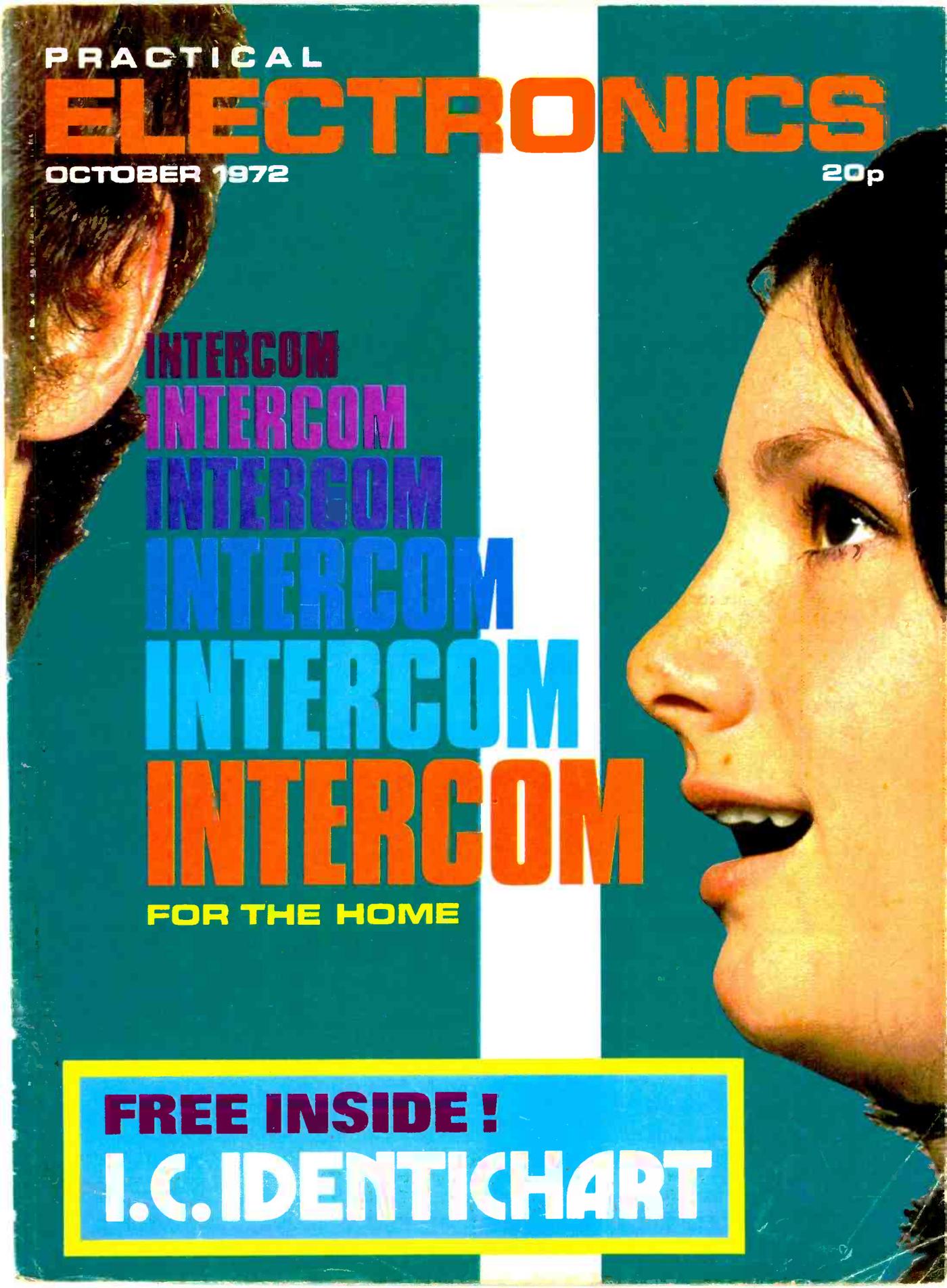


PRACTICAL

# ELECTRONICS

OCTOBER 1972

20p



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FOR THE HOME

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**I.C. IDENTICHART**

# Why take the risk?

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

## Use Antex low-leakage soldering irons



220-240 Volts or  
100-120 Volts

### Model X25

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 in ceramic and steel shaft Bits do not "freeze" and can easily be removed

PRICE: £1.75 (rec. retail)

Suitable for production work and as a general purpose iron

### Model CCN 220 volts or 240 volts

The 15 watt miniature model CCN. also has negligible leakage.

Test voltage 4000v. A.C.

Totally enclosed element in ceramic shaft. Fitted long-life iron-coated bit 3/32"

4 other bits available

1/8", 3/16" 1/4" and 1/16"

PRICE: £1.80 (rec. retail)

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

PRICE: £1.95 (rec. retail)

## A SELECTION OF OTHER SOLDERING EQUIPMENT.



### MODEL CN

Miniature 15 watt soldering iron fitted 3/32" iron-coated bit. Many other bits available from 1/16" to 3/16". Voltages 240, 220, 110, 50 or 24

PRICE: £1.70 (rec. retail)

### MODEL CN2

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

PRICE: £1.70 (rec. retail)



### MODEL G

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

PRICE: £1.83 (rec. retail)

### MODEL SK.1 KIT



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

PRICE £2.75

(Rec. retail)

### 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 and

booklet "How to Solder"



PRICE £2.40

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### MODEL MES.KIT

Battery-operated 12v. 25 watt iron fitted with 15' lead and 2 heavy clips for connection to car battery. Packed in strong

plastic wallet with booklet "How to Solder." PRICE £1.95

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## The other pocket calculators fit neatly into your briefcase.

The Sinclair Executive is the world's smallest and lightest electronic calculator.

How light? Just 2½ oz. Less than the bunch of keys you're probably carrying now.

And how small? It's 5½ inches long, 2½ inches wide, and an incredible ⅜ inch thick – same as a cigarette.

Yet this featherlight wafer of British technology offers more than some desk-top models.

With its brilliant 8-digit display it adds and subtracts, of course. It multiplies and divides – and by a constant figure over and over again, if you want it to (to work out discounts for example, for currency conversions, or for percentages). It works to 2, 4 or 6 decimal places – or it allows the decimal point to float. It rounds off automatically to the nearest decimal place.

### The Secret of the Sinclair Executive

The Executive's 'brain' is an electronic marvel – a 7,000-transistor integrated circuit (the largest ever produced for commercial use).

But the real genius lies in the circuitry linking the brain, the batteries, the keyboard and the display. Circuitry soaks up power, which is why other pocket calculators have to use large batteries – and that, in turn, makes them bulky.

In the Executive, the Sinclair flair for miniaturisation has developed circuitry which absorbs virtually no power. Tiny hearing-aid batteries take up the minimum space, allow an elegantly slim case, and

give a full three-months average life.

Yet small though it is, the Executive is far from frail. Every one is covered by an unbeatable five-year guarantee.

### Smallest... lightest... and quite exceptionally powerful!

The easiest way to test the Executive's full performance is to try it for yourself.

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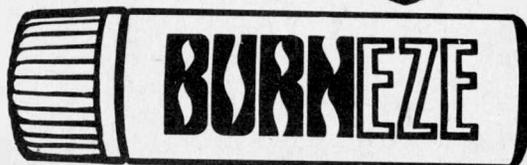
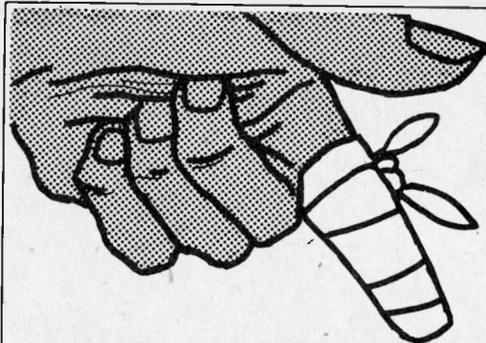
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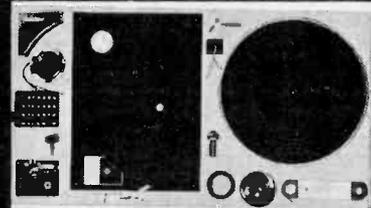
# Connoisseur

## B.D.2 Press button speed change turntable



Now, a new development on the well established Connoisseur BD2 belt drive turntable - press button speed change. This new development is exciting news for the enthusiast and comes as part of an integrated turntable and pickup arm assembly which also features a special version of the popular SAU 2 arm. This is now fitted with a new lifting device which gives improved lowering characteristics, the headshell allowing for lateral adjustment of the cartridge. The BD2 is supplied as a chassis unit or spring mounted on a wood plinth with dust cover.

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The B.D.1 well known for its superb performance and quality two speed working through a flexible belt drive system is now available in kit form. Construction is simplicity itself with no soldering required. Now it's so easy to own the best.

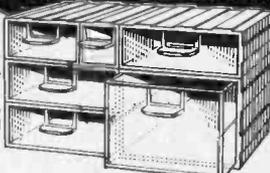
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26p P. & P.



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£7.25

Solve your communication problems with this 4-Station Transistor Intercom system (1 master and 3 Subs), in de-luxe plastic cabinets for desk or wall mounting. Call/talk/listen from Master to Subs and Subs to Master. Ideally suitable for Business, Surgery, Schools, Hospital, Office and Home. Operates on one 9V battery. On/off switch. Volume control. Complete with 3 connecting wires each 66ft. and other accessories. P. & P. 40p.

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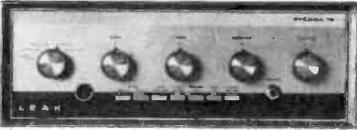


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Teak or Walnut case for Stereofetic tuner only.

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## SINCLAIR PHASE LOCK LOOP STEREO FM TUNER



Incorporates varicap diodes, printed circuit, coils, squelch circuit I.C. Decoder, etc., supplied completely built and tested and ready to be mounted into any cabinet you choose. It may be used with any High Fidelity Amplifier. Power requirements 25/30V DC.

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## BSR TAPE DECK SCOOP



Reels not supplied

### BSR TD2

FANTASTIC VALUE, ONLY Lasky's can offer you a tape deck at such an amazing price. The BSR TD2 tape deck operates by a simple reliable mechanism using the minimum of controls.

With 1/2 track mono heads. Incorporates fast wind and fast rewind, records at 3 1/2 ips. giving up to 3 hrs playing time, takes up to 5 1/2 in. spools. Size 1 3/4 in. x 8 1/2 in. front to rear, 2 1/4 in. below plate, 1 1/4 in. above plate.

ALSO SUITABLE FOR USE AS A TAPE TRANSPORTER

**LASKY'S PRICE £8-95** C & P 35p

## BELTEK C5700 8 TRACK

### Stereo car Player

Accepts all standard pre-recorded 8 track stereo cartridges. Features include automatic head cleaner, channel select and channel repeat push buttons, slider type volume and tone controls, channel balance. Output 5 watts per channel, frequency response 50Hz-10KHz. Output imp. 4 ohms, size 4 1/2 (W) x 1 1/4 (H) x 6 1/2 (D) in. Operates on 12V DC negative earth. Beautifully styled with black ivory and chrome trim.

**BELTEK C5700** complete with mounting brackets and 8 track pre-recorded demonstration cartridge. C & P 30p

**£19-75**

### BELTEK R5310 FM TUNING ADAPTOR

Matches the C5700, the ideal car stereo system.

**LASKY'S PRICE £18-95** C & P 25p

Add £3-75 to any BELTEK car player for pair of FANTAVOX KS701 car speakers.



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(C & P 75p on all Tape Decks.)

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**2 CSS-8 Speakers** List Price £25-00 (pair) Lasky's Price £15-95 C & P 50p

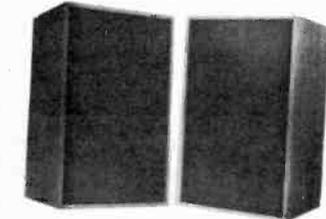
**2 ADM 11/8 mics.** Suitable for use on all Akai tape recorders. List Price £11-90. Lasky's Price (pair) £7-50. C & P 15p.

## FANTASTIC VALUE WHARFEDALE SCOOP!

**10" BRONZE C/S**  
 10 in. cloth surround 15 ohms.  
**LASKY'S PRICE £2-45** C & P 20p



## STEREOSOUND SPEAKERS



An attractive bookshelf speaker system with teak veneer finish. Imp. 8 ohms. Max. Power 12W. Size 1 1/4 (H) x 9 (W) x 7 1/2 (D) in.  
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## LEAK SPEAKERS

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### EXCLUSIVELY FROM LASKY'S

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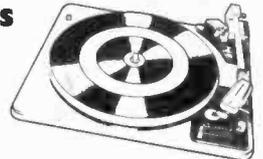
## BSR TD8S

### 8 TRACK STEREO CARTRIDGE PLAYER

The TD8S is suitable for use with most modern stereo amplifiers and delivers a pre-amp output of 125mW. Power requirements: 210/250V AC, 50Hz. Frequency response: 50Hz-10KHz. 4 pole dynamically balanced synchronous motor. Black and woodgrain plastic cabinet. Size: 8 1/2 (W) x 3 1/2 (H) x 10 1/2 (D) in.  
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SP25 Mk. III Deck Only

4 speed

Automatic Single Player

Lasky's price **£11-50**

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complete with stereo cartridge	£11-50
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SPC1 cover	£3-60
Price together	£6-50

## SP 25 Package

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Total List Price .. .. . £24-95

**Package Price £18-50**

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SHURE M44E Cartridge	List	£8-59
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**Package Price £35-00**

## CARRIAGE—all units

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## THE FABULOUSLY SUCCESSFUL VISCOUNT III AUDIO £52 complete

14 + 14 watts r.m.s. 40Hz to 40kHz ± 3dB. Total distortion at 10 watts at 1kHz — 0.1%.

This is real value for money! We have designed 2 systems and the heart of them all is the Viscount III amplifier. A unit of great eye appeal with teak finished cabinet. FET's (Field effect transistors) are incorporated on the input stages, just like top priced units. FET's give you more of the signal you want and almost none of the hiss you don't. Both units have output sockets for headphones and tape recorder. Filters and tone controls give a wide range of bass and treble adjustment.

For both systems we have chosen the famous Garrard SP25 Mk. III deck which comes complete with simulated teak plinth and dust cover.

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

### SPEAKERS

**Duo Type II** Size approx. 17in. x 10½in. x 6½in. Drive unit 13in. x 8in. with parasitic tweeter. Max power 10 watts, ohms. Simulated Teak cabinet. £14 pair + £3 p & p.

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### SPECIFICATION

14 watts per channel into 3 to 4 ohms (suitable 3-15 ohms). Total distortion @ 10W @ 1kHz 0-1%. P.U.1. (for Ceramic cartridges) 150mV into 3 Meg. P.U.2. (for magnetic cartridges) 4mV @ 1kHz into 47K equalised within ±1dB R.I.A.A. Radio 150mV into 220K. (Sensitivities given at full power.) Tape out facilities: headphone socket, power out 250mW per channel. Tone controls and filter characteristics. Bass: +12dB to -17dB @ 60Hz. Bass filter: 6dB per octave cut. Treble control: treble +12dB to -12dB @ 15kHz. Treble filter: 12dB per octave. Signal-to-noise ratio: (all controls at max) —P.U.1. and radio —65dB, P.U.2 —58dB. Cross talk better than —35dB on all inputs. Overload characteristics better than 26dB on all inputs. Size approx. 13½in. x 9in. x 3½in. Send S.A.E. for fully illustrated brochure. 12 MONTH'S WRITTEN GUARANTEE.

PRICES: SYSTEM 1	
Viscount III R 101 amplifier	£22.00 + 90p p&p
2 x Duo Type II speakers	£14.00 + £2 p&p
Garrard SP25 Mk. III with MAG. cartridge plinth and cover	£23.00 + £1.50 p&p
<b>Total</b>	<b>£59.00</b>

Available complete for only £52 + £3.50 p & p

PRICES: SYSTEM 2	
Viscount R 101 amplifier	£22.00 + 90p p&p
2 x Duo Type III speakers	£32.00 + £3 p&p
Garrard SP25 Mk. III with MAG. cartridge plinth and cover	£23.00 + £1.50 p&p
<b>Total</b>	<b>£77.00</b>

Available complete for £69 + £4 p & p

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The whole system is complete including superb cabinets in simulated teak—just simply screw together the components and you save pounds!

Amplifier is based on the famous Mullard Unilex system. Garrard 2025TC turntable complete with stereo ceramic cartridge, teak simulated plinth and tinted acrylic cover. Plus the big 13in. X 8in. EMI Twin-cone speakers ready for mounting in their elegant cabinets, which simply need screwing and glueing together. All glue and screws supplied.

Easy to follow step-by-step instructions guide you quickly and effortlessly to taking the wraps off truly realistic stereo sound.

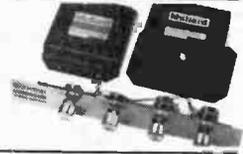
£25 complete plus £2.80 p. & p. Diamond Stylus £1.25 extra.

Power output: 4 watts per channel into 8 ohms. Inputs: 120 mV (for ceramic cartridges). Stereo headphones with adaptor £4.00.

### UNISOUND MODULES ONLY £6.95

If you prefer, you can buy the three modules—pre-amplifier power supply/dual power amplifier, and control panel—for themselves for only £6.95. P. & P. 50p extra.

No soldering, just simply screw together with screwdriver supplied. Their overall specification is the same as shown for the complete Unisound console, using the high efficient I.C. monolithic power chips to ensure very low distortion at all power levels, correct operation in all ambient temperatures, full power over the audio spectrum.



AN **R T V C** EXCLUSIVE DESIGN

## A 'NATURAL' ONLY FROM **R T V C** THE TOURIST PB CAR RADIO KIT

Apart from the output stage, which is an integrated circuit, the only other electronic components that need soldering are some capacitors, resistors, etc. The kit includes a pre-built RF tuner unit, and fully modulated IF stages which are pre-aligned before despatch. As well as electronic components, this kit also contains 2 diamond-spun aluminium knobs, elegant matching front panel, dial, washers, screws and wire.

The Tourist PB is suitable for 12 volt working on both negative and positive earth vehicles. It covers the full medium and long wave bands. Four push-buttons for medium wave, one for long wave. It is permeability tuned and sturdily constructed. Output is a full 2.5 watts into an 8 ohm speaker. But the Tourist PB will operate into any loudspeaker from 8 to 15 ohms. Power consumption is less than 1 amp.

The Tourist PB can be mounted in any standard size dash panel and it has an illuminated tuning scale for easy reading at night. Chassis size is: 7in wide, 2in. high and 4 1/8 in. deep (excluding front panel, etc.).

★ Circuit diagram and comprehensive instructions 50p, free with parts.

★ Fully retractable lockable car aerial £1.25 post paid.

PRICE ONLY £7 + p & p 50p

8 ohm speaker with baffle and fixing strips £1.50 + 25p p & p, post free if brought with the kit.

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*Triacs	Diac	IC and Transistor Sockets	Plugs (Pin Headers) for DIL Sockets
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Integrated Circuits	*Tunnel Diodes	Operational, etc.	Digital
<p><b>Audio</b></p> <p>PA230 Low noise mono-pre-amp £1.31 each</p> <p>MC1303 Stereo pre-amp £2.19 each</p> <p>PA263/A1286 3.5w rms amp with PC board £1.75 each</p> <p>MFC6040 Electronic attenuator 86p each</p> <p>MC1310 Monolithic FM Stereo Decoder</p>	<p>1N3716 4.7mA peak point £1.78 each</p>	<p>RF</p> <p>*PA189 RF up to 50 MHz £1.48 each</p> <p>MC1304 Stereo De-modulator £3.50 each</p> <p>MC1350 Limiting FM IF amp 94p each</p> <p>MC1310 Coil-less stereo de-mod £2.77 each</p>	<p>Full range of DTL, TTL and ECL Typical prices—</p> <p>MIC 7400J 25p each</p> <p>MIC 7413J 40p each</p> <p>Dual schmitt</p>
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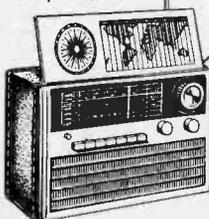
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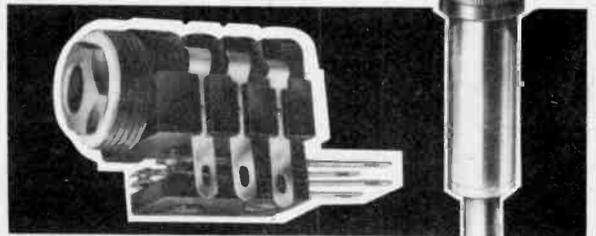
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# THIS IS THE FIRST PAGE OF THE GREAT BI-PAK SECTION

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AC113	0-20	AD161 &		BC149	0-12	BD138	0-50	BF194	0-12	OC20	0-38	2G373B	0-12	2N2220	0-22	2N3055	0-50	2N4060	0-12
AC115	0-23	AD162 (MP)		BC150	0-18	BD139	0-55	BF195	0-12	OC22	0-42	2G374	0-17	2N2221	0-20	2N3056	0-14	2N4061	0-12
AC117K	0-20		0-55	BC151	0-20	BD140	0-60	BF196	0-14	OC23	0-46	2G375	0-20	2N2222	0-20	2N3057	0-18	2N4062	0-12
AC122	0-12	ADT140	0-50	BC152	0-17	BD155	0-80	BF197	0-14	OC24	0-56	2G377	0-30	2N2268	0-17	2N3392	0-14	2N4284	0-17
AC125	0-17	AF114	0-24	BC153	0-28	BD175	0-60	BF200	0-45	OC25	0-38	2G378	0-16	2N2369	0-14	2N3393	0-14	2N4285	0-17
AC126	0-17	AF115	0-24	BC154	0-30	BD176	0-60	BF222	0-95	OC26	0-25	2G381	0-16	2N2369A	0-14	2N3394	0-14	2N4286	0-17
AC127	0-17	AF116	0-24	BC157	0-18	BD177	0-60	BF257	0-45	OC28	0-50	2G382	0-16	2N2411	0-24	2N3395	0-14	2N4287	0-17
AC128	0-17	AF117	0-24	BC158	0-12	BD178	0-65	BF258	0-60	OC29	0-42	2G414	0-30	2N2412	0-24	2N3402	0-21	2N4288	0-17
AC132	0-14	AF118	0-35	BC159	0-12	BD179	0-70	BF259	0-85	OC36	0-50	2G401	0-30	2N2456	0-47	2N3403	0-21	2N4289	0-17
AC134	0-14	AF124	0-30	BC160	0-45	BD180	0-70	BF262	0-55	OC37	0-50	2G417	0-25	2N2456A	0-21	2N3404	0-28	2N4290	0-17
AC137	0-14	AF125	0-25	BC161	0-50	BD185	0-65	BF263	0-55	OC41	0-20	2N388	0-35	2N2712	0-21	2N3405	0-42	2N4291	0-17
AC141	0-14	AF126	0-28	BC167	0-12	BD186	0-65	BF270	0-35	OC42	0-24	2N388A	0-55	2N2714	0-21	2N3414	0-15	2N4292	0-17
AC141K	0-17	AF127	0-28	BC168	0-12	BD187	0-70	BF271	0-30	OC44	0-15	2N404	0-20	2N2904	0-17	2N3415	0-15	2N4293	0-17
AC142	0-14	AF139	0-30	BC169	0-12	BD188	0-70	BF272	0-80	OC46	0-12	2N404A	0-28	2N2904A	0-21	2N3416	0-28	2N4293A	0-17
AC142K	0-17	AF178	0-50	BC170	0-12	BD189	0-75	BF273	0-75	OC70	0-35	OC70	0-10	2N2905	0-21	2N3417	0-28	2N4294	0-17
AC151	0-15	AF179	0-50	BC171	0-14	BD190	0-75	BF274	0-35	OC71	0-35	OC71	0-10	2N2906	0-15	2N3418	0-28	2N4295	0-17
AC154	0-20	AF180	0-50	BC172	0-14	BD195	0-85	BF275	0-60	OC72	0-14	2N598	0-42	2N2906A	0-18	2N3702	0-10	2N4296	0-17
AC156	0-20	AF181	0-45	BC173	0-14	BD196	0-85	BF276	0-27	OC74	0-14	2N599	0-45	2N2907	0-20	2N3703	0-10	2N4297	0-17
AC156	0-20	AF186	0-45	BC174	0-14	BD197	0-90	BF284	0-22	OC75	0-15	2N696	0-12	2N2907A	0-20	2N3704	0-10	2N4298	0-17
AC157	0-24	AF229	0-37	BC176	0-22	BD198	0-90	BF285	0-22	OC76	0-15	2N697	0-13	2N2907A	0-22	2N3705	0-11	2N4299	0-17
AC165	0-20	AL102	0-65	BC177	0-19	BD200	0-95	BF287	0-22	OC77	0-25	2N698	0-24	2N2920	0-14	2N3706	0-10	2N4300	0-17
AC166	0-20	AL103	0-65	BC178	0-19	BD200	0-95	BF287	0-22	OC77	0-25	2N699	0-24	2N2924	0-14	2N3706	0-09	2N4304	0-17
AC167	0-20	ASB26	0-25	BC179	0-19	BD205	0-80	BF288	0-22	OC81D	0-15	2N706	0-09	2N2924A	0-14	2N3707	0-11	2N4305	0-17
AC168	0-24	ASB27	0-25	BC180	0-24	BD206	0-80	BF290	0-20	OC82	0-15	2N706A	0-09	2N2926 (G)	0-12	2N3708	0-07	2N4306	0-17
AC169	0-14	ASB28	0-25	BC181	0-24	BD207	0-95	BF291	0-20	OC82D	0-15	2N708	0-12	2N2926 (Y)	0-12	2N3709	0-09	2N4307	0-17
AC176	0-24	ASB29	0-25	BC182	0-10	BD208	0-95	BF292	0-20	OC83	0-20	2N711	0-30	2N2926 (Y)	0-10	2N3710	0-09	2N4308	0-17
AC177	0-24	ASB30	0-25	BC192L	0-10	BDY20	1-00	BFY53	0-17	OC84	0-20	2N717	0-35	2N2926 (O)	0-11	2N3711	0-09	2N4322A	0-17
AC178	0-28	ASB51	0-25	BC183L	0-10	BF117	0-45	BSX19	0-15	OC140	0-20	2N718	0-24	2N2926 (R)	0-10	2N3820	0-50	2N4323	0-17
AC179	0-28	ASB52	0-25	BC183L	0-10	BF117	0-45	BSX19	0-15	OC140	0-20	2N718A	0-50	2N2926 (R)	0-10	2N3821	0-35	2N4324	0-17
AC180	0-17	ASB54	0-25	BC184	0-12	BF118	0-70	BSX20	0-15	OC169	0-25	2N726	0-28	2N2926 (B)	0-10	2N3822	0-50	2N4325	0-17
AC180K	0-20	ASB56	0-25	BC184L	0-12	BF119	0-70	BSY25	0-15	OC170	0-25	2N727	0-28	2N2926 (B)	0-10	2N3823	0-28	2N4325	0-17
AC181	0-17	ASB56	0-25	BC186	0-28	BF121	0-45	BSY26	0-15	OC171	0-25	2N743	0-20	2N2926 (B)	0-10	2N3903	0-28	2N4326	0-17
AC181K	0-17	ASB57	0-25	BC187	0-28	BF123	0-45	BSY27	0-15	OC200	0-25	2N744	0-20	2N2926 (B)	0-10	2N3904	0-30	2N4327	0-17
AC187	0-22	ASB59	0-25	BC187	0-11	BF125	0-45	BSY28	0-15	OC201	0-28	2N914	0-14	2N3011	0-10	2N3905	0-28	2N4328	0-17
AC187K	0-20	ASB21	0-40	BC208	0-11	BF127	0-50	BSY29	0-15	OC202	0-28	2N918	0-30	2N3011	0-14	2N3906	0-27	2N4361	0-17
AC188	0-22	BC107	0-09	BC209	0-12	BF152	0-55	BSY38	0-18	OC203	0-25	2N920	0-21	2N3053	0-17	2N4058	0-12	40362	0-45
AC188K	0-20	BC108	0-09	BC212L	0-11	BF153	0-45	BSY39	0-18	OC204	0-25	2N920	0-21						
ACY17	0-25	BC109	0-10	BC213L	0-11	BF154	0-45	BSY40	0-28	OC205	0-35	2N1131	0-20						
ACY14	0-20	BC113	0-10	BC214L	0-14	BF155	0-70	BSY41	0-28	OC309	0-40	2N1132	0-22						
ACY19	0-20	BC114	0-15	BC225	0-25	BF156	0-48	BSY45	0-12	P346A	0-20	2N1302	0-14	AA119	0-08	BY133	0-21	OA10	0-35
ACY20	0-20	BC115	0-15	BC226	0-35	BF157	0-45	BSY55A	0-12	P397	0-42	2N1303	0-14	AA120	0-08	BY164	0-50	OA47	0-07
ACY21	0-20	BC116	0-15	BCY30	0-24	BF158	0-55	Bu105	2-00	OC71	0-43	2N1305	0-17	AA129	0-08	BYX38/30	0-42	OA79	0-07
ACY22	0-16	BC117	0-15	BCY31	0-28	BF159	0-60	CI11E	0-50	ORP12	0-43	2N1307	0-21	AA130	0-09		0-42	OA79	0-07
ACY27	0-18	BC118	0-10	BCY32	0-30	BF160	0-40	C400	0-30	ORP60	0-40	2N1306	0-21	AA131	0-09	BYZ10	0-35	OA81	0-07
ACY28	0-19	BC119	0-30	BCY33	0-22	BF162	0-40	C407	0-25	ORP61	0-40	2N1307	0-21	BA100	0-10	BYZ11	0-30	OA85	0-09
ACY29	0-35	BC120	0-80	BCY34	0-25	BF163	0-40	C424	0-20	RT140	0-12	2N1308	0-23	BA106	0-10	BYZ12	0-30	OA89	0-06
ACY30	0-28	BC125	0-12	BCY70	0-14	BF164	0-40	C425	0-60	RT141	0-17	2N1309	0-23	BA116	0-21	BYZ21	0-30	OA90	0-06
ACY31	0-28	BC126	0-18	BCY71	0-18	BF165	0-40	C426	0-35	T843	0-30	2N1613	0-20	BA126	0-22	BYZ23	0-25	OA91	0-06
ACY34	0-21	BC132	0-12	BCY72	0-14	BF167	0-22	C428	0-20	UT46	0-20	2N1711	0-20	BA148	0-14	BYZ16	0-40	OA95	0-07
ACY35	0-21	BC134	0-18	BCZ10	0-20	BF173	0-22	C441	0-30	2G301	0-09	2N1889	0-32	BA154	0-12	BYZ17	0-35	OA200	0-04
ACY36	0-28	BC135	0-12	BCZ11	0-25	BF176	0-35	C442	0-30	2G302	0-19	2N1890	0-35	BA155	0-14	BYZ18	0-35	OA202	0-05
ACY40	0-17	BC136	0-15	BCZ12	0-25	BF177	0-35	C444	0-35	2G303	0-19	2N1893	0-47	BA156	0-13	BYZ19	0-28	SD10	0-06
ACY41	0-18	BC137	0-15	BD121	0-60	BF178	0-30	C460	0-22	2G304	0-24	2N2147	0-72	BY100	0-15	CG62		SD19	0-05
ACY44	0-35	BC139	0-40	BD123	0-65	BF179	0-30	MAT100	0-19	2G306	0-40	2N2148	0-57	BY101	0-12	(Eq) OA91		IN34	0-07
AD130	0-38	BC140	0-30	BD124	0-60	BF180	0-30	MAT101	0-20	2G308	0-35	2N2160	0-60	BY105	0-17		0-05	IN34A	0-07
AD140	0-48	BC141	0-30	BD131	0-50	BF181	0-30	MAT120	0-19	2G309	0-35	2N2192	0-35	BY114	0-12	CG651	0-05	IN34A	0-07
AD142	0-48	BC142	0-30	BD132	0-60	BF182	0-40	MAT121	0-20	2G339	0-20	2N2193	0-35	BY126	0-14	(Eq) OA70		IN316	0-06
AD143	0-38	BC143	0-30	BD133	0-65	BF183	0-40	MFF102	0-42	2G339A	0-16	2N2194	0-35	BY127	0-15	OA79	0-06	IN414B	0-06
AD149	0-50	BC145	0-45	BD135	0-40	BF184	0-25	MFF104	0-87	2G344	0-18	2N2217	0-22	BY128	0-15	OA5	0-35	I8021	0-10
AD161	0-33	BC147	0-10	BD136	0-40	BF185	0-30	MFF105	0-37	2G345	0-16	2N2218	0-20	BY130	0-16	OA58L	0-21	I8651	0-06

### DIODES AND RECTIFIERS

AA119	0-08	BY133	0-21	OA10	0-35
AA120	0-08	BY164	0-50	OA47	0-07
AA129	0-08	BYX38/30	0-42	OA79	0-07
AA130	0-09		0-42	OA79	0-07
AA131	0-09	BYZ10	0-35	OA81	0-07
BA100	0-10	BYZ11	0-30	OA85	0-09
BA116	0-21	BYZ21	0-30	OA90	0-06
BA126	0-22	BYZ23	0-25	OA91	0-06
BA148					

# The largest selection

## NEW LOW PRICE TESTED S.C.R.'s

PIV 1A	3A	5A	5A	7A	10A	16A	30A
705	T068	T066	T064	T048	T048	T048	T048
50	0-23	0-23	0-35	0-35	0-47	0-50	0-53
100	0-35	0-35	0-47	0-47	0-50	0-53	0-53
200	0-35	0-35	0-49	0-49	0-57	0-61	0-75
400	0-43	0-47	0-56	0-56	0-67	0-75	0-93
600	0-53	0-57	0-68	0-68	0-77	0-85	1-05
800	0-63	0-70	0-80	0-80	0-90	1-20	1-40

## SIL. RECTS. TESTED

PIV	300mA	750mA	1A	1.5A	3A	10A	30A
50	0-04	0-06	0-05	0-07	0-14	0-21	0-30
100	0-04	0-06	0-05	0-07	0-14	0-21	0-30
200	0-05	0-09	0-06	0-14	0-20	0-24	0-10
400	0-06	0-13	0-07	0-20	0-27	0-37	1-25
600	0-07	0-16	0-10	0-22	0-34	0-45	1-86
800	0-10	0-17	0-11	0-25	0-37	0-55	2-00
1000	0-11	0-25	0-14	0-30	0-46	0-63	2-50
1200		0-33		0-38	0-57	0-75	

TRIAC		
VBO	2A	10A
TO-1 TO-86 TO-88		
5p	5p	5p
100	80	76
200	60	90
400	70	75

**DIACS**  
**FOR USE WITH TRIACS**  
 BR100 (D39) 37p each

**FREE**  
 One 50p Pak of your own choice free with orders valued \$4 or over.

**BRAND NEW TEXAS GERM. TRANSISTORS**  
 Coded and Guaranteed

Pak No.	EQVT
T1	8 2G3713 OC71
T2	8 D1374 OC44
T3	8 D1216 OC81D
T4	8 2G381T OC81
T5	8 2G382T OC82
T6	8 2G344B OC44
T7	8 2G345B OC44
T8	8 2G378 OC78
T9	8 2G399A 2N1202
T10	8 2G417 AF117

All 50p each pak

**2N2060 NPN SIL. DUAL TRANS. CODE D1699 TEXAS.** Our price 25p each.

**120 VCB MIXIE DRIVER TRANSISTOR.** 8im. B5X21 & C407, 2N1893 FULLY TESTED AND CODED ND 120. 1-24 17p each. TO-5 N.P.N. 25 up 15p each.

Sil. trans. suitable for P.E. Organ. Metal TO-18 Eqvt. ZTX300 5p each.

## POWER TRANS BONANZA!

**GENERAL PURPOSE GERM. PNP**  
 Coded GPI00. BRAND NEW TO-3 CASE. POSS. REPLACE.—OC25-28-29-30-35-36. NKT 401-403-404-405-406-430-451-452-453. T13027-3028, 2N280A, 2N456A-457A-458A, 2N511 A & B. 2G220-222. ETC. VCB0 50V VCB0 50V 10A PT. 30 WATTS Hic 30-170.  
 PRICE 1-24 25-99 100 up 43p each 40p each 36p each

**SILICON High Voltage 250V NPN TO-3 case. G.P. Switching & Amplifier Applications.** Brand new Coded R 2400 VCB0 250V/VC0 100/1C 6A/30 Watta. HFE type 20/1F 5MHZ.  
 OUR PRICE EACH: 1-24 25-99 100 up 50p 45p

**ADI61/162 PNP M/P COMP GERM TRANS.** OUR LOWEST PRICE OF 55p PER PAIR

**FULL RANGE OF ZENER DIODES**  
 TO-1 TO-86 TO-88  
 2-33V 400mV (DO-7 Case) 13p ea. 11W (Top Hat) 18p ea. 10W (SG-10 Stud) 25p ea. All fully tested 5% tol. and marked. State voltage required.

**10 amp POTTED BRIDGE RECTIFIER** on heat sink. 100PIV. 90p each

**NEW LINE Plastic Encapsulated 2 Amp BRIDGE RECTS.**  
 50 v RMS 32p each  
 100 v RMS 37p each  
 400 v RMS 46p each  
 Size 15 mm x 6 mm.

**UNIJUNCTION**  
 U18 Eqvt. 2N2646, 2N1843, BEN3000  
 27p each 25-99 25p 50p up 30p

**CADMIUM CELLS**  
 ORP12 43p  
 ORP60, ORP61 40p each

**GENERAL PURPOSE NPN SILICON SWITCHING TRANS. TO-18 SIM. TO 2N705/8, B5Y-27/28/95A.** All usable devices no open or short circuits. ALSO AVAILABLE in PNP Sim. to 2N2906, BCY70. When ordering please state preference NPN or PNP.  
 20 For 0-50  
 50 For 1-00  
 100 For 1-75  
 500 For 7-50  
 1000 For 18-00

**SIL. G.P. DIODES**  
 300mV 30 0-50  
 40PIV (Min.) 100 1-00  
 Sub-Min. 500 5-00  
 Full Tested 1,000 9-00  
 Ideal for Organ Builders.

**2N3055**  
 115 WATT SIL POWER NPN 50p EACH

**ALARGE RANGE OF TECHNICAL AND DATA BOOKS ARE NOW AVAILABLE EX. STOCK. SEND FOR FREE LIST.**

**SILICON 50 WATTS MATCHED NPN/PNP**  
 BIP 19 NPN TO-3 Plastic. BIP 20 PNP. Brand new. VCB0 100V/VC0 50/1C 10A. HFE type 100/1F 3mHZ.  
 OUR PRICES PER PAIR: 1-24 prs. 60p 25-99 prs. 55p 100 prs. 50p

## KING OF THE PAKS Unequaled Value and Quality

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UIC04	-12 x 7404	0-50	UIC51	-12 x 7451	0-50	UIC93	-5 x 7493	0-50
UIC05	-12 x 7405	0-50	UIC53	-12 x 7453	0-50	UIC94	-5 x 7494	0-50
UIC06	-8 x 7406	0-50	UIC54	-12 x 7454	0-50	UIC95	-5 x 7495	0-50
UIC07	-8 x 7407	0-50	UIC60	-12 x 7460	0-50	UIC96	-5 x 7496	0-50
UIC10	-12 x 7410	0-50	UIC70	-8 x 7470	0-50	UIC100	-5 x 74100	0-50
UIC13	-8 x 7413	0-50	UIC72	-8 x 7472	0-50	UIC121	-5 x 74121	0-50
UIC20	-12 x 7420	0-50	UIC73	-8 x 7473	0-50	UIC141	-5 x 74141	0-50
UIC30	-12 x 7430	0-50	UIC74	-8 x 7474	0-50	UIC151	-5 x 74151	0-50
UIC40	-12 x 7440	0-50	UIC75	-8 x 7475	0-50	UIC154	-5 x 74154	0-50
UIC41	-5 x 7441	0-50	UIC76	-8 x 7476	0-50	UIC193	-5 x 74193	0-50
UIC42	-5 x 7442	0-50	UIC80	-5 x 7480	0-50	UIC199	-5 x 74199	0-50
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## 74 Series T.T.L. I.C's

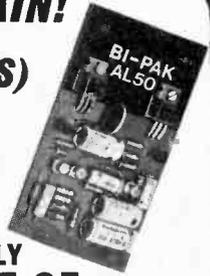
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SN7401	0.15	0.14	0.12				
SN7402	0.15	0.14	0.12				
SN7403	0.15	0.14	0.12				
SN7404	0.15	0.14	0.12				
SN7405	0.15	0.14	0.12				
SN7406	0.35	0.31	0.28				
SN7407	0.35	0.31	0.28				
SN7408	0.18	0.17	0.16				
SN7409	0.18	0.17	0.16				
SN7410	0.15	0.14	0.12				
SN7411	0.25	0.24	0.23				
SN7412	0.35	0.31	0.28				
SN7413	0.29	0.28	0.24				
SN7416	0.43	0.40	0.38				
SN7417	0.43	0.40	0.38				
SN7420	0.15	0.14	0.12				
SN7422	0.15	0.14	0.12				
SN7423	0.50	0.48	0.45				
SN7425	0.50	0.48	0.45				
SN7427	0.45	0.42	0.40				
SN7428	0.70	0.65	0.60				
SN7450	0.15	0.14	0.12				
SN7432	0.45	0.42	0.40				
SN7433	0.80	0.75	0.70				
SN7437	0.64	0.62	0.60				
SN7438	0.64	0.62	0.60				
SN7440	0.15	0.14	0.12				
SN7441	0.67	0.64	0.58				
SN7442	0.67	0.64	0.58				
SN7443	£1.30	£1.25	£1.20				
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SN7445	£1.30	£1.25	£1.20				
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SN7447	£1.00	0.97	0.95				
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SN7450	0.15	0.14	0.12				
SN7451	0.15	0.14	0.12				
SN7453	0.15	0.14	0.12				
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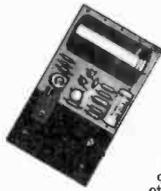
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  - ★ Overall size 63mm x 105mm x 13mm.

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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 Main 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—Disco Systems, Public Address, Intercom Units, etc. Handbook available, 10p **PRICE £2.95**

TRANSFORMER BMT80 £1.95 p. & p. 25p.

### 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 60K Ω
2. Radio, Tuner	35 mV into 60K Ω
3. Magnetic P.U.	1.5 mV into 60K 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	+ 20dB
Supply	+ 35 volts at 20mA
Dimensions	292mm x 82mm x 35mm



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Type No.	Price	1-24	25-99	100 up
BP930	12p	11p	10p	10p
BP932	13p	12p	11p	11p
BP938	13p	12p	11p	11p
BP935	13p	12p	11p	11p
BP936	13p	12p	11p	11p
BP941	13p	12p	11p	11p
BP946	25p	24p	22p	22p
RP946	12p	11p	10p	10p
BP948	25p	24p	22p	22p
BP951	65p	60p	55p	55p
BP962	12p	11p	10p	10p
BP9093	40p	38p	35p	35p
BP9094	40p	38p	35p	35p
BP9097	40p	38p	35p	35p
BP9099	40p	38p	35p	35p

Devices may be mixed to qualify for quantity price. Larger quantity prices on application. (DTL 930 Series only).

### LINEAR I.C's—FULL SPEC.

Type No.	Price	1-24	25-99	100 up
BP 201C—SL201C	63p	53p	45p	45p
BP701C—SL701C	63p	50p	45p	45p
BP 702C—SL702C	63p	50p	45p	45p
BP 702—72702	63p	45p	40p	40p
BP709—72709	80p	34p	30p	30p
BP 709P—µA709C	80p	34p	30p	30p
BP 710—72710	44p	42p	40p	40p
BP 711—µA711	45p	42p	40p	40p
BP 741—72741	75p	60p	50p	50p
µA703C—µA703C	28p	26p	24p	24p
TAA 285	70p	60p	55p	55p
TAA 293	80p	75p	70p	70p
TAA 350	170p	158p	150p	150p

B.G.S. EA1000 B-68

## NUMERICAL INDICATOR TUBES



MODEL	CD86	GR116	3015F Minitron
Anode voltage (Vdc)	170min	175min	5
Cathode Current (mA)	2.3	14	8
Numerical Height (mm)	16	13	9
Tube Height (mm)	47	32	22
Tube Diameter (mm)	19	13	12 wide
I.C. Driver Rec.	BP41 or 141	BP41 or 141	BP47
PRICE EACH	£1.70	£1.55	£1.90

All Indicators 0.9 + Decimal point. All side viewing. Full data for all types available on request.

### RTL MICROLOGIC CIRCUITS

	Price each	1-24	25-99	100 up
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uL900 Buffer	35p	33p	27p	27p
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1T4	-18	30F5	-64	EB3A1	-54	EM84	-39	PCF809	-38	UABC80	-32
384	-28	30FL1	-65	EB3C1	-30	EM87	-60	PCLR3	-57	UAF42	-50
3V4	-47	30FL12	-69	EB3C0	-22	EY61	-36	PCLR4	-34	UBC41	-52
5V4G	-31	30PL14	-68	EBF80	-82	EY86	-29	PCL85	-38	UBF80	-34
5V4G	-35	30L1	-29	EBF83	-39	EY87	-29	PCL86	-38	UBF89	-32
5Y3GT	-34	30L15	-70	EBF89	-29	EZ40	-42	PCL88	-65	UCC94	-32
6Z4G	-35	30L17	-67	EC081	-17	EZ41	-43	PCL800	-75	UCC95	-38
6Y80L2	-54	30P4	-65	EC089	-20	EZ60	-22	PCL805	-38	UCF80	-32
6AL5	-11	30P12	-72	EC083	-35	EZ61	-23	PENA4	-77	UCH42	-32
6AM6	-13	30P19	-65	EC085	-34	EZ90	-25	PEN36C	-70	UCH81	-32
6AQ5	-22	30PL1	-60	EC080A	-54	GZ30	-34	PFL200	-52	UCL82	-32
6AT6	-20	30PL13	-89	ECF80	-31	GZ32	-40	PL36	-49	UCL83	-55
6AU6	-20	30PL14	-66	ECF82	-82	GZ34	-48	PL81	-44	UF41	-56
6BA6	-20	35L6GT	-45	ECB36	-55	KT41	-77	PL81A	-47	UF60	-30
6BE6	-21	33V4	-25	ECH42	-59	KT61	-55	PL82	-31	UL41	-57
6BJ6	-41	35Z4GT	-25	ECH81	-29	KT66	-78	PL83	-33	UL84	-30
6BW7	-52	40C6D	-68	ECH83	-40	LN319	-63	PL84	-30	UM84	-22
6F14	-40	807	-45	ECH84	-36	LN329	-72	PL500	-63	UY41	-30
6E23	-68	AC/VP2	-77	ECL80	-35	LN389	-63	PL504	-63	UY85	-22
6F26	-63	B349	-66	ECL82	-31	N78	-87	PM84	-38	VF4B	-77
6J7G	-34	B729	-62	ECL86	-35	F61	-40	FX25	-95	W77	-43
6K7G	-19	CCH35	-87	EFL89	-38	PCB80	-34	PY32	-55	Z77	-22
6K8G	-17	CY31	-30	EF41	-60	PC86	-47	PY33	-55	Transistors	
6Q7G	-35	DAF91	-22	EF80	-23	PC88	-47	PY81	-25	AC107	-17
68N7GT	-30	DAF96	-36	EF85	-28	PC86	-42	PY82	-25	AC127	-18
6V8G	-28	DF91	-16	EF86	-30	PC97	-39	PY83	-28	AD140	-37
6V6GT	-28	DF96	-36	EF89	-28	PC90	-31	PY88	-35	AP116	-20
6X4	-23	DH77	-20	EF91	-13	PC94	-29	PY800	-34	AP116	-20
6X5GT	-23	DK32	-33	EF92	-30	PC85	-23	PY801	-34	AF117	-20
10L13	-58	DK91	-28	EF98	-65	PC98	-38	R19	-30	AF125	-17
12A8B	-296	DK92	-50	EF183	-28	PC99	-45	R20	-56	AF127	-17
12A77	-17	DK96	-45	EF184	-31	PC0189	-48	R25	-84	OC26	-25
12A7U	-20	DL35	-40	EH90	-35	PC805	-56	U26	-56	OC44	-12
6X4	-23	DH77	-20	EF91	-13	PCF80	-28	U47	-84	OC45	-12
19BG6G	-80	DL94	-47	EL34	-45	PCF82	-33	U49	-58	OC71	-12
20F2	-67	DL96	-38	EL41	-54	PCF86	-48	U52	-31	OC72	-12
20P3	-77	DY86	-24	EL84	-23	PCF800	-58	U78	-24	OC75	-12
25L6GT	-19	DY87	-24	EL90	-26	PCF801	-28	U91	-59	OC81	-12
25U4GT	-57	DY802	-33	EL95	-33	PCF802	-40	U28	-64	OC82	-12
30C1	-28	EAPC50	-32	EL98	-33	PCF805	-61	U301	-88	OC82D	-12
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Amazing Radio Construction set. Become a radio expert for £2.45. A complete Home Radio Course. No experience needed. Parts including simple instructions for each design. Illustrated step-by-step plans, all transistors, loudspeaker, personal phone, knobs, screws, etc., all you need. Presentation box 45p extra as illus. (if required) (parts available separately) no soldering necessary. **Send £2.45 + 20p p & p.**

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CUTS OUT NOISE POLLUTION—SOOTHS YOUR NERVES! The RELAXATRON is basically a pink noise generator. Besides being able to mask out extraneous unwanted sounds, it has other very interesting properties. IF YOU WORK IN NOISY OR DISTRACTING SURROUNDINGS, IF YOU HAVE TRUBLE CONCENTRATING, IF YOU FEEL TENSED, UNABLE TO RELAX—then build this fantastic Relaxatron. Once used you will never want to be without it—TAKE IT ANYWHERE. Uses standard PP3 batteries (current used so small that battery life is almost shelf-life). **CAN BE EASILY BUILT BY ANYONE OVER 12 YEARS OF AGE** using our unique, step-by-step, fully illustrated plans. No soldering necessary. All parts including case, a pair of crystal phones, Components nuts, Screws, Wire, etc., no soldering. **Send only £2.75 + 25p p & p.** (Parts available separately.)

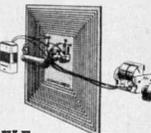


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Don't confuse with ordinary electric organs that simply blow air over mouth-organ type reeds, etc. Fully transistorised. **SELF-CONTAINED LOUD-SPEAKER.** Fifteen separate keys span two full octaves—play the "Yellow Rose of Texas", play "Silent Night", play "Auld Lang Syne", etc. etc. You have the thrill and excitement of building it together with the pleasure of playing a real, live, portable electronic organ. **NO PREVIOUS KNOWLEDGE OF ELECTRONICS NEEDED.** No soldering necessary, simple as ABC to make. Anyone over nine years can build it easily in one short evening following the fully illustrated, step-by-step, simple instructions. **ONLY £3.25 + 25p p & p** for kit, including case, nuts, screws, simple instructions, etc. Uses standard battery (parts available separately). Have all the pleasure of making it yourself, finish with an exciting gift for someone.

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**FULLY TRANSISTORISED PRINTED CIRCUIT METAL DETECTOR MODULE.** Ready built and tested—just plug in a PP3 battery and 'phones and it's working. Put it in a case, screw a handle on and YOU HAVE A PORTABLE TREASURE LOCATOR. **EASILY WORTH ABOUT £20!** EXTREMELY SENSITIVE—PENETRATES EARTH, SAND, ROCK, WATER, ETC. EASILY LOCATES COINS, GOLD, SILVER, JEWELLERY, HISTORICAL RELICS, BURIED PIPES, ETC. So sensitive it will detect certain objects buried SEVERAL FEET BELOW GROUND! GIVES CLEAR SIGNAL ON ONE COIN: £4.95 + 30p carr. etc.



**CONCORD ELECTRONICS LTD. (PEI0U), 8 Westbourne Grove, London, W.2. Callers welcome.**

**BEDFORD ELECTRONICS**  
2 GROVE PLACE, BEDFORD  
(continuation of Lurke Street)

**MULLARD C296 POLYESTER FILM CAPACITORS**  
400V: 0.001, 0.0015, 0.0022, 0.0033, 0.0047, 2ip, 0.0068, 0.01, 0.015, 0.022, 0.033, 3p, 0.047, 0.068, 0.1, 4p, 0.15, 5ip, 0.22, 7p, 0.33, 10ip, 0.47, 12p, 160V: 0.01, 0.015, 0.022, 0.033, 0.047, 0.068, 3p, 0.1, 3ip, 0.15, 4p, 0.22, 4ip, 0.33, 5ip, 0.47, 7p, 0.68, 10p, 1.0, 12p.

**MULLARD C280 METALLISED FILM CAPACITORS 250V**  
0.01, 0.015, 0.022, 3p, 0.033, 0.047, 0.068, 3ip, 0.1, 4p, 0.15, 0.22, 4ip, 0.33, 6p, 0.47, 7ip, 0.68, 10p, 1.0, 12p, 1.5, 18p, 2.2, 21p.

**CERAMIC CAPACITORS 50V (Square plaquette body)**  
E12 Series 22pF-1,000pF, 1ip, 0.0015-0.01, 2p, 0.015-0.047, 2ip.

**HIGH VOLTAGE CAPACITORS 1000V d.c. (300V a.c.)**  
0.001, 0.0022, 0.0033, 0.0047, 7p, 0.0068, 0.01, 0.022, 10p, 0.047, 0.1, 12p, 0.22, 20p, 0.47, 22p.

**ISKRA POLYSTYRENE CAPACITORS 160V, 2 1/2%**  
Values in pF: 5, 10, 15, 22, 33, 47, 56, 68, 100, 150, 220, 330, 470, 560, 680, 820, 1000, 3ip.

**SOLID TANTALUM RESIN DIPPED BEAD CAPACITORS**  
µF/V: 0.1/35, 0.22/35, 0.47/35, 1.0/35, 2.2/35, 4.7/35, 10/6.3, 10/16, 10/25, 22/16, 47/6.3, 100/3, 15p.

**MULLARD 015/016/017 ELECTROLYTICS (Replaces C426/C437)**  
µF/V: 1/63, 1.5/63, 2.2/63, 3.3/63, 4.7/63, 6.8/63, 10/25, 10/63, 15/10, 15/63, 22/25, 22/63, 33/16, 33/40, 47/10, 68/16, 100/4, 100/10, 100/25, 150/16, 220/16, 5p, 47/63, 470/6.3, 5ip, 68/63, 330/16, 9p, 100/63, 150/63, 680/16, 1500/6.3, 11p, 220/63, 470/40, 1000/16, 15p, 330/63, 680/40, 1000/25, 1500/16, 2200/10, 3300/6.3, 18p.

RESISTORS	Type	Tolerance	Range	Values	Price each
ISKRA 1/2W	5%	4R7-2M2	E24	1p	
ISKRA 1/2W	10%	3M3-10M	E12	1p	
MULLARD 1/3W	10%	1R-3R9	E12	1p	
ISKRA 1/5W	5%	4R7-1M	E24	1p	
WIREWOUND 2.5W	10%	R22-R47	E12	9p	
WIREWOUND 2.5W	5%	1R-270R	E12	7p	
PRESETS 100R, 250R, 500R and Decades to 5M, 0.1W, 5p, 0.25W, 6p.					

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**LOW COST BRIDGE RECTIFIERS**

DC output	Type Nos.	
Amps	Volts	
10	60	PM7A1
	125	PM7A2
	250	PM7A4
when mounted	375	PM7A6
15	60	PM7A1Q
	125	PM7A2Q
	250	PM7A4Q
when mounted	375	PM7A6Q

AMP tags electrically isolated from mounting bracket. Mount them on a chassis, the equipment box, transformer housing etc.

**AVAILABLE EX STOCK**  
**AEI SEMICONDUCTORS**  
AEI Semiconductors Limited  
Carholme Road Lincoln

**STEREO IC DECODER**  
HIGH PERFORMANCE PHASE LOCKED LOOP (as in 'W.W.' July '72)  
**MOTOROLA MC1310P**  
**EX STOCK DELIVERY**

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

**KIT COMPRISES FIBREGLASS PCB** (Printed and tinned), Resistors, I.C., Capacitors, Preset Potm. & Instructions. Only £3.50 post free.

**LIGHT EMITTING DIODE (Red)**  
Suitable as stereo 'on' indicator. For above with panel mounting clip and instructions. Only 35p + p.p.

**MC1310P only £2.77 + p.p. 6p**

**Fi-Comp Electronics**  
**BURTON ROAD, EGGINOTON, DERBY DE6 6GY**



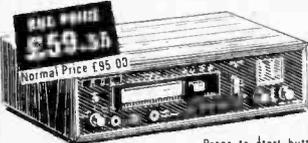
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# ROC ELECTRONICS!



**ROC PRICE £10.50**  
Normal Price £15.70

**OLSON AM-357 4-WATT STEREO AMPLIFIER**  
Here's a marvellous value for someone just starting to set themselves up in audio! At only £10.50, you get a fine amplifier in a scratch resistant metal cabinet, with a smart brushed aluminium front panel. It incorporates separate tone and volume controls for each channel. Inputs are provided for turntable (ceramic cartridge), tuner and tape deck or recorder. Frequency response: 20-20,000 Hz  $\pm$  3dB. Output: 2 watts r.m.s. per channel into 8 ohms. Inputs: phono 80mV; tuner/aux 80mV. Size 8" wide, 2 1/4" high, 4 1/2" wide.



**ROC PRICE £59.50**  
Normal Price £95.00

**8-TRACK STEREO CARTRIDGE TAPE DECK MODEL RP-1000ST**  
The popular Lear-Jet type recording unit is the heart of the fantastic RP-1000ST, which has full record and playback facilities. Automatic track change with manual over-ride. Press to start button. Stereo headphone and Left and Right Mic sockets on front panel. Dual recording level meter, and Left and Right volume controls. Built-in pre-amp. Tape speed 3 1/2 ips (9.5 cms). Frequency response: playback 30-10,000 Hz; recording/playback 30-8,000 Hz. Line output: fully variable 0-500mV. The RP-1000ST incorporates all the features you'd expect on a top quality Cartridge Tape Deck. Size 16" wide, 4" high, 9" deep. Cabinet in walnut, including connecting leads.



**ROC PRICE £28.00**  
Normal Price £30.70

**A-3000 36-WATT SOLID STATE STEREO AMPLIFIER**  
The A-3000 looks as good as it sounds! Giving you a big performance this superb audio amplifier has a full range of facilities on the front and rear panels. On the front - all the controls you're ever likely to need plus a headphone socket. On the rear - signal inputs, speaker outputs and a line fuse for circuit protection. Specifications: 18 watts rms per channel into 8 ohms. Frequency response 20-35,000 Hz ( $\pm$  2db). Inputs: Magnetic, Ceramic, Tuner, Tape, Aux. Tape Play. Size: 345mm x 300mm x 130mm.

**REALISTIC 30 WATT STEREO AMPLIFIER MODEL SA-500**  
A superb hi-fi amplifier with all the features you've ever wanted - for under £46.00. Saving over £10.00 on the normal retail value. Up-to-the-minute slider controls for bass and treble. Separate volume and balance controls. Headphone socket on front panel. Push-button input controls - magnetic phono (high/low) tuner, aux, mono, monitor. Loudness push-button control for perfect sound at low output levels. Left and right push-button on/off switches for speakers. Noise filtering and tape monitoring facilities. Two auxiliary AC outlets. Frequency response 20-20,000 Hz  $\pm$  1 db at full power. 15 watts rms per channel. Walnut cabinet with satin aluminium trims. Inputs: phono 2.5mV and 5mV RIAA; tuner/aux 250mV. Hum and noise: phono - 50db; tuner/aux - 65db. How's that for a specification! Size 14 1/2" wide, 3 1/2" high, 10 1/2" deep.



**ROC PRICE £35.20**  
Normal Price £55.50

**OLSON RA-310 AM/FM/MPX STEREO TUNER**  
This ROC Tuner is especially designed to match the Olson AM-395 Stereo Amplifier. In price and value, as well as it's good looking design! But of course it's also ideal for use with any other amplifier. The RA-310 costs £10.00 less than the normal retail value, and yet it is a highly sophisticated unit, incorporating the latest solid state techniques. Operation is drift free for supreme station-holding capability. You can connect this Tuner to a stereo amplifier, to a tape deck or a tape recorder. And of course it covers all the stations in the AM and FM bands. FM: 87-108 MHz; AM: 525-1605 kHz. FM Sensitivities: FM, 3uV; AM, 250uV. Stereo separation 30dB at 1kHz, image rejection 60dB. Size: 11 1/2" wide, 4" high, 7 1/2" deep.



**ROC PRICE £31.20**  
Normal Price £50.00

**REALISTIC SA-100B 6-WATT STEREO AMPLIFIER**  
Here's a fabulous, exciting value in miniature! This high quality stereo amplifier measures only 9" wide, 3" high x 5 1/2" deep. And yet it has separate ganged volume, balance and tone controls. Plus speaker in/out, mono/stereo, phono/tuner and power on/off slide switches. The ends are alled walnut, with matching enamelled metal top. The front panel is satin aluminium and walnut-brown enamel. Frequency response is 50 to 10,000 Hz  $\pm$  3dB. Output 3 watts r.m.s. per channel into 8 ohms. Inputs are 100mV for both phono and tuner.



**ROC PRICE £12.45**  
Normal Price £21.00

**EAGLE LC 07 STEREO MOVING-MAGNET CARTRIDGE**  
Here's your opportunity to own a transcription cartridge for the price of a ceramic! Is specially designed to match top quality tone arms, and to get the very best from your hi-fi amplifier. 0.7 mil diamond stylus. Output: 7mV per channel. Frequency range: 20-21,000 Hz. Channel balance:  $\pm$  1.5dB. Channel separation: 20dB. Compliance: 12 x 10.9 cm/dyne. ROC PRICE £6.37



**ROC PRICE £24.10**  
Normal Price £39.60

**OLSON AM-395 40-WATT STEREO AMPLIFIER**  
An ideal unit for your new stereo separate system. It is more than £10.00 below the normal retail price! Making the AM-395 one of Britain's best hi-fi buys. It takes in signals from magnetic or ceramic pick-ups, tuners (see Olson RA-310) and tape decks. And it's got outputs for tapping and for headphones. There are separate bass and treble controls, separate Left and Right channel volume controls. And a loudness switch for boosting the bass and treble notes when listening at low output levels. Frequency response: 20-20,000 Hz  $\pm$  3dB. Output: 20 watts r.m.s. per channel into 8 ohms. Inputs: magnetic phono 3.0mV RIAA, crystal phono 100mV; tape 160mV; tuner 160mV. Size 11 1/2" wide, 4" high, 7 1/2" deep. The specification reads well - sounds even better!



**ROC PRICE £17.80**  
Normal Price £25.00 per pair.

**R.446 3-WAY MATCHED SPEAKERS**  
These will do justice to your amplifier - and to your pocket. At only £17.80 a pair, they are real value-for-money. Each cabinet is heavily lagged and teak finished. They handle 16 watts rms (8 watts rms each). Each loudspeaker contains a large dual cone base unit, plus a separate tweeter. Frequency range: 40 to 19,000 Hz. Size 14" high, 9" wide, 6 1/2" deep.



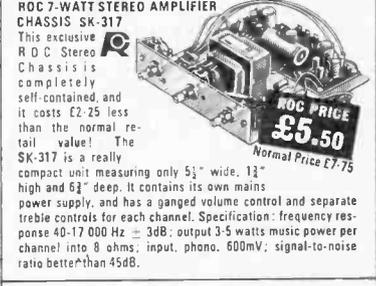
**"WATTS" RECORD CLEANERS**  
The original "Dust Bug" Automatic Record Cleaner keeps your records like new - for perfect record reproduction. 35p

**R.307 TRANSISTORIZED STEREO PRE-AMPLIFIER**  
Now your amplifier that could only reproduce ceramic or crystal pick-up cartridges, can accept signals from moving-magnet cartridges! The R.307 steps up signals from between 5-20mV to 200-800 mV. Input: 5-20mV. Equalisation: RIAA. Output: 200-800mV flat. Frequency range: 20-22,000 Hz. Dimensions: 3 1/2" x 1 1/2" x 2 1/4". Supply: 240 Vac. ROC PRICE £4.92

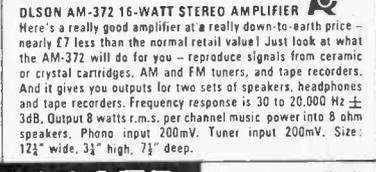


**ROC PRICE £27.55**  
Normal Price £42.00

**PALACE AM/FM/MPX STEREO TUNER AMPLIFIER SSA-16**  
This is one of the lowest priced stereo tuner amplifiers on the market. It covers the full range of both AM and FM broadcast frequencies. And when you're switched to FM, an indicator lights up when a stereo signal is received - that's the time to switch to "Stereo"! The SSA-16 has all the facilities you'd expect to find on tuners costing twice as much - separate volume, bass, treble, balance and tuning controls. Selector switch for tape, phono, AM, FM, stereo. Jack socket on front panel for stereo headphones. Frequency range: FM 88-108 MHz; AM 525-1605 kHz. Frequency response: 50-10,000 Hz  $\pm$  3dB. Power output: 4 watts total music power into two 8 ohm speakers. Size: 16" wide, 4 1/2" high, 8" deep.



**ROC 7-WATT STEREO AMPLIFIER CHASSIS SK-317**  
This exclusive R.O.C. Stereo Chassis is completely self-contained, and it costs £25.55 less than the normal retail value! The SK-317 is a really compact unit measuring only 5 1/2" wide, 12" high and 6 1/2" deep. It contains its own mains power supply, and has a ganged volume control and separate treble controls for each channel. Specification: frequency response 40-17,000 Hz  $\pm$  3dB; output 3.5 watts music power per channel into 8 ohms; input, phono, 60mV; signal-to-noise ratio better than 45dB.



**ROC PRICE £15.10**  
Normal Price £25.20

**OLSON AM-372 16-WATT STEREO AMPLIFIER**  
Here's a really good amplifier at a really down-to-earth price - nearly £7 less than the normal retail value! Just look at what the AM-372 will do for you - reproduce signals from ceramic or crystal cartridges, AM and FM tuners, and tape recorders. And it gives you outputs for two sets of speakers, headphones and tape recorders. Frequency response is 30 to 20,000 Hz  $\pm$  3dB. Output 8 watts r.m.s. per channel music power into 8 ohm speakers. Phono input 200mV. Tuner input 200mV. Size: 12 1/2" wide, 3 1/2" high, 7 1/2" deep.

**ROCELECTRONICS LTD**  
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Plays 12", 10" or 7" records. Auto or Manual. A high quality unit backed by BSR reliability with 12 months' guarantee. AC 200/250V. Size 13½ x 11½ in. Above motor board 3½ in. Below motor board 2½ in.



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Plays all records

RCS DE-LUXE 3 WATT AMPLIFIER. Ready made, tested. Printed circuit. 3 watts output. Tone and volume controls. Complete with output valve and rectifier, two knobs, and high performance loudspeaker. Double wound fully isolated mains transformer. A.C. mains 200/250V. Response 50-12,000 cps. Sensitivity 300mV. £4 Post 25p

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4 speeds. Plays all sizes of records. 4 pole heavy duty motor. 9 in. steel turntable. Plug in head complete with stereo/mono cartridge. Adjustable stylus pressure. Auto-stop. Brown and Cream finish. AC mains 110/240V. Base plate size 12½ in. 8 in. Operating area 14 in. x 12½ in. Above motor board 3 in., below motor board 2½ in. Ideal for Home Hi-Fi or Discoteque.



GARRARD AUTOCHANGERS with Sonotone Cartridges. Stereo Diamond and Mono Sapphire. Model 1025 £10. Model 3500 Stereo and Mono Autochanger £14. Post 25p.

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### SINGLE PLAYER

Heavy duty 4-speed motor with separate pick-up arm fitted LP/78 turnover mono £4-50 cartridge



HI-FI PICK UP CARTRIDGES. Diamond LP/Stereo, Stereo/Mono 9TA £2-50; GP84 £2-50; GP83 £2. Sapphire Mono GP91 £1-50; Powerpoint LP/78 60p.

## GARRARD DECCADEC SP25 Mk. II RECORD PLAYER

Single play Stereo/Mono Derram transcription head and arm. Four speeds. 10½ in. turntable. Anti-rumble filter. Bias compensation. Laboratory motor.



SPECIAL PRICE £18-50 Post 25p

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Cut out for most Garrard or B.S.R. Most will play with cover in position. Latest Design. Covered in black leatherette. Antimagnetic. 12½ x 14½ x 7½ in. high. Post 25p

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32/450V 20p 8+8/450V 18p 350+50/325V 45p  
25/25V 10p 8+18/450V 20p  
50/50V 10p 16+18/450V 25p 32+32+32/350V 43p  
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5000mF 6V 25p; 12V 42p; 25V 75p; 50V 95p.

CERAMIC, 1pF to 0.01µF, 4p. Silver Mica 2 to 5000pF, 4p. PAPER 50V 0.1µF, 0.1µF, 1µF 15p; 2mF 150V 15p. 500V 0.001 to 0.05µF, 0.1µF, 0.25µF, 0.47µF, 25p. SILVER MICA. Close tolerance 1%, 2.2-500pF 8p; 560-2,200pF 10p; 2,700-5,800pF 20p; 8,000pF-0.01, mid 30p each. TWIN GANG. "0-0" 208pF+176pF, 65p; Slow motion drive 365pF+365pF with 25pF+25pF, 50p; 500pF slow motion, standard 45p; small 3-gang 300 pF £1-60. SHORT WAVE SINGLE 10pF, 30p, 25pF, 55p, 50pF, 55p.

SHORT WAVE SINGLE GANG. Precision Silver Plated Gangable Tuning Condensers. 50p each Values up to 100pF. Section Couplers supplied FREE with two or more gangs.

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HEATER TRANS. 6.3 v. 3a. 25 ohms to 1 meg. 60p  
Ditto tapped sec. 1.4 v. 2, 3, 4, 5, 6.3 v. 1½ amp. 95p  
GENERAL PURPOSE LOW VOLTAGE. Tapped outputs at 2 amp. 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30v. £2-25  
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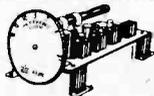
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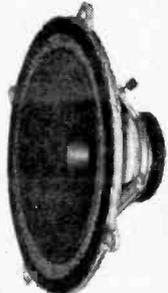


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with lids and screws

Type	L	W	D	Price p. & p.
GB7*	5 1/2 in	2 1/2 in	1 1/2 in	38p 15p
GB8*	4 in	4 in	1 1/2 in	38p 15p
GB9*	4 in	2 1/2 in	1 1/2 in	38p 13p
GB10*	5 1/2 in	4 in	1 1/2 in	44p 18p
GB11	4 in	2 1/2 in	2 in	38p 13p
GB12	3 in	2 in	1 in	33p 13p
GB13	6 in	4 in	2 in	52p 18p
GB14	7 in	5 in	2 1/2 in	63p 19p
GB15	8 in	6 in	3 in	81p 26p
GB16	10 in	7 in	3 in	92p 26p

\* These sizes fit standard veroboards

**EQUIPMENT CASES**  
with sloping front panel

Type	H	W	D	Price p. & p.
SF1	2 in	5 1/2 in	2 1/2 in	45p 12p
SF2	2 in	7 1/2 in	3 1/2 in	60p 16p
SF3	2 in	9 1/2 in	4 1/2 in	75p 19p

Plain aluminium.  
Stove - enamelled silver-grey hammer finished, 20p extra.

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

Type	W	A	B	C	D	Price p. & p.
GB20	8	9	3 1/2	3	1	£1.42 30p
GB21	10	9	3 1/2	3	1	£1.58 30p
GB22	12	9	3 1/2	3	1	£1.72 30p

**VEROBOARD**

Size	0-1 matrix	0-15 matrix
2 1/2 in x 3 1/2 in	22p	16p
3 in x 5 in	24p	25p
3 1/2 in x 3 1/2 in	24p	25p
3 1/2 in x 5 in	27p	29p
1 7/8 in x 2 1/2 in	75p	57p
1 7/8 in x 3 1/2 in	41p	78p

Pins—either size; packet of 36, 18p

**ELECTROLYTICS**

1µF 450V	19p	1,000µF 25V	27p
2µF 500V	20p	1,000µF 50V	39p
4µF 350V	14p	2,000µF 25V	36p
6µF 450V	16p	2,000µF 50V	53p
16µF 450V	17p	2,500µF 25V	45p
25µF 25V	7p	2,500µF 50V	60p
25µF 50V	8p	3,000µF 25V	48p
32µF 450V	24p	5,000µF 25V	55p
50µF 50V	10p	5,000µF 50V	98p
100µF 25V	10p	8-8µF 450V	18p
100µF 50V	10p	8-16µF 450V	20p
250µF 25V	12p	16-16µF 450V	27p
250µF 50V	17p	16-32µF 450V	63p
500µF 25V	18p	32-32µF 450V	49p
500µF 50V	25p	50-50µF 350V	38p

**MINIATURE ELECTROLYTICS**

1µF 63V	6p	47µF 16V	7p
2.2µF 63V	6p	47µF 25V	6p
3.3µF 63V	6p	68µF 16V	6p
4.7µF 63V	6p	100µF 10V	6p
6µF 40V	7p	220µF 16V	7p
10µF 25V	6p	330µF 16V	11p
10µF 64V	7p	470µF 10V	11p
16µF 40V	7p	1,000µF 16V	19p
30µF 15V	7p	1,500µF 16V	23p

**CASSETTE OWNERS!**

For Philips and similar cassette recorders.  
PU12 Power unit for connection to 12V + or - E car electrical systems, giving 7 1/2V, stabilised output. **£3.25**

PU14 As above but switched for 6V, 7 1/2V or 9V output. **£5.10**

PP75 Mains power supply, output 7 1/2V d.c. **£1.95**

All units are complete with cable and plug.

**VARIABLE POWER SUPPLY**

Input: 240V, a.c.  
Output: Switched 3, 4.5, 6, 7.5, 9, 12 volts d.c. at 500mA **£4.20**

**BATTERY ELIMINATORS**  
suitable for transistor radios and similar light current equipment

PP6 Input 240V a.c. Output 6V d.c.  
PP9 Input 240V a.c. Output 9V d.c.  
Price £1.50 plus 12p p. & p.

**NEW ILLUSTRATED 1972-73 CATALOGUE**  
Post Free 15p

**CONTROLS, Log. or Lin.**

Single, less switch, 15p  
Single, D.P. switch, 24p  
Tandem, less switch, 40p  
5KΩ, 10kΩ, 25kΩ, 50kΩ, 100kΩ, 250kΩ, 500kΩ, 1MΩ, 2MΩ

**SLIDER CONTROLS, 87mm.**  
complete with knobs.

Single, 44p; Tandem, 55p. 10kΩ, 25kΩ, 50kΩ, 100kΩ, log. or lin.

**RESISTORS**

Carbon  
All 5%, high-stability, E12 values. ±W, 1p; ±W, 1p; 1W, 4p; 2W, 6p

Wire-wound  
5W, 10p; 10W, 12p

**LOUDSPEAKERS**

7 in x 4 in, 3Ω—£1.12, 8Ω—£1.12, 15Ω—£1.40.  
8 in x 5 in, 3Ω—£1.85, 8Ω—£1.77, 15Ω—£1.70.  
10 in x 6 in, 3Ω—£2.32, 8Ω—£2.32, 15Ω—£2.32.  
Bin round, 3Ω—£2.10, 8Ω—£2.50, 15Ω—£2.10.  
Adastr "Hi-Ten", 10in, 10W, 8 or 15Ω—£3.40.  
Please add 20p p. & p. to all speakers.

**BONDED ACRYLIC FIBRE**  
B.O.F. wadding, 18in wide, lin thick. The ideal lining for speaker enclosures. 25p per yard.

**PLUGS**

Car aerial 14p  
Co-axial 9p  
D.I.N. 2 pin (speaker) 10p  
D.I.N. 3 pin 13p  
D.I.N. 4 pin 14p  
D.I.N. 5 pin, 180° 13p  
D.I.N. 5 pin, 240° 15p  
D.I.N. 6 pin 15p  
Jack, 2 1/2mm unscreened 9p  
Jack, 2 1/2mm screened 10p  
Jack, 3 1/2mm unscreened 8p  
Jack, 3 1/2mm screened 12p  
Jack, 4 1/2mm unscreened 12p  
Jack, 4 1/2mm screened 20p  
Jack, stereo, unscreened 20p  
Jack, stereo, screened 35p  
Phono, plastic top 5p  
Phono, plated metal 12p  
Phono, fitted 4 ft lead 8p  
Wander, red or black 3p  
Banana 4mm, red or black 6p



**SOCKETS**

Car aerial 8p  
Co-axial, surface 8p  
Co-axial, flush 10p  
D.I.N. 2 pin (speaker) 9p  
D.I.N. 3 pin 9p  
D.I.N. 5 pin, 180° 9p  
D.I.N. 5 pin, 240° 9p  
Jack, 2 1/2mm 10p  
Jack, 3 1/2mm 10p  
Jack, 4 1/2mm unscreened 15p  
Jack, 4 1/2mm screened 24p  
Co-axial 17p  
Jack, 4 1/2mm switched 15p  
Jack, stereo, switched 25p  
Phono, single 16p  
Phono, 2 on a strip 16p  
Phono, 3 on a strip 16p  
Phono, 4 on a strip 10p  
Wander, single, red or black 5p  
Wander, twin strip 7p  
Banana 4mm red, or black 6p

**LINE SOCKETS**

Car aerial 14p  
Co-axial 17p  
D.I.N. 2 pin (speaker) 15p  
D.I.N. 3 pin 16p  
D.I.N. 5 pin, 180° 16p  
D.I.N. 5 pin, 240° 16p  
Jack, 3 1/2mm 10p  
Jack, 4 1/2mm screened 49p  
Jack, stereo, screened 30p  
Phono, plated metal 14p

**CAPACITORS**

2.2pF	500V	S/M	71p	0.0027µF	500V	S/M	15p
3.3pF	500V	S/M	71p	0.003µF	500V	Cer.	5p
5pF	500V	S/M	71p	0.0033µF	1,000V	MDC	6p
10pF	125V	P.S.	5p	0.0036µF	500V	S/M	15p
10pF	500V	S/M	71p	0.0047µF	125V	P.S.	9p
15pF	125V	P.S.	5p	0.0047µF	500V	Poly.	6p
15pF	500V	Cer.	4p	0.0047µF	500V	S/M	20p
18pF	500V	S/M	71p	0.0047µF	1,000V	MDC	6p
22pF	125V	P.S.	5p	0.005µF	100V	Mylar	3p
22pF	500V	P.S.	71p	0.005µF	500V	Cer.	5p
22pF	500V	S/M	71p	0.0068µF	125V	P.S.	10p
27pF	500V	Cer.	5p	0.0068µF	500V	S/M	30p
33pF	125V	P.S.	5p	0.0068µF	500V	Poly.	6p
33pF	500V	S/M	71p	0.0082µF	125V	P.S.	10p
39pF	500V	S/M	71p	0.0082µF	500V	S/M	30p
47pF	125V	P.S.	5p	0.01µF	18V	Disc	4p
47pF	500V	Cer.	4p	0.01µF	125V	P.S.	10p
50pF	500V	S/M	71p	0.01µF	160V	Poly.	4p
56pF	500V	S/M	71p	0.01µF	250V	M.F.	3p
68pF	125V	P.S.	5p	0.01µF	400V	Poly.	3p
68pF	500V	S/M	71p	0.01µF	500V	Cer.	5p
75pF	500V	S/M	71p	0.01µF	500V	S/M	30p
82pF	500V	S/M	71p	0.01µF	500V	MDC	7p
100pF	125V	P.S.	5p	0.015µF	1,000V	MDC	9p
100pF	500V	S/M	71p	0.015µF	160V	Poly.	3p
100pF	500V	Cer.	5p	0.015µF	400V	Poly.	3p
120pF	500V	S/M	71p	0.02µF	100V	Mylar	3p
150pF	125V	P.S.	5p	0.022µF	18V	Disc	5p
150pF	500V	S/M	71p	0.022µF	250V	M.F.	3p
150pF	500V	Cer.	5p	0.022µF	400V	Poly.	3p
180pF	125V	P.S.	5p	0.022µF	600V	MDC	71p
200pF	500V	S/M	71p	0.022µF	1,000V	MDC	9p
220pF	125V	P.S.	5p	0.033µF	250V	M.F.	4p
220pF	500V	Cer.	5p	0.033µF	400V	Poly.	4p
250pF	500V	S/M	8p	0.047µF	12V	Disc	6p
270pF	500V	Cer.	5p	0.047µF	160V	Poly.	3p
300pF	500V	S/M	8p	0.047µF	250V	M.F.	3p
330pF	125V	P.S.	5p	0.047µF	400V	Poly.	4p
330pF	500V	S/M	8p	0.047µF	600V	MDC	8p
390pF	500V	S/M	8p	0.047µF	1,000V	MDC	10p
470pF	125V	P.S.	5p	0.1µF	30V	Disc	6p
470pF	750V	Disc	5p	0.1µF	250V	M.F.	4p
500pF	500V	S/M	8p	0.1µF	400V	Poly.	5p
560pF	500V	S/M	8p	0.1µF	600V	MDC	13p
680pF	125V	P.S.	5p	0.1µF	1,000V	MDC	13p
680pF	500V	S/M	8p	0.15µF	250V	M.F.	5p
820pF	500V	S/M	8p	0.22µF	160V	Poly.	6p
0.001µF	100V	Mylar	3p	0.22µF	250V	M.F.	5p
0.001µF	125V	P.S.	6p	0.22µF	400V	Foil	10p
0.001µF	400V	Poly.	3p	0.22µF	1,000V	MDC	15p
0.001µF	500V	S/M	10p	0.33µF	250V	M.F.	8p
0.001µF	500V	Cer.	5p	0.47µF	250V	M.F.	8p
0.001µF	1,000V	MDC	6p	0.47µF	400V	Foil	15p
0.0015µF	400V	Poly.	3p	0.47µF	1,000V	MDC	20p
0.0015µF	500V	S/M	10p	1.0µF	250V	M.F.	15p
0.0015µF	500V	Cer.	5p				
0.0018µF	500V	S/M	10p				
0.002µF	100V	Mylar	3p				
0.002µF	500V	Cer.	5p				
0.0022µF	125V	P.S.	6p				
0.0022µF	500V	S/M	10p				
0.0022µF	1,000V	MDC	6p				

Note:  
S/M = silver mica 1% tol.  
P.S. = polystyrene 2 1/2% tol.  
MDC—a.c. rating = 300V.  
M.F. = Mullard min. foil.  
Cer. = ceramic.

**MAIL ORDERS:** Some items have a post and packing charge shown against them. Where p. & p. is not shown the charge is 12p for any selection. When both classes of goods are ordered the charge is 12p plus 20p p. & p. charges shown. (Overseas extra.) Telephone 01-692 4412

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BFS96 13p	ZTX312 9p	ZTX530 19p	ZS172 14p	KSO47A 17p
BFS97 21p	ZTX313 10p	ZTX531 20p	ZS174 15p	KSO51A 17p
BFS98 18p	ZTX314 11p	ZTX550 15p	ZS176 21p	KSO56A 17p
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ZTX302 15p	ZTX501 11p	ZS140 22p	KSO30A 17p	KS150A 17p
ZTX303 12p	ZTX502 15p	ZS141 39p	KSO33A 17p	KS180A 17p

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Set of Main Amp. semiconductors (stereo)	£5-60
Set of Pre-amp. semiconductors (stereo)	£1-55
Set of Power Supply semiconductors	£2-15
Main amp. printed circuit board	£1-45
Pre-amp. printed circuit board	£1-95
Power Supply printed circuit board	£0-60
(P.C.B.'s are glass fibre and are roller tinned and drilled)	
Set of GEMINI TUNER semiconductors	£6-60

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350 ZS170	£20-00	110 ZTX300	£9-50
24 ZN7474E	£14-40	14 KSO47A	£2-30

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5 transistor amplifier complete with volume control, is suitable for 9V d.c. and a.c. supplies. Will give about 1W at 8 ohm output. With high I.M.P. input this amplifier will work as a record player, baby alarm, etc. amplifier.



£1-75

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Enables you to work your Transistor Radio, Amplifier or Cassette, etc., from the a.c. mains through this compact Eliminator. Just by moving a plug you can select the voltage you require, 6, 7 1/2 or 9 volt. This means all your transistor power pack applications can be handled by this one unit. Approx. size 2 1/2 in x 2 1/2 in x 3 1/2 in. Our Price £2-75 plus 10p P. & P. Same model suitably wired for the Philips Cassette £3 plus 10p P. & P.



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24-hr. Nixie dig. clock kit. We supply: a complete set of components; a complete set of easy to follow instructions; printed circuits made to make construction as simple as possible; a cabinet and front panel to give a professional finish. All for the price of the components. £22-50 + 50p P. & P. Please send S.A.E. if you require more information.



### EA1000 3 WATT AUDIO AMPLIFIER

An Audio Amplifier designed around the TAA821 Linear I.C.:-  
Supply Voltage . . . . . 9-24V  
Speaker Imp . . . . . 8-16 ohm  
Frequency . . . . . 50Hz-25kHz  
Overall Size . . . . . 2in x 3in x 1 1/2in  
Ideal Amplifier for radios, record players, stereo units, etc.  
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3 volt 70 ohm.  
Single Pole Changeover . . . . . 40p plus 5p P. & P.  
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1B40K05  
Bridge Rectifier (Texas)  
Plastic encapsulated 50V  
at 4A. Approx. size 1 1/2in. x 1 1/2in. x 1 1/2in. Our Price 80p each.

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2 1/2in 8 ohm . . . . . 50p  
2 1/2in 80 ohm . . . . . 50p  
2 1/2in 40 ohm . . . . . 50p  
Please include 5p P. & P. each L.S.



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EMI LOUSPEAKER 450  
10W 13in x 8in ± two 2-2 1/2in  
tweeters and cross-over. All wired  
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Three Channel: Bass—Middle—Treble. Each channel has its own sensitivity control. Just connect the input of this unit to the loudspeaker terminals of an amplifier, and connect three 250V up to 500W lamps to the output terminals of the unit, and you produce a fascinating sound-light display. (All guaranteed) £18-50 plus 38p P. & P.



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## PROBLEMS OF PROGRESS

THE pace of technical progress has become so accelerated that many interesting developments and techniques, especially in the field of integrated circuits, hardly see the light of day before their demise is threatened by yet another new development. Innovation leap-frogs innovation, and consequently valuable and thought-provoking devices become redundant long before they have been fully exploited. This poses problems to industrial users of such components, and despite crystal-ball gazing and shrewd planning ahead, many equipment makers have been caught out by this explosive state of the art.

The break-through in small calculator designs based on the single-chip i.c. is an outstanding case at this particular time. Commercial desk calculators costing in the region of £250 have been replaced overnight by new instruments selling at one third the price. Business people who purchased their calculator last year must be wringing their hands and wishing they had waited until the spring of '72. But it is easy to be wise after the event.

The same problem, although on a smaller scale, affects a magazine such as ours, catering for the private constructor. Does one sit back neglecting contemporary and readily available devices, just waiting for the "ultimate" one to turn up? For example, to have knowledge of impending changes in i.c. design that are likely to revolutionise the commercial calculator in the near future is one thing; it is quite a different thing, though, to predict with any certainty if and when these new l.s.i. chips will be made available to private individuals—and if so at what cost.

In such circumstances the P.E. Digi-Cal desk calculator was commissioned. The abundance of cheap TTL devices seemed to justify such a project being presented to the private constructor. The total cost of material for this project made it a most favourable proposition in view of the then prevailing cost of a comparable commercial instrument. However, between the completion of this design and the publication of the first article, the big break-through in cheap commercial calculators occurred.

Though "priced out of the market" the Digi-Cal remains a unique and valuable contribution to the record of design information published expressly for the benefit of private constructors and electronics enthusiasts. As an education exercise, the real worth of this project cannot be denied. Certainly it offers the technically inquisitive far more than the mere assembly of any commercial kit can possibly provide.

F.E.B.

## THIS MONTH

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### SPECIAL DATA SHEET

#### I.C. LEAD-OUT IDENTICHART

We apologise for any slight loss of quality of print in this month's issue. Supplies of the normal paper were not available due to the Docks Dispute.

*Our November issue will be published on  
Friday, October 13*

**M**OST of the cheaper intercoms on the market at the present time have a low output which can be very distorted. In order to overcome these difficulties it was decided to build a battery powered intercom using an integrated circuit chosen from the General Electric range of audio amplifiers.

The i.c. chosen was the PA234 which has a quoted output of just under one watt when working from an 18V supply with a typical distortion of three per cent. A preamplifier is needed to drive this i.c. and a simple, one transistor, common base type is used.

Even though the basic system described here is only a simple master/slave one it is very easy to extend it to master/master or master and two or more slaves, with or without call facilities; the necessary alterations for these additions are given at the end.

As no commercial cases could be found which looked right, it was decided to build these as well.

### CIRCUIT OPERATION

The amplifier circuit diagram is shown in Fig. 1. It will be seen that TR1 is connected in the common base mode which is relatively rare.

In this configuration the signal is applied to the emitter producing the advantages of low input impedance—of the order of approximately 50 ohms, and a high output impedance, thus making it ideally suited to its purpose.

The microphone/speaker is a 25 ohm loudspeaker and this is easily matched to the preamplifier stage, another advantage being that this configuration prevents inductive pickup from TV sound. Whilst experimenting with the prototype a standard high gain common emitter preamplifier was used and the TV pickup drowned all other signals.

The purpose of C1 is to filter out any TV or other radiated interference; the final version gives

no mains hum even though the cables run alongside mains leads for some distance.

The biasing for TR1 is provided by R1, R2 and C2 which ensures that the base is near earth potential as far as alternating signals are concerned. R3 serves a dual purpose in that it reduces the supply of 18V down to 9V for the preamplifier and in conjunction with C3 decouples the two stages preventing any feedback via the supply.

Potentiometer VR1 is a volume control and should be adjusted to give the best output. The signal is then fed via C4 and R4 to the input terminal, pin 3, of the i.c. The ratio of R5 to R6 is determined from the manufacturer's data sheet and controls the correct biasing of the i.c., whilst the gain is determined by the ratio R5 to R4.

The output is stabilised against oscillation by the capacitor C5, and C7 further stabilises the arrangement.

The circuit for the call oscillator is given in Fig. 2 and it will be seen that it is a conventional multi-vibrator working at about 1kHz. Other frequencies can be selected by varying R8, R9 and C8, C9.

The power supplies are two PP6 batteries connected in series to give 18 volts.

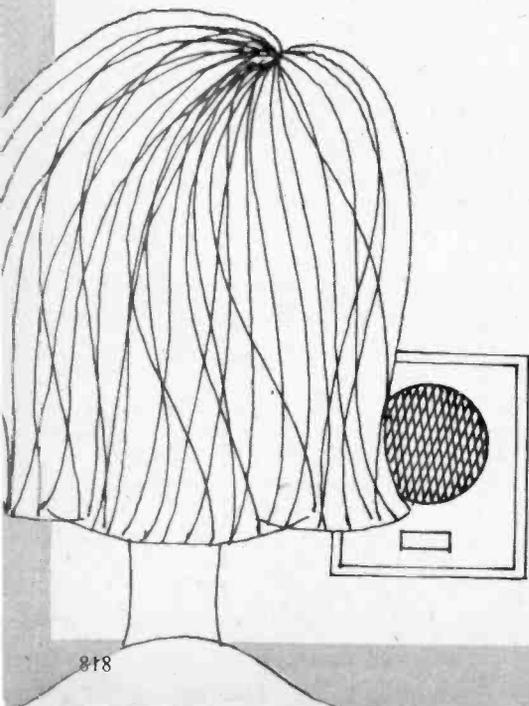
### MASTER/SLAVE SWITCHING

Fig. 3 shows a simple master/slave set up. S1 is a miniature lever key switch having four sets of changeover contacts on each side. This switch is wired so that when the key is in the central position the master loudspeaker is in the listen mode. If now S2 is operated then power is applied to the amplifier and the slave can talk to the master.

Should the master wish to call the slave then pushing the key one way the oscillator which provides the calling tone and the amplifier are both powered and the output is fed to the slave speaker.

Pushing the key the other way switches the slave to the listen position thus enabling the master station to speak. This arrangement of switching ensures that privacy is enjoyed by the slave station—the master can not easily listen in, though, if desired, by mounting S2 at the master end one can control all functions from the one position.

The wiring of the switch is shown in Fig. 7.



# I.C. INTERCOM

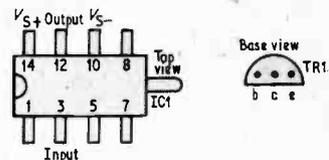
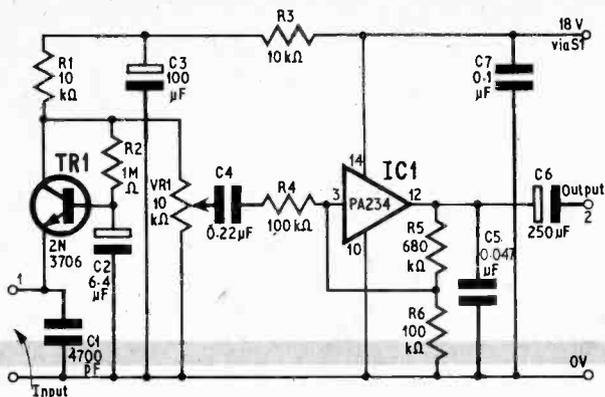


Fig. 1. Circuit diagram of the main amplifier

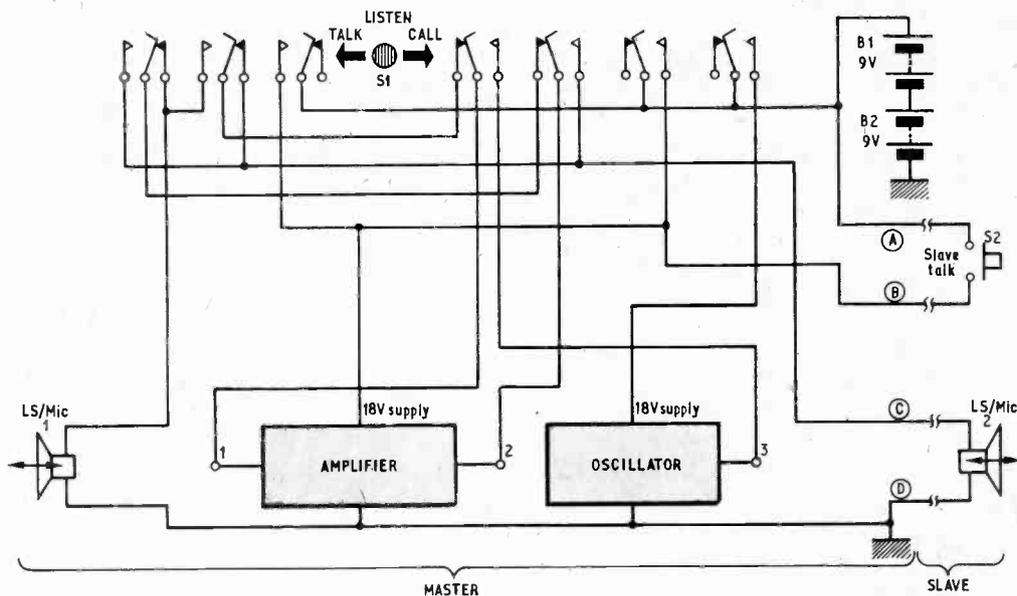


Fig. 3. Diagram showing the switching arrangement for a simple master/slave system. Only four wires connect the master to the slave (labelled A, B, C, D). Switch S2 and loudspeaker LS/MIC2 are in the slave

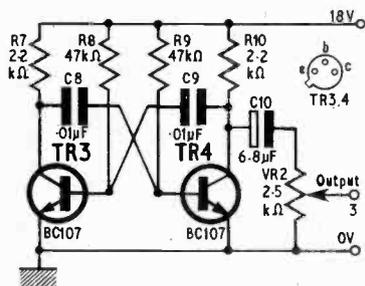
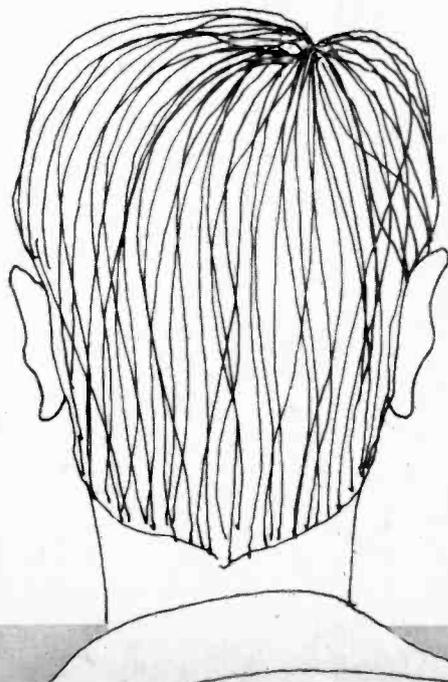


Fig. 2. Circuit diagram of the call oscillator



By R. A. PENFOLD

# COMPONENTS . . .

## AMPLIFIER BOARD

### Resistors

- R1 10k $\Omega$
- R2 1M $\Omega$
- R3 10k $\Omega$
- R4 100k $\Omega$
- R5 680k $\Omega$
- R6 100k $\Omega$
- All  $\pm 10\%$ ,  $\frac{1}{4}$ W carbon

### Potentiometer

- VR1 10k $\Omega$  log.

### Capacitors

- C1 4,700pF
- C2 6.4 $\mu$ F 25V elect.
- C3 100 $\mu$ F 25V elect.
- C4 0.22 $\mu$ F
- C5 0.047 $\mu$ F
- C6 250 $\mu$ F 30V elect.
- C7 0.1 $\mu$ F

### Semiconductors

- TR1 2N3706
- IC1 PA234 (General Electric)

### Speakers

- LS/MIC1, LS/MIC2 22 $\Omega$  3in (2 off)

### Switches

- S1 Miniature lever Keyswitch, 4 pole changeover in each position
- S2 Push on, release off push button

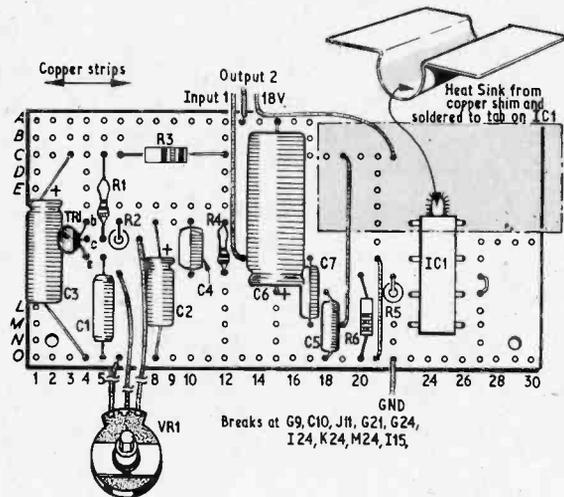


Fig. 4. Layout of the components on the amplifier board. The copper heatsink is carefully soldered to the i.c. tab

## COMPONENT ASSEMBLY

The components are mounted on 0.1-in pitch Vero-board as shown in Fig. 4 and Fig. 5, and special care is needed to ensure that no solder bridges are formed between adjacent strips. No real trouble should be encountered in the construction providing the diagrams showing the layout are followed carefully and that all breaks are made.

When soldering the i.c. in position do not leave the iron in place for too long. The i.c. needs a heat sink of at least 1 sq in and this can be made from an offcut of phosphor bronze draught strip though any copper or tin sheet will do. This heat sink, which should be bent so that it does not touch other components, is soldered directly onto the tab attached to the i.c.—take great care not to bend this tab too much or else it will break off and render the i.c. useless.

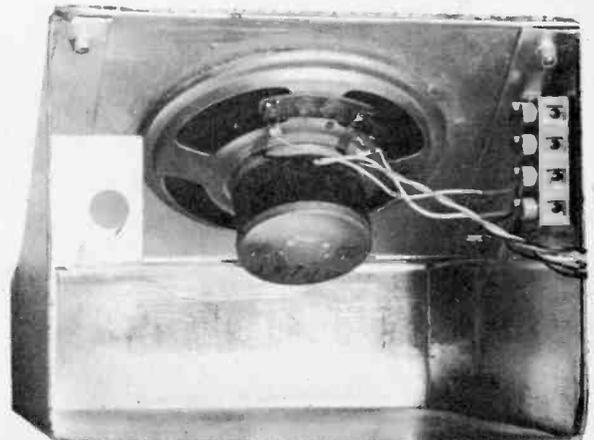
## CASE CONSTRUCTION

The case for the master station was made from 20 gauge aluminium sheet. Fig. 6 gives the various details of sizes and cuts to be made.

A number of home constructors are put off making their own cases by the thought that it is too difficult and that the finished job will look "home made". Provided that the aluminium is marked out accurately and carefully before any cuts or bends are made no difficulty should be encountered.

When all the various bits have been cut out an Abra-file can be used to cut the hole for the loud-speaker and key switch. The exact size of these will depend on the actual components obtained. The holes for fixing the key switch should be drilled at the same time.

The inside of the master box is seen here with the components removed from their positions. The brackets which hold the potentiometer and the call oscillator board can be seen fixed to the inside



# COMPONENTS . . .

## OSCILLATOR BOARD

### Resistors

- R7 2.2kΩ
- R8 47kΩ
- R9 47kΩ
- R10 2.2kΩ
- All ±10%, ¼W carbon

### Potentiometer

- VR2 2.5kΩ miniature skeleton preset

### Capacitors

- C8 0.01μF
- C9 0.01μF
- C10 6.8μF 35V elect.

### Transistors

- TR3, TR4 BC107 or similar

### Miscellaneous

- B1, B2 9V battery (2 off)
- 0.1in matrix Veroboard (see text for sizes)
- Aluminium for cases
- Terminal block, copper for heatsink, four way connecting wire

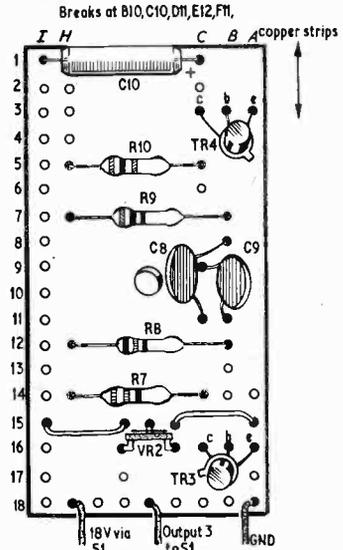


Fig. 5. Layout of the components on the call oscillator board

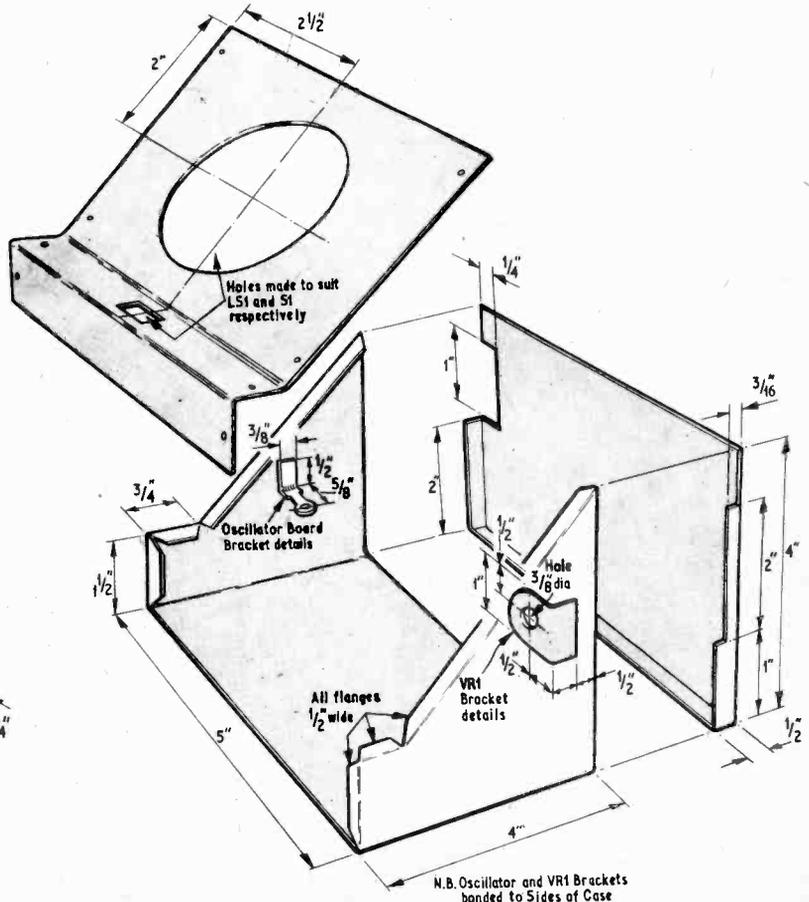
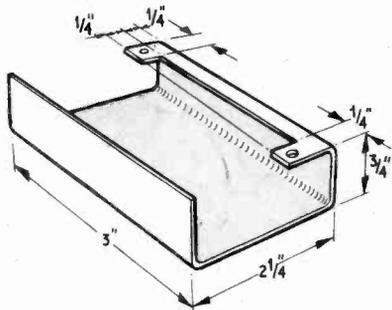


Fig. 6. Construction of the case for the master. 20 s.w.g. aluminium should be used and cut and bent to the sizes shown



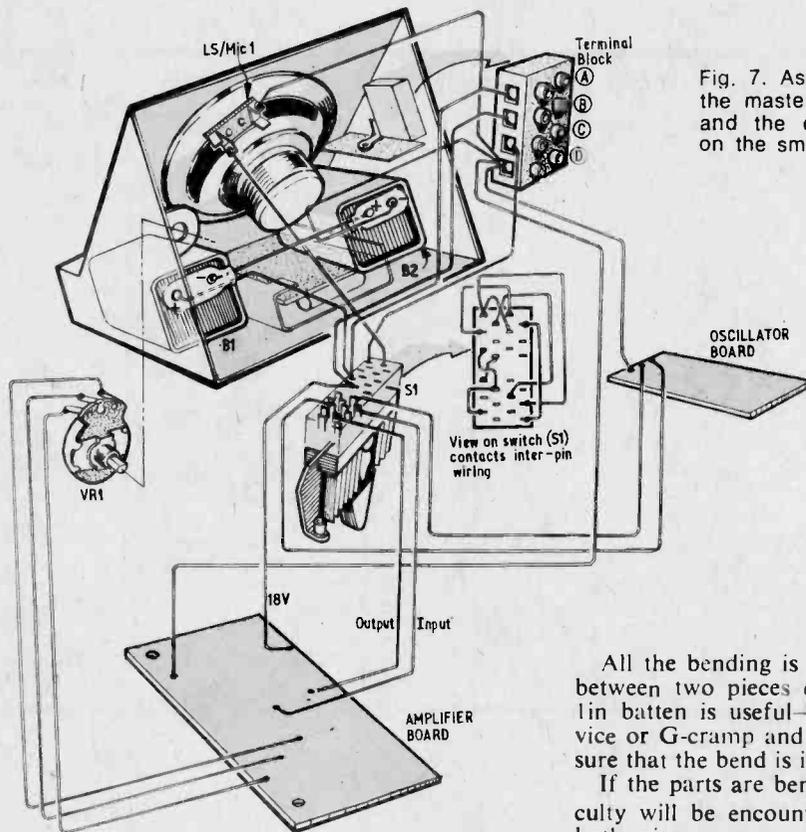
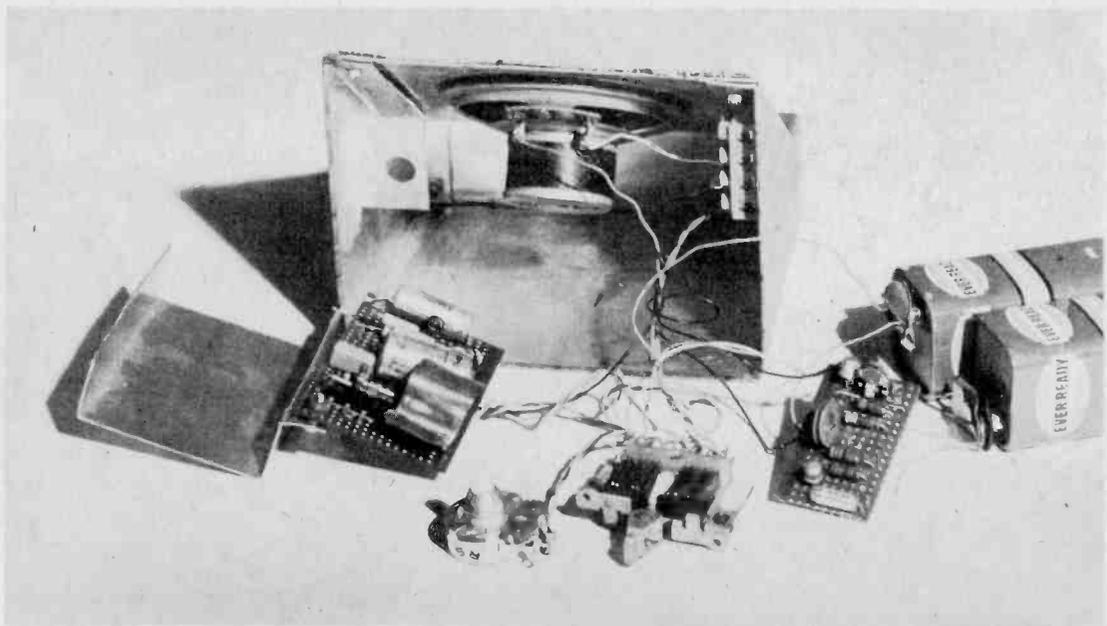


Fig. 7. Assembly and interwiring of the master box. The potentiometer and the call oscillator are mounted on the small brackets as shown

All the bending is done by placing the aluminium between two pieces of suitable sized wood—2in × 1in batten is useful—clamping the ends either in a vice or G-cramp and then carefully bending, making sure that the bend is in the correct direction!

If the parts are bent in a logical sequence no difficulty will be encountered with the overlaps. When both pieces are completed offer them up together and hold in place whilst you drill suitable holes for holding them together; self tapping screws or pop rivets are ideal. Then cover the sloping front with speaker cloth and the rest with Fablon or similar.



## ASSEMBLY OF THE UNIT

When fitting the switch it is necessary to wire it up first and then fit it in position.

Any offcuts left can be used to make the bracket for VR1 which is glued in position using Evostick or Araldite. Other pieces can be used to make the circuit board support. The terminal block is also glued to the inside of the case on the opposite side to VR1 as shown in Fig. 7.

The case for the slave station can be purchased, adapted from an available tin or constructed from aluminium. It should be covered in the same way as the master station.

The amplifier circuit board should then be

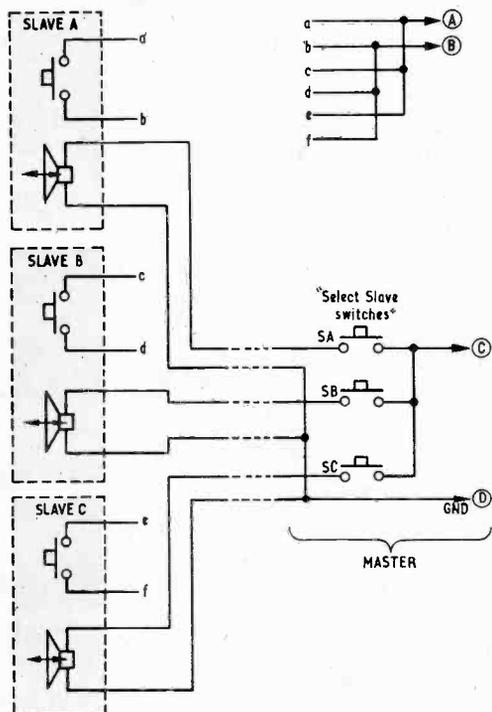


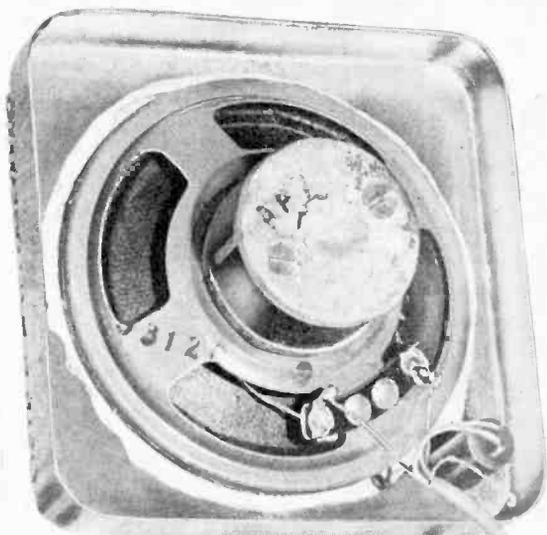
Fig. 8. Switching arrangement to give multiple slave operation, though none of the slaves has a call facility. The "select slave" switches are push buttons mounted on the master box

mounted on the bracket shown using insulating washers to ensure that the Veroboard strip is not shorted. The call oscillator can be mounted on its bracket which is then glued to the inside of the case behind the terminal block; to aid adjustment it helps if the preset on this board is easily accessible.

## TESTING THE FINISHED UNIT

Before commencing testing ensure that all components are in the correct position, that their values and polarities are as in the diagram and also that you have made all the breaks. Trace all wires to see that they do go to the right terminals and most important that no solder bridges are present.

When you are completely satisfied connect the external speaker and plug the batteries in. It helps

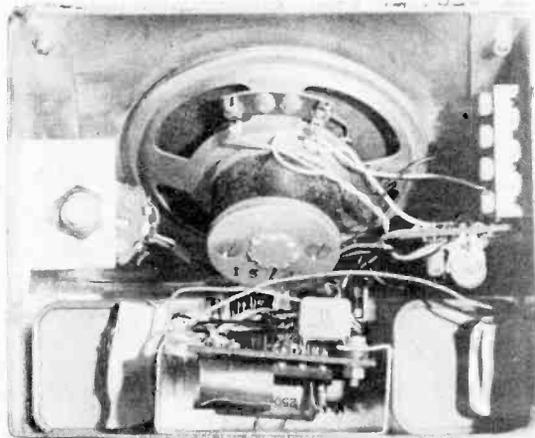


The internal construction of the slave showing the speaker and the push button in place

if a working transistor radio is placed near the slave station, when the switch is pushed one way you should hear the radio—adjust VR1 to give the best results. If testing is carried out with the stations too close together, feedback will occur giving an almighty howl.

Should you have no helper available you can short the two terminals taking power to the slave button at the master terminal block, this will be the same as pressing the "talk" button at the slave. Should there be a lot of distortion occurring when the slave talk button is pressed and the only cure is to reduce the volume you can try decoupling the two power lines going to the slave with a capacitor—say 50 $\mu$ F—connected across the appropriate terminals at the station end. When the lever key is pushed towards "call" the tone should sound in the slave speaker. The volume and quality can be adjusted to some extent by altering the value of the preset on the oscillator board.

*continued on page 839*



Completed master unit



## GRAVITATIONAL WAVES

Some time ago details of an experiment to detect gravitational waves by radio was described. This experiment, which was originally suggested by Dr John Jelley, made some stir when the results were reported in *Nature*. There were two series of the experiments but the results were negative. There were certain difficulties mainly due to the high level of noise on the frequency of operation.

The original paper on gravitational waves was put forward by Joseph Weber in 1969. He claimed at that time that he detected these waves as coming from the centre of the Galaxy.

The possibility of these waves was predicted by Einstein in 1916 but nothing much was attempted in the way of investigation. The principle which underlies the theory is that gravitational waves are a form of radiation which affects mass. Small displacements of mass are caused by the radiation setting up a definite vibration. If they are in line with the radiation the masses do not move with respect to each other.

Professor Weber's experiment was made with two huge aluminium cylinders deep down in the earth. Though Weber is satisfied that his results are positive, and indicate quite definitely that these waves come from the galactic centre, not all the scientific community accepts this.

## SOURCE CONFIRMED

It is, therefore, quite a move forward when independent experimenters confirm the source of the waves. Three physicists from Israel have published some work on their

experiments and it seems to be a big step forward in this field. They are using the earth itself as the detector. Its great mass is much more sensitive than arrays of discs or cylinders.

If these waves are in fact coming from a specific point in the galaxy, then using the earth as a detector, all those points in line with the waves would vibrate the earth. Since the earth revolves on its axis this particular point on the earth would show a peak of activity twice in a sidereal day.

This effect will occur every 11hr 58min and has been detected by Dr Sadeh of Tel Aviv and Dr A. Ben-Menahem of the Weizmann Institute. They have set up a seismometer in the fairly noise free area on the Gulf of Aqaba.

The team set out to discover if pulsars were the cause of the gravitational waves; pulsars are dense stars and revolve very rapidly. Since it is unlikely that they are completely homogeneous, there will be angular moments which will show as a variation of the gravitational effect. In other words there will be a certain frequency of change which could be detected.

## FIRST EVIDENCE

The first evidence that this was right thinking came in 1971. The Israeli physicists found that there was a peak in the recording which corresponded to a periodicity of 0.53-0.60 seconds. Moreover, as each day passed the event came a little earlier in time. This was a clear indication that the origin of this event was outside the earth.

The twice a day response confirmed that the position of the source was at a celestial longitude of Right Ascension 11hr 33min. This position corresponded to the pulsar known as CP 1133.

As a check on this the team have examined the radio period of the pulsar and find that their events are in agreement. According to the present model of the pulsar, the radio pulses occur once with each revolution of the star. Gravity waves however would be emitted twice every revolution. Measurements confirmed that the seismometer events did occur at twice the rate of the radio pulses from CP 1133. The actual period of the gravitational waves is 0.594 seconds.

It would seem that there is a chance for confirmation of Weber's untiring efforts in this field. Certainly the benefits to astrophysics will be very great.

## EARLY LINK-UP

It would seem possible that the planned space link-up exercises between America and Russia will be undertaken earlier than was previously expected. While the main

exercise remains set for 1975 between a *Soyuz* and *Apollo* vehicle, it is possible that a *Salyut* orbital station might be used.

The problems that have to be solved are many. Not the least of these is that of communications. The languages are different, the mode of procedures between the crews and ground will have to be rationalised to name two aspects.

There is also the problem of the airlock system. The *Apollo* atmosphere is nearly pure oxygen, at a pressure of 5lbs per square inch, while the Russians use a mixture of nitrogen and oxygen at the normal atmospheric pressure of sea level.

## LUNA-20

Some new evidence about the lunar rock formation has been brought back by *Luna-20*, the automatic probe sent by the USSR to collect samples from the Moon.

The samples came from the highland area between the Mare Crisium and the Mare Fecunditatis. The soil in this region is much lighter and contains fragments of minerals and crystalline rocks. It is rich in aluminium, calcium and magnesium oxide and the surfaces are well preserved. The iron and titanium content is less than that brought back from the actual maria by *Luna-16*.

Altogether some 70 elements have been detected in the lunar soil by Soviet scientists. They are particularly interested in the nature of the lunar iron.

It seems that the lunar iron is even more rust proof than the meteoritic iron, and attempts are being made to simulate lunar conditions on earth with the possible benefits to industry. Already some success has resulted from the sublimation of iron from basalts which have been heated to a high temperature in a vacuum.

## MYSTERY MOON

There are some rather puzzling features about Titan, Saturn's largest moon. Theoretically the gases should have boiled off, since this body has a low escape velocity.

The present low density atmosphere of molecular hydrogen and methane, from which the gases must be escaping quite rapidly into space, must have come into being long after the solar system was formed. This means that there must be a constant replenishing probably by evaporation and gassing from the solid surface.

Measurements made by L. Tafton of the McDonald Observatory suggest that there is some other major constituent in the atmosphere. It also seems probable that methane is present in the solid as well as in the gaseous state.

# 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.

## TTL EQUIVALENT GATE

	A	B	output
same	0	0	0
different	1	0	1
different	0	1	1
same	1	1	0

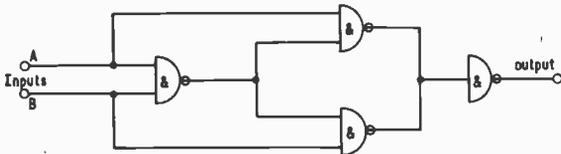


Fig. 1. TTL equivalence gate and truth table

I HAVE built and tested an equivalence gate for use in TTL circuitry, see Fig. 1. It uses one inexpensive integrated circuit package, type SN7400, a quadruple 2-input NAND gate.

If the inputs *A*, *B* are the same, the output goes low ("0" in positive logic). If the inputs are different the output goes high ("1" in positive logic), see truth table in Fig. 1.

S. L. Thompson,  
Rainham.

## VARIABLE ATTACK AND DECAY

ANY audio circuit which produces a simulation of an instrument has not only to copy the frequency and waveform produced by the instrument but also has to emulate the general shape of the envelope, because the sound produced from any instrument, when it is played, does not immediately attain full volume but is a gradual build up. It also dies away slowly afterwards. It is in this respect that most simple electronic devices are inaccurate, as they produce an envelope with virtually no rise or decay time.

The circuit shown in Fig. 1 will produce a note with a rise and decay time variable between two limits. With the values given the note produced is approximately 830Hz.

The first stage TR1 and TR2 are in the normal multivibrator configuration and the waveform which should be obtained from point A is shown in Fig. 2. Transistor TR3 is an overdriven amplifier to produce a good square wave and Fig. 3 shows the waveform that should be obtained at the output, point B. Transistor TR4 acts as an attenuator and is controlled by C3, VR1 and VR2 connected to its base.

The output from the circuit is taken from TR4 collector ( $R_L$ ), and if a resistive load is used its value should be 5.6k $\Omega$ , but other loads can be used to give different tones. An inductive load gives a sawtooth waveform and has a peculiar metallic tone. Other loads, such as capacitive, could be tried.

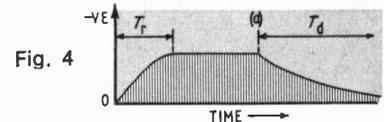
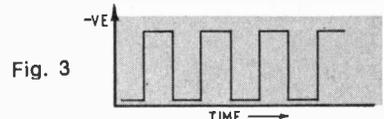
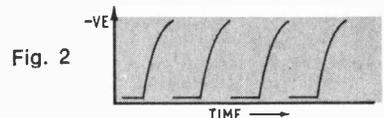
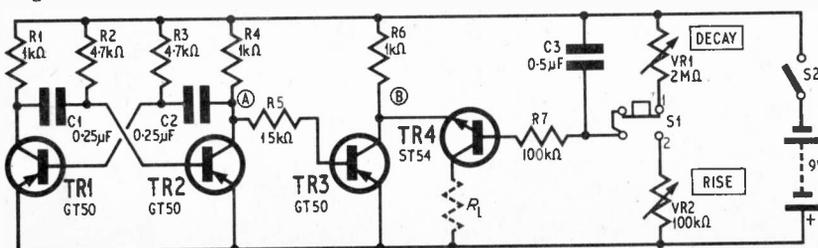
The envelope produced is shown in Fig. 4;  $t_r$  is the rise time, which will occur if S1 is pressed at time 0. Potentiometer VR2 gives a rise time variable between 0.50 milliseconds. The decay time  $t_d$  is controlled by VR1 and starts at point (a) in Fig. 4 and can be varied between 0.200 milliseconds.

The output should be attenuated before (if desired) it is amplified as it is in the region of 7V.

Switch S1 should be of the push-on, release-off type with position 1 normally closed and position 2 normally open. The switch should be the break-before-make type because if the rise and decay time were both set at 0, the battery could be shorted out.

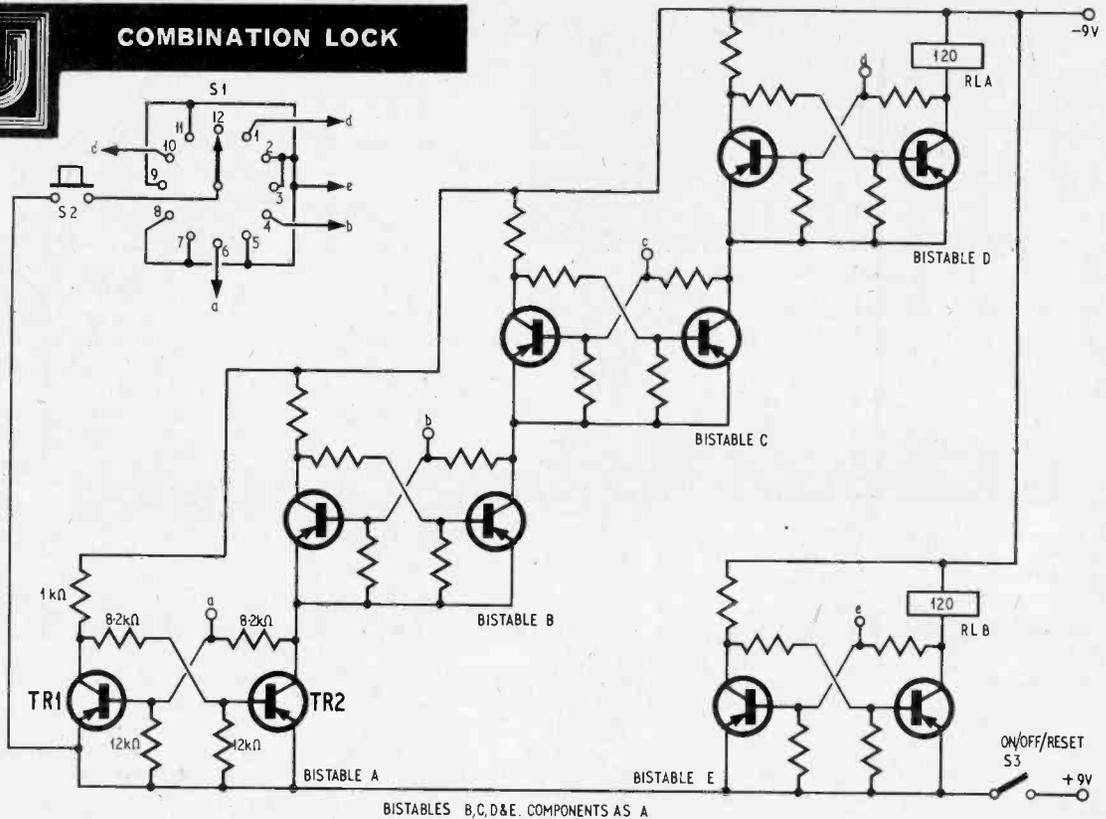
N. R. Adams,  
Colehill,  
Dorset.

Fig. 1. Circuit of variable attack and decay





## COMBINATION LOCK



BISTABLES B,C,D&E COMPONENTS AS A

**T**HE circuit shown above is a 4-digit combination lock, against which the chances of finding the correct sequence of operation is 1 in 19,958,400, which is about 0.000 000 05, making it quite hard to pick!

Fundamentally, it consists of a four stage binary computer, the fifth stage being the alarm flip-flop which is only activated when the wrong digits are dialled. Each flip-flop, when switched, provides the power supply for the preceding flip-flop and so on up the chain until the relay is activated, and thus driving the lock mechanism.

The flip-flops of the computer are simple bistables, i.e. it has two stable states. When one transistor is conducting the other one is not. The non-conducting transistor is made to conduct by applying a pulse to the base of conducting transistor.

In the combination lock this is accomplished by shorting the base of the first transistor of each stage to the positive line. When the power supply to a flip-flop is switched on, one transistor will always conduct first. This must be the first in each stage (due to inequalities in the circuit).

Operation of the combination lock is quite simple. The first number is dialled in this case number 6, and the pushbutton switch S2 is pressed momentarily switching on bistable A. The second number is dialled and the procedure is repeated. This procedure is repeated with the last two numbers till the lock is operated.

Resetting of the bistable is accomplished by disconnecting the power supply and then reconnecting it.

G. E. Kaparnick,  
Swindon, Wilts.

## BACK NUMBERS WANTED

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

### November 1968

Mr. E. J. Holt, Serenje Secondary School, P.O. Serenje, Central Province, Zambia.

### January to October 1968

Mr. M. Swire, Apt. 2K, 277 Eastern Parkway, Brooklyn, New York, 11238, USA.

### July 1968

Mr. B. J. Carling, 15 Hillary Drive, Crowthorne, Berkshire, RG11 6QF.

### March, April 1971

Mr. R. Brown, P.O. Box 926, Chingola, Zambia.

### July 1968, March 1972

Mr. N. Harvey, 47 Goffs Park Road, Crawley, Sussex, RH11 8AX.

### March 1966

Mr. N. Sherwood, 1 Aspen Grove, Scunthorpe, Lincolnshire, DN16 2EW.

### July 1967

Mr. H. Anderson, Verites, Charterhouse, Godalming.

### April 1972

Mr. R. Ellsmore-Creed, Seal House, Seal Square, Selsey.

### June, July, September 1970 and April 1971

Mr. S. T. Bartley, 41 Braemar Road, London, E13 8EH.

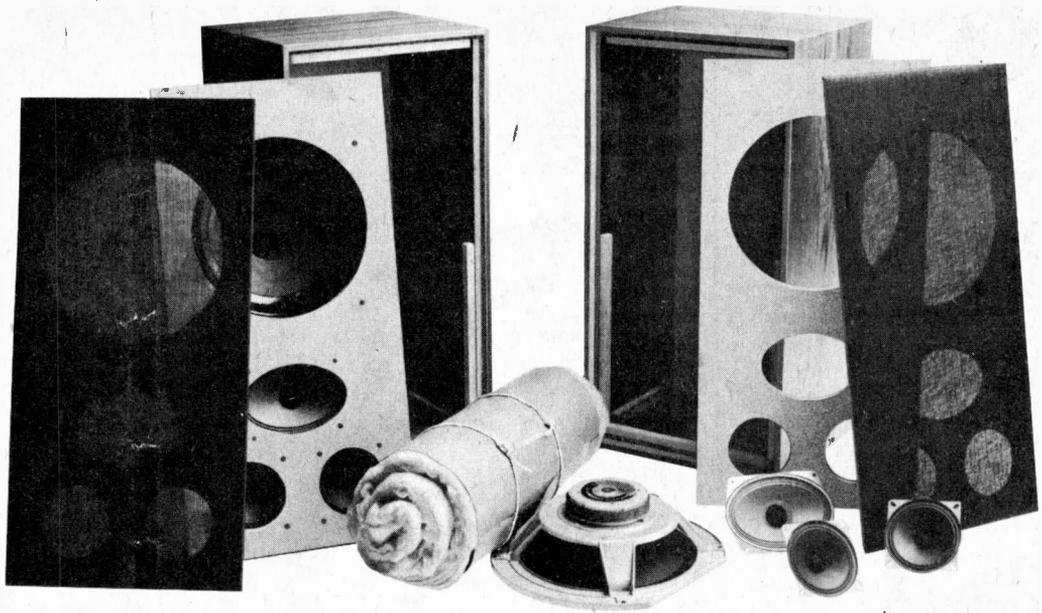
### September, November 1970, February 1971, February 1972

Mr. C. P. Newton, Broadmead House, Broadmead Road, Send, Woking, Surrey.

### January, February 1969, January, April 1970, January 1972

Mr. M. B. Firth, Pine Cottage, Pontardulais Road, Gorseinon, Swansea, Glam.

We regret that back numbers of Practical Electronics can no longer be supplied. We will try to publish announcements of readers' requirements (without a guaranteed date) free of charge.



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FR65	Dual Cone	6.80	<b>High Frequency Units</b>		
FR8	Dual Cone	8.90*	CT5	Cone	1.20
<b>Crossover Networks</b>			CT10/8	Horn	2.40
CN23	2 way	1.10	CT10/16	Horn	2.40
CN28	2 way	1.10	HT15	Horn	3.50
CN216	2 way	1.10	MHT10	Horn	3.60
SN75	2 way	2.20	HT21	Horn	4.20
FF5	3 way	2.60	DT33	Dome	5.20

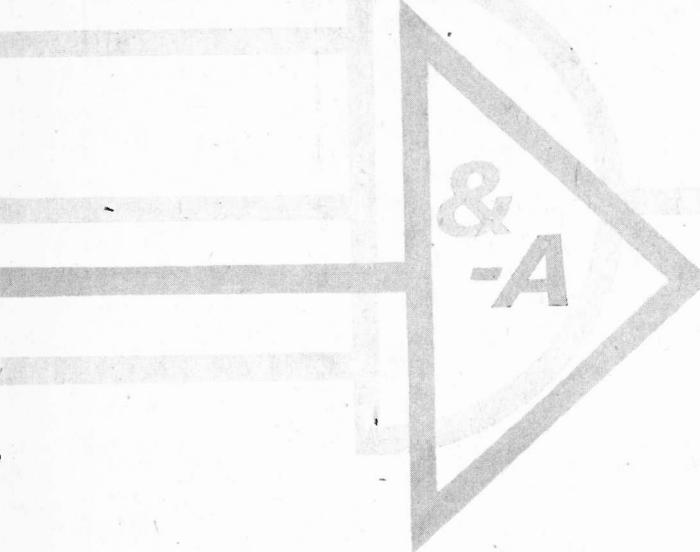
\*Please send me your free advance copy of full cabinet details.

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PE 1





# Designing with Integrated circuits

BY A. FOORD

*A new series designed to help the experimenter to use I.C.s in practical applications. The circuits provided are not intended as definitive designs, but rather as a basis on which to experiment further.*

## 1 The 741 as an ASTABLE

THERE are literally thousands of different integrated circuits on the market, and it would take every page of every issue of the magazine to make any impression in reviewing the complete field. Integrated circuits can be divided into two very broad categories, those intended for general applications and those designed with a specific function in mind.

The state of the art is such that many integrated circuits are so complex as to prohibit experimentation. Those for TV signal processing, for example, cannot adequately be used unless we are prepared to rewire a TV! Where appropriate such i.c.s usually appear in constructional articles.

In general research and development a selection of TTL and a few linear circuits allows much "routine" work to be achieved quickly. Manufacturers short form catalogues show where to go for "state-of-the-art" circuits if they become necessary.

Rather than extract up to the minute information from data sheets and application notes, we hope to show how the "standard" integrated circuits can be used in many cases. We will place the emphasis on designing circuits using integrated circuits and not necessarily on reviewing a different one each month. We feel that this is more useful for the reader who wishes to experiment because he will often be able to use the same integrated circuit more than once.

Readers requiring further details of individual i.c.s and their performance, are recommended to consult manufacturers' data sheets.

### OPERATIONAL AMPLIFIERS

The first generation of linear integrated circuits were the  $\mu$ A702 and 709 operational amplifiers and the 710

comparator. Both the 702 and 709 have their own disadvantages. The 702 has the limited input voltage range of +1.5V to -6V and can "latch up" if this is exceeded. It can however be used for many feedback applications from d.c. to 30MHz.

The 709 is an improvement on the 702's performance by providing a higher input impedance, a large input common mode range of  $\pm 10$ V and a high output swing. It has its own characteristics (cross-over distortion, for example) and is not short-circuit proof. It can be used for high performance applications from d.c. to 5MHz or so.

Both the 702 and 709 require several external components to provide frequency compensation so that they are stable under closed loop conditions, and do not become unstable when overall feedback is applied. This compensation can be chosen to obtain the best bandwidth for a given closed loop gain.

The first of the "second generation" of integrated circuits was the  $\mu$ A741 which overcomes many of the disadvantages of the 702 and 709 series. It is very suitable for general work where a wide bandwidth and a fast slew rate are not required.

This month we introduce the 741C amplifier and will use it again later in the series. Although it is convenient for demonstration purposes its bandwidth restricts its use and the 702 or 709 circuits can be used, within their limitations, when we wish to work outside the frequency limit of the 741.

The 702, 709, 741 integrated circuits are available, under slightly different numbers, from many manufacturers. (Some guidance on these numbers can be seen in the table on the P.E. I.C. Identichart in this issue.)

**THE 741C OPERATIONAL AMPLIFIER**

The 741C is a high performance operational amplifier intended for a wide range of analogue applications from d.c. to 1MHz. Its high common mode range and absence of "latch up" make it ideal for a voltage follower.

It requires no external components for frequency compensation and is stable under closed loop conditions including unity gain and integrator applications. It is protected against an indefinite short circuit to ground or to either supply rail. The input offset voltage is typically 2mV and this may be nulled by a simple circuit.

Its connections are shown in the diagrams for the various package outlines. Typical parameters are shown in the Table 1.1. Versions without the "C" suffix have slightly improved parameters, such as working temperature range.

**LOW FREQUENCY MULTIVIBRATOR**

To start the series, let us look at the 741 wired in an astable multivibrator configuration. Although not necessarily the best application for the 741, it does illustrate how very simple the external circuitry of an i.c. can be to provide a useful application.

Fig. 1.1 shows a basic astable multivibrator suitable for generating a fixed frequency square wave for test purposes. It has a negative feedback loop from the output to the inverting input via R3 and a positive feedback loop from the output to the non-inverting input via R1 and R2. The circuit changes state regeneratively each time the two inputs are at the same potential.

If we assume that the circuit is operating and that the output has just switched to +V<sub>o</sub> (the positive saturated output level) then the voltage V<sub>1</sub> at the non-inverting input (marked +) will depend on R1 and R2. The voltage V<sub>2</sub> at the inverting input (marked -) will be rising exponentially towards +V<sub>o</sub> from an initial negative value.

Let constant  $k = \frac{R_1}{R_1 + R_2}$  Initially  $V_1 = +kV_o$   
 $V_2 = -kV_o$

When V<sub>2</sub> reaches V<sub>1</sub> the amplifier will change state with the output switching to -V<sub>o</sub>, V<sub>1</sub> switching to -kV<sub>o</sub>, while V<sub>2</sub> now falls exponentially towards -V<sub>o</sub> from its initial value of +kV<sub>o</sub>. When V<sub>2</sub> reaches V<sub>1</sub> (which is now -kV<sub>o</sub>) the circuit changes state again and the cycle repeats.

**Table 1.1: Typical Characteristics of the 741C**

Large signal open loop gain	100dB
Input resistance	1 Megohm
Differential input offset voltage	2mV
Differential input offset current	30nA
Input voltage range	±13V
Maximum output voltage swing	±13V
Common mode rejection ratio	90dB
Input bias current	200nA
Output resistance	75 ohms
Supply voltages	±15V
Slew rate at unity gain	0.5V/μs

**ANALOGUE COMPUTING** Computing system where continuous signals represent mechanical (or other) parameters.

**COMMON MODE REJECTION RATIO** A common mode input is one applied to both inputs of an operational amplifier. In theory this should produce no output, since only the difference between the inputs is amplified. The CMRR is a measure of this rejection to a common input signal, and should be large.

**COMPARATOR** An amplifier designed for comparing two inputs and giving a 0 or 1 output. Usually the output is compatible with logic levels.

**DIFFERENTIAL INPUT** An input applied between two terminals, neither of which is at earth potential.

**DIFFERENTIAL INPUT RATING** The maximum differential input which may be applied between the two terminals.

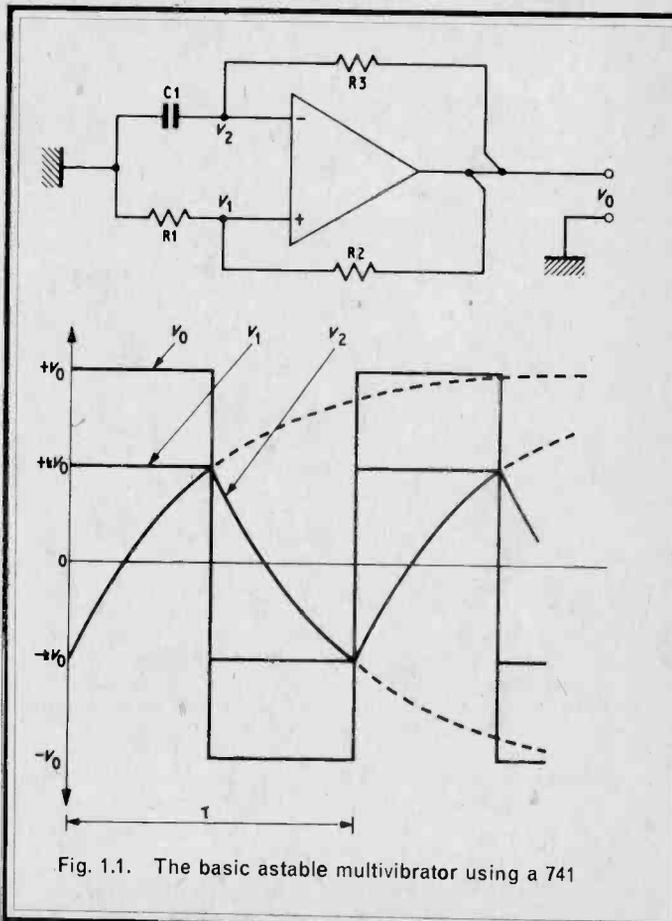


Fig. 1.1. The basic astable multivibrator using a 741

**DIGITAL COMPUTING** Computing system where two valued signals represent mechanical (or other) parameters.

**FREQUENCY COMPENSATION** The compensation required in feedback amplifiers to ensure stability and prevent unwanted oscillations.

**INPUT COMMON MODE RANGE** The maximum input which can be applied to either input without causing damage or abnormal operation.

**INPUT OFFSET CURRENT** The difference in input bias current requirements for the two inputs.

**INPUT OFFSET VOLTAGE** That voltage which must be applied between the input terminals to obtain a zero output voltage.

**INTEGRATED CIRCUIT** An electronic device containing several elements, active or passive, which perform all or part of a circuit function.

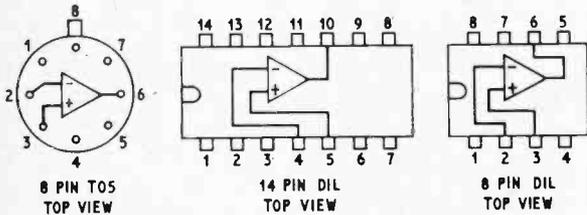
**LATCH UP** The switching of an electronic circuit to an unintended mode by improper voltage application.

**OFFSET ERRORS** Errors produced by input offset voltage and input offset current.

**OPEN LOOP GAIN** The gain of an amplifier before negative feedback is applied.

**OPERATIONAL AMPLIFIER** Originally a direct coupled high performance amplifier used in analogue computing to perform mathematical operations (summation, scaling, subtraction, integration, etc.). Today a low frequency packaged amplifier (about d.c. to 1MHz)

**SLEW RATE** The maximum rate of change of the output voltage for large signals. Usually in  $V/\mu s$ .



Basic connections (looking at top) of inputs and output for the 741. For details of other connections, see the I.C. Lead-out Identichart

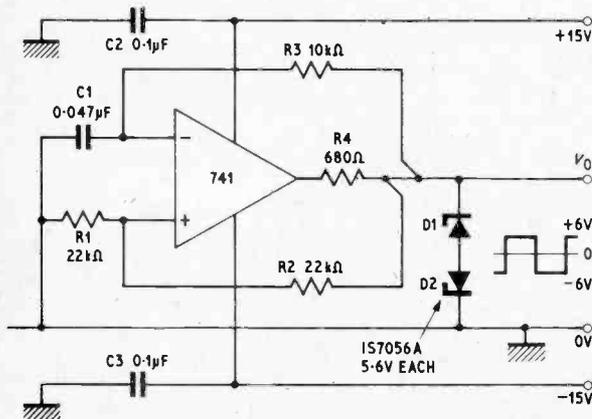


Fig. 1.2. A practical circuit for 1kHz operation

## PERIOD OF OSCILLATION

If we assume that the inputs of the amplifier draw no current and that the positive and negative saturation levels are equal, then the period of oscillation is given by:

$$\tau = 2C_1 R_3 \log_e \left( \frac{1+k}{1-k} \right)$$

For  $R_1$  equal to  $R_2$ , this becomes  $\tau = 2.2C_1 R_3$  secs.

Although there is no need to do so, it is convenient to make  $R_3$  equal to the parallel combination of  $R_1$  and  $R_2$  to minimise offset errors. The maximum allowable value for  $k$  depends on the differential input rating of the amplifier. For the 741, values for  $k$  of up to 0.9 are suitable. For a 709 with  $\pm 12V$  supplies a  $k$  of 0.2 would be used.

## PRACTICAL CIRCUIT

A practical circuit for a nominal 1kHz operation is shown in Fig. 1.2. The Zener diodes clip the output level at  $\pm 6V$  to aid slew rate slightly. The measured frequency was 844Hz. This is 13 per cent lower than the nominal value, probably due to the 20 per cent tolerance of the capacitor.

Rise and fall times were  $10\mu s$ , equivalent to a bandwidth of 35kHz. Although this is noticeable for a 1kHz square wave, it is still good enough for simple audio testing to illustrate the effects of tone controls, instability and ringing, or filters. For higher frequencies a 709 can be used with a value of 0.2 for  $k$ .

At frequencies lower than 1kHz, or if slightly longer rise and fall times can be tolerated, the Zener diodes may be removed and  $R_4$  shorted out, so that the circuit relies on the symmetrical limiting characteristics of the amplifier.

**Part 2 Next month: Introduction to basic logic gates**

# NOUGHTS & CROSSES

By R. K. Johnson B.Sc.

*A novel entertainment for parties and fêtes*

**N**OUGHTS and crosses is a simple but fascinating game whose rules can be understood even by young children. Two players alternately place noughts and crosses in a three by three grid in an attempt to obtain a complete line of their own symbol either diagonally, horizontally or vertically.

With this machine the player is given the advantage of starting first and makes his play by using a pen to "write" a nought on to a colourful illuminated screen. The computer instantly replies by displaying a cross. Two anti-cheat devices are included to foil baffled players.

Most of the 945 different games that can be played against the computer will be drawn or lost, but in two per cent of the games the player can get three noughts in a line. Finding these winning

games is not easy and presents an interesting problem in logic for the player. Schoolchildren will play for hours trying to find one or more ways of beating the computer.

## ANALYSIS OF THE GAME

The object of the game is to obtain a row (horizontally, vertically or diagonally) of three noughts, while preventing the computer from obtaining a row of three crosses.

In the usual game using pencil and paper the first player has a choice of nine places, his opponent then has a choice of eight places, and so on. Thus there are  $9 \times 8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1 = 362,880$  ways of filling the places. Though not all of these represent interesting games, the number is too large for a simple computer and so must be reduced.

This is done by allowing the player any choice of position, but limiting the machine to just one reply. The total is then  $9 \times 1 \times 7 \times 1 \times 5 \times 1 \times 3 \times 1 = 945$  possible games, a number which allows simplified circuitry but still provides variety of play.

For further analysis of the game the squares are numbered 1 to 9 as in Fig. 1.

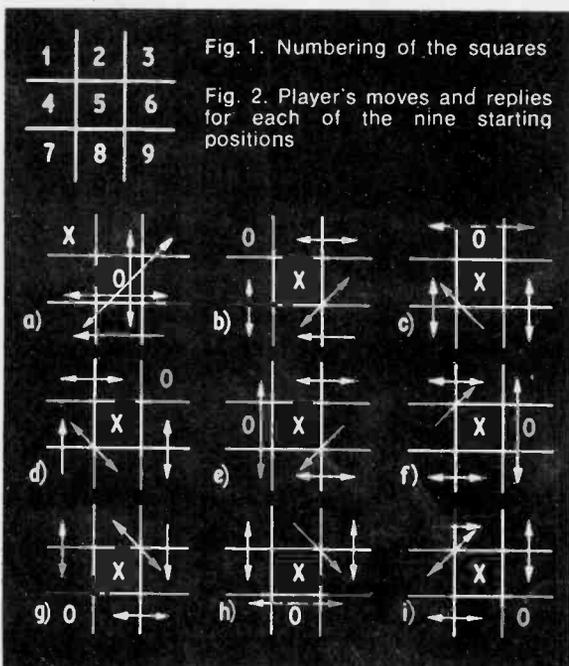
Square 5 is the most important because it controls four of the eight possible rows of three. Squares 1, 3, 7 and 9 each control three rows. Least important are squares 2, 4, 6 and 8 because each can only block two rows.

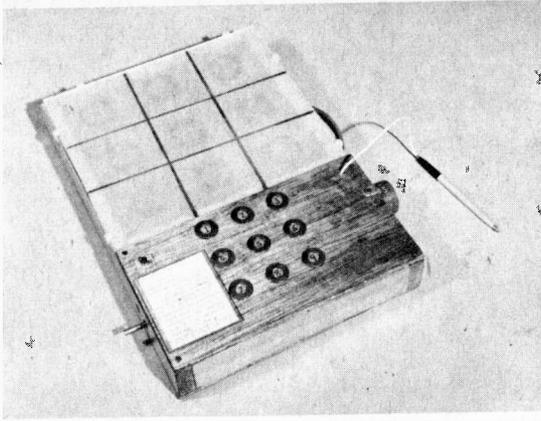
## TACTICS OF THE MACHINE

The first basic principle of play is that if the player's first move is in one of squares 1, 2, 3, 4, 6, 7, 8 or 9, then the computer's best reply is square 5. If the player's first move is square 5, then the computer's reply should be either 1, 3, 7 or 9, but in practice it is made to be always square 1.

The player's first move determines the computer's reply for each successive move in that game. These moves and the corresponding replies are shown in Fig. 2(a) to (i).

Consider Fig. 2(a). The player has started with square 5 and the computer has replied with square 1.





The completed prototype showing the general appearance of the unit with the "how to play" notice in position

The double-headed arrows indicate reversible positions; for example if the player plays square 2 the computer answers with square 8 (to block the row), while if the player plays square 8, the computer replies with square 2 (to block the row).

This illustrates the second design principle: when the player fills in a second "0" in any line, the computer should block the line with an "X".

It will be seen in Fig.2(a) that one of the arrows is single-headed indicating an irreversible play. If the player plays square 9 the reply is square 7, whereas if square 7 is played the reply is not square 9, but square 3.

This illustrates the third principle: if the player is just about to start a line of "0"s, the computer should reply with a second "X" in a line so as to force the player on to the defensive.

If these three principles are followed in the usual pencil and paper game then the player cannot lose.

Possible moves and replies for the eight other starting positions can be followed by reference to Figs. 2(b) to (i).

### INPUT UNIT

The player makes each move by touching the pen to one of nine 1in diameter brass washers (corresponding to the nine squares). Each washer is connected to the gates of two thyristors (SCRs).

When a washer is touched, one of these thyristors switches on a lamp indicating the player's "0", and the other thyristor, by means of the memory store, switches on the computer's reply "X".

Once on, the thyristors will stay on until the power supply is interrupted. Thus the use of thyristors has the important advantage that once a move is made, it cannot be changed either accidentally or deliberately. If toggle switches were used instead, players could cheat by flicking the switches to find the best move at each stage.

Fig. 3 shows the circuit diagram for these thyristors and Fig. 4 shows how they may be mounted on a piece of Veroboard. Eighteen 50 p.i.v. 1A SCRs were used in the prototype, but thyristors with other ratings may be used providing they are all of the

same type to ensure that the lamps light equally brightly.

Also needed for the input unit is the pen and a resistor which may be fitted inside the pen. The resistor should be the highest value that will give reliable triggering of the thyristors. A 150 ohm 1/4W resistor was suitable in the prototype.

The pen is a plastic ballpoint of the kind that unscrews in the middle and has a retracting button at the top end. With the ink tube and button removed, flexible cable may be led in at the top hole, knotted, and soldered to the resistor which in turn is soldered to a thick wire which is then soldered or glued with "Araldite" epoxy resin, so as to protrude through the lower hole as in Fig. 5.

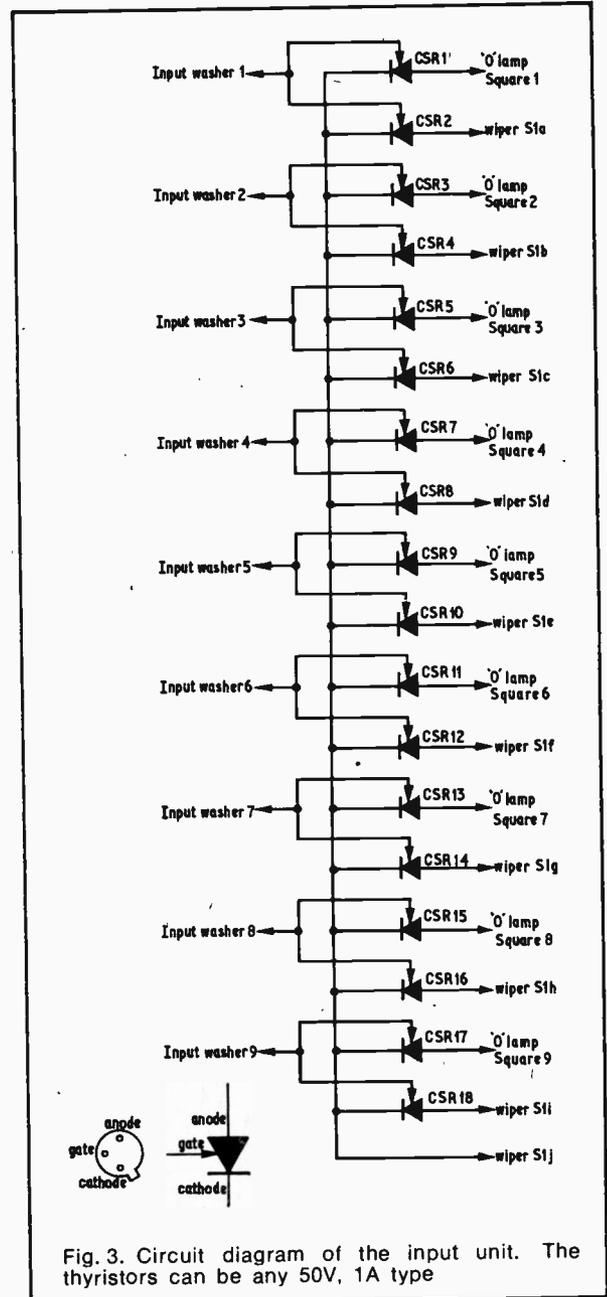


Fig. 3. Circuit diagram of the input unit. The thyristors can be any 50V, 1A type

# COMPONENTS

## Resistor

R1 150Ω ¼W carbon (see text)

## Thyristors

CSR1-CSR18 Any 50V 1A type (18 off)

## Switches

S1 10 pole 10 way wafer switch (1 wafer must be a break-before-make type)

S2 Push-to-break push button switch

## Lamps and holders

LP1-LP18 M.E.S. lamps and holders (for voltage ratings see text) (18 off)

## Miscellaneous

1in dia. brass washers (9 off), ballpoint pen, large knob, mirror clips (6 off), two pieces of glass or Perspex, plywood or hardboard, 2in×1in softwood, red and green cellophane or cinemoid, tracing paper, Araldite (for details of these materials see text), 5in×1½in 0.15in matrix Veroboard

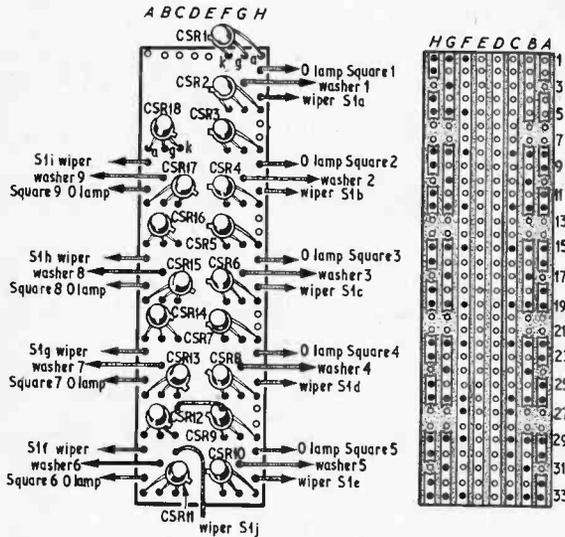


Fig. 4. Layout of the thyristors on the Veroboard panel

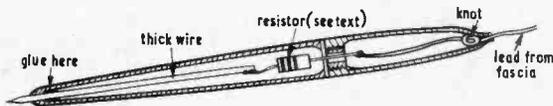
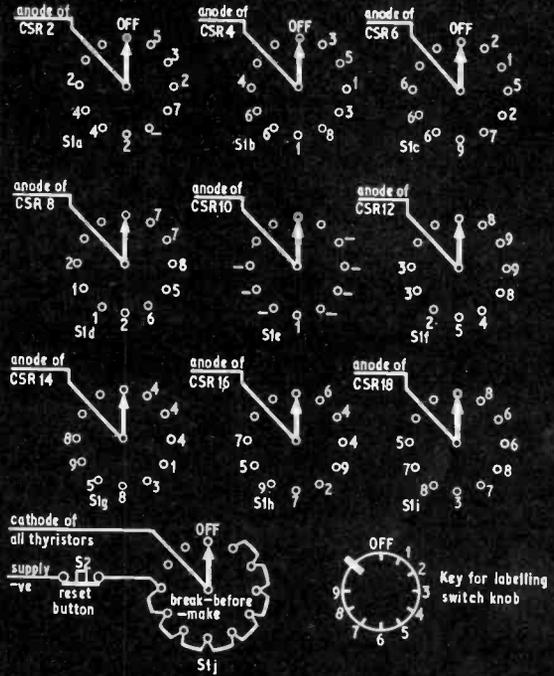


Fig. 5. Internal construction of the "pen"



## MEMORY SWITCH

The memory switch consists of a 10 pole 10 way wafer switch. One way is used as an "off" position and the other nine positions of the switch are used to set the initial play number (i.e. select the required programme).

Nine of the wafers are used to route current to the correct lamps and the tenth wafer forms another anti-cheat device. This tenth wafer must be "break-before-make" type. This ensures that if a player tries to cheat by turning to a different programme part way through a game, the power supply to the thyristors is cut off momentarily and the display unit is wiped clean.

Fig. 6 shows the ten wafers. Wafers S1a to S1i must be wired together by reference to the numbers shown round each wafer in Fig. 6. All the contacts marked "1" must be wired together (for connection later to the "X" lamp in square 1 of the display unit). Similarly all the contacts marked "2" are wired together (for connection later to the "X" lamp in square 2 of the display unit), and so on. Great care should be taken at this stage to ensure correct wiring.

All except one of the contacts of wafer S1j are wired together, as shown in Fig. 6.

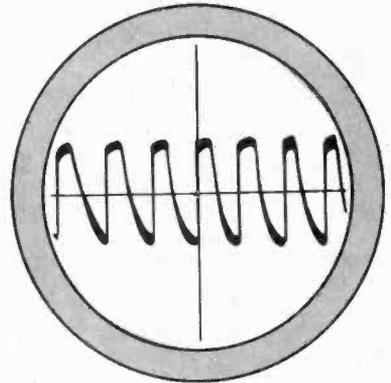
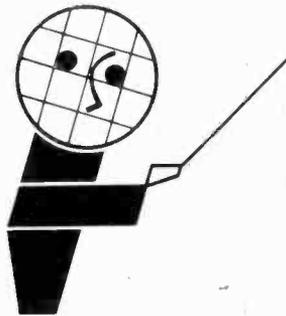
## OUTPUT DISPLAY UNIT

This consists basically of 18 m.e.s. lamps in lamp-holders under a translucent screen. Nine lamps (green) are used to indicate the "0"s and the other nine (red) to indicate the "X"s using filters as described later.

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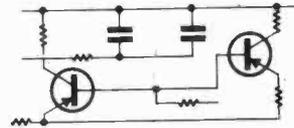
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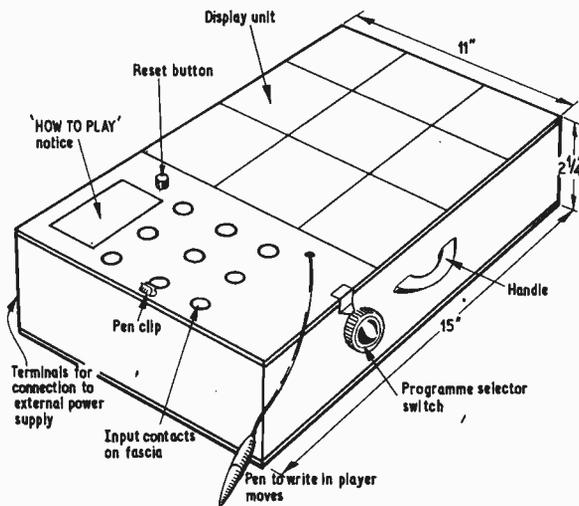


Fig. 7. General layout and dimensions of the complete unit (above)

Fig. 8. Construction of the cabinet and display unit (right)

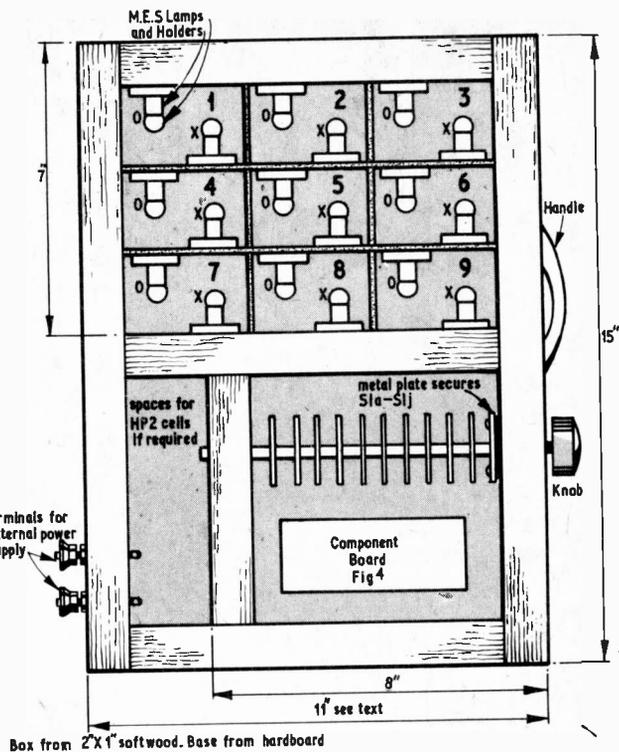


Fig. 9. Arrangement of the "0" and "X" filters under the tracing paper (bottom right)

## CONSTRUCTION OF CABINET AND DISPLAY UNIT

Fig. 7 shows the general layout. Fig. 8 shows the fascia and glass panels removed.

The dimensions are not critical except that the cabinet must be deep enough (at least 2 1/4 in) to take the wafer switch with all its wiring.

The lamp compartments should be as small as possible to give a bright display while ensuring that there is enough room to unscrew and replace lamps.

If a compartment is needed for HP2 cells (see "Power Supply" section below) then a maximum size of 11 in × 15 in overall may be used. If an external power supply is to be used then 8 in × 15 in will give a better, brighter display.

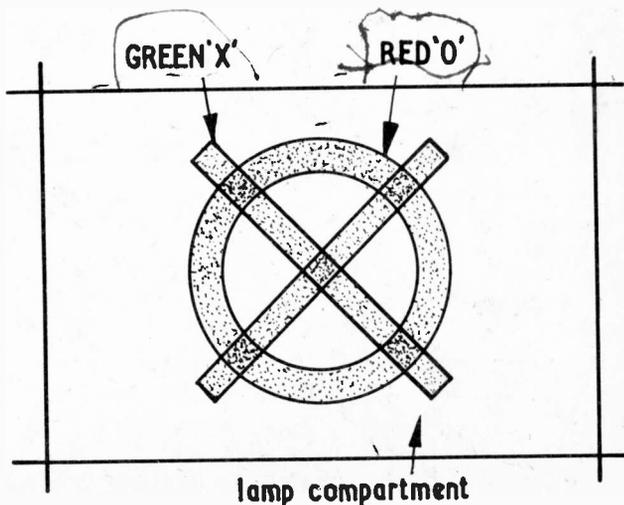
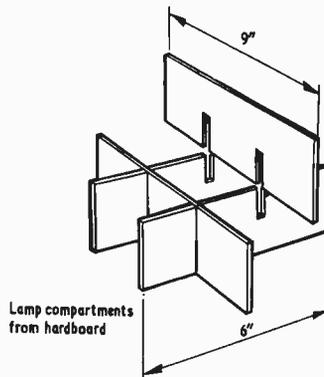
The cabinet may be made by glueing and pinning four pieces of 2 in × 1 in softwood to each other and to a rectangular (11 in × 15 in) hardboard base, see Fig. 8.

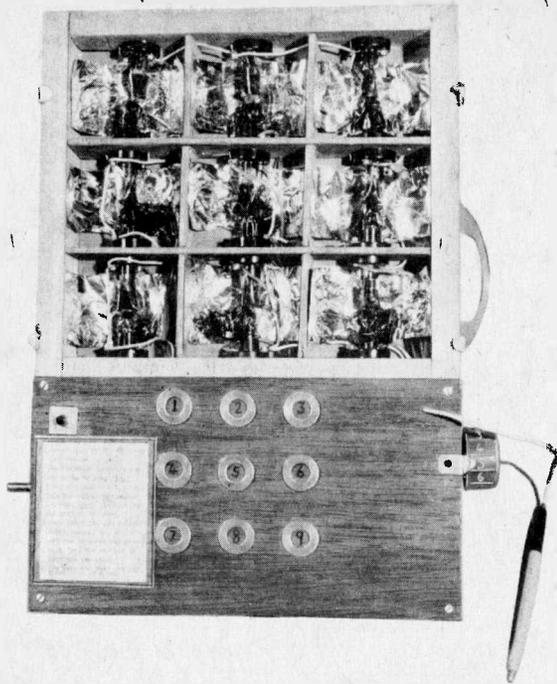
Four slotted partitions for the lamp compartments can be cut as shown, the m.e.s. lampholders screwed in position and the partitions slotted together and held in position by a 9 in crosspiece.

A metal plate, drilled to take the fixing bolt of the wafer switch can be screwed in position as shown. A short piece of softwood may be necessary to steady the end of the switch shaft if a battery compartment is required. Terminals or a power lead may be fitted for connection to an external power supply.

## NOUGHTS AND CROSSES

The nine "0" lamps are each wrapped in one or more layers of green cellophane and the nine "X" lamps





lamps are similarly wrapped in red cellophane or cinemoid. (Cellophane is obtainable from artists' supply shops and cinemoid, used in stage lighting, is obtainable from large electrical lighting shops.)

The lamp compartments are covered by two sheets of glass or Perspex which sandwich a sheet of tracing paper between them. Also sandwiched (under the tracing paper) are nine large red "0"s and nine large green "X"s cut out of cellophane, one of each over each lamp compartment (see Fig. 9). Thus when a green "0" lamp lights, it illuminates that square with green light except where the red "0" shape absorbs the green light and so appears as a black "0". Similarly when a red "X" lamp lights, a red square with a black "X" appears.

The cellophane or cinemoid should be chosen so that when a red and a green piece are overlapped and held to the light, it should appear as dark as possible without the individual colours being too dense for the lamps. In the prototype it was found that six layers of pale green cellophane and one layer of primary-red cinemoid were most suitable.

The brightness of the display is improved by fitting reflectors of aluminium kitchen foil behind the lamps, taking care not to cause a short circuit between the lampholder terminals.

The two sheets of glass may be held in place by mirror clips.

### FASCIA PANEL

The fascia is cut from  $\frac{1}{4}$ in or  $\frac{1}{2}$ in plywood or hardboard. Nine holes are drilled under the positions of the nine brass 1in washers (see Fig. 7). Leads are soldered to the washers, passed through the holes and the washers are glued in position using "Araldite" epoxy resin. They should be numbered 1 to 9 as in Fig. 1.

The "push-to-break" reset switch is fixed to the fascia. A hole is also drilled for the lead to the pen. The wood may be finished with varnish or stain. A carrying handle, and a pen clip may be added.

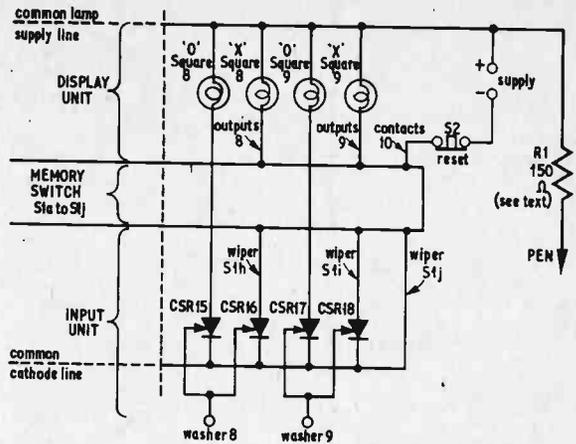


Fig. 10. Part of the complete circuit to show the method of interwiring the display, memory and input units

A large 12-faced plastic knob is needed for the wafer switch. The knob should be marked from 1 to 9 plus an "off" position corresponding to the switch positions shown in Fig. 6. A small metal pointer may be fixed to the fascia to facilitate reading the knob.

### INTERWIRING OF THE UNITS

Fig. 10 shows part of the complete circuit.

One side of all the lamps is connected to the positive terminal using thick wire and a circuit similar to a ring main to keep the resistance to a minimum.

The pen lead is also connected to the positive terminal.

The negative terminal is connected through the reset switch to all the contacts on the tenth wafer, using thick wire.

The wiper of the tenth wafer is connected to the common cathode lines on the Veroboard (Fig. 4) again using thick wire.

The lead from washer 1 is connected to the gates of thyristors CSR1 and CSR2 (Fig. 4 and 10) and similarly with the leads from the other eight washers. Heat shunts should be used to protect the thyristors while soldering.

The anode of thyristor CSR2 is connected to the wiper of wafer S1a (see Figs. 4 and 10). The anodes of the eight other even numbered thyristors are similarly connected. If possible colour coded wire should be used here.

A lead from all the switch contacts marked 1 in Fig. 8 is connected to lamp 1 "X" (i.e. the red lamp in square 1). Similarly all the contacts marked 2 are wired to lamp 2 "X" and so on.

Finally each of the anodes of the "0" thyristors is wired to the corresponding green "0" lamp (Fig. 4).

### POWER SUPPLY

This must be capable of lighting up to nine lamps in parallel, with least reduction in brightness.

Lead-acid accumulators or a tapping off a car battery or Nife alkaline cells give a bright display and can be re-charged.

**Table 1: POWER SUPPLIES AND LAMPS**

POWER SUPPLY	LAMPS
1 lead-acid accumulator (2.2V)	1.25V, 0.25A
2 lead-acid accumulators (4.4V)	2.5V, 0.3A or 3.5V, 0.3A
3 lead-acid accumulators (6.6V)	5.5V, 0.3A or 6V, 0.3A
2 NiFe cells (2.4V)	1.25V, 0.25A
4 HP2 dry cells (2 pairs in parallel) (3V)	1.25V, 0.25A
Mains driven d.c. power pack	bulb to suit voltage (allow 1V drop across thyristors)

**Table 2: "TRUTH TABLE" FOR CHECKING COMPUTER'S REPLIES**

SWITCH POSITION	WASHER TOUCHED WITH PEN								
	1	2	3	4	5	6	7	8	9
1	5	3	2	7	-	8	4	6	8
2	3	5	1	7	-	9	4	4	6
3	2	1	5	8	-	9	4	4	6
4	7	3	2	5	-	8	1	9	8
5	-	8	7	6	1	4	3	2	7
6	2	1	9	2	-	5	8	7	3
7	4	6	6	1	-	2	5	9	8
8	4	6	6	1	-	3	9	5	7
9	2	4	6	2	-	3	8	7	5

Table 1 shows which lamps to use depending on the available power supply. If more powerful lamps are used, make sure that the thyristors can carry the necessary current.

If a power-pack is used, it must have a low internal resistance and be capable of delivering enough current for nine lamps.

High power U2 dry cells can be used, but have a limited life and the display will not be very bright.

### TESTING

Table 2 shows the "truth table" for checking the computer's replies. For example with the switch set to position 1, if the pen is touched to washer 1 the green lamp in square 1 and the red lamp in square 5 should light. If the pen is then touched to washer 2, the green lamp in square 2 and the red lamp in square 3 should light. In this way the circuit should be carefully and methodically tested for each switch position, using the reset button where necessary.

### METHOD OF PLAY

The player decides at the beginning of a game which position he will play initially and then moves the memory switch to indicate that position. This switch must be left in that position for the rest of the game. The player then uses the pen to write in his initial play and carries on with the rest of the game.

A notice suitable for fixing to the fascia near the reset button is shown in the photographs. The aim of the game should be given as "to get three noughts in a line".

It is left to the constructor to find the 18 winning games. ★

## I.C. INTERCOM

continued from page 823

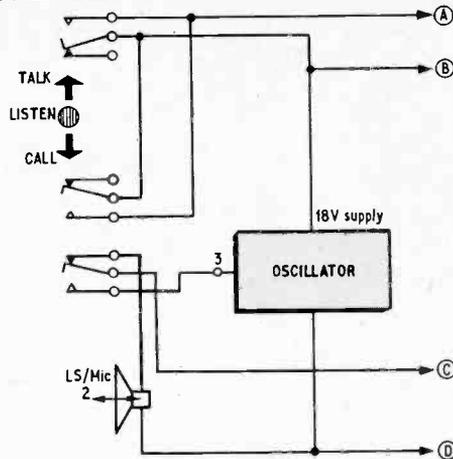


Fig. 9. A call oscillator identical to the one in the master can be used to give the slave a call facility. The switch is a miniature lever switch as used in the master. The letters to the right show how the modified slave is connected to the master

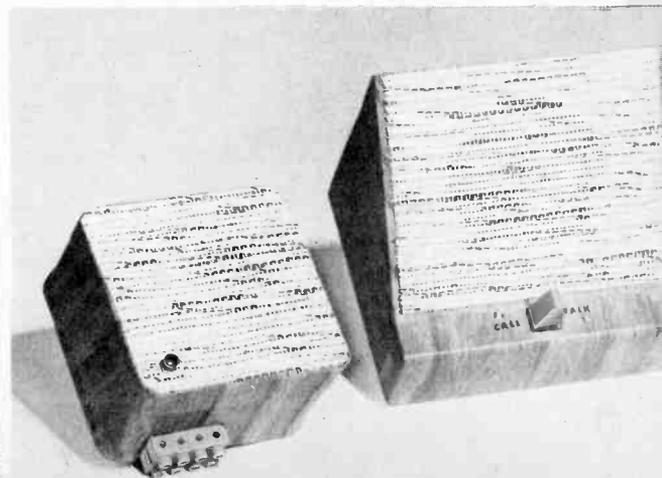
### MODIFICATIONS TO THE BASIC SYSTEM

The basic system can easily be extended by connecting slaves in parallel. Fig. 8 shows a typical set up with three slaves none of which have call facilities to the master; in this case it is the master station which has to initiate any communication by pressing the relevant button. If it is wished to give the slave a call facility then Fig. 9 shows the arrangement and this can easily be wired in if the master/slave set up is sufficient.

If any of the configurations using two or more slaves are built then the cases may have to be redesigned. For example, if it is decided to build the master/two slaves with call facilities then the slaves will have to have a case large enough to accommodate the speaker, the call oscillator and the lever key whilst the master will need to be enlarged so that the multi-button switch and the indicator lights can be fitted.

Depending on what loudspeaker is finally used will dictate the method of fixing; the easiest is to glue them to the case making the hole a little smaller than the speaker. ★

The completed intercom





## PART 2

POWER SUPPLY...

PRE-AMPLIFIER...

TREMOLO...

# ELECTRONIC PIANO

By A. J. Boothman B.Sc.

To achieve a logical building sequence the order of construction presented will be the power supply unit, pre-amplifier and tremolo unit, main amplifier and pitch printed circuit boards. The mounting of the keyboard and other assembly details will round off the series.

To assist in lining up the p.c.b.s the power unit and amplifier are used as test gear, hence the order of construction.

### POWER SUPPLY CIRCUIT

The circuit of the power supply is shown in Fig. 2.1 and is based on well established design principles. A transformer using the 20 volt secondary tap produces an open circuit voltage of approximately 30 volts across a large reservoir capacitor, and this reduces to about 26 volts at 2 amps. Two 6.8 volt Zener diodes connected in series act as the reference voltage with which a portion of the output voltage at the emitter of a ZT3055 is compared. Any error is amplified and fed to the output transistor, thus regulating the output voltage. Capacitor C4 produces a slow rise in output voltage at switch on, whilst C3 and R3 give high negative feedback of any ripple voltage which might be developed at the output.

The output voltage range of the supply is 16-21 volts, controlled by VR1, and the maximum output

current is 2 amps. Worst case dissipation in the output transistor TR3 is 18W with 700mW in the driver transistor TR2. Two Zener diodes are used rather than one high voltage type in order to reduce the power requirement in one package. TR1 and each Zener diode have maximum power dissipation levels of approximately 75mW.

The earth connector allows the earth to the piano circuits to be disconnected in the event of any instabilities which might occur when the piano is connected to a self earthed external amplifier.

### P.S.U. ASSEMBLY

The small components for the power supply unit are mounted on a simple printed circuit an etching and drilling pattern for which is given in Fig. 2.2.

With the p.c.b. completed and terminal pins inserted first the pre-set potentiometer is mounted, then the resistors, diodes, transistors, capacitors and finally the a.c. input terminal strip as in Fig. 2.3.

The two regulator transistors are mounted on a heatsink and the assembly completed using the transformer for mounting the board. The large capacitors, heatsink and transformer are mounted on a baseboard as seen in the photograph.

After assembly the power supply can be checked for correct operation by measurement of voltage at

# POWER SUPPLY

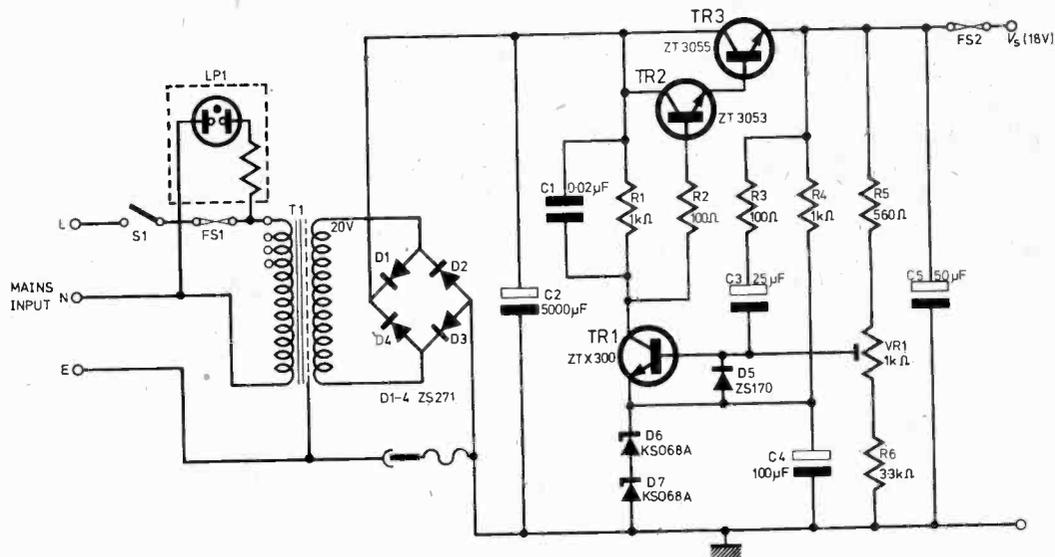


Fig. 2.1. Circuit diagram of power supply unit

a number of points. The voltage across the 5000 $\mu$ F capacitor (two 2,500 $\mu$ F capacitors, connected in parallel, were used in the prototype) on no load should be approximately 29 volts with a voltage on load of 25V at 1.5A. The emitter voltage of TR1 is 13 volts, with 18.5 volts at the collector for an output voltage of 17 volts.

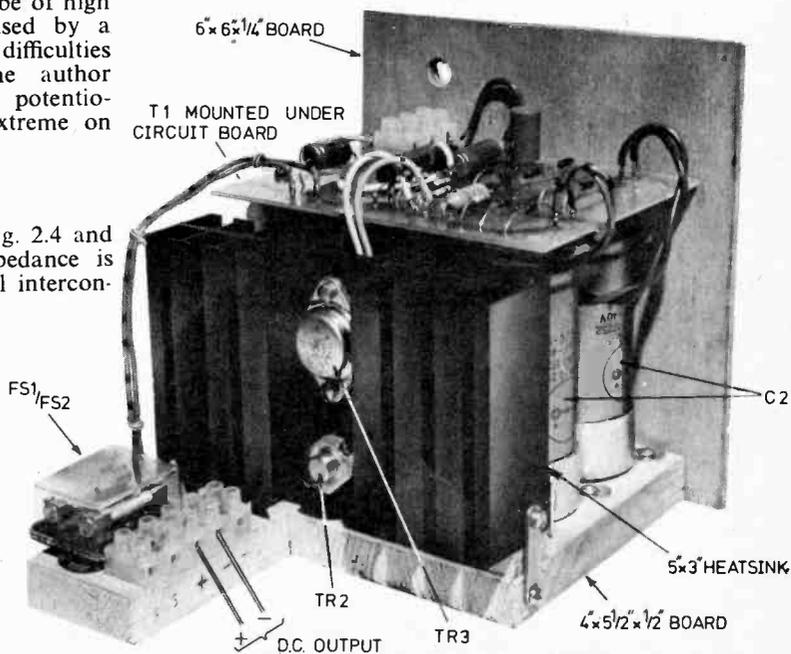
The voltage on the slider of the preset potentiometer is 14 volts. This component should be of high quality as severe damage could be caused by a faulty condition. After experiencing some difficulties with cheap skeleton potentiometers the author decided to use a multi-turn linear track potentiometer which is probably at the other extreme on cost.

## PRE-AMPLIFIER CIRCUIT

The pre-amplifier circuit is shown in Fig. 2.4 and consists of three stages. The input impedance is very low, and allows an unscreened signal interconnection between the pitch boards.

It is essential that the amplifier should be able to handle a wide range of signals, since the peak level for one note is approximately 80mV peak-to-peak on maximum attack. The maximum input signal which can be presented at the input is approx. 2.6 volts peak-to-peak which represents 32 notes in the maximum attack position.

Perspective view of power supply module



# POWER SUPPLY BOARD

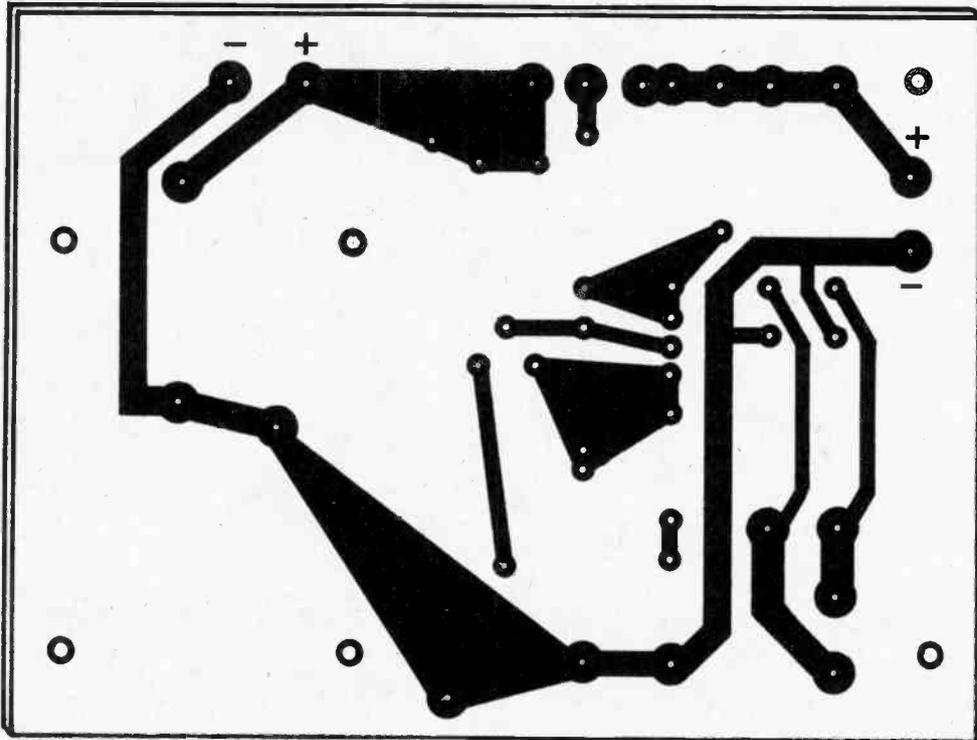


Fig. 2.2. Etching and drilling details for p.s.u. printed circuit board (full size)

## COMPONENTS . . .

### POWER SUPPLY UNIT

#### Resistors

R1 1k $\Omega$	R4 1k $\Omega$
R2 100 $\Omega$	R5 560 $\Omega$
R3 100 $\Omega$	R6 3.3k $\Omega$

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

#### Potentiometer

VR1 1k $\Omega$  preset

#### Capacitors

C1 0.02 $\mu$ F polyester 125V	C4 100 $\mu$ F elect. 15V
C2 5,000 $\mu$ F elect. 35V	C5 50 $\mu$ F elect. 25V
C3 25 $\mu$ F, elect. 15V	

#### Diodes

D1-D4 ZS271 (Ferranti) 4 off
D5 ZS170 (Ferranti)
D6-D7 K5068A (Ferranti) 6.8V 400mW Zener (2 off)

#### Transistors

TR1 ZTX 300 Ferranti	TR3 ZT 3055 Ferranti
TR2 ZT 3053 Ferranti	

#### Transformer

T1 Mains transformer, Douglas type MT3AT

#### Miscellaneous

FS1 — 200mA fuse, FS2 — 1.5A fuse, S1 — Main toggle switch, heatsink, LP1 — Mains neon

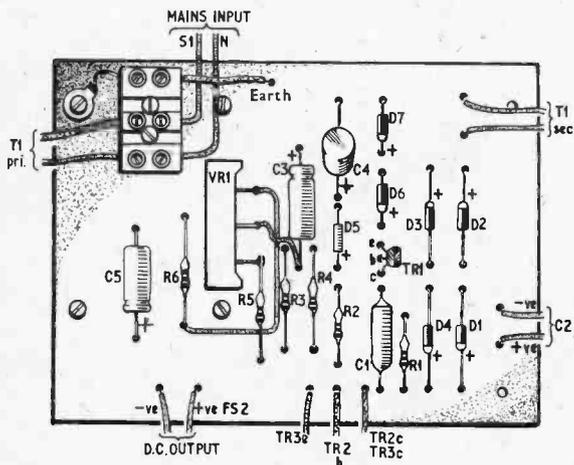


Fig. 2.3. Component assembly on p.s.u. printed circuit board

The output from the first stage is fed via a resistor network to a compound emitter follower containing two transistors (TR5, TR6). The design of this portion of the circuit is determined by the condition required for the tremolo effect. The tremolo circuit, which is described later, acts as a shunt modulator by presenting a variable impedance across VR2, so giving a variable degree of attenuation of the signal between the first and second stages.

Output from the emitter follower is again at low impedance and the nominal attenuation (tremolo off)

for the second stage is a factor of two. Thus the overall voltage gain to the output of the emitter follower is approximately 1.5.

### LEVEL CONTROL SETTINGS

The second stage is followed by the two level determining elements, the first being the foot soft pedal control, whilst the second is the keyboard level control. The latter item consists of a five position switch with fixed resistors giving stepped attenuation levels.

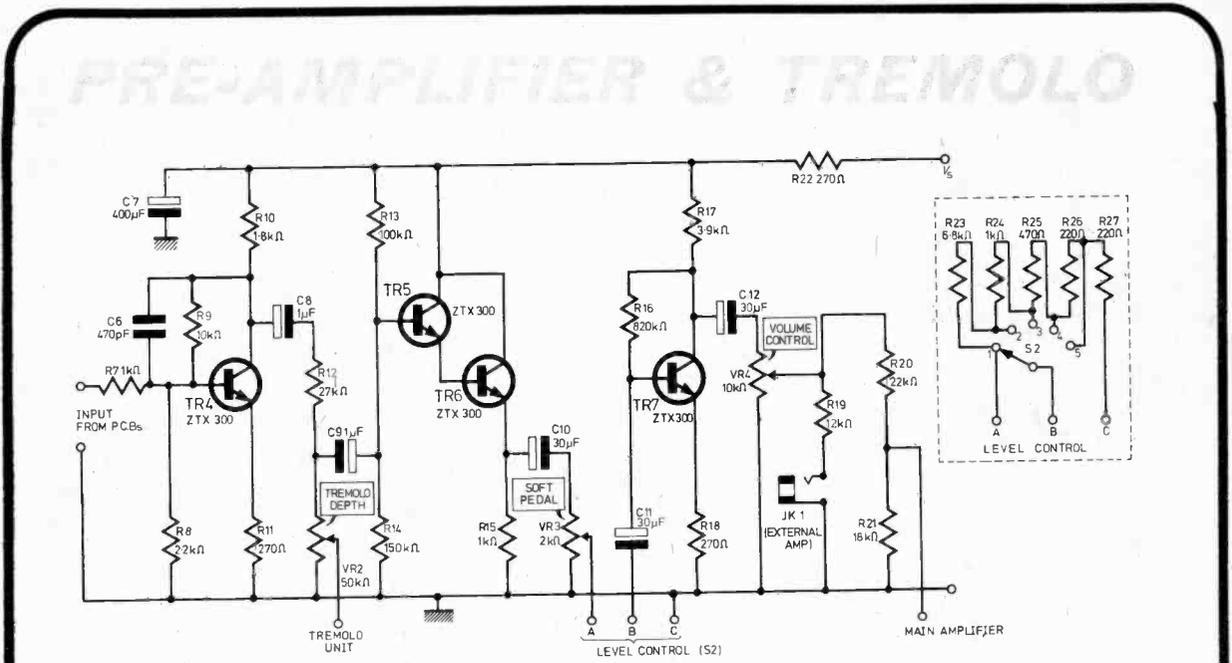


Fig. 2.4. Circuit diagram of pre-amplifier

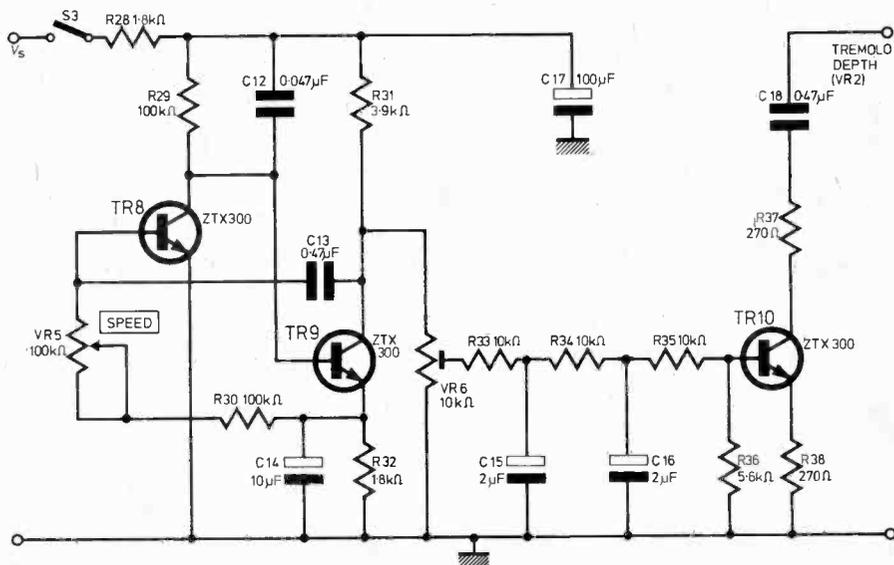


Fig. 2.5. Circuit diagram of tremolo unit, S3 is the keyboard on/off control switch

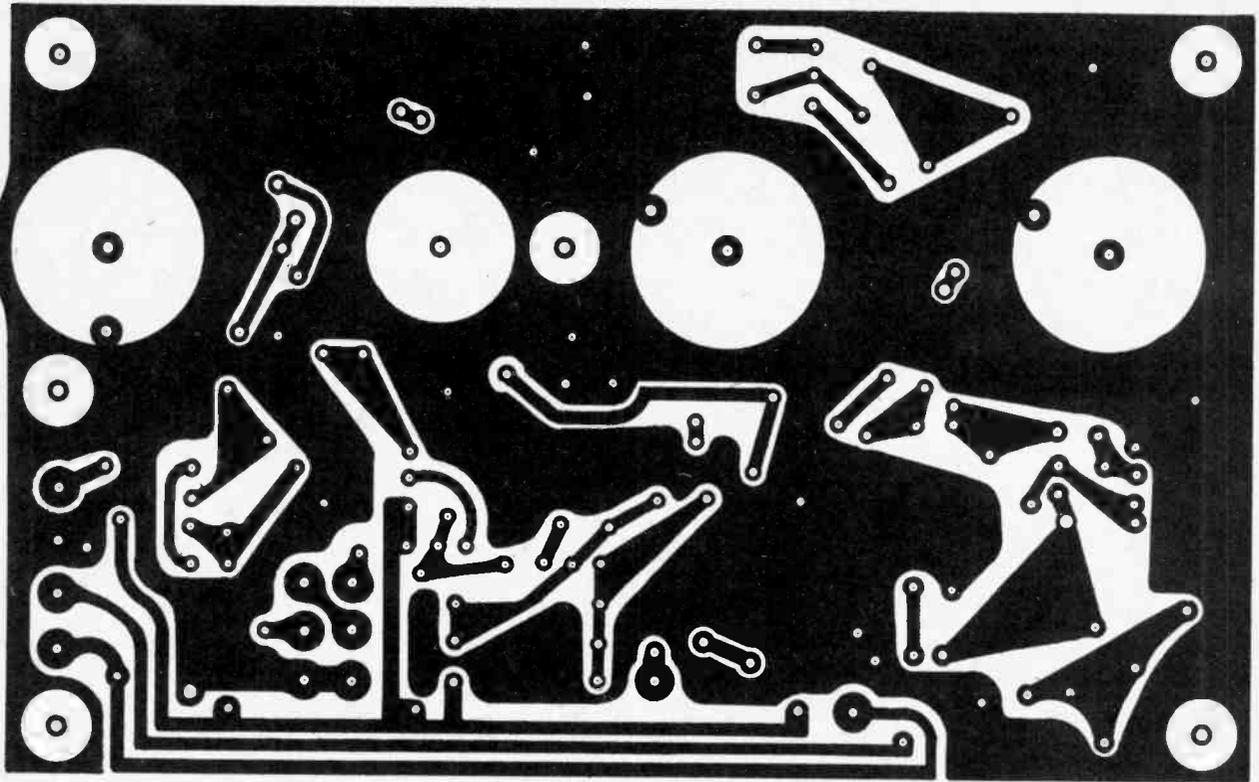


Fig. 2.6. Etching and drilling details for pre-amplifier and tremolo printed circuit board (full size). The white circles for JK1, VR2, VR4 and VR5 should be only  $\frac{3}{8}$ in diameter

## COMPONENTS . . .

### PRE-AMPLIFIER

#### Resistors

R7 1k $\Omega$	R18 270 $\Omega$
R8 2.2k $\Omega$	R19 12k $\Omega$
R9 10k $\Omega$	R20 22k $\Omega$
R10 1.8k $\Omega$	R21 18k $\Omega$
R11 270 $\Omega$	R22 270 $\Omega$
R12 27k $\Omega$	R23 6.8k $\Omega$
R13 100k $\Omega$	R24 1k $\Omega$
R14 150k $\Omega$	R25 470 $\Omega$
R15 1k $\Omega$	R26 220 $\Omega$
R16 820k $\Omega$	R27 220 $\Omega$
R17 3.9k $\Omega$	

All resistors  $\pm 5\%$   $\frac{1}{2}$ W carbon

#### Capacitors

C6 470pF polyester 125V
C7 400 $\mu$ F elect. 15V
C8-C9 1 $\mu$ F elect. 15V (2 off)
C10-C12 30 $\mu$ F elect. 15V (3 off)

#### Transistors

TR4-TR7 ZTX300 (Ferranti) (4 off)

#### Potentiometers

VR2 50k $\Omega$ carbon lin.
VR3 2k $\Omega$ carbon log.
VR4 10k $\Omega$ carbon log.

#### Miscellaneous

S2—5-way single pole rotary switch
JK1—Standard jack socket

### TREMOLO UNIT

#### Resistors

R28 1.8k $\Omega$	R34 10k $\Omega$
R29 100k $\Omega$	R35 10k $\Omega$
R30 100k $\Omega$	R36 5.6k $\Omega$
R31 3.9k $\Omega$	R37 270 $\Omega$
R32 1.8k $\Omega$	R38 270 $\Omega$
R33 10k $\Omega$	

All resistors  $\pm 5\%$   $\frac{1}{2}$ W carbon

#### Capacitors

C12 0.047 $\mu$ F polyester 125V
C13 0.47 $\mu$ F polyester 125V
C14 10 $\mu$ F elect. 15V
C15 2 $\mu$ F elect. 15V
C16 2 $\mu$ F elect. 15V
C17 100 $\mu$ F elect. 25V
C18 0.47 $\mu$ F polyester 160V

#### Transistors

TR8-TR10 ZTX 300 (Ferranti) (3 off)

#### Potentiometers

VR5 100k carbon lin.
VR6 10k $\Omega$ preset

#### Switch

S3—On/off switch

Normal setting is position 2 which gives the nominal output, on maximum master volume, for a five note input. Position 1 gives the nominal output when a single note is played and is only for special single note solo effects.

Positions 3, 4 and 5 give quick operation attenuated levels as required. In position 2 the attenuation between stages two and three is a factor of five.

The single transistor third stage has a gain of approximately ten, and again has a high dynamic range, such that the maximum output swing capability is 8V peak-to-peak.

Overall pre-amplifier voltage gain with the level control in position 2 totals a factor of three, and is followed by a master volume control which feeds the external amplifier jack socket, and a fixed attenuation network prior to the main internal amplifier.

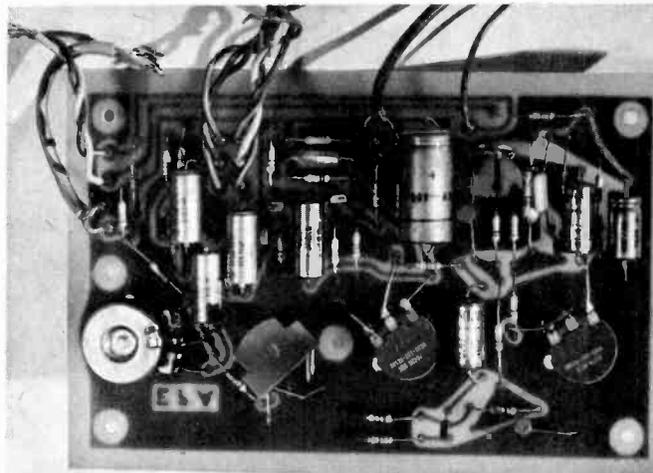
### TREMOLO CIRCUIT

The tremolo circuit is shown in Fig. 2.5. and consists of a multivibrator (TR8, TR9) supplying a square wave output across a preset potentiometer in the range of 5-10Hz. The output from the preset feeds two low pass filters to give a ramp waveform at the base of TR10.

Preset adjustment ensures that the transistor operates from the off condition and provides maximum voltage change at the collector. In turn the degree of voltage swing is controlled by VR2 when applied to the pre-amplifier.

### PRE-AMPLIFIER AND TREMOLO ASSEMBLY

The pre-amplifier and tremolo circuits are mounted on the same printed circuit board, which



Photograph of the completed pre-amplifier and tremolo board

also acts as the panel to hold the external amplifier output socket, the master volume control, and the tremolo rate and depth controls.

Figs. 2.6 and 2.7 give details of the printed circuit board and component assembly. As before all holes should first be checked against the diagrams, and any missed holes should be drilled before proceeding. This may be particularly necessary in the case of the potentiometer peg location holes which will vary in position for different types and sizes of potentiometer.

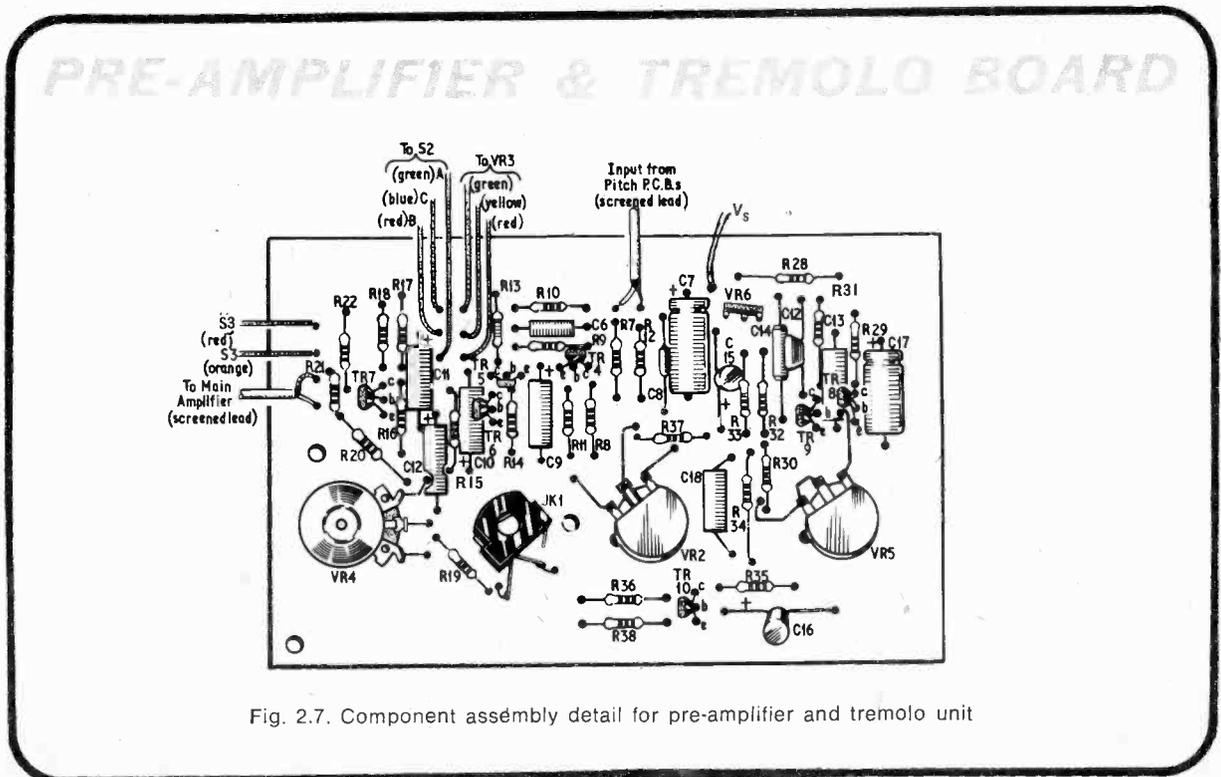


Fig. 2.7. Component assembly detail for pre-amplifier and tremolo unit

Next the terminal pins should be fitted, followed by the potentiometers, jack socket, and preset potentiometer. Fit the resistors, transistors and capacitors in that order, and finally wire the potentiometers and output socket.

### MAIN AMPLIFIER

The circuit of the main amplifier is shown in Fig. 2.8 and is based on the Sinclair integrated circuit type IC-12.

The amplifier is intended as a low power unit to drive the two small internal loudspeakers, or the headphones. Whilst the power is adequate for home use in a small or medium size room, an external amplifier is recommended for any serious use of the instrument outside the domestic circle.

The circuit within the package is fully explained in the Sinclair booklet which is supplied with the unit. If you should purchase a unit which includes the earlier simple two page leaflet the booklet can be obtained by writing to Sinclair Radionics Limited.

### COMPONENT CHANGES

A printed circuit card is supplied with each unit and the photograph shows the assembled unit. Some of the component values have been changed from those suggested by Sinclair for the average application. The components affected are marked with an asterisk in Fig. 2.8 and the associated components list.

C19 (0.5 $\mu$ F) has been chosen for the input coupling capacitor since, as explained later, the input impedance has been reduced such that bass response could suffer if this capacitor were not increased. C20 (0.01 $\mu$ F) has been used to provide a small amount of treble cut as a form of tone shaping on the internal amplifier setting. C25 (400 $\mu$ F) prevents any possible instabilities due to the length of the supply lines.

### MAXIMUM BASS

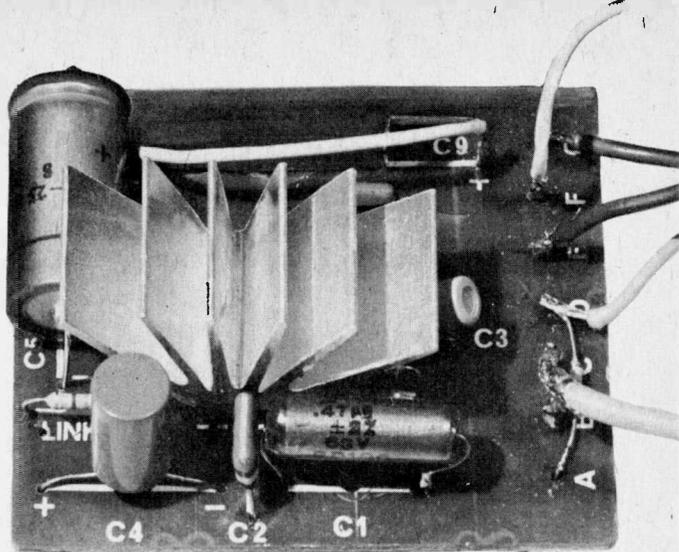
To provide maximum bass response a 1,000 $\mu$ F coupling capacitor (C27) is connected at the output. Due to the large size of this capacitor it has been removed from the p.c.b. as supplied by Sinclair. It will also be noted that the connection of this capacitor within the circuit has been removed from the live side of the speakers and inserted on the ground side. This prevents the possible shorting out of C27 to earth by the insertion of a jack plug into the headphone socket where the jack plug is connected to some other equipment which is earthed.

This rearrangement means, that it is necessary to connect a wire link across the connections intended for C27, thus making pin F an earth point.

The input impedance is reduced by the choice of R39 which minimises pick-up between the pre-amplifier board and main amplifier. R41 (470 $\Omega$ ) is used to hold the amplifier gain at 60. This gives an input sensitivity of approximately 200mV peak-to-peak for a 3 watt output into 6 ohms.

Sinclair Radionics state that it is very important that the i.c. only be used mounted on the printed circuit board which is supplied with it. Due to the very high gain of the device, the slightest coupling between output and input can cause trouble in the way of distortion and instability.

Next month: Pitch Board



Proprietary board assembly for the main amplifier

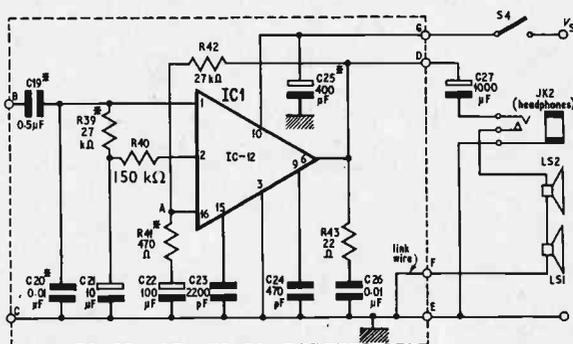


Fig. 2.8. Circuit diagram of main amplifier

## COMPONENTS . . .

### MAIN AMPLIFIER

#### Resistors

- R39\* 27k  $\Omega$
- R40 150k  $\Omega$
- R41\* 470  $\Omega$
- R42 27k  $\Omega$
- R43 22  $\Omega$
- All resistors  $\pm 5\%$   $\frac{1}{4}$ W carbon

#### Capacitors

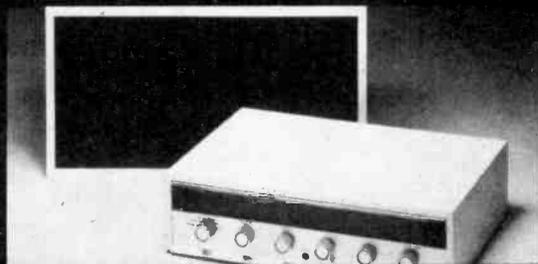
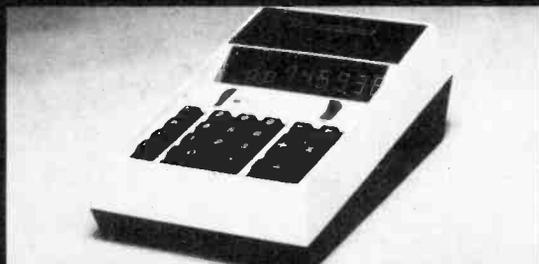
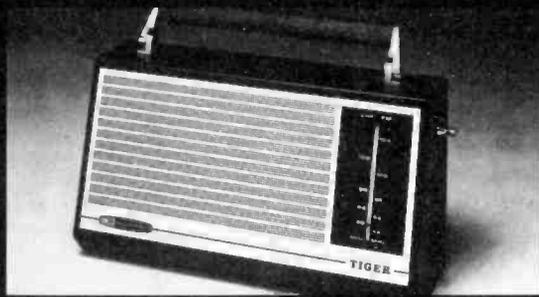
- C19\* 0.5 $\mu$ F polyester 125V
- C20\* 0.01 $\mu$ F polyester 125V
- C21 10 $\mu$ F elect. 15V
- C22 100 $\mu$ F elect. 15V
- C23 2,200pF polyester 125V
- C24 470pF polyester 125V
- C25\* 400 $\mu$ F elect. 25V
- C26 0.01 $\mu$ F polyester 125V
- C27 1,000 $\mu$ F elect. 15V

#### Integrated Circuit

- IC1—Super IC-12 with printed circuit board. (Sinclair Radionics Ltd.).

#### Miscellaneous

- JK2—Jack socket to match headphones
- LS1-LS2 3  $\Omega$  elliptical loudspeakers 8in  $\times$  2 $\frac{1}{2}$ in.
- S4—On/off switch



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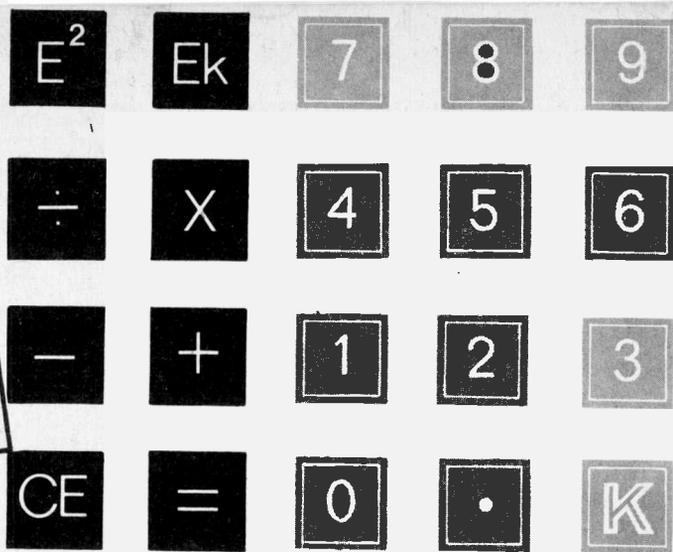
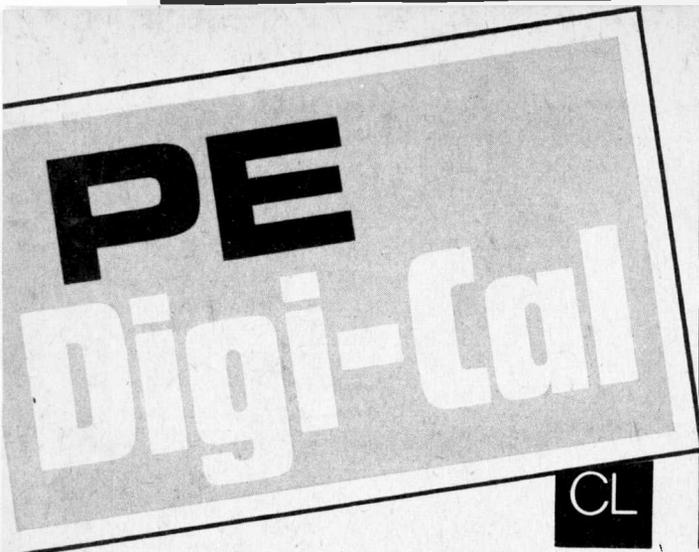
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By R.W.COLES PART 4

## KEYBOARD LOGIC AND HARDWARE

**S**ATISFACTORY functioning of the keyboard is vital for correct calculator operation and to make things as easy as possible for the user, a great deal of thoughtful design has been carried out as regards key-top labels, keyboard layouts, the required function of each of the keys, and compensation for possible "finger-trouble"! The author's solutions to these problems are embodied in the Digi-Cal keyboard, but should any constructor wish to alter either the physical layout or the logic there is plenty of scope for modifications to produce a "custom" design.

### KEYBOARD DEFINITION

The keyboard circuitry can be split up into a number of independent or interlocking sub-circuits, and each of these performs a different function, corresponding to one of the following list of keyboard requirements:

1. Convert figure key depressions into a four bit B.C.D. code and generate a single coincident clock pulse to enter the B.C.D. data into the (separate) entry register.
2. Convert arithmetic key depressions into a static two bit code suitable for use by the programme and arithmetic sections.
3. Record the number of decimal places in each figure entry and control the final alignment of the number so that it has the correct number of decimal places as entered on the thumb-wheel switch.
4. Produce a three bit code representing the number of decimal places to be displayed, dependent upon whether entries or answers are being read out.
5. Generate a single pulse to start the programme when the EQUALS key is pressed.
6. Switch on the overflow lamp when an OVERFLOW input is received from the arithmetic section.

### BLOCK DIAGRAM

The circuit of the keyboard panel can be subdivided into a number of relatively straightforward logic groups.

Fig. 4.1 shows these groups laid out in the form of a functional block diagram and it is best to understand the keyboard using this diagram before studying the full circuit in detail.

In the block diagram the circuit has been simplified as far as possible and the symbol consisting of a switch in a box with an arrowed input is used to represent gating functions which control the switched path, the arrow showing the input which has control.

### ARITHMETIC KEYS

Starting at the top of the diagram, the four main arithmetic keys are fed to an encoding circuit which generates a unique binary code for each depression. This code is "staticised" in two latch flip-flops so that the code remains on the output wires until over-ridden by a future (different) arithmetic selection.

The  $E^2$  key is in parallel with the "MULTIPLY" key since squaring is simply a modified multiplication sequence; a separate  $E^2$  output is also produced to modify the programme.

The narrow START pulse required by the programme is generated by a monostable triggered by the EQUALS key, and this monostable is also used to start the second half of the multiply and divide sequences on command from the arithmetic section.

### NUMERAL KEYS

The number keys are encoded to their B.C.D. equivalent in a diode matrix, the outputs of which are also staticised by four flip-flops so as to present a steady logic output during the clock pulse which enters the data into the entry register, the data in the latches remaining until either a different number key is pressed, or the EQUALS key is pressed in which

# KEYBOARD LOGIC

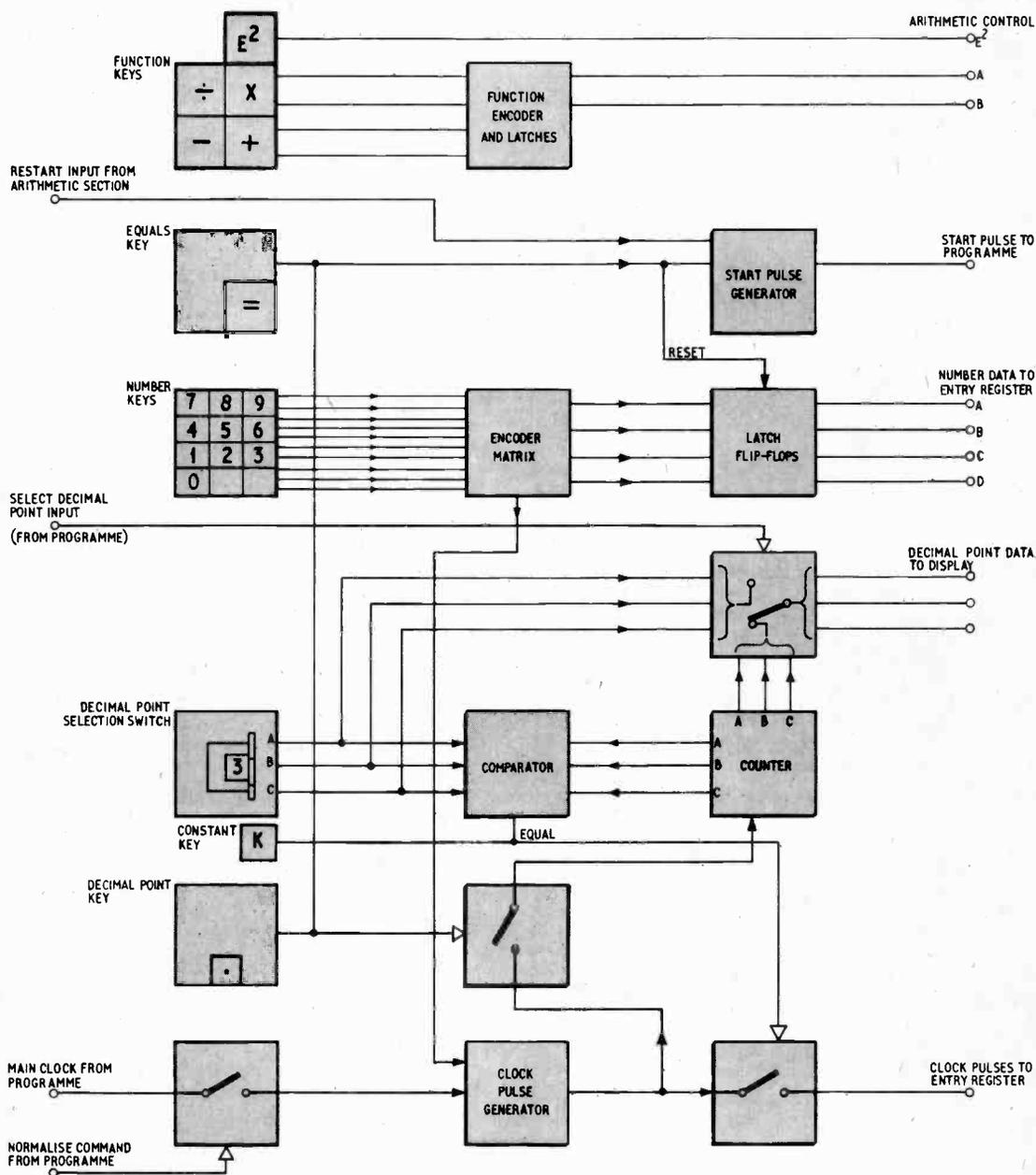


Fig. 4.1. Simplified block diagram of the keyboard logic. The symbol of a switch in a box with an arrowed input represents a group of logic gates, the arrow being the input which has control

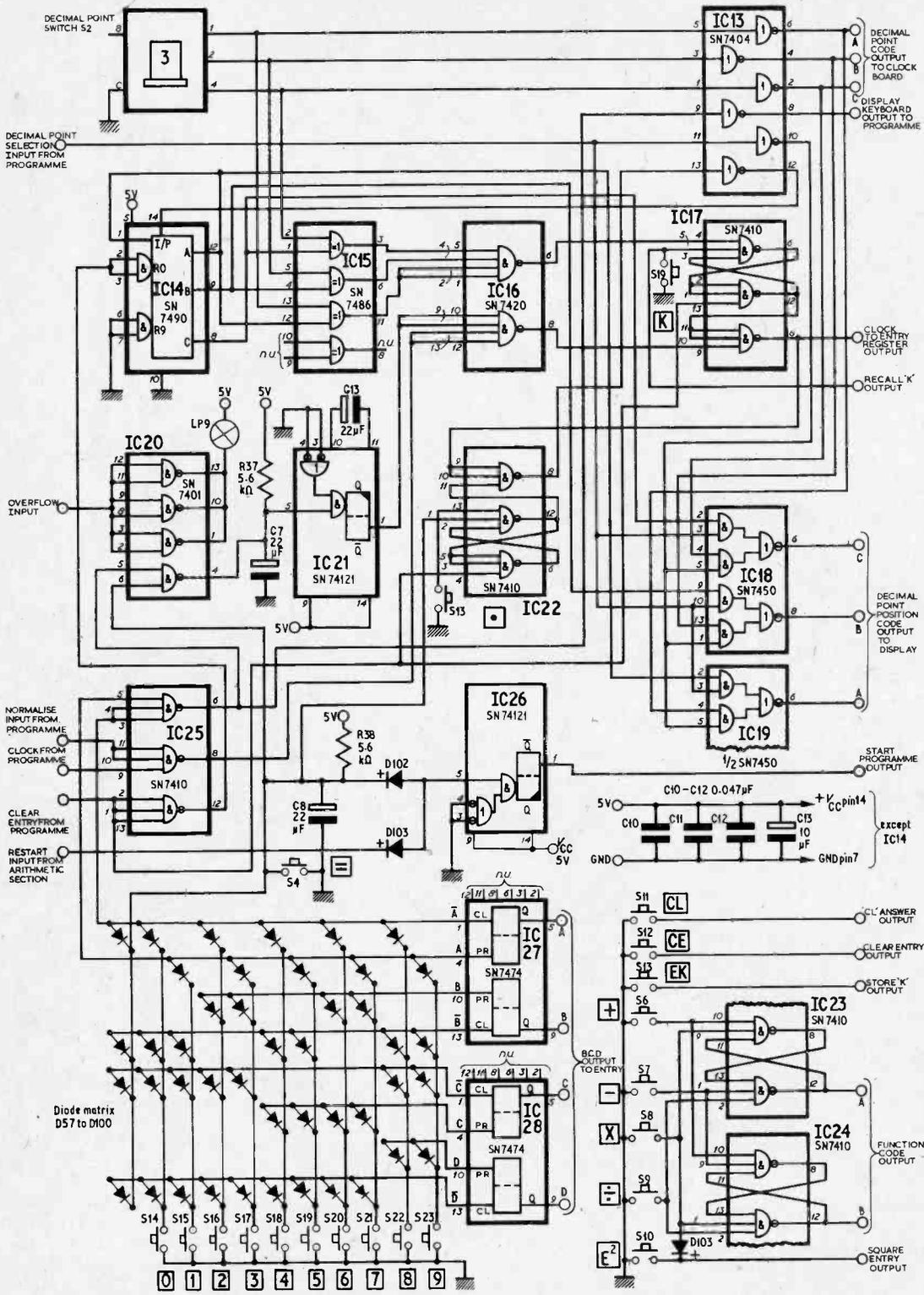


Fig. 4.2. The complete circuit diagram of the keyboard logic panel. All i.c.s have pin 7 as ground and pin 14 as 5V except IC14 whose power supplies are shown

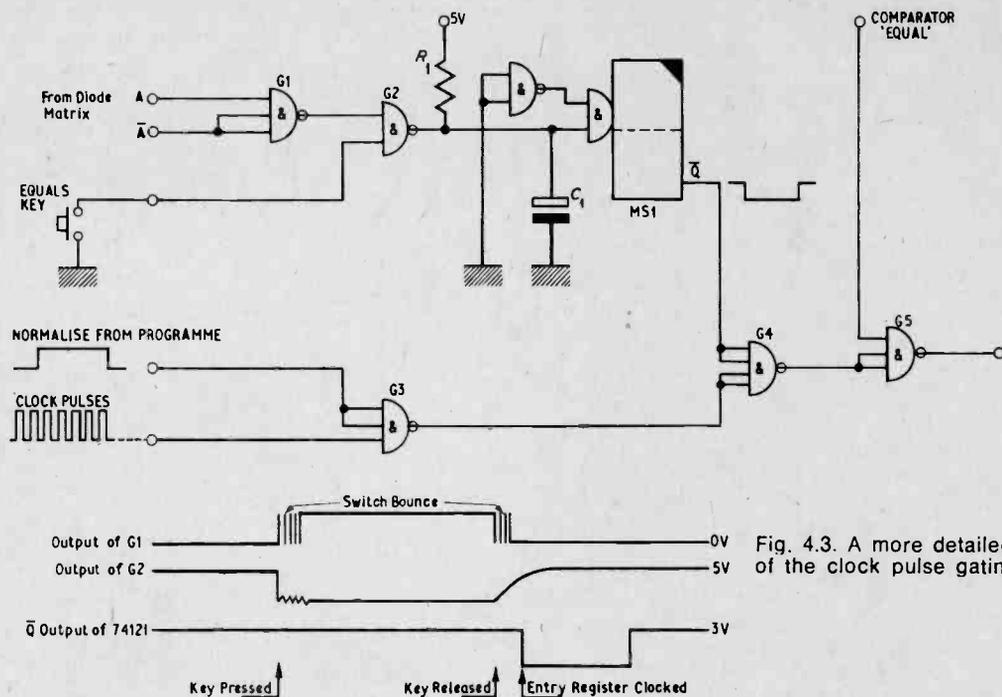


Fig. 4.3. A more detailed diagram of the clock pulse gating circuit

case the latches are cleared. An output is also generated from the matrix whenever any key is pressed, and this signal is used to trigger the clock pulse generator, but more of this later.

### DECIMAL POINT POSITIONING

If the decimal point key is pressed during an entry then a latch is set which in turn opens a gate to allow any subsequent clock pulses through to a counter. This counter counts the clock pulses after the point entry and gives an output which is compared with the setting of the decimal point thumbwheel in a comparator circuit.

When the correct number of decimal places have been entered the comparator registers the equality and shuts off the clock pulses from the clock pulse generator. It is this mechanism which prevents entry of too many decimal places in any figure entry.

If the number entered has too few decimal places then when the programme is started a NORMALISE command from the programme allows the main calculator clock pulses through to the clock generator in the keyboard, and the entry register data is rapidly shifted along until the comparator again registers equality then shuts off the clock.

This process ensures that all numbers can be entered without regard to the position of the point, normalisation being automatically carried out by the calculator itself.

### OTHER FUNCTIONS

There are two additions to the clocking circuit to allow for special conditions. The EQUALS key is allowed to close the path connecting the clock pulses to the counter, this being done to cater for the occasions when only whole numbers are entered, the decimal point being unused.

Also, the RECALL CONSTANT (K) key is allowed to shut off the clock path to the entry register so as to inhibit normalisation, this being necessary because the constant in store is correctly aligned to start with.

The three bit output of the thumbwheel switch is used to define decimal point position when the answer to a calculation is being displayed, and the three bit output of the counter is used to define it when an entry is being displayed. Switching between the two sources is carried out by a gating arrangement controlled primarily by the programme.

Any keys not shown on the simplified diagram have no associated logic circuitry and are passed out to the rest of Digi-Cal as switch closures to earth.

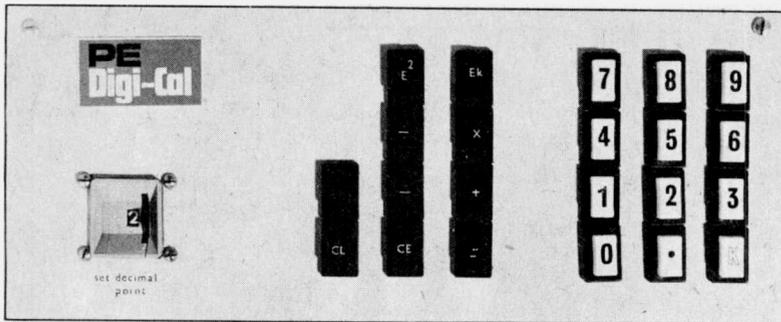
The full circuit of the keyboard is given in Fig. 4.2, and with the knowledge of its operation gained from the simplified diagram it should be possible to pick out the various logic groups previously discussed. One particular group may still be a little difficult to trace out, and that is the clock generation and gating.

To see this circuit in a clearer light it has been redrawn in Fig. 4.3 in an integrated way, and because this section is so important we can go through it step by step.

### CLOCK CIRCUIT

The clocking is initiated by detecting any output from the diode matrix which is an indication of a key depression. Because the normally high A, B, C, and D outputs of the matrix will always have either their true or their complement output active (i.e. low) for any one of the ten relevant key depressions a detection circuit can be made by "ORing" together the true and complement version of any one of them.

In Fig. 4.3 G1 performs the detection by using the two "A" outputs from the matrix. The "logic 1"



The upper side of the keyboard showing the arrangement of the switches in the slots

output from G1 is applied to G2 which is an open collector gate with  $R_1$  and  $C_1$  in its collector circuit to give a slow "0" to "1" transition. The other input to G2 is an inhibiting input from the EQUALS key which prevents a clock pulse being generated by the latch reset when the EQUALS key is pressed.

The output of G1 is shown for a typical key depression and as you can see it carries with it a faithful (though inverted) representation of the switch bounce which is a feature of all mechanical switch operations, and which must be removed before the signal is used to trigger the monostable.

The output of G2 is "cleaned-up" by  $R_1$  and  $C_1$  to give the output pulse shown, and the slow transition after the key is released is used to activate the level sensitive trigger input of the SN74121. The fairly long negative going pulse from the monostable is "ORed" with the possible output of G3 and fed out to the entry register via G5 which is controlled by an inhibitory input from the COMPARATOR EQUAL latch. Gate G3 is used to control the main clock input used during the normalising cycle, being enabled by a long pulse from the programme.

## DIODE MATRIX

The diode matrix used to encode the figure keys into their binary equivalent is so named because of its physical construction, the logic it performs being simply that of eight multi-input OR gates, the number of inputs to each gate being set by the number of diodes connected to its output line.

In the circuit diagram the eight horizontal lines represent the gate outputs, the requisite inputs being made by the diode links to the eleven vertical lines from the number keys and the reset line.

The matrix is built using the same technique as was employed for the display matrix (Part 3) with a small piece of Veroboard providing the vertical output lines to the latches and the key inputs being wired to the horizontal strips on the mother board.

Remember that it is necessary to make guide funnels on the blank side of the small piece of Veroboard to ease the location of the diodes prepriated to the mother board, and most important, the cathode end of the diodes should be mounted next to the mother board.

The outputs from the matrix drive the PRESET and CLEAR inputs of the four latch bistables, which do not use their D inputs or CLOCK inputs in this application (IC27, IC28).

The use of SN7474 flip-flops in this position is a bit extravagant, since a couple of SN7400s cross coupled to form four latches would work just as

well and can be incorporated if desired, the more versatile SN7474s being used in the prototype to allow for possible future modification to enter data automatically from a source such as a tape reader.

## FUNCTION CODER

Unlike the number coder and latches, the function coder and latches do not need a separate set of coding gates, the latches being built from SN7410 three input NAND gates, ICs 23 and 24, and the two inputs to each gate left after making the latch coupling are sufficient to provide the gating required to encode the arithmetic keys.

The E<sup>2</sup> key is coded in the same way as MULTIPLY and a diode D103 is used to facilitate this.

## EQUALS KEY

Pressing the EQUALS key is the signal to start the selected arithmetic programme, and as may be expected, when it is pressed several things happen at once.

The earth appearing on the EQUALS line:

- resets the number latches via the matrix;
- inhibits the generation of a clock pulse which would normally result from the previous reset (see G2, Fig. 4.3);
- sets the decimal point latch IC22 to allow subsequent clock pulses through to the counter (this latch may have already been set by operation of the DECIMAL POINT key during figure entry).

When the key is released and the earth disappears the resulting positive going signal on the line is "debounced" and used to trigger the START PROGRAMME monostable IC26 via a simple diode gate D101, D102. The output from the monostable is a very narrow pulse which is used to initiate the programme sequence. The diode gate is required so that the programme can also trigger the monostable to generate a "RESTART" pulse required in some arithmetic sequences.

## DECIMAL POINT NORMALISATION

When the decimal point latch is set clock pulses are allowed through to the SN7490 decade counter IC14, which in effect counts the number of figures after the point in a number entry. The contents of this counter are continually compared with the decimal point switch output so as to detect a state of equality.

The thumbwheel switch output is already in a binary code though of an inverted form so that a logic "1" is represented by an earth connection and

# COMPONENTS...

## KEYBOARD PANEL

### Resistors

R37, R38 5.6kΩ ¼W ±10% carbon

### Integrated Circuits

IC13 SN7404  
 IC14 SN7490  
 IC15 SN7486  
 IC16 SN7420  
 IC17 SN7410  
 IC18, IC19 SN7450 (or SN7451) (2 off)  
 IC20 SN7401  
 IC21 SN74121  
 IC22, 23, 24, 25 SN7410 (4 off)  
 IC26 SN74121  
 IC27, IC28 SN7474 (2 off)

### Capacitors

C7, C9 22µF 15V elect. (2 off)  
 C8, C13 10µF 15V elect. (2 off)  
 C10, C11, C12 0.047µF (3 off)

### Switches

S2 Birch Stolec EB10N 1248 and a pair of end plates  
 S3-S23 On/off push button (Bulgin type MP22, white 12 off, black 9 off)

### Lamp and holder

LP9 6V 40mA lamp and holder (Bulgin type D22)

### Diodes

D57-D103 West Hyde type "red" (47 off)

### Miscellaneous

9.5in×3.3in 0.1in matrix Veroboard

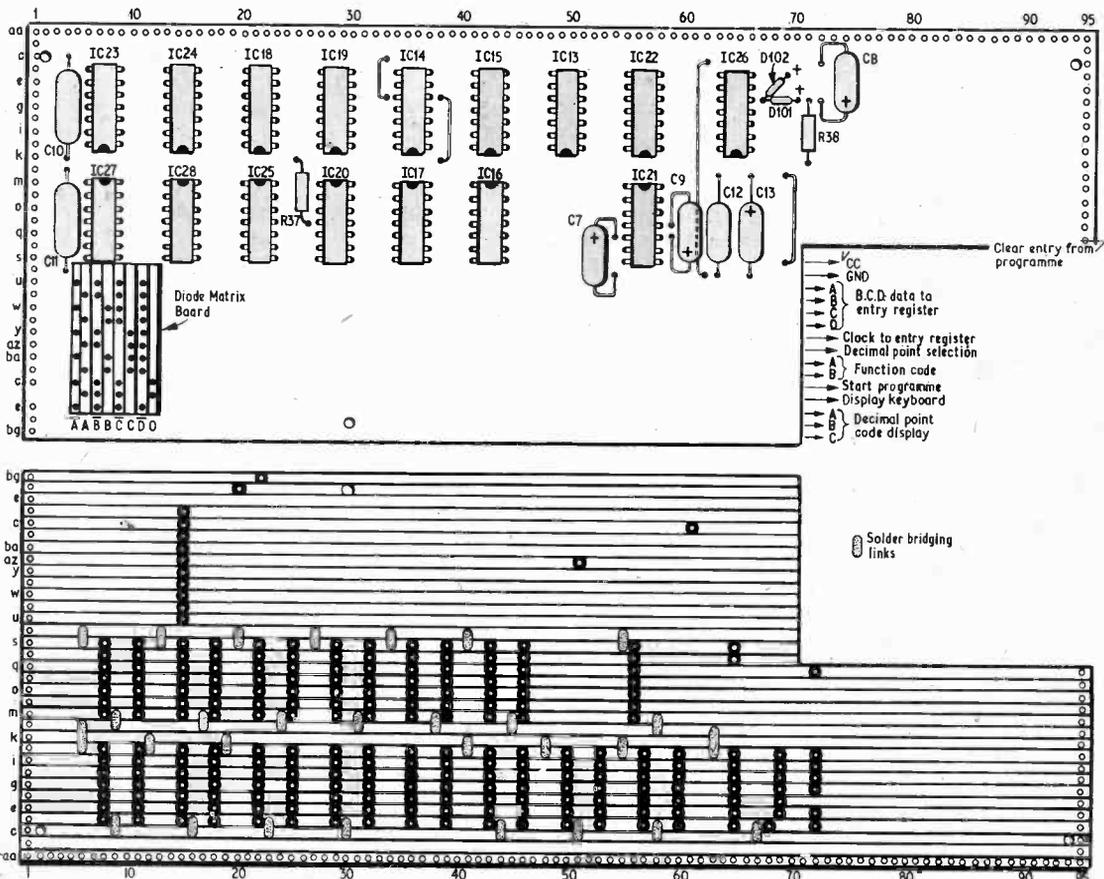
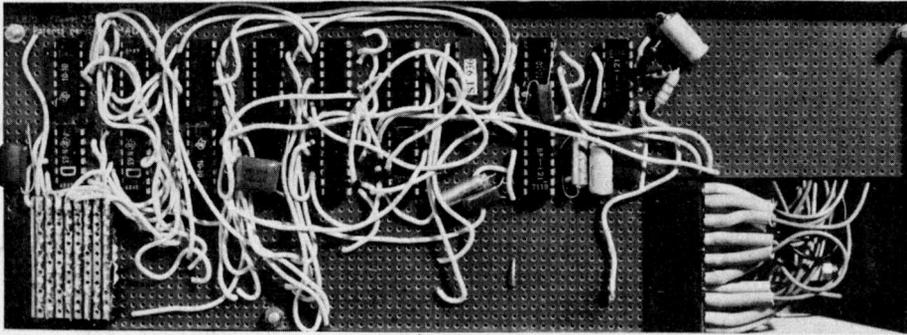


Fig. 4.4. Layout of the components on the Veroboard panel and the cuts which must be made in the copper strips. The links shown are for the power supply lines only and can either be made above or below the board. The black dots on the "diode matrix" board show the positions of the diodes which are arranged with the cathodes towards the main panel



A photograph of the keyboard logic panel in the prototype. The edge connector is an optional extra as wires can be soldered directly to the board

logic "0" by an open circuit. This suits our purpose admirably since the SN7486 used as a comparator, IC15, gives a "1" from each of its gates when its inputs are exactly opposite.

By comparing the true counter outputs with the complement switch outputs a comparator is formed which gives three "1" outputs when the count equals the switch setting. These three ones are used to enable a gate IC16, which in turn sets a latch, IC17, the output of which forms the input to G5 of Fig. 4.5 and serves to shut off the supply of clock pulses to the entry register.

### DISPLAY CONNECTIONS

The position of the decimal point in the display can be governed either by the contents of the counter, IC14, or by the thumbwheel switch setting depending on a command from the programme.

Switching between these two sources is carried out by the AND OR INVERT gates IC18 and IC19, but note that for this purpose the outputs from the thumbwheel switch are inverted by IC13, to make them compatible with the counter outputs. The selected point data is fed to the display via a three line bus.

### OVERFLOW INDICATION

If an OVERFLOW condition is detected during an arithmetic operation a "1" input on the OVERFLOW line drives three SN7401, IC20, gates in parallel to switch on the panel indicator bulb. The correct procedure is then to use the CLEAR key to erase all data and then re-enter the problem in a rescaled form. It is necessary to parallel connect three gates for this job because of the current requirements of the bulb.

### PROGRAMME RESET

To return the keyboard to its correct state for a further calculation it is necessary to rest the DECIMAL POINT and EQUALS latches and the decimal point position counter. This is carried out by a CLEAR ENTRY command from the programme which, as its name implies, also clears the contents of the entry register.

### CONSTRUCTION

The layout of the Veroboard panel is shown in Fig. 4.4, the panel itself being cut to size from a West Hyde type 122 board.

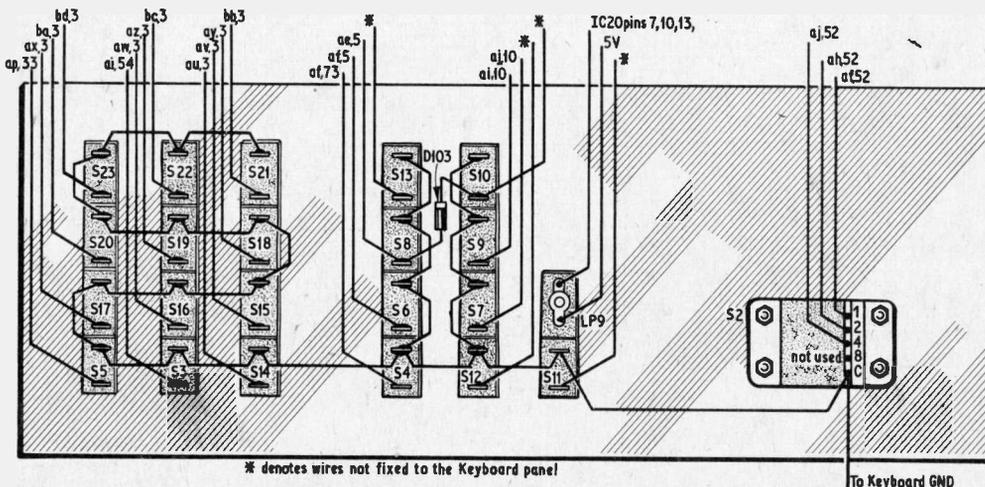


Fig. 4.5. The switches are wired as shown. All wires except those with an asterisk go to the panel shown in Fig. 4.4

The finished panel will be mounted upside down under the keyboard proper, affixed to the recessed wooden blocks either by means of wood screws, or, as in the prototype, by captive 6B.A. bolts cemented into the blocks with Araldite.

Needless to say, it is advisable to make all the board fixing arrangements before commencing the wiring.

Wiring up is carried out as before with thin single core wire, using terminal pins where necessary to increase the wire handling capacity of a particular pad.

Off board wiring is achieved with thin flexible stranded wire left long enough that the board can be easily removed for access, but not too long that stray pick-up could become a problem.

An edge connector was used to carry some of the off-board wiring in the prototype to help with development, this would not be necessary, or even advantageous to any significant extent with later versions, due to the very large number of interconnections required in all.

The switches are wired up as shown in Fig. 4.5.

## TESTING

As with the display board last month it is advisable to wire up the keyboard logic a section at a time, testing each block before proceeding. In this way small mistakes can be easily discovered and dealt with before they become buried in several different circuit blocks.

Almost all the logic can be tested at the wiring stage without undue complication, outputs being monitored with a multimeter or by connecting them temporarily to the display board input if desired. If the latter course is chosen remember that the display board requires an inverted B.C.D. input, which while easily accommodating the decimal point outputs and function code outputs, will require temporary connection to the  $\bar{Q}$  rather than the Q outputs of the figure latches for correct display.

The clock pulse output is long enough to be detected on a meter which is an advantage for tests of this type, the EQUALS triggered START pulse is however far too short to be detected in this way but fortunately this part of the circuit is quite simple and can be left unchecked at this stage.

**Next month: Entry Register (constant store, entry register and multiplexer)**

# POINTS ARISING

## SQUARE WAVE GENERATOR (Sept. 1972)

In the lower half of Fig. 6, the connections for the switch should read as follows reading from top to bottom:

- (a) Top group is S1b numbered 1,2,3,W,4;
- (b) Bottom group is S1a numbered 4,3,2,1;
- (c) S1b wiper should read S1a wiper.

# NEWS BRIEFS

## TECHNICAL INFORMATION SERVICE

A NEW technical information service, aimed at giving firms, corporate bodies, instructors, students, and others engaged in educational work, advice on correct electrical installation practice according to I.E.E. "Regulations" has been established by the National Inspection Council for Electrical Installation Contracting.

The service is confined to technical matters and excludes advice on commercial or trading aspects, industrial or labour relations, and information relating to manufacturers' products.

The aim is to promote a high standard of installation and maintenance safety of electrical wiring and appliances. The subscription fee is £3.50 per year to cover the services offered. Further information is available from the Council at Trafalgar Buildings, 1 Charing Cross Road, London SW1A 2DT.

## NEW POCKET CALCULATOR

WHAT is claimed to be the world's smallest electronic calculator has just been announced by the British company Sinclair Radionics Ltd. At only just over  $\frac{1}{2}$ in thick and  $5\frac{1}{2}$ in  $\times$  2in this can really claim to be a pocket sized calculator.

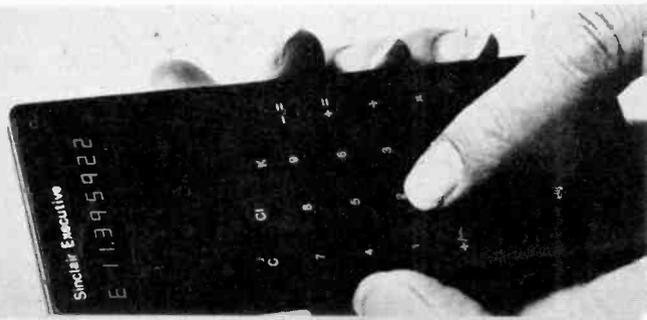
Known as the Sinclair Executive this calculator embodies many new techniques. Firstly the single MOS chip which forms the calculator consumes a mere 20 mW of power making it possible to run the whole machine from three mercury cells of the type used in hearing aids. This is made possible by switching off the i.c. completely between clock pulses relying on the capacitance of the MOS elements to store the information. Secondly the clock rate is reduced when the calculator is not performing a calculation so as to conserve power.

The battery voltage is just sufficient to drive the display thus eliminating the usual dropper resistors which consume power.

The keyboard was specially developed for the calculator being only 4mm in depth. The contacts are gold plated and the keys are arranged so that it is virtually impossible to touch two at the same time.

The L.E.D. display has a capacity of eight digits. The calculator can perform all the usual arithmetic functions as well as automatic squaring, reciprocals and can operate in either fixed or floating decimal point mode. It also has a memory for calculations with a predetermined factor.

Although, at £79 this calculator is not the cheapest on the market, it must pose quite a threat to the present Japanese domination of the calculator field.



# report from AUSTRALIA

BY J.M.WALDIE

In this report, the main theme will be the audio scene, which again should be of interest to intending migrants and visitors.

Audiophiles here have a very large range of components from which to choose; it is likely that the range encountered in the average store will be greater than in a similar situation in the U.K. The possession of a respectable audio system, at least in the large cities, appears to be the rule rather than the exception, despite the "outdoor life" philosophy of the average Australian.

## LOCAL PRODUCTS

The number of companies producing audio systems is relatively small. There are about six brands of Australian-made amplifiers (including Leak and Philips); only two very simple belt-driven turntables are produced here; I understand that there are only two locally produced reel-to-reel recorders and only one cassette system. There are, of course, several brands of "mid-Fi" modular grams and radiograms, including such brands as Kreisler (division of Philips); AWA (Amalgamated Wireless Australia), Thorn, Pye and HMV.

## IMPORT TRADE

However, there is sufficient industry to warrant relatively high import surcharges—designed to protect local manufacturers (which, in some areas, are non-existent). Despite this, Japanese equipment dominates the retail trade, followed by British, German, Scandinavian and—to an increasing degree—American audio components.

For example, of the 30,000 reel-to-reel mains-operated recorders and decks imported in 1970-71, 26,000 came from Japan. Some \$A 2 million worth (F.O.B. values) of amplifiers also arrived in the same period, of which well over half also came from Japan, and approximately one-quarter (in terms of value) from the U.K.

The British, however, have the lion's share of the turntable market: of the 200,000 units imported in the year ending June 1971, 176,000 came from the U.K. This is largely due to the practice of installing Garrard and BSR decks in mass-produced "unit-audio" systems.

There is a very wide range of loudspeakers—both imported and home-grown—available, and the Australian audiophile has a bewildering selection from which to choose. There are three locally-made brands of any consequence, and some very presentable designs have been issued. Japanese cabinets again dominate the imported systems. It is in this area that the Americans have been active, promoting the more expensive brands such as JBL, A.R., Marantz and Advent.

## QUADRAPHONY

Largely due to the Japanese dominance in Australia in the audio field (Japan is one of Australia's largest customers for ore and coal; consequently the trade relations between the companies are maintained at a very close level), the current interest among audiophiles is the idea of 4-channel sound.

The battle between proponents for the CD-4 discrete system of quadraphonic disc reproduction (JVC/National/RCA) and the various matrix methods for obtaining more or less the same result (dominated by Sony's SQ system), is now in full swing.

Records produced by both methods are now available; the record manufacturers appear to be taking sides but showing apparent preference for the matrix method. It has been announced, for example, that EMI, with CBS, have opted for the Sony SQ system, but the decision to market SQ records will depend on demand. This demand will presumably originate from new owners of SQ equipment, but who would buy such equipment without a guaranteed source of quadraphonic records?

This chicken-and-egg situation is likely to delay still further the final decision. On the other side of the fence, aurally speaking, RCA have announced, in America, that eventually all records issued by that particular stable will be "in discrete" quadraphony, a move that must be followed not only here but worldwide. And to confuse matters even more, according to local sources of information, A&M records are being matrixed to the Sansui QS method (not necessarily compatible with Sony's SQ) and two big German companies, Polydor and Deutsche Grammophon, are opting for a discrete system not necessarily similar to JVC/Nivico.

Record manufacturers I spoke to locally all indicated that the outlook was in such confusion that nobody really knows what is happening next.

## ORIENTAL CUSTOM

Australian audiophiles may have an extensive selection of audio equipment available but they don't grow on trees. For English equipment, the list retail price is likely to be double that in the U.K. For example, a Garrard Zero 100 deck has a list price here of \$A 269 (about £120) which compares with the U.K. list price of £54. On the other hand, the difference in price of Japanese equipment is very much less; a Sansui SD 5000 deck is listed here at \$A 756 (£345) which compares to £328 in the U.K.

This, of course, explains to some extent why Japanese equipment is so popular. However, we not only import oriental equipment but, to some extent, their methods of selling; it is usual to "haggle" over prices and the published list prices are something of a myth. Moreover, it is always possible to "trade-in" an article, which might not even be electrical.

## COLOUR TELEVISION

It was recently announced that Australia will "go colour" in March 1975. The system to be adopted will be the 625-line PAL format and all four Sydney stations (1 national, 3 commercial) are in the process of preparing their studios and transmitting equipment.

The manufacturers, however, are treating the news with some trepidation; on the one hand, it could be regarded as a shot in the arm for the electronics industry, but a real concern is being expressed regarding imported receivers which, at the current import rates, could possibly be landed and sold at prices below those expected for locally-produced sets.

The matter will be discussed with the Tariff Board, who decide the magnitude of import duties applicable to any imports. And there are a number of critics who feel that, at an anticipated price of £500 for a 25in set, the sales to Australians, who for the most part regard television as a distraction rather than as a necessary part of life, may just not warrant the large initial outlay.

# NEXT MONTH

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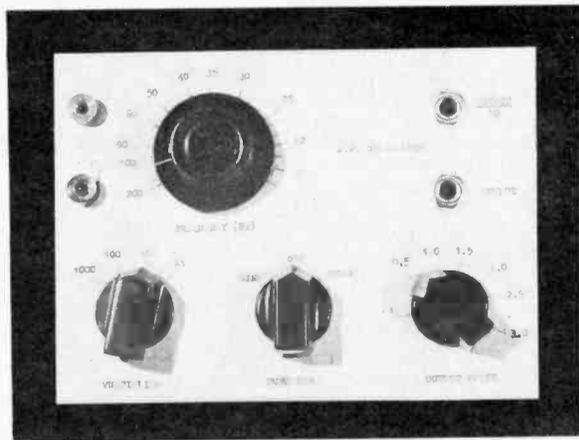
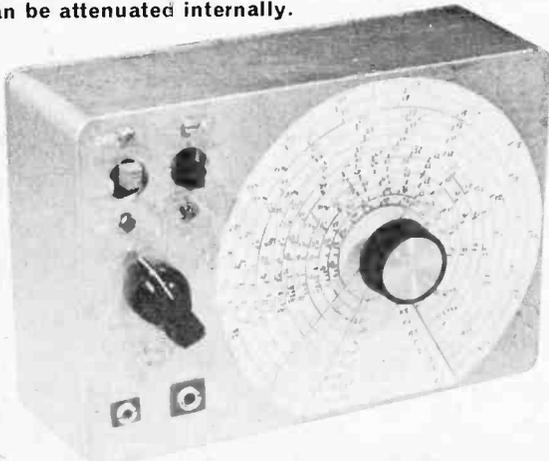
# SYNTHESISERS



## A.F. SIGNAL GENERATOR

For checking and measuring the characteristics of audio equipment, including frequency response, distortion, power output, signal to noise ratio, and dynamic range, one of the most important aids is an a.f. signal generator.

This instrument provides a sine wave output in the frequency range 19Hz to 200kHz in four bands. Square wave pulses from 19Hz to 20kHz are also available. Maximum output is just over 1V r.m.s. and can be attenuated internally.



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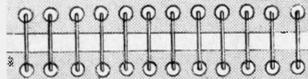
Values of resistor or capacitors can be determined simply by turning a pointer until the signal from an audio generator is reduced to a minimum.

There is no meter so the unit is inexpensive and robust. The components are readily available and the instrument is easy to construct.

PRACTICAL

# ELECTRONICS

NOVEMBER ISSUE ON SALE OCTOBER 13



# INDUSTRY NOTEBOOK

By Nexus



## VALUE ON THE BRIDGE

There was a bumper gathering of 300 delegates at the I.E.E. conference on *Advances in Marine Navigational Aids*. They came from all over the world to hear and discuss 55 papers.

It was a heady occasion embracing just about every navigation technique all the way from visual aids (the earliest known lighthouse was at Alexandria about 265 B.C.) to such twentieth century exotica as "System of location of balloons, ships or buoys by means of a low-orbiting satellite".

For the student of marine electronics the occasion was fascination itself. For the practical mariner, expected to foot the bill for equipment as well as understand and evaluate all the rival and complementary systems available, it was more like a nightmare.

The Chief Marine Superintendent of the B.P. Tanker Company Ltd., Mr R. Maybourn, put his finger on the shipowner's problem in his paper "Cost benefit and related factors—a shipowner's point of view". A navigation outfit for a modern tanker has an installed cost of almost £45,000 using fairly conventional equipment. Using some of the sophisticated systems described at the conference could result in a doubling of the cost with only dubious advantages.

## EXOTIC IDEAS

Mr Maybourn criticised the electronics industry for developing expensive and exotic ideas without adequate reference to the shipowners, and which are not clearly related to adequately defined problems or needs. He suggested that we often seem to have the solution first and the problem becomes one of finding a need to which to match it.

On computerised anti-collision systems, he wondered whether the problem had been adequately identified or even if the current problem is being solved. He referred to the computer as something which mesmerises the electronics engineer "itching to use its spare capacity in much the same way as an idle hand does a work study practitioner".

What Mr Maybourn asked of the industry was for far more reliability in existing equipment, and some element of standard design in equipment in regard to dimensions, methods of fitting and presentation of data which, he said, was chaotic and certainly would not be tolerated in the aircraft industry.

This point of view deserves some sympathy but should be examined in an historical perspective. Most of the exciting new concepts such as satellite navigation and the v.l.f. Omega system have their origin in military developments as, indeed, did marine radar and Decca Navigator before them. These last two items are now accepted as standard fit and comparatively inexpensive aids. What Mr Maybourn and the shipping industry are getting is the best of both worlds.

## HIGH RELIABILITY

If the electronics industry demonstrated anything at all at the Conference it was that today's technology is available with high reliability and at a bargain price, while tomorrow's technology is being seriously considered and will be available in due course to merchant shipping at a fair price.

Timing is terribly important. The Marconi "Predictor" anti-collision radar system has been available for four years, yet less than a dozen have been sold. It was, and is, a brilliant example of electronic engineering and necessarily expensive. Decca Radar brought out a simple anti-collision radar with limited capability about the same time at about half the price and have sold some 700 equipments. It was what the shipowner wanted at a price he could afford. But the outlook for "Predictor" remains bright and Marconi still expect it to do well. It was only the timing that was seriously adrift.

## TOUGH COMPETITION

On the other hand, you don't need to invent new technology to invent new systems. I was at the inauguration of the Southampton Harbour Radar system, said to be the finest in Europe if not in the whole world. I searched in vain for completely new technology in both the operations room and the equipment areas. Decca Radar, the prime contractors, had done a wonderful systems engineering job

using off-the-shelf equipment freely available on the open market.

I was also at the unveiling of a new marine radar display concept introduced by Kelvin Hughes and reviewed at the Conference by marine consultant Captain J. P. Stewart. The system uses television techniques and is a notable advance, yet the only device in any way unusual for a radar is a light-sensitive "image retaining panel". This panel has been commercially available for ten years but nobody had apparently thought of using it in a radar application until Kelvin Hughes originated the idea.

What is worrying the marine electronics industry is an unrealistic pricing policy. Competition is so severe that few companies are making sufficient money to support future civil (as distinct from naval) R and D at a reasonable level.

## TXE2 TAKES TO THE ROAD

The Post Office is always fair game for the knockers and I have knocked away in my time with the best of 'em. SDS Components Ltd, the Portsmouth-based component distributors have gone one step further than knocking by abandoning postal delivery and employing Securicor to make all deliveries.

But the Post Office is not all that bad, although you might still think so when out driving and you get stuck behind one of the eighty or so 27ft long trailers now being built to house mobile electronic telephone exchanges. Each of these will house a Plessey TXE2 equipment and will be on the move to a site where 1,000 would-be telephone subscribers can stop biting their nails with frustration and get hooked into the network.

The Post Office already has 250 mobile exchanges of conventional types but these can only handle 400 lines each. The TXE2 electronic exchange in two trailers can handle 1,000 and a dual installation housed in three trailers will serve 2,000 subscribers.

Deliveries commence next May and the investment by the Post Office is £3 million. At least they are trying to keep pace with a demand that seems insatiable.

## GOONHILLY 3

I was sorry to see that the 10th anniversary of the Post Office satellite station at Goonhilly Downs passed with so little notice. The occasion was marked by the inauguration of Goonhilly 3 making the station the busiest satellite terminal in Europe.

It seems more than ten years since we were all startled by *Telstar 1* and *Relay* before *Early Bird*, the first of the *Intelsat* satellites, really got going with a full commercial service.

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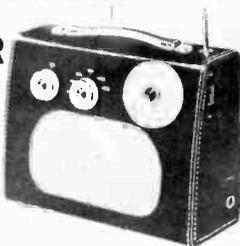
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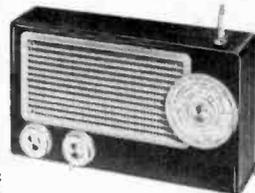
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TOTAL BUILDING COSTS **£3.98** P.P. & INS. 30p (OVERSEAS P. & P. £1)

### POCKET FIVE



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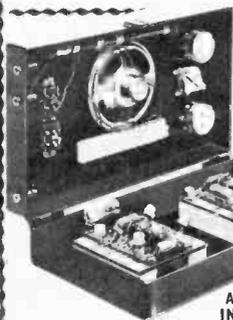
TOTAL BUILDING COSTS **£2.50** P.P. & INS. 22p (OVERSEAS P. & P. 63p)

### TRANS EIGHT



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# PATENTS REVIEW...

## MOVEMENT DETECTOR

BP 1 267 194

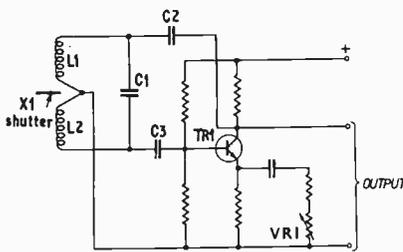


Fig. 1

British Patent 1 267 194 from Rotameter Manufacturing Co Ltd describes a simple but probably very effective circuit for sensing and registering very small physical movements of objects.

The basic circuit is shown in Fig. 1 and relies on a Hartley oscillator with two magnetically coupled inductors L1, L2, a bridging capacitor C1 and d.c. blocking capacitors C2, C3. The variable resistor VR1 controls, along with the mutual inductance of inductors L1, L2, the amplitude of the circuit oscillations. The frequency of the oscillations depends upon the values chosen for the inductors L1, L2 and capacitor C1.

A small shutter X1, formed from non-magnetic but electrically conductive material (e.g. copper, brass, etc.), is movable into and out of a small gap which is left between the magnetically coupled ends of the inductors L1, L2.

If the object whose movement is to be sensed is mechanically coupled to the shutter, then any movement, however slight, will cause a change in the amplitude of oscillation. This change may in some cases be reasonably linear.

By amplifying TR1 output a direct dial readout can be obtained or, alternatively, the amplified output can be fed to a "pot coil" electromagnet arranged to apply a restoring force to the object which has moved. This restoring force will tend to move everything back to the original or null position, i.e. seek equilibrium in this state.

Component values are suggested which will detect and register a 0.025mm movement with a transistor output change of 200 millivolts.

## ELECTRONIC SPEEDOMETER

In conventional electronic speedometers there is sometimes a problem in raising sufficient control voltage to not only display the speed, but also record the maximum speed obtained. Mechanical systems can introduce an inaccuracy of around 15 per cent which can be hopeless when the engine speeds are in the order of 10,000 r.p.m.

Porsche KG now claim (BP 1 254 486) a form of electronic speedometer which should be free from such problems. In Fig. 1 Porsche show how pulses derived from the ignition coil (at a frequency directly proportional to the engine speed) are shaped, integrated by the filter circuit and fed via the servo amplifier to a reversible servo motor. This motor drives the speedometer pointer through gearing to provide a direct readout indication of speed.

The car battery voltage is fed to the stabiliser to give a stabilised output voltage which is fed to the shaper and is also tapped by the servo motor to provide a feedback voltage to the servo amplifier. The servo motor also drives a maximum speed indicator through a ratchet which can be released for zeroing by a spring loaded button.

If it is thought wise, and safe, to provide an automatic switch-off for the engine, e.g., to avoid stripping the car gears, the speed voltage signal at the filter can be compared by the critical speed circuit with a predetermined limiting value to operate an ignition interrupter switch.

Instead of sensing pulses derived from the ignition coil, an

independent inductor associated with the engine shaft can be used to produce the necessary pulses.

## PATENT ACTIVITY IN THE OPTICAL FIBRE FIELD

At least two different uses for light fibres in motor cars have now been patented by Joseph Lucas (Industries) Ltd.

In the first patent, published a few months ago (BP 1 258 395) Lucas described and claimed as novel the use of a light fibre with one end set in the door frame and the other behind a dashboard warning indicator. The door itself carries a mirror which is arranged so that light is reflected from a lamp into the doorframe end of the fibre only when the door is closed. Light thus emerges from the other end of the fibre to illuminate the dashboard indicator when the door is safe.

In their more recent patent (BP 1 264 325) Lucas claim as novel the use of fibres extending variously from all the crucial car driving lights (headlights, sidelights, etc.) to various dashboard instruments. Thus any unlit instrument on the dashboard is a fail-safe signal of an extinguished driving light.

The above patents are only reported briefly, because they are technically simple. But in view of recent published correspondence on this topic they may be interesting references for anyone working in the field. Incidentally, it should be borne in mind that although the patents have only recently been published, they were applied for several years ago.

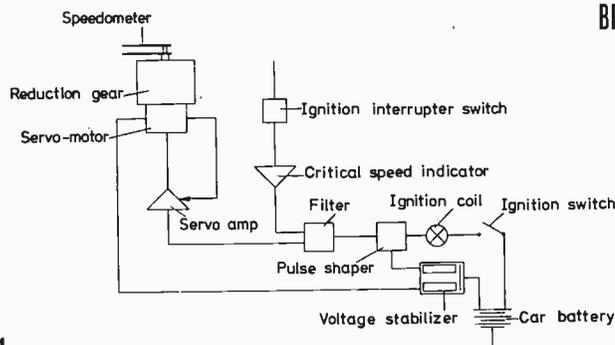


Fig. 1

BP 1 254 486

# MARKET PLACE

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

## FIRE ALARM KIT

The new fire regulations require all properties which provide overnight accommodation for more than six people to be fitted with an acceptable fire alarm system. To meet this need **Ramick Security Services** have developed a new "Fire Alarm Kit" complete with instruction and wiring diagram to enable the handyman or an electrician to install a system for the smaller size hotel or boarding house.

The kit costs £30 complete and comprises a Control Unit; Heat-switch; Preswitch; Testswitch and a 12V d.c. 4in gong alarm bell.

The control unit operates from the mains a.c. supply but the voltage to the sensors is only 12V d.c. A battery is incorporated in the unit together with an automatic change-over circuit so that in the event of a mains failure the installation remains operative and changes back to a.c. supply when reconnected.

Whenever the alarm bell rings it continues until the control unit is reset manually. The control unit is contained in a pressed steel case, suitable for wall mounting, and has a mains indicator light and an on/off switch on the front panel.

The Heatswitch is a bi-metallic switch with a combined rate of rise and fixed temperature automatic fire detector to B.S. 3116. The contacts close when the temperature reaches 135°F (57°C) or if there

is an unusually rapid increase in temperature. The unit can be mounted in any position and provides coverage of approximately 500 square feet per heatswitch.

The Preswitch is a push button unit with a cast aluminium front plate and can be supplied for surface mounting or flush mounting. Breaking the glass front operates the button which activates the alarm.

The Testswitch has a manually biased push button and indicator light complete with housing and is designed for fitting at the end of the twin wire circuit connecting the sensors to the control unit. When the switch is operated the indicator light is energised (and remains energised until the control unit is reset) and the control circuit, external wiring and alarm bell is checked.

Further details can be obtained from **Ramick Security Services**, The Lodge, Randalls Road, Leatherhead, Surrey.

## PRINTED CIRCUIT BOARDS

Sometime ago we mentioned a versatile printed circuit board called **Nippiboard** marketed by **NIP Electronics**.

Although these boards have proved very successful, from the response of users they seem to suffer from two limitations. These limitations are that the boards are not pre-drilled and, more important, do not take integrated circuits.

Now, **NIP Electronics** have introduced a new range of boards called "NIP-E-Boards." These boards are available pre-drilled and are suitable for transistor circuits, integrated circuit designs or a combination of both.

The integrated circuit range of boards were designed in order to cater for the vast expansion of component manufacture in standardised DIL packages, such as relays, readout devices, as well as integrated circuits and transistor arrays.

All boards are made from s.r.b.p. or glass fibre and are available pre-drilled or undrilled according to choice.

The designs of the boards are such that they will all accept edge connectors; a range of card handles, stand-off mounting pillars, and edge connectors is also available.

Further details and prices of the **NIP-E-System** can be obtained from **NIP Electronics**, P.O. Box 11, St. Albans, Herts.

## POCKET METER

Readers should find the **TS-60R Multimeter** from **West Hyde Developments** an excellent purchase.

This pocket multimeter makes no pretensions to be up to professional standard but still covers most ranges needed for checking out the majority of circuits published in this magazine.

The meter movement is a 1000Ω/V type and the ranges covered are: a.c. voltages 0-15V, 0-150V, 0-1000V; d.c. voltages 0-15V, 0-150V, 0-1000V; d.c. current 1mA, 150mA; resistance 100kΩ. A feature of the meter is the "printed circuit" rotary switch.

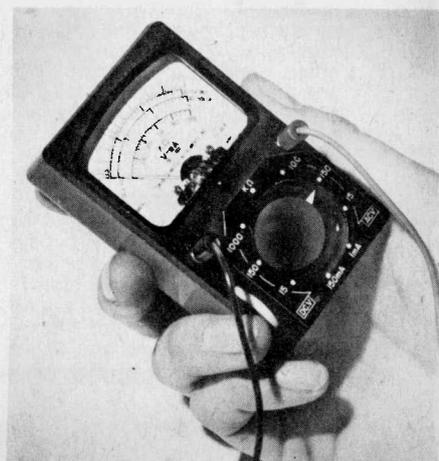
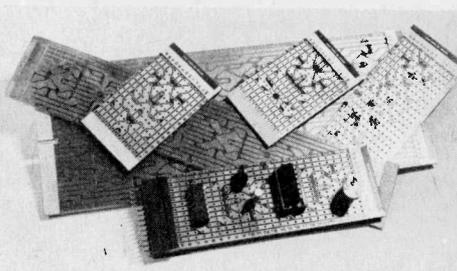
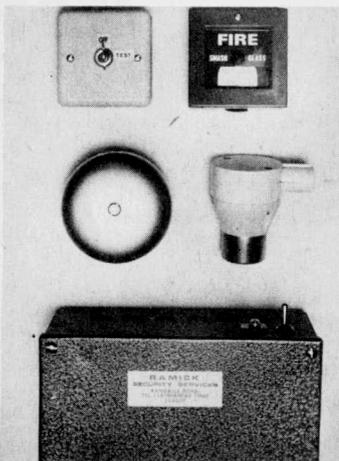
The meter costs only £2 and in the event of a meter breakdown it is probably cheaper to throw it away and buy a replacement, whereas with the more expensive counterpart it would cost more to repair than the purchase price of the **TS-60R**.

Further details of the **TS-60R** multimeter can be obtained from **West Hyde Developments Ltd.**, Ryefield Crescent, Northwood Hills, Northwood, Middlesex.

Whilst on meters, a comprehensive range of **Avometer** spare parts is always held in stock by **Instrument Services** and they are able to offer a rapid **Avometer** repair and recalibration service.

Complete refurbishing to "as new" is claimed to take approximately seven days. The company also offers a similar service to users of **G.E.C.** "Selectest" and "Minitest" instruments.

Further information of the meter repair service can be obtained from **Instrument Services Company (London) Ltd.**, 208 Maybank Road, London E18.



(above) NIP-E-Boards from NIP Electronics  
(left) Ramick Fire Alarm Kit  
(right) TS-60R Multimeter from West Hyde

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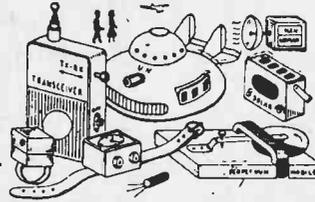
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# Readout —

## A SELECTION FROM OUR POSTBAG

Correspondents wishing to have a reply must enclose a stamped addressed envelope. We regret we are unable to guarantee a reply on matters not relating to articles published in the magazine. Technical queries cannot be dealt with on the telephone.

### Strong objection

Sir—I object strongly to the article *Digi-Cal*. Whilst I can understand people building their own electric organ or colour TV, I am sure nobody with any sense will build this machine at £110. These calculators can be purchased from about £60. Further to this, the cost of a simple counter with Nixie tube readout is approx. £5 per unit, i.e. with a six digit readout this section is approx. £30. Careful design should therefore give a complete calculator for £60. Still not worth making.

As a "Practical" magazine the very least I would expect is for articles to be practical propositions.

G. A. Bobker,  
Unsworth, Bury, Lancs.

I am sorry to hear that Mr Bobker objects so strongly to the *Digi-Cal* series, and though in the light of the latest developments in the field of m.o.s. technology I can sympathise with his comments on price differential, his letter does point to one very important advantage of these current articles.

The logic operations involved in any calculator are necessarily complex, and the new "single-chip" devices are valuable simply because the complex logic has been "wired-up" entirely by the i.c. manufacturer. Mr Bobker's concept of a calculator made from SN7490's and Nixies shows, I am afraid, a lamentable grasp of the way machines of this type operate, and since he himself is active in the circuit design field he could learn a tremendous amount about logic in general and calculating circuits in particular by following the *Digi-Cal* series. I am sure many readers will be glad of the chance to delve into this interesting and relevant field of electronics before the rapid march of technology reduces us all to mindless "wirer-upper" of a circuit which can be built in half an hour but which is

far too involved to be explained to "mere amateurs".

It does seem to be true that calculators are going the way of medium-wave transistor pocket radios, where the vast quantities which can be sold reduce prices to a level where amateur designs are difficult to justify on economic grounds, and to those readers who want a cheap calculator to use immediately without knowing what makes it tick, I can thoroughly recommend the new ready made machines available from retailers at low cost.

For those of us who also want to know what's going on inside, I hope *Digi-Cal* will help. After all, now that single-chip organs, f.m. tuners, and even computers are with us, it may be our last chance.

—R. W. Coles.

### What is the point?

Sir—Over the years I have successfully constructed many of the circuits published in P.E. The amount of enjoyment derived from assembling these projects has been twofold. Firstly, the satisfaction of building something with one's hands and seeing it working and secondly, knowing you have saved quite a bit doing it.

Therefore when you announced the P.E. *Digi-Cal*, which is the sort of project right up my street, I could hardly wait for the August issue to get cracking. Imagine my dismay at seeing the total cost as being approx. £110 when one can buy a ready built article to the same specification for £43.25.

Even if your design had cost the same I would have built it for the satisfaction to be obtained, but I cannot see anyone wanting to construct *Digi-Cal* with such a price difference. So really, what is the point of publishing a design like that.

This is my only criticism so far of an otherwise excellent magazine which I have taken since it first came out.

Brian Harrison,  
Settle, Yorks.

### Beyond reason

Sir—I have been reading PRACTICAL ELECTRONICS since its inception in November 1964 and on average consider about 50 per cent of the constructional projects of interest to me (not that that figure relates to the quantity constructed!). But aren't we getting a little above ourselves with the introduction of a project to build an electronic calculator?

Now I am not one to decry the technical capabilities of your readers (quite the opposite) but what astounds me is the cost. Your author quotes a bulk component cost £110 yet one can buy an equally sophisticated machine (with all the trimmings like leading zero suppression, floating DP, constant key, etc.) for £56 and no extras like replacing over-soldered transistors or mis-wired ic's!

My point, to which I laboriously come, is *what is the function of the constructional feature?* I think it should be a medium through which constructors can promulgate their brainchildren so that readers can build a piece of equipment which is impossible to buy either because it is prohibitively expensive or because no manufacturer's specification matches that of the constructors. The intrinsic pleasure of building is enhanced when one notices that there are still pennies in the pocket.

Come on P.E. Continue to disseminate the superb features that you do but let us keep our exuberant competition with the pros within the bounds of reason.

J. E. Barrett,  
London, S.W.6.

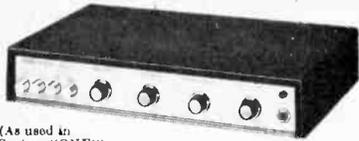
We recognise and understand the bewilderment caused to some readers because of the relatively high cost of building the P.E. *Digi-Cal*. This very creditable project provides a dramatic illustration of the far-reaching effects of rapid and stupendous advances in technology. See Editorial Comment, page 817.

### Advance information

Sir—Could you please inform me if it is possible to purchase a full copy of PRACTICAL ELECTRONICS,



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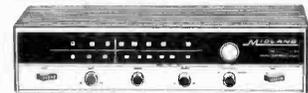
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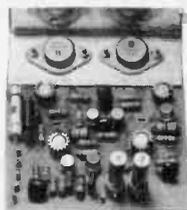
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2N3703	0-10	BC148	0-09
2N3704	0-10	BC177	0-15
2N3819	0-25	BC184L	0-11
2N4286	0-15	BC212L	0-14
2N4289	0-15	BD130	0-85
2N4443	0-88	BD131	0-77
2N5062	0-42	BD132	0-81
2N5088	0-46	BD135	0-25
2N5192	0-77	BD136	0-27
2N5195	0-80	BDY20	0-87
2N5457	0-30	BFY51	0-20
40361	0-45	BRV39	0-30
40392	0-45	BY164	0-45
40432	1-60	MJ481	1-20
40512	1-79	MJ491	1-35
40669	1-20	MJE3055	0-68
AC128	0-26	OA91	0-06
AD142	0-50	OC35	0-63
AD149	0-68	SCGN1	0-12
AD161	0-42	SD4	0-09
AD162	0-40	TO3 Transistor covers, ea. 7p	

## RESISTORS 10%—5%—2%

Code	Power	Tolerance	Range in ohms	Values 1 to 9	10 to 99	100 up (see note below)
C	1/20W	5%	82-220K	E12	9	8
C	1/8W	5%	4.7-470K	E24	1	0-8
C	1/4W	10%	4.7-10M	E12	1	0-8
C	1/2W	5%	4.7-10M	E24	1-2	0-9
C	1W	5%	4.7-10M	E12	2-5	2-9
MO	1/2W	2%	10-1M	E24	4	3
WW	1W	10%	0-22-3.9	E12	7	2 net
WW	3W	5%	±1/20Ω	1-10K	E12	7
WW	7W	5%	1-10K	E12	9	8

Codes: C = carbon film high stability low noise  
MO = metal oxide ElectroSil TR5 ultra low noise  
WW = wire wound Pleseey

Values:  
E12 denotes series: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades. E24: as E12 plus 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 72, 91 and their decades. Prices are in pence each for same ohmic value and power rating, NOT mixed values. (Ignore fractions of 1p on total value of resistor order.)

## Minitron DIGITAL INDICATOR



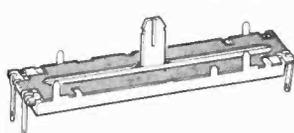
TYPE 3015F Seven segment indicator compatible with standard logic modules and power supplies. Figs. 6-9 from well illuminated filament segments to give character of 9mm height plus decimal point. Power requirement 8mA from 5V d.c. per segment. A limited number of alphabetical symbols also available. In 16 lead DIL case.

Suitable BCD decoder driver type FLL121T net £1-36  
DIL Socket: 16 lead 30p. No. 3015G showing + or - and fig. 1 and decimal point 2£.

## PRECISION COMPONENTS

Resistors by Rivlin, 0.1% to 0.01%, £1 to 2£.  
Capacitors by MFD, 0.1 μF to 22 μF, 70p to £3-50. Prices and delivery times on request.

## SLIDE POTENTIOMETERS



Robust construction, smooth silent action. In values from 4k7Ω to 1MΩ, linear or log. 28p each. Escutcheon, light grey, 10p.  
Knobs, flat, grip type, in black/red/green/yellow/blue/light grey/dark grey or white, 5p each.

## SOLDERSTAT SOLDER IRONS

As appointed distributors for well-known Eimco-Wolf "Solderstat" irons, we offer this model HMS 16 or 24 watt, a.c. mains, net £1-87

INFINITELY VARIABLE TEMPERATURE CONTROLLED SOLDER IRON 20  
DE-SOLDER BRAID  
Per 6ft length, net 50p.

NIPPBOARDS  
A useful board for circuit building.  
Type 1A. Single basic pattern 2 1/2" x 1 7/8", 15p.  
Type 2A. Two ptns. side by side, 28p.  
Type 2AS. Dual channel, 28p.  
Type 3A. 3 ptns. side by side, 36p.  
Type 4AS. Dual channel, 2 above 2, 44p.  
Many others in stock up to 10 patterns.

## PUBLICATIONS

Handbook of Transistor Equivalents, 40p. Handbook of Tested Transistor Circuits (H. Ness), 40p. Radio & Electronics. Colour codes & data wall chart, 15p. Engineers Reference Handbook & Tables, 20p. (Add 3p for postage on each of above if bought separately.)

## SIEMENS TTL INTEGRATED CIRCUITS

Part No.	Price	Part No.	Price
FLH101 (7400)	20p	FLJ121 (7473)	45p
FLH201 (7401)	20p	FLJ141 (7474)	45p
FLH191 (7402)	20p	FLJ151 (7475)	45p
FLH291 (7403)	20p	FLJ131 (7476)	45p
FLH211 (7404)	25p	FLH221 (7480)	88p
FLH271 (7405)	25p	FLH231 (7483)	87p
FLH381 (7408)	25p	FLH241 (7485)	1-38
FLH391 (7409)	25p	FLH341 (7486)	33p
FLH111 (7410)	20p	FLJ161 (7490)	80p
FLH351 (7413)	35p	FLJ221 (7491A)	1-28
FLH121 (7420)	20p	FLJ171 (7492)	85p
FLH181 (7430)	20p	FLJ181 (7493)	80p
FLH141 (7440)	24p	FLJ231 (7494)	1-13
FLH101 (7414)	1-22	FLJ191 (7495)	87p
FLH281 (7442)	1-16	FLJ261 (7496)	1-48
FLH361 (7443)	1-45	FLJ301 (74100)	1-64
FLH371 (7444)	1-45	FLJ281 (74104)	45p
FLH151 (7450)	20p	FLJ271 (74107)	53p
FLH161 (7451)	20p	FLK101 (74121)	48p
FLH171 (7452)	20p	FLY101 (7466)	20p
FLH181 (7454)	20p	FLJ101 (7470)	45p
FLY101 (7466)	20p	FLJ211 (74191)	1-80
FLJ101 (7470)	45p	FLJ241 (74192)	1-74
FLJ111 (7472)	32p	FLJ251 (74193)	1-74

## BAXANDALL SPEAKER

As designed by P. J. Baxandall and originally described in "Wireless World". Complete kit inc. spkr., equaliser and special cabinet kit (18in x 12in x 10in) cut to size. 60p. 10 watt RMS/15Ω loading. Part cost carr. in U.K. 60p.  
Net £1-81  
Speaker unit and equaliser kit, net. Post free 24-81.  
Pack flat cabinet assembly (all cut to shape), natural teak finish with instructions, 28 net. Part cost carr. in U.K. 60p.

## SIEMENS THYRISTORS

0-8A-400V, 55p. 600V, 70p.  
3A-400V, 60p. 600V, 85p.

## CARBON SKELETON PRE-SETS

Small high quality, type PR linear only: 100Ω, 220Ω, 470Ω, 1K, 2K2, 4K7, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M2, 5M, 10MΩ. Vertical or horizontal mounting, 5p each.

## ZENER DIODES

3% full range, E24 values: 400mW: 2.7V to 36V, 14p each; 1W: 6.3V to 82V, 27p each; 1.5W: 4.7V to 75V, 48p each.  
Clip to increase 1.5W rating to 3 watts (type 260F) 4p.

## MINIATURE TOGGLE SWITCHES

2A/250V. DP/DT, 48p.

## MAINLINE AMPLIFIER KITS

70 watt power amp module kit, £12-60 net. Power supply kit, 28-50 net.

## SIEMENS CAPACITORS

POLYCARBONATE—5% TOLERANCE  
250V up to 0.1μF: 100V/0.1μF and above.  
0.01, 0.012, 0.015, 0.018, 0.022, 0.027, 0.033, 0.047, 0.056, 4p each.  
0.068, 0.082, 0.1, 0.12, 0.15, 4p each.  
0.18, 0.22, 5p each.  
0.27, 0.33, 6p; 0.39, 7p; 0.47, 8p; 0.56, 10p; 0.68, 11p; 1μF, 13p.

## ELECTROLYTIC CAPACITORS

(Values in μF/V)  
0.47/100, 1/100, 2.2/63, 4.7/35, 10/25, 22/16, 47/10, 47/25, 100/10, 220/3, 7p each.  
10/63, 22/35, 47/35, 100/16, 100/25, 220/6, 220/10, 220/16, 470/3, 7p each.  
47/50, 47/63, 100/35, 220/16, 8p each; 100/50, 220/35, 10p each; 100/63, 470/25, 1000/10, 12p each; 220/63, 470/35, 1000/16, 17p each; 1000/25, 20p each; 470/63, 1000/35, 23p each; 2200/25, 36p each; 1000/63, 2200/35, 4700/16, 40p each.

Tantalum and other capacitors, etc. see latest 1972 catalogue—issue No. 6.

## 1972 ELECTROVALUE CATALOGUE (No. 6)

Third printing with latest price and information details. Contains 96 pages plus cover. More items, more information, more diagrams than ever. Post free in U.K. 10p.

## NEWMARKET LINEAR I.C.s

LIC 709C/14 dual in line, 34p. | 709C/5, TO5 39p.  
LIC 741C/14 dual in line, 40p. | 741C/5, TO5 42p.

## CARBON TRACK POTENTIOMETERS

CARBON TRACK POTENTIOMETERS, long spindles. Double wipers.  
SINGLE GANG linear 100Ω to 2.2MΩ, 12p; Single gang log, 4.7kΩ to 2.2MΩ, 12p; Dual gang linear 4.7kΩ to 2.2MΩ, 42p; Dual gang log, 4.7kΩ to 2.2MΩ, 42p; Log/antilog, 10kΩ, 22kΩ, 47kΩ, 1MΩ only 42p; Dual antilog, 10kΩ only, 42p. Any type with 2A.D.F. mains switch, 12p extra.  
Only decades of 10, 22 and 47 available in ranges quoted.  
DUAL CONCENTRIC in any combination of P.20 values, 60p; with switch, 72p. Knobs, pair 24p.

## DISCOUNTS

10% on orders £5 to £15.  
15% on orders over £15. No discount on items marked Net. Prices subject to alteration without notice.

## POSTAGE AND PACKING

FREE, unless otherwise stated. Handling surcharge 10p on mail orders under 2£. Overseas orders: cart. and insurance charged at cost. U.S.A. CUSTOMERS are invited to contact ELECTROVALUE AMERICA, P.O. Box 27, Swarthmore, PA 19081.

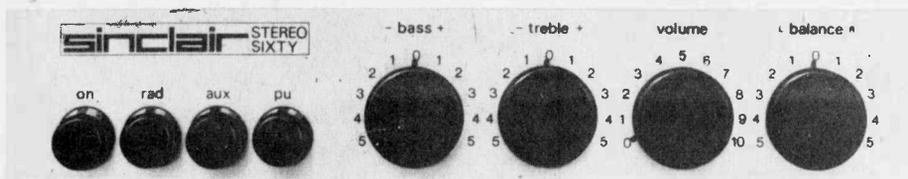
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ELECTROVALUE LTD.—AN INDEPENDENT COMPANY SINCE ITS ESTABLISHMENT IN 1965

# Sinclair Project 60

## Stereo 60



Built and tested post free  
**£9.98**

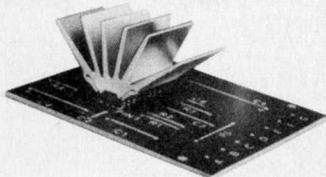
### pre-amplifier/control unit

The versatility of Project 60 high-fidelity modules is well demonstrated in this excellent unit. It provides the facilities essential to good stereo and will enhance the quality of any system it is used with, whether Project 60 or any other top line power amplifiers. Compact, yet robustly constructed, the unit is easily panel mounted and will operate satisfactorily from 18 to 35 volts supply. Silicon epitaxial transistors are used throughout to achieve a very high signal to noise ratio with excellent separation between channels. Distortion at maximum output is barely 0.02% with magnetic p.u. input. Accurate equalisation is provided for all inputs, which are selected by push buttons. For maximum effectiveness, the Sinclair A.F.U. is recommended for use with the Stereo 60 pre-amp/control unit. A comprehensive manual supplied with Project 60 modules makes installing and connecting easy and ensures best possible results from your system.

#### SPECIFICATIONS

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

### Super IC.12 Integrated circuit high fidelity amplifier



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

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

#### SPECIFICATIONS

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

Manual available separately 15p post free.

With FREE printed circuit board and 40 page manual.

**£2.98** Post free

### Project 605



The easy way to buy and build Project 60

Project 605 is one pack containing: one PZ5, two Z30's, one Stereo 60 and one Masterlink. This new module contains all the input sockets and output components needed together with all necessary leads cut to length and fitted with neat little clips to plug straight on to the modules. Thus all soldering and hunting for the odd part is eliminated. You will be able to add further Project 60 modules as they become available adapted to the Project 605 method of connecting.

Complete Project 605 pack with comprehensive manual, post free **£29.95**

Everything you need to assemble a superb 30 watt high fidelity stereo amplifier without having to solder.

# sinclair

Sinclair Radionics Ltd, London Road, St. Ives, Huntingdonshire PE17 4HJ. Tel: St. Ives 64311

# the world's most advanced high fidelity modules

## Z.30 & Z.50 power amplifiers

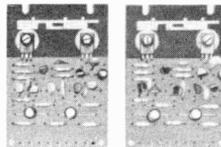
Built, tested and guaranteed with circuits and instructions manual. Z.30 £4.48 Z.50 £5.48

The Z.30 and Z.50 are of advanced design using silicon epitaxial planar transistors to provide unsurpassed standards of performance. Total harmonic distortion is an incredibly low 0.02% at 15w (8Ω) and all lower outputs. Whether you use Z.30 or Z.50 amplifiers in your Project 60 system will depend on personal preference, but they are the same size and are intended for use principally with other units in the Project 60 range. Their performance and design are such, however, that Z.50s and Z.30 may be used in a far wider range of applications.

**SPECIFICATIONS (Z.50 units are interchangeable with Z.30s in all applications).— Power Outputs:** Z.30 15 watts R.M.S. into 8 ohms using 35 volts: 20 watts R.M.S. into 3 ohms using 30 volts.

Z.50 40 watts R.M.S. into 3 ohms using 40 volts: 30 watts R.M.S. into 8 ohms using 50 volts.

**Frequency response:** 30 to 300,000Hz ±1dB. **Distortion:** 0.02% into 8 ohms. **Signal to noise ratio:** better than 70dB unweighted. **Input sensitivity:** 250mV into 100 Kohms (for 15w into 8Ω). For speakers from 3 to 15 ohms impedance. **Size:** 14 x 80 x 57mm.



## Project 60 Stereo F.M. Tuner

Built and tested. Post free. £25

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

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



## A.F.U. High & Low Pass Filter Unit

Built, tested and guaranteed. £5.98

For use between Stereo 60 unit and two Z.30s or Z.50s. The unit is very easily mounted and is unique in that the cut-off frequencies are continuously variable. As attenuation in the rejected band is rapid (12dB/octave), there is less loss of the wanted signal than has previously been possible. Amplitude and phase distortion are negligible. The A.F.U. is suitable for use with any other amplifier system. There are two filter sections – rumble (high pass) and scratch (low pass). H.F. cut-off (–3dB) variable from 28KHz to 5KHz. L.F. cut-off (–3dB) variable from 25Hz to 100Hz. Distortion at 1KHz (35V. supply) 0.02% at rated output. Operating voltage from 15 to 35V. Current 3mA. **Size:** 66 x 40 x 90mm.



## Power Supply Units

Designed specifically for use with the Project 60 system of your choice. Use PZ.5 for normal Z.30 assemblies and PZ.6 or PZ.8 where a stabilised supply is essential.

PZ.5 30 volts un stabilised £4.98  
 PZ.6 35 volts stabilised £7.98  
 PZ.8 45 volts stabilised £7.98  
 (less mains transformer) £7.98  
 PZ.8 mains transformer £5.98



### Typical Project 60 applications

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

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

## Guarantee

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

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

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This informative book gives useful advice and hints on treasure hunting. THE FAMOUS "CONCORD" well known for reliability and sensitivity, £24 + P&P 50P

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THE "ATLANTA". British made. Ready to use, ultra lightweight, good sensitivity, £9.95 + P&P 40P

THE "PUP"

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ALL OUR DETECTORS ARE BACKED BY A 12 MONTH GUARANTEE

### STOCK TAKING CLEARANCE SPECIAL £1 BARGAIN PACKS

- A 10 OC74 PNP Germ. O/P D 10 2N744 NPN Sil. 300mV similar to OC81 300mhz
- B 40 OC71 PNP Germ. LF AMP unmarked E 10 1N47Z Diodes 1200V 1 amp
- C 12 2N1303 PNP Germ. Gen./ Purpose F 25 OA81 Diodes unmarked

\* Please add 10p to orders under £2

### BRAND NEW GUARANTEED TRANSISTORS

2G304 20p	2N3053 20p	ASY32 20p	BCJ10 20p	NKT221 25p
2G271 10p	2N3134 30p	ASY76 20p	BCZ11A 30p	OC28 45p
2N697 12p	2N3135 20p	AS220 30p	BF194 14p	OC45 10p
2N744 17p	2N3702 10p	BC107 10p	BF200 30p	OC71 10p
2N1303 15p	2N3707 12p	BC108 10p	BFY51 16p	OC74 20p
2N1305 20p	2N4036 55p	BC109 10p	BFY52 20p	OC139 25p
2N1309 25p	25002 50p	BC148 10p	BFX87 25p	OC200 25p
2N1596 15p	25323 60p	BC187 27p	BFX88 20p	OC201 50p
2N1613 15p	25324 18p	BCY30 35p	GET25 10p	V30/30P 30p
2N1711 24p	AC128 18p	BCY32 45p	GET875 12p	
2N1997 30p	AD149 30p	BCY34 35p	GET875 12p	
2N2270 60p	ASY29 20p	BCY43 15p	GET882 10p	

### SPECIALS

ISKRA RESISTORS 1/4W carbon film low noise all values 1p each  
ON/OFF TOGGLE SWITCH 10p  
GRELCO 5-WAY SCREW CONNECTOR 13p  
2 POLE SW STANDARD JACK SOCKETS 9p  
RED PUSH BUTTON SWITCH SP. ROUND hole fix 10p

SUB MIN ELECTROLYTIC CAPACITORS, 5p each  
Values µF/V: 6.4/25; 10/16; 20/64; 80/25; 125/10; 125/16; 25/6.4; 4/10  
POLYSTYRENE CAPACITORS 3p each  
0.033; 0.047; 0.1  
LOUDSPEAKERS, 2 1/2in 8 ohm, 45p  
BATTERY CLIPS. PP3 with leads, 6p, PP1, 7p pair  
\*Please add 10p to orders under £2.

# MARSHALL'S INTEGRATED CIRCUITS

NEW LOW PRICES LARGEST RANGE  
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### MOTOROLA

We can now offer a vast range of Motorola IC's at industrial distributor prices.

Examples	£p	Data Sheets
MC724P	0.68	
MC790P	1.24	£0.12
MC1303L	2.70	extra

### FAIRCHILD (RTL)

L900	L923	1-5	6-11	12+
40p	40p		37p	35p
Data sheet 121p				

### LINEAR

Op. Amps.	1-11	12-24	25-90
	£p	£p	£p
L702A TO5	2.80	2.70	2.60
L702C TO5	0.77	0.72	0.67
L703C TO5	0.62	0.57	0.52
L709C TO5	0.38	0.36	0.31
L709C DIL	0.33	0.31	0.27
L710C TO5	0.47	0.42	0.37
L710C DIL	0.45	0.40	0.35
L711C TO5	0.49	0.44	0.39
L711C DIL	0.45	0.40	0.35
L716 TO5	1.87	1.75	1.70
L723C TO5	0.75	0.72	0.66
L739	1.95	—	—
L741C TO5	0.40	0.38	0.34
L741C DIL	0.38	0.36	0.32
LM741CN DIL	0.70	0.65	0.60
SN72700P DIL	0.45	0.40	0.35

### RCA COSMOS PLESSEY

£p	£p
SL403D 1.50	SL611C 1.70
SL621C 2.60	SL701C 1.45
SL702C 1.25	
CD4001AE 0.93	DATA SHEETS
CD4009AE 1.98	
CD4011AE 0.93	17p
CD4013AE 1.88	
CD4015AE 4.38	
CD4017AE 4.42	
CD4018AE 3.95	
CD4020AE 5.50	
CD4024AE 2.98	

TH9013P £4.57  
20 WATT AMP  
TH9014P £1.50  
PRE-AMP  
DATA SHEETS £0.12

### MULLARD DTL

£p	£p
FCH101 0.874	FCH121 1.05
FCH201 1.384	FCH31 1.50
FCJ101 1.824	FCJ111 1.55
FCJ201 1.80	FCJ211 2.75
FCK101 4.374	FCY101 1.05
TAA241 1.30	TAA241 1.30
300 2.00	310 1.30
320 0.85	320 0.85
350 2.10	435 0.73
521 0.57	522 1.13
570 2.60	530 4.95
700 3.50	811 4.45
TAB101 0.974	TAD100 1.974
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SN7403	0.20	0.18	SN7410	0.22	0.20
SN7404	0.22	0.20	SN7411	0.22	0.20
SN7405	0.22	0.20	SN7412	0.48	0.42
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SN7422 0.48	0.42	SN74105 1.52	1.33
SN7423 0.52	0.45	SN74107 0.43	0.38
SN7425 0.48	0.42	SN74109 1.06	0.93
SN7426 0.32	0.28	SN74110 0.80	0.70
SN7427 0.48	0.42	SN74111 1.57	1.38
SN7428 0.71	0.62	SN74118 1.45	1.27
SN7430 0.20	0.18	SN74119 1.82	1.68
SN7432 0.48	0.42	SN74120 1.06	0.93
SN7433 0.71	0.62	SN74121 0.43	0.38
SN7437 0.52	0.45	SN74122 0.52	0.47
SN7438 0.52	0.45	SN74123 0.90	0.80
SN7439 0.52	0.45	SN74128 0.80	0.70
SN7440 0.20	0.18	SN74141 0.90	0.80
SN7441A		SN74443 0.80	0.80
SN7442 1.04	0.88	SN74150 1.19	1.05
SN7443 1.04	0.88	SN74151 1.18	1.00
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SN7447 1.30	1.20	SN74156 1.30	1.15
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SN7453 0.20	0.18	SN74164 4.48	3.90
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SN7474 0.45	0.39	SN74175 1.44	1.28
SN7475 0.60	0.55	SN74176 1.30	1.10
SN7476 0.47	0.42	SN74177 1.30	1.10
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CA3022	1.81 1.33	CA3067	2.72 2.24
CA3023	1.55 1.28	CA3068	3.01 2.48
CA3026	2.82 2.41	CA3070	2.15 1.78
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CA3028B	1.17 0.97	CA3072	2.07 1.71
CA3029	0.52 0.43	CA3075	1.46 1.21
CA3029A	0.63 0.52	CA3076	1.67 1.38
CA3030	1.08 0.89	CA3078A	
CA3030A	1.64 1.35		4.88 3.86
CA3033	4.93 4.07	CA3078T	2.80 2.31
CA3035	1.52 1.28	CA3079	2.91 2.45
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2N1711	17p	2N3858	16p	AC128	20p	BC160	11p	BF123	27p	B8X61	62p
2N1893	34p	2N3858A	16p	AC141K	30p	BC161B	11p	BF125	27p	B8X76	25p
2N2102	30p	2N3859	16p	AC142K	25p	BC168B	10p	BF127	27p	B8X77	25p
2N2144	60p	2N3859A	16p	AC151V	12p	BC168C	10p	BF152	20p	B8X78	25p
2N2148	60p	2N3860	16p	AC152V	15p	BC169B	11p	BF153	20p	B8W70	28p
2N2192	40p	2N3866	70p	AC153	15p	BC169C	11p	BF154	18p	B8Y24	20p
2N2192A	40p	2N3877	25p	AC153K	22p	BC170	11p	BF156	22p	B8Y25	20p
2N2193	58p	2N3877A	20p	AC154	20p	BC171	13p	BF159	27p	B8Y26	20p
2N2194	21p	2N3878	16p	AC176	15p	BC171	15p	BF160	23p	B8Y27	20p
2N2194A	30p	2N3900	20p	AC176K	17p	BC182	10p	BF161	35p	B8Y28	15p
2N2195	37p	2N3900A	21p	AC187K	17p	BC182L	10p	BF163	20p	B8Y38	15p
2N2195A	18p	2N3901	32p	ACV17	25p	BC183	8p	BF166	35p	B8Y39	15p
2N2196	18p	2N3903	22p	ACV18	15p	BC184	11p	BF167	18p	B8Y61	25p
2N2197	18p	2N3904	22p	ACV19	20p	BC184L	11p	BF172	19p	B8Y62	25p
2N2198	20p	2N3905	22p	ACV20	20p	BC186	25p	BF178	31p	B8Y64	30p
2N2219	20p	2N3906	22p	ACV21	18p	BC187	25p	BF179	38p	B8Y66	78p
2N2220	20p	2N3906A	22p	ACV22	13p	BC204	11p	BF180	35p	B8Y65	78p
2N2221	20p	2N4036	40p	ACV22	13p	BC204	11p	BF181	34p	B8Y78	40p
2N2221A	20p	2N4037	35p	ACV28	18p	BC205	10p	BF182	40p	B8Y79	40p
2N2222	20p	2N4038	12p	ACV30	42p	BC206	11p	BF183	40p	B8Y79	40p
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2N2714	17p	2N4917	17p	AD150	55p	BC239	8p	BF2243	14p	C444	20p
2N2904	18p	2N4918	50p	AD161	33p	BC251	20p	BF2251	19p	D40N1	50p
2N2904A	28p	2N4919	53p	AD162	36p	BC252	18p	BF237	22p	D40N3	62p
2N2905	28p	2N4920	60p	AD161 PR	35p	BC253	28p	BF238	22p	GET111	45p
2N2905A	28p	2N4921	50p	AD162	60p	BC257	8p	BF244	18p	GET114	20p
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2N2906A	23p	2N4926	90p	ADZ12	£1.75	BC261	20p	BF246	48p	GET119	35p
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500 mA	Ref. No.	Price P. & P.	3A	Ref. No.	Price P. & P.
MT 102 AT†	1-45 24p	3A	MT 105 AT	3-91 41p	
1A	MT 103 AT†	2-00 32p	4A	MT 106 AT	5-08 41p
2A	MT 104 AT†	3-10 32p	6A	MT 107 AT	7-47 50p

60 volts. All tapped at 0-24-30-40-48-60V

500 mA	Ref. No.	Price P. & P.	2A	Ref. No.	Price P. & P.
MT 124 AT†	1-46 21p	2A	MT 127 AT	3-18 41p	
1A	MT 126 AT†	2-24 28p	3A	MT 125 AT	4-59 41p

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8N7427	0.42	0.39	0.35	8N7493	0.75	0.70	0.65	8N74177	1.60	1.35	1.20
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AD140	50p	BCZ11	50p	MJE520	75p	OC203	50p	2N706	10p	2N3820	25p
AD149	50p	BD124	80p	MJE2955		OC217	1.25	2N930	20p	2N3866	85p
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AF124	25p	BF173	25p	NKT214	20p		45p	2N1304	22p	2N4126	15p
AF139	30p	BF179	30p	NKT216	40p	RA8508AF		2N1305	22p	2N4871	35p
AF186	40p	BF180	30p	NKT217	40p		55p	2N1307	25p	2N5457	30p
AF239	40p	BF194	15p	NKT403	70p	TA2963	75p	2N1308	25p	2N5777	55p
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BC107	10p	BFY50	20p	OA92	10p		1.00	2N2224	25p	2S324	95p
BC108	10p	BFY51	20p	OC16	75p	TIP34A			25p	40250	50p
BC109	10p	BFY52	20p	OC20	90p		1.50	2N2369A		40360	40p
BC109C	12p	BFY54	50p	OC25	40p	TIP35A			15p	40361	40p
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1N25	0-50	ASV29	0-25	BYZ15	1-00
1N26	0-25	ASV36	0-25	BYZ16	0-62
1N725A	0-20	ASV50	0-17	BYZ28C3V3	
1N914	0-07	ASV51	0-40		
1N4007	0-20	ASV53	0-20		
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18130	0-13	ASV62	0-25	CRS105	0-25
18131	0-18	ASV68	0-33	CRS140	0-45
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2N709	0-15	BC118	0-25	GD12	0-05
2N901	0-20	BC121	0-10	GET102	0-20
2N1131	0-25	BC122	0-20	GET103	0-20
2N1132	0-25	BC125	0-68	GET113	0-20
2N1302	0-18	BC126	0-65	GET114	0-15
2N1303	0-18	BC140	0-55	GET115	0-45
2N1304	0-22	BC147	0-15	GET116	0-80
2N1305	0-22	BC148	0-13	GET120	0-25
2N1306	0-20	BC149	0-15	GET872	0-80
2N1307	0-25	BC157	0-12	GET876	0-20
2N1308	0-25	BC158	0-16	GET880	0-37
2N2147	0-75	BC160	0-63	GET881	0-25
2N2148	0-75	BC169	0-18	GET892	0-25
2N2180	0-60	BCY31	0-35	GET895	0-25
2N2181	0-60	BCY32	0-65	GET844	0-08
2N2219	0-20	BCY32	0-65	GET846	0-10
2N2369A	0-15	BCY33	0-25	GET841	0-15
2N2444	1-99	BCY34	0-30	GJ3M	0-25
2N2413	0-28	BCY38	0-40	GJ4M	0-28
2N2456	0-45	BCY39	1-00	GJ5M	0-25
2N2904	0-20	BCY40	0-20	GJ7M	0-27
2N2904A	0-25	BCY42	0-25	HG1005	0-50
2N2906	0-20	BCY70	0-15	HJ100A	0-20
2N2907	0-23	BCY71	0-20	MAT100	0-25
2N2924	0-23	BCZ10	0-35	MAT101	0-30
2N2925	0-15	BCZ11	0-60	MAT120	0-25
2N2926	0-10	BD121	0-65	MAT121	0-30
2N3054	0-50	BD123	0-60	MAT129	0-87
2N3055	0-75	BD124	0-75	MJE2955	1-87
2N3702	0-10	BDY11	1-62	MJES055	0-37
2N3705	0-10	BF115	0-25	NKT128	0-35
2N3706	0-23	BF117	0-50	NKT129	0-30
2N3707	0-12	BF167	0-25	NKT211	0-25
2N3709	0-10	BF173	0-25	NKT213	0-25
2N3710	0-10	BF181	0-25	NKT214	0-15
2N3711	0-10	BF184	0-20	NKT216	0-37
2N3819	0-25	BF185	0-20	NKT217	0-35
2N5027	0-53	BF194	0-17	NKT218	1-13
2N6088	0-33	BF195	0-15	NKT219	0-33
28501	0-50	BF196	0-18	NKT222	0-20
28502	0-75	BF197	0-15	NKT224	0-22
28501	0-87	BF891	0-28	NKT221	0-24
28702	0-62	BF898	0-28	NKT271	0-25
AA129	0-20	BFX12	0-20	NKT262	0-25
AAZ12	0-30	BFX13	0-25	NKT273	0-15
AAZ13	0-10	BFX29	0-25	NKT274	0-20
AC107	0-37	BFX30	0-25	NKT275	0-25
AC126	0-20	BFX32	0-25	NKT277	0-25
AC127	0-25	BFX63	0-60	NKT278	0-25
AC128	0-20	BFX84	0-25	NKT301	0-40
AC187	0-25	BFX85	0-30	NKT304	0-75
AC189	0-25	BFX86	0-25	NKT403	0-75
AC171	0-80	BFX87	0-25	NKT404	0-55
ACY18	0-25	BFY06	0-25	NKT678	0-30
ACY19	0-25	BFY10	1-00	NKT713	0-25
ACY20	0-20	BFY11	1-25	NKT773	0-25
ACY21	0-20	BFY17	0-25	NKT777	0-88
ACY22	0-10	BFY18	0-25	O79B	0-38
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ACY28	0-17	BFY24	0-45	O48	0-12
ACY39	0-50	BFY44	1-90	O47	0-10
ACY40	0-15	BFY50	0-22	O470	0-10
ACY41	0-15	BFY51	0-20	O471	0-10
ACY44	0-25	BFY62	0-22	O473	0-10
AD140	0-50	BFY63	0-17	O474	0-10
AD149	0-50	BFY64	0-42	O479	0-10
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AD182	0-87	BSX27	0-60	O485	0-12
AF106	0-20	BSX80	0-93	O486	0-15
AF114	0-25	BSX76	0-15	OA90	0-08
AF115	0-25	BSY26	0-18	OA91	0-07
AF116	0-25	BSY27	0-17	OA95	0-07
AF117	0-40	BSY95	0-10	OA202	0-20
AF118	0-62	BSY95A	0-12	OA202	0-20
AF119	0-20	BSY95	0-12	OA210	0-25
AF124	0-25	BT102/600R		OA211	0-50
AF125	0-20			AZ200	0-55
AF126	0-17	BTY42	0-92	AZ201	0-60
AF127	0-17	BTY79/100R		AZ202	0-45
AF128	0-40			AZ203	0-42
AF178	0-55	BTY79/400R		AZ204	0-30
AF179	0-65			AZ205	0-42
AF180	0-52	BY100	0-15	AZ206	0-42
AF181	0-42	BY126	0-15	AZ207	0-47
AF186	0-40	BY127	0-17	AZ208	0-38
AFY19	1-13	BY182	0-55	AZ209	0-32
AFZ11	0-40	BY213	0-25	AZ210	0-32

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2G309	20p	2N3566	15p	2N4548	35p	BC122	15p	BFX30	25p	NKT230	30p	2G310	20p	2N3568	15p	NKT230	30p	2G311	20p
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2G313	20p	2N3570	15p	2N4548	35p	BC134	12p	BFX48	47p	NKT242	27p	2G314	20p	2N3572	15p	NKT242	27p	2G315	20p
2G315	20p	2N3572	15p	2N4548	35p	BC136	12p	BFX65	30p	NKT243	65p	2G316	20p	2N3575	15p	NKT243	65p	2G317	20p
2G317	20p	2N3575	15p	2N4548	35p	BC138	15p	BFX86	25p	NKT244	17p	2G318	20p	2N3577	15p	NKT244	17p	2G319	20p
2G319	20p	2N3577	15p	2N4548	35p	BC137	15p	BFX88	25p	NKT245	20p	2G320	20p	2N3580	15p	NKT245	20p	2G321	20p
2G321	20p	2N3580	15p	2N4548	35p	BC140	15p	BFX89	25p	NKT262	20p	2G322	20p	2N3582	15p	NKT262	20p	2G323	20p
2G322	20p	2N3582	15p	2N4548	35p	BC141	15p	BFX93A	70p	NKT271	20p	2G324	20p	2N3584	15p	NKT271	20p	2G325	20p
2G324	20p	2N3584	15p	2N4548	35p	BC147	10p	BFY11	42p	NKT272	20p	2G326	20p	2N3586	15p	NKT272	20p	2G327	20p
2G326	20p	2N3586	15p	2N4548	35p	BC148	10p	BFY18	25p	NKT282	20p	2G328	20p	2N3588	15p	NKT282	20p	2G329	20p
2G328	20p	2N3588	15p	2N4548	35p	BC149	10p	BFY21	25p	NKT273	20p	2G330	20p	2N3590	15p	NKT273	20p	2G331	20p
2G330	20p	2N3590	15p	2N4548	35p	BC152	17p	BFY21	25p	NKT275	20p	2G332	20p	2N3592	15p	NKT275	20p	2G333	20p
2G332	20p	2N3592	15p	2N4548	35p	BC153	20p	BFY24	45p	NKT278	25p	2G334	20p	2N3594	15p	NKT278	25p	2G335	20p
2G334	20p	2N3594	15p	2N4548	35p	BC154	20p	BFY29	40p	NKT281	27p	2G336	20p	2N3596	15p	NKT281	27p	2G337	20p
2G336	20p	2N3596	15p	2N4548	35p	BC157	15p	BFY30	40p	NKT282	20p	2G338	20p	2N3598	15p	NKT282	20p	2G339	20p
2G338	20p	2N3598	15p	2N4548	35p	BC158	15p	BFY41	50p	NKT283	20p	2G340	20p	2N3600	15p	NKT283	20p	2G341	20p
2G340	20p	2N3600	15p	2N4548	35p	BC159	12p	BFY43	62p	NKT403	75p	2G342	20p	2N3602	15p	NKT403	75p	2G343	20p
2G342	20p	2N3602	15p	2N4548	35p	BC160	35p	BFY50	20p	NKT404	55p	2G344	20p	2N3604	15p	NKT404	55p	2G345	20p
2G344	20p	2N3604	15p	2N4548	35p	BC167	11p	BFY51	20p	NKT406	62p	2G346	20p	2N3606	15p	NKT406	62p	2G347	20p
2G346	20p	2N3606	15p	2N4548	35p	BC168H	10p	BFY53	15p	NKT451	82p	2G348	20p	2N3608	15p	NKT451	82p	2G349	20p
2G348	20p	2N3608	15p	2N4548	35p	BC168L	10p	BFY53	15p	NKT452	82p	2G350	20p	2N3610	15p	NKT452	82p	2G351	20p
2G350	20p	2N3610	15p	2N4548	35p	BC169	10p	BFY53	15p	NKT453	82p	2G352	20p	2N3612	15p	NKT453	82p	2G353	20p
2G352	20p	2N3612	15p	2N4548	35p	BC170	12p	BFY77	57p	NKT713	20p	2G354	20p	2N3614	15p	NKT713	20p	2G355	20p
2G354	20p	2N3614	15p	2N4548	35p	BC171	15p	BFY77	57p	NKT717	42p	2G356	20p	2N3616	15p	NKT717	42p	2G357	20p
2G356	20p	2N3616	15p	2N4548	35p	BC172	15p	BFY90	65p	NKT717	42p	2G358	20p	2N3618	15p	NKT717	42p	2G359	20p
2G358	20p	2N3618	15p	2N4548	35p	BC175	22p	BFY90	65p	NKT734	27p	2G360	20p	2N3620	15p	NKT734	27p	2G361	20p
2G360	20p	2N3620	15p	2N4548	35p	BC175	22p	BFY90	65p	NKT736	35p	2G362	20p	2N3622	15p	NKT736	35p	2G363	20p
2G362	20p	2N3622	15p	2N4548	35p	BC176	20p	BFY90	65p	NKT773	25p	2G364	20p	2N3624	15p	NKT773	25p	2G365	20p
2G364	20p	2N3624	15p	2N4548	35p	BC178	20p	BFY90	65p	NKT773	25p	2G366	20p	2N3626	15p	NKT773	25p	2G367	20p
2G366	20p	2N3626	15p	2N4548	35p	BC179	20p	BFY90	65p	NKT773	25p	2G368	20p	2N3628	15p	NKT773	25p	2G369	20p
2G368	20p	2N3628	15p	2N4548	35p	BC182	10p	BFY90	65p	NKT773	25p	2G370	20p	2N3630	15p	NKT773	25p	2G371	20p
2G370	20p	2N3630	15p	2N4548	35p	BC182L	10p	BFY90	65p	NKT773	25p	2G372	20p	2N3632	15p	NKT773	25p	2G373	20p
2G372	20p	2N3632	15p	2N4548	35p	BC183	9p	BFY90	65p	NKT773	25p	2G374	20p	2N3634	15p	NKT773	25p	2G375	20p
2G374	20p	2N3634	15p	2N4548	35p	BC183L	9p	BFY90	65p	NKT773	25p	2G376	20p	2N3636	15p	NKT773	25p	2G377	20p
2G376	20p	2N3636	15p	2N4548	35p	BC184	7p	BFY90	65p	NKT773	25p	2G378	20p	2N3638	15p	NKT773	25p	2G379	20p
2G378	20p	2N3638	15p	2N4548	35p	BC184L	11p	BFY90	65p	NKT773	25p	2G380	20p	2N3640	15p	NKT773	25p	2G381	20p
2G380	20p	2N3640	15p	2N4548	35p	BC186	25p	BFY90	65p	NKT773	25p	2G382	20p	2N3642	15p	NKT773	25p	2G383	20p
2G382	20p	2N3642	15p	2N4548	35p	BC187	27p	BFY90	65p	NKT773	25p	2G384	20p	2N3644	15p	NKT773	25p	2G385	20p
2G384	20p	2N3644	15p	2N4548	35p	BC187L	27p	BFY90	65p	NKT773	25p	2G386	20p	2N3646	15p	NKT773	25p	2G387	20p
2G386	20p	2N3646	15p	2N4548	35p	BC188	20p	BFY90	65p	NKT773	25p	2G388	20p	2N3648	15p	NKT773	25p	2G389	20p
2G388	20p	2N3648	15p	2N4548	35p	BC188L	20p	BFY90	65p	NKT773	25p	2G390	20p	2N3650	15p	NKT773	25p	2G391	20p
2G390	20p	2N3650	15p	2N4548	35p	BC189	20p	BFY90	65p	NKT773	25p	2G392	20p	2N3652	15p	NKT773	25p	2G393	20p
2G392	20p	2N3652	15p	2N4548	35p	BC190	20p	BFY90	65p	NKT773	25p	2G394	20p	2N3654	15p	NKT773	25p	2G395	20p
2G394	20p	2N3654	15p	2N4548	35p	BC190L	20p	BFY90	65p	NKT773	25p	2G396	20p	2N3656	15p	NKT773	25p	2G397	20p
2G396	20p	2N3656	15p	2N4548	35p	BC191	20p	BFY90	65p	NKT773	25p	2G398	20p	2N3658	15p	NKT773	25p	2G399	20p
2G398	20p	2N3658	15p	2N4548	35p	BC191L	20p	BFY90	65p	NKT773	25p	2G400	20p	2N3660	15p	NKT773	25p	2G401	20p
2G400	20p	2N3660	15p	2N4548	35p	BC192	20p	BFY90	65p	NKT773	25p	2G402	20p	2N3662	15p	NKT773	25p	2G403	20p
2G402	20p	2N3662	15p	2N4548	35p	BC192L	20p	BFY90	65p	NKT773	25p	2G404	20p	2N3664	15p	NKT773	25p	2G405	20p
2G404	20p	2N3664	15p	2N4548	35p	BC193	20p	BFY90	65p	NKT773	25p	2G406	20p	2N3666	15p	NKT773	25p	2G407	20p
2G406	20p	2N3666	15p	2N4548	35p	BC194	20p	BFY90	65p	NKT773	25p	2G408	20p	2N3668	15p	NKT773	25p	2G409	20p
2G408	20p	2N3668	15p	2N4548	35p	BC194L	20p	BFY90	65p	NKT773	25p	2G410	20p	2N3670	15p	NKT773	25p	2G411	20p
2G410	20p	2N3670	15p	2N4548	35p	BC195	20p	BFY90	65p	NKT773	25p	2G412	20p	2N3672	15p	NKT773	25p	2G413	20p
2G412	20p	2N3672	15p	2N4548	35p	BC196	20p	BFY90	65p	NKT773	25p	2G414	20p	2N3674	15p	NKT773	25p	2G415	20p
2G414	20p	2N3674	15p	2N4548	35p	BC196L	20p	BFY90	65p	NKT773	25p	2G416	20p	2N3676	15p	NKT773	25p	2G417	20p
2G416	20p	2N3676	15p	2N4548	35p	BC197	20p	BFY90	65p	NKT773	25p	2G418	20p	2N3678	15p				

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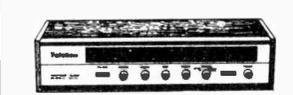
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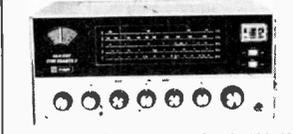


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High quality instrument with 28 ranges. D.c. volts 1-5-1,500V. A.c. volts 1-5-1,500V. Resistance up to 1,000 megohms. 220/240V a.c. operation. Complete with probe and instructions. \$17-50. P. & P. 30p. Additional Probes available: R.P. \$2.12. H.V. \$2-50

## SINCLAIR IC-12



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Ideal for home, office, stores, factories, etc. Supplied complete with batteries, cable and free instructions.  
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Model 450. 13" x 8" with twin tweeters/crossover. 55-13,000Hz. 8 watt R.M.S. Available 8 or 15 ohms. £8-50 each. P. & P. 25p.

#### TE 1018 DE-LUXE MONO HIGH IMPEDANCE HEADSET

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5 microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. 3 1/2" x 5" x 3". Inputs Mics: 3 x 3mV 50K; 2 x 3mV 500 ohms. Phono meg. 4mV 50K. Phono 1 meg. 100mV 1 meg. Output 520mV 100K. £8-97. P. & P. 20p.

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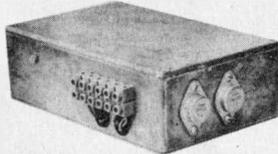
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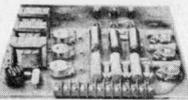
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This Capacitor-Discharge Electronic Ignition system was described in the November and December issues of Practical Electronics. It is suitable for incorporating in any 12v ignition system in cars, boats, go-karts, etc., of either pos. or neg. earth and up to six cylinders. The original coil, plugs, points and contact-breaker capacitor fitted in the vehicle are used. No extra or special components are required. Helps to promote easier starting (even under sub-zero conditions), improved acceleration, better high-speed performance, quicker engine warm-up and improved fuel economy. Eliminates excessive contact-breaker point burning and the need to adjust point and spark-plug gaps with precision. Construction of the unit can easily be completed in an evening and installation should take no longer than half an hour. A complete complement of components is supplied with each kit together with ready-drilled roller-tinned professional quality fibre-glass printed-circuit board, custom-wound transformer and fully-machined die-cast case. All components are available separately. Case size 7 1/2in x 4 1/2in x 2 1/2in approx. Complete assembly and wiring manual 25p, refundable on purchase of kit. Price: £10.50 plus 50p P. & P. S.A.E. with all enquiries.

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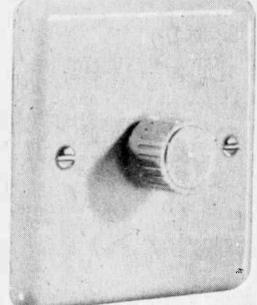
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Double Leaf Contact. Very slight pressure closes both contacts. 6p each, 60p doz. Plastic pusher suitable for operating, 5p each, 45p doz.



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5 amp changeover contacts, 6p each. \$1 doz. 15 amp Model 10p each or \$1.05 doz.



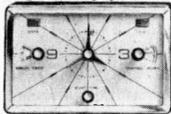
### MINIATURE WAFER SWITCHES

2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 2 way—2 pole, 4 way—3 pole, 4 way—2 pole 6 way—1 pole, 12 way. All at 20p each, \$1.80 for ten, your assortment.

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26 yards length 70W. Self-regulating temperature control. 50p post free.

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Have radio playing and kettle boiling as you awake, switch on lights to ward off intruders, have warm house to come home to. All possible with electrical programmer clock by famous maker with 15 amp on/off switch. Switch on time can be set anywhere to stay on up to 8 hours. Independent 60 minute memory jogger. A beautiful unit. Price \$1.95 + 20p p. & p. or with glass front chrome bezel 75p. extra.



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Complete Kit (except wooden battens) to make the metal detector as the circuit in Practical Wireless, August issue. \$2.95 plus 20p post and insurance.

### SNAP ACTION SLIDE SWITCH

Rated 5a. 240v. Made by Arrow. Type fitted in the handles of electric drills, vacuums, etc. 5p each, 10 for 45p.



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For digital, instruments counters, timers, clocks, etc. Hi-vac XN. 3. Price \$1.45 each. 10 for \$13.

### 12 WAY SUB-MINIATURE MULTI-CORE CABLE

7-0076 copper cores each core P.V.C. insulated and of different colour. P.V.C. covered overall and approx. 3/16in. thick. Price 80p per yard.



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Almost zero resistance in sub light increases to 10 K Ohms in dark or dull light, epoxy resin sealed. Size approx. 1in dia. by 1/2in thick. Rated at 500 Mw, wire ended. 48p with circuit. Also ORP12 light cell 45p.

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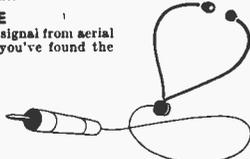


### GOOD COMPANION

We can now offer these again in modular version using Mullard A.F. and I.F. Modules and Radiomobile Permeability Tuner. Should not take more than an evening to make. Cabinet size approx. 1 1/2in wide x 8in. high x 3 1/2in. deep. Complete assembly instructions—\$4.75 plus 25p post and ins.

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Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV amplifier, anything—complete kit comprises two special transistors and all parts including probe tube and crystal earpiece. \$2—twin stethoscope instead of earpiece 75p extra—post and ins. 20p.



### STANDARD WAFER SWITCHES

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

No. of Poles	2 way	3 way	4 way	5 way	6 way	8 way	9 way	10 way	12 way
1 pole	40p	40p							
2 poles	40p	40p							
3 poles	40p	40p							
4 poles	40p	40p							
5 poles	40p	40p							
6 poles	40p	40p							
7 poles	40p	40p							
8 poles	40p	40p							
9 poles	40p	40p							
10 poles	40p	40p							
11 poles	40p	40p							
12 poles	40p	40p							

### 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 \$2.50, plus 20p post and insurance.



### THIS MONTH'S SNIP

**REPEATING TIME SWITCH.** 1 or 2 on/off per 24 hours. Repeats until reprogrammed. Switches up to 15 amp. Switching time completely adjustable through 24 hours. Precision made with 24-hour dial. Miniature—will fit into 2in. cube. Mains operated clock but switch may be isolated for switching battery sets. Ideal for: shop window lighting, anti-theft devices, central heating control and many other automatic processes. Price with instructions \$2 each plus 20p post and insurance.



### MULLARD AUDIO AMPLIFIER MODULE

Uses 4 transistors, and has an output of 500mW into ohm speakers. Input suitable for crystal mic. or pick-up. 9V battery operated. Size 2in long x 1 1/2in wide x 1in high. SPECIAL SNIP PRICE 65p each. 10 for \$5.90.

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(A 50 Amp Switch.) Just the thing if you want to come home to a warm house without it costing you a fortune. You can delay the switch on time of your electric fires, etc., up to 14 hours from setting time or you can use the switch to give a boost on period of up to 3 hours. Equally suitable to control processing. Regular price probably around \$5. Special snip price \$1.50. Post and ins. 25p.



### HONEYWELL THERMOSTAT

Made by Honeywell for normal air temperatures 40-80°F (5-25°C). This is a precision instrument with a differential which can be adjusted to better than 1.5°F. A mercury switch breaks on temp. rise—the switch is operated by a coiled bimetal element and an adjustable heater is incorporated for heat anticipation. Elegantly styled and encased in an ivory plastic case with clear plastic windows, thermometer above and switch setting scale below—size approx. 3-8in x 3-2in x 1-4in deep—can be mounted on conduit box or directly on wall. Price \$1.25 each or ten for \$11.25.



### ZPM MODULATION MOTOR

Could also be used to open ventilators, doors, valve, damper, etc. particularly suitable for remote control. Made by Satchwell. Essentially a reversible geared motor fitted with internal limit switches to stop it at the end of its travel. Size approx. 6in x 6in x 3 1/2in, and weighing approx. 3 1/2 lb. This is extremely powerful and would lift a heavy door or open a long line of ventilators. To operate this motor you put the 50 cycle supply through a changeover switch. For instance a thermostat with changeover contacts could automatically regulate the temperature in a growing house, chicken hatchery, etc. An indicator on the motor graduated 0-10 shows the state of open or close. Also internally fitted is a variable resistor, wires from this to a volt meter would give a remote indication of the open or close position. A very expensive motor if built direct from Satchwell, our price complete with step down Transformer is \$15.

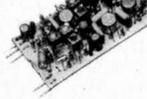


### INTEGRATED CIRCUIT BARGAIN

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### MULLARD I.F. MODULE

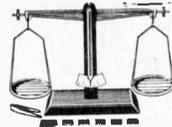
This is a fully screened intermediate frequency module for amplification and detection of i.f. signals at 10.7MHz and a.m. signals at 470KHz. The first stage is used as an i.f. amplifier for i.f. and a self-oscillating mixer for a.m. operation, in conjunction with an external oscillator coil. 85p each; 10 for \$7.95. With connection dig.



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**KA3 Water Pump Kit.** Thirteen parts. Top of pump is transparent so that operating parts may be observed. Small parts are brightly coloured to be seen easily while working. Three types of pump may be made: Lift pump, Force Pump and Force Pump with reservoir and nozzle.

**KA4 Buzzer Kit.** Eleven parts. Transparent covers allow the operation of buzzer to be seen. Illustrates and teaches how electromagnetism with an automatic switch results in an operating buzzer.

**KA5 2-Pole.** Including enamel wire, armature and pole piece, etc. Motor operates from 1 1/2 volt battery. Illustrates and teaches how electro-magnetism operates a motor.

**KA7 Electro-Magnet Kit.** Fifteen parts, includes compass. Makes two electro-magnets, one with one layer of wire and one with several layers of wire. Picks up tacks, nails and any small parts showing how magnetism works.

**KA8 Current and Resistance Kit.** Twenty-nine parts, including bench and light bulb. Concise interesting and educational projects to learn the application of "OHMS LAW" and see the difference in current and resistance with different types and lengths of wire.

**KA9 Bell Kit.** Eight parts, including bell and push button switch. Build a complete electric bell and see how the hammer is triggered to make the bell ring.

**KA10 Morse Key Buzzer and Bell Kit.** 25 part kit easy to construct, simple to operate.

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**Pre-Amplifier Module.** 2 channel for Stereo. Input sensitivity 320mV. Part of the Mullard Unix system and completely enclosed. Size 4in x 4in x 4in. Screw down input and output terminals. Price \$1.80 each; 10 for \$16.20.

**Stereo Power Module.** Mullard Ref. No. EP9002. Rated at 12V 5VA. This has 2 separate outputs to eliminate cross talk. Again part of the Mullard Unix system but suitable for many other purposes. Completely encased with screw down input and output terminals. Size 3 1/2in x 2 1/2in x 2 1/2in. approx. Price \$2.30 plus 20p post; 10 for \$20.70.

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5ft 80 watt, radar red, radar blue. 5ft 80 watt, B.C. ends, pink, blue, green, peach. Up to 3ft 40p each; 4ft 50p each; 5ft 60p each. All less 10% on 10 or more.

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100V	0.22 $\mu$ F	6p
100V	0.33 $\mu$ F	9p
100V	0.47 $\mu$ F	10p
100V	0.68 $\mu$ F	15p
250V	0.01 $\mu$ F	5p
250V	0.015 $\mu$ F	5p
250V	0.022 $\mu$ F	5p
250V	0.033 $\mu$ F	6p
250V	0.047 $\mu$ F	6p
250V	0.068 $\mu$ F	6p
250V	0.1 $\mu$ F	6p

### ELECTROLYTIC

Voltage	Capacitance	Price
10V	22 $\mu$ F	7p
10V	470 $\mu$ F	11p
16V	47 $\mu$ F	7p
25V	10 $\mu$ F	9p
25V	100 $\mu$ F	11p
25V	220 $\mu$ F	14p
25V	470 $\mu$ F	14p
25V	1,000 $\mu$ F	22p
25V	2,200 $\mu$ F	42p
35V	4.7 $\mu$ F	7p
35V	220 $\mu$ F	14p
100V	10 $\mu$ F	8p
100V	22 $\mu$ F	9p
100V	47 $\mu$ F	14p

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AD162	27p	NKT211	24p	IN4003	7p
AF139	28p	NKT212	24p	IN4004	8p
BC107	9p	NKT213	24p	IN4005	10p
BC108	8p	NKT214	19p	IN4006	12p
BC109	9p	NKT218	24p	IN4007	18p
BC147	8p	NKT219	24p	IN4148	4p
BC148	8p	NKT223	26p	2N1302	16p
BC149	8p	NKT224	21p	2N1304	21p
BCY70	14p	NKT242	14p	2N1613	14p
BCY71	20p	NKT243	51p	2N1711	15p
BCY72	14p	NKT401	70p	2N2904	29p
BFX29	24p	NKT402	75p	2N2905	24p
BFY30	19p	NKT403	64p	2N2906	18p
BFY51	18p	NKT453	41p	2N2907	22p
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mF	V	mF	V	4L914	30p	40	750	2p	
2	15	2	15	7400/01/10/	30p	40	750	2p	
2.5	50	1000	3	30	15p	100	750	2p	
4	10	1000	16	MC1027	£2	120	750	2p	
6.4	50	1000	25	Disc Ceramics		1000	50	21p	
10	40	1000	35p	pF	V	1	500	2p	0-01 30p
16	15	2000	12	5	750	2p	0-01	350p	2p
25	15	2500	25	10	750	2p	0-022	30p	2p
32	25	2000	25	25	750	2p	0-047	30p	2p
40	6	Panel Neon Red							
50	10	Int. Res. 240V							
50	50	15p							
64	10								
64	15	IN4001	6p						
64	25	IN4002	7p						
64	40	IN4003	7p						
100	6	IN4004	9p						
100	50	IN914	11p						
250	6	2N706	6p						
250	10	2N708	13p						
250	15	2N1303	17p						
250	25	2N3866	80p						
400	10	2N3055	57p						
500	10	BC108	11p						
500	12	BCY30	11p						
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6	6, 12, 20V at 20A	£6.88	55p
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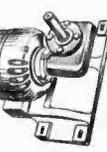
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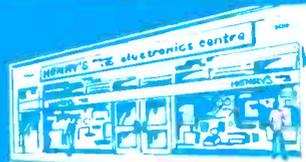
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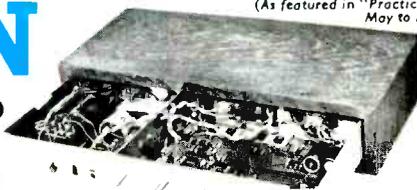


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(As featured in "Practical Wireless" May to August 1972)

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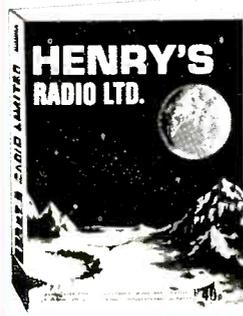
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