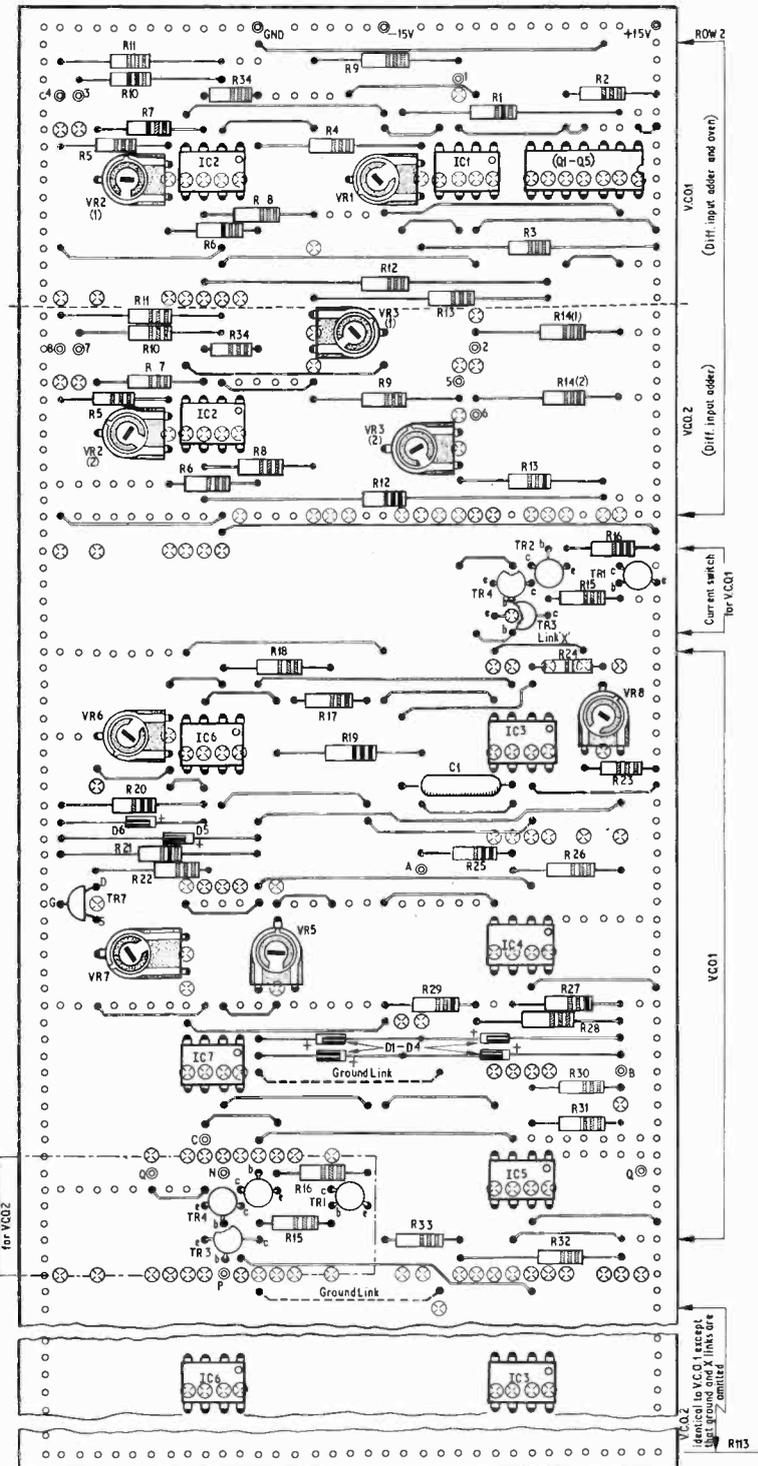
Transistors

- TR1-TR2 BC204 (2 off)
- TR3-TR4 BC209C (2 off)
- TR5 2N3819

Diodes

- D1-D6 IN914 (6 off)

Note: For components marked with an asterisk only 1 off is required.

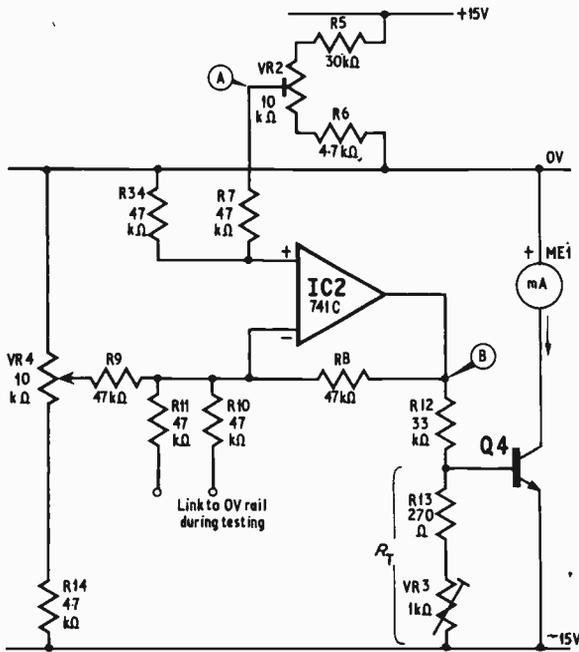


1. Slider VR4 (1)
2. Hi-end VR4 (1)
3. R10 Control Input (1)
4. Spare Control Input (1)
5. Slider VR4 (2)
6. Hi-end VR4 (2)
7. R10 Control Input (2)
8. Spare Control Input (2)

Fig. 10.7. Board layout of oscillator module. Link point Q to Q. Link point N to junction of R33 and R33 or V.C.O.2. Link point P to junction of R28 and R29 on V.C.O.2

the oven temperature to fall and thus the comparator switching waveform will tend to move more positive and revert to a straight line trace.

Monitor the base/emitter voltage of Q2 again which, with the comparator positive, should not be greater than 680mV. If it is, or if, after a few seconds, the comparator waveform does not show signs of rippling, then the heat dissipation of Q1 is insufficient to maintain the set temperature. Much,



$$V_{BE} Q2 = 680\text{mV}; R_T = 750\Omega$$

Bias Voltage "A"	Total Voltage "B" Bias + Control	I _c	V _{BE} (Q4) (mV)
2.74	2.74	12nA (calc)	395
2.74	5.75	160nA	461
2.74	7.76	600nA	500
2.74	8.76	1.5μA	528
2.74	9.76	3.7μA	550
2.74	10.78	7.0μA	570
2.74	11.78	20.0μA	595
2.74	12.78	41.0μA	617
2.74	14.39	60.0μA	630
Referred to 0V Rail			Referred to -15V Rail

Fig. 10.8. Measurements of Q4V_{be} made with Avo 8 which illustrate the degree of error that is possible when interpreting the reading

of course, depends upon the ambient conditions when these measurements are being made and it is best to set up the low load point at the coolest temperature at which the v.c.o. is likely to be operated.

Under cool conditions therefore, if the comparator still does not ripple, it will be necessary to adjust the value of R1 to increase the current through Q1. In the prototype a value of 270 kilohms proved to be satisfactory and gave the desired comparator switching waveform at low load. The value of R1 is quite important because if it is too low the current switched by Q1 will be excessive and cause a considerable degree of jitter on the oscillator waveform.

Monitor Q2V_{be} once more and adjust VR1 as necessary to bring the voltage to 680mV. All setting-up on the prototype oscillator was carried out at this value and it is important to bear in mind that the values of all subsequent measurements bear a close relation to this figure. If Q2V_{be} is lower than 680mV this implies that the temperature of the oven is higher and thus Q4 will pass a higher current for any given value of control voltage. Since the frequency of the oscillator is linearly related to the current through Q4 then the frequency will also be higher.

The reverse will occur if the value of Q2V_{be} is higher than the specified figure. However, for small variations from the specified value, the performance of the oscillator will still remain wholly logarithmic and sufficient tolerance has been allowed in the biasing control VR2 to compensate for such variations. Once satisfied that the upper and lower temperature set points have been correctly established VR1 may be locked with a small dab of non-conductive adhesive such as Araldite. Link the bases of Q4 and Q5 temporarily to the -15V rail.

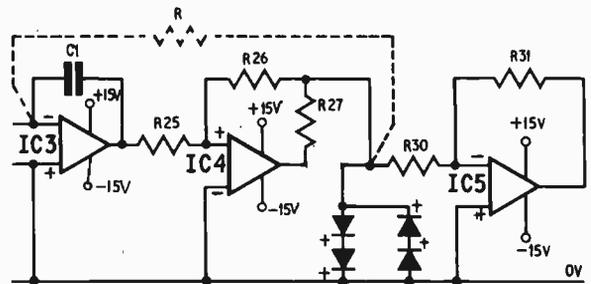


Fig. 10.9. Basic circuit elements of the oscillator and inverter (IC5). Resistor R is any value between 2kΩ and 1MΩ and is temporarily coupled as shown to prove oscillator function

PROVING THE OSCILLATORS

Fig. 10.9 shows the circuit elements involved in the construction of the oscillator section. When these items have been assembled temporarily connect a resistor of between 2 kilohm and 1 megohm from the junction of R27/R30 and the inverting input of IC3. With an oscilloscope monitoring the output of IC3 apply power and a triangular waveform will be observed at a frequency dependent upon the value of linking resistor chosen. Having proved the functioning of the oscillator assemble one current switch and couple to a current generator having first removed its base shorting link. Resistors R28/29 and R32/33 should be added at this time. The purpose of these resistors is to establish a negative bias point for transistors TR3 and TR4 in the

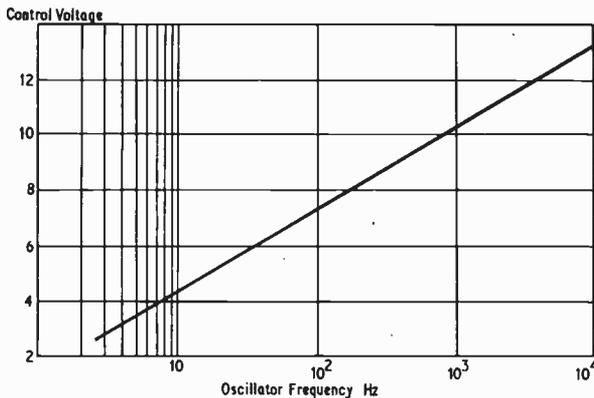


Fig. 10.10. Control voltage/frequency relationship

current switch and whereas the exact value of the resistors concerned is not entirely critical it is important that R28/32 and R29/33 be as closely matched as possible to ensure that the bias points of TR3 and TR4 are the same.

A quick check may now be made to ensure that the separate circuits work together as a complete unit. Remember to reset VR2 and VR4 to about mid position. Depending upon the setting of VR3 it is possible that rotation of VR4 will cause the oscillator to go into saturation towards either extremity but this is not important at this stage and will be dealt with during final setting up.

The next stage is to build the second oscillator following the same general pattern and, having established that it functions, begin the process of matching the performance. The closest possible matching of performance will be obtained if relatively close tolerance components have been used in the construction and, for this reason, 2 per cent resistors have been specified throughout. In particular it is prudent to obtain a matched pair of integrating capacitors (C1).

BIASING

Firstly it is necessary to establish a value of minimum bias on Q4 and Q5 which will support oscillation. Due to the inherently close electrical matching of the transistors on the 3046 the same level of bias will result in current flows through the transistors which are, for all practical purposes, identical. In the prototype it was found that the output of IC2 was at +2.74V referred to the OV rail for an oscillation frequency of 0.2Hz.

Set VR4 to its minimum position and adjust VR2 until the output voltage on IC2 (both oscillators) reaches +2.74V as above. Monitoring the integrator output waveform on both oscillators at the same time, if possible, adjust VR3 on Q4 and Q5 with the greatest care so that both oscillators are running at the same frequency—the exact rate is not critical. With VR4 still at its minimum setting apply an external control voltage to R10 on both oscillators at the same time having first broken the temporary link connecting R10 to the OV rail. A fresh 9V battery with a suitable potentiometer coupled across its terminals is ideal for the purpose of providing the control voltage.

Connect the positive end of the battery to the OV rail and the slider of the potentiometer to both R10's. With the slider hard negative monitor the

output frequencies of both oscillators, preferably at the same time, and confirm that they are running at the same frequency which should be in the region of 3kHz. Note that since the oscillators are not phase locked a certain degree of drift between them is almost inevitable and it should be the aim to reduce the amount of drift, by adjustment of VR3, to within 1 per cent or better of the frequency being monitored. Thus for a frequency of 3kHz a drift of about 30Hz would be at the limits of acceptability. Compare frequencies at various settings of the potentiometer to ensure that the frequencies and drift relationships remain stable over the full range.

OFFSETTING SATURATION

If, at the minimum setting, either or both oscillators go into saturation due to the adjustments made to VR3 it will be necessary to establish a slightly higher bias point by re-adjustment of VR2 and then repeat the whole of the setting up procedure so far outlined. Careful adjustment will result in a pair of oscillators which track the control voltages very accurately. It should not be the aim to reduce the drift between the oscillators to a very low figure as the beat frequency introduced by a drift of 0.5 per cent to 1 per cent will add interest and colour to the sound when both oscillators are being programmed in harmony. On the other hand a very low beat frequency can add quite unpleasant characteristics to a sound.

When satisfied that the oscillators are tracking over the full range of the control potentiometer the control voltage measured at the output of IC2 should be plotted against the frequency of oscillation at various points in the range. Fig. 10.10 shows the result of plotting the performance of the prototype oscillators.

F.E.T. CHARACTERISTICS

Before beginning the assembly of the sine shaper it is necessary to determine the exact characteristics of the f.e.t. which is to be used in the circuit. The two operational parameters which require to be known are the saturation current (I_{DSS}) at zero gate bias and the gate bias required to reduce the current through the device to negligible proportions. Fig. 10.11a/b illustrates the methods of making the measurements specified. If a variable voltage source

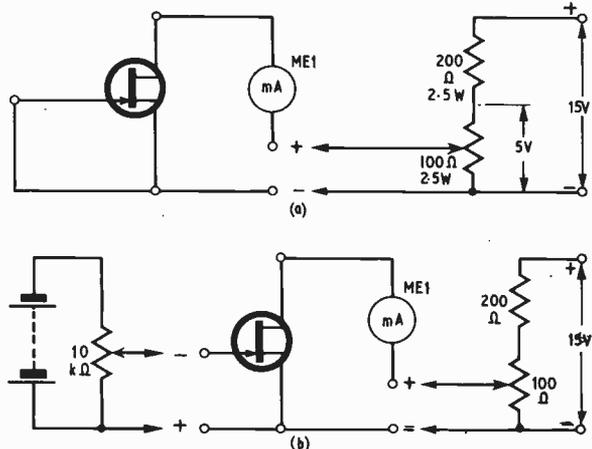


Fig. 10.11(a). Method for determining I_{DSS} at $V_{GS}=0$ (b) method for determining V_{GS} when $I_{DS}=0$

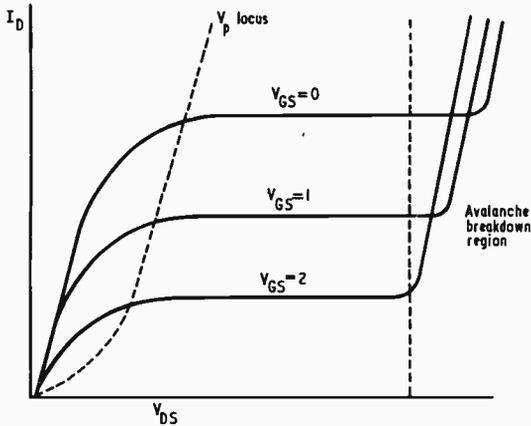


Fig. 10.12. Graph showing how V_p and I_{DSS} vary with V_{GS}

is available it is preferable to use this in the source drain circuit rather than the divider arrangement illustrated and thereby gain the benefit of greater accuracy in the measurements.

The first stage is to measure the I_{DSS} at zero gate bias. With the variable voltage source at zero volts and the milliammeter on the 1mA range gradually increase the voltage setting, plotting, at various stages, the current/voltage relationship.

The point which is of interest is that at which further increases in voltage result in only a very small increase in current through the device. The voltage at which this phenomenon first occurs is known as the pinch-off voltage (V_p) and should be carefully recorded. After the pinch-off point has been reached the voltage may be increased quite significantly with very little increase in current until the avalanche breakdown region is reached. At this point the current through the f.e.t. will increase hugely and almost instantaneously and result in the destruction of the device. Hence the requirement to plot the measurements very carefully and note the point at which V_p is reached.

Fig. 10.12 shows a typical family of curves for any one f.e.t. and depicts the way in which the pinch-off voltage reduces as the gate bias is made progressively more negative with respect to the source. The next measurement to make therefore is the point at which the current through the f.e.t. reduces to negligible proportions and the set-up for doing this is illustrated in Fig. 10.11b. Having made the connections shown and with the 10 kilohm potentiometer wiper at the positive end of its travel adjust the variable voltage source so that the meter is indicating the I_{DSS} . At this point gradually advance the wiper and note that the meter reading reduces in proportion. Switch to a lower range on the meter as required and advance until the reading is zero. At this point carefully measure and note the voltage across the gate/source of the f.e.t.

The value of resistor R22 in the sine shaper is calculated on the basis of the readings above in the following way:—

$$R22 = \frac{V_p}{2.I_{DSS}}$$

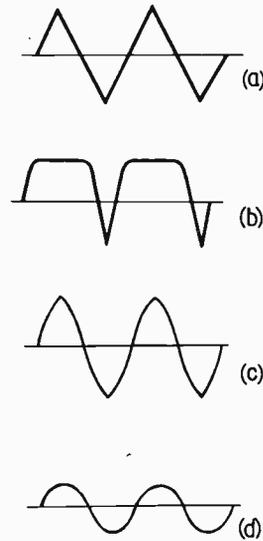


Fig. 10.13. Showing the effect on the sine shaper output waveform of adjustment of VR6 and VR7 (a), VR6 too low (b), VR6 too high (c), VR7 too high (d), VR7 too low

The V_p in the above calculation refers to the value of gate/source voltage at which the current through the f.e.t. is zero. The value of the resistor will depend on the actual characteristics of individual f.e.t.s but would normally be expected to be quite small. In the prototype, for example, R22 was 180 ohms in one shaper and 270 ohms in the other. The value of VR7 should be chosen to provide a fairly wide margin of adjustment over the calculated value of R22 and in most cases a 500 ohm preset would be satisfactory.

ASSEMBLY

Having completed the above measurements the sine shaper can now be assembled. Bear in mind that f.e.t.s can be rather tricky to handle and it is a wise precaution to solder all the other components in position before actually inserting and fixing the f.e.t.

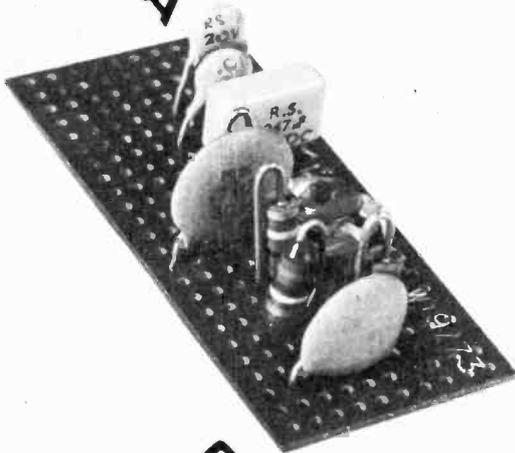
Setting-up the sine shaper consists of adjusting the values of VR5, 6 and 7 to provide the optimum sine wave. With power on adjust VR4 so that the oscillator is running at about 3kHz and monitor the output of IC7. The preset adjustments should be made with reference to Fig. 10.13 which illustrates the various waveform characteristics associated with these controls.

If a sine-wave oscillator is available it is helpful to compare the output of the shaper with a "genuine" sine wave of the same frequency. The scale of the waveform on the oscilloscope screen should be as large as possible for this purpose. This latter procedure was carried out with the prototype shapers and resulted in a sine wave output having a total harmonic distortion of only 1 per cent. A wave analyser or distortion meter if available could enable a higher purity sine wave to be obtained.

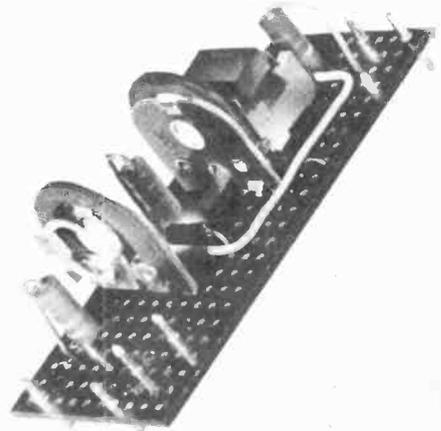
Next month: Envelope shaper, mixer networks and analogue memories for the keyboard unit.

QUICKIES

WAA WAA

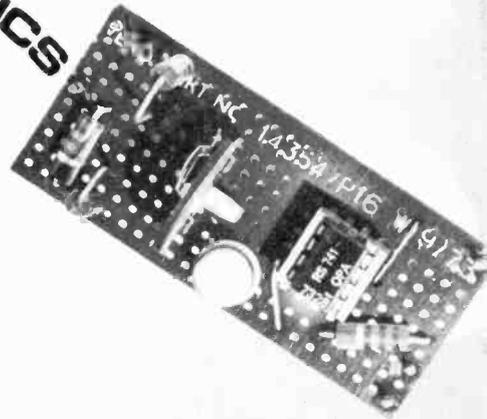
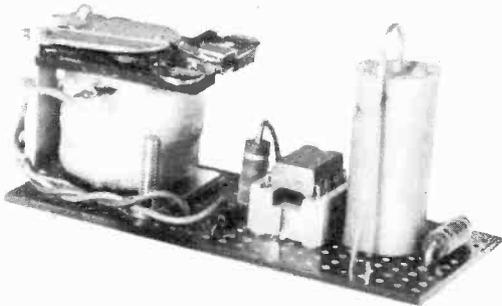


THERMOMETER



OPTOELECTRONICS

TOUCH SWITCH

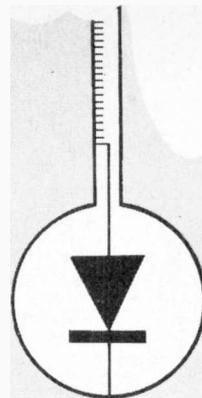


4 EASY-TO-BUILD PROJECTS FOR THE WINTER EVENINGS

THERMOMETER

A temperature measuring device
with many applications

HENRY'S RADIO 2/9/74.



THE electronic thermometer has been proposed in various forms, usually associated with a thermistor detecting element. This latter is a resistor the value of which changes with changes in temperature, hence the name from thermal resistor.

However, whilst capable of providing an indication with fairly simple circuitry, this device is basically non-linear, the change in resistance for a given change in

temperature is not the same for all temperatures.

There is a much smaller and, in linearity terms, more accurate device readily available, the forward-biased semiconductor diode.

operating range of these diodes is quite sufficient for most applications.

Circuit

A number of alternative approaches offer themselves for use here. One could use the "bridge" method with the measuring diode set up in a bridge circuit and the amplifier looking at the bridge signal.

However, a simpler approach is to use the amplifier as a differential amplifier which can compare two input voltages, one due to the diode and the other variable in order to select the point at which the scale of the instrument starts.

Such a circuit is shown in Fig. 1, where the diode D1 is connected to vary the inverting input of the operational amplifier whilst the non-inverting input is set by the potentiometer VR1. The choice of inputs is required to give an increasing output voltage for

Diode Probe

It is admitted that the range over which a small silicon switching diode can be used in temperature terms is limited to the area which will not damage the device, namely from around -60°C to $+180^{\circ}\text{C}$. In addition, the variation of resistance and thus voltage across the diode is very small for a change in temperature of 1 degree C, in the region of 2.5 to 3.5mV.

Thus the change needs to be amplified in some way if it is to be useful.

The advent of cheap integrated circuit amplifiers has provided the answer to that problem and the

COMPONENTS . . .

Resistors

R1 22k Ω

R2 1.5k Ω

R3 1.5k Ω

All 10% $\frac{1}{4}\text{W}$ carbon

Potentiometers

VR1 10k Ω

VR2 22k Ω } skeleton presets

Diodes

D1 1N914 (or 1S914 or other silicon diode)

D2 BZY88 (5.6V) Zener diode

Integrated Circuit

IC1 741 Operational Amplifier

Miscellaneous

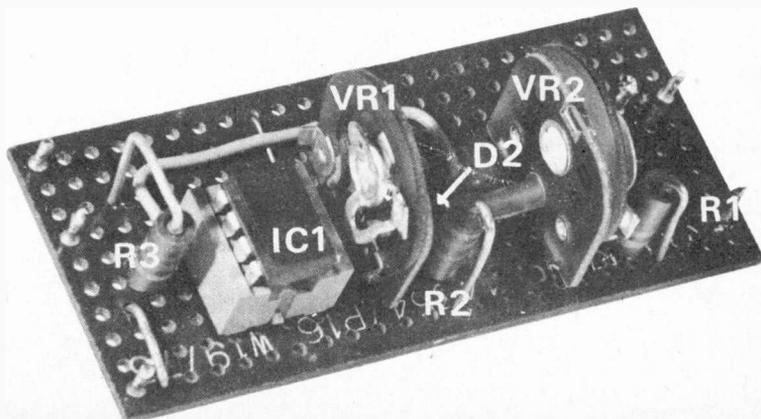
ME1 0-1mA Meter (see text)

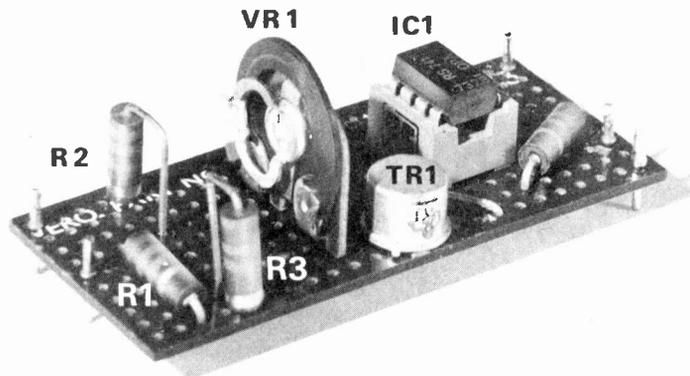
Veroboard (free with this issue)

Total cost (excluding meter) about 95 pence.

Meters are available from about £2.50.

£3.45
approx.





or its holder if one is used as in the prototype, and one to separate the output from VR1.

As can be seen, pins have been used to bring out the battery, input and output connections but of course wiring may be connected directly to the board if desired

Applications

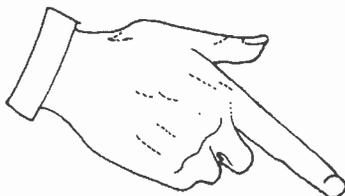
A circuit of this type can be used anywhere it is necessary to measure and control as a result of light variation. A side light control for a car is a typical idea. Other automotive applications include

light actuation of a garage door, car light failure alarm and perhaps even a burglar alarm.

Similarly in the home there are many applications starting off with things like a burglar alarm, light switches to turn house illumination on after dusk both for convenience and security and the like.

In technical areas devices of this sort can be used as object counters on a production line, as end-stops for limiting machine travel, as automatic door openers and so on.

Dependent on the light resistor used the equipment will be sensitive to slightly different areas of the visible light spectrum but for normal visible light work most types will suffice including the well-known ORP 12 and its brothers from Mullard. ★



TOUCH SWITCH

Multi-purpose switching by touch alone

THE touch switch has many household, commercial and industrial applications. Specific examples in each area are intrusion alarms, opening supermarket doors and safety devices for machine operators.

In principle, simply touching a wire or metal plate will cause a relay to operate. To fulfil this the intermediary circuitry must be sufficiently sensitive to detect the very small noise currents provided by the hand.

Timer Chip

Touch switch circuits usually consist of cascaded amplifier stages (f.e.t. or bipolar). Construc-

tion of these for a beginner can be irksome and the results disappointing through spurious triggering, a common condition with these circuits

A convenient and economic package which can be simply adapted for this role is the Signetics 555 timer integrated circuit. Although this is usually used to provide accurate delay periods from microseconds to hours it will suit our purpose to use this facility to provide a variable period latch for the relay.

Input sensitivity is extremely high and the chip has a useful relay drive capability so that any relay coil operating in the 6-9V range and up to 200mA.

Simple Circuit

The first thing that one notices in looking at the circuit of Fig. 1 is its simplicity and economy in parts which makes for easy construction.

Since the internal functioning of the 555 was more than adequately covered in the June 1973 issue it will suffice to say that the circuit operates as a sensitive monostable.

In the quiescent state, that is with no hand applied to the touch plate or wire, battery drain is about 7mA none of this being taken by the relay. When a hand is applied the relay coil current flows and the contacts close for a period determined by the timing constants R1 and C1.

For the component values shown the time is around 3 seconds but longer delay periods can be achieved by increasing the value of C1. With the resistor given delay periods in seconds for a particular capacitor can be approximated by the simple equation $t = 9C_1$ where C_1 is in microfarads. For a delay of an hour you would, for example, need a $400\mu\text{F}$ capacitor but leakage would no doubt affect this estimate. A practical limit for very long delays would be about $10,000\mu\text{F}$.

Triggering

The current required at pin 2 to activate the circuit need only be half a microamp which indicates the extreme sensitivity. Unfortunately this can create problems of backlash triggering particularly with inductive loads. This is obviated by the inclusion of R2

The transient suppressing diode protecting the chip can in fact be any switching diode.

Touch Off

There are times when a touch on/touch off switching facility might be required as with say, a bedside night light. For this do

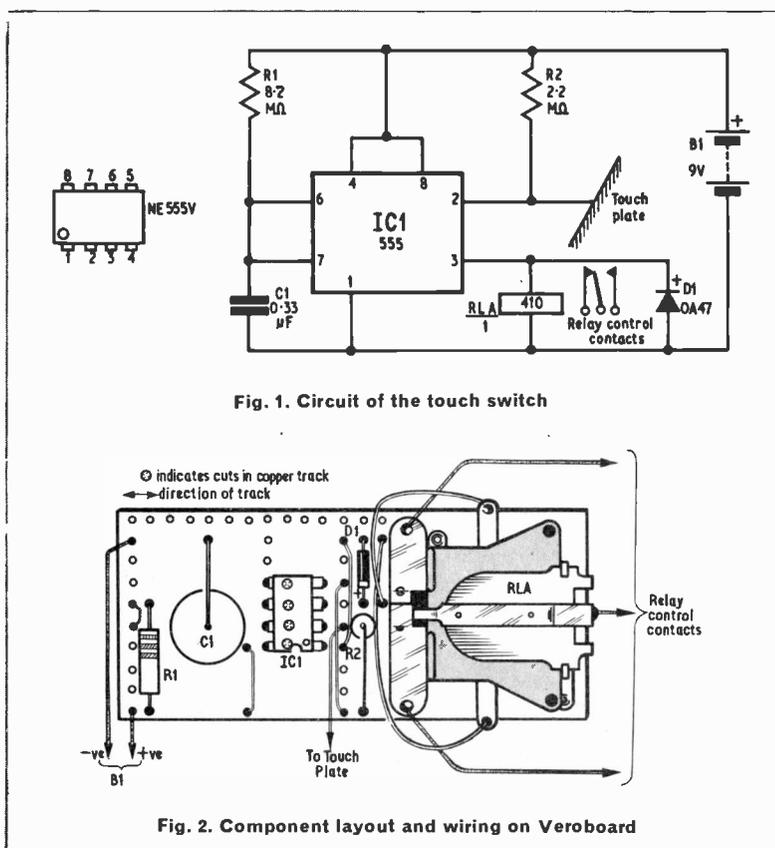


Fig. 1. Circuit of the touch switch

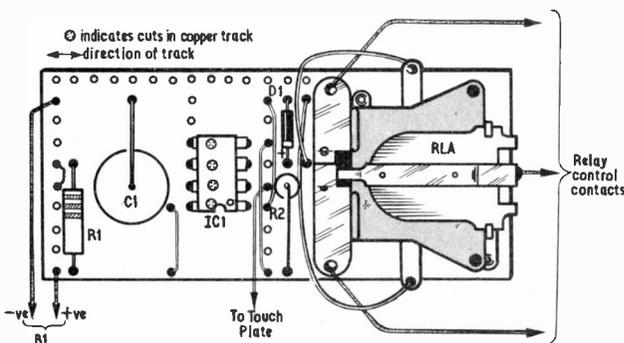


Fig. 2. Component layout and wiring on Veroboard

not connect pin 4 to the supply line but to another touch plate. A simple method of providing two adjacent touch plates is to join equal numbers of copper strips on a largish piece of Veroboard and simply wiring each "plate" to the appropriate 555 pin.

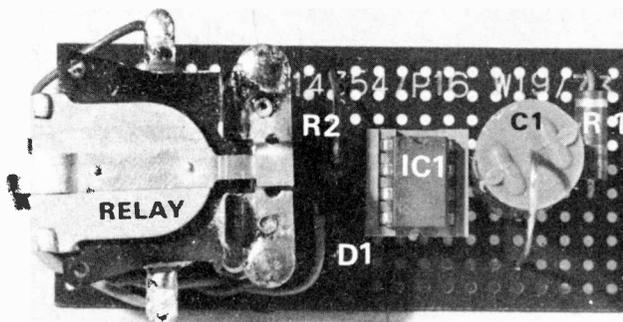
The 8 pin d.i.p. socket was included as it simplifies any future need to remove the chip either through damage or for use in another project

Other Relays

The delay periods provided by the timing component are almost independent of supply voltage. Since the 555 can be operated between 4.5 and 16V the supply rail can be lifted to accommodate other relay drive requirements but this should not exceed 16V and 200mA. ★

Construction

The components are easily mounted on the sample Veroboard as in Fig. 2. Cuts to be made in the copper underside are also clearly shown.



COMPONENTS . . .

Resistors

- R1 8.2MΩ
- R2 2.2MΩ
- All 10% ½ watt carbon

Capacitors

- C1 0.33μF polyester (see text)

Integrated Circuit

- IC1 NE555V (Signetics)

Diode

- D1 OA47

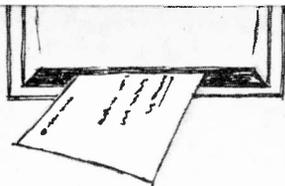
Relay

- RLA 6V 410Ω coil (type 912 R.S.)

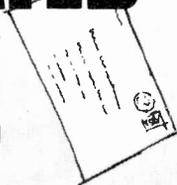
Miscellaneous

- Veroboard (free with this issue), 9V battery

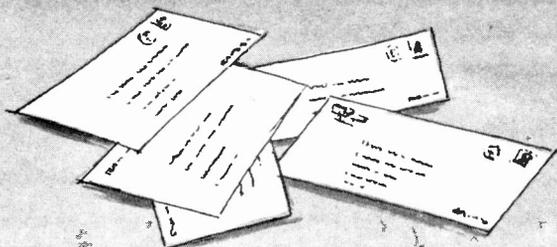
£2 approx.



AUTOMATED MAIL



By **F. J. MORRIS** B.Sc.(Eng.), A.C.G.I.



RAPID, often startling, developments which have been made in the field of telecommunications owe much to the application of electronics. But electronics are, of course, contributing to the advance of other forms of human communication. Take, for example, one of the most traditional communications systems of all—the letter post. Electronics have an essential role in the multi-million pound plans to automate Britain's postal service.

THE NEED FOR AUTOMATION

The need to automate the postal service is imperative for two major reasons. First, to reduce the service's dependence on manpower (75 per cent of all Britain's postal costs are for labour) and secondly to maintain traditionally high standards while meeting the demands of today's fast moving world.

Since each of the 35 million letters the Post Office handles every working day in this country may have to be sorted up to eight times during its journey there is clearly ample scope for mechanisation and, helped by electronics, much has already been achieved. Electronics systems are enabling machines to select, stack and sort letters automatically at speeds far higher than even the most skilful postman-sorter.

The key to automation is the British postcode system, of its kind the most advanced in the world. Postcodes have been developed as the answer, or at least a supremely effective compromise, to the so far insuperable problem of total automation through machine-read addresses. Research is progressing but apart from the obvious difficulties with machine-reading of handwritten addresses it will still be many years before even typescript addresses can be read reliably without unreasonable restrictions on inks or type faces.

The postcode, however, by expressing an address in a machine language, easily keyed and translatable electronically, enables a high degree of automatic sorting to be introduced with present technology.

THE PRESENT SITUATION

Fully mechanised sorting offices are now operating at 12 centres in Britain and the eventual total will be around 100. Progress and the eventual success of the system depend on two factors—the completion of the programme to give each of Britain's 20 million addresses its own postcode; and the subsequent use of the postcodes by the public. In fact, postcoding of the country will be completed by August this year and while use of existing postcodes is rising steadily the importance of maximum use will become clear from the remainder of this article.

THE POSTCODE

The postcode is familiar to most people but the reasoning behind its planning and form is not so widely known and its explanation is appropriate here.

In fact the principle is simple. Each code consists of between five and seven alpha-numerical characters. The first one or two alphabetic characters in the code refer to one of 121 main towns or code centres in the UK (e.g. S for Sheffield, IP for Ipswich, LS for Leeds). A number following the alphabetic characters in the first or "outward" part of the code represents a sub-division of the area (e.g. IP3, IP7, IP17). These districts are geographic units similar in concept to the familiar London postal districts, such as SE1.

Each district is sub-divided into smaller areas or sectors which are again geographic units, represented by the first character or "inward" part of the postcode (e.g. IP3 9--, LS8 5--, etc.). Finally, the last two characters of the postcode give information about a street, part of a street, or, in the case of larger firms, a single address.

Thus a complete code in the case of part of a street in Ipswich for example reads IP3 7PS with the final two letters, PS, pinpointing that part of the street—usually between 15 and 20 addresses.

INITIAL SORTING

During initial sortation specially trained operators at postcoding desks equipped with electronic keyboards read each code and print onto the envelopes a series of code marks. The complete code is translated into a pattern of up to 28 marks and printed in two rows of 14. The code marks are virtually invisible to the naked eye but glow blue under ultra-violet exposure (see Fig. 1). The glow remains for a time after the ultra-violet light has been removed and this after-glow is detected by a photo-multiplier tube and the pattern recovered.

The pattern is next translated electronically to decide into which of 144 sorting boxes the letter is to be deposited by the machine. Once the postcode has been transcribed at the coding desk repeated exposure of the code marks and subsequent reading allow fully automatic sorting of the letter during its journey until it reaches the postman who is to take it on his delivery round.

FOUR PROCESSES

While looking in closer detail at the electronics behind the coding desk and the automatic sorting machine it is necessary to follow in sequence the

*Post Office Mechanisation Branch

four processes which a letter goes through from being received in the sorting office and being slotted automatically into its sorting box on the machine. The first two processes—segregation and facing—are preparatory to the final two—coding and sorting.

When letters arrive in a fully mechanised sorting office those which can be handled by automatic sorting machinery must be segregated from those which cannot. A wide assortment of letter shapes and sizes are found in every mail collection and those that are too unwieldy or thick must be culled from the letter stream before being allowed to pass into and possibly jam, or severely damage, the automatic sorting equipment.

The letters pass through a series of ingenious processes—rotating slatted drums, tilted conveyor belts, spaced rollers—which between them allow the unsuitably sized letters to slip from, or be plucked out of the stream, collected and then sorted by hand. The remaining letters are stacked automatically and passed to the next machine—the automatic letter facer (ALF). This is the first of the automatic sorting stages to employ electronics (see Fig. 2).

AUTOMATIC LETTER FACER (ALF)

The job of ALF is to arrange the letters so that they face the same way (the stamp upwards) preparatory to the stamps being postmarked or cancelled. Additionally ALF separates First and Second class letters so that the former may be sorted later.

While the operation of letter sorting machinery relies on the glow picked up from the code-marks printed onto the envelopes at the coding desk, ALF relies on a similar glow effect but obtained from the stamps themselves. Each stamp is surfaced with bars of phosphorescent material. The number of bars differ according to the value of the stamp. This enables the machine to detect if a stamp is present on the envelope, its position and whether the letter is being sent First or Second class.

ALF first strips letters off the feed stack and accelerates them along a series of rollers to obtain a stream of letters with a small gap between each one. The letters then pass under the first of two arrays of ultra-violet (UV) lamps which causes the phosphor on the stamps to glow. The glow continues after the letter has left the UV section and passes under two photo-multiplier tubes.

One of the tubes scans the top section of the letter face (which was exposed to the UV) and the other tube looks at the bottom of the face. In the dark only a tiny current flows in the multiplier but the glow from a UV "excited" stamp boosts the current.

The change in the current is detected and if a stamp is "seen" at either end of the letter face the letter is allowed to pass on. If no glow is picked up ALF assumes that the letter is facing the wrong way up and routes the letter through a twisted belt section to turn the letter over.

Now, all facing the same way, the letters pass under a second series of UV lamps and photomultiplier tubes. This time the number of phosphor bars on the stamps are noted and the letters identified as First or Second Class. At this stage, also, underpaid letters and those bearing no stamps are spotted.

ALF actually sorts letters into five boxes (cancelling their stamps on the way) of which two are for First Class, two for Second Class and the fifth for underpaid letters. Pairs of boxes are needed so

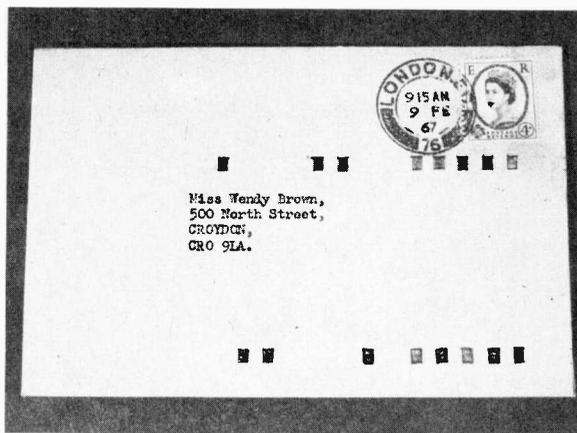


Fig. 1. A typical postcode pattern. The dots imprinted at the coding desk are normally almost invisible to the naked eye and have been outlined here

that letters with stamps in the leading position can be separated from those with stamps in the trailing position. The operator who unloads ALF correctly combines these two stacks before passing them to the next stage, the postcoding desk.

CODING DESK

The Coding Desk, with the help of an operator, provides each letter with its pattern of UV sensitive marks translated from the postcode. Where letters do not carry a postcode the operators imprint a code giving the post-town destination of the letter which enables initial automatic sorting to go ahead. But without the complete information which the correct postcode provides these letters must pass through a second coding desk to identify the delivery street

Fig. 2. Inside an automatic letter facing machine (ALF) which arranges letters so that they face the same way and the correct way up in the sorting office. ALF also separates first and second class mail and cancels the stamps, dealing with up to 20,000 items of mail an hour

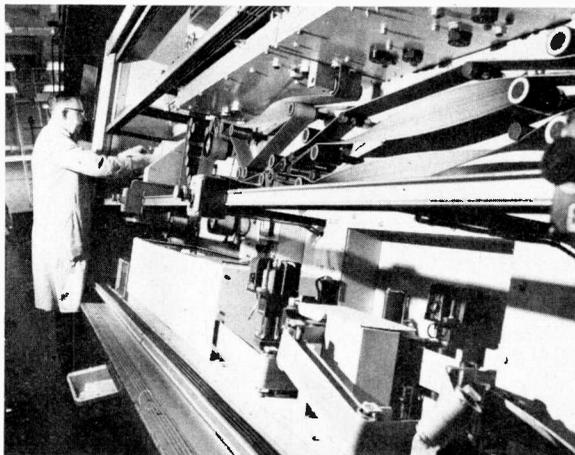


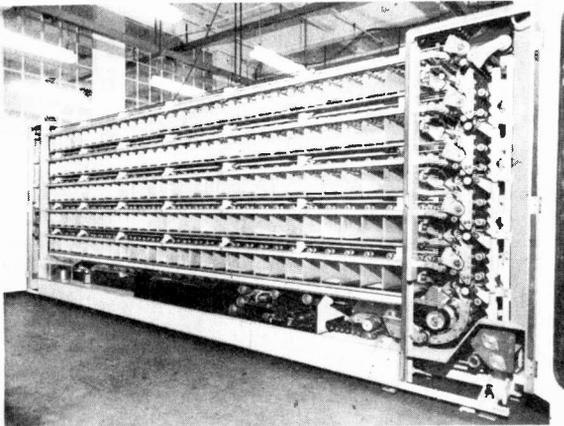


Fig. 3. Letters passing through a postcoding desk operated by a specially trained postman

when they arrive at the delivery sorting office. The full potential of the postcode is therefore missed and hence the importance of using the postcode wherever it is known.

The coding desk presents each letter at a display "window" facing the operator who is seated at a keyboard (see Fig. 3). The operator, who is a specially trained postman, types out the postcode on his keyboard which converts each character into a different pattern of binary signals on six wires.

Fig. 4. A medium speed Letter Sorting Machine with 144 selection boxes. These automatic machines read the first half of the postcode and sort the letters to their office of destination. At this office coded letters are again automatically sorted by machines which read the second half of the code and sort for the appropriate delivery postman



ELECTRONIC TRANSLATOR

The signals from each coding desk keyboard are sent to an electronic translator which contains a memory store of the patterns sent out from the keyboards. The translator recognises when the operator has completed a postcode and converts it into a pattern of 28 binary digits (bits). This 28 bit answer is then transmitted to the coding desk. Once this answer is received the coded letter is moved on to the print position.

Because the code marks are indelible the letter is held for a time in a cancel position so that the operator has time to correct any mistake before the irrevocable printing step is taken.

The information received by the translator on the code pattern to be printed applies to the letter held in the "cancel" position and must be remembered until the letter is printed. Thus two translations must be stored in the desk and kept in synchronisation as the letters pass through. From being first presented in the display window to printing the average time the letter spends in the coding desk is two seconds.

After printing, the letter is ejected and collected and stacked automatically before being passed through the sorting machine. (In delivery offices post-coded letters arriving from other offices have already been through the coding desk stage at the previous office and are simply sorted automatically down to street or single address level. Here the last part, or "inward" code is used).

THE LETTER SORTING MACHINE

Like the coding desk and ALF the sorting machine (see Fig. 4) is fed letters in stacks and has first to separate them into a stream of spaced letters. They are then passed under UV lamps to generate the glow from the imprinted code-marks which are detected by the code-mark reader.

In the reader the row of marks on the letter pass a narrow slot behind which is a photo-multiplier tube which "recognises" each mark it sees by the increased current caused in the tube. The coded marks are read and stored in the sorting machine's memory. The code is fed into a second electronic translator which returns a 15-bit pattern identifying the box to which the letter should be routed.

ROTATION

The machine continues to store the translation and passes it on in stages for every two inches of letter travel. About three feet after passing the code-reader the letter is rotated through 90 degrees to travel the remainder of the machine with its longest edge forwards.

Just before the right-angle rotation a photo-electric beam is broken to give an exact positional reference of the letter within the machine. The original code-mark translation continues to be passed on its stages while the machine keeps track of the letter. When it arrives at the appropriate sorting box the box is opened and the letter has been sorted.

If the sorting machine is being used for outward mail (that is letters which are to go on to another sorting office) the letters are taken from the boxes, bundled and sent on by road or rail in the normal way. If the machine is sorting letters which are to

be delivered in the sorting office area (inward mail) the letters are taken from the boxes and prepared for actual delivery by the postman on his round.

SYNCHRONISATION

All three of the machines described in this article, ALF, the coding desk and the sorting machine, must perform the required operation on each letter passing through the machine at the correct relative time.

To achieve this on the sorting machine and ALF it is necessary to pick up a signal to keep the electronics in synchronisation with the machine and hence the letters moving through it. This is achieved

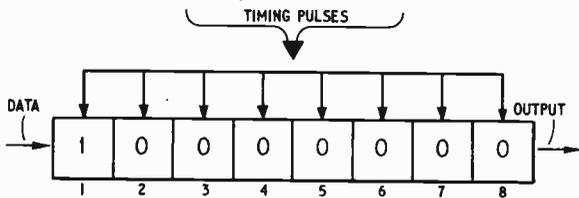


Fig. 5a. Diagrammatic representation of a shift register. The timing pulses cause the data held in each of the bistables to be shifted one place to the right

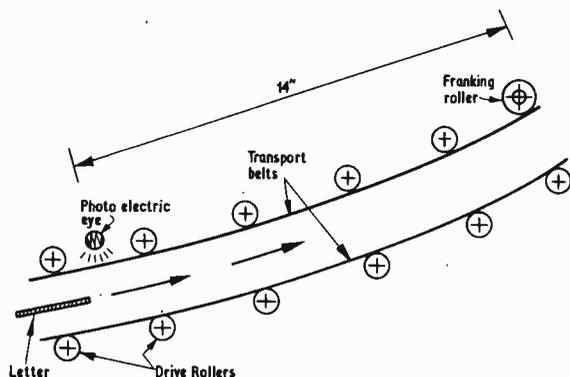


Fig. 5b. After eight shifts the letter will have reached the franking roller and a logic 1 in position 8 of the shift register causes the stamp to be cancelled

by shining a light beam through a series of holes drilled around the perimeter of a wheel driven by the machine's transport belts. A phototransistor is illuminated by the beam whenever a hole passes. The current changes in the phototransistor are detected and used to generate timing pulses which step data through electronic models of the machines and hence control the letter flow.

All the control functions of the machines follow a simple scheme. Somewhere on the machine some characteristic of the letter is inspected and the signals generated are converted to logic voltages. From this information a decision is taken as to which of a number of operations the letter should undergo. However the alternative operations may be carried out some distance down the machine and it is necessary to keep track of the letter and its data until the point of operation is reached.

SHIFT REGISTER

This letter tracking is achieved by storing the data in a shift register and moving it one place down the machine for each timing pulse received. Thus on the sorting machine and ALF each stage of the shift register represents information associated with a letter whose leading edge is in a particular 2in length of belt.

At some later stage on the machine, where the operation has to be carried out, the associated shift register stage can be looked at electronically to detect when the letter is present and then indicate the operation. The word carried down the shift register varies in complexity from a single bit on part of ALF indicating whether or not a letter has to be turned over, to the 15 bits identifying the sorting machine outlet.

The Shift Register has a vital role to play in postal machines; repeatedly information is collected some distance from the position where action is taken on it.

In simple terms, let the figure represent an 8 stage shift register which represents the occupancy of 16 inches of a machine's transport belts. When no letters are present all the stages of the shift register are at logic "0" (Fig. 5a). A photo-electric eye detects the leading edge of a letter and marks the first stage of the shift register at logic "1" so it now reads 100 000 00. Each timing pulse from the machine passes the information on stage down the register. So, after 7 pulses, stage 8 alone will be marked 000 000 01 if no more letters have entered this section of belt.

A logic circuit is used to detect stage 8 being switched to logic "1" and causes the franking roller (14 inches from the photoelectric eye) to operate, cancelling the stamp (Fig. 5b).

Shift registers can be made to carry much more information and this need not all be collected at the same time.

ELECTRONIC CIRCUITS

From the "job descriptions" of the machines involved in automated mail handling it is clear that they rely heavily on electronics for both machine timing control and data storage.

All the electronic circuits required are constructed from components soldered onto small plug-in printed circuit boards. The components used—silicon planar epitaxial diodes and transistors, metal oxide resistors and polystyrene capacitors—are all highly reliable. However reliable, of course, some failures are inevitable, in which case a new circuit can readily be inserted in exchange.

Many thousands of these circuits are in use by the Post Office throughout the country. Although more than a hundred different circuits have been developed for various tasks, perhaps a dozen commonly-used circuits form some 90 per cent of the total.

DIGITAL LOGIC

Most of these common circuits are digital logic circuits requiring inputs of either +6.6 volts (logic "0") or 0 volts (logic "1") and giving outputs at the same levels. Some of the circuits, however, have to interface between the logic system and the electro-magnetic devices used to control the machine. One

of these gives a logic output when the current in a phototransistor exceeds a certain level; another has to apply voltage to a load device (which could be a diverter or print pin solenoid) whenever its input is at 0 volts. However, not all circuits operate with logic levels at either input or output.

DOLLILOG

The range of logic circuits is often referred to as "Dollilog". This name derives from "Dollis Hill Logic" after the PO Research Station at Dollis Hill where the system was developed.

Some of the more common Dollilog circuits are described briefly in the following paragraphs together with some ideas on how they are used.

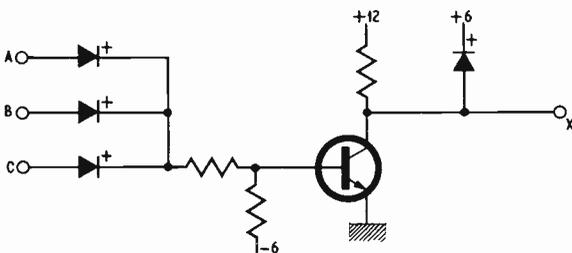


Fig. 6. Circuit diagram of a three input NAND gate used in the Dollilog system

NAND GATE

The diagram (Fig. 6) shows a three input NAND gate. The output (x) of this circuit will be at the logic "0" voltage (+6.6 volts) only if all three of the inputs (A, B and C) are at the logic "1" voltage (0 volts). In this case the transistor will be cut off.

If any one of the inputs is at the logic "0" voltage the transistor will be saturated and the output will be at the logic "1" voltage.

The NAND gate can be used to detect when several different conditions occur simultaneously and cause some process to be carried out.

Other logic circuits are used, one of which only gives the logic "1" output voltage when all three inputs are at logic "0", this being a NOR gate. Another circuit gives a logic "1" if both inputs are the same.

SCHMITT TRIGGER

The Schmitt trigger has two outputs which are never the same. The outputs states interchange whenever an input voltage exceeds one threshold or falls below another.

POWER AMPLIFIER

The power amplifier's output transistor will be saturated whenever the input to the circuit is at logic "1". The usual circuit can control loads of up to 25 watts although other high power versions exist.

BISTABLE MULTIVIBRATOR

The bistable multivibrator is another circuit which has two outputs which are always opposite. The outputs are switched by pulses applied to "set" and "reset" inputs. Bistables can be used to store information.

SHIFT REGISTER

Shift registers are arrays of bistables with a common clock input which can be pulsed to step data along the register.

NEW TECHNOLOGY

To some readers, these circuits will look a little dated. To some extent this is true; it must be remembered, however, that the system has proved satisfactory in use. The Post Office has to consider any change on this scale very seriously. Various factors have to be considered such as replacement cost, the cost of training maintenance engineers in any new system and the compatibility of any new equipment with the old.

At present, many new techniques are being tried and tested. The coding desk keyboard contains a number of DTL integrated circuits while the new memory which will replace the sorting machine's original mechanical memory is being developed using MOS integrated circuits. A new translator uses small general purpose computers rather than specially built electronic circuits. At present, however, only the relatively cheap keyboard, where size is critical, uses integrated circuits in a production item.



EE POINTS THE WAY

IN THE NOVEMBER ISSUE — AN 8 PAGE SUPPLEMENT

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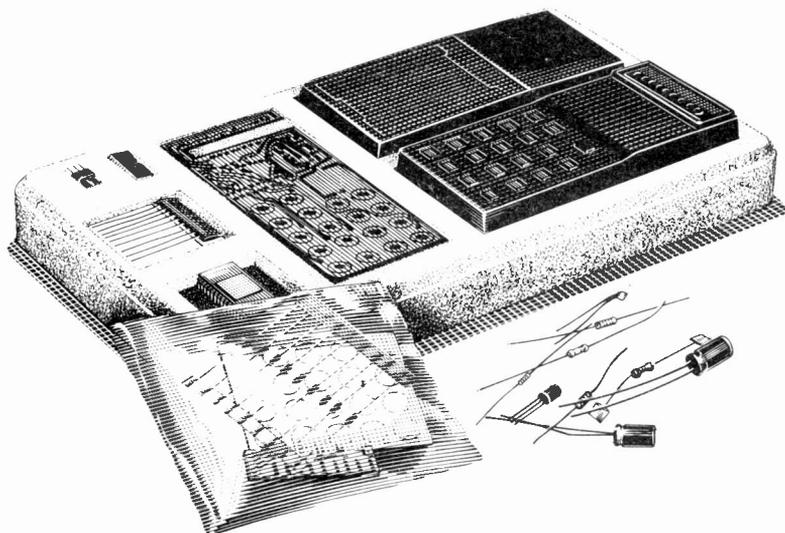
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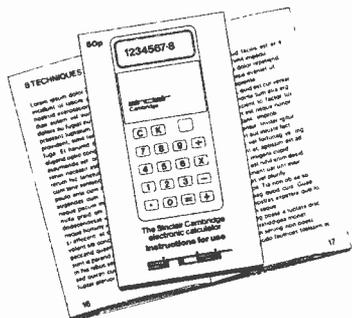
1. Coil.
2. Large-scale integrated circuit.
3. Interface chip.
4. Thick-film resistor pack.
5. Case mouldings, with buttons, window and light-up display in position.
6. Printed circuit board.
7. Keyboard panel.
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10. Soft wallet.



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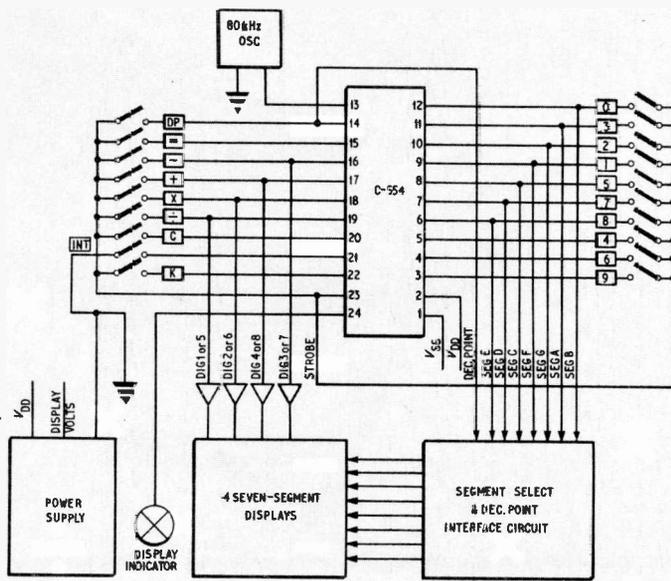


Fig. 1. Block diagram of a four digit calculator using the C554 integrated circuit

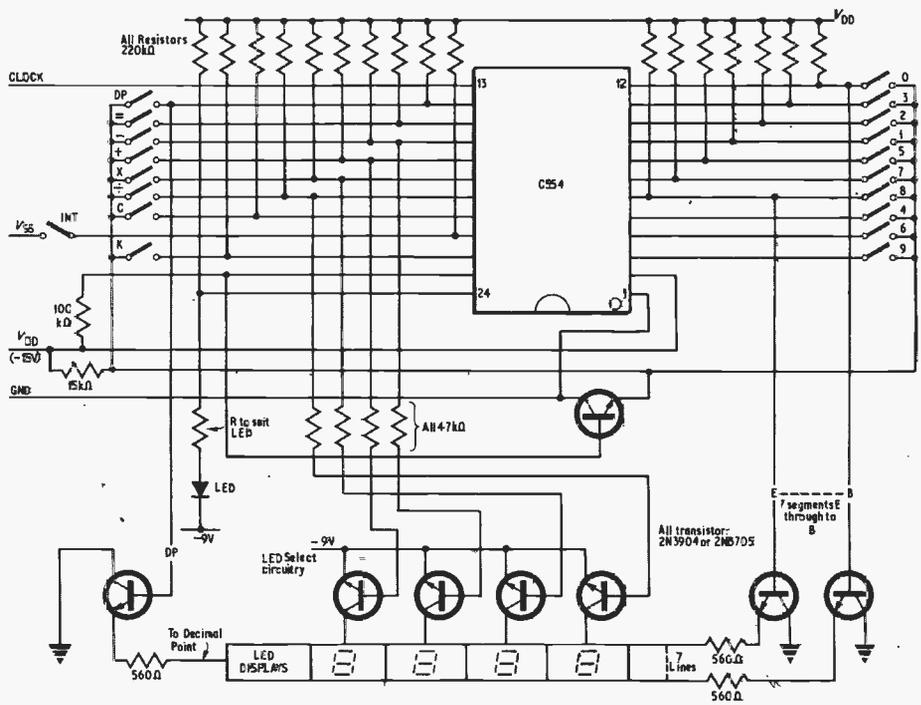


Fig. 2. A more complete circuit diagram showing l.e.d. seven segment display with all the necessary driver transistors. All voltages are with respect to the V_{SS} line

DEVICES ... APPLICATIONS

FOUR DIGIT MOS CALCULATOR I.C.

IT SEEMS only a short while ago that we were all impressed by the technology needed to put a complete calculator on one chip, yet already General Instrument Microelectronics have developed a second generation M.O.S. calculator integrated circuit. The main advantage of the new device is greatly reduced power consumption, this being made possible by reducing the necessary supply voltage from 25 volts to 15 volts.

The new calculator i.c.s. type C550 and C554, enable either eight (C550) or four (C554) digit calculators to be built. The reduction in power supply voltage is made possible by the use of new materials. The new process is called General Instrument Advance Nitride Technology (GIANT). Reduction of power supply voltage reduces chip consumption to a mere 150mW.

FOUR DIGIT CALCULATOR

Since eight digit calculator i.c.s. are most widely used the more unusual four digit i.c. (C554) will be described. This calculator needs only a four digit display so is much cheaper and probably just as useful as the eight digit type.

Fig. 1 shows the block diagram of a calculator built around the C554. All switches would be contained on a keyboard. Some of the connections to the i.c. are used both as inputs and outputs, this being done to keep the pin count down to 24. The i.c. is driven by an 80kHz clock generator.

The i.c. generates a strobe pulse at pin 23 which is fed to all the keyboard contacts except the interchange (INT) switch. If any of the keyboard contacts are closed during the strobe pulse then the appropriate input will be fed to the i.c. The strobe pulse only occupies a very small proportion of the total clock period, the rest being used to display the output.

DISPLAY

A multiplexing system is used for the output whereby each of the four digits is selected in turn. A seven segment output is generated on the same lines used as numerical inputs (pins 6 to 12) as well as decimal point information. The display can be any seven segment type such as l.e.d., liquid crystal or hot filament; the driver (interface) circuit is the only thing that needs changing.

Fig. 2 shows a more detailed circuit diagram using l.e.d. seven segment displays and single-transistor drivers. The 220k Ω resistors are needed because the MOS output transistors are "open drain" types. All voltages are specified with respect to the V_{ss} level. The 560 Ω resistors are simply to limit the current through the l.e.d.s and the 4.7k Ω resistors are to limit the transistor base current.

INTERCHANGE SWITCH

One point that has not been so far explained is the interchange switch labelled INT. The C554 has been described as a four digit device in that it only displays

four digits at a time but, in fact, it can accept up to eight digit inputs and produces an eight digit output. The interchange switch interchanges the two sets of four digits so that more accurate answers may be obtained if desired. The l.e.d. shown indicates which of the groups is being displayed. The decimal point appears in whichever group is appropriate; if the decimal point does not occur in the group being displayed it will be obvious as all the decimal points on all four digits will be illuminated.

As mentioned earlier the C554 needs a 15V power supply and an 80kHz clock input. Both of these needs can be satisfied with the circuit shown in Fig. 4. An oscillator generates the 80kHz clock pulses and its output is fed to a regulator which gives 15V at up to 10mA.

USING THE CALCULATOR

The C554 can perform all the normal arithmetic operations: addition, subtraction, multiplication and division. The true sign of answers is given if the result is negative the minus sign replacing the most significant digit so that only three digits are available.

There is a single CLEAR key which can be used to clear either the complete calculator or the last entry. If the depression of the CLEAR key is followed by pressing a function key, only the last entry will be cleared; if a digit key is pressed then the whole calculator will be cleared.

There is a CONSTANT facility whereby a result of a calculation might be stored to be used after the entry of another number. The constant store can hold a multiplier, divisor, subtrahend or addend.

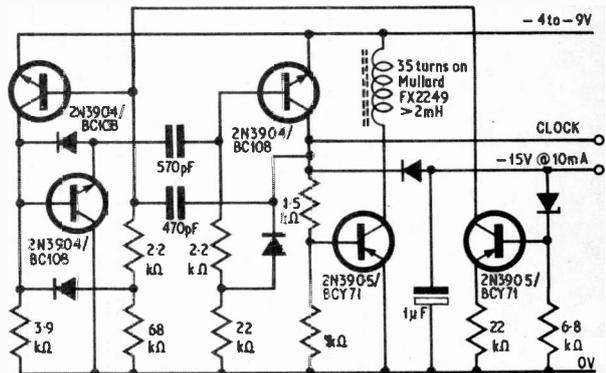


Fig. 3. A power supply and clock generator for the C554 i.c. which is all that is needed to complete the calculator in Fig. 2

Semiconductor TESTER

BY J. H. PERKIN



FOLLOWING the circuit description last month the construction of the semi-conductor Tester will be described.

CONSTRUCTION

Most of the components are mounted on 0.15in matrix Veroboard measuring $3\frac{1}{4}$ in \times $1\frac{1}{4}$ in. Breaks in the copper strips should be made as shown in the Veroboard layout of Fig. 7.

The positions of the components are shown the reverse of Fig. 7, but the layout is not critical. The resistors and capacitors are mounted first, remembering to connect the electrolytic capacitor C6 (2 μ F) the correct way round i.e. +ve to +ve. The component leads are fed through the Veroboard holes and bent so as to lie along the copper strips. The leads are then cut so that about 0.1in of lead remains on the copper strip, and then the leads are carefully soldered to the strip.

The transistors and diodes are mounted last, care being taken not to overheat the leads as this can cause component failure.

Meter face

The meter face should be modified to include all the numbers in Fig. 8. Letraset can be used for this purpose.

Case and component interconnections

The case used was a 18cm \times 15cm \times 13.5cm West Hyde MOD303.

The lettering on the front panel may be done using Letraset. The components are then mounted on the front panel and the connections shown in the circuit diagram are made. Use a different coloured wire for each connection link if possible for simplicity.

Connect one male battery connector to a female battery connector by 4in of wire for the battery "jumper" lead.

VEROBOARD PANEL

Printed Circuit Supporting Bracket

The bracket used to support the Veroboard panel may be made from aluminium sheet, 22 s.w.g. being quite suitable.

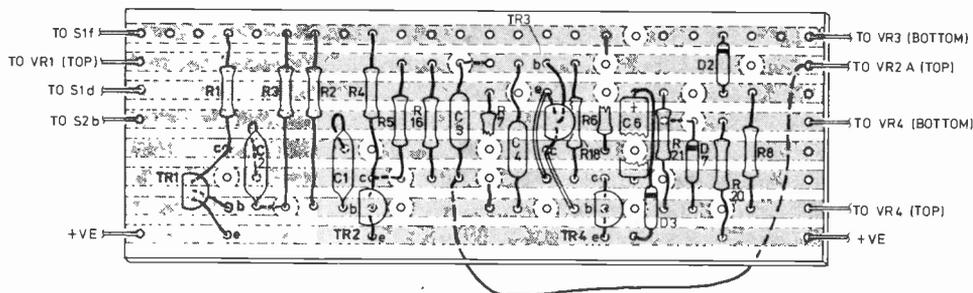


Fig. 7. Layout of the components on the Veroboard panel

Two holes should be made in the Veroboard panel to align with holes made in the bracket.

The batteries are retained in the case in the prototype using one piece of 1in wide elastic which is 8.5in long. Each end of the elastic is secured to the base of the case by a 4BA bolt, and nuts. The feet supplied with the case are now stuck to the base of the case. The test leads are made as shown in Fig 9, each lead being about 60cms long.

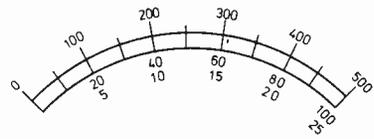


Fig. 8. The modified meter face

TESTING

Testing may be accomplished as follows, the components being tested are listed at the beginning of each test to facilitate fault finding by beginners.

1. S3, Batteries, S1A, S1B, S1C, R9, D4, D5, 52A, 52B, 526, ME1, R14, S4. Socket leads C and E.

(a) Set METER switch to I_{ce0} , DEVICE switch to PNP, and ON/OFF switch to ON:—meter should indicate zero.

(b) Connect a resistor of approximately 50 k Ω between leads C and E:—meter should read approximately 200 μ A.

(f.s.d. = 10mA).

(c) Depress F.S.D. \div 20 switch:—meter should read approximately 200 μ A.

(f.s.d. = 0.5mA). Release F.S.D. \div 20 switch.

(d) Set DEVICE switch to NPN and repeat 1(b) and 1(c).

(e) Connect lead C to lead E:—meter should read approx. 10mA (f.s.d. = 10mA).

(f) Set (METER switch to I_c and repeat (e).

(g) Disconnect lead C from lead E:—meter should read zero.

Switch OFF tester.

2. R1 to 6, R16, R21, R18, R17, VR2A, C1, C2, C3, C6, D3, D7, TR1 to TR4, S1F, S2A, 52C, Meter, R7, C4.

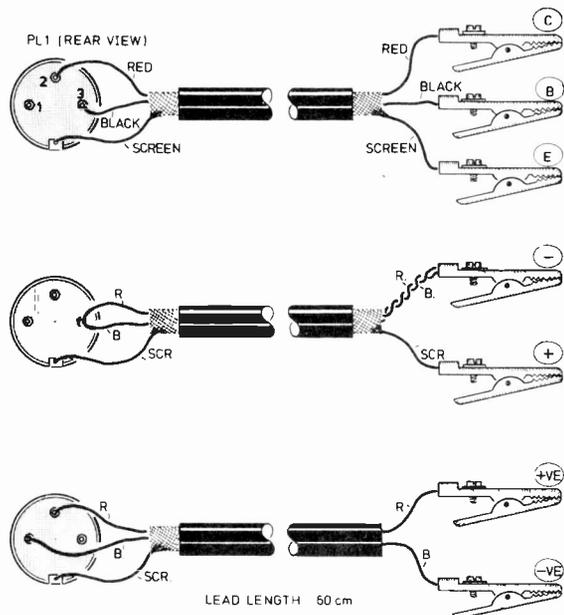
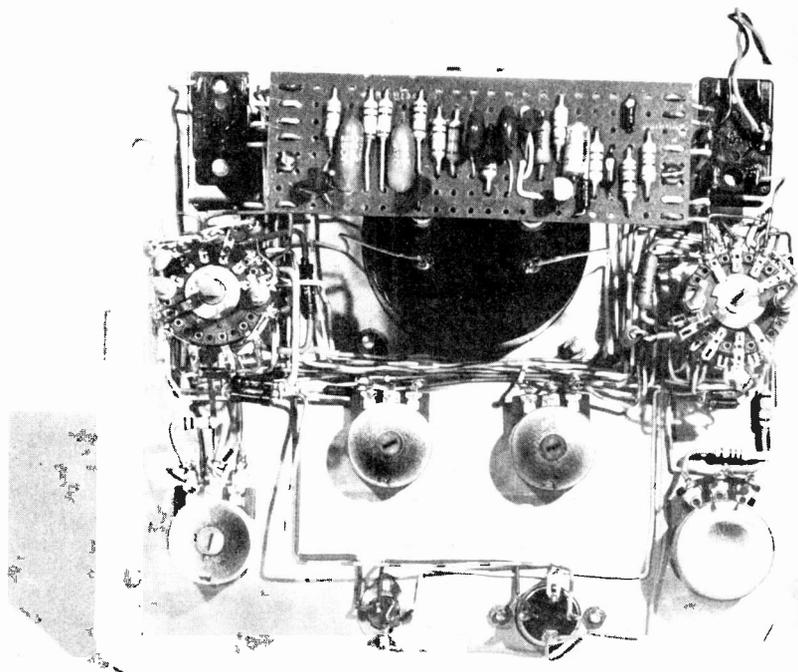
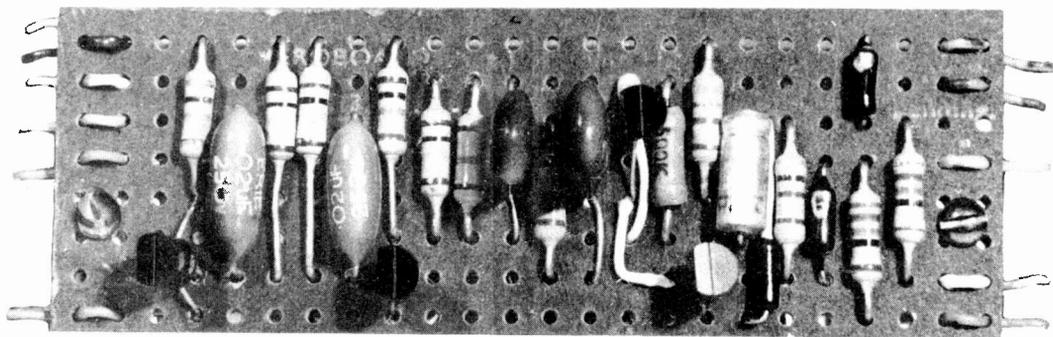


Fig. 9. Transistor, CSR and diode leads

Rear view of the front panel of the Semiconductor Tester





Photograph of the components on the Veroboard panel

(a) set METER switch to h_{fe} , DEVICE SWITCH TO PNP, ON/OFF switch to ON:—meter should read approx. f.s.d. If meter reading is somewhat less than f.s.d. decrease value of R16, if meter reading is greater than f.s.d. increase value of R16.

(b) Set DEVICE switch to NPN:—meter reading should remain as in 2 (a). Switch tester OFF.

3. VR1, R15, R19, C3, R22, S1E, S2D, VR2B, R10.
 (a) Connect a "working" transistor to the transistor socket SK1 or the "Flying Leads" lead C to collector, lead B to base, and lead E to emitter. Set METER switch to I_c , DEVICE switch to PNP or NPN depending on transistor type, set SET I_c to min. switch ON tester:—meter reading should increase as SET I_c control is turned from min. to max. Adjust SET I_c so that the meter current is 2mA (f.s.d. = 10mA).

(b) Set METER switch to h_{fe} and adjust h_{fe} control:—it should be possible to find a position where the meter deflection is a minimum. Switch OFF tester and remove the transistor.

4. S1F, LP1, D2, R8, VR4, R20, VR3, D1, R11, S2A, R13, R12, S2C, S4, S2B, S1E, R22, S2D, D6, R23, leads b.

(a) Set DEVICE switch to THY ZEN UJT V, METER switch to THY GATE 1, turn SET I to max. and SET V to min. short leads B and C, switch ON tester and adjust SET V from min. to max.:—meter reading should increase from zero to approx. $\frac{1}{4}$ f.s.d.

(b) Set SET V to min, depress and hold F.S.D. \div 20 switch and adjust SET V for f.s.d., release F.S.D. \div 20 switch:—meter should now be 1/20 of f.s.d. Remove short between leads B and C, switch OFF tester.

(c) Set METER switch to THY GATE V, switch ON tester, adjust SET V from min. to max.:—meter reading should decrease from 12V to 0V (f.s.d. is 25V).

(d) Set METER switch to THY HOLD I, turn SET I to min, short leads C and E, and increase SET I from min. to max.:—meter reading should increase to approximately f.s.d. when lamp L1 should be lit.

(e) Set SET I to min., depress and hold F.S.D. \div 20, increase SET I control until meter reads f.s.d., release F.S.D. \div 20:—meter should read 1/20 f.s.d.

OPERATING INSTRUCTIONS

Transistor testing

1. Connect transistor to socket SK1 or to flying leads, E to emitter B to base, C to collector.
2. Set DEVICE to PNP or NPN depending on transistor type).
3. Set METER switch to I_{ceo} , switch tester ON—meter shows I_{ceo} (f.s.d. 10mA). Operate F.S.D. \div 20 if required.
4. Set METER switch to I_c .
5. Adjust SET I_c control for required I_c on meter (f.s.d. 10mA).
6. Set METER switch to h_{fe} .
7. Adjust h_{fe} control for minimum reading. The h_{fe} is indicated on h_{fe} scale.

Diode Testing

1. Connect to socket SK1 on to flying leads of transistor lead, E to anode and C to cathode.
2. Set METER switch to I_{ceo} .
3. Set DEVICE switch to PNP, switch TESTER ON meter shows forward current (f.s.d. 10mA) $R_F = \frac{12000}{I_f \text{ (in mA)}} - 1200$.
4. Set DEVICE switch to NPN—meter shows reverse current $R_R = \frac{12000}{I_R \text{ (in mA)}} - 1200$ (F.S.D. \div 20 may be used if required)

Zener Diodes (0-10V)

1. Connect diode to socket SK1 or to flying leads of transistor lead. C to cathode E to anode, connect lead B to lead C.
2. Set DEVICE switch to THY ZEN UJT V.
3. Set SET V to min.
4. Set SET I to min.
5. Switch METER switch to THY GATE V/V, switch tester ON—meter reads Zener voltage (f.s.d. = 25V).
6. Adjust SET I from min. to max. meter reading should only change by a small amount. This check gives a rough indication of the a.c. resistance of the diode. (The current through the diode

at any point can be found by setting meter switch to THY HOLD I, I.

Note that for Zener voltages in excess of 10V it is necessary to insert a battery of known voltage between the emitter lead of the Zener diode and lead E of the tester, then Zener Voltage = meter reading + battery voltage.

Thyristor Testing

1. Connect the thyristor to SK1 or to the flying leads of the transistor testing lead anode to E, cathode to C, Gate to B.
2. Set SET V to min.
3. Set SET I to max.
4. Set DEVICE switch to THY ZEN. UJT. V.
5. Set METER switch to THY GATE I, switch tester ON.
6. Adjust SET V slowly clockwise noting the meter current. When the lamp L1 lights (thyristor conducting). Use $FSD \div 20$ if required. Meter reading to gate trigger current.
7. Set SET V to min.
8. Switch tester OFF then ON—lamp L1 should extinguish indicating that thyristor has reset.
9. Set METER switch to THY GATE V—meter indicates supply voltage.
10. Adjust SET V slowly clockwise—meter reading slowly falls then suddenly drops to zero, note the voltage (trigger voltage) at which the meter reading suddenly falls.
Gate trigger voltage = Supply voltage - trigger voltage
11. Set SET V to min.
12. Set METER switch to THY HOLD I, I.
13. Adjust SET I from max. to min. and note the point at which the meter current falls to zero, this current is the thyristor holding current. (F.S.D. $\div 20$ may be used if required).

Unijunction transistor testing

1. Set DEVICE switch to THY, ZEN, UJT, V.
2. Set METER switch to THY GATE V, V.
3. Set SET V to min.
4. Connect unijunction to SK1 on to flying leads Base 1 to C, Base 2 to E, Emitter to B.
5. Switch tester ON.
6. Adjust SET V (noting decrease in meter voltage reading until meter "kicks" when:—

$$\text{Intrinsic Standoff ratio} = \frac{\text{decrease in meter voltage}}{\text{maximum meter voltage}}$$

Using tester as a Voltmeter

1. Set DEVICE switch to PNP.
2. Set METER switch to THY GATE U, V.
3. Connect voltmeter lead to voltage to be measured

Using tester as an Ammeter (f.s.d. = 100mA or 5mA).

1. Set METER switch to THY HOLD I, I.
2. Connected current lead to current source (F.S.D. $\div 20$ may be used if required). ★

TRANSFORMERS

MAINS ISOLATING SERIES
Primary 120/240 Volts. Secondary 120/240 Volts Centre Tapped and Earth Shielded
ALSO AVAILABLE WITH 115/120V SEC. WINDING

Ref. No.	VA (Watts)	Weight lb oz	Size cm.	P & P £ p
07	20	1 8	7.0 x 6.0 x 6.0	1.94 30
149	60	3 12	9.9 x 7.7 x 8.6	2.88 36
150	100	5 8	9.9 x 8.9 x 8.6	3.16 52
151	200	8 0	12.1 x 9.3 x 10.2	5.31 52
152	250	13 12	12.1 x 11.8 x 10.2	7.01 67
153	350	15 0	14.0 x 10.8 x 11.8	9.40 82
154	500	19 8	14.0 x 13.4 x 11.8	13.55 *
155	750	29 0	17.2 x 14.0 x 14.0	19.26 *
156	1000	38 0	17.2 x 16.6 x 14.0	24.97 *
158	2000	60 0	21.6 x 15.3 x 18.1	41.25 *

PLEASE NOTE
NEW ADDRESS
AS BELOW

Ref. No.	VA (Watts)	Weight lb oz	Size cm.	Auto Taps	P & P £ p
113	20	1 0	5.8 x 5.1 x 4.5	0-115-210-240	1.02 27
64	75	2 4	7.0 x 6.7 x 6.1	0-115-210-240	2.00 30
4	150	3 4	8.9 x 7.7 x 7.7	0-115-200-220-240	2.42 36
66	300	6 4	9.9 x 9.6 x 8.6	"	4.70 52
67	500	12 8	12.1 x 11.2 x 10.2	"	6.98 67
84	1000	19 8	14.0 x 13.4 x 14.3	"	12.69 82
93	1500	30 4	14.0 x 15.9 x 14.3	"	18.39 *
95	2000	32 0	17.2 x 16.6 x 14.0	"	24.00 *
73	3000	40 0	21.6 x 13.4 x 18.1	"	32.67 *

TOTALLY ENCLOSED 115V AUTO TRANSFORMERS
115V 500 Watt totally enclosed auto transformer, complete with mains lead and two 115V outlet sockets. £9.49. P & P 67p.
Also available a 20 Watt version, £2.02. P & P 22p.

LOW VOLTAGE SERIES (ISOLATED)

Ref. No.	Ampls.	Weight lb oz	Size cm.	Secondary Windings	P & P £ p	
111	0.5	0.25	4	4.8 x 2.9 x 3.5 0-12V at 0.25A x 2	1.02 22	
213	1.0	0.5	4	6.1 x 5.8 x 4.8 0-12V at 0.5A x 2	1.22 22	
71	2	1	12	7.0 x 6.4 x 6.1 0-12V at 1A x 2	1.60 22	
18	4	2	12	8.3 x 7.7 x 7.0 0-12V at 2A x 2	2.24 36	
70	6	3	12	8.9 x 8.0 x 7.0 0-12V at 3A x 2	2.70 42	
108	8	4	5	8.9 x 8.9 x 8.6 0-12V at 4A x 2	3.00 52	
72	10	5	6	4	9.9 x 9.6 x 8.6 0-12V at 5A x 2	3.55 52
17	16	8	8	12	12.1 x 9.9 x 10.2 0-12V at 8A x 2	5.48 52
115	20	10	11	8	14.0 x 9.6 x 11.8 0-12V at 10A x 2	6.98 67
187	30	15	15	8	14.0 x 12.1 x 11.8 0-12V at 15A x 2	12.90 82
226	60	30	32	0	17.2 x 15.3 x 14.0 0-12V at 30A x 2	23.72 *

Ref. No.	Ampls.	Weight lb oz	Size cm.	Secondary Taps	P & P £ p
112	0.5	1	4	6.1 x 5.8 x 4.8 0-12-15-20-24-30V	1.22 22
79	1	2	4	7.0 x 6.7 x 6.1	1.62 36
3	2	3	4	8.9 x 7.7 x 7.7	2.42 36
20	3	4	8	9.9 x 8.3 x 8.6	2.99 42
21	4	5	8	9.9 x 8.6 x 8.6	3.55 52
51	5	6	12	12.1 x 8.6 x 10.2	4.42 52
117	6	8	0	12.1 x 9.3 x 10.2	5.28 52
88	8	12	0	12.1 x 11.8 x 10.2	6.82 67
89	10	13	12	14.0 x 10.2 x 11.8	8.36 67

Ref. No.	Ampls.	Weight lb oz	Size cm.	Secondary Taps	P & P £ p
102	0.5	1	12	7.0 x 6.4 x 6.1 0-19-25-33-40-50V	1.60 30
103	1.0	2	12	8.3 x 7.4 x 7.0	2.34 36
104	2.0	5	8	7.9 x 8.9 x 8.6	3.25 42
105	3.0	6	12	9.9 x 10.2 x 8.6	4.41 52
106	4.0	10	0	12.1 x 10.5 x 10.2	5.84 52
107	6.0	12	0	14.0 x 10.2 x 11.8	8.63 67
118	8.0	18	0	14.0 x 12.7 x 11.8	11.27 97
119	10.0	25	0	17.2 x 12.7 x 14.0	14.13 *

Ref. No.	Ampls.	Weight lb oz	Size cm.	Secondary Taps	P & P £ p
124	0.5	2	4	7.0 x 6.7 x 6.1 0-24-30-40-48-60V	1.62 36
126	1.0	3	4	8.9 x 7.7 x 7.7	2.26 36
127	2.0	6	4	9.9 x 9.6 x 8.6	3.55 42
125	3.0	8	12	12.1 x 9.9 x 10.2	5.41 52
123	4.0	13	12	12.1 x 11.8 x 10.2	6.98 67
120	6.0	15	8	14.0 x 12.1 x 11.8	10.12 82
122	10.0	25	0	17.2 x 12.7 x 14.0	16.75 *

EQUIPMENT TRANSFORMER
Ref. 238 PRI 240V Screen Sec. 3-0 3V. RMS at 200mA. Size cm. 2.8 x 2.6 x 2.0. Weight 2oz. £1.18. P & P. 10p.

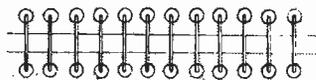
Ref. No.	Ampls.	Weight lb oz	Size cm.	P & P £ p
45	1.5	1 8	7.0 x 6.1 x 6.1	1.61 30
5	4.0	3 4	8.9 x 7.7 x 7.7	2.45 42
86	6.0	6 4	9.9 x 9.6 x 8.6	3.70 52
146	6.0	6 12	9.9 x 10.2 x 8.6	4.22 52
50	12.5	12 0	14.0 x 10.2 x 11.8	6.29 67

All ratings are continuous. Standard construction: open with folder tags and vacuum impregnation. *Carriage via B.R.S.

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BC107/108/109 12p each. 2N3055 60p each. AD161/162 60p pair + mica and bushes

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INDUSTRY NOTEBOOK

By Nexus



TOUGH FIELD

It takes a lot of guts to take on the big boys, especially in a field as tough as mobile radio-telephones. This is the field where household names like Cossor, Ultra and STC have all chucked in the sponge within the past year or so.

Pye is still undisputed market leader and Burndept, strengthened by the acquisition of Cossor and Ultra business, is second. The question is whether Dymar can succeed when better-known companies have failed?

I can report that there was no lack of confidence in the Dymar management when the company launched its new 'Lynx' range of mobiles on September 12. For one thing the Lynx, with a 20W output, has a technical edge on the competition and Dymar has prepared the sales ground well by appointing a nation-wide network of distributors and service centres.

Although Dymar as a name is not yet well known, the company has a huge back-log of experience in both design and manufacture of mobile radio. To date, Dymar has produced 30,000 mobile equipments of which half have been made under contract to other companies' designs and about 7,500 have been land or marine mobiles of Dymar's own design and manufacture.

Approximately £150,000 has been invested in the Lynx development and it could be a real winner. In fact the company expects no less than half the total 1974 turnover in Lynx with the other half split 35 per cent in marine radiotelephones, and 15 per cent in instruments of which Dymar make a range for manufacture, testing and servicing of r.f. systems.

SATELLITE NAVIGATION

While Dymar was launching Lynx in Whitehall, Redifon was launching a marine satellite navigation receiver half-a-mile away in the Strand.

The Redifon Satellite Navigator is another milestone along the road forecast by J. R. Brinkley when, earlier this year, he said the company was now fully committed to a huge modern technology programme to win a large share of the communications and navigation markets. It was on that occasion that he was able to announce that the Redifon Omega Navigator had already been fitted to 100 ships and had realised £0.5 million in revenue.

What industry observers are waiting for now is the Redifon v.h.f./u.h.f. programme. No hardware has yet been announced although R and D expenditure in this area is said to be £100,000. As part of the expansion programme a new plant is under construction in Wales which could ultimately house 1,000 workers.

BATTLE CONTINUES

The light-emitting-diode battle continues with increasing intensity. Ferranti's new green LED's are reported to be coming out of the factory at 1.5 million a year now, stepping up to a rate of 10 million a year by the Spring of '74.

Plessey's Optoelectronics and Microwave Unit at Towcester is also in on the action with a new yellow gallium phosphide device which is claimed to have a higher light output and spot brightness than any other solid state light source currently available. The Towcester Unit is also offering custom-built hybrid arrays in green, yellow and red, a typical array recently produced for a customer having 32 diodes. They are assembled and encapsulated on a metallised ceramic substrate which can include dropping resistors if required.

INSTRUMENTS— A HARD LIFE

The instrument industry is struggling back to life after three years in the doldrums. Renewed activity springs from the big investment programmes now being undertaken by many major user companies.

But the instrument business is no sinecure. John Ceresa, marketing director of Rascal Instruments, recalls that 13 years ago a 10MHz counter cost £400. By 1970, in ten years, the price had dropped 75 per cent for the same instrument in a solid state version and with much improved performance and reliability. You then found you had to

sell four times as many to make the same turnover and maybe eight times as many to make the same profit.

Another angle on the life and hard times of instrument men comes from David George, managing director of SE Laboratories, one of the companies who have been through a bad patch. He says it is suicidal for any company to try to compete in every generation of instruments. One of the ways of cutting R and D costs is to do a deal with a complementary manufacturer elsewhere in the world. SE Labs has actually done this with Data Precision Corporation in USA.

I note with interest that even Tektronix with a near stranglehold on the top end of the oscilloscope market is finding it hard to expand any further without diversifying into other fields. Although the oscilloscope market shows no signs of a decline—it is still growing at least 10 per cent a year—Tektronix has moved into programmable calculators and more recently has acquired a Californian Company which specialises in TV studio equipment.

AD-POWER WORKS!

Just when you think there are no surprises left in the industry you encounter another. I had this experience when I visited Kingshill Electronic Products who make professional quality power supplies for the universities, the Government, and the industry in general. The company is a subsidiary of Islington Metal and Plating Works Ltd., one of the pioneers of chromium plating nearly 50 years ago. The electronics off-shoot was started in 1964 by Dr. Henry Herbst who still sits in the managerial chair. His sort of company would normally have a flock of travelling salesmen chatting up potential customers and a sales programme involving appearances at major electronic exhibitions.

Not Kingshill. Herbst has never had a salesman on the road, has never shown at an exhibition. Kingshill sells on press advertising and personal recommendation. It seems to work. The production lines turn out 18,000 units a year which not only go to U.K. users but also to out-of-the-way places like Fiji and Thailand.

The premises were a surprise, too. They were originally stables for the horses of the old London horse-drawn trams. Not so unexpected is that Herbst, with a solid business now established in power supplies and a firm economic base from which to operate, is looking for new electronic fields to conquer.

PRICES NOW INCLUDE VAT SUPERSOUND 13 HI-FI MONO AMPLIFIER



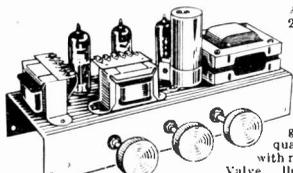
A superb solid state audio amplifier. Brand new components throughout. 3 silicon transistors plus 2 power output transistors in push-pull. Full wave rectification. Output approx. 13W r.m.s. into 8 ohm. Frequency response 12Hz-30KHz \pm 3db. Fully integrated pre-amplifier stage with

separate Volume, Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, switchgear panel, input and output plugs. Overall size 3in high x 6in wide x 7in deep. A.C. 200/250V.

PRICE £11-60

P. & P. 40p.

DE LUXE STEREO AMPLIFIER



A.C. mains 200-240 volts. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up: $\times 2$ ECL86 Triode Pentodes.

1 \times EZ80 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate "balance" control fitted at the rear of the chassis. Input sensitivity is approximately 300mV for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11in. w x 4in. x. Overall height including valves 5in. Ready built and tested to a high standard. **Price £9-90.** P. & P. 50p.

NEW! POWER SUPPLY UNIT

200/240V A.C. input. Four switched fully smoothed D.C. outputs giving 6V and 7.5V and 9V and 12V at 1 amp continuous (1 amp intermittent). Fitted insulated output terminals and pilot lamp indicator. Hammer finish metal case, overall size 6" x 3 1/4" x 2 1/4". Suitable for Transistor Radios, Tape Recorders, Amplifiers, etc., etc. Ready built and tested.

PRICE £5

P. & P. 35p.

BLACK ANODISED 16g. ALUMINIUM HEAT SINKS. For T03, complete with mica's and bushes. Size 2 1/2in x 3in approx. 25p pair. P. & P. 6p.

HIGH GRADE COPPER LAMINATE BOARDS. 8" x 6", 5 for 55p. P. & P. 23p.

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 watt at 1 amp or 10-0-10, 20-0-20, 30-0-30V, at 2 amp full watt. Size 3 1/4in. x 3 1/4in w x 3in d. Price £2-10. P. & P. 40p.

MAINS TRANSFORMER. For transistor power supplies. Pri. 200/240V Sec. 9-0-9 at 500mA. £1 P. & P. 25p. Pri. 200/240V Sec. 12-0-12 at 1 amp. £1-10 P. & P. 25p. Pri. 200/240V Sec. 10-0-10 at 2 amp. £1-65 P. & P. 35p.

GENERAL PURPOSE HIGH STABILITY TRANSISTOR PRE-AMPLIFIER. For P.U. Tape, Mike, Guitar, etc., and suitable for use with valve or transistor equipment. 9-18V. Battery or from H.T. line 200/300V. Frequency response 15Hz-25KHz. Gain 20dB. Solid encapsulation size 1 1/4 x 1 1/4 x 1/2in. Brand new — complete with instructions. Price £1. P. & P. 15p.

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
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Transistor Characteristics	£1-20
All three together	£2-80

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.

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RECORD PLAYER BARGAINS

Main 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 50p P. & P. **Garrard SP25 Mk. III** with heavy precision machined die cast turntable. £10-68. Carr. 55p.

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, SL651B, AT660, 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. 70p. **Now only £4-95**

LATEST ACOS GP91/18C Mono Compatible Cartridge with T/O stylus for LP/EP/78. Universal mounting bracket. £1-50. P. & P. 15p.

SONOTONE STARC 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. £2-30. P. & P. 15p.

LATEST RONETTE T/O Mono Compatible Cartridge for EP/LP/Stereo/78. £1-63. P. & P. 15p.

LATEST RONETTE T/O Mono Compatible Cartridge for EP/LP/78 mono/stereo records on mono equipment £1-50. P. & P. 15p.

QUALITY RECORD PLAYER AMPLIFIER MK II

A top-quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, and rectifier. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. 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.

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Beautifully made teak finish enclosure with most attractive Tygan-Vynair front. Size 16in high x 10 1/2in wide x 6in deep. Fitted with E.M.I. Ceramic Magnet 13in. cone bass unit, two H.F. tweeter units and crossover. Max. power handling 10W. Available 3, 8 or 15 ohm impedance.

Our Price £9-25

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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 1/2 watts. Volume and tone controls. Chassis size only 7in. wide x 3in. deep x 6in. high overall. A.C. mains 200/240V. Supplied absolutely Brand New, completely wired and tested with good quality output transformer.

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£3-30

P. & P. 40p

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EMI CERAMIC MAGNET HEAVY DUTY TWEETER. approx 3 1/2in. AV. 3 or 8 or 15 ohms. £1-25 plus 20p P. & P. **BRAND NEW.** 12in 15W I/FD 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. 45p each.



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LIMITED NUMBER OF BRAND NEW ELAC 10" TWIN CONE LOUSPEAKERS. With large ceramic magnet and plasticated cone surround, 8 ohm impedance.

£2-70. P. & P. 35p.

Also available specification as above but size 10" x 6" £2-70 and size 8" round £2-60 P. & P. 35p.

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10 watts peak handling, 3, 8 or 15 ohm. £2-45. P. & P. 36p. **35 ohm SPEAKERS 3" 8" 15" £1-70.** P. & P. 25p.

"POLY PLAS" WIDE RANGE ELECTRO-DYNAMIC SPEAKER

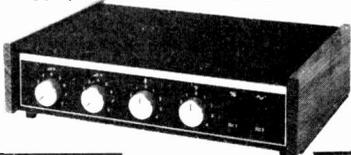
Size 1 1/2in x 1 1/2in x 1 1/2in deep. Weight 19oz. Power handling 20W r.m.s. (40W peak). Impedance 8 ohm only. Response 40Hz-20KHz. Can be mounted on ceilings, walls, doors, under tables, etc., and used with or without baffle. Send S.A.E. for full details. Only £6-55 each. P. & P. 34p.

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Adjustable headband with comfortable flexifoam ear-muffs. Wired and fitted with standard stereo 3 1/2 jack plug. Frequency response 30-15,000Hz. Matching impedance 8-16 ohms. Easily converted for mono. **PRICE £3-30.** P. & P. 25p.

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

A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. (Very simple to modify to suit magnetic cartridge—instructions included). Output stage for any speakers from 5 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled 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 specifications: Power output 14W 12-30,000Hz. Sensitivity better than 80mV into 1M Ω . Full power bandwidth \pm 3dB 12-15,000Hz. Bass boost approx. to \pm 12dB. Treble cut approx. to \pm 16dB. Negative feedback 18dB over main amp. Power requirements 35V at 1-0 amp. Overall size—12" wide x 8" deep x 3" high.

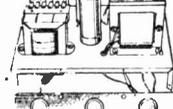
Fully detailed 7-page construction manual and parts list free with kit and send 18p plus large S.A.E.

PRICES AMPLIFIER KIT, £11-55. P. & P. 25p. (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 then provide mixing and fading facilities for medium powered Hi-Fi Discosqueque use.

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 7 1/2in. w. x 4in. d. x 4 1/2in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4 1/2 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. 45p.

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**PART 2:
A.M. AND F.M.
DEMODULATION
AND FREQUENCY
SYNTHESISERS**

BY J.B.DANCE M.Sc.

IN LAST MONTH'S article the basic principles of phase locked loops were described. This month we will look at the application of these principles in f.m. radio reception, a.m. demodulation and frequency synthesisers.

RECEIVER TECHNIQUES

An amplitude modulated (a.m.) radio signal consists of a high frequency sine wave, whose frequency is fixed for any particular broadcasting station, but whose amplitude varies in sympathy with the audio signal that is the information to be transmitted. The carrier frequency f_s ranges from about 200kHz up to many megahertz, whilst the audio frequency ranges from 30Hz to 15kHz. The receiver must be able to reproduce the modulating audio signal as faithfully as possible and must provide as much separation as possible between signals whose carrier frequencies are close.

T.R.F. RECEIVERS

One of the simplest forms of radio receiver is the so-called "tuned radio frequency" (t.r.f.) receiver. The basic form of this type of receiver is shown in the block diagram of Fig. 2.1.

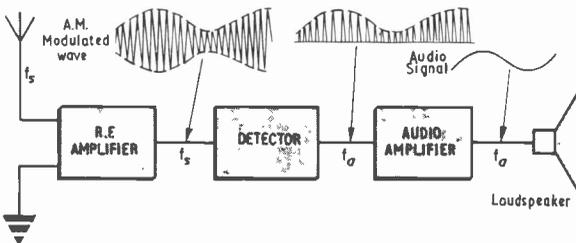


Fig. 2.1. A block diagram showing the stages in a t.r.f. receiver

The incoming signal is amplified in the radio frequency stage. No change in the frequency or in the form of the signal takes place in this stage, but tuned circuits are employed to provide selectivity and to reject unwanted signals of other frequencies.

The signal is then demodulated or detected, usually by a stage that provides some amplification. The audio signal from the detector (f_a) is fed to an audio amplifier which can provide sufficient power output to drive the loudspeaker.

The selectivity provided by receivers of this type is very limited, partly because it is not practical to employ more than about four tuned circuits operating at the radio frequency f_s . Each tuned circuit requires a separate gang of the tuning capacitor and the relatively long connections to this capacitor can lead to unwanted feedback and oscillation.

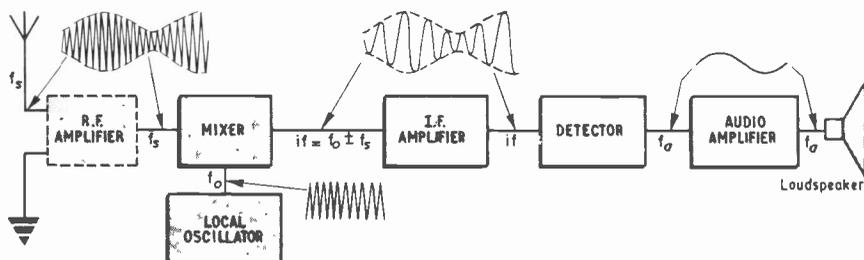
It is normally necessary to employ a fairly large value of tuning capacitor (typically 300pF to 500pF per gang) in order that the desired tuning range can be covered. This may make it impossible to design the tuned circuits for optimum Q factor (especially at high signal frequencies); the selectivity and gain therefore suffer.

The limitations of t.r.f. receivers become very noticeable at the higher frequencies. The pass band is so broad that it is impossible to obtain adequate selectivity and noise rejection, whilst the signal frequency amplification is normally inadequate in the short wave bands.

SUPERHETERODYNE RECEIVERS

Many of the disadvantages of the t.r.f. receiver can be avoided by the use of the superheterodyne principle, but some other undesirable features are then introduced. A block diagram of a superheterodyne receiver is shown in Fig. 2.2.

Fig. 2.2. A block diagram of a superheterodyne receiver. The use of an r.f. stage is optional



The incoming signal from the aerial at a frequency f_s may be fed into a radio frequency stage (shown dotted) or directly into the mixer stage. In the latter stage it is mixed with a frequency f_o generated by a local oscillator. The frequency f_o is varied with the frequency to which the receiver is tuned.

The output from the mixer consists mainly of the sum and difference frequencies of the signals which are fed into it, that is, $f_o + f_s$ and $f_o - f_s$. It is arranged that the frequency of one of these outputs (normally the difference frequency in receivers covering the long, medium and short wave bands) is kept constant no matter what the frequency of the input signal, f_s . This constant frequency output signal is known as the intermediate frequency or *i.f.*

The mixer stage is followed by one or more stages of amplification at the intermediate frequency. These stages involve the use of a number of tuned circuits (typically six) which resonate at the intermediate frequency.

The intermediate frequency tuned circuits are fixed tuned and they can therefore be designed with the optimum inductance/capacitance ratio for high selectivity and gain; they provide virtually all of the selectivity of the receiver. Each tuned circuit can be incorporated inside a metal can so that unwanted coupling is reduced to a minimum.

DISADVANTAGES OF SUPERHETS

Superheterodyne receivers have the disadvantage that they tend to suffer from spurious responses. Noises such as whistles may be generated when the local oscillator frequency (or one of its harmonics) beats with certain incoming frequencies. One of these undesired responses occurs at the image frequency, where a signal at a frequency of $f_s + 2i.f.$ mixes with the local oscillator frequency to form an interfering signal.

Image frequency interference may be reduced by using tuned circuits before the mixer or by using a high intermediate frequency so that the image frequency is far away from f_s and easily rejected by the tuned circuits in the r.f. amplifier, though this latter method tends to reduce selectivity.

Another disadvantage of superhets is that the tuned circuits used throughout cannot be formed on an integrated circuit chip. Integrated circuits are not only smaller but because of the ease of assembly they greatly reduce labour costs.

THE SYNCHRODYNE

The synchronodyne receiver is the forerunner of the phase locked loop and aroused great interest in the late 1940's. The synchronodyne type of receiver is illustrated in the block diagram of Fig. 2.3.

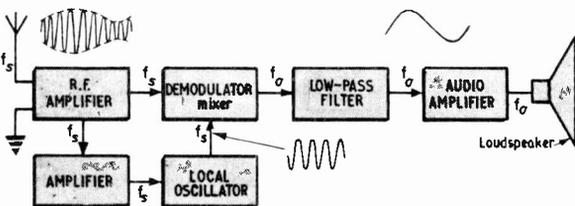


Fig. 2.3. The stages employed in a synchronodyne receiver

The signal from the aerial is fed via an optional radio frequency stage to the demodulator and also, via another amplifier stage, to a local oscillator. This signal keeps the local oscillator locked or synchronised to the input signal frequency—hence the name synchronodyne.

When the two signals of the same frequency come together in the demodulator stage (which is like the mixer of a superheterodyne), sum and difference frequencies are formed. The sum frequency, $2f_s$, is not required and is rejected by the succeeding low-pass filter. One might expect the difference frequency to be zero, but this really means that the carrier frequency is zero. In other words the output of the demodulator in Fig. 2.3 consists of the required audio signal minus the carrier.

Any interfering radio signals will not have the same frequency as the local oscillator. They therefore produce an output signal from the demodulator stage which is normally of a much higher frequency than that due to the wanted signal. The interfering signal cannot pass through the low-pass filter which follows the demodulator.

SYNCHRODYNE SELECTIVITY

One of the great advantages of the synchronodyne is that it does not obtain its selectivity by means of conventional tuned circuits, but by the use of a low-pass audio filter. This low-pass filter can be very simple (see Part 1) and can be designed to cut off at any point so as to provide the desired selectivity. It is easy to make the selectivity variable by adjusting the value of a single component.

Another important advantage of the synchronodyne receiver is that relatively few tuned circuits are employed in it. The only tuned circuit which is essential is the one in the oscillator circuit, but it is normally desirable to include some tuned circuits in the radio frequency stages to prevent very strong unwanted signals from overloading the mixer stage.

The local oscillator of a synchronodyne receiver must be locked in frequency to the wanted signal if one is to avoid the generation of beat frequencies. This type of receiver is either correctly tuned or not tuned at all. Unlike most other forms of receiver, a distorted audio output signal cannot be obtained as a result of the mis-tuning of the local oscillator.

As the local oscillator tuning is altered, the oscillator will remain synchronised to the incoming signal over a certain range, although the local oscillator signal may change in amplitude somewhat. Thus the only effect of a slight oscillator mis-tuning will be an alteration in the audio volume.

ADVANTAGES AND DISADVANTAGES

The synchronodyne receiver does not suffer from image responses. We have seen that an interfering signal at a frequency of twice the intermediate frequency plus the wanted signal frequency can produce an image response in a superheterodyne receiver; in the synchronodyne, however, the "intermediate frequency" is zero and therefore the image frequency becomes equal to the wanted signal frequency.

For domestic listening, the main objection to the use of the synchronodyne receiver is the loud whistles which are generated when one is tuning into a signal. These whistles are, of course, due to the local

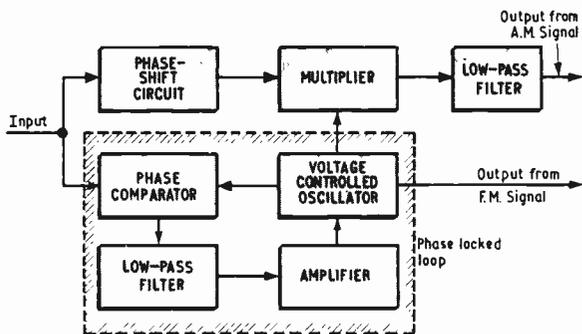


Fig. 2.4. An a.m. demodulator using a phase locked loop. The components of the loop itself are shown inside the box.

oscillator beating with the input signal before their frequencies become locked together. This problem can be overcome by the use of switched tuning.

Another reason for the limited use of synchronous receivers in the past has been the lack of simple, but effective phase locking circuits.

Other names for the synchronous receiver include "homodyne", "phase control" or "PC" receivers, synchronous detectors and phase locked detectors.

A.M. DEMODULATION

The block diagram (Fig. 2.4) shows a practical circuit for a.m. receivers using a phase locked loop.

The phase locked loop (comprising the units shown inside the dotted line) locks onto the input signal in the normal way. The voltage controlled oscillator produces a signal of the same frequency as the input signal, but it is unmodulated.

When the free-running frequency of the voltage controlled oscillator is the same as that of the incoming signal, locking will occur with these two signals 90° out of phase. In the system of Fig. 2.4, the phase shift circuit changes the phase of the input signal by 90° so that it is in phase with the output from the voltage controlled oscillator.

The two signals of the same phase are mixed in a second phase comparator or multiplier. The output from the multiplier is passed through a second low-pass filter so that only the difference frequency remains. This difference frequency is proportional to the amplitude of the input signal and is therefore the required audio output.

Systems such as that shown in Fig. 2.4 provide a higher degree of noise rejection than can be obtained from conventional a.m. demodulators which detect the peaked noise pulses.

F.M. DEMODULATION

The voltage controlled oscillator is normally designed so that its frequency is linearly related to the applied control voltage. As this latter voltage keeps the voltage controlled oscillator frequency the same as the incoming signal frequency, the control voltage is linearly related to the frequency deviation of the input signal.

In other words, the output voltage from the system (Fig. 1.1.) is the demodulated audio signal when the incoming signal is a frequency modulated one. The voltage controlled oscillator produces a greatly amplified copy of the input signal from which most of the noise has been removed.

One might expect that a very simple f.m. receiver could be constructed by merely feeding the input signal to the phase locked loop. In actual practice, however, a somewhat more complex system than this must be employed.

Currently available phase locked loops cannot operate at frequencies above about 60MHz. Most f.m. signals will therefore have to be converted to a lower frequency before they are passed to the phase locked loop. However, it seems likely that phase locked loops will be available at some future date which can operate at typical f.m. frequencies (about 100MHz) and it may then be possible to construct an f.m. receiver without the use of a frequency converter.

SENSITIVITY

Although phase locked loops can operate with a signal of just under a millivolt, some problems do arise if one wishes to operate them from an input of about $10\mu\text{V}$ (such as one may obtain from a receiving aerial at a considerable distance from the transmitter). It is generally better to amplify the signal before feeding it to the phase locked loop. Some tuned circuits are usually included in the system before the phase locked loop in order to reject signals which could produce spurious responses.

The phase locked loop may be employed to demodulate both narrow and wide band f.m. signals. It offers greater linearity than can be obtained by any other means and is therefore especially suitable for high fidelity systems.

At the other extreme, phase locked loops are employed in communications receivers where they are excellent for recovering weak signals in a noisy region of the radio spectrum.

FREQUENCY SYNTHESISERS

Frequency synthesisers are required for use in radio communications networks which will generate any one of a large number of frequencies with great accuracy at the touch of a button. For example, an aircraft navigation/communication band synthesiser may be required to produce frequencies in the range 108 to 136MHz at 50kHz intervals so as to cover each of the 560 channels.

Such frequency synthesisers can be designed using banks of quartz crystals and tuned circuits. However, it is normally more economic to employ a single quartz crystal to provide one accurate reference frequency and to obtain the other frequencies from it by the use of a phase locked loop together with a digital pulse frequency dividing circuit. This system has the additional advantage that fewer spurious frequencies are generated.

The basic system used in a phase locked loop frequency divider is illustrated by the block diagram of Fig. 2.5. The reference frequency is generated by a very stable quartz crystal controlled oscillator which is kept in a special constant temperature oven. If the frequency of this oscillator is 100kHz, the pulses may be divided in frequency to produce, perhaps, a 1kHz signal. The latter is fed as the reference signal to the input of the phase locked loop of Fig. 2.5.

DIVIDER CIRCUIT

The main difference between the frequency synthesiser circuit of Fig. 2.5 and the simple phase locked loop is the inclusion of a frequency divider circuit

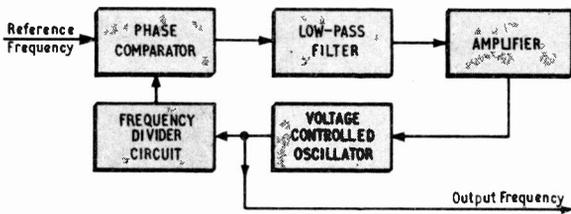


Fig. 2.5. The building blocks of a simple frequency synthesiser using a phase locked loop

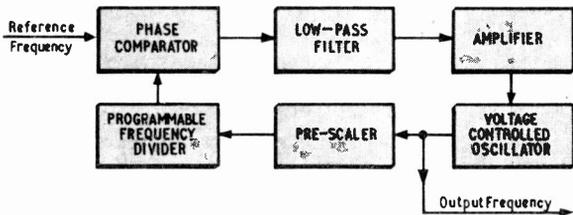


Fig. 2.6. In this type of frequency synthesiser a fast divider (the pre-scaler) is used to divide the pulse frequency.

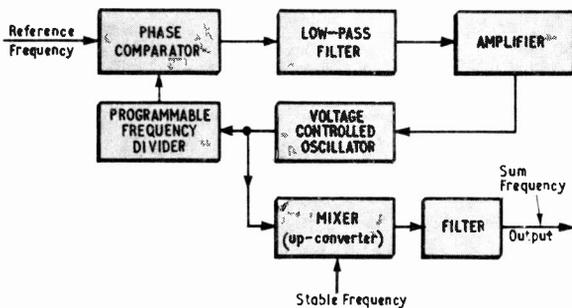


Fig. 2.7. Because phase locked loops can handle only relatively low frequencies, a mixer can be used to multiply the voltage controlled oscillator frequency.

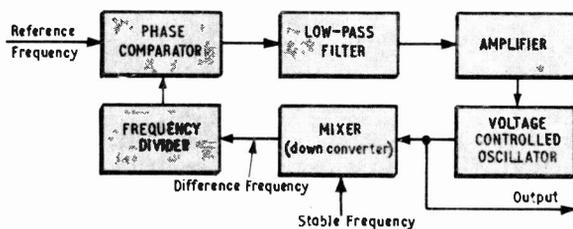


Fig. 2.8. In this type of frequency synthesiser a mixer is used to reduce the high voltage controlled oscillator frequency for the divider stage

between the voltage controlled oscillator and the phase comparator. This enables the voltage controlled oscillator to operate at a much higher frequency than the input reference signal.

If the reference signal has a frequency of 1kHz and the frequency divider is set so that it divides by, say, 569, the phase locked loop will come into lock when the voltage controlled oscillator frequency is 569kHz.

This frequency is divided so that it produces the same frequency as the input reference signal. In order to obtain any other output frequency from the voltage controlled oscillator, it is only necessary to change the factor by which this frequency is divided before it is fed to the phase comparator.

All frequencies generated in this way have the same stability as the reference frequency.

HARMONIC LOCKING

Phase locked loops will lock to a multiple of the input frequency, but the locking range decreases as higher and higher harmonics are used, since the amplitude of such harmonics is low.

Harmonic locking can be used in frequency synthesisers, but in general one should not attempt to lock a phase locked loop to a harmonic higher than about the tenth.

HIGHER FREQUENCIES

Digital frequency synthesisers are often required which will provide outputs of the order of some hundreds of megahertz. Voltage controlled oscillators can generate such frequencies, but programmable counters which can operate at above about 25MHz are very expensive.

It may therefore be more economic to operate the voltage controlled oscillator at a lower frequency and to multiply this frequency by a number of cascaded frequency multiplier stages. However, such a system has the disadvantage that tuned circuits are required in the multiplier stages and these must be re-tuned whenever the frequency is changed.

A more convenient system is shown in Fig. 2.6. The output from the voltage controlled oscillator is divided in frequency by a pre-scaler before being passed to a programmable frequency divider.

Other techniques for obtaining high frequency outputs include mixing the output from the voltage controlled oscillator with a stable frequency. The sum frequency is the required output, as shown in Fig. 2.7.

In yet another system, the output from the voltage controlled oscillator is mixed with a stable reference frequency and the difference frequency output is used to operate the programmable frequency divider. This type of system is illustrated in Fig. 2.8.

If a signal from a frequency synthesiser is fed to the mixer stage of a radio receiver together with the input signal, one can select the signal to be received merely by choosing the ratio by which the voltage controlled oscillator signal is divided. The drift in the tuning of such a system is quite negligible, since the reference frequency is crystal controlled.

Next month this series will continue with a review of the types of phase locked loops available from various manufacturers together with practical examples of the circuits in which they can be used.

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AC126	12p	AF178	32p	BF178	32p	OC70	12p	2N3711	11p
AC127	15p	AF180	40p	BF179	32p	OC71	12p	2N3819	32p
AC128	15p	AF181	40p	BF180	32p	OC72	12p	2N4062	12p
AC131	12p	BC107	12p	BF181	32p	OC81	12p	2N4286	20p
AC132	12p	BC108	12p	BF194	14p	OC82D	12p	2N4289	20p
AC176	15p	BC109	12p	BF195	14p	2N2646	60p	40360	35p
AC187	22p	BC147	12p	BF197	15p	2N2904	20p	40361	35p
AC188	22p	BC148	12p	BF200	32p	2N2926	10p	40362	40p
AD140	50p	BC149	12p	BFY50	20p	2N3054	58p	40408	40p
AD149	45p	BC157	14p	BFY51	20p	2N3055	60p	ZTX108	15p
AD161	33p	BC158	14p	BFY52	20p	2N3702	13p	ZTX300	15p
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AF117	20p	BD133	75p	OC35	50p	2N3707	12p		
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100/4, 100/10, 100/25, 150/6/3, 150/16, 220/4, 220/6/3, 220/16, 330/4, 330/16, 330/40,
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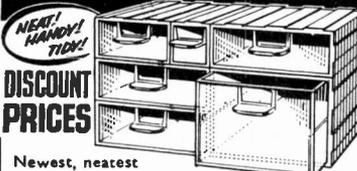
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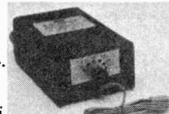
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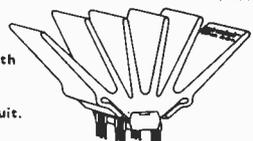
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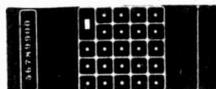
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INGENUITY UNLIMITED

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.

PSU PROTECTION

WHEN using a regulated PSU to reduce a supply voltage there is always the danger of component failure in the PSU and consequent damage to the equipment. A fuse will protect equipment when an excess of current is drawn but might be too slow to cope with overvoltage conditions.

In Fig. 1 the values shown suit a car battery supply being used to drive a battery tape recorder at 7.5V. The load requirement is 300mA and the trip voltage was set to 8V to protect the recorder in the event of regulator fault.

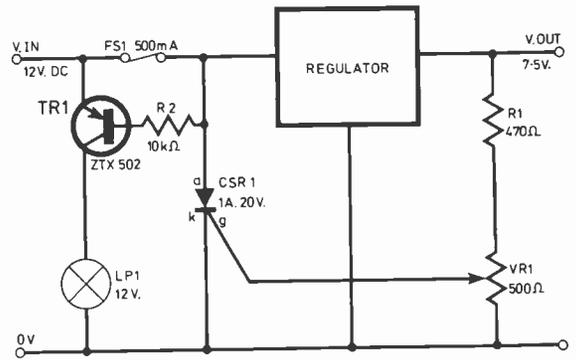


Fig. 1. Power supply protection circuit

R1 and VR1 form a potential divider which samples the output voltage as set by adjustment of VR1. The CSR1 is selected to carry at least twice the fuse rating. The full supply voltage is connected to the input of the regulator.

Transistor TR1 is held biased off by R2 and CSR1 so that the lamp LP1 is held off. If the output voltage rises above a set trip value then CSR1 will conduct, FS1 will blow and TR1 will be supplied with base current via R2 and the lamp will light up.

J. Sadler,
Cheshire.

R/C SERVO AMPLIFIER

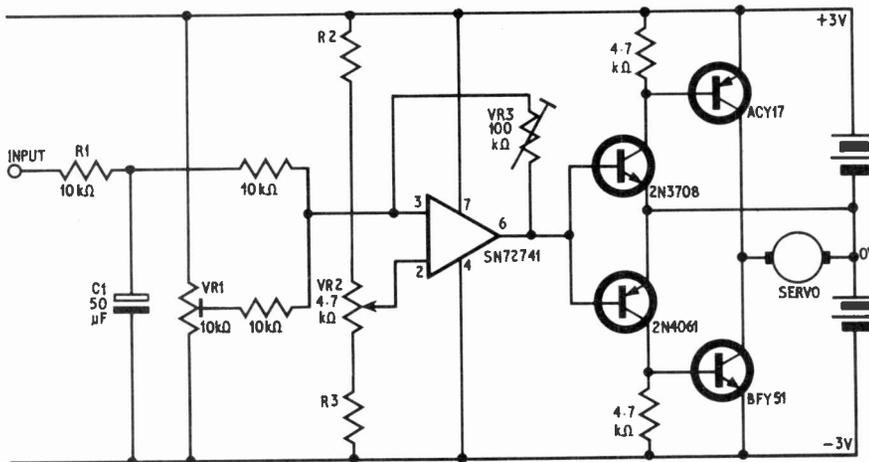


Fig. 1. Circuit diagram for the servo amplifier

A DIGITAL proportional decoder was published in the series *Logical Radio Control* (no issues available) and I have developed the following servo amplifier to go with such a device, see Fig. 1. Using a 741 operational amplifier for compactness, the circuit accepts the positive-going pulses, of variable length, from the decoder. These are integrated by R1 and C1 to give a d.c. which, using my decoder, varies from +0.2 to +1.2V.

Potentiometer VR1 is adjusted to give a value equivalent to minus the centre voltage at its wiper. In my case this is -0.7V. The 741 is used as a summation amplifier.

If VR3 is set at 10kΩ so that the gain of the 741

is unity, then the output will be $1.2-0.7V = +0.5V$ at one transmitter control extreme and $0.2-0.7V = -0.5V$ at the other. In fact, the gain is set so that the output swings $\pm 3V$.

The transistors form a current amplifier to drive the servomotor and feedback from the motor is provided via the potentiometer VR2 which is ganged to the motor. The deadband of the servo may be controlled by varying VR3 and when the optimum value is found replacing with a fixed resistor.

The values of R2 and R3 are found by experiment.
P. Skan,
Sutton Coldfield.

CAR LIGHTS MONITOR

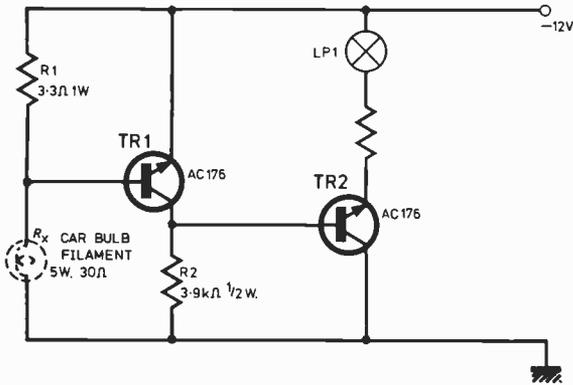


Fig. 1. Circuit diagram of the car lights monitor

PERHAPS the enclosed circuit of a car light monitor would be of interest to some of your readers. The circuit, Fig. 1, was designed to indicate the presence of a bulb failure in either the two front side lights or the two rear lights (the number plate light could also be included).

The 3.3Ω resistor R1 makes no visible difference to the bulbs light output as only approximately 1V is dropped across it. When the bulb filament R_x goes open circuit there is no forward bias to TR1 and its collector voltage rises and turns TR2 hard on, illuminating the indicator bulb LP1.

The circuit as shown will operate on positive earth cars; for negative earth cars *pnp* transistors, such as the AC128, should be used. The connecting details are shown in Fig. 2.

A wide variety of bulbs can be used in the LP1 position as long as the ratings of TR2 are not exceeded. The prototype used 6V 0.1A bulbs with 33Ω ballast resistors.

I. K. Staley,
Mansfield,
Notts.

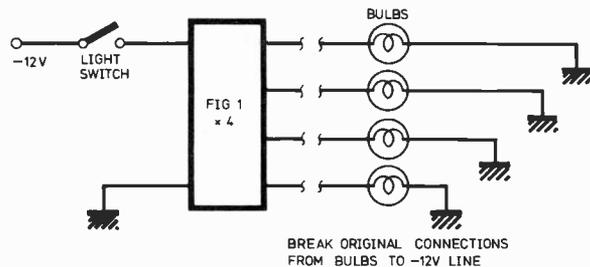
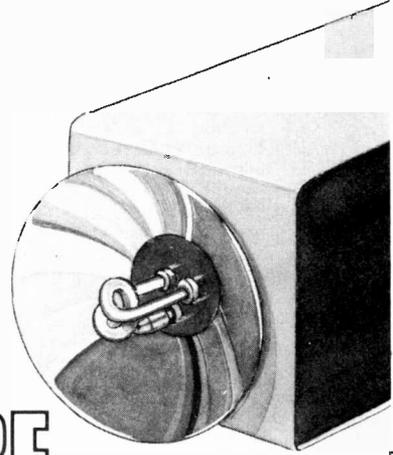


Fig. 2. Showing how the circuit is connected into the car wiring. The circuit in Fig. 1 is repeated for each light to be monitored

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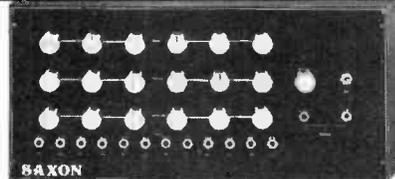
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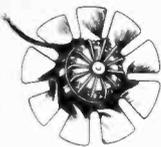
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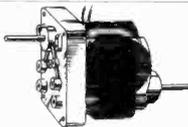
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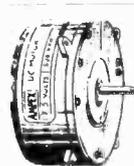
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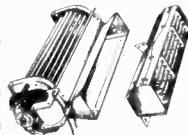


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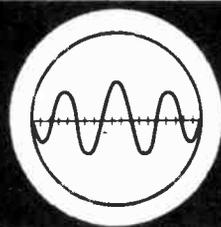
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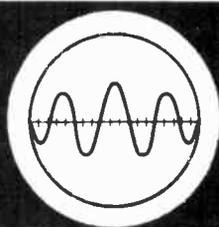
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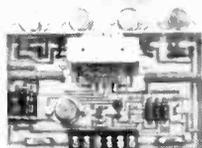
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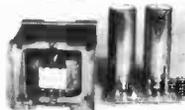
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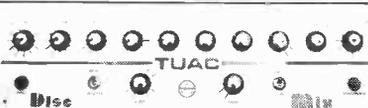
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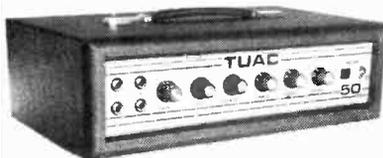
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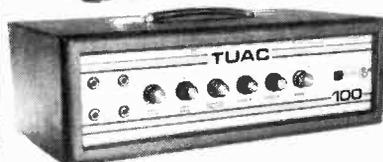


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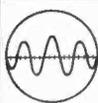
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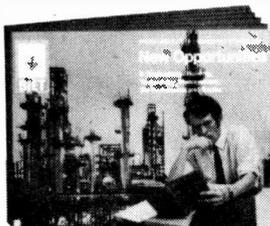
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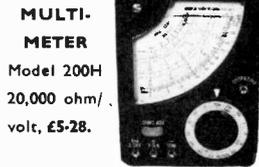
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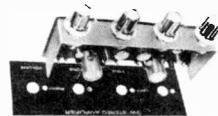


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2N696	0-150	2N2219A	0-270	2N3108	0-540	2N3636	0-120	2N4135	1-500	2N5132	0-080
2N697	0-160	2N2221	0-190	2N3109	0-540	2N3636A	0-130	2N4140	0-270	2N5133	0-080
2N699	0-340	2N2221A	0-230	2N3110	0-540	2N3639	0-200	2N4141	0-290	2N5134	0-080
2N706	0-100	2N2222	0-190	2N3117	0-850	2N3640	0-200	2N4142	0-310	2N5135	0-090
2N708	0-145	2N2222A	0-245	2N3120	0-540	2N3641	0-200	2N4143	0-320	2N5137	0-100
2N718	0-230	2N2243	0-930	2N3121	0-580	2N3642	0-150	2N4208	1-870	2N5138	0-090
2N722	0-680	2N2243A	0-930	2N3133	0-280	2N3643	0-150	2N4209	2-000	2N5139	0-090
2N744	0-180	2N2270	0-390	2N3134	0-280	2N3644	0-160	2N4227	0-300	2N5140	0-170
2N753	0-180	2N2297	0-400	2N3135	0-260	2N3645	0-160	2N4228	0-370	2N5141	0-165
2N760	0-270	2N2303	1-330	2N3136	0-280	2N3646	0-130	2N4248	0-110	2N5142	0-105
2N760A	0-270	2N2368	0-150	2N3209	0-605	2N3665	0-800	2N4249	0-130	2N5143	0-105
2N834	0-235	2N2369	0-135	2N3248	1-890	2N3686	0-950	2N4250	0-150	2N5910	0-270
2N914	0-200	2N2369A	0-170	2N3249	2-020	2N3691	0-500	2N4257	0-175	BC107	0-130
2N915	0-380	2N2483	0-210	2N3250	0-300	2N3692	0-500	2N4257A	0-230	BC108	0-420
2N916	0-300	2N2484	0-245	2N3250A	0-440	2N3693	0-150	2N4258	0-245	BC109	0-140
2N917	0-330	2N2509	0-710	2N3251	0-580	2N3694	0-150	2N4258A	0-275	BC177	0-180
2N918	0-330	2N2510	0-710	2N3251A	0-620	2N3724	1-420	2N4274	0-135	BC178	0-180
2N929	0-165	2N2511	1-130	2N3252	0-680	2N3724A	1-400	2N4275	0-135	BC179	0-180
2N929A	0-170	2N2586	1-080	2N3253	0-740	2N3725	1-425	2N4313	0-250	BC261A	0-340
2N930	0-180	2N2604	1-300	2N3299	0-340	2N3725A	1-090	2N4354	0-210	BC261B	0-340
2N930A	0-680	2N2605	0-800	2N3300	0-405	2N3734	1-470	2N4355	0-240	BC262A	0-360
2N956	0-320	2N2657	3-070	2N3301	0-285	2N3735	2-700	2N4356	0-240	BC262B	0-360
2N960	2-210	2N2658	4-000	2N3302	0-420	2N3735	0-165	2N4400	0-190	BC263A	0-380
2N995	1-080	2N2890	3-800	2N3304	0-700	2N3904	0-180	2N4011	0-240	BC263B	0-380
2N131	0-235	2N2891	3-500	2N3439	0-600	2N3905	0-175	2N4402	0-190	BCY70	0-155
2N1132	0-235	2N2894	3-220	2N3440	0-460	2N3906	0-165	2N4403	0-240	BCY71	0-220
2N1420	0-215	2N2894A	0-685	2N3444	0-830	2N3945	0-500	2N44916	0-110	BCY72	0-120
2N1613	0-180	2N2904	0-225	2N3502	0-790	2N3946	1-200	2N4970	0-160	BFX86	0-210
2N1711	0-220	2N2904A	0-255	2N3503	1-150	2N3947	0-570	2N4973	0-300	BFX89	0-240
2N1893	0-270	2N2905	0-270	2N3504	0-790	2N3962	0-380	2N4964	0-170	BFX92	0-280
2N1990	0-290	2N2905A	0-300	2N3505	0-790	2N3963	0-455	2N4965	0-170	BFX93	0-330
2N2017	0-870	2N2906	0-230	2N3545	4-500	2N3964	0-500	2N4966	0-170	BFX94	0-330
2N2102	0-375	2N2906A	0-245	2N3546	1-320	2N3965	0-780	2N4967	0-170	BFX85	0-280
2N2192	0-405	2N2907	0-210	2N3547	1-750	2N4030	0-465	2N4968	0-170	BFX86	0-230
2N2192A	0-405	2N2907A	0-220	2N3548	1-900	2N4031	0-510	2N4969	0-170	BFX87	0-230
2N2193	0-470	2N3011	0-180	2N3549	2-100	2N4032	0-530	2N4970	0-160	BFX88	0-210
2N2193A	0-470	2N3012	0-230	2N3550	2-500	2N4033	0-570	2N4971	0-340	BFY80	0-190
2N2194	0-485	2N3015	0-405	2N3563	0-130	2N4036	0-480	2N4672	0-360	BFY51	0-160
2N2194A	0-530	2N3019	0-540	2N3564	0-150	2N4037	0-460	2N5055	0-200	BFY52	0-190
2N2195	0-420	2N3020	0-580	2N3565	0-110	2N4121	1-135	2N5056	2-000	BSV38	0-210
2N2195A	0-470	2N3053	0-180	2N3566	0-130	2N4122	0-150	2N5057	1-170	BSY39	0-170
2N2217	0-275	2N3054	0-450	2N3567	0-120	2N4123	0-145	2N5127	0-110	BSY51	0-200
2N2218	0-215	2N3072	0-580	2N3568	0-170	2N4124	0-145	2N5128	0-140	BSY52	0-200
2N2218A	0-245	2N3073	0-455	2N3569	0-158	2N4125	0-160	2N5129	0-090	BSY53	0-200
2N2219	0-240	2N3107	0-540	2N3576	1-220	2N4134	1-500	2N5130	0-080	BSY54	0-260
								2N5131	0-100	BSY95A	0-130

THYRISTORS

Type No	Price	IT (RMS)	V DROM
NAS106F	0-250	4A	50
NAS106A	0-310	4A	100
NAS106B	0-360	4A	200
NAS106D	0-580	4A	400
NAS206F	0-283	6A	50
NAS206A	0-348	6A	100
NAS206B	0-405	6A	200
NAS206D	0-653	6A	400
NAS306F	0-313	8A	50
NAS306A	0-389	8A	100
NAS306B	0-450	8A	200
NAS306D	0-725	8A	400
NAS406F	0-350	10A	50
NAS406A	0-434	10A	100
NAS406B	0-504	10A	200
NAS406D	0-812	10A	400
NAS806F	0-438	16A	50
NAS806A	0-543	16A	100
NAS806B	0-630	16A	200
NAS806D	1-015	16A	400

Type No.	IF	VRM	Price
N7001	4A	50PIV	0-320
N7012	2A	100PIV	0-360
N7013	4A	200PIV	0-430
N7014	4A	400PIV	0-560
N7015	4A	600PIV	0-755
N7021	6A	50PIV	0-380
N7022	6A	100PIV	0-430
N7023	6A	200PIV	0-540
N7024	6A	400PIV	0-650
N7025	6A	600PIV	0-810

TRIACS WITH INTERNAL TRIGGERS

Type No.	Price	IT (RMS)	V DROM
NASQ1810	0-310	1-6A	100
NASQ1820	0-330	1-6A	200
NASQ1840	0-360	1-6A	400
NASQ4510	0-390	4-5A	100
NASQ4520	0-440	4-5A	200
NASQ4540	0-710	4-5A	400
NASQ6520	0-420	6-5A	100
NASQ6520	0-480	6-5A	200
NASQ6540	0-780	6-5A	400
NASQ8510	0-460	8-5A	100
NASQ8520	0-500	8-5A	200
NASQ8540	0-830	8-5A	400
NASQ10010	0-500	10A	100
NASQ10010	0-550	10A	200
NASQ10040	0-880	10A	400

2 AMP ENCAPSULATED PLASTIC BRIDGE RECTIFIERS

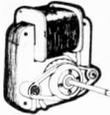
Type No.	IF	VRM	Price
N6001	2A	50PIV	0-350
N6002	2A	100PIV	0-380
N6003	2A	200PIV	0-430
N6004	2A	400PIV	0-500
N6005	2A	600PIV	0-500

PLASTIC RECTIFIER

Type No.	Price	IT (RMS)	V DROM
NAS1610	0-295	1-6A	100
NAS1620	0-314	1-6A	200

ADD 10% to order for VAT, p. & p. 15p per order.

Available from **THE RADIO SHOP**
16 CHERRY LANE, BRISTOL BS1 3NG
Tel. Bristol 421196. Open Mon.-Sat. 9.00 a.m.-5.30 p.m.



MAINS MOTOR

Precision made—as used in record decks and tape recorders—ideal also for extractor fan, blower, heaters, etc. New and perfect. Snip at 75p. Postage 20p for first one then 10p for each one ordered.

MUSIC ON TAPE

A further buy enables us to offer these at an even lower price—namely 65p each or 5 for £2.50. Send for list of titles. We can't repeat when sold out.

BALANCED ARMATURE UNIT

500 ohm, operates as speaker or microphone, so useful in intercom or similar circuits, 37p each, 10 for £3.78.



CAR ELECTRIC PLUG

Fits in place of cigarette lighter. Useful method for making a quick connection into the car electrical system, 85p each or 10 for £3.42.



12 VOLT 1 1/2 AMP POWER PACK

This comprises double-wound 230/240V mains transformer with full wave rectifier and 2000 mF smoothing. Price £2.20, plus 20p post & packing.



Heavy Duty Mains Power Pack. Output voltage adjustable from 15-40V in steps—maximum load 250W—that is from 6 amp at 40V to 15amp at 15V. This really is a high power heavy duty unit with dozens of workshop uses. Output voltage adjustment is very quick—simply interchange push on leads. Silicon rectifiers and smoothing by 3,000mF. Price £2.35 plus 65p post.

BAKELITE INSTRUMENT CASE

Size approx. 6 1/2" x 3 1/2" x 2" deep with brass inserts in four corners and bakelite panel. This is a very strong case suitable to house instruments and special rigs, etc. Price, 50p each. Paxolin lid 11p extra.



MINIATURE WAFER SWITCHES

2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole 6 way—1 pole, 12 way. All at 25p each.



CONNECTING WIRE

7-0076 Copper conductors. 500 metre drums available in the following colours: Red/Brown, Yellow, Green/Grey, Blue/Green, Red/Orange, Green/White, Grey/White, Blue/Orange, Brown/Red, Brown/White, Red/Grey, Blue/Grey, Blue/Brown. Price £2.20 per drum plus 40p post. State alternative colours.

Screened Cable. 70076 core suitable for pick up or mic lead or for inter-connecting amplifiers. 10 metres. 35p.

DOOR SWITCH

As fitted to refrigerators, etc. Switches off as door closes. White 17p each. Black 15p each.

MICRO SWITCH

5 amp changeover contacts, 11p each. 10 for 99p. 15 amp on/off. Model 16p each. Changeover 18p each.



U.V. LIGHTING

Useful for flaw detection in metals and for looking for water marks, etc., also for fitting over tropical fish tanks—African violets and other indoor plants which must have U.V. for healthy growth. The outfit comprises of a 12in U.V. tube—choke—starter holder and tube ends. Price £2.20 plus 20p post.

80 WATT TUBULAR ELEMENTS

Brass encased with beaded flex ends. Standard replacements in most absorption type refrigerators but also has dozens of other uses. 83p each.

SPIT MOTOR

200-250V Induction Motor, driving a Carter gear box with 1 1/2in. of output drive shaft running at 5 revs per minute.

Intended for roasting chickens. Also suitable for driving models—windmills, coloured disc lighting effect, etc., etc. £2.04 plus 20p post and insurance.



SWITCH TRIGGER MATS

So thin is undetectable under carpet but will switch on with slightest pressure. For burglar alarms, shop doors, etc. 24in x 18in £1.99. 13in x 10in £1.21.

ROCKER SWITCH

13 amp self-fixing into an oblong hole. Size approximately 1" x 1" 9p each, 10 for 82p.



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 ether connection and over-load 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 2kW elements at 240V. Price £1.38 each.

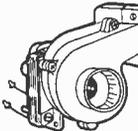


MULLARD AUDIO AMPLIFIERS

All in module form, each ready built complete with heat sinks and connection tags, data supplied. Model 1133 300mW power output 72p. Model 1172 750mW power output 84p. Model EP9000 4 watt power output £1.66. (Triplex DLY STEREO. Complete £11.30.

CENTRIFUGAL BLOWER

Miniature mains driven blower centrifugal type blower unit by Woods. Powerful but specially built for quiet running—driven by cushioned induction motor with specially built low noise bearings. Overall size 4 1/2" x 4 1/2" x 4". When mounted by flange, air is blown into the equipment but to suck air out, mount it from centre using clamp. Ideal for cooling electrical equipment or fitting into a cooker hood, film drying cabinet or for removing flux smoke when soldering etc. A real bargain at £2.05.



MIGHTY MIDGET

Probably the tiniest possible radio, as described in Practical Wireless, 4 January 73. All electronic parts £2.20 post paid.

TAPE PLAYBACK UNITS

Mains operated. Made by Reditune the famous "music in the background people". These are complete units for playing tape at standard speed (3 1/2"). These have a superior motor driven fly wheel to control the tape through the capstan and also an even equalizer useful valve amplifier with EL84 output. In a steel case with carrying handle. Tested and in good working order £2.50 or some in need of repair but complete £3.50. Cassettes of tape pre-recorded £1.10 (please state type of music required) 75p cartridge up to 200 miles then 50p per 100 miles extra.



6 MAINS TRANSFORMERS

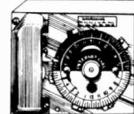
Our Ref: MTM1 27V at 8A. Upright mounting fully shrouded—flying leads—fully tapped primary. Price £3.30.
Our Ref: MTM2. 12V at 1A. Upright mounting with fixing lugs, tag connections. 240V Primary—12V 1A secondary. Price 85p.
Our Ref: MTM3. 6-3V 2A upright mounting with fixing lugs, tag connections. 240V Primary 6-3V 2A secondary. Price 77p.
Our Ref: MTM4. 18V—1A with thermal cut-out, upright mounting with fixing lugs—tag connections. Primary 240V—secondary 18V at 1A. Price 85p.
Mains Isolation, 350W earth shielded—flex leads—upright mounting lugs for fixing terminals for output. Price £2.50 each.
Mains Transformer Bargain. Standard mains 240V input. Secondary 2-4V 9A intermittent 5A continuous. Price 55p.

DISTRIBUTION PANELS

Just what you need for work bench or lab. 4 x 13 amp sockets in metal box to take standard 13 amp fused plugs and on/off switch with neon warning light. Supplied complete with 7 feet of heavy cable. Wired up ready to work. £2.50 plus 20p post and insurance.

24-HOUR TIME SWITCH

Made by Smiths, these are A.C. mains operated, NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. Two completely adjustable time periods per 24 hours, 5A changeover contacts will switch circuit on or off during these periods. £2.75 post and ins. 25p. Additional time contacts 55p pair.



THYRISTOR LIGHT DIMMER

For any lamp up to 1kw. Mounted on switch plate to fit in place of standard switch. Virtually no radio interference. Price £2.95, plus 20p post and insurance. Industrial model 5A £3.30. Not on plate.



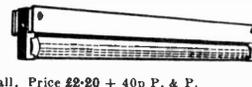
THIS MONTH'S SNIP

WALL THERMOSTATS

Made by the famous Smiths Instrument Co. called Colourstat. Wall mounting and in a handsome plastic case (cream and beige). Adjustable by slider (lockable) and may be set to control temperatures from around freezing through to 50°C. The slide panel is engraved and indicates "frost", "warm", "very warm", etc. The thermostat will control heaters, etc., up to 15A at normal mains voltage and is ideal for living room, bed room and greenhouse, etc. Price £1.65. Don't miss this.

THE TWENTYLITE

Fluorescent lighting units with polyester choke and finished white enamel. 2ft. model, ideal kitchen, bedroom, hallway, porch, lift, etc., with tube. Assembled ready to install. Price £2.20 + 40p P. & P.



10 AMP. DIMMER/CONTROLLER

For the control of lighting of stage or studio or portable equipment in workshops, etc. This has socket outlets each controlled by 5 AMP Solid State Regulator. Also fitted with master switch fuse and neon indicator and terminating with 6 feet of flex. Overall length 17in. 3 1/2in. x 1 1/2in. deep. £7.50 plus 25p P. & P.

TANGENTIAL HEATER UNIT

This heater unit is the very latest type, most efficient, and quiet running. Is as fitted in cooler and blower heaters costing £15 and more. We have a few only. Comprises motor, impeller, 2kW element and 1kW element allowing switching 1, 2 and 3kW and with thermal safety cut-out. Can be fitted into any metal line case or cabinet. Only needs control switch. £2.85. 2kW Model as above except 2kW £2.75. Don't miss this. Control Switch 44p. P. & P. 40p.



TERMS: 10% discount if ten of an item ordered, send postage where quoted—other items, post free if order for these items is £6.00, otherwise add 20p.

Voltage Changing Transformers made by Parmeko. Upright mounting, fully shrouded and with terminal blocks for input and output. For changing mains voltage, ideal for working low voltage equipment from 230/240 mains and for increasing voltage due to losses in long leads. Voltage up or down between 190-250V 250W. Price £1.65 plus 30p post, etc.

Door Opening or Platform Rotating Motors. Very powerful motors estimated rating at 1/2 h.p. Reversible with gearbox and "V" belt drive wheel of 7in diameter. Price of motor which weighs approx. 15lb is £10. Note. These are ex-equipment but guaranteed for six months.

Gas and Smoke detector/Sensor—ref. GD1— recently referred to as the electronic nose—£2 each; circuit of smoke detector alarm included. Constructional details appeared in September's Practical Wireless, so we can supply the SLO3D at £1.75, the ZN414 at £1.35, also most other items, send for PC 10 radio parts list.

Spring Return Water Switch. As used in intercom and other similar equipment a two water 6 pole 3 way switch, spring return from centre position when turned clockwise and permanent off or on when turned anti-clockwise. Price 55p each.

A.C. Buzzers. 12V. Fix these into a box which will resonate and they will give a loud piercing note. Suitable for alarms or signal. 33p each.
Push-on Tag Connectors. These are being increasingly used on cars and domestic appliances. 2 sizes prevail, the most popular being for 3in tag. We offer these at attractive prices. 10 for 10p; 50 for 40p; 100 for 70p; 1,000 for 55p.
4 Minute Timed On Switch by Smiths. Our ref. TS AU1. This is for processing photographic plates, etc. Has a scale graduated 0-4min. Turn the pointer knob, and set it at the desired time—switch will stay closed until pointer knob returns to zero. Clockwork motor, so can be independent of mains if desired, but the switch itself is double pole, rated 250V, 15Amps. Price £1.65.

One Hour Timed On Switch by Smiths. Our ref. TS AU2. As TS AU1 except that the complete rotation of the pointer knob lasts for 1hr. Price £1.10 each.



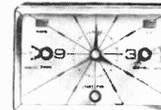
DRILL CONTROLLER NEW IKW MODEL

Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. £1.95. 13p post and p. Made up model also available. £2.95.

MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6v, 9v, 12v volts 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.

Stereo Pre-amp Module. Mullard ref. LP 7182/2—transistors and all ancillary components mounted on PC board £1.32 with connection dig.



15A ELECTRICAL PROGRAMMER

Learn in your sleep! Have radio playing and kettle boiling as you awake—switch on lights to ward off intruders—have a warm house to come home to. All these and many other things you can do if you invest in an electrical programmer. Clock by famous maker with 15 amp on/off switch. Switch-on time can be set anywhere to stay on up to 6 hours. Independent 60 minute memory jogger. A beautiful unit. Price £2.15 + 20p p. & p. or with glass front chrome bezel 83p extra.

THERMAL CUTOUT

A miniature device 2in dia. on one screw fixing mount—can be used for motor overload protection, fire alarm, soldering iron, switch off, etc., etc. 15 amp contacts open with flame—radiant or conducted heat. 11p each or 10 for 99p.

HONEYWELL PUSH BUTTON MICRO SWITCHES

As used in some vending machines, etc. Each switch is a changeover type rated at 15A 250V a.c. Intended for panel mounting with fixing nuts and single black push knob. Single changeover switch 28p, Double switch 42p, Triple switch 61p.

MACLAREN THERMOSTAT

Make and break 20A a.c. with the sensor probe coupled by 2 feet capillary covering range of 10-100°C—complete with large engraved control knob. Price 85p.

J. BULL (ELECTRICAL) LTD.

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

G.W. SMITH & CO (RADIO) LTD

AUDIOTRONIC MODEL ATM.1

Top value 1,000 o.p.v. pocket multimeter. Ranges: 0/10/50/250/1,000V. A.C. and D.C. D.C. Current 0-1mA/100mA. Resistance: 0/150K ohms. Decibels: -10 to +22dB. Size: 90 x 60 x 28mm. Complete with test leads. £2-95. Post 15p.



Model 9-100TR MULTIMETER/TRANSISTOR

TESTER. 100,000 O.P.V. mirror scale/overload protection. 0/0-120/0-12/230/120/600V d.c. 0/6/30/120/600V a.c. 0/12/600µA/12/300mA/12 amp. d.c. 0/10 KΩ/1 MΩ/100 MΩ. -20 to +50dB. 0-01-2 MFD. Transistor tester measures Alpha, beta and Ico. Complete with batteries, instructions and leads. £14-95. 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 100µA/1/10/100mA/1A. Resistance 300 ohms/300/300K/3MΩ. Complete with batteries, test leads, instructions and sturdy steel carrying case. OUR PRICE £4-95. Post 25p.



LB3 TRANSISTOR TESTER

Tests ICO and B. Pnp/npn. Operates from 9V battery. Complete with all instructions, etc. £3-95. Post 20p.



LB4 TRANSISTOR TESTER

Tests PNP or NPN transistors. Audit indicator operates on two 1.5V batteries. Complete with all instructions, etc. £4-50. Post 20p.



MODEL 500 30,000 O.P.V.

with overload protection 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. 0/50µA/5/50/500mA. 12 amp. d.c. 0/60K/6 Meg/60 MegΩ. £10-50. Post paid. Leather case £1-75.



MODEL 449A IN CIRCUIT TRANSISTOR TESTER

Checks true a.c. beta in/out. Checks Ico. Checks diodes in/out. Checks SCR, etc. Beta Ht 10-300 LO 10-50 Ico 0-5000µA. 220/240V a.c. operation. £17-50. Post 25p.



U4312 MULTIMETER

Extremely sturdy instrument for general electrical use. 667 O.P.V. 0/0-3/1-5/7-5/30/60/150/300/600/900V d.c. and 750V. 0/0-3/1-5/7-5/30/60/150/300/600/900V a.c. 0/300µA/1-5/6/15/60/150/600mA/1-5/6 amp. d.c. 0/1-5/15/60/150/600MA. 1-5 amp. a.c. 0/200/3/3k/30kΩ. Accuracy Knife edge meter, mirror scale. Complete with sturdy metal carrying case, leads and instructions. £9-75. Post 25p.



KAMODEN HM-350 TRANSISTOR TESTER

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



HIOKI MODEL 700X

100,000 O.P.V. Overload protection. Mirror scale. 0/30-6/1-2/1-5/8/6/12/30/60/120/300/600/1,200V d.c. 1-5/3/8/12/30/60/150/300/600/1,200V a.c. 0/30µA/3/6/30/60/150/300mA. 0/12 amp. d.c. 2K/200K/2 Meg/20 Meg ohm -20 to +63dB. £14-95. Post 20p.



MODEL C-7080 EN

Giant 6in mirror scale. 20,000 O.P.V. 0/0-3/2-5/10/50/250/1,000/5,000V d.c. 0/2-3/10/50/250/1,000/5,000V a.c. 0/50µA/1/10/100/500mA/10 amp. d.c. 0/2K/200K/20 meg. -20 to +50dB. £13-95. Post 50p.



370 WTR MULTIMETER

Features a.c. current ranges. 20,000 O.P.V. 0/0-3/2-5/10/50/250/500/1,000V d.c. 0/2-5/10/50/250/500/1,000V a.c. 0/50µA/1/10/100mA/1/10 amp. d.c. 0/100mA/1/10 amp. a.c. 0/5K/50K/500K/5MΩ/50MEG. -20 +62dB. £17-50. Post 25p.



TMK LAB TESTER

100,000 O.P.V. 6 1/2in scale buzzer short circuit check. Sensitivity: 100,000 OPV d.c. 5/Volt a.c. D.C. volts: 0-5, 2-5, 10, 50, 250, 1,000V. A.C. volts: 3, 10, 50, 250, 500, 1,000V. D.C. current: 10, 100µA, 10, 100, 500mA, 2, 5, 10A. Resistance: 1K, 10K, 100K, 10 meg. 100 meg. Decibels: -10 to +49dB. Plastic case with carrying handle, size 7 1/2in x 6 1/2in x 3 1/2in. £19-95. P. & P. 25p.



MODEL U4311 SUB-STANDARD MULTI-RANGE VOLT AMPMETER

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



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

Input impedance 10MΩ. Ranges: 0/0-25/1/2-5/10/50/250/1,000V d.c. 0/2-5/10/50/250/1,000V a.c. 0/25µA/2-5/25/250µA d.c. -20 to +63dB. 0/5K/50K/500K/5MΩ/500MΩ. £14-95. Post 30p.



TE-40 HIGH SENSITIVITY A.C. VOLTMETER

10 meg. input 10 ranges: 0/1-003/1-3/1-3/10/30/100/300V. R.M.S. 4cps.-1-2 Mc/s. Decibels -40 to +50dB. Supplied brand new complete with leads and instructions. Operation 230V. a.c. £17-50. Carr. 25p.



TMK MODEL 117 P.E.T. ELECTRONIC VOLTMETER

Battery-operated, 11 meg. input. 26 ranges. Large 4 1/2in mirror scale. Size 5 1/2in x 4 1/2in x 2 1/2in. D.C. volts 0-3-1,200V. A.C. volts 5-300V R.M.S. 8-0-800V P-P. D.C. Current 0-12-12MA. Resistance up to 2,000M ohm. Decibels -20 to +51dB. Complete with leads/instructions. £17-50. P. & P. 20p.



KAMODEN HMG-500 INSULATION RESISTANCE TESTER

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



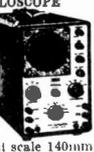
MODEL TE15 GRID DIP METER

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



TO-3 PORTABLE OSCILLOSCOPE

8in tube, Y amp. Sensitivity 0-1V p-p/CM. Bandwidth 1-3cps-1.5MHz. Input imp. 2 meg Ω 25pF X amp. sensitivity 0-9V. p-p/CM. Bandwidth 1-3cps-800KHz. Input imp. 2 meg Ω 20pF. Time base 5 ranges 10cps-300KHz Synchronisation. Internal/external. Illuminated scale 140mm x 215mm x 330mm. Weight 15 1/2lb. 220/240V a.c. Supplied brand new with handbook. £52-50. Carr. 50p.



CI-5 PULSE OSCILLOSCOPE

For display of pulsed and periodic waveforms in electronic circuits. VERT. AMP. Bandwidth 10MHz. Sensitivity at 100KHz V RMS/mm. 0-1-25; HOR. AMP. Bandwidth 500KHz. Sensitivity at 100KHz. V RMS/mm. 0-2-25; Pre-set triggered sweep 1-3,000µsec.; free running 20-200,000Hz in nine ranges. Calibrator pips. 220mm x 360mm x 430mm, 115-230V a.c. operation. £39. Carr. paid.



RUSSIAN CI-18 DOUBLE BEAM OSCILLOSCOPE

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



TE-202 RF SIGNAL GENERATOR

Accurate wide range signal generator covering 10 bands. Directly calibrated. Variable R.F. attenuator audio output, Xtal socket for calibration. 220/240V a.c. Brand new with instructions. £17-50. Carr. 37p. Size 140mm x 215mm x 170mm.



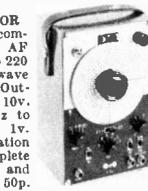
TE22 SINE SQUARE WAVE AUDIO GENERATORS

Size: 20cs to 200 kc/s on 4 bands. Square: 20cs to 30 kc/s. Output impedance 5,000 ohms. 200/250V a.c. Supplied brand new and guaranteed with instruction manual and leads. £17-50. Carr. 37p.



ARF-300 AFRF 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.



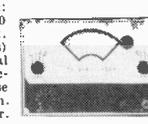
MODEL AT201 DECADE ATTENUATOR

Frequency range 0-200KHz. Attenuator 0-111dB. 0-1dB step. Impedance 600 ohms. Max. Input power 30dBm. Size 180mm x 90mm x 55mm. £12-50. Post 37p.



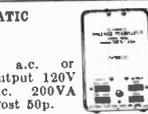
BELCO AF-5A SOLID STATE SINE SQUARE WAVE C.R. OSCILLATOR

Sine 18-200,000 Hz. Square 18-50,000 Hz. Output max. +10dB (10K ohms) Operation internal batteries. Attractive 2-tone case 7 1/2in x 5in x 2in. Price £17-50. Carr. 17p.



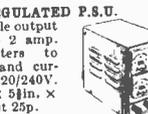
MCA.220 AUTOMATIC VOLTAGE STABILISER

Input 88-125V a.c. or 176-250V a.c. Output 120V a.c. or 240V a.c. 200VA rating. £11-97. Post 50p.



PS.200 REGULATED P.S.U.

Solid state. Variable output 5-20V d.c. up to 2 amp. Independent meters to monitor voltage and current. Input 220/240V. a.c. Size 7 1/2in x 5 1/2in x 3 1/2in. £19-95. Post 25p.



PS.100B REGULATED POWER SUPPLY

Solid state. Output 6, 9 or 12V d.c. up to 3 amps. Meter to monitor current. Input 220/240V a.c. Size 4in x 3 1/2in x 3 1/2in. £11-97. Post 25p.



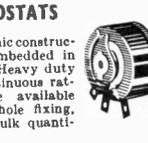
230V/240V SMITHS SYNCHRONOUS GEARED MOTORS

Built in gearbox. All brand new and boxed. 30 RPH CW; 2 RPH CW; 20 RPH CW; 2 RPH ACW; 30 RPH CW. 50p each, Post 12p.



POWER RHEOSTATS

High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Wide range available ex-stock. Single hole fixing, 1/2in dia. shafts. Bulk quantities available.



25 WATT. 10/25/50/100/250/500/1000 ohms. 95p. P. & P. 10p.

60 WATT. 10/25/50/100/250/500/1000/2500 or 5000 ohms. £1-25. P. & P. 10p.

100 WATT. 1-5/10/25/50/100/250/500/1000 or 2500 ohms. £1-95. P. & P. 15p.

240° Wide Angle Ima Meters

MW1-6 60mm square £3-97
MW1-8 80mm square £4-97
Post extra



ALL PRICES ARE SUBJECT TO 10% VAT

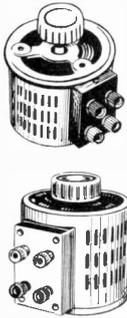


HIGH QUALITY CONSTRUCTION KITS
 Appointed stockists at all branches
 Complete with comprehensive, easy to follow instructions, and covered by full guarantee.
 Post and packing 15p per kit

- AF20 Mono transistor amplifier..... £2.80
- AF30 Mono transistor pre amplifier..... £2.81
- AF310 Mono amplifier for two for stereo..... £3.31
- ATS Automatic light control..... £2.58
- AT30 Photo cell switching unit..... £3.70
- AT50 450W Trac light dimmer/switch control..... £3.32
- AT55 1 300W Trac light dimmer/switch control..... £3.70
- AT56 2 200W Trac light dimmer/switch control..... £3.90
- AT80 Psychedelic light control..... £7.80
- AT86 Psychedelic light control 3 channel..... £14.95
- HF61 Medium wave transistor radio..... £3.32
- HF67 FM transistor receiver..... £2.86
- HF310 FM tuner unit..... £16.81
- HF328 On line FM tuner unit..... £24.12
- HF330 Stereo decoder for HF310/HF325..... £9.96
- HF396 Aerial amplifier for AM/FM bands I, II, III..... £11.77
- OP310 Stereo preamp for use with 2x AF310..... £21.27
- GU330 Tremolo unit for guitars etc..... £7.50
- NT10 Power supply 100 mA 9V stab. 12V unstab..... £8.15
- NT300 Professional stereo power supply..... £12.51
- NT30 2x 30 Volt, 2.2 Amp..... £12.51
- NT305 Transistor converter 12/15V AC/DC to 6V, 7.5V or 9V DC..... £4.50
- NT310 Power supply 240V AC to 2x 18V DC at 2 Amps..... £4.80
- NT315 Power supply 240V AC to 4x 1.5V DC 500 mA..... £9.57

"YAMABISHI" VARIABLE VOLTAGE TRANSFORMERS

Excellent quality at low cost. All models—Input 230V. 50/60 c/s. Variable output 0-260V.



MODEL S-260 GENERAL PURPOSE BENCH MOUNTING

- 1 amp..... £7.00
- 2 amp..... £8.05
- 5 amp..... £11.75
- 8 amp..... £15.90
- 10 amp..... £22.50
- 12 amp..... £23.60
- 20 amp..... £29.00
- 25 amp..... £38.00
- 40 amp..... £52.00

MODEL S-260B

- Panel mounting
- 1 amp..... £7.00
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Carriage and Packing Extra

AUTO TRANSFORMERS

0/116/230V. Step up or step down. Fully shrouded.

- | | | |
|-------|--------|---------------|
| 50W | £2.95 | P. & P. 18p |
| 150W | £3.20 | P. & P. 18p |
| 300W | £4.00 | P. & P. 23p |
| 500W | £5.80 | P. & P. 33p |
| 1000W | £8.25 | P. & P. 38p |
| 1500W | £11.25 | P. & P. 43p |
| 2250W | £19.00 | P. & P. 50p |
| 5000W | £40.00 | P. & P. 1£1.8 |



230 VOLT A.C. 50 CYCLES RELAYS

Brand new. 3 sets of changeover contacts at 5 amp rating. 50p each. Post 10p (100 lots £3.0) Quantities available.



REFLEX HORN SPEAKER RUM.6

Built in driver unit. Impedance 16 ohm. Power rating 10W. Response 380-7,000Hz. Approx. size 6in x 6in. Weatherproof and shock proof.

OUR PRICE £4.97 P. & P. 30p

BVD.5 VERNIER TUNING DIAL

Approx. 7-1 ratio planetary drive vernier dials. Log scale 0-180 degrees. Blank scales 1 to 5. Scale width 4in. Dial size 3in x 3in. Overall size 7 1/2in x 4 1/2in x 1 1/2in deep including knob and coupling. 1in dia. shaft.



OUR PRICE £1.62 P. & P. 15p

1021 STEREO LISTENING STATION



For balancing and gain selection of loudspeakers with additional facility for stereo head-phones. 2 gain controls. Stereo speaker-on-off slide switch, stereo headphone sockets 6in x 4in x 2 1/2in.

OUR PRICE £2.25 P. & P. 20p

AUDIOTRONIC AHA101 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 5V/100mV. Output 50mW per channel.

OUR PRICE £7.50 P. & P. 20p

EA.41 REVERBERATION AMPLIFIER



Self contained, transistorised, battery operated. Simply plug in microphone, 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.

OUR PRICE £7.50 P. & P. 15p

MP7 MIXER PREAMPLIFIER



Microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. 9 1/2in x 5in x 3in. Inputs: Micro 3 x 3mV 20K, 2 x 2mV 400 ohm. Phono mag. 4mV 50K. Phono ceramic 100mV 1 meg. Output 250mV 100K.

OUR PRICE £8.97 P. & P. 20p

Send S.A.E. for new 8-page list of Semiconductors and Valves

ALL PRICES ARE SUBJECT TO 10% V.A.T.

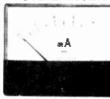


SEW CLEAR PLASTIC PANEL METERS

USED EXTENSIVELY BY INDUSTRY, GOVT. DEPTS., EDUCATIONAL AUTHORITIES, ETC.
 Over 200 ranges in stock—other ranges to order. Quantity discounts available.
 Send for fully illustrated brochure.

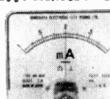
TYPE 8W.100 100mm x 80mm Fronts

50µA.....	£4.15	100µA.....	£4.25
500µA.....	£3.95	1mA.....	£3.95
1000µA.....	£3.95	5mA.....	£3.70
5000µA.....	£3.70	10mA.....	£3.60
10mA.....	£3.60	50V d.c.....	£3.60
50V d.c.....	£3.60	300V d.c.....	£3.60
300V d.c.....	£3.60	1 amp. d.c.....	£3.60



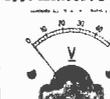
TYPE MR.85P. 4 1/2in. x 4 1/2in. Fronts

50mA.....	£3.90	100mA.....	£3.90
500mA.....	£3.90	1 amp.....	£3.90
5 amp.....	£3.90	15 amp.....	£3.90
30 amp.....	£3.95	20V d.c.....	£3.90
50V d.c.....	£3.90	50V d.c.....	£3.90
50V d.c.....	£3.90	300V d.c.....	£3.90
300V d.c.....	£3.90	100µA.....	£4.40
100µA.....	£4.40	50-0-50µA.....	£4.25
50-0-50µA.....	£4.25	100µA.....	£4.25
100-0-100µA.....	£4.05	300µA.....	£3.90
300µA.....	£3.90	5000-500µA.....	£3.90
5000-500µA.....	£3.90	1mA.....	£3.90
1mA.....	£3.90	10-1mA.....	£3.90
10-1mA.....	£3.90	5mA.....	£3.90
5mA.....	£3.90	10mA.....	£3.90



TYPE MR.38P. 1 21/32in. square Fronts.

200mA.....	£2.85	300mA.....	£2.85
500mA.....	£2.85	750mA.....	£2.85
1 amp.....	£2.85	2 amp.....	£2.85
5 amp.....	£2.85	10 amp.....	£2.85
3V d.c.....	£2.85	10V d.c.....	£2.85
15V d.c.....	£2.85	20V d.c.....	£2.85
50V d.c.....	£2.85	100V d.c.....	£2.85
100-0-100µA.....	£2.40	50V d.c.....	£2.85
50V d.c.....	£2.85	100V d.c.....	£2.85
100V d.c.....	£2.85	150V d.c.....	£2.85
150V d.c.....	£2.85	500V d.c.....	£2.85
500V d.c.....	£2.85	750V d.c.....	£2.85
750V d.c.....	£2.85	15V a.c.....	£2.85
15V a.c.....	£2.85	50V a.c.....	£2.85
50V a.c.....	£2.85	150V a.c.....	£2.85
150V a.c.....	£2.85	300V a.c.....	£2.85
300V a.c.....	£2.85	500V a.c.....	£2.85
500V a.c.....	£2.85	8 Meter 1mA.....	£2.80
8 Meter 1mA.....	£2.80	500µA.....	£2.85
500µA.....	£2.85	100µA.....	£2.85
100µA.....	£2.85	50µA.....	£2.85



TYPE SD.880 82.5mm x 110mm Fronts

10mA.....	£3.10	50mA.....	£3.10
50mA.....	£3.10	100mA.....	£3.10
100mA.....	£3.10	500mA.....	£3.10
500mA.....	£3.10	1 amp.....	£3.10
1 amp.....	£3.10	5 amp.....	£3.10
5 amp.....	£3.10	10 amp.....	£3.10
10 amp.....	£3.10	5V d.c.....	£3.10
5V d.c.....	£3.10	10V d.c.....	£3.10
10V d.c.....	£3.10	20V d.c.....	£3.10
20V d.c.....	£3.10	50V d.c.....	£3.10
50V d.c.....	£3.10	300V d.c.....	£3.10
300V d.c.....	£3.10	15V a.c.....	£3.30
15V a.c.....	£3.30	300V a.c.....	£3.30
300V a.c.....	£3.30	5mA.....	£3.30
5mA.....	£3.30	10mA.....	£3.30
10mA.....	£3.30	50µA.....	£3.40
50µA.....	£3.40	50-0-50µA.....	£3.40
50-0-50µA.....	£3.40	100µA.....	£3.35
100µA.....	£3.35	100-0-100µA.....	£3.35
100-0-100µA.....	£3.35	200µA.....	£3.35
200µA.....	£3.35	500µA.....	£3.35
500µA.....	£3.35	1mA.....	£3.35
1mA.....	£3.35	5mA.....	£3.35
5mA.....	£3.35	10mA.....	£3.35
10mA.....	£3.35	50V d.c.....	£3.35
50V d.c.....	£3.35	300V d.c.....	£3.35
300V d.c.....	£3.35	15V a.c.....	£3.30
15V a.c.....	£3.30	300V a.c.....	£3.30
300V a.c.....	£3.30	100mA.....	£3.30
100mA.....	£3.30	500µA.....	£3.30
500µA.....	£3.30	1mA.....	£3.30
1mA.....	£3.30	5mA.....	£3.30
5mA.....	£3.30	10mA.....	£3.30
10mA.....	£3.30	50V d.c.....	£3.30
50V d.c.....	£3.30	300V d.c.....	£3.30
300V d.c.....	£3.30	15V a.c.....	£3.30
15V a.c.....	£3.30	300V a.c.....	£3.30
300V a.c.....	£3.30	100µA.....	£3.30
100µA.....	£3.30	500µA.....	£3.30
500µA.....	£3.30	1mA.....	£3.30
1mA.....	£3.30	5mA.....	£3.30
5mA.....	£3.30	10mA.....	£3.30
10mA.....	£3.30	50V d.c.....	£3.30
50V d.c.....	£3.30	300V d.c.....	£3.30
300V d.c.....	£3.30	15V a.c.....	£3.30
15V a.c.....	£3.30	300V a.c.....	£3.30
300V a.c.....	£3.30	100µA.....	£3.30
100µA.....	£3.30	500µA.....	£3.30
500µA.....	£3.30	1mA.....	£3.30
1mA.....	£3.30	5mA.....	£3.30
5mA.....	£3.30	10mA.....	£3.30
10mA.....	£3.30	50V d.c.....	£3.30
50V d.c.....	£3.30	300V d.c.....	£3.30
300V d.c.....	£3.30	15V a.c.....	£3.30
15V a.c.....	£3.30	300V a.c.....	£3.30
300V a.c.....	£3.30	100µA.....	£3.30
100µA.....	£3.30	500µA.....	£3.30
500µA.....	£3.30	1mA.....	£3.30
1mA.....	£3.30	5mA.....	£3.30
5mA.....	£3.30	10mA.....	£3.30
10mA.....	£3.30	50V d.c.....	£3.30
50V d.c.....	£3.30	300V d.c.....	£3.30
300V d.c.....	£3.30	15V a.c.....	£3.30
15V a.c.....	£3.30	300V a.c.....	£3.30
300V a.c.....	£3.30	100µA.....	£3.30
100µA.....	£3.30	500µA.....	£3.30
500µA.....	£3.30	1mA.....	£3.30
1mA.....	£3.30	5mA.....	£3.30
5mA.....	£3.30	10mA.....	£3.30
10mA.....	£3.30	50V d.c.....	£3.30
50V d.c.....	£3.30	300V d.c.....	£3.30
300V d.c.....	£3.30	15V a.c.....	£3.30
15V a.c.....	£3.30	300V a.c.....	£3.30
300V a.c.....	£3.30	100µA.....	£3.30
100µA.....	£3.30	500µA.....	£3.30
500µA.....	£3.30	1mA.....	£3.30
1mA.....	£3.30	5mA.....	£3.30
5mA.....	£3.30	10mA.....	£3.30
10mA.....	£3.30	50V d.c.....	£3.30
50V d.c.....	£3.30	300V d.c.....	£3.30
300V d.c.....	£3.30	15V a.c.....	£3.30
15V a.c.....	£3.30	300V a.c.....	£3.30
300V a.c.....	£3.30	100µA.....	£3.30
100µA.....	£3.30	500µA.....	£3.30
500µA.....	£3.30	1mA.....	£3.30
1mA.....	£3.30	5mA.....	£3.30
5mA.....	£3.30	10mA.....	£3.30
10mA.....	£3.30	50V d.c.....	£3.30
50V d.c.....	£3.30	300V d.c.....	£3.30
300V d.c.....	£3.30	15V a.c.....	£3.30
15V a.c.....	£3.30	300V a.c.....	£3.30
300V a.c.....	£3.30	100µA.....	£3.30
100µA.....	£3.30	500µA.....	£3.30
500µA.....	£3.30	1mA.....	£3.30
1mA.....	£3.30	5mA.....	£3.30
5mA.....	£3.30	10mA.....	£3.30
10mA.....	£3.30	50V d.c.....	£3.30
50V d.c.....	£3.30	300V d.c.....	£3.30
300V d.c.....	£3.30	15V a.c.....	£3.30
15V a.c.....	£3.30	300V a.c.....	£3.30
300V a.c.....	£3.30	100µA.....	£3.30
100µA.....	£3.30	500µA.....	£3.30
500µA.....	£3.30	1mA.....	£3.30
1mA.....	£3.30	5mA.....	£3.30
5mA.....	£3.30	10mA.....	£3.30
10mA.....	£3.30	50V d.c.....	£3.30
50V d.c.....	£3.30	300V d.c.....	£3.30
300V d.c.....	£3.30	15V a.c.....	£3.30
15V a.c.....	£3.30	300V a.c.....	£3.30
300V a.c.....	£3.30	100µA.....	£3.30
100µA.....	£3.30	500µA.....	£3.30

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4 bands covering 550kHz-30MHz continuous and electrical bandspread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. SSB-CW. ANL. Variable BFO. 8 meter. Sep. bandspread dial. IF frequency 445kHz audio output 1.5W. Variable RF and AF gain controls 115/250V a.c. Size: 7in x 13in x 10in with instruction manual.
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FULL RANGE OF TRIO STOCKED

TRIO JR310 SSB RECEIVER



Covers 3.5, 7, 14, 21, 28, 28.5 and 29.1MHz bands, and WWV 15MHz. SSB, AM and CW. AF output more than 1W. Crystal controlled BFO for 85B. 8 meter, ANL, etc. A.C. 110/120-220/240V. Size 9.30 x 17.9 x 310mm.
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TRIO JR599 RECEIVER



9 wavebands covering 1.8-29.7MHz. 144-146MHz and 10.00MHz WWV. SSB, CW, AM and FM. AF output more than 1W. 8 Meter. Switch control. BFO. Variable RF and AF controls. 4-16 ohm output and phone jack. Power requirements 100/240V a.c. 12-14V d.c.
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TRIO TR2000 TRANSCIEVER

Fully transistorised portable VHF Transciever. Will transmit and receive on 6 channels between 144-146MHz. 1W transmitter. 12V d.c. internal or external supply. Built in charger for nickel cells. Power/volume switch, squelch control, channel selector, mike socket, earphone/external speaker socket. Complete with microphone. 144-48, 144-72 and 145-32 crystals.
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High quality TS515 SSB/CW amateur band receiver covering 80, 40, 20, 15 and 10 metre bands with PS515 power supply and speaker unit. Transmit/receive frequency 3.5-29.7MHz. Output 1.5W. Power requirements 110-120/220-240V a.c.
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Solid state mobile transceiver for 12V d.c. neg. use. Transmits and Receives on any 12 of 28 channels between 144 and 146MHz. Power output 10W and 1W switchable. Controls: Volume/on/off, squelch, channel selector. Internal 8in speaker. Complete with dynamic mike, PTT switch, three sets of crystals for 144-48MHz, 144-60MHz, 145-00MHz, mounting bracket and instructions.
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A beautifully styled 4 track stereo deck with an outstanding specification offered at a remarkably low price. Incorporates a host of features including switchable noise filter, normal/chrome tape selector, twin VU meter, slider record/playback level control, front panel headphone socket, recording indicator lamp, phono/Din line input sockets, 3.5mm mike input sockets, etc. etc. Frequency response 100-8kHz (100-12kHz CrO2). 8/N -45dB. Crosstalk -45dB. Separation -30dB. Noise limiter -6dB at 10kHz. Complete with phone connecting leads.
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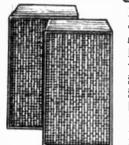


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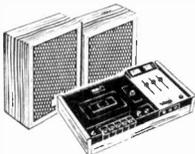
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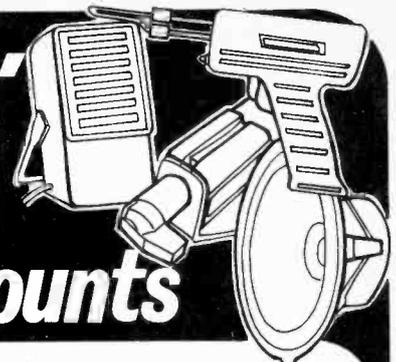
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EMI 13in x 8in 3, 8 or 15 ohm	£	EM1 13in x 8in 3, 8 or 15 ohm	1-30
Plain	2-05	FANE, 7in x 4in, 3 or 8 ohm	1-00
With Co-Axial Tweeter	2-20	8in Dual cone 8 ohm	2-40
Twin Tweeter	3-55	CELESTION 8in, 15 ohm	1-55
Type 350, 8 ohm, 20W	8-00	ADASTRA 10in, 8 or 15 ohm, 10W	2-75
6in, 8 ohm, 10W	2-70	BAKER GROUP 25 12in, 8 or 15 ohm, 25W	6-45
8in, 8 ohm, 10W	3-75		P. & P. 0-25
12in, 8 ohm, 20W	5-50	5in, 8 ohm, 5W C/Mag.	0-85
8in x 5in, C/Mag, 5W	1-20	2 1/2in, 8 ohm or 64 ohm	0-50
8in x 5in, Dual cone 8 ohm, 10W	2-45		P. & P. 0-10
ELAC 8in 8 ohm Dual cone	2-10		
TWEETER AND CROSSOVER		Dome Tweeter 8 ohm, 30W	
EMI 3 1/2in, 3 or 8 ohm C/Mag	1-00	Crossovers CN23 (3 ohm), CN28 (8 ohm), CN216 (16 ohm)	1-00
Cone Tweeter 8 or 15 ohm, 10W	1-90		P. & P. 0-10
Cone Tweeter 8 ohm, 3W	1-00		
Horn Tweeter 8 ohm, 20W	5-50		
KIT FORM CABINETS, TEAK VENEER, 12in x 12in x 6in with 8in, 8in x 5in or 6 1/2in and 3 1/2in cutout		13in x 8in cutout	3-25
	2-45	18in x 11in x 9in with 13in x 8in cutout for EMI 350	4-25
			P. & P. each 0-35
17in x 10in x 6in with 8in or			
MICROPHONES		TW206	
CM20 Crystal Hand	0-50	CONDENSER MIKE 600 ohm, uni-dir	7-90
CM70 Planet stick metal, switch crystal	1-55	Cassette Stick Mike with R. Control on/off switch (2-5 and 3-5mm J/Ply)	1-85
DM160 Dynamic uni-dir, ball metal	3-95	Lapel, type, crystal	0-40
UD130 50K/600 ohm, uni-dir, ball metal	4-50		P. & P. 0-15
SOLDERING IRONS		spare Bib, etc.)	
ANTEX CN240 15W	1-60	X25 25W (low leakage)	1-60
SK1 Kit (15 watt iron, 2			P. & P. 0-10
CARTRIDGES		9THAC/G 8 1/2in fit, stereo cer. diam.	
ACOS GP91/28C or GP91/38C Stereo comp	1-00	19-TI Stereo crystal	0-80
GF93/1 Stereo crystal	1-35	BR SC5M Stereo ceramic	2-25
GF94/1 Stereo crystal	1-75	SX6H Stereo crystal	1-60
GF96/1	1-35	SX5M Stereo crystal	1-60
GF96/1	1-75	X5H Mono/stereo	1-25
GP101	0-75	X5M Mono/stereo	1-25
SONOTONE 9THAC Stereo ceramic, diam.	1-80	GOLDRING G800 G850	3-35
			2-85
			P. & P. 0-05
STYLI FOR ABOVE CARTRIDGES—		GOLDRING G800	
Soapstone	0-85	G850	1-95
D. Diamond	1-25		P. & P. 0-03
BATTERY ELIMINATORS		socket) 6, 7-5 or 9 d.c. output at 300mA	
240V input 6, 7-5 or 9 300mA	2-20		2-20
12V d.c. input (fits in car lighter)			P. & P. 0-10
TAPES		7in 65p 95p	
5in	Std. 45p LP 55p DP 70p	P. & P. 1-3 each	0-09
5 1/2in	55p 65p 85p	4 or more lot	0-30
LOW NOISE CASSETTES		Cassette Head Cleaner	
C60	1-5 35p 6-10 38p 11-20 30p	P. & P. 1-5 each	0-85
C90	35p 45p 48p 40p	6-10 lot	0-03
C120	55p 52p 60p	11-20 post free	0-15
PLASTIC LIBRARY CASES for 5in Reels		7in Reels	
5in Reels	0-18	P. & P. 1-3 each	0-05
6 1/2in Reels	0-22	4 or more	0-20
CASSETTE CASES			0-10
BIB ACCESSORIES		Book, Ref. 66	
Compact Tape Head Cleaning Kit, Ref. J	0-45	Stylus Balance, Ref. 32A	1-15
Tape Editing Kit, Ref. 23	1-30	Spirit Lever, Ref. 46	0-50
Recording Tape Splicer, Ref. 20	1-15	Cassette Case (holds 12 cassettes) Ref. 34	1-00
Cassette Tape, Editing, Ref. 24	1-40	Hi-Fi Stereo Test Cassette	1-80
Cassette Salvage Kit, Ref. 29	0-40	Groove-Kleen Record Cleaner	1-80
Hi-Fi Stereo Hints and Tip			P. & P. 0-10

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221	8	6	6	£2.80
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★ S.a.e. please for full technical details.

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SG 3402N for Ring Modulator	£1.69

CAPACITORS

Sub-miniature Axial lead electrolytic

Mfd V	Price	Mfd V	Price
1 63 6p	68	6.3 6p	6p
1.5 63 6p	68	16 6p	6p
2.2 63 6p	68	63 10p	6p
3.3 63 6p	100	4 6p	6p
4.7 63 6p	100	10 6p	6p
6.8 40 6p	100	25 6p	10p
6.8 63 6p	100	40 6p	12p
10 25 6p	100	63 12p	18p
10 63 6p	150	6.3 6p	12p
15 16 6p	150	16 6p	12p
15 40 6p	150	25 6p	18p
15 63 6p	160	40 10p	22p
22 10 6p	150	63 12p	1000 4 10p
22 25 6p	220	4 6p	1000 10 12p
22 63 6p	220	10 6p	1000 16 18p
33 6.3 6p	220	16 6p	1000 25 22p
33 16 6p	220	25 10p	1500 6.3 12p
33 40 6p	220	40 12p	1500 10 18p
47 4 6p	220	63 18p	1500 16 22p
47 10 6p	300	4 6p	2200 6.3 18p
47 25 6p	330	10 6p	2200 10 22p
47 40 6p	330	16 10p	3200 6.3 22p
47 63 6p	330	63 22p	4700 4 22p

Tantalum Bead

Mfd V	Price	Mfd V	Price
0-1 35 12p	10	16 14p	10p
0-22 35 12p	10	25 16p	10p
0-47 35 12p	15	16 18p	10p
1.0 35 12p	22	16 18p	10p
2.2 35 12p	47	6.3 18p	10p
4.7 35 14p	100	3 18p	10p

Trimmers—compression type

3 to 40pF	13p	20 to 250pF	18p
30 to 140pF	13p	100 to 500pF	21p

Silver Mica 50pF ± 1pF, ≥ 50pF ± 1%
2.2, 3.3, 5, 10, 18, 20, 22, 25, 27, 30, 33, 39, 47, 50, 56, 68, 75, 82, 100, 120, 150, 180, 200, 220 7p; 250, 270, 300, 330, 390, 470, 500, 560, 680, 820 8p; 1000, 1500 10p; 1800 11p; 2200 13p; 2700 16p; 3600 18p; 4700, 5000 20p; 6800 27p; 8200, 10,000 34p.

MIXED DIELECTRIC

1000VDC; 300VAC; Non-inductive.
0.001uF, 0.0022uF, 0.0033uF, 0.0047uF 7p;
0.01uF, 0.022uF 10p; 0.047uF, 0.1uF 12p;
0.22uF 23p; 0.47uF 30p.

POLYESTER FILM METALLISED 250VDC

0.01uF, 0.015uF, 0.022uF 3p; 0.033uF, 0.047uF, 0.068uF 3p; 0.1uF 4p; 0.15uF 4p;
0.22uF 5p; 0.33uF 7p; 0.47 8p; 0.68uF 12p;
1uF 14p; 1.5uF 21p; 2.2uF 25p.

Wide range of transistors, diodes and I.C.'s in stock see our catalogue for details.

PLUGS AND SOCKETS



DIN PLUGS	MAINS	RS8 8 way chassis socket	Std. 1" stereo plug
2 pin (1 flat) 8p	P360 3 pin 1.5A chassis plug with 1 line socket. Per pair 24p	SA 2190 3 pin 5A chassis plug 17p	Plastic 16p
3 pin 9p	SA 1862 Line socket for above 19p	SA 1862 Line socket for above 19p	Screened 25p
4 pin, 5 pin A (180°), 5 pin B (240°), 6 pin 10p	McMURDO	PHONO	Open mono socket 1" 10p; Moulded mono socket 1" with 2 break contacts 2p; Moulded stereo socket 1" with 3 break contacts 18p;
DIN Sockets	RP8 8 way chassis plug 36p	JACK	3.5mm. plug plastic 8p; screened 11p; open socket 8p.
2 pin 6p			
3 pin, 4 pin, 5 pin A (180°), 5 pin B (240°), 6 pin 7p			

WIRE & CABLES

Hook-up wire, 7 strand 0.2mm. PVC covered tinned copper wire for light general connexions up to 1.4A. 11 colours: black, blue, brown, green, grey, orange, pink, red, violet, white, yellow. 10 metres of any one colour 15p. Pack of 11 (1 of each colour) 10m. coils £1.50.

Single core screened 6p per metre.
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High quality single screened 50Ω 100pF per metre, ideal for high grade audio connexions 11p per metre.

Extra flexible 55 strand 0.1mm. PVC covered plain copper wire rated at 6A. Ideal for test leads etc. Red or black 4p per metre.

Mains 3-core miniature 2.5A black PVC covered 13 strand 0.2mm. per conductor 71p per metre.

POTENTIOMETERS

Rotary miniature carbon track 1/4" spindle

Single gang Lin or Log
5k, 10k, 20k, 50k, 100k, 250k, 500k, 1M, 2M (and 1k Lin) 12p

Dual gang (Stereo) without switch Log or Lin 5k to 2M as above 38p.

Single gang with DP switch 250V 2A Log or Lin 5k to 2M as above 23p

PRESETS
Sub-miniature 0.1W Vert or Horiz.
100, 250, 500, 1k, 2.5k, 5k, 10k, 25k, 50k, 100k, 250k, 500k, 1M 6p

Wirewound 10% 1W 1/4" spindle 10, 50, 100R 34p; 250, 500, 1k, 5k 33p; 10k, 37p; 25k 40p; 50k 44p.

RESISTORS

Carbon Film 1W 5% 1Ω to 1M; 10% 1.2M to 10M E12 1p	Carbon Film 1/2W 5% 1Ω to 10Ω; 10% 1.2M to 10M E12 1p
Carbon Film 1/4W 5% 1Ω to 910k E12 & E24 1p	Carbon Film 1/4W 5% 10Ω to 10M E12 3p
Carbon Film 1W 5% 10Ω to 10M E12 3p	Metal Oxide 1/2W 5% 10Ω to 1M E12 & E24 4p
Wirewound 2 1/2W 10% 0.22ohms to 0.47ohms E12 10p	Wirewound 2 1/2W 5% 1ohm to 270ohms E12 10p
E12 values 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and decades	E24 values 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and decades

KNOBS

All 1/4" shaft. Grub screw fixing

Diameter shown in brackets

K30/1 (13mm) 24p; K30/3 (17mm) 22p; K30/2 (13mm) 26p; BK12 32mm long, black pointer with white stripe 6p; K30/8 (32mm) 41p; F18 (26mm) with number-etal skirt 21p; F12 (33mm) 21p; MK50 (34mm) 27p; CK4 (36mm) 141p

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OUT FRIDAY OCT. 19

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20p**

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4 6, 12V at 20A		£6.50-60p
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6 6, 12, 20V at 20A		£6.90-60p
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Contracts	700	16-24	4M 2B	60p*
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 Manufactured by Clare-Elliott Ltd. Type F. 2 c/o permanent latching in either direction. Coil 1150 ohm. 15-30 Volt D.C. Size 1/4" high, 1/2" wide, 1/4" thick. Complete with 3in. leads. New 65p. Post 5p.

BLOWER UNIT
 200-240 Volt A.C. Precision German built. Dynamically balanced, quiet, continuously rated, reversible motor. Consumption 60mA. Size 120 mm. dia. x 60 mm. deep. Price £3. Post 30p.

4 BANK 3c/o PUSH BUTTON ASSEMBLY
 Black rectangular buttons. 5 units (min. order) 85p. Post 15p.

'HONEYWELL' PUSH BUTTON, PANEL MOUNTING MICRO SWITCH ASSEMBLY
 Each bank comprises a c/o rated at 10 amps 240V. A.C. Black knob in. Fixing hole 3/8 in. ONE bank 30p; TWO bank 40p; THREE bank 50p. Quote for quantity.

VERY SPECIAL OFFER
 Micro Switch. 5 amp c/o contacts. M.f.g. bg. Honeywell. NEW. Twenty for £1-50. Post 10p (min. 20).

'HONEYWELL' LEVER OPERATED MICROSWITCH
 15 amps 250 volt A.C. c/contacts. In maker's carton. PRICE: 10 for £1-90, Post 15p.

INSULATION TESTERS NEW!
 Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L Bin, W 4in, H 6in, weight 6lb., 1,000V, 1,000 megohms, £34. Post 60p. 500V, 500 megohms, £28. Post 60p.

BALANCE/LEVEL METERS
 100-100 Micro Amp. Size 1½in x 1½in x 1in. Price only 70p. Post 5p.

METERS NEW! 2½in. Flush round. Available in D.C. Amps 1, 5, 10, 15, 20 or A.C. Amps 1, 5, 10, 15, 20, both types £2.00. Post 15p. Voltmeter 0-300V A.C. £2. Post 15p.

Personal callers only. Open Sat.
9 LITTLE NEWPORT STREET
LONDON WC2H 7JJ
 Phone 01-437 0576

SPECIAL INTRODUCTORY OFFERS—IMPORTER TO CONSUMER!

ALL NEW GOODS—FULLY GUARANTEED—PLEASE ADD VAT TO TOTAL PRICES

HILLS HEADPHONE JUNCTION BOX MODEL JB-3
Designed to connect headphones to amplifier previously not fitted with headphone socket, or alternatively for remote switching. 3 position switch allows instant switching between speakers and headphones or both simultaneously.
Rec. Retail £1.75
OUR PRICE £1.25 P & P 15p



HILLS DYNAMIC HEADPHONE MODEL H-707 VS DE-LUXE
An extremely high quality headphone supplied with Padded Headphone and Earcups together with SLIDER volume controls for precise listening levels. Specially offered at an unbeatable price. 8 ohms. 20-20,000Hz.
Retail Price £7.95
OUR PRICE £5.75 P & P 25p



CAR STEREO SPEAKERS MODEL CRB-200
These dual purpose Car Speakers can be used for either shelf mounting or converted to door mounting. 5in 5 watt Speakers ensure a brilliant audio performance.
Rec. Retail £5.25* *Per pair
OUR PRICE £3.50* P & P 25p



Antex Soldering Iron CCN240, Rec. Retail £2.15. Our Price £1.80. P & P 10p
Antex Soldering Iron X25, Rec. Retail £1.93. Our Price £1.40. P & P 10p
Ferranti Radio Chip ZN414, Our Price £1.10. P & P 5p
Hills Coiled Headphone Extension Cable 15ft. Rec. Retail £2.25. Our Price £1.45. P & P 10p

"HOMER" INTERCOM
One of the leading makes. Ideal for home, office, factories, etc. This 2 station Intercom includes volume control and on-off switch. Supplied with 66ft. cable and batteries.
Rec. Retail £3.50
OUR PRICE £2.75 P & P 15p

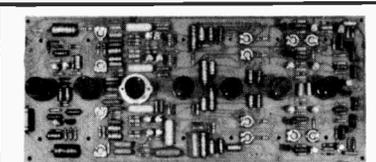


HILLS DYNAMIC HEADPHONE MODEL H-101 VSM
Offered at a remarkably low price. Supplied with padded Headband and Earcups, adjustable volume controls with stereo and mono switch. 8 ohms imp., 30-18,000Hz.
Rec. Retail £5.25
OUR PRICE £3.75 P & P 25p

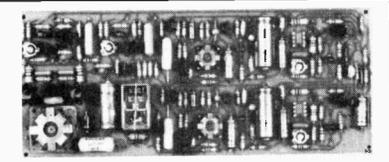


PLINTH AND COVER FOR GARRARD Sp-25 III BSR MP-80. Our Price £2.75, plus 65p P. & P.
ELAC SPEAKER, 8In 8 ohm CERAMIC AND TWEETER. £2.70, plus 20p P. & P.
OTHER ITEMS AT BARGAIN PRICES OFFERED IN OUR AUDIO COMPONENTS CATALOGUE. PLEASE WRITE FOR A FREE COPY (ENCLOSING 3p STAMP).
VAT Please add 10% to the total value of goods including postage and packing.

HILLS COMPONENTS LTD.
UNIT No. 6, MELINITE INDUSTRIAL ESTATE, BRIXTON ROAD, WATFORD, HERTS. WD2 5SL. Tel. Watford 27711



PHONOSONICS NEW LOW PRICES FOR MANY PCB'S AND KITS



AURORA
Multichannel Sound Controlled Light (PE Apr./Aug. 71). S/c's (excl. SCR's), Rs, Cs, Pots, Cores—8 ch. £17.90; 4 ch. £9.95. Reg. PSU £3.65. PCB—4 ch. control (4 1/2in x 10 1/2in) Mk. 2—also holds rotary or slider pots £2.20. PCB (4 1/2in x 5in) Mk. 2—for PSU, Sync Gen. 8 cores, 8 SCR's, £1.10. SCR's—1A, 50p.

A. F. SIGNAL GENERATOR
(PE Nov. 72). S/c's, Rs, Cs, Pots, S/w's. PCB (2 1/2in x 4in) also holds S/w's, £3.15.

BIOLOGICAL AMPLIFIER
(PE Jan./Feb. 73). P/A Set—S/c's, i.c.'s, Rs, Cs, Pots, PCB (1 1/2in x 3 1/2in), £3.50. O/P Stages (S/c's, Rs, Cs, Pots and S/w's as reqd.). Alphaphone 53P, Cardiophone 66p, Freq. Meter £1.60, Vis-Feedback 55p. Audio Amp PC7 avail. to order £5.20.

LOUD-HAILER AND SIREN
(Pre-amp and Siren Generator)
(PW Dec. 72). S/c's, Rs, Cs, Pot, PCB (2 1/2in x 2 1/2in), £2.20 (White stocks last). Main Amp Module PC5+ obtainable to special order, £6.

ELECTRONIC PIANO
(PE Sep. 72/Jan. 73). PCB PRICES DOWN. Details in lists.

GEMINI STEREO AMPLIFIER
(PE Nov. 70/Mar. 71) Stereo Sets & PCBs. Pre-amp—S/c's, £1.80. Rs, Cs, Pots, Mks—S/w's—with 1/2W MO Rs, £10.90—with 1/2W or 1/4W CF Rs, £8.90. PCB (3 1/2in x 10 1/2in) for sets with MO and 1/2W Rs, also holds rotary or slider pots and Mks—S/w's, £11.90. Main Amp—Rs, Cs, Pots, £5.20. PCB (3 1/2in x 5in), £1.15. PSU—Rs, Cs, Pot, £3.70. PCB (2in x 4in), 65p.

GEMINI STEREO TUNER
(PE Apr./Jun. 72). Rs, Cs, Pot, £3.80. PCB as publ., £1.50.

8 WATT AMPLIFIER
(PW Nov./Dec. 72). Pre-amp—S/c's; Rs, Cs, Pots, S/w—Mono, £2.50; Stereo, £5.20. PCB (3 1/2in x 7 1/2in) (Stereo) also holds rotary or slider pots and S/w, £1.50. Main Amp—S/c's, Rs, Cs, Pot—Mono, £3.65; Stereo, £7.30. PCB (2 1/2in x 3in) Mono), 60p.

MICROPHONE MIXER
(PE Apr. 69). S/c's, Rs, Cs, Pots, £2.60. PCB (3 1/2in x 4 1/2in) also holds 6 rotary or 4 slider pots, £1.10.

LOGICAL RADIO CONTROL AND MODEL SERVO CONTROL
(PE Feb./Jun. 72)—Details in lists—Hurry not many left!

REVERBERATION UNIT
(PW Nov./Dec. 72). S/c's, Rs, Cs, Slider Pots, T/fmr, £6.80. PCB (2in x 1 1/2in) also holds sliders, £1.20. 9in Spring Unit avail. to order, £3.75.

VIBRASONIC GUITAR PRE-AMP
(PW Sept. 70). Incl. Mic P/A, 2-Guitar P/A, Trem and Tone Controls, Master Volume. S/c's, Rs, Cs, LDR, Rotary Pots, Lamp, Coupling T/fmr, £6.65. PSU, £2.80. PCB (3 1/2in x 10 1/2in) Mk. 2, also holds 7 rotary or slider pots, £1.75.

HI-FI TAPE LINK
(PE Mar./Apr. 73). S/c's, i.c.'s, Rs, Cs, Relay and pc-base, Pot Cores and pc-bases, S/w's, Pots, Panel Lamp—Mono, £11.80; Stereo, £18.70. PSU, £2.50. PCB—Main Circuit (3 1/2in x 9in) (Stereo) also £2.50. PCB—Sub-Assembly. (2 1/2in x 6 1/2in) (Stereo) Mk. 2 holds sliders and cores, £1.85. PCB—Sub-Assembly. (2 1/2in x 6 1/2in) (Stereo) Mk. 2 holds Sw, Rs, Cs, Presets and mounts on S/w's, 80p.

ULTRASONIC TRANSMITTER-RECEIVER
(PE May 72). S/c's, Rs, Cs, Pot, Relay, Dual PCB (2in x 5 1/2in), £3.90. T/ducers avail. to order, £6.30 per pair.

TAPE NOISE LIMITER
(PE Feb. 72). S/c's, Rs, Cs, Pot, PCB (1 1/2in x 3in), £2.20. Reg. PSU and PCB (1 1/2in x 2 1/2in), £3.10.

VERSATILE LIGHT EFFECTS UNIT
Single Channel Sound Controlled Light with built-in variable strobe. (PE June 72). S/c's, Rs, Cs, Pots, T/fmrs, Keyswitch, £8.85. PCB (3 1/2in x 7 1/2in) Mk. 2, also holds pots, Sw, T/7 T/fmr, £1.50. SCR's—1A, 50p.

ALSO
PCBs as published (while stocks last) for:
DIGITAL PSU (PE Aug. 72), 50p
OSCILLOSCOPE P/A (PE Aug. 72), 33p
SCORPIO (PE Nov./Dec. 71), 60p
TRIFFID (PE Feb. 73), 60p

PHOTOPROCESS CONTROL
(PE Jan./Feb. 72). For colour and B & W—finds exposure, controls timing, stabs, mains voltage. S/c's, SCR, LDR, Rs, Cs, Pots, Relay, Keyswitch, T/fmr, £7.50. PCB (3 1/2in x 5 1/2in) also holds pots, Sw, relay, £1.20.

AND
DIGITRONIC (PW Mar. 73). Read-out PCB (1 1/2in x 3 1/2in), 60p.

SOUND SYNTHESIZER
(PE 1973)
Details of PCBs & Components in lists. SOME PRICES DOWN.

SEMICONDUCTORS

AC128	20p	ZTX531	22p
AC176	20p	2N706	13p
AD161	40p	2N914	22p
BC107	9p	2N1304	20p
BC108	9p	2N2905	23p
BC109	9p	2N2907	22p
BC147	11p	2N3702	10p
BC148	11p	2N3704	10p
BC149	11p	2N3823E	31p
BC157	12p	2N5777	40p
BC158	12p	2N914	4p
BC159	12p	1N4001	6p
BC204	14p	1N4002	7p
BCY71	22p	1N4004	8p
BFY51	16p	1N4005	10p
BSY95A	12p	BA145	17p
OC28	45p	OA91	7p
OC71	12p	OA200	7p
OC84	24p	Z1J	50p
ORP12	48p	741C	36p
T1543	24p	(8-pin DIL)	100/63
ZTX107	9p	µA7815	£2.47
ZTX503	14p	(TO3 can)	150/63

ELECTROLYTIC

		220/10	6p
		220/16	6p
	1.0/63	6p	220/25
	2.2/63	10p	220/40
	4.7/63	6p	226/63
	10/25	6p	330/10
	10/63	6p	470/6.3
	15/40	6p	470/25
	22/10	6p	470/40
	22/25	6p	470/40
	33/6.3	6p	500/64
	33/16	6p	680/6.3
	33/40	6p	680/25
	47/6.3	6p	1000/10
	47/25	6p	1000/25
	47/40	6p	1000/40
	47/63	6p	2200/25
	100/10	6p	2200/40
	100/25	6p	3300/63
	100/40	6p	3300/100
	100/63	6p	4700/16
	150/16	6p	4700/25
	150/63	12p	4700/40

CAPACITORS

		0.1/35	12p
		0.22/25	12p
		0.47/35	12p
		1.0/35	12p
		1.5/35	12p
		2.2/35	12p
		4.7/35	12p
		10/16	12p
		10/25	12p
		15/6.3	12p
		22/16	12p
		47/6.3	12p
		47/16	25p
		100/16	25p
		100/25	25p
		220/25	40p
		330/40	50p
		3300/63	11p
		3300/100	£3
		4700/16	60p
		4700/25	75p
		4700/40	93p

POLYESTER

C280AE	250V(µF)	0.01	3p
		0.015	3p
		0.022	3p
		0.033	3p
		0.047	3p
		0.068	3p
		0.15	4p
		0.22	5p
		0.33	7p
		0.47	9p
		0.68	11p
		1.0	14p

SWITCHES

Shaft assembly	48p
Wafers	33p
Screens	(per
pk of 5)	12p
Spacers	8p
pk of 10)	8p
Rotary:	
3P4V	30p
Multipole	3p
Lever:	
4CL/4CL	£1.30
4CL/4CN	£1.30
Knobs	6p
Slip:	
DPDT	24p

NEW!

RONDO (PE current series)	
PHASING UNIT (PF Sept. 73)	
ENLARGER EXPOSURE METER AND THERMOMETER (PE SEPT. 73)	
SEMICONDUCTOR TESTER (PE OCT. 73)	
WIND AND RAIN EFFECTS (PE OCT. 73)	
DETAILS IN LISTS	
TRANSFORMERS (MAINS)	
Sub-min 12V-0-12V 50mA	£1.30
Min 0-6V 0-6V 6VA	£1.30
Min 0-12V 0-12V 6VA	£1.30
Min 0-20V 0-20V 6VA	£1.30
17 1/2V 1-6A	£1.88
0-25-30 0-25-30V 1-5A	£3.60

POST & PACKING
U.K. 10p per order. EXPORT at cost—please allow for this when ordering and also state whether air or surface mail required—kit weights are shown in our list.

V.A.T.
U.K. Orders only—add 10% to total cost or order.

LIST
S.A.E. for free itemised list and with all enquiries please.

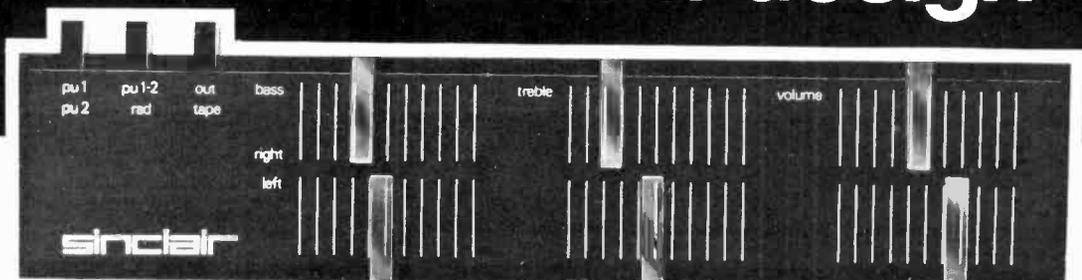
GENERAL
All PCBs Fibreglass, Drilled, Roller-Tinned. Layout and Circuit Diagrams Free with each PCB. Unless stated "as published", PCBs are designed by Phonosonics. Pots are rotary unless stated as slider. All components are brand new, top quality, guaranteed. Prices and deliveries of individual components subject to stock availability.

PHONOSONICS, DEPT. PE11, 25 KENTISH ROAD, BELVEDERE, KENT DA17 5BW **MAIL ORDER ONLY**

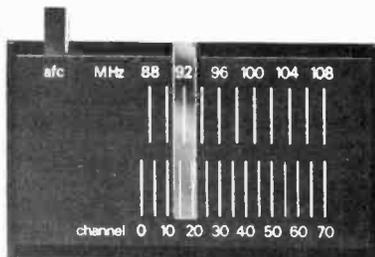
now...

Project 80

... exciting new thinking
in modular hi-fi design



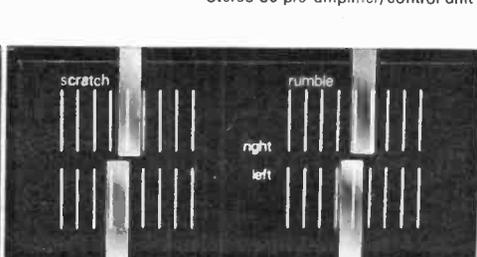
Stereo 80 pre-amplifier/control unit



Project 80 tuner



Stereo decoder



Project 80 Active Filter Unit (AFU)

the slimmest, most elegant hi-fi modules ever made



Living with hi-fi takes on new meaning now that Project 80 is here. These amazing new modules mark a brilliant technical advance all round; their size and presentation bring exciting new opportunities to install systems in ways hitherto only dreamed about but never before made practical. You can build a Project 80 system virtually anywhere and it is unbelievably simple to install and connect up. Everything that could possibly be wanted in a top quality do-it-yourself domestic hi-fi system will be found in Project 80 - compactness, elegantly ultra-modern styling, ease of fixing and operation, new control methods, and above all superb performance. New as well as popular established ideas on installation are featured on page four of this announcement to provide just a few examples of the system's fantastic versatility.

sinclair

INTERNATIONAL AUDIO FAIR STAND 58

Project 80 new modules

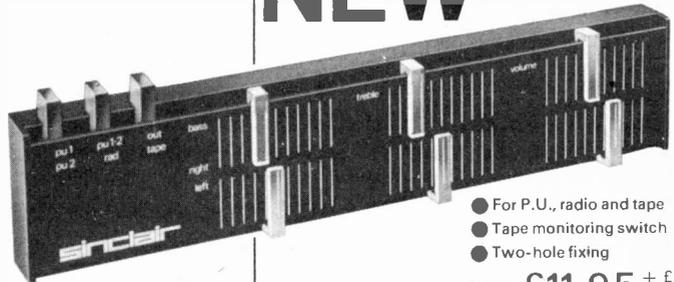
Stereo 80 pre-amplifier and control unit

As with other Project 80 units, the Stereo 80 is mounted by means of two bolts fixed at the rear which pass through holes drilled in the wood or plastic on which modules are to be mounted. *All the electronics are contained within the $\frac{3}{4}$ " deep front panel!* Connecting leads are taken away similarly out of sight. Each channel in the Stereo 80 has its own independent tone and volume controls operated by sliders. This enables exceptionally good environmental matching to be obtained. Provision is made for magnetic and ceramic pick-ups, radio and tape in and out. A virtual earth input stage forms part of the up-dated circuitry of the Stereo 80 to ensure the finest possible quality from all signal sources. Generous overload margins are allowed on all inputs. Clear instructions with template are supplied.

TECHNICAL SPECIFICATIONS

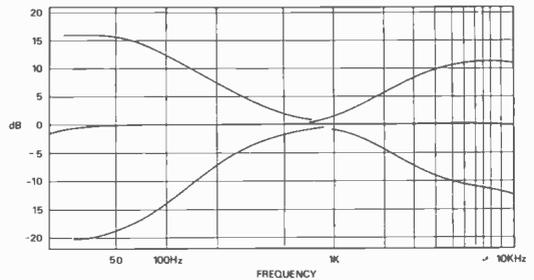
Size - 260 · 50 · 20mm ($10\frac{1}{4}$ · 2 · $\frac{3}{8}$ ins)
 Finish - Black, with white markings
 Inputs - Mag P U 3mV RIAA corrected; Ceramic P U. 300 mV
 Radio 300 mV; Tape 30 mV
 S/N ratio - 60db
 Frequency range - 20Hz to 15KHz · 1dB · 10Hz to 25KHz \pm 3dB
 Power requirements - 20 to 35 volts
 Outputs - 100mV \pm AB monitoring for tape
 Controls - Press button for tape, radio and P U. selection Volume, Bass: 12dB to 14dB at 100Hz, Treble +11dB to -12dB at 10KHz

NEW



- For P.U., radio and tape
- Tape monitoring switch
- Two-hole fixing

R.R.P. **£11.95** + £1.19 V.A.T.



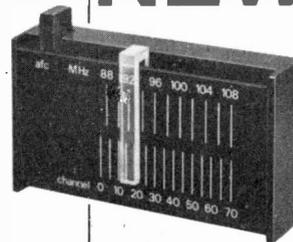
Project 80 FM tuner smaller, more efficient

A truly remarkable tuner in every way - its unbelievably compact size - its original circuitry - its dependable performance - all this in a boldly designed modern case measuring 85 · 50 · 20mm ($3\frac{1}{2}$ · 2 · $\frac{3}{8}$ ins). Greater adaptability (and possibly financial convenience) results from the tuner and stereo decoder section being made available separately.

TECHNICAL SPECIFICATIONS

Size - 85 · 50 · 20mm (approx $3\frac{1}{2}$ · 2 · $\frac{3}{8}$ ins)
 Tuning range - 87 to 108 MHz
 Detector - I.C. balanced coincidence, for good A.M. rejection
 AFC - Switchable, with thermistor control to prevent from drift
 One 26 transistor I.C.
 Twin dual varicap tuning
 Distortion - 0.3% at 1KHz for 75KHz deviation
 Ceramic filter in I.F. section
 Aerial impedance - 75 Ω or 240-300 Ω
 Sensitivity - 4 microvolts for 30dB quieting
 Power requirements - 12 to 45 volts

NEW



- AFC switch
- Twin dual varicap tuning
- 4-hole ceramic filter
- Slider tuning

R.R.P. **£11.95** + £1.19 V.A.T.

Project 80 stereo decoder

Making the Project 80 decoder separate from the F.M. tuner gives the constructor a wider choice of systems as well as saving money in cases where stereo reception may not be required. This unit gives a 40dB channel separation with an output of 150mV per channel. The gallium arsenide light emitting beacon automatically lights up to show when a stereo transmission is tuned in. Designed essentially as an integral part of Project 80 systems, this multiplex stereo demodulator may be used in many cases with existing single channel frequency modulated tuners to provide stereo reception.
 Size - 47 · 50 · 20mm ($1\frac{7}{8}$ · 2 · $\frac{3}{8}$ ins)
 One 19 transistor I.C.

NEW



- Solid-state stereo indicating beacon
- Readily adaptable for use with other tuners

R.R.P. **£7.45** + 0.74p V.A.T.

new constructional techniques

...and again Sinclair leads the world

- 1962 Micro-miniature power amp small enough to stand on a 10p. piece. Slimline pocket receiver smaller than a 20 cigarette pack
- 1963 Micro-6 receiver, smaller than a matchbox
- 1964 Pocket F.M. receiver, PWM amp.
- 1965 Z.12 power amplifier module, PZ.3 power supply
- 1966 Stereo 25 pre-amp/control unit
- 1967 Micromatic. Q.14 loudspeaker; the first Neoteric
- 1968 IC.10, the first ever integrated circuit for constructors' use

- 1969 Q.16 - improved version of Q.14 Systems 2000 and 3000: Project 60 launched
 - 1970 IC.12: Project 60S
 - 1971 Project 60 stereo FM tuner. Z.50: PZ.8
 - 1972 Improvements to Project 60 with Z.50 MK.2 and PZ.8 Mk.3 The Executive Calculator: Digital multi-meter Q.30 speaker
 - 1973 Cambridge Calculator
- PROJECT 80 LAUNCHED**

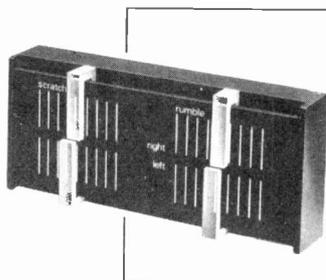
... and next ?

Project 80 active filter unit

This efficiently designed unit makes a highly desirable part of any worthwhile system where inputs may be from record, radio or tape. As with Stereo 80, separate controls are applied to each channel thereby making it easier to obtain ideal stereo balance in any kind of indoor environment

TECHNICAL SPECIFICATIONS

Size - 108 x 50 x 20mm (4 1/4 x 2 x 3/8 ins)
 Voltage gain - minus 0.2dB
 Frequency response - 36Hz to 22KHz, controls minimum
 Distortion - at 1KHz - 0.03% using 30V supply
 HF cut off (scratch) - 22KHz to 5.5KHz, 12dB/oct. slope
 L.F. cut off (rumble) - 28dB at 20Hz, 9dB/oct. slope



NEW

- For scratch and rumble control
- Transistorised active circuitry

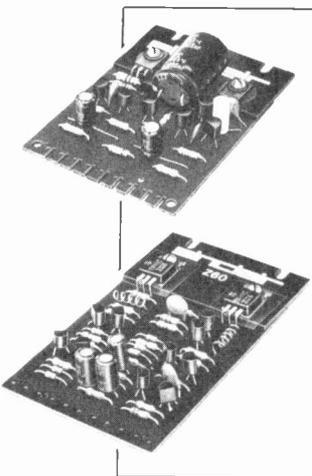
R.R.P. **£6.95** + 0.69p V.A.T.

Z.40 & Z.60 power amplifiers totally short-circuit proof

Either of these entirely new power amplifiers is intended for use in Project 80 installations although, of course, they are readily adaptable to an even wider range of applications. Both Z.40 and Z.60 incorporate built-in protection against shortcircuiting and risk of damage arising from mis-use is greatly reduced. Comprehensive instructions are supplied with each of the modules

Z.40 Technical Specifications
 Size - 55 x 80 x 20mm
 (2 1/8 x 3 1/8 x 3/8 ins) 9 transistors
 Input sensitivity - 100mV
 Output - 15 watts RMS continuous into 8 Ω (35V). 30 watts music power into 4 Ω (30V)
 Frequency response - 10Hz - 100KHz ± 1dB
 Signal to noise ratio - 64dB
 Distortion - at 10 watts into 8 Ω less than 0.1%
 Power requirements - 12-35 volts

Z.60 Technical Specifications
 Size - 55 x 98 x 20mm
 (2 1/8 x 3 7/8 x 3/8 ins) 12 transistors
 Input sensitivity - 100-250mV
 Output - 25 watts RMS into 8 Ω (45V). 50 watts music power into 4 Ω (50V)
 Distortion - typically 0.03%
 Frequency response - 10Hz to more than 200KHz ± 1dB
 Signal to noise ratio - better than 70dB
 Built-in protection against transient overload and short circuit
 Load impedance - 4Ω min, max safe on open circuit



NEW

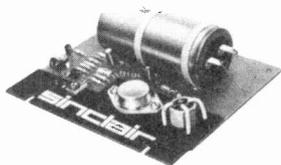
Z.40
 R.R.P. **£5.45** + 0.54p V.A.T.

Z.60
 R.R.P. **£6.95** + 0.69p V.A.T.

Sinclair power supply units PZ.8

the worlds most advanced unit in its class

Stabilised power supply unit. Re-entrant current limiting makes damage from overload or even direct shorting impossible, a principle never before incorporated in a commercially available constructor module. Normal working voltage (adjustable) 45V
 R.R.P. £7.98 + 0.79p V.A.T.
 Without mains transformer
 PZ.5 30V un stabilised
 R.R.P. £4.98 + 0.49p V.A.T.
 PZ.6 35V, stabilised
 R.R.P. £7.98 + 0.79p V.A.T.



Recommended Project 80 applications

System	The Units to use	Units cost
Simple battery record player	Z.40	£5.45 + 54p V.A.T.
Mains powered record player	Z.40, PZ.5	£10.43 + £1.04 V.A.T.
30W. RMS continuous sine wave stereo amp.	2 - Z.40s, Stereo 80; PZ.6	£30.83 + £3.08 V.A.T.
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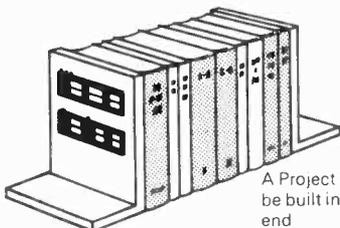
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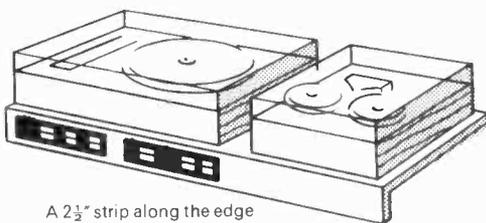
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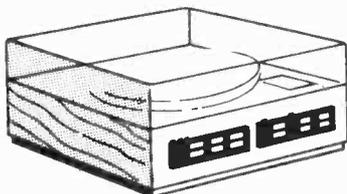
Sinclair Project 80 the ultra-modern non-obtrusive hi-fi



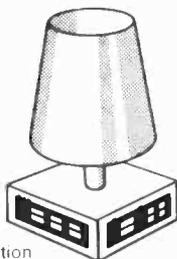
A Project 80 system could be built into a book-shelf end



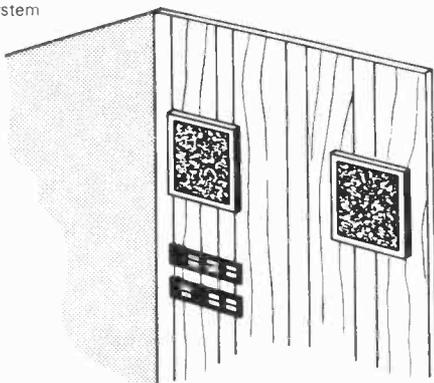
A 2½" strip along the edge a shelf could be sufficient to contain a complete system



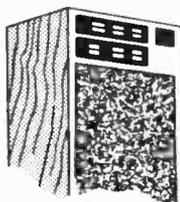
The modules mount very easily onto a playing plinth



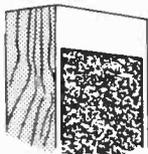
A novel application would be to build around the base of a lampshade



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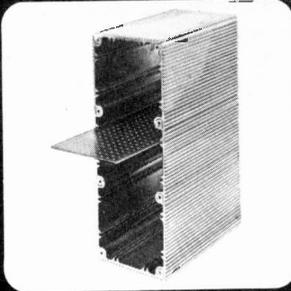
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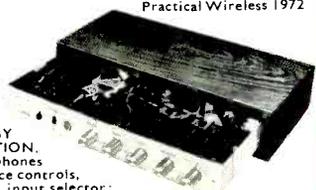
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BUILD THE TEXAN

20 + 20 WATT IC STEREO AMPLIFIER

As featured by Practical Wireless 1972



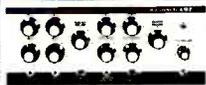
6-IC's, 10 transistors, stabilisers, Gardners low field transformer, Fibre Glass PC Panel, complete chassis work. Now available built and tested as well as in kit form.

HIGH QUALITY & STABILITY ARE PREDOMINANT FEATURES—DEVELOPED BY TEXAS ENGINEERS FOR PERFORMANCE, BY RELIABILITY AND EASE OF CONSTRUCTION. FACILITIES. On/off switch, indicator, headphones socket, separate treble, bass, volume and balance controls, scratch and rumble filters, mono/stereo switch, input selector; Mag. P.U., Radio Tuner, Aux. Can be altered for Mic, Tape, Tape-head, etc. Constructional details Ref. No. 21, 30p. Distributed by Henry's throughout UK.

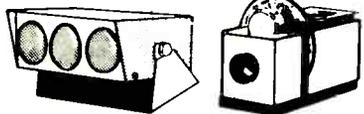
FREE Teak cabinet with complete kit.

KIT PRICE £28.50 (+ VAT + 50p carr/packing) or
built and tested £35.00 (+ VAT + 50p carr/packing) as illustrated

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- DISCO MINI:** A complete portable disco, fitted mixer/preamp, 2 decks all facilities. 100 watt amplifier for above. **£98.50**
- SL100:** 100 watt mixer/amplifier with slider controls. **£69.00**
- R50:** 50 watt mixer/amplifier. **£49.50**
- DISCO AMP:** 100 watt mixer/amplifier chassis unit. **£65.85**
- DISCO MIXER/PREAMPLIFIERS (O/P for up to 6-100 watt amplifiers):**
- SDLI (rotary controls):** **£49.50**
- SDLII (slider controls):** **£58.50**
- DISCO VOX (slider controls):** The complete disco unit. **£69.50**
- DJ100:** 100 watt power amplifier for above. **£38.75**
- DJ30L:** 3 channel 3kW sound to light. **£29.50**
- DJ40L:** as 30L plus built-in microphone. **£38.75**
- DIMANATIC:** 1kW adjustable speed auto dimmer. **£25.00**
- SCENESTROBE:** **£19.00**
- ROAD STROBE:** **£25.00**
- Disco anti-feedback microphone:** **£11.95**
- Coit 150 watt liquid wheel projector:** **£22.50**
- 150 watt Q1 liquid wheel projector:** **£50.00**
- 150 watt Q1 cassette wheel projector:** **£50.00**
- Spare Effects cassettes, large range of patterns:** **£8.00**
- Mini spot bank fitted 3 lamps:** **£11.00**
- Auto Trilite (mini with flashers):** **£17.00**
- MIXERS/MICS/SPEAKERS/LIGHTING, UK'S LARGEST RANGE**



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A completely new high stability stereo FM tuner. Features variable capacity diode tuning, stabiliser power supply, IC Decoder, high gain low noise, IF stages, LED indicators, Tuning meter, AFC. Easy to construct and use. Mains operated. Slim modern design with fibre glass PC, teak cabinet, etc. Available as a kit to build or ready built. Overall size: 8in x 2 1/2in x 6 1/2in. Produced to give high performance with a realistic price. (Parts list and constructional details Ref. No. 5, 30p.) Henry's are sole distributors UK and Europe.



Kit Price £21.00 (+ VAT)
or built and tested **£24.95 (+ VAT)**

LIVING SOUND LOW NOISE TOP QUALITY CASSETTES MADE BY EMI TO INTERNATIONAL STANDARDS ESPECIALLY FOR HENRY'S. ALL POST PAID LESS THAN REC. PRICES.

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Quantity and trade enquiries invited.

LEARN A LANGUAGE—complete with phrase book. German, French, Spanish, Italian. £1.36 per course. £5 for any 4.

LOW COST HI-FI SPEAKERS SPECIAL OFFERS

EMI 13in 8in—full range speakers (post 20p each or 30p pair); *150TC—8 ohms Twin Cone 10 watt, £2.20 each or £4 pair; *450 10 watt c/o Twin Tweeters 3, 8 or 15 ohms, £3.50 each or £6.90 pair; EW 15 watt 8 ohms c/o Tweeter, £4.30 each or £7.90 pair; 350 20 watt c/o Tweeters 8 or 15 ohms, £7.50 each or £14.20 pair.



Polished wood cabinet £4.60, post 35p.

8 ohms full range (post 20p)
FR4 4in 5 watt, £4; FR65 6in 10 watt, £5.50;
FR8 8in 15 watt, £7.60; FR23 9 x 6in 15 watt, £6.00.

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AA12 5in 15 watt, £3.20; B110 5 1/2in 15 watt, £5.60; B200 8in 15 watt, £6.45; B139/2 13in x 8in 30 watt LF, £12.25.

TWEETERS AND CROSSOVERS (post 20p)
K2006 10 watt 8 or 15 ohms, £1.90; FHT6 15 watt 8 ohms, £3.20; K2011 30 watt 8 ohms, £3.75; T27 KEF, £4.25; Axcnt 100 30 watt 8 ohms, £4.90; K4009 1kHz/5kHz c/o, £2; SN75 3kHz var. c/o, £1.75.

SPEAKER KITS (carr. etc. 35p)
20-2 8in 30 watt, £10 each; 20-3 8in 40 watt, £15 each; LINTON 2 20 watt, £15.95 pair; GLENDALE 3 30 watt, £28.95 pair; DOVEDALE 3 50 watt, £42 pair; KEF KK2, £20.40 each; KEF KK3, £32 each.

TEXAN STEREO SYSTEM

PLUS Price Savings



The Texan Stereo Systems include the high quality Texan Stereo amplifier assembled and ready to use. A pair of Type 200 20 watt Speaker-Tweeter systems, size 12 x 12 x 10in and a choice of Garrard players built into a plinth with cover with Goldring G800 magnetic cartridge. System 25 uses Garrard SP25 Mk.III and system 76 the Garrard AP76 de luxe turntable. All necessary leads are supplied.

SYSTEM 25 (list approx. £109) **£79.50**

SYSTEM 76 (list approx. £117) **£89.50**

(plus 10% VAT and plus £1.45 carr/packing).

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Call, write or phone your order 01-402 4736. EASY TERMS FOR CALLERS

KITS - TEST GEAR - AMPLIFIERS - SPEAKERS - DECKS POWER SUPPLIES - TRANSISTORS - IC's

See pages 934, 935 and 936 of this magazine

BUILD YOURSELF A POCKET CALCULATOR

A complete kit, packaged in a polystyrene container and taking about 3 hours to assemble—that's the Sinclair Cambridge pocket calculator from Henry's. Some of the many features include interface chip, thick-film resistor pack, printed circuit board, electronic components pack. Size: 4 1/2in long x 2in wide x 1 1/2in deep. Free of charge with the kit for the more advanced technologist is a 32-page booklet explaining how to calculate Logs, Tangents, Sines, etc.



Price £24.95 (+ VAT)

Also assembled ready to use **£27.22 (+ VAT)**

Prices and descriptions correct at time of press E & OE.

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