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JANUARY 1977

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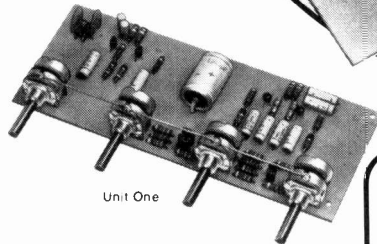
STIRLING SOUND policy is to ensure customer satisfaction by designing and making their products in their own factory in Essex and selling direct. Production control-checked throughout! All QV Modules are compatible within the range and with much other equipment.

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Combined pre-amp with active tone-control circuits -15dB at 10kHz treble and 30Hz bass Stereo Vol/balance treble bass 200mV out for 50mV in Takes 10-16V £7.80

SS100 Active tone control stereo -15dB on bass and on treble £1.60

SS101 Pre-amp for ceramic cartridges radio, tape Stereo Passive tone control circuit shown in data supplied £1.60



Unit One

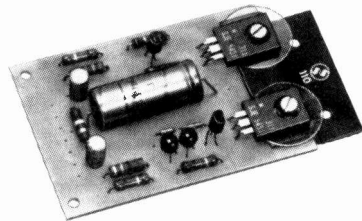
SS102 Stereo pre-amp for low output magnetic P.U.s R.I.A.A. corrected Linear feedback facility £2.65



SS140

40 watts r.m.s. into 4 ohms using 45V supply such as SS345 ideal for small discos and P.A. 101 x 76 x 19mm (4 x 3 x 3/4in)

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New style for power amps SS105 SS110 and SS120

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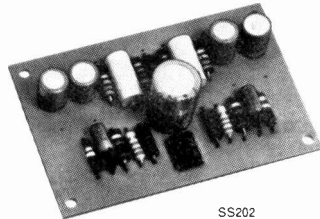
SS103-3 Stereo version of above £3.25

SS105 5 watts r.m.s. into 4 ohms, using 12V (SS312 for example) £2.25

SS110 10 watts r.m.s. using 24V and 4 ohm load Use SS324 as the power supply £2.75

SS120 20 watts r.m.s. into 4 ohms using 34V Use SS324 for your power supply £3.25

Modules SS105 110/120 all measure 89 x 50 x 19mm (3 3/4 x 2 1/4in) Suitable power supplies will be found in the accompanying range



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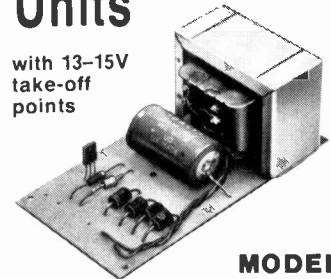
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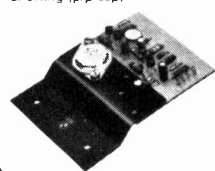
MODELS TO CHOOSE FROM

All the following are supplied assembled complete with mains transformers and low volt take-off points Complete with mains transformers (except SS300) All at 8% VAT rate Add 50p for p.p any model except SS300

SS312	12V/1A	£3.75†
SS318	18V/1A	£4.15†
SS324	24V/1A	£4.60†
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PRACTICAL ELECTRONICS

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An initial 20W r.m.s. + 20W r.m.s. stereo with standard controls can be expanded to give a 40W + 40W system with (in addition to the normal bass, treble and balance controls) a further range comprising 'rumble' and 'hiss' switchable controls with a range of frequencies; and a stereo image width control.

STEREO PRE-AMP: CP-P1 PRICE £13.30 + £1.66 VAT

Specification			
Input	Sensitivity	Signal/Noise	Impedence
Magnetic	3mV	> 70dB	47kΩ
Tuner	100mV	> 70dB	10kΩ
Tape	100mV	> 70dB	10kΩ
Auxiliary	1-100mV	60dB-70dB	200kΩ

Magnetic μ p overload: 33dB.
Distortion: 0.04% at 1kHz.
Output: 1V r.m.s. into 10kΩ.
Supply voltage: \pm 18V nominal.
Tone controls: Bass \pm 12dB at 100Hz.
Treble \pm 12dB at 10kHz.

Description: This is a general purpose 2 channel pre-amplifier suitable for use with gramophone, tape, microphone or tuner inputs. It requires no external components other than the potentiometers for the bass, treble, balance and volume controls and the input selector switch. The unit is internally protected against accidental reversed supply connection.



AMPLIFIER: CP2-15-20 PRICE: £12.85 + £1.61 VAT

40W r.m.s. single
20W r.m.s. + 20W r.m.s. stereo



Specification:
Power output:
40W r.m.s. into 8Ω, 1 channel; or
30W r.m.s. into 15Ω, 1 channel; or
20W r.m.s. + 20W r.m.s. into 4Ω, 2 channel; or
15W r.m.s. + 15W r.m.s. into 8Ω, 2 channel.
Input sensitivity: 1V r.m.s.; Frequency response: 20Hz-20kHz, at -3dB.
Distortion: 0.04% at 15W; Supply Voltage: \pm 18V nominal; Size: 5.1 x 4 x 1.25in. (130 x 102 x 32mm).

Description: This module is designed to give either a 20W + 20W stereo amplifier or alternatively a 40W single channel. It has built-in protection against accidental reversed supply connection and it incorporates a thermal shut-down facility to prevent over-dissipation. No external components are required.

FUNCTION GENERATOR: CP-FG1 PRICE: £11.75 + £1.47 VAT

For those requiring a wider range of facilities, this module provides bass and treble filter controls, comprising switchable cut-off frequencies for rumble and hiss reduction. Also included is a stereo separation control. The unit is complete except for the potentiometers and switches.

POWER SUPPLY: CP-PS 18/2D PRICE: £5.75 + 72p VAT

This is suitable for one 20W + 20W complete system.
For a 40W + 40W system, two power supplies are required.

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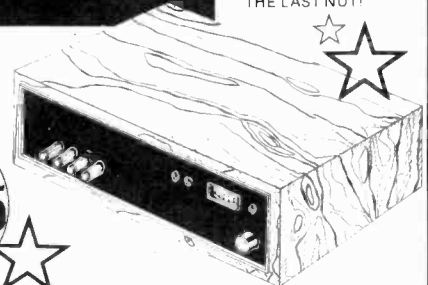
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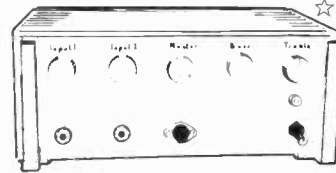
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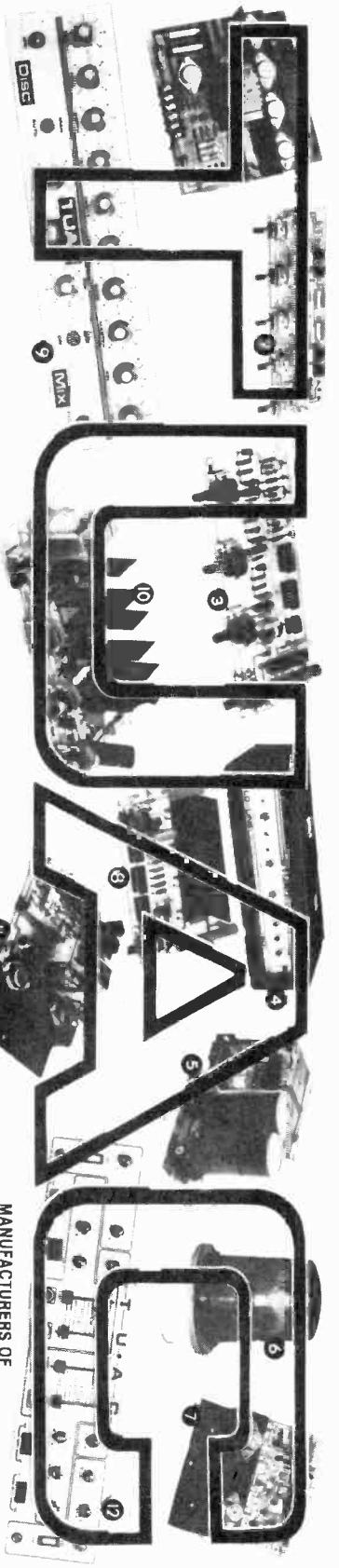


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POWER HANDLING GUIDE

System Impedance	Capacity
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4 ohms	156 watts
8 ohms	78 watts
16 ohms	39 watts



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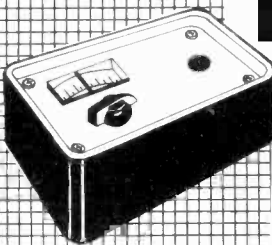
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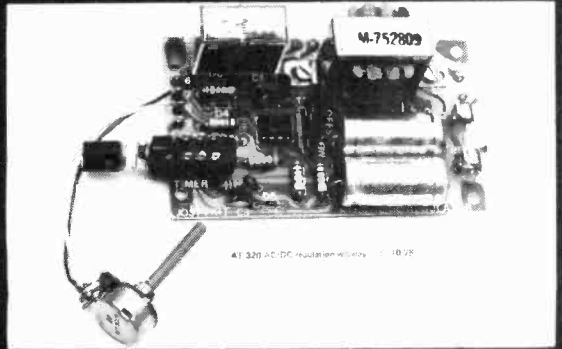
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The Dynamic Twosome: Signalmaster/Audiomaster

After long and thorough deliberation, we are proud to announce a new unit from Larsholt - the Audiomaster. As ever, the instructions are designed to lead the unwary and the inexperienced through point-to-point steps that culminate in a professionally styled and finished amplifier to complement the Signalmaster FM tuner. Price £79.00



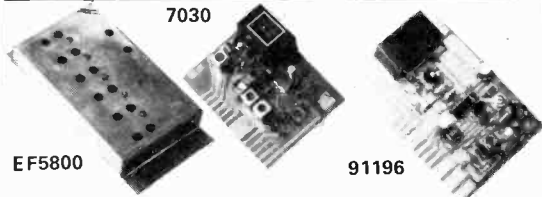
Power: 25+25W RMS
THD: Less than 0.3%
Dynamic range: an exceptional 80dB
(Signalmaster shown on top of the Audiomaster)

The Signalmaster Mk.8 is equally simple to assemble, and results reflect the superb Scandinavian styling and careful electronic engineering. £85.00.



International Mk.2:
A choice of tuners for the more experienced constructors.

A chassis, cabinet and front panel designed to be used with a variety of electronics inside. The standard set, with the Larsholt 7253 varicap FM tuner set, plus all necessary parts to complete costs £65.00. Alternative modules for the signal processing stages are available for the more advanced F.M. radio enthusiast/constructor. (EF5800/7030/91196)



From left to right, the EF5800 6 circuit varicap FM tunerhead. Two MOS RF stages, both with AGC control, and an ultra stable oscillator. Next the 7030 Linear Phase 10.7MHz IF. Distortion 0.08%, muting, AGC, meter, auto stereo switch outputs. Finally the new 91196 mpX decoder and combined birdy filter. Mono THD 0.05%, stereo sep. 55dB at 1kHz, 42dB at 10kHz - the best decoder module yet. EF5800.....£14.50 7030.....£10.95 91196.....£12.99 (Built).

Overall performance of the three modules when correctly assembled:- 30dB S/N at 0.85uV input. 60dB at 5uV. THD 0.09%. AFC holds THD below 0.2% over 400kHz if required. AGC effective over a 90dB range. Image rejection -90dB. Noise floor -73dB.

Components: Coils, ICs Filters, etc.

Radio ICs: (and modules)	Coils and filters:-
CA3089E/HA1137W FM 1.94	AM IFTs TOKO
CA3090/A2 Cmix 3.75	YRCS/YICS types(10mm) 0.30
MC1310/KB4400 mpX 2.20	7MCS types (7mm) 0.30
HA1196 mpX 4.20	FM IFTs:-
HA1197 AM radio 1.40	KACS/KALS types(10mm) 0.33
TBA120AS FM IF 1.00	94A types (10mm) 0.30
TBA651 AM radio 1.81	AM filters:-
UA720/CA3123E AM rad 1.40	CFT types ceramic (455) 0.55
LM380N 2W Audio 1.00	CFU type ceramic (470) 0.60
TBA810AS 7W Audio 1.09	SFD470 types (470) 0.75
TCA940 10W Audio 1.80	FM filters:-
TDA2020 20W Audio 2.99	CFS/SFE ceramic (10.7) 0.50
LM381N stereo preamp 1.81	SFE5MA (TV sound) 0.80
LM3900 Quad amp 0.68	3132 linear phase 2.25
78M12-20-24 volt reg ea:1.20*	MPX 19&38kHz notch
NE550A variable reg 0.80*	BLR3107 (4k7 imp) 1.75
TAA550B varicap reg 32v 0.50*	BLR2007 (3k3 imp) 1.75
NE560/2B PLL IC ea:2.50	23 or 36MHz chokes 0.33
NE561B PLL IC 3.50	Tunerheads: (& tunersets)
NE565A/567V PLL ea:2.50	EF5600 5 gang varicap 12.80
810k kit for TBA810 amp2.75	EC3302 3 gang varicap 5.50
2020k kit for 2020 amp 9.35	8319 (Larsholt) 12.00
92310 kit for mpX decoders 5.35	7252 tuner set complete 26.00
7020 kit for 3089 FM IF 6.65	7253 stereo tuner set 26.00
971197 kit for varicap AM radio tuner 9.65	Standard transistors also kept in stock - see lists for further detail and price information.
7700 built TV sound tuner 27.00	

Terms: Vat extra, 12.5% unless marked *, which is 8%, all complete tuners require £3.00 for packing and carriage. The standard P&P rate remains at 22p per order. Catalogue 40p. Phone (0277) 216029 (After 3pm please). SAE for free price lists.

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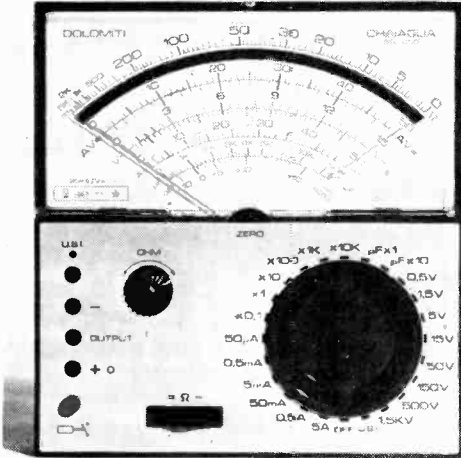
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4007A 22	4023A 21	4072A 25
4008A 1-46	4024A 72	4073A 32
4009A 47	4025A 21	4075A 32
4010A 44	4027A 48	4078A 12
4011A 22	4028A 81	4082A 29
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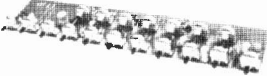
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Printed circuit module assembled &
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* Front panel to suit £3.50

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- Needs only front panel* knobs and selector switch.
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- Perfect for incorporation in your system

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- Using these modules, mixers may be built to your specification up to 20 Channels, mono or stereo, or a combination of both. System 7000 custom-mixer modules have monitoring facilities too!

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- Accept low/high 2 mics, ceramic & magnetic cartridges, all musical instruments & line signals
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- Stereo—IM7001S

Power supply for up to 20 modules—PPM18 **£8.50**

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- Will match any other make of amplifier

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Stereo—IM7002S

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A COMPLETE
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- Needs only front panel*
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THREE CHANNEL 3KW SOUND/LITE—Low Cost— Superb Value



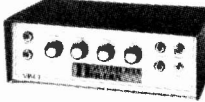
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- Vynide covered case
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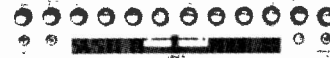


SAXON 150 HEAVY DUTY AMPLIFIER **£59.00**

SYSTEM 7000

COMPLETE DISCO MIXERS (with Auto Fade)

*Ready to plug in & use
* Mono or Stereo



- Automatic mic. override
 - Mixes two decks, tape & mic
 - Facilities as for modular version opposite
 - Mute positions on headphone selector for ease of monitoring
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 - Left/right deck fader
 - May be operated from any power supply or from mains
- Stereo 18V **£53.50**
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The choice of the professional D.J.

Controls: Mic. volume, bass, treble, A/fade depth, tape, L/deck r/deck vols., treble, bass, master, headphones vol., selector, left/right fader.

MONO 18V **£37.50** MONO MAINS **£43.50**

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- Similar to the modules opposite these mixing modules are complete with front panels, sockets, knobs, monitor switch etc. Up to 20 channels (mono or stereo) may be incorporated in one system with any number of output tracks.

Ideal for the economical & quick assembly of a purpose built mixer with individual channel monitoring, and optional extra facilities—consult our technical dept. to discuss your needs.

- Stainless steel panels
 - Built-in monitoring
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Power supply **£8.50**

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- 4000W Handling
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OURS HAS! — PLUS:

- Stainless steel panel
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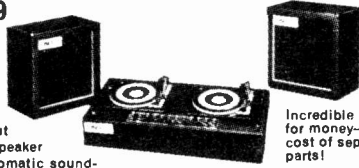
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THE CENTAUR

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- 100W rms stereo output
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- Four channel fully automatic sound-lite with variable speed sequence
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- Twin BSR decks with autostop & lift arm



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- All connecting leads supplied—ready to plug in
- Loudspeakers have kick-proof grills
- Four colour built-in light display gives ever changing pattern with or without music

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£89.90

- 50W rms output
- Twin heavy duty loudspeakers
- Separate mic. input
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- Smart Vynide cases—clip together to form one neat package
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- Tremendous value—price includes leads just plug in & go!

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- Heavy duty boom mic. stand £12.50

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A full range of custom consoles are available using System 7000, from 50W mono to 500W stereo. Ask for our price list.



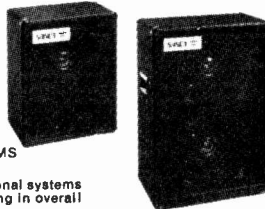
LOUDSPEAKER CABINETS

- Kick proof grills.
- Jointed construction
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- Smart & professional
- Heavy duty units.
- Black Vynide

Single Twelve: Empty £14
With 60W unit £35.00
Twin Twelves: Empty £24
With units from £58.00
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This cabinet is 3-4 times as loud as conventional systems for a given input power—as thus there is a saving in overall size & cost.

- Many other cabinets available—ask for details.



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- £19 with plain motorboard.
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- Black Vynide finish
- Protective corners
- With your choice of cutouts

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- 2-3 Joules
- 80W Tube for long life
- Compact 4" x 4" x 4"

PRO-STROBE £32.50

- 6-8 Joules
- External trigger
- Long Life tube timer circuit



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GOOD NEWS FROM

Connoisseur

THE NEW BD2/A



Based on the popular BD2, the new BD2/A offers the hi-fi enthusiast all the features usually associated with Connoisseur turntables, such as low rumble, wow and flutter, plus the addition of an automatic pick-up arm lift-off at the end of the record. This is achieved by an ingenious, though simple, electromagnetic system, which avoids having any physical contact with the pick-up arm. It is possible, therefore, to use top quality cartridges, tracking at less than one gram, without putting any extra side pressure on the stylus.

The BD2/A comes either as a chassis model, or mounted on a slimline plinth, standing on rubber anti-vibration feet, finished in genuine American walnut, and fitted with a bronze, hinged dust cover. For those with restricted space, a compact plinth measuring only 13½" x 15½" x 5½" is still available.

Specification

Rumble - 65dB when measured in accordance with DIN 45539 using weighting network, referred to 7cm/sec. at 330Hz.

Wow and flutter Less than 0,1%

Hum level - 80dB

The BD2/A sells for a recommended price of only £55.00 + VAT. Ask your local hi-fi dealer, or write to the factory, for further details.

Connoisseur

Manufactured by: - A. R. Sugden & Co (Engineers) Ltd., Atlas Mill Road, Brighouse, West Yorkshire, HD6 1ES. Telephone: Brighouse (04847) 2142. Telegrams & Cables: Connoisseur, Brighouse.



A Happy Christmas to all our readers

Of course, by "Santas" I mean Dads, Grand-dads and Uncles who, at this time of the year, are often desperate for inspiration!

Well, if *your* son, grandson or nephew is keen on electronics, may I make a suggestion? Buy a Home Radio Catalogue. In it you will find *dozens* of wonderful presents. When you give him the present you have chosen you can double his pleasure by giving him the catalogue as well!

This is the one catalogue every electronic enthusiast must have. Its 200 pages are crammed with over 5,000 items, well over 1,000 of them illustrated. It's a present that will last for years, because it can be updated with new price lists, supplied free on request. With every catalogue comes a free bargain list—another worthwhile bonus. At the price of £1 plus 40p for postage and packing its certainly wonderful value; so send off the coupon with a cheque or P.O. for £1.40 ... and become the Santa of the year!

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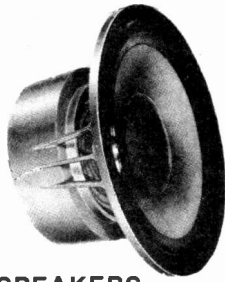
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AC176K	£0.26	BC169C	£0.12	BD131	£0.35	BU208/02	£2.95	2N1616	£0.20
AC178	£0.25	BC170	£0.10	BD132	£0.38	E1222	£0.38	2N1889	£0.45
AC179	£0.25	BC171	£0.10	BD131/132MP	£0.80	MJE2955	£0.88	2N1890	£0.45
AC180	£0.20	BC172	£0.10	BD133	£0.80	MJE3055	£0.88	2N1893	£0.30
AC180K	£0.30	BC173	£0.12	BD135	£0.36	MP1113	£0.45	2N1217	£0.75
AC181	£0.20	BC177	£0.16	BD136	£0.36	MPP102	£0.35	2N1292	£0.38
AC181K	£0.30	BC178	£0.16	BD137	£0.38	MPF104	£0.39	2N1293	£0.38
AC187	£0.16	BC179	£0.16	BD138	£0.45	MPF105	£0.39	2N1294	£0.38
AC187K	£0.26	BC180	£0.25	BD139	£0.54	MPSA05	£0.20	2N2217	£0.22
AC188	£0.16	BC181	£0.25	BD139/140MP	£1.20	MPSA06	£0.20	2N2218	£0.22
AC188K	£0.26	BC182L	£0.10	BD155	£0.80	MPSA55	£0.20	2N2219A	£0.20
AD140	£0.60	BC183	£0.10	BD175	£0.60	MPSA56	£0.20	2N2219A	£0.24
AD142	£0.85	BC183L	£0.10	BD176	£0.60	OC22	£1.50	2N2290A	£0.18
AD143	£0.75	BC184	£0.10	BD177	£0.68	OC23	£1.50	2N2904	£0.21
AD149	£0.60	BC184L	£0.10	BD178	£0.68	OC24	£1.40	2N2905A	£0.18
AD161	£0.36	BC207	£0.11	BD179	£0.72	OC26	£0.60	2N2905A	£0.21
AD162	£0.36	BC208	£0.11	BD201/202MP	£1.70	OC29	£1.00	2N2908	£0.16
AD161/162MP	£0.75	BC212	£0.11	BD203	£0.80	OC35	£0.90	2N2906A	£0.19
AF114	£0.20	BC213	£0.11	BD204	£0.80	OC36	£0.90	2N2907	£0.20
AF115	£0.20	BC213L	£0.11	BD203/204MP	£1.70	OC70	£0.15	2N2926G	£0.09
AF116	£0.20	BC214	£0.12	BDY20	£0.80	OC71	£0.15	2N2926V	£0.08
AF117	£0.20	BC214L	£0.12	BDX77	£0.90	TIC44	£0.29	2N2926W	£0.08
AF118	£0.40	BC229	£0.16	BF458	£0.37	TIC45	£0.29	2N2926R	£0.08
AF124	£0.30	BC238	£0.16	BF459	£0.37	TIP29A	£0.44	2N2926B	£0.08
AF125	£0.30	BC251	£0.15	BF529	£0.25	TIP29B	£0.52	2N3053	£0.16
AF126	£0.30	BC251A	£0.15	BF536	£0.17	TIP29C	£0.62	2N3054	£0.40
AF139	£0.58	BC301	£0.30	BF537	£0.17	TIP30A	£0.54	2N3055	£0.40
AF180	£0.58	BC302	£0.28	BF538	£0.17	TIP30B	£0.60	2N3414	£0.16
AF180K	£0.58	BC303	£0.32	BF539	£0.17	TIP30C	£0.70	2N3415	£0.16
AF181	£0.58	BC304	£0.32	BF540	£0.17	TIP31A	£0.54	2N3416	£0.29
AF186	£0.58	BC327	£0.16	BF541	£0.17	TIP31B	£0.66	2N3417	£0.29
AF239	£0.38	BC328	£0.15	BF542	£0.17	TIP31C	£0.68	2N3614	£0.85
AL202	£0.95	BC337	£0.15	BF543	£0.17	TIP32A	£0.54	2N3615	£0.90
AL103	£0.95	BC338	£0.15	BF544	£0.17	TIP32B	£0.78	2N3616	£0.90
AL104	£1.00	BC440	£0.30	BF545	£0.17	TIP32C	£0.80	2N3646	£0.09
AL110	£1.00	BC441	£0.30	BF546	£0.17	TIP41A	£0.66	2N3702	£0.08
AL113	£1.00	BC460	£0.38	BF547	£0.17	TIP41B	£0.70	2N3703	£0.08
BC107A	£0.08	BC461	£0.38	BF548	£0.17	TIP41C	£0.80	2N3704	£0.07
BC107B	£0.08	BC477	£0.20	BF549	£0.17	TIP42A	£0.72	2N3705	£0.07
BC107C	£0.08	BC478	£0.19	BF550	£0.14	TIP42B	£0.78	2N3707	£0.08
BC108A	£0.08	BC479	£0.20					40408	£0.48
BC108B	£0.08	BC547	£0.12					40409	£0.48
BC108C	£0.08	BC548	£0.12					40420	£0.52

74 SERIES TTL ICs

FULL SPECIFICATION GUARANTEED. ALL FAMOUS MANUFACTURERS

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
7400	£0.14	7409	£0.15	7441	£0.64	7482	£0.85	7493	£0.40
7401	£0.14	7410	£0.14	7442	£0.64	7483	£0.95	7494	£0.88
7402	£0.15	7411	£0.23	7445	£0.90	7484	£0.98	7495	£0.80
7403	£0.15	7412	£0.23	7446	£0.90	7485	£1.20	7496	£0.80
7404	£0.15	7413	£0.27	7447	£0.78	7486	£0.30	74100	£1.00
7405	£0.15	7414	£0.58	7448	£0.80	7489	£2.90	74110	£0.50
7406	£0.30	7416	£0.28	7475	£0.48	7490	£0.42	74118	£0.90
7407	£0.30	7417	£0.28	7480	£0.50	7491	£0.75	74119	£1.85
7408	£0.15	7440	£0.15	7481	£0.95	7492	£0.45	74121	£0.30

CMOS ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CD4000	£0.14	CD4012	£0.18	CD4022	£0.95	CD4031	£2.20	CD4046	£1.00
CD4001	£0.18	CD4013	£0.50	CD4023	£0.18	CD4035	£1.05	CD4047	£1.10
CD4002	£0.18	CD4015	£0.90	CD4024	£0.72	CD4037	£0.95	CD4049	£0.55
CD4006	£0.98	CD4016	£0.50	CD4025	£0.18	CD4040	£0.95	CD4050	£0.55
CD4007	£0.18	CD4017	£0.90	CD4026	£0.98	CD4041	£0.82	CD4054	£1.20
CD4008	£0.95	CD4018	£1.00	CD4027	£0.60	CD4042	£0.82	CD4055	£1.20
CD4009	£0.55	CD4019	£0.52	CD4028	£0.85	CD4043	£0.98	CD4056	£1.40
CD4010	£0.55	CD4020	£1.10	CD4029	£1.15	CD4044	£1.40	CD4069	£0.40
CD4011	£0.18	CD4021	£0.98	CD4030	£0.55	CD4045	£1.40	CD4070	£0.40

LINEAR ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CA3011	£0.80	LM309K	£1.75	MC1468R	£2.50	UA711C	£0.32	72748	£0.35
CA3014	£1.37	LM320-5V	£2.00	MC1496G	£0.90	72711	£0.32	72748P	£0.35
CA3018	£0.70	LM320 12V	£2.00	NE536	£2.00	UA723C	£0.50	SN76013N	£1.40
CA3020	£1.40	LM320-15V	£2.00	NE581A	£2.10	72723	£0.50	SN76023N	£1.40
CA3028A	£1.10	LM320-24V	£2.00	NE54					

SEMICONDUCTORS—COMPONENTS

DIODES

Type	Price	Type	Price	Type	Price	Type	Price
AA129	£0-08	BY100	£0-16	BY212	£0-31	OA91	£0-07
AA30	£0-09	BY107	£0-12	BY212	£0-31	OA95	£0-07
AAZ13	£0-10	BY105	£0-18	BY213	£0-26	OA182	£0-07
AAZ17	£0-10	BY114	£0-12	BY216	£0-41	OA200	£0-08
BA100	£0-10	BY124	*£0-12	BY217	£0-36	OA202	£0-08
BA102	£0-32	BY126	*£0-15	BY218	£0-36	SD10	£0-06
BA148	£0-15	BY127	*£0-16	BY219	£0-28	SD19	£0-06
BA154	£0-12	BY128	£0-16	CA23	£0-35	IN34	£0-07
BA155	£0-14	BY130	*£0-17	CA27	£0-07	IN34A	£0-07
BA156	£0-14	BY133	*£0-21	CA70	£0-07	IN514	£0-06
BA173	£0-15	BY164	£0-51	CA79	£0-07	IN516	£0-06
BB104	£0-15	BY176	*£0-75	CA81	£0-07	IN4148	£0-06
BAX13	£0-07	BY296	£0-00	OA85	£0-09	IS44	£0-05
BAX16	£0-08	BYZ10	£0-36	OA90	£0-07	IS920	£0-06

SILICON RECTIFIERS

Type	Price	Type	Price	Type	Price	Type	Price
IS920	£0-06	IN4003	£0-07	IS020	£0-10	IS031	£0-25
IS921	£0-07	IN4004	£0-08	IS021	£0-11	IN5400	£0-13
IS922	£0-08	IN4005	£0-09	IS023	£0-13	IN5401	£0-15
IS923	£0-09	IN4006	£0-10	IS025	£0-14	IN5402	£0-16
IS924	£0-10	IN4007	£0-11	IS027	£0-16	IN5404	£0-17
IN4001	£0-05	IS015	£0-09	IS029	£0-20	IN5406	£0-21
IN4002	£0-06					IN5407	£0-25

TRIACS

2 AMP T05 CASE			10 AMP T04E CASE		
Volts	No.	Price	Volts	No.	Price
100	TR12A-100	£0-31	100	TR110A-100	£0-77
200	TR12A-200	£0-51	200	TR110A-200	£0-92
400	TR12A-400	£0-71	400	TR110A-400	£1-12

6 AMP T06E CASE			10 AMP T04E CASE		
Volts	No.	Price	Volts	No.	Price
100	TR16A-100	£0-51	100	TR110A-100	£0-77
200	TR16A-200	£0-61	200	TR110A-200	£0-92
400	TR16A-400	£0-77	400	TR110A-400	£1-12

THYRISTORS

600mA T018 CASE			7 AMP T04E CASE		
Volts	No.	Price	Volts	No.	Price
10	THY600/10	£0-13	50	THY7A-50	£0-48
20	THY600/20	£0-13	100	THY7A-100	£0-51
30	THY600/30	£0-19	200	THY7A-200	£0-57
50	THY600/50	£0-22	400	THY7A-400	£0-62
100	THY600/100	£0-25	600	THY7A/600	£0-78
200	THY600/200	£0-38	800	THY7A/800	£0-92
400	THY600/400	£0-45			

1 AMP T05 CASE			10 AMP T04E CASE		
Volts	No.	Price	Volts	No.	Price
50	THY1A-50	£0-26	100	THY10A-100	£0-51
100	THY1A-100	£0-27	200	THY10A-200	£0-62
200	THY1A-200	£0-28	400	THY10A-400	£0-71
400	THY1A-400	£0-36	600	THY10A-600	£0-99
600	THY1A-600	£0-45	800	THY10A/800	£1-22
800	THY1A/800	£0-58			

3 AMP T06E CASE			16 AMP T04E CASE		
Volts	No.	Price	Volts	No.	Price
50	THY3A/50	£0-25	50	THY16A-50	£0-54
100	THY3A/100	£0-27	100	THY16A-100	£0-58
200	THY3A-200	£0-33	200	THY16A-200	£0-62
400	THY3A-400	£0-42	400	THY16A-400	£0-77
600	THY3A-600	£0-50	600	THY16A/600	£0-90
800	THY3A-800	£0-65	800	THY16A-800	£1-39

5 AMP T06E CASE			30 AMP T094 CASE		
Volts	No.	Price	Volts	No.	Price
50	THY5A-50	£0-36	50	THY30A-50	£1-18
100	THY5A-100	£0-48	100	THY30A-100	£1-43
200	THY5A-200	£0-50	200	THY30A-200	£1-63
400	THY5A-400	£0-57	400	THY30A-400	£1-79
600	THY5A-600	£0-69	600	THY30A/600	£3-50
800	THY5A-800	£0-81			

5 AMP T022 CASE			No.		
Volts	No.	Price	Price		
400	THY5A-400P	£0-57	BT101/500R	£0-80	
600	THY5A-600P	£0-69	BT102/500R	£0-80	
800	THY5A/800P	£0-81	BT106	£1-25	
			BT107	£0-93	
			BT108	£0-98	
			2N3228	£0-70	
			2N3225	£0-77	
			BTX30/50L	£0-33	
			BTX30/400L	£0-46	
			C106-4	£0-60	

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Pak No.	Qty	Description	Order No.	Price
U50	100	Germ gold bonded OA47 diode	16130	£0-60
U51	150	Germ OA70/B1 diode	16131	£0-60
U52	100	Silicon diodes 200mA OA200	16132	£0-60
U53	150	Diodes 75mA 1N4148	16133	£0-60
U54	50	Sil rect to hat 750mA	16134	£0-60
U55	20	Sil rect stud type 3 amp	16135	£0-60
U56	50	400mW zeners DO7 case	16136	£0-60
U57	30	NPN trans BC107/8 plastic	16137	£0-60
U58	30	PNP trans BC177/178 plastic	16138	£0-60
U59	25	PNP TO59 2N2917/1 silicon	16139	£0-60
U60	25	PNP TO59 2N2905 silicon	16140	£0-60
U61	30	NPN TO18 2N706 silicon	16141	£0-60
U62	25	NPN BFY50/51	16142	£0-60
U63	30	NPN plastic 2N3906 silicon	16143	£0-60
U64	30	PNP plastic 2N3905 silicon	16144	£0-60
U65	30	Germ 0071 PNP	16145	£0-60
U66	15	Plastic power 2N3055 NPN	16146	£1-20
U67	10	TO3 metal 2N3055 NPN	16147	£1-20
U68	20	Unijunction trans IS43	16148	£0-60
U69	10	1 amp SCR T039	16149	£1-20
U70	8	3 amp SCR T066 case	16150	£1-20

Code Nos mentioned above are given as a guide to the type of device in the pak. The device themselves are normally unmarked.

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Manufacturers' Fall Outs' which include Functional and part-Functional Units. These are classed as 'out-of-spec' from the maker's very rigid specifications, but are ideal for learning about ICs and experimental work.

U721—30 Assorted Linear Types 709, 741, 747, 748, 710, 588 etc.
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U76SD FM STEREO DECODER
5 ICs 76110 equivalent to MC1310P-MA767
Data supplied with pak.
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U76A AUDIO POWER OUTPUT AMPLIFIERS
8 assorted types SL403, 76013, 76003, etc.
Data supplied with pak.
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74G—100 Gates assorted 7400-01-04-10-50-60, etc.
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74F—50 Flip-Flops assorted 7470-72-73-74-76-104-109 etc.
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74M—30 MSI Assorted Types 7441-47-90-154, etc.
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- R3—60 mixed ½W 10-82kΩ. ORDER No. 16215 *60p
- R4—60 mixed ½W 100-820kΩ. ORDER No. 16216 *60p
- R5—40 mixed ½W 100-820Ω. ORDER No. 16217 *60p
- R6—40 mixed ½W 1-8 2kΩ. ORDER No. 16218 *60p
- R7—40 mixed ½W 10-82kΩ. ORDER No. 16219 *60p
- R8—40 mixed ½W 100-820kΩ. ORDER No. 16220 *60p
- R9—60 mixed ½W 1-10MΩ. ORDER No. 16230 *60p
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C3	50	Precision resistors. Mixed values	16166	£0-60
C4	80	½W resistors mixed preferred values	16167	£0-60
C5	5	Pieces assorted ferrite rods	16168	£0-60
C6	2	Tuning ganks MW/1W VHF	16169	£0-60
C7	1	Pack wire 50 meters assorted colours single strand	16170	£0-60
C8	10	Reed switches	16171	£0-60
C9	3	Micro switches	16172	£0-60
C10	15	Assorted pots	16173	£0-60
C11	5	Metal jack sockets 3x3 5mm 2x standard switch types	16174	£0-60
C12	30	Paper condensers preferred types mixed values	16175	£0-60
C13	20	Electrolytics trans. types	16176	£0-60
C14	1	Pak assorted hardware—nuts bolts, washers, etc.	16177	£0-60
C15	5	Mains slide switches ass.	16178	£0-60
C16	20	Assorted tag strips and panels	16179	£0-60
C17	15	Assorted control knobs	16180	£0-60
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C19	2	Relays 6-24V operating	16182	£0-60
C20	1	Pak, copper laminate approx. 200 sq. in.	16183	£0-60
C21	15	Assorted fuses 100mA-5 amp	16184	£0-60
C22	50	Metres PVC sleeving assorted size and colour	16185	£0-60
C23	60	½ watt resistors mixed preferred values	16188	£0-60
C24	25	Presets assorted type and value	16186	£0-60
C25	30	Metres stranded wire assorted colours	16187	£0-60

SLIDER PAKS

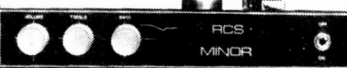
Pak No.	Qty	Description	Order No.	Price
S1	6	Slider potentiometers, mixed values	16190	£0-60
S2	6	Slider potentiometers, all 470 ohms	16191	£0-60
S3	6	Slider potentiometers, all 10kΩ lin	16192	£0-60
S4	6	Slider potentiometers, all 22kΩ lin	16193	£0-60
S5	6	Slider potentiometers, all 47kΩ lin	16194	£0-60
S6	6	Slider potentiometers, all 47kΩ log	16195	£0-60

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Pak No.	Qty		
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MC2	24	miniature ceramic capacitors 3 of each value—100pF, 120pF, 150pF, 180pF, 120pF, 270pF, 330pF and 390pF	16161 *£0-60
MC3	24	miniature ceramic capacitors, 3 of each value—470pF, 560pF, 680pF, 820pF, 1,000pF, 1,500pF, 2,200pF and 3,000pF	16162 *£0-60
MC4	21	miniature ceramic capacitors, 3 of each value—4,700pF, 6,800pF, 0.01µF, 0.015	

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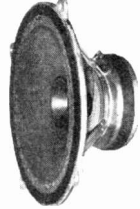
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TO AID THE MOTORIST

ANY device that will aid the motorist in keeping down the costs of running a car must be assured of a warm welcome as petrol prices soar skywards yet again. The Car Exhaust Monitor featured in this issue makes effective use of the solid state sensor in a simple-to-install system. With this system the driver has at all times a visual indication of the comparative efficiency of the combustion processes, as derived through the monitoring of waste products at the exhaust.

As a corrective for bad driving habits or as an early warning of the need for service attention the Exhaust Monitor will be a boon and should play a useful part in holding down motoring costs, not to mention assisting in the reduction of pollution.

On the bigger, wider scale, it is clear that electronics is becoming more and more important to the motor industry. The internal combustion engine with its dependence upon such different but interacting electrical, hydraulic, and pneumatic systems is ripe for takeover by an electronic co-ordinating master mind. A built-in computerised control system based upon a microprocessor looks like the inevitable solution, and it is known that the electronics industry is working closely with the motor industry towards such a goal. More efficient and safer driving must be the outcome of this harnessing of the newest technology. But these integrated electronic control systems will not appear overnight, not at any rate in popular family cars.

In the meanwhile, as he awaits delivery of his new Aston Martin Lagonda—that brilliant example of automobile engineering which appears to epitomise the ultimate in the use of built-in electronic systems—the electronics enthusiast has a number of immediate remedies open to him for improving the efficiency and safety of his present vehicle, in addition to this month's motoring project. Like the P.E. Scorpio Ignition System, for example.

WIN A MICROPROCESSOR

From any flights of fancy the name Lagonda may have evoked, we come right down to earth again and invite readers to think about microprocessors, instead. Recall all you have read and heard about these miniature packages of high computing power and then study the points mentioned in this month's thought stimulating competition. A microprocessor could be well within your grasp. That's a fact.

Three complete SC/MP Introkits with Keyboards, plus 25 CPU chips—these are the attractive prizes kindly donated by National Semiconductor (UK) Ltd and A. Marshall (London) Ltd. Thus manufacturer, distributor and P.E. join forces to swing the spotlight onto Microprocessors For The Constructor in this very practical way. Worth thinking about, yes indeed.

F.E.B.

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Low Cost RADIO CONTROL SYSTEM

By G.D. SOUTHERN

Part 1 - CODER

THE requirement was for a simple low cost radio control system for a model boat. Something offering a greater area of control than a single channel system was needed, without the complexity of an expensive proportional system. A multi-channel tone system was considered but for total reliability needs had to be excluded.

The outcome was a companion coder/decoder which can be used with most transmitter/receivers.

The system is basically a four channel one but modifications are offered to extend the facility.

Standard TTL logic techniques are used to maintain the intention for high reliability at low cost.

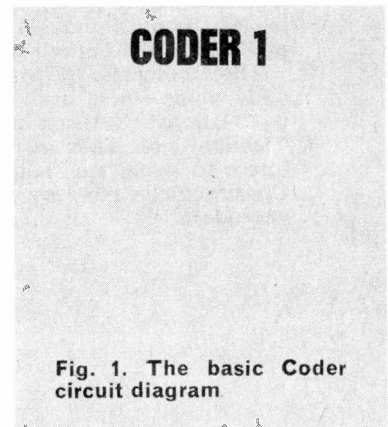
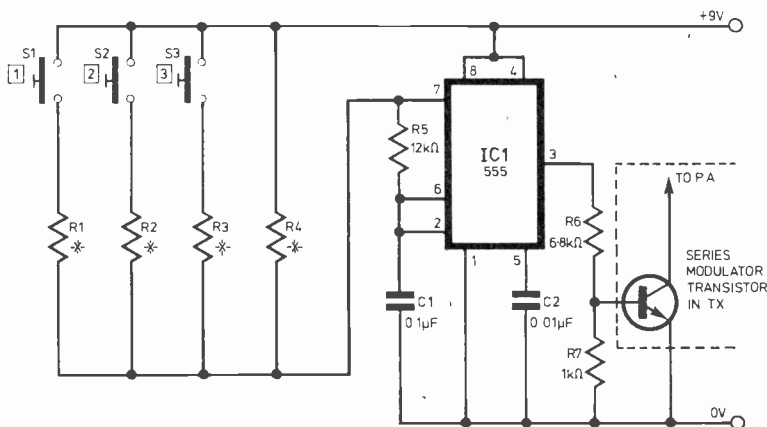
This month the alternatives of coder will be described. Next month the decoder circuitry will be given with setting up details for the system.

CODER DESCRIPTION

The coder circuit in its prototype form is shown in Fig. 1. Capacitor C1 charges through a selected resistor network from the positive supply line and discharges through resistor R5 via an internal transistor in the .555 integrated circuit. By varying these resistors, the astable duty cycle and frequency can be varied (see Tables).

This coder (Coder 1) can generate four tone frequencies. In order to radiate a continuous tone to trigger the fifth channel (O/P5) of the decoder, the circuit is arranged to oscillate at a low frequency when the three push-buttons are released (channel 4).

In this system only a single command operation can be carried out at a time. However, decoder O/P5



is arranged so that whenever the transmitter is modulated the model boat motor will run. This is unaffected by the frequency of modulation so long as the frequency is within the overall bandwidth of the system.

The advantage of this is that with transmitter/receiver failure or the model running out of range the motor will stop.

Resistor R4 is chosen so that the oscillator functions within the passband of the fourth channel (O/P4) of the decoder. The frequency range involved in this case is 150–317Hz and the value of the resistor is so chosen to provide a frequency of 215Hz at 9 volts. Although this means that one of the decoder channels cannot be used, it simplifies the design of the coder.

To increase the frequency of the coder for the other channels resistor R4 has to be shunted by a resistor of lower value. By pressing one of the push buttons 1, 2 or 3, channels 1, 2 or 3 of the decoder can be triggered. But as each respective tone frequency is within the overall bandwidth of the system, channel 5 output will remain high as long as the circuit is oscillating.

Coder 1 channel frequencies are shown in Table 1 together with fundamental changes expected for 6V supply lines.

Table 2 shows similar information for the modified Coder 2 which has a greater control facility.

It should be noted that the values of the charging resistors are for the prototype coders and will vary with different units. However, instructions for the selection of these, in conjunction with the decoder, will be given next month.

MODIFICATIONS

The circuit for Coder 2 is shown in Fig. 2. The circuit of Coder 1 has been modified by the addition of a transistor TR1 and five diodes D1–D5. This modification enables the coder to oscillate at frequency slightly higher than the top limit of channel 1 (631Hz) and so allows channel 4 to be fully utilised for control purposes.

When all the push-buttons are released transistor TR1 will be saturated, because the base-emitter junction will be forward biased by the current flowing through resistor R7 and diode D5. Capacitor C1

Table 1

Frequency (Hz)		Decoder Passband (Hz)	Decoder O/P	Charging Resistor
V _{CC} = 9V	V _{CC} = 6V			
591	598	478–631	1	R1 = 5.6k Ω
433	437	381–478	2	R2 = 22k Ω
338	342	317–381	3	R3 = 43k Ω
215	216	150–317	4	R4 = 56k Ω

Note that if one of buttons 1, 2 or 3 is pressed either resistor R1, R2 or R3 is connected in parallel with resistor R4

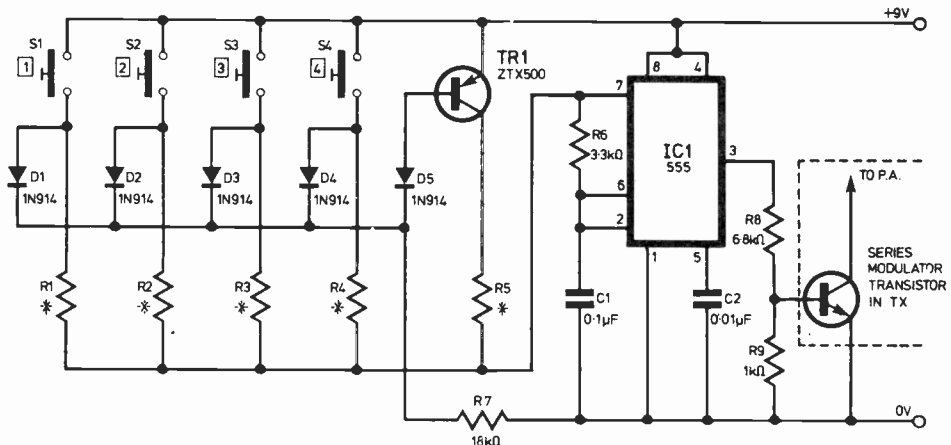
Table 2

Frequency (Hz)		Decoder Passband (Hz)	Decoder O/P	Charging Resistor
V _{CC} = 9V	V _{CC} = 6V			
718	724		5	15k Ω
547	551	478–631	1	22k Ω
423	435	381–478	2	22k Ω + 8.2k Ω
340	349	317–381	3	39k Ω
294	292	150–317	4	47k Ω

Note that the resistor values quoted in the above tables apply to the prototype units only and will require adjustment

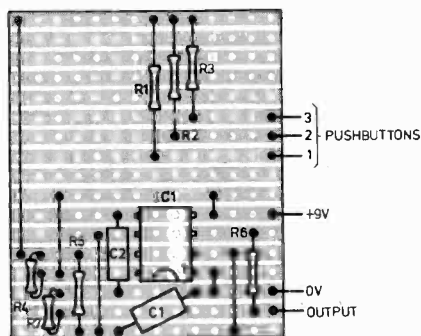
CODER 2

Fig. 2. Modified Coder circuit diagram allowing full control facilities on channel 4



can charge via resistors R6, R5 and the collector-emitter junction of transistor TR1. Resistor R5 is chosen so that the circuit oscillates at a frequency above 631Hz.

CODER 1



CODER 2

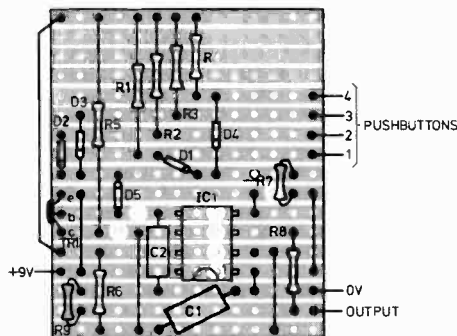


Fig. 3. Component layouts and Veroboard cutting details for Coder 1 and 2

COMPONENTS ...

CODER 1

Resistors

- R1*–R4* see text
- R5 12k Ω
- R6 6.8k Ω
- R7 1k Ω
- All $\frac{1}{4}$ W high stab.

Capacitors

- C1 0.1 μ F 250V polyester
- C2 0.01 μ F 250V polyester

Semiconductors

- IC1 555

CODER 2

Resistors

- R1*–R5* see text
- R6 3.3k Ω
- R7 18k Ω
- R8 6.8k Ω
- R9 1k Ω
- All $\frac{1}{4}$ W high stab.

Capacitors

- C1 0.1 μ F 250V polyester
- C2 0.01 μ F 250V polyester

Semiconductors

- D1–D5 1N914 (5 off)
- TR1 ZTX500
- IC1 555

When button 4 is depressed, transistor TR1 is cut off because the voltage dropped across diode D4 is less than the voltage across diode D5 and the base-emitter junction of TR1. This means the current will flow through R7 from the negative line via diode D4 and push-button 4 to the positive line.

As transistor TR1 is now cut off capacitor C1 will charge via resistors R6, R4 and push-button 4, but will of course still discharge via resistor R6 and the internal discharge transistor in the integrated circuit. Thus the frequency of oscillation is now governed by the value of resistor R4 and not by the value of two resistors in parallel as was the case with Coder 1.

When button 4 is released transistor TR1 will again saturate, bringing resistor R5 again into the charging circuit. The switching speed of TR1 can be neglected at the frequency the circuit works at. Push-buttons 1, 2 and 3 work in a similar manner to push-button 4.

TRANSMITTER MATCHING

Most radio control transmitters employ a modulation transistor in series with the power amplifier (P.A.) stage. The coder circuit is easily coupled to this type of circuit, and all that is required are two resistors.

These ensure that the modulation transistor is fully saturated when the output of the 555 is high and cut-off when the output is low. This will maintain clean modulation of the P.A. stage.

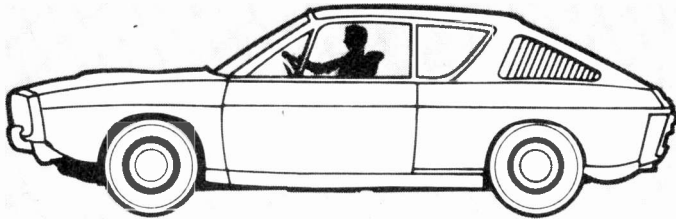
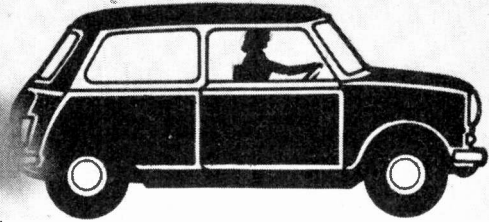
CONSTRUCTION

The coder units are constructed on 0.1in single-sided Veroboard. The layout is not critical and as can be seen from the board drawings, the completed unit can be assembled on a small piece of board (Fig. 3).

Care should be taken when cutting the copper strips as small slivers of copper could be left on the board, thus shorting out the section.

Next Month: The decoder will be described together with final adjustments.

CAR EXHAUST



MONITOR

By E. BALL MSc & R. A. CRANE PhD

IN these days of soaring fuel costs it is of vital importance to motorists to make the most of every gallon of petrol used by their cars. The Exhaust Monitor described here enables motorists to see while they are actually driving, the efficiency of the burning process and therefore adjust their driving habits to those which most efficiently burn the fuel. The design can also be used to indicate the condition of the spark plugs, points and the condenser as the efficient burning of fuel depends on these components and any inefficiency is easily detected by the Monitor.

The use of the Monitor may be favourably compared with the inlet manifold vacuum indicators which have enjoyed popularity from time to time. The vacuum gauge uses the inlet manifold depression to indicate conditions which lead to poor burning of the fuel. The Exhaust Monitor, however, is more direct in operation as it actually measures the concentration of unburnt gas and partial combustion products in the exhaust system.

TRANSDUCER HEART

The heart of the unit is a combustible gas detector transducer type TGS308 which is mounted in an add on tube at the rear end of the exhaust system. The transducer has already been fully described in this magazine in the July and September 1973 issues.

In brief the device contains two heaters and a semiconductor resistance element. When at the normal operating temperature the resistance of this element varies with the percentage of combustible gas at the element surface.

In this design only one of the heaters is used, the other being kept as a spare in case of damage.

The exhaust gas is taken from the main exhaust stream by the gas collecting tube and diluted with air in the mixing tube. This mixing is performed in the same fashion as the bunsen burner or gas cooker. The diluted gas is then tested by the gas detector.

METER SCALING

The electronics used to supply the heater and convert the change in element resistance into a signal to drive a dashboard mounted meter are contained in a small box mounted at some convenient point in the car.

The meter scale is not calibrated directly in terms of parts per million combustible gas for two reasons. First, there is a mixture of combustible gases present (petrol, carbon monoxide, alcohol) and the sensitivity of the transducer is different for each gas. Secondly, of course, the amateur constructor has no access to complex test equipment necessary to set up precisely known gas concentrations.

For these reasons the scale is left uncalibrated and arbitrarily marked as "Good" and "Bad". These bands can then be coloured green and red.

CIRCUIT

The circuit is shown in Fig. 1. It is powered from the car 12V electrical system and will work with either positive or negative earth vehicles as all the components are electrically insulated from the mounting box and car chassis.



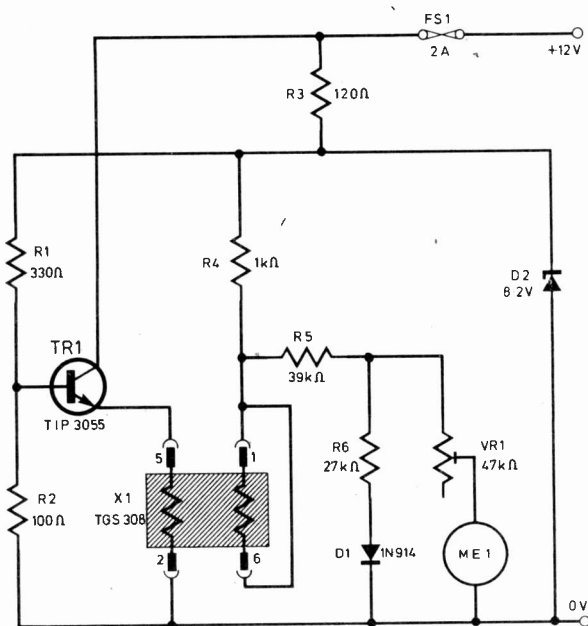


Fig. 1. Circuit of Monitor

COMPONENTS . . .

Resistors

R1	330Ω	R3	120Ω 1W	R5	39kΩ
R2	100Ω	R4	1kΩ	R6	27kΩ

All resistors ± 10 per cent $\frac{1}{4}$ W except R3.

Potentiometer

VR1 47k skeleton preset

Semiconductors

TR1 TIP3055 (with insulating kit)
 D1 1N914
 D2 8.2V ± 5 per cent 1W Zener diode

Miscellaneous

18 gauge aluminium box with lid;
 X1 TGS308 combustible gas detector;
 ME1 100 μ A 2in meter; FS1 2A fuse;
 Veroboard (0.1in matrix); B7G valve base;
 1 Jubilee clip to suit exhaust pipe

The resistor R3 and the Zener diode D2 are used to derive an 8.2V reference supply, which stabilises the instrument against the variations in battery voltage usually encountered. The transducer heater supply voltage, 1.2V on pin 5, is derived from this 8.2V reference via R1, R2 and TR1. The current is approximately 0.5A so the power dissipated in TR1 is $(12-1.2) 0.5 = 5.4$ W.

Under conditions of high battery voltage this could be higher, up to 8W at 17V so TR1 must have adequate heatsinking arrangements. In the prototype TR1 was mounted on the metal case containing the electronics (using a mica insulating washer).

If the case is clamped in close thermal contact with a car body member this will further aid the heatsinking arrangements but is not absolutely essential.

INTERPRETING THE METER

The drive to the transducer resistance element is from the 8.2V stabilised supply through the resistor R4. The voltage developed across the element is a

function of the combustible gas concentration at the element surface and this voltage is applied to the 100 μ A indicating meter via a non-linear shaping circuit comprising R5, R6, D1 and VR1.

These are used to make the best use of the meter scale with the concentrations of gas present in the exhaust system. With no combustible gas present in the exhaust system, that is with the car engine stopped, the voltage dropped across the resistance element is a maximum and VR1 is used to set the reading on the meter to the maximum point on its scale. This corresponds to perfect combustion of the fuel and thus the right half of the scale of the meter is labelled "Good" and the left half "Bad".

CONSTRUCTION

The unit is built in three parts: tailpipe unit, electronics and meter. The exhaust tailpipe unit is mounted on the end of the exhaust pipe and holds the gas sensor. This is connected with a three core mains cable to the electronics unit mounted at some interior convenient point and fixed if possible in close thermal contact with a body member or panel.

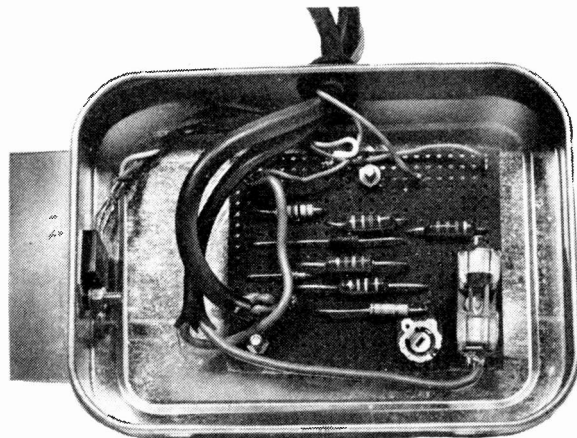
Finally the dashboard mounted meter is connected to the electronics unit with a two core cable.

ASSEMBLY

Details of the exhaust tailpipe unit are shown in Fig. 2. The transducer is plugged into a B7G valve socket which is screwed to an aluminium or steel mounting bracket with self tapping screws. The tube should be just larger than the diameter of the exhaust pipe and is clamped onto the end of the pipe using a Jubilee clip. The author's car was an Avenger 1300 estate and a 50.8mm tube was found satisfactory.

Although this size would be satisfactory for a number of other cars there are a large variety of possible exhaust sizes and the reader is advised to check before proceeding. It is possible that if difficulty is experienced in getting a suitable tube that one of the popular chromed extension tailpipes could be obtained from a car accessory shop.

The gas collecting tube is 6.35mm diameter non ferrous metal bent as shown. The end of this tube is flattened and a 2mm jet hole drilled in a flattened portion. The mixing tube is again non ferrous metal this time of 12.5mm diameter drilled with 4×2 mm



CAR EXHAUST MONITOR

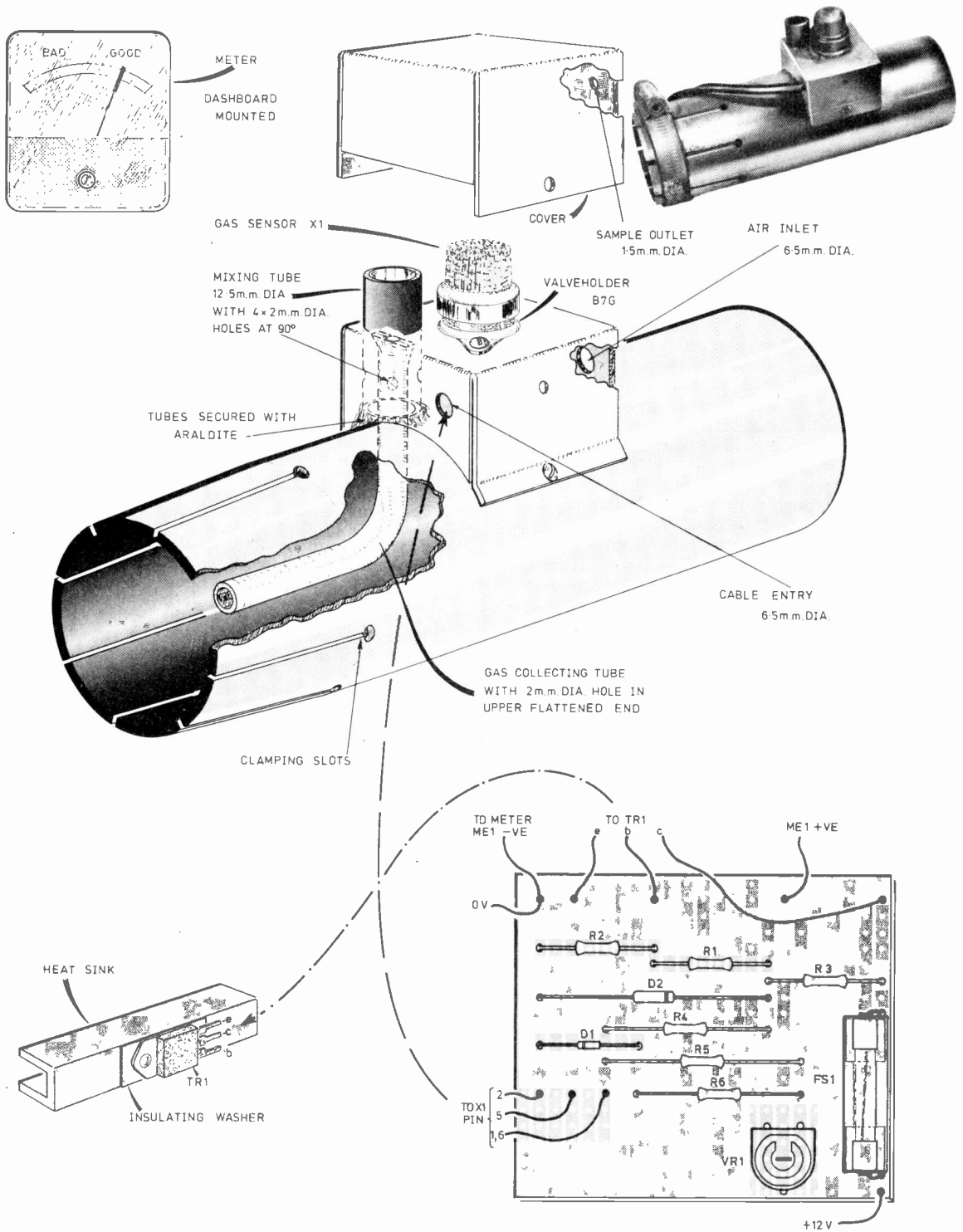
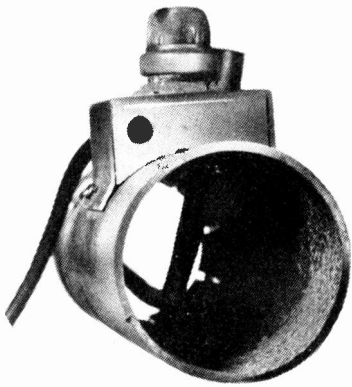


Fig. 2. The Monitor assembly consists of meter, tailpipe unit and electronics



air holes every 90 degrees as shown. These two tubes are fixed to the tailpipe extension with Araldite epoxy resin in the positions indicated.

When fixed the sensor mounting chassis complete with the valve holder is slotted over the mixing tube and held in place with self tapping screws. Finally the transducer is plugged in and the cover fitted. The case used to contain the electronics unit should be about 102 × 76 × 25mm with a lid and should preferably be made of aluminium because of its superior thermal conduction properties. TR1 is fixed to the inside of this using an insulating mica washer.

The other components are mounted on Veroboard as shown and fixed inside the case using three spacers and 6BA fixings.

The meter can be mounted on a simple bracket which is then fixed to the car dashboard. Different brackets of course may be used to suit individual tastes and requirements.

When installing the unit into the car it is important that any wiring should not come into contact with the exhaust system and careful routing of the cables is necessary, particularly the supply cable if it is taken underneath the car and via the engine compartment.

Long term testing of the unit has revealed that the aluminium parts corrode slightly and deposits of carbon and other combustibles form in the tail pipe extension and in the chamber above the mixing tube. These deposits should be removed if they build up. The period of time for the deposits to accumulate will depend very much upon the condition of the engine, whether it is in tune or burning excessive oil. However, periodic maintenance every 3 months or 3,000 miles should suffice for the average motorist.

THE GAUGE IN USE

After switching on the gas sensor requires several minutes to warm up to maximum sensitivity but nevertheless still gives useful indications during this period, easily detecting whether the choke has been left out. When both the engine and unit are warmed up, however, the needle can be moved between "Bad" and "Good" by the style of driving.

Using the engine as a brake for example produces efficient combustion and therefore a "Good" reading. On the other hand rapid depression of the accelerator pedal produces an over rich mixture and this sends the needle well into the "Bad" region. Between these extremes we have found other interesting observations, e.g. letting the car labour up hills in top gear produces less efficient combustion than changing down a gear. ★



BOOK REVIEWS

ELECTRONICS ENGINEER'S REFERENCE BOOK

(Fourth Edition)

Ed. by L. W. Turner

Published by Newnes-Butterworth

1,420 pages, 220mm × 140mm. Price £25.00

AUTOMATIC TESTING SYSTEMS and APPLICATIONS

By R. Knowles

Published by McGraw-Hill

246 pages. Price £6.30

WE all need to keep up-to-date in our knowledge, but production costs of print and paper are still soaring. According to the Publishers Association the cost of text books has risen 17 per cent in the past year and the average price now works out at £1.52 per 100 pages. It is in this context that one needs to examine the "Electronics Engineer's Reference Book" published by Newnes-Butterworth with a cover price of £25. It sounds an awful lot of cash for one binding but some of the 27 sections are complete books in themselves: that on Telecommunications, for example, having 231 pages and Solid State Devices having 123 pages. Altogether there are 63 authors, all specialists, who have contributed and the complete work has been ably edited by Leslie W. Turner, now a consultant engineer but well known for many years during his time as Head of Engineering Information with the BBC.

The last edition came out in 1967 so there was plenty of scope for an up-dated edition and this, the fourth edition, has been completely re-written. The cut-off point for editorial copy was clearly some time in 1975. Nonetheless the book is as nearly up-to-date as can be reasonably expected and includes new techniques like laser communications and plasma and liquid crystal displays but stops short of microprocessors.

The first 14 sections deal with theory, materials and circuits, the remaining 13 on applications. There are over 1,400 pages, hundreds of diagrams, tables and illustrations and comprehensive references for further reading. All in all a handsome and useful volume for both the newcomer and the old-timer who still needs to keep abreast of new developments. Nearly all the authors are industry men writing for industry as well as for students.

The fast-growing automatic test industry is dealt with in "Automatic Testing, Systems and Applications". This is a book for industry with sections on economic benefits and systems management as well as theory and practice covered in its 246 pages.

But I only realised what good value such books are when I saw "Freshwater": A comedy by Virginia Woolf with a cover price of £3.00 for its slender 75 pages.

NEXUS

SOLID STATE NOVELTY PROJECTS

By M. H. Babani

Published by Bernards (Publishers) Ltd

92 pages, 180 × 108mm. Price 85p

A COLLECTION of ten circuits for the electronics enthusiast, covering games, musical instruments, lighting controls, even a mosquito repeller! Most of the material has appeared previously in *Electronics Australia*.

G.C.A.



BY FRANK W. HYDE

SECOND YEAR

In completing its second year in orbit, *Ariel V* has doubled its planned life of operation. Some degradation with time has been observed but this has not detracted from the value of the real scientific performance. An interesting point that has arisen here, is that as the various subsystems are affected by age the operations control centre at the Appleton Laboratory have become more flexible in order to adjust quickly to changing conditions. This has brought a certain swift sophistication and perhaps a more close relationship between the satellite and the human interface.

The satellite gas supplies should last, in the case of the pointing of the spin axis, for a third year. After that the individual pointing for observation will cease and an all sky survey continued. Gas has been conserved beyond the design period because of the aptitude the operators have developed over time, and also the modifications that have been made to computer software to take into account the irregular changes in gas pressure.

MANOEUVRES

The gas manoeuvres are restricted to times when the jet manifolds are warmer than the central propane tank to avoid the possibility of liquid propane passing through the valves. As this depends upon the time of day and the attitude of the spacecraft to the Sun, operational schedules are affected and also the scientific programme is restricted by prohibiting the viewing of certain sources at a given time of year.

There is an on-board magnetorquer which has been used regularly to minimise the attitude drift rate of the spin axis. This can also be used to a limited extent to control the manoeuvres and also to conserve the gas supply.

The battery charging cycle takes power from the solar cells during the 60 minutes that the satellite is in sunlight and then supplies the power needed during the 35 minutes of darkness. This is also expected to carry on during the third year. During the two years of operation all systems have performed satisfactorily using all modes of the design.

The attitude measurements have made use of the back-up sensor system to allow for partial failure of the primary system. It has also been possible to refine the accuracy of some of the measurements by using the positions of known X-ray sources. In order to optimise calculations of spacecraft attitude, data obtained since launch have been used as a basis for making changes in the computer software.

OBSERVATIONS

Normally, the satellite is either pointed at a different source at the beginning of each day, or otherwise adjusted to a new position from which to take further observations of the same source as on the previous day. A complete sequence of observations on a source will usually take between two days and perhaps three weeks.

Since launch, the pointing axis has been scanned completely around the plane of the Milky Way once, and twice more through the region of the Milky Way in the direction of the centre of the Galaxy as this part of the sky is particularly rich in X-ray sources. In addition, the spin axis has been pointed at a large number of individual sources, many of them believed to be external galaxies.

Finally, there have been three extended periods, from 10 to 26 days each in duration, when the spin axis has been so pointed that the Sky Survey Experiment can monitor the behaviour of the Milky Way sources.

EXPERIMENTS

All of the experiments have produced outstanding results. However, one of the striking features of *Ariel V* has been the way in which the different experiments have complemented one another to produce results unrivalled elsewhere. On five occasions since launch, results from

several experiments have been simultaneously published in "Nature" magazine, all dealing with different observations of the same object.

The outstanding observations of this character are those of the transient X-ray sources. These turn on rapidly and within a few days reach a peak of brightness. They then decay over a few hours, days or weeks.

X-RAY SOURCES

One of these transients (A0620-00), first observed by the Sky Survey Experiment in August 1975, became for six weeks the brightest X-ray source in the sky. Only four transients had been detected prior to the launch of *Ariel V*, and observations of these were sketchy, but *Ariel V* has observed no less than 14.

Two further transients (A1118-61 and A0535+26) were found by the Mullard Space Science Laboratory and Birmingham to be modulated with periods of 6.75min and 1.73min respectively. This caused considerable excitement, because those modulated X-ray sources which had previously been found, varied either with periods of hours, the modulation arising from the orbital motion of the X-ray star about an ordinary star, or seconds, the modulation then arising from a spinning neutron star. A periodicity of minutes might arise alternatively from an extraordinarily close pair of orbiting stars, or from a very slow rotator.

For some months the explanation was uncertain; then it became clear that a slowly rotating neutron star was involved. Subsequently, with their experiment on the Copernicus satellite, MSSL found no less than six slow rotators amongst the ordinary X-ray sources.

INTERCOSMOS 16

A combined effort in instrumentation was undertaken by Russia and Sweden in the form of an ultra-violet spectrometer-polarimeter. With this instrument it became possible to make measurements of the polarisation of ultra-violet radiation coming from the solar atmosphere.

The instrument was coupled with a small telescope with a focal length of 100mm. It has a mirror device which enables the unit to register the direction of the radiation from spectral regions not accessible to ground based observatories. Simultaneous observations of the solar conditions were made from a tower solar telescope at the Crimean Observatory.

MEMORIES

A TWO-PART ARTICLE BY A. BRIAR

INTRODUCTION

Due to the ever increasing demand for faster speeds and further miniaturisation in computers, the integrated circuit memory came into existence. This device has been with us for many years now and new developments are occurring almost daily; the subject has become so diverse and complex that it is a specialist field in its own right. But in an area that is growing at such a rate, especially since the advent of microprocessors, the time is perhaps ripe to stand back and take stock of some of the achievements and discoveries to date and to differentiate between the categories and specific devices currently available. Also, around this subject has grown a whole new crop of abbreviations which tend to be confusing to the newcomer but which, it is hoped, will be adequately explained in this article.

THIS article is intended to simplify the whole subject of binary storage memories, and by starting from the basic magnetic core store it will cover the developments with integrated circuit memories to date and show how the whole field has expanded. The article has been aimed at the reader with little or no knowledge of this subject but who it is hoped will, after reading it, possess a more than working appreciation of the modern memory systems available and their applications. It should also provide a useful "recap" for others, particularly in view of the developing interest in microprocessors.

WHAT IS A MEMORY?

For the purpose of this article a rather simple definition can be offered:

Any device that can hold information, in whatever form, such that the information can be retrieved again can be called a *memory*.

Within this definition it is apparent that examples of memories are numerous and even include such devices as cassette tapes and gramophone records. Also, the simple bistable circuit can be considered as a form of memory and this device is perhaps the cornerstone of the modern memory system.

Since cassette tapes and gramophone records are mechanically driven systems they must, by their inherent speed limitations, be unsuitable for the fast access times required by modern computers. To be of use to these machines, stored information must be available in nanoseconds and mechanical devices (which have other advantages) are used as backing stores where access speeds are less important and where interchangeability is desirable.

The only way that fast access speeds to the memories can be achieved is by electronic methods. Until only a few years ago all computer memories

relied on magnetic core stores, but with the advent of highly sophisticated integrated circuit memories these former devices are rapidly being replaced.

BINARY STORES

A computer stores the information in binary form, that is, each digit of information is stored in one of two stable states. There are two types of memory capable of storing the information in this form:

1. The READ ONLY MEMORY (ROM). With this memory the information has been previously stored (or programmed) and cannot be modified (that is to say that new information cannot be written into it).

However, the information can be recalled at will without destroying the contents of the memory and also, the electric power to the device can be removed without any effect on the information stored such that when the power is restored the information is again readily available.

Because of this latter characteristic the device is said to be NON VOLATILE.

2. The RANDOM ACCESS MEMORY (RAM). This type of memory can be written in to and read out from. It is the most widely used type since information can be stored, updated, modified or recalled at any time.

However, the device cannot be physically removed from its circuit nor can it sustain a total power failure without losing the information stored within it.

Because of this aspect the memory is said to be VOLATILE. (Although there are some RAMs which can sustain a partial shut down of the power, but these devices operate normally on at least two separate voltage levels).

Later in this article a closer look will be taken at both of these types of memory, but it is important at this stage to realise the fundamental differences between them.

HOW INFORMATION IS STORED

As mentioned in a previous section, until only a few years ago computers used magnetic core storage for the fast access memory within their central processor unit (CPU)—the heart or brain of the machine. Core stores rely on the principle of magnetism to hold the information and the results, although satisfactory, were very expensive to achieve.

We will now look at the principles behind magnetic cores and at the various types of integrated circuit memories that replaced them.

MAGNETIC CORE STORAGE TECHNIQUES

One of the characteristics of ferrous materials is that they can be magnetised; using this ability information can be stored within a piece of ferrous material.

Consider a small torroid made from magnetic material through which a loop of wire is passed (see Fig. 1). If a current is now passed through this

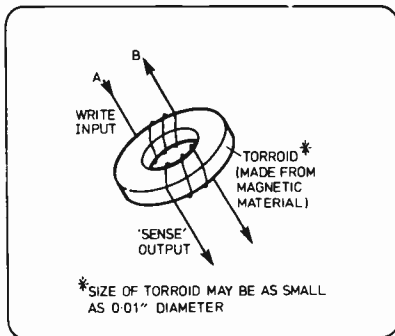


Fig. 1. Example of magnetic core store using a torroid

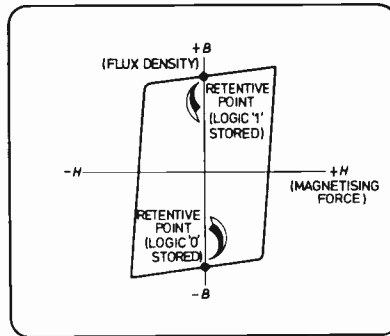


Fig. 2. Hysteresis curve for a magnetic core store

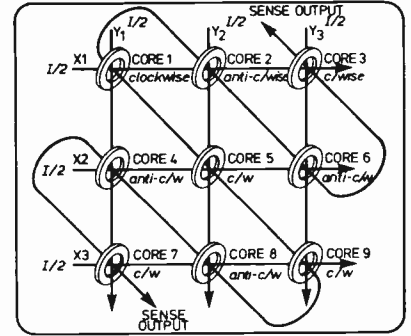


Fig. 3. Two plane ferrite core matrix array

wire in the direction A-B, then the torroid will be magnetised by the inductive effect and, since the current is in one direction only, the torroid (or core) will be magnetised in only one direction until it becomes saturated, i.e. any increase in the current in the wire will not cause any further increase in magnetism.

When the current is removed the core retains its magnetism, the amount remaining dependent upon the actual material of the torroid. The material chosen for this type of torroid is one that gives an almost square hysteresis response and a hysteresis loop for the material can be seen in Fig. 2.

The remaining magnetism corresponds to the amount of flux density held at the Retentive Point which is the point to which the core falls back to upon removal of the current (the current corresponding to the magnetising force).

Now, if a current is passed in the opposite direction, then a negative magnetising force is applied and the core saturates in the opposite direction.

When this current is removed the core falls back to the retentive point in the negative sense. Since there are two stable states for the core to take up, a convention can now be assumed of positive magnetism being logical "1" and negative magnetism being logical "0".

DISTURBANCE

Having stored the information in the core, a method must be found of detecting what has been stored. By resetting the core always to the "0" state the resulting large or small change in the magnetic state of the core can be found; this change in magnetism upon resetting is called disturbance.

If a large disturbance is detected then the core had previously stored a "1"; conversely, a small disturbance indicates a "0". Note that even though the core was already in the "0" state there will still be some disturbance due to the hysteresis loop not being exactly square, and thus there will be a very small change in flux density as the core saturates with the resetting pulse.

The disturbance is detected on the sense winding which also runs through the core and a separate sense amplifier detects this disturbance pulse not by

responding to changes in amplitude but by determining the width of the pulse, i.e. time taken to reset the core to "0". If the core had been in the "1" state then the time taken to reset to the "0" state will be very much longer than if the core had already been in the "0" state.

COINCIDENT CURRENT

Large matrix stores in computers make use of these techniques and millions of identical cores are connected together to make it possible. Use is usually made of the *Coincident Current* method whereby there are two energising windings to each core, neither of which, independently, is enough to saturate the core; but when both currents are present simultaneously then saturation can take place.

This method allows the addressing of one core at a time out of the whole array by use of a grid system such as that in Fig. 3. To energise core "6", currents X3 and Y3 would be required. This system

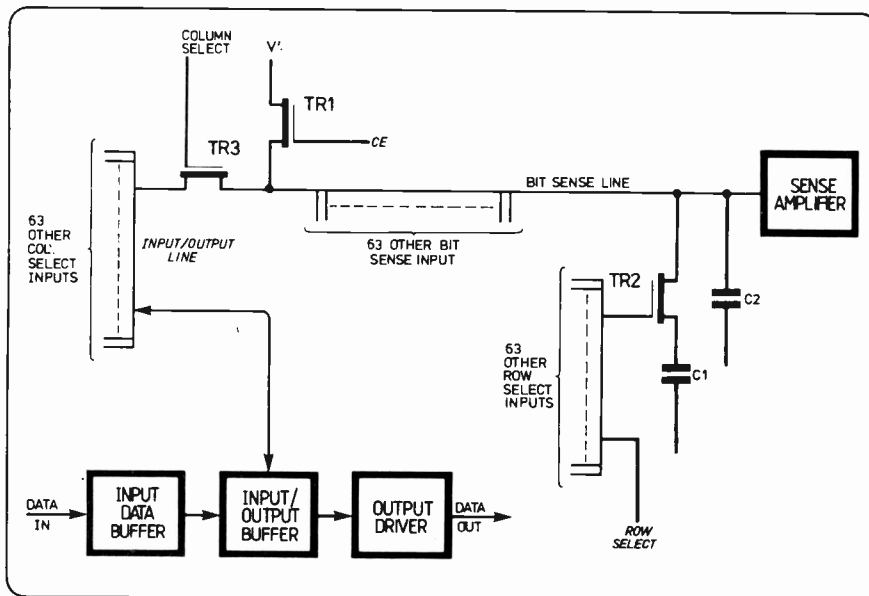


Fig. 4. Simplified memory cell of 2107B device

may be enlarged to three planes by use of a Z winding and this is usually how the large matrix core stores are operated.

The sense winding for the plane is connected as shown going alternately clockwise then anti-clockwise through the cores; the sense amplifier is unaffected by the fact that the disturbance pulses may be in either direction but just detects the duration of any pulse.

This type of storage system is very fast for accessing to any particular core, but since a large amount of the internal wiring of the matrix is done by hand during manufacture the cost per BIT (Binary Digit) of stored information is very high.

CAPACITOR STORAGE TECHNIQUES

Another method of storing information is by storing a charge on a capacitor within an integrated circuit; an example of this type of memory is the 2107B device by Intel. With this device each BIT of information is stored within a memory cell consisting of a single transistor and a storage capacitor as shown in Fig. 4.

Initially the CE signal is present and allows TR1 to conduct which in turn allows capacitor C_2 to charge up to a value approaching V_c . After CE has disappeared the Row and $Column$ inputs are presented and TR2 and TR3 both conduct (TR1 having now cut off). Now, if the storage capacitor C_1 within the memory cell had stored a logical "1" previously then C_2 will very slightly increase its charge via TR2 to a value

$$V_c \left(\frac{C_2}{C_2 - C_1} \right)$$

(the value of C_2 is very much larger than the value of C_1). The sense amplifier connected to the sense line detects this small increase in the charge stored on

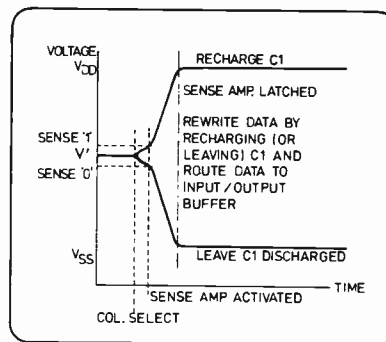


Fig. 5. Bit sense line voltage

C_2 and latches itself and therefore the sense line to the logic high state thereby recharging C_1 via TR2. If the storage cell had previously held a "0", i.e. C_1 is in the discharged state, then the sense line voltage becomes

$$V_c \left(\frac{C_2}{C_2 - C_1} \right)$$

The sense amplifier detects this change and latches itself to the logic "0" state (0V) thereby leaving C_1 in the discharged state.

Fig. 5 shows the latching action of the sense line. Once latched, the sense amplifier also routes the appropriate logic level to the *Input/Output* line via TR3.

If new data is to be read into the memory cell then both *Row* and *Column* addresses must be present and the input presented via the input buffer; this will override any information that is contained within the memory cell and it therefore takes up its new state.

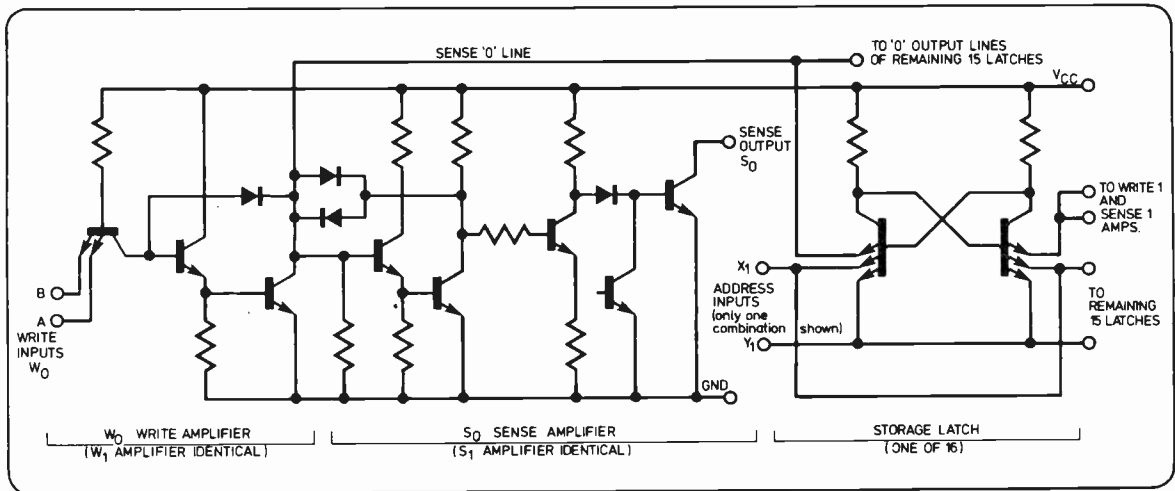


Fig. 6. Transistor latch store (part of SN7484)

LEAKAGE OF CHARGE

Unfortunately, with this type of memory the information contained within the memory cell will gradually disappear due to the leakage of the charge from the storage capacitor; for this reason each memory cell has to be "refreshed" at periodic intervals by enabling the *Row* addresses (only) in sequence. Thus the cells are read and sensed and the sense amplifiers then proceed to "top" them back up again by their latching action.

In most devices of this type (where "refresh" is needed, and called DYNAMIC) the refresh function can be carried out automatically by the device itself, if required; though this may cause problems with the internal circuitry if a refresh cycle is being carried out independently by the device at the same time that a Read or Write demand is received.

To overcome this problem the device can be refreshed at periodic intervals under the control of the external circuitry.

TRANSISTOR LATCH STORAGE TECHNIQUES

The transistor latch storage technique was the most widely used with the advent of TTL technology, and it is the natural successor to the simple bistable latch. Now, however, a large number of these transistor latches have been combined into a single i.c. package to form very large memories.

Each latch will store one BIT of information and an example of such a latch is shown in Fig. 6 where the SN7484 by Texas Instruments has been chosen.

Once again the now familiar *Row* and *Column* inputs are apparent (termed *X* and *Y* respectively here) and these are normally held at logic "0" (0V). The latch itself must have one transistor conducting and the other cut off and the former finds its current path out through the address lines. If the sense of the latch is to be determined then both of the address lines must go high to logic "1" and now the conducting transistor of the latch has to find its current path via either the "0" or "1" sense amplifiers.

Whichever of the sense amplifiers is activated then the output of that amplifier drops to logic "0" and this is presented at the output as inverted data (which fact is unimportant since the information had previously been inverted before being stored). With this type of sensing there is no destruction of the information stored.

If new information is to be written into the latch then it is addressed as before and the information is presented at the write input. If the information to be written in is the same as before then there will be no change to the latch, but if different, then the latch takes up the state of the sense "0" and sense "1" lines by finding a current path through the one which has the logic "0" thereby switching on that transistor and, since there is no current path for the other transistor down the logic "1" line, then that transistor switches off.

This type of memory will retain its information for as long as the power to the i.c. is present and does not need refreshing; it is known as a STATIC type.

RANDOM ACCESS MEMORIES (RAMs)

A very simple summary of the function of RAMs was given in an earlier section and to recap, the RAM can be written into or read out from at will and is the most widely used type of memory. There are two basic types of RAM:

- (1) The DYNAMIC type in which the information needs constantly to be *refreshed* to prevent its loss.
- (2) The STATIC type in which the memory retains its information for as long as the power is present and needs no refreshing.

To understand the reason for these two types it is necessary briefly to touch on the history of their development. Initially the technology which made large and cheap production of integrated circuits a viable proposition was the advent of the TTL range.

The RAMs using TTL technology stored the information in latches (as in the example given in the previous section) but an upper limit was reached in the amount of information that this type of device could contain.

With the demand for even bigger and faster memories to pacify the fast growing computer industry, the MOS technology came forward with the Dynamic RAM where memory sizes could be increased remarkably (a typical capacity of this type of device being 4096 BITS).

Because of the drawbacks of "refresh" characteristic to dynamic memories, research was carried out to find a way of increasing the capacity of static devices and again the MOS field held the answer: at present the memory capacity of MOS static memories is mainly confined to 1024 BITS but the power requirements are simpler than the MOS dynamic types.

It is now also possible to obtain static RAMs in the Schottky bipolar technology and extremely fast speeds may be obtained with these devices; as yet the maximum capacity of these devices is still limited to about 256 BITS.

The major advantage of the integrated circuit RAM is that its cost per BIT is small and the devices are so arranged that they can easily be expanded to form one vast memory incorporating many hundreds of packages. This is ideal for computers and the days of magnetic core stores are now over for new designs.

Next month: Read Only Memories, including PROMs and EPROMs, and Charge Coupled Devices.

POINTS ARISING

SIMPLE TOUCH DIMMER (*Ingenuity Unlimited*
November 1976)

In Fig. 1, the line joining the base of TR1 to the earth rail should be deleted.

Thermal Resistance & Derating of Devices

By C. Rudd

THERMAL resistance is analogous to electrical resistance in that it restricts the flow of heat while electrical resistance restricts the flow of charge as current. In fact, it is found that most of the simple equations relating to the flow of direct current have counterparts in those relating to the flow of heat.

The thermal resistance between two points is defined as the temperature difference between those points divided by the rate of flow of heat from the hotter point to the colder. The units of thermal resistance are therefore kelvin (or degrees Celsius, it makes no difference) per watt. Now, the active part of a semiconductor device will have a maximum permissible temperature (usually called the maximum junction temperature, denoted by $T_{j \text{ max}}$) beyond which damage or incorrect operation will occur. Therefore, the total thermal resistance between the active regions of the device and the surrounding environment (ambient) should be made as small as possible so that as much heat per second as possible can be conducted away.

This total thermal resistance between the junctions of a device and ambient will usually comprise several components. First, there will be a resistance between the

device's junction and its case comprised of several internal components which do not, in general, concern us since we cannot alter them. The total thermal resistance is usually denoted by θ_{jc} , which might be anywhere between three and ten kelvin per watt for a typical power transistor. Secondly, if a heat sink is fitted to the device there will be a "mounting" thermal resistance due to the insulating washers, if any, between the device and the sink and, finally, a thermal resistance between the heat sink and ambient. Generally the mounting and sink thermal resistance are lumped together and denoted by θ_{ca} .



Since all the electrical power dissipated in a device must, ultimately, appear as heat, as much electrical energy as is pumped into the device per second must escape as heat energy once the device's various temperatures have settled down to steady values. Thus it is clear that if θ_{ja} is the total thermal resistance between the device's junctions and ambient, and P is the rate at which power is dissipated in the device (the rate of conversion from electrical energy to heat energy), then the junction temperature must be $\theta_{ja} \cdot P$ above ambient temperature to maintain a sufficient flow of heat energy out of the device. Note the analogy here with the Ohm's law formula; voltage drop equals current times resistance.

Thus if T_a is the ambient temperature

$$T_j = T_a + \theta_{ja} \cdot P$$

Since T_j must never rise above $T_{j \text{ max}}$, the maximum tolerable dissipation must decrease as the ambient temperature rises. This is known as "derating", and the rate of change of a device's maximum power dissipation with ambient temperature is known as its "derating factor".

By rearranging the above equation to give P in terms of T_a , T_j and θ_{ja} and differentiating with respect to T_a , it is easy to show that the derating factor must be minus the reciprocal of the total thermal resistance between junctions and ambient. Therefore, the units of derating factor are watts per kelvin, typical values for power transistors being between 0.33 and 0.1 WK⁻¹. ★

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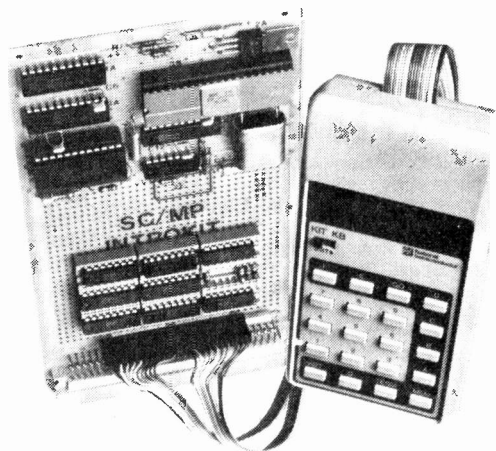
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There is no entry fee, but each entry must be fully completed in ink on the proper printed coupon cut from PRACTICAL ELECTRONICS, and must bear the entrant's own full name and address. Every accepted entry will be examined and the first prizes as described, will be awarded to three entrants who, in the opinion of the expert panel of judges, have shown the most skill and judgement in listing the eight features in order of importance. The other prizes will be awarded to the senders of the 25 next best attempts in order of merit. No entrant may win more than one prize.

In the event of a tie or ties, for any of the prizes, a further eliminating competition will be held, by post, between the tying competitors to determine such winner(s) or winning order.

Any entry which does not comply with the printed instructions or is received after the closing date will be disqualified as will any received mutilated or illegible, incomplete or bearing alterations. No responsibility will be accepted for entries lost or delayed in the post or otherwise.

The judges' decisions, and those of the Editor of PRACTICAL ELECTRONICS in all other matters affecting the competition, will be final and legally binding. No correspondence will be entered into.

The competition is open to all readers in Great Britain, Northern Ireland, the Channel Islands and Isle of Man except employees (and their families) of IPC Magazines Ltd., the printers of PRACTICAL ELECTRONICS, A Marshall (London) Ltd or of National Semiconductor (U.K.) Ltd.

The winners will be notified and the result announced in the earliest possible issue of the magazine.

FREE ENTRY COUPON

Please post to:
PRACTICAL ELECTRONICS MICROPROCESSOR COMPETITION
55 EWER STREET, LONDON, SE99 6YP

My order of importance for the eight features is listed on the right. In entering the competition, I agree to the rules as final and legally binding.

NAME
(Mr./Mrs./Miss)

ADDRESS
(Block letters)

1st	
2nd	
3rd	
4th	
5th	
6th	
7th	
8th	

Closing date for entries Monday, January 24, 1977

CUT ALONG THE LINE

MARKET PLACE

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

CIRCUIT BOARD

A claimed new concept in prototype printed circuit boards has just been launched by **P.B. Electronics**, makers of the well-known S-DeC prototype wiring system. Known as Blob Board, it allows the user to go direct from circuit diagram to completed board.

Component layouts can be drawn direct onto the board, eliminating, it is claimed, many of the errors which can occur in transferring from circuit diagram to ordinary p.c.b.s. The component layout is simply drawn on the board pattern using an ordinary felt pen. The components are then laid over their respective drawings and "blob" soldered in position. Components can be reused and re-soldered making circuit prototype modifications and amendments fairly easy.

Initially, there are 12 different boards available in a wide variety of patterns which, between them, will accommodate most components from discretely to i.c.s.

Addresses of nearest stockists and prices of the Blob Board can be obtained from **P.B. Electronics (Scotland) Ltd. (Dept. P.E.), 57 High Street, Saffron Walden, Essex CB10 1AA.**

SERVICING PROBE

A small and lightweight signal injector probe suitable for radio and TV servicing is the latest product from **Carlo Gavazzi (UK) Ltd.**

Known as the Pantec USIJET, it can be used for fault finding in a.f., i.f., and r.f. amplifier stages, l.w., m.w., s.w., u.s.w., and f.m. wavebands for radio and v.h.f. and u.h.f. channels up to 500MHz for television.

The circuit consists of two signal generators, one at audio and the other at radio frequencies. The impulsive waveform derived from a blocking oscillator-type circuit produces a signal with a wide range of harmonic frequencies up to 500MHz.

By injecting the signal at various points in an amplifier circuit, the probe is an effective dynamic analyser for tracing breaks and component

failure. The fundamental frequencies are 1kHz and 500kHz, with an output voltage of 20V peak-to-peak. Maximum permissible voltage at the probe tip is 500V d.c. Powered by a self-contained 1.5V cell, the current consumption is about 25mA.

Further details and price of the Pantec USIJET can be obtained from **Carlo Gavazzi (UK) Ltd. (Dept. P.E.), North Crawley Road, Newport Pagnell, Bucks., MK16 9HF.**

UPDATED OSCILLOSCOPE

Some four years ago, **Scopex Instruments**, was formed to manufacture and market oscilloscopes. Their first design was the 4D10, a 10MHz dual trace instrument offered at less than £100.

Now, as part of their programme of expansion and updating, Scopex have announced the 4D10A, broadly similar to the 4D10 in appearance and facilities, but incorporating a number of significant improvements.

All power supply lines are now stabilised, producing a rock steady display even with 10 per cent variations in mains voltage. Measurement accuracy is ± 3 per cent for both time and voltage, maintained over the same mains input range. The vertical input attenuators are those designed for the 25MHz bandwidth 4D25, and allow the full 10MHz bandwidth to be achieved even on the 50V/cm range.

Added features in the new instrument are a TV field sync separator and a non-reflective Glarecheq screen filter. The graticule is ruled on the reverse of the latter and is actually in contact with the c.r.t. face, virtually eliminating parallax. The adoption of aluminium for the case has reduced the overall weight by 25 per cent compared with the 4D10.

Price of the 4D10A is £150 excluding VAT. Further details are available from **Scopex Instruments Limited (Dept. P.E.), Pixmore Industrial Estate, Pixmore Avenue, Letchworth, Herts SG6 1JJ.**

RECORD CLEANER

An anti-static device has been incorporated into the Mark 3 version of the Groovac vacuum record cleaner manufactured by **RI Audio**. Not only does the device discharge static on records but also the new cleaner is claimed to be considerably more effective in removing dust, both surface and microdust.

The new device consists of a small carbon fibre brush and a suction cleaning nozzle attached to the arm. The device is "earthed" via electrical connectors inside the arm. Static electricity on the record is discharged by the carbon fibres which track across the record just ahead

of the suction nozzle and pick-up stylus. In addition to eliminating static, the carbon fibre brush also gathers surface dust which would otherwise collect on the suction nozzle hairs and impair tracking.

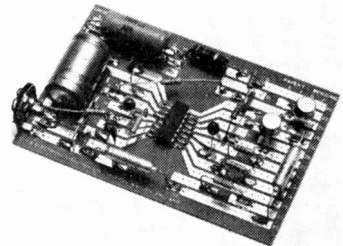
Tracking of the vacuum cleaning nozzle and carbon fibre brush across the record has been improved by replacing the plain bearing with a ball bearing, this also makes it possible to achieve a lower tracking force of 0.5 gram. The bearing housing has been redesigned to include a fluid seal which eliminates air leaks.

Anti-skating force, or bias, is provided by a hair-spring mechanism in place of the inclined face previously employed. The bias force is adjustable with the new design.

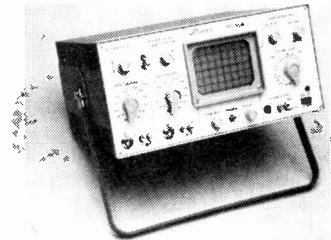
Suction is provided by a pump mounted inside an enclosure for acoustic isolation. In use the pump is suspended by springs to ensure that mechanical vibration is not transmitted to the enclosure.

Further details and price of the Groovac III vacuum record cleaner can be obtained from **RI Audio (Dept. P.E.), Kernick Road, Penryn, Cornwall.**

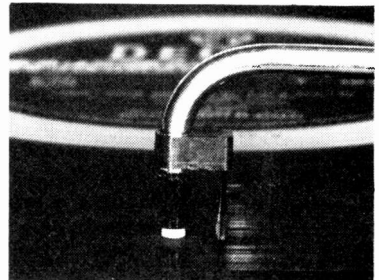
New "Blob" Printed Circuit Board from P.B. Electronics



The 4D10A Oscilloscope from Scopex Instruments

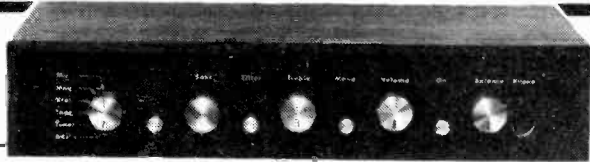


RI Audio Groovac III record cleaner



20x20 Watt STEREO AMPLIFIER

Superb Viscount IV unit in teak-finished cabinet. Black fascia with aluminium rotary controls and pushbuttons, red mains indicator and stereo jack socket. Function switch for mic, magnetic and crystal pick-ups, tape, tuner, and auxiliary. Rear panel features two mains outlets, DIN speaker and input sockets, plus fuse. 20+20 watts rms, 40+40 watts peak



HOW YOU CAN SAVE

SYSTEM 1B

For only £80, you get the 20+20 watt Viscount IV amplifier, a pair of our 12-watt-rms Duo Type IIb matched speakers, a BSR MP 60 type deck complete with magnetic cartridge, de luxe plinth and cover.

£80.00

+ p & p £6.50

Carriage surcharge to Scotland: System 1b £2.50, System 2 £5

SYSTEM 2

Comprising our 20+20 watt Viscount IV amplifier, a pair of our large Duo Type III matching speakers which handle 20 watts rms each, and a BSR MP 60 type deck with magnetic cartridge, de luxe plinth and cover.

£92.00

+ p & p £7.60

£29.90

+ p & p £2.10

SPEAKERS Two models—Duo IIb, teak veneer, 12 watts rms, 24 watts peak, 18 1/2" x 13 1/2" x 7 1/4" approx

£34

+ p & p £6.50

Duo III, 20 watts rms, 40 watts peak, 27" x 13" x 1 1/4" approx

£48

+ p & p £7.50



TURNTABLE Popular BSR MP 60 type, complete with magnetic cartridge, diamond stylus, and de luxe plinth and cover.

£24.00

+ p & p £3.50

VALUE



30x30 AMPLIFIER KIT

Specially designed by RT-VC for the experience constructor, this kit comes complete in every detail. Same facilities as Viscount IV amplifier. Chassis is ready punched, drilled and formed. Cabinet is finished in teak veneer. Black fascia and easy-to-handle aluminium knobs. Output 30+30 watts rms, 60+60 peak.

£29.00

+ p & p £2.10

STEREO CASSETTE DECK KIT

Again, this kit is specially designed for the experienced constructor — for mounting into his own cabinet. Features include solenoid assisted AUTO-STOP, 3-digit counter, record/replay PC board, mains transformer and input and output controls. AC BIAS AND ERASE

DELUXE ACCESSORY KIT

Comprises of a matched pair of dynamic mics, and two replacement slider level controls.

£3.95

+ p & p £1

P & P FREE WHEN PURCHASED TOGETHER



DIY STEREO SYSTEM

COMPLETE WITH SPEAKERS Here's real value in DIY! Comprises ready-built amplifier module, 3-speed Garrard auto-return deck, and teak-veneered simulate cabinets with clear plastic top. Easily built by hobbyists.

£26.95

+ p & p £4.05



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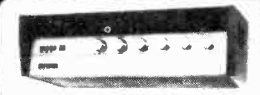
+ p & p £1

TOURIST IV PUSH BUTTON CAR RADIO KIT (Motor Top 10 Award)

Complete with speaker, baffle and fixing strips. The Tourist IV, for the experienced constructor only. The Tourist IV has five push buttons, four medium band and one top long wave band. The tuning scale is nylon mated and attractive spun aluminium control knobs are used for manual tuning and volume control. The modern style fascia has been designed to blend with most car interiors and the finished radio will slot into a standard car radio aperture. Size approx 7" x 2" x 4 1/2". Power Supply: Nominal 12 volts positive or negative earth (altered internally). Power Output: 4 watts into 4 ohms.

£10.50

+ p & p £1.50



35-WATT DISCO AMP

Here's the mono unit you need to start off with. Gives you a good solid 35 watts rms, 70 watts peak output. Big features include two disc inputs, both for ceramic cartridges, tape input and microphone input. Level mixing controls fitted with integral push-pull switches. Independent bass and treble controls and master volume.

£27.50

+ p & p £1.50



PORTABLE DISCO CONSOLE WITH BUILT-IN PRE-AMPLIFIERS

Here's the big-value portable disco console from RT-VC! It features a pair of BSR MP 60 type auto-return, single-play professional series record decks. Plus all the controls and features you need to give fabulous disco performances. Simply connects into your existing slave or external amplifier.

£55.00

+ p & p £6.50

70 and 100 WATT DISCO AMPLIFIERS

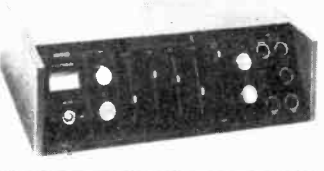
Brilliantly styled for easy disco performance! Slipping fascia, so that you can use the controls without fuss or bother. Brushed aluminium fascia and rotary controls. Five smoothly acting, vertically mounted slide controls — master volume, tape level, mic level, deck level. PLUS INTER-DECK FADER for perfect graduated change from record to deck No. 1 to No. 2 or vice versa. Pre fade level control (PFL) lets YOU hear next disc before fading it in. VU meter monitors output level. 70 watts rms, 140 watts peak output. All the big features as on the 70 watt disco amplifier, but with a massive 100 watts rms, 200 watts peak output power.

£49.00

+ p & p £3.00

£65.00

+ p & p £4.00



EASY-TO-BUILD, WITH ENCLOSURE

Specially designed by RT-VC for cost-conscious hi-fi enthusiasts, these kits incorporate two teak-simulate enclosures, two EMI 13" x 8" (approx.) woofers, two 3 1/4" (approx.) tweeters and a pair of matching crossovers. Easily constructed, using a few basic tools. Supplied complete with an easy-to-follow circuit diagram, and crossover components. Input 15 watts rms, 30 watts peak, each unit. Cabinet size 20" x 11" x 9 1/2" (approx.).

£25.50

+ p & p £5.50

15-WATT KIT IN CHASSIS FORM

When you are looking for a good speaker, why not build your own from this kit. It's the unit which we supply with the above enclosures. Size 13" x 8" (approx.) EMI woofer, 3 1/4" (approx.) tweeter, and matching crossover. Power handling capacity 15 watts rms, 30 watts peak.

£7.50

+ p & p PER SET

DECCA 20 WATTS STEREO SPEAKER

This matching loudspeaker system is hand made as only Decca know how, built to a specification not down to a price. The kit comprises of two 8" diameter approx. bass drive unit, with heavy die cast chassis laminated cones with rolled P.V.C. surrounds. Two 3 1/2" diameter approx. domed tweeters complete with crossover networks.

Our price per stereo pair **£30.00** + £1.00 P & P

DIY SPEAKER KITS

'COMPACT' FOR TOP VALUE

How about this for incredible bookshelf value from RT-VC! A pair of high efficiency units for only £7.50—just what you need for low-power amplifiers. These infinite baffle enclosures come to you ready mitered and professionally finished. Each cabinet measures 12" x 9" x 5" (approx.) deep, and is finished in Rosewood. Complete with two 8" (approx.) speakers for max. power handling of 7 watts.

£7.50

+ p & p £1.70 per pair

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200	0.27*	0.35	0.45	0.40	0.58	0.60	0.68	1.14
400	0.30*	0.40	0.50	0.45	0.87	0.88	0.98	1.40
600	—	0.85	0.70	—	1.09	1.19	1.26	1.80

TRIACS (PLASTIC TO-220 PKG ISOLATED TAB)

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	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
100V	0.60	0.60	0.70	0.70	0.78	0.78	0.83	0.83	1.01	1.01
200V	0.64	0.64	0.75	0.75	0.87	0.87	0.87	0.87	1.17	1.17
400V	0.77	0.80	0.83	0.83	0.97	1.01	1.13	1.19	1.70	1.74
500V	0.96	0.99	0.87	1.01	1.21	1.26	1.42	1.50	2.11	2.17

N.B. Triacs without internal trigger disc are priced under column (a). Triacs with internal trigger disc are priced under column (b). When ordering please indicate clearly the type required.

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AC128	0.13	BC126	0.20*	BC327	0.18*	BDY62	1.15	BU105	1.80*	CRS3-60	0.80	TIP41A	0.88	2N3440	1.56
AC128K	0.25	BC141	0.28	BC328	0.16*	BF178	0.28	BU105/02	1.90*	MJ460	0.80	TIP42A	0.72	2N3442	0.50
AC141	0.18	BC142	0.23	BC337	0.17*	BF179	0.30	BU126	1.60*	MJ481	1.05	IN2070	0.14	2N3525	0.80
AC141K	0.28	BC143	0.23	BC338	0.17*	BF194	0.10*	BU204	1.60*	MJ490	0.90	IN4001	0.04*	2N3702	0.10*
AC142	0.18	BC144	0.30	BCY30	0.55	BF195	0.10*	BU208	2.60*	MJ491	1.15	IN4002	0.05*	2N3703	0.10*
AC142K	0.28	BC147	0.09*	BCY31	0.55	BF196	0.12*	BU209	1.15	MJE340	0.40*	IN4003	0.06*	2N3704	0.10*
AC176	0.16	BC148	0.09*	BCY32	0.60	BF197	0.12*	BY207	0.20*	MJE371	0.60	IN4004	0.07*	2N3705	0.10*
AC176K	0.25	BC149	0.09*	BCY33	0.55	BF224J	0.18*	BYX36		MJE520	0.45	IN4005	0.08*	2N3706	0.10*
AC187	0.18	BC152	0.25*	BCY34	0.55	BF244	0.17*		300.12*	MJE521	0.55	IN4006	0.09*	2N3707	0.10*
AC187K	0.25	BC153	0.18*	BCY38	0.50	BF257	0.30*		600.15*	OA5	0.50*	IN4007	0.10*	2N3714	1.05
AC188	0.18	BC157	0.09*	BCY39	1.15	BF258	0.35		900.18*	OA90	0.08	2N696	0.14	2N3715	1.15
AC188K	0.25	BC158	0.09*	BCY70	0.12	BF307	0.22		1200.021*	OA91	0.08	2N697	0.12	2N3716	1.25
AD140	0.50	BC159	0.09*	BCY71	0.18	BFW60	0.17*	BYX38		OC41	0.15	2N706	0.10	2N3771	1.60
AD142	0.50	BC160	0.32	BCY72	0.12	BFX29	0.26		300.050	OC42	0.15	2N929	0.14	2N3772	1.60
AD143	0.46	BC161	0.38	BD115	0.55	BFX30	0.30		600.055	OC44	0.32	2N930	0.14	2N3773	2.10
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AF111	0.20	BC184	0.11*	BD138	0.48	BFY52	0.19	BZ88 Series		SC40A	0.73	2N1202	0.44	2N4348	0.10
AF115	0.20	BC184L	0.11*	BD139	0.58	BFY64	0.35	Zeners	0.11	SC40B	0.81	2N2369	0.14	2N4870	0.35*
AF116	0.20	SC207B	0.12*	BD181	0.88	BFY90	0.65	CI06A	0.40	SC40D	0.98	2N268A	0.14	2N4871	0.35*
AF117	0.20	BC212	0.11*	BD182	0.92	BFY90	0.65	CI06B	0.45	SC40E	0.65	2N269A	0.16	2N4819	0.70*
AF118	0.50	BC212L	0.11*	BD183	0.97	BFY99	0.40	CI06C	0.45	SC41A	0.65	2N2646	0.50	2N4920	0.50*
AF129	0.35	BC213	0.12*	BD232	0.60*	BSX19	0.16	CI06F	0.35	SC41B	0.70	2N2905	0.18	2N4922	0.58*
AF239	0.37	BC213L	0.12*	BD233	0.48*	BSX20	0.18	CI06S	0.25	SC41D	0.85	2N2905A	0.22	2N4923	0.46*
BC107	0.09	BC214	0.14*	BD237	0.55*	BSX21	0.20	CRS110	0.25	SC41F	0.60	2N2926B	0.10*	2N5060	0.20*
BC107B	0.09	BC214L	0.14*	BD238	0.60*	BSY95A	0.12	CRS120	0.35	S72	0.20	2N2926A	0.09*	2N5061	0.25*
BC108	0.09	BC237	0.16*	BD104	1.20	BT106	1.90	CRS140	0.40	TIP26A	0.44	2N2927	0.99*	2N5062	0.27*
BC109	0.09	BC238	0.16*	BDV20	0.60	BT107	1.60	CRS160	0.65	TIP30A	0.52	2N2928	0.18*	2N5456	0.65
BC109C	0.12	BC300	0.34	BDY38	0.60	BT108	1.60	CRS3-05	0.34	TIP31A	0.54	2N3053	0.15		

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SEMICONDUCTOR UPDATE

By R.W. COLES

CA3140

LD130

THE SUCCESSOR ?

Every now and again a truly great i.c. is produced which becomes an industry standard against which others are judged. Such an i.c. is the 741, and although a host of "dual 741s", "quad 741s" and, of course, "improved 741s" have appeared in recent years, up to now no-one has dared to say that their new operational amplifier chip will displace the 741 as an industry standard. Sooner or later, of course, a successor worthy of the name will come along, and RCA think they now have the necessary contender in their new **CA3140** Bi MOS operational amplifier, and after studying the data sheet, I must say they could be right.

The 741 is a popular device because it has a good "mix" of characteristics which makes it suitable for 70 per cent of op-amp applications. You can buy devices with a wider bandwidth, or higher input impedance but you generally either have to compromise other characteristics such as supply voltage range, or simply pay a higher price for the goodies you need. A 741 replacement must retain this good "mix" of characteristics while improving as many as possible so as to increase the percentage of op-amp applications it can handle, but, of course, it must also keep a low price tag!

The CA3140 has an MOS input stage which gives it a 1.5 terra-ohm input Z , without sacrificing input offset voltage (2mV max), or ruggedness (protection diodes built in). Slew rate is a creditable 9V/ μ s with full internal compensation to make application easy, and if that's not enough to sway you, perhaps the fact that it will operate on supplies of from 4V to 44V might help!

The CA3140 certainly seems a heavyweight contender, but only we, the users, can decide the eventual outcome of this title fight!

REVOLUTION

Digital voltmeters used to be large, cumbersome, expensive animals that sat on a trolley in the corner of a lab and were talked about in hushed whispers by those fortunate enough to co-exist with them. "Digital voltmeter" was synonymous with "extreme accuracy" and if you were doing anything run of the mill, the DVM

stayed on its trolley and you had to use your Avo with the bent needle as usual!

Integrated circuits spoiled the DVM's hallowed position of the trolley in the corner, and soon, 3½-digit, digital multimeters were as "common-as-muck" and could be seen in the hands of all and sundry. We have now reached the position where even the humble moving coil panel meter is being overtaken by the digital revolution, mainly because the ± 2 per cent accuracy it has traditionally offered can easily be bettered by a digital unit, albeit at a higher cost.

Even the cost advantage of the moving coil meter is fast disappearing, and a new device from Siliconix, the **LD130**, must surely be another nail in its coffin. The LD130 is a low cost CMOS chip which contains nearly all the analogue and digital circuitry required to build a 3-digit, bipolar, digital voltmeter. The chip runs off plus and minus 5V supplies, is t.t.l. compatible, and lives in a tiny 18-pin d.i.p.

The 999 full scale count gives a resolution of 0.1 per cent of course, but the LD130 backs this up with a very creditable 0.1 per cent (plus or minus one count) accuracy, and an automatic zeroing system which used to appear only on the more expensive DVMs. Display outputs are multiplexed and would normally drive a 3-digit, 7-segment, i.e.d. display via an external decoder chip and three digit drive transistors. Thanks to the BCD output format it is also possible to drive all sorts of other displays such as gas-discharge or filament types, or even latch the information in a store for micro-processor interface.

On the analogue side, the high input impedance of the MOS buffer amplifiers makes possible the high accuracy and ensures the need for the minimum of external components, in fact just three capacitors and a voltage reference of about 2V. Best of all though, you don't have to keep it on a trolley in the corner, any convenient pocket will do!

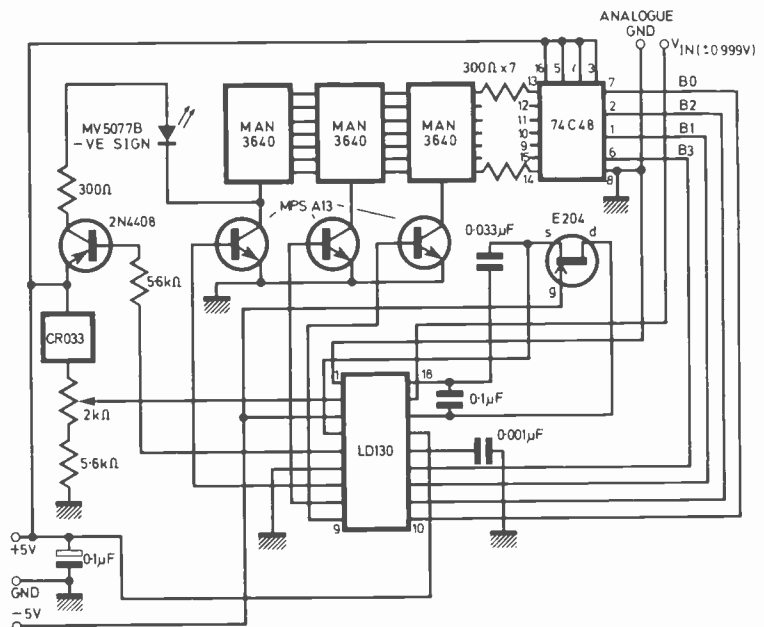
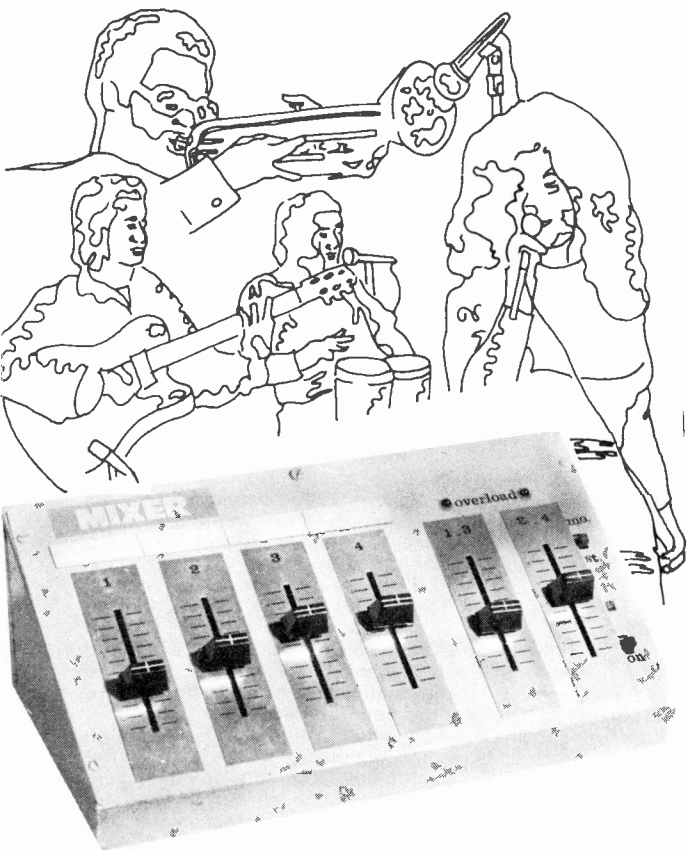


Fig. 1. Circuit diagram for a 3 digit DVM using the LD130. The CR033 is a current regulator diode



MICROPHONE MIXER

By R. S. WILSON B.Sc.

AUDIO mixer designs are part of the bread and butter of electronics magazines so perhaps one should not try to apologise for yet another. However, most designs do not provide for high quality low impedance microphone inputs without resorting to the use of expensive microphone matching transformers.

This design seeks to provide simple transistor matching for such microphones without the need for input transformers, and the result is a low cost but powerful and versatile unit, with many applications for recording enthusiasts, or as a mixer for a sound reinforcement system. The inputs are unbalanced but this will be found to be no disadvantage except in the most difficult recording situations. The full specifications for the mixer are listed in the table.

DESIGN AND FACILITIES

The main design point is the use of a low noise transistor connected as a common-base amplifier, for each input. The characteristics of a transistor in common-base mode are a very low input impedance, the possibility of very high voltage gain, and a high output impedance. The first two of these provide the possibility of an ideal match for a low impedance microphone input. For load resistances of 10 to 100 kilohms the input resistance is in the order of 50 ohms, exactly right for maximum power transfer from a 50 ohm microphone. We are of course more concerned with voltage gain than power gain, however for a given input current the voltage is directly proportional to the power, since $P = V \times I$.

Provided that we can make the load resistance high enough we can achieve a very high gain from a simple circuit. The present circuit does not achieve the maximum gain possible but a choice of an 18 volt supply enables the use of a 15 kilohm load resistance, which is enough for our purposes. To increase the load resistance further would depress the voltage on the collector of the transistor leading to asymmetrical cut off, and a consequent reduction in the overload point. The stage could be redesigned to utilise a smaller collector current than the 0.3mA used here, this would enable a greater load resistance to be used but would probably result in a higher noise from the stage.

For portability and to keep down the cost of construction the unit is operated from two 9 volt batteries in series (PP6 type). Current drain is about 10mA and the batteries will give many hours of use. It has also been found that the unit will operate on a much reduced voltage with only a slight loss of gain.

A block diagram of the mixer is shown in Fig. 1. There are four identical channels each comprising an r.f. filter, an impedance changer/amplifier stage, a channel fade potentiometer and a buffer stage.

SPECIFICATION . . .

Frequency Response:

58Hz—12kHz (—1dB)
40Hz—22kHz (—3dB)

Inputs:

Low Impedance	Gain 64dB*
	Impedance 58Ω
	Overload point 80mV r.m.s.
High Impedance	Gain 31dB*
	Impedance 70kΩ

* Gain is reduced by 6dB with S1 set to MONO

Outputs:

Main	Maximum level 5V r.m.s. (onset of clipping)
	Impedance 600kΩ approx.
Optional High Impedance	Gain (1st stage only) 46dB
	Impedance 700kΩ approx.

Noise:

Maximum 1mV at output, equivalent to 74dB below maximum output

Stereo Separation: Greater than 40dB

Power Consumption: 11mA from 18V supply

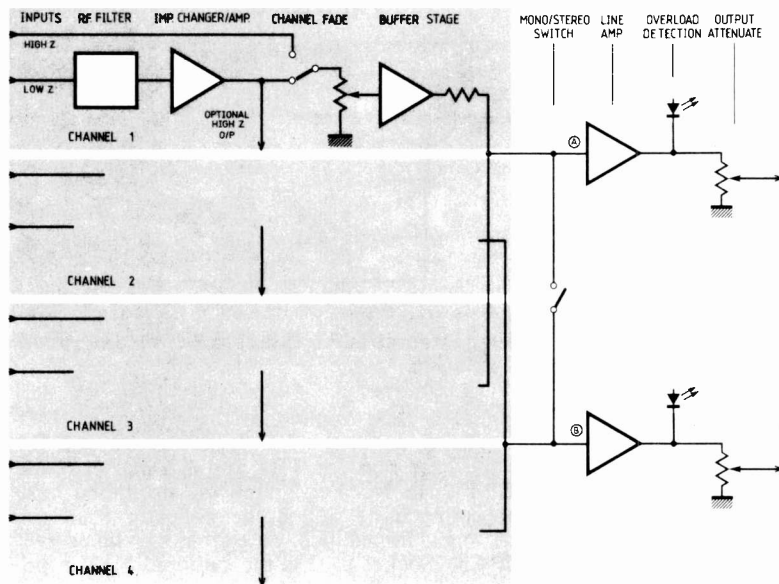


Fig. 1. Block diagram of the complete mixer

Channels one and three feed into line amplifier "A", while channels two and four feed into line amplifier "B". This arrangement enables channels one and two to be used as a stereo pair, and channels three and four as a second stereo pair.

Each channel has a less sensitive high impedance input via a breakjack which feeds directly on to the top of the channel fader control, and which breaks the connection from the output of the first stage. Each channel also has a high impedance output taken directly from the output of the first stage, and brought out at the rear of the mixer through a coaxial socket. Together, these two sockets increase the versatility of the mixer, for example the outputs could be taken to a suitable amplifier and used as a "pre-fade listen" facility. Alternatively the output could be fed to a suitable frequency shaping circuit, tone control unit, ring modulator, etc., and then back into the mixer via the breakjack to be mixed as usual with the other signals.

CHANNEL FADERS

A 500 kilohm slider potentiometer takes the output from the first stage: this is much larger than is normally used in transistor circuits, but because of the high impedance output from the first stage a high value is needed to minimise loading of the circuit. Placing the control here reduces the noise from the first stage as the signal is faded out, maintaining a good signal to noise ratio overall.

The wiper of the fader control in each channel feeds the signal to the base of a transistor connected in the common-collector (emitter follower) mode. The characteristics of the common-collector amplifier are a high input impedance, a low output impedance, a voltage gain of less than unity but a large output current. This stage is desirable as a buffer to match the high impedance output of the first stage to the relatively low impedance of the line amplifier which follows. It also serves to isolate the channel faders from each other so that operation of one of the faders does not adversely affect the signal levels of the other channels, by shorting them to earth. The outputs of the common collector

stages are connected together via isolation resistors. The emitter load resistors of this stage are quite small, and to simply connect them together would result in a great loss of gain due to virtually shorting out the emitter loads. The value of these isolation resistors is necessarily a compromise between losing gain through shorting out the emitter resistors as just described and losing gain through insertion of the resistors in the signal path.

A mono/stereo switch connects all four channels to both line amplifiers when in the MONO position. Operation of this switch causes a loss of gain of about 6dB, but has no other effect on the operation of the circuits. Obviously to avoid sudden changes in signal level it should not be operated during the course of a recording.

The line amplifiers are straightforward common-emitter amplifiers with a low impedance input and a moderately high impedance output. They give additional gain to overcome the losses caused by the isolation resistors and to boost the signal to a useful level, in fact in this design the output stage will give over 5 volts r.m.s. before clipping takes place. A slide potentiometer connects the output from the line amplifiers to the output sockets, providing a means of matching the output voltage to the following equipment and a means of fading out all the channels. As with the previous faders, operation of these also reduces the noise levels. In the prototype 500 kilohm potentiometers were used.

The arrangement of the output circuits adds further to the versatility of the mixer. In the mono mode there are two separately controllable outputs which could be used for example to feed two tape recorders, or a tape recorder and a public address system.

OVERLOAD INDICATORS

Finally the outputs of the line amplifiers are also connected to l.e.d. overload indicators. The gain of the mixer is such that it is fairly easy to overload the final stages, and the l.e.d.s light up as clipping point is approached. There is a slight tendency with these simple overload circuits for the l.e.d.s to pull the

output into clipping, with of course consequent distortion, and so the mixer should be operated below the point at which the l.e.d.s light up.

CIRCUIT DESCRIPTION

The complete circuit is shown in Fig. 2. Since each channel is identical it is only necessary to describe channel one and line amplifier "A".

The low impedance input is introduced via a three pin DIN socket (SK1) which is an unbalanced input. The author terminates all his screened twin cables with a three pin DIN plug, pins 1 and 3 being connected to the two cores and pin 2 to the screen. The connection between pins 2 and 3 on the mixer automatically unbalances the microphone cable so the same cable can be used for balanced connections if necessary. Capacitor C1 provides an r.f. filter function at the input. When long microphone cables are used they tend to act as aerials, picking up radio transmissions which are then amplified and detected in the high gain mixer, appearing as unwanted signals at the output. It is somewhat disconcerting to have Radios 2, 3 and 4 all appearing on your recording. Unfortunately, C1 reduces the gain of the mixer in the present design by about 2dB at 18kHz. If this is unacceptable, or the user is still troubled by breakthrough a more efficient filter is needed. Fig. 3 gives a suggested circuit.

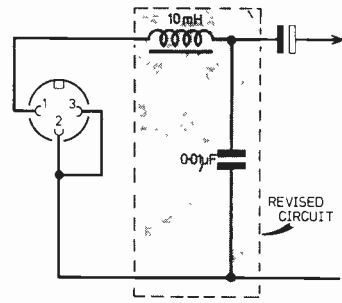
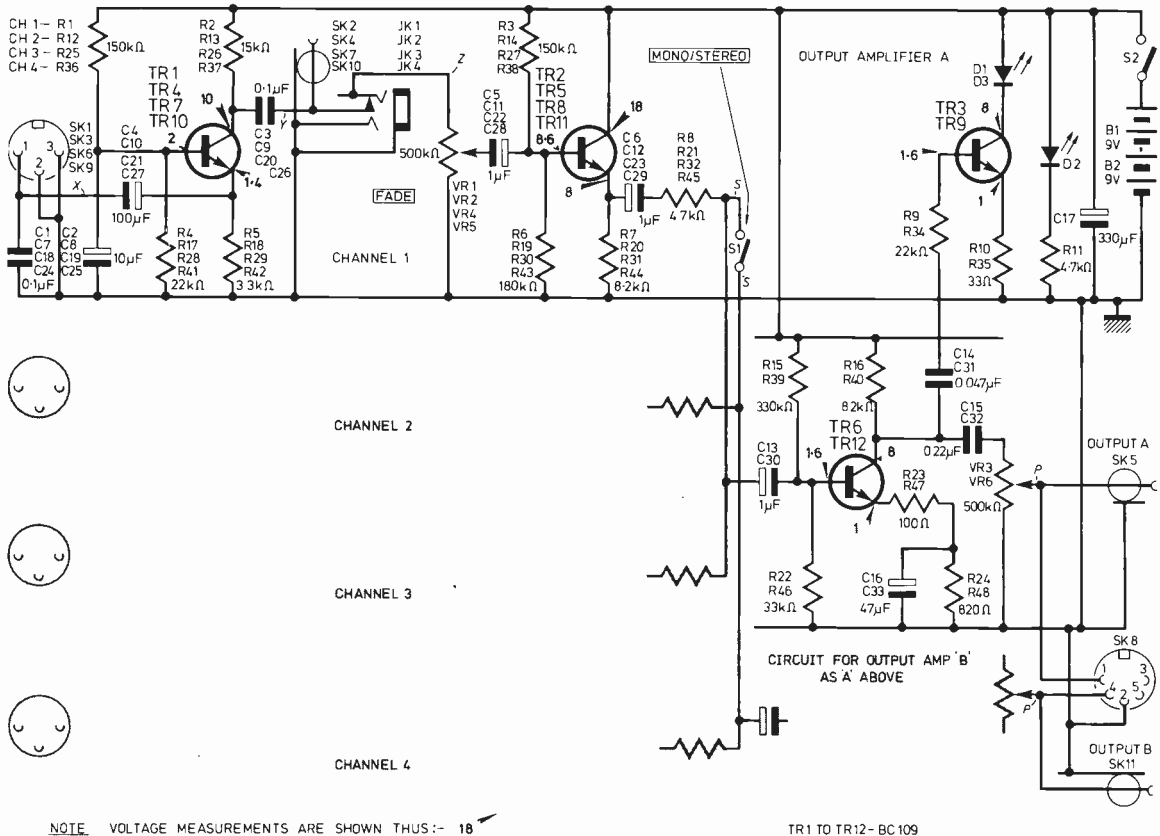


Fig. 3. Suggested circuit (replacing C1) for improved input r.f. filtering

The signal is then applied to the emitter of TR1 via the isolating capacitor C4. Resistors R1 and R4 produce the base bias for TR1 and C2 short circuits the base to earth for a.c., giving the grounded base mode of connection. R2 is the collector load for TR1, the high impedance output being taken via capacitor C3. Socket SK2 is the optional high impedance output from the channel.

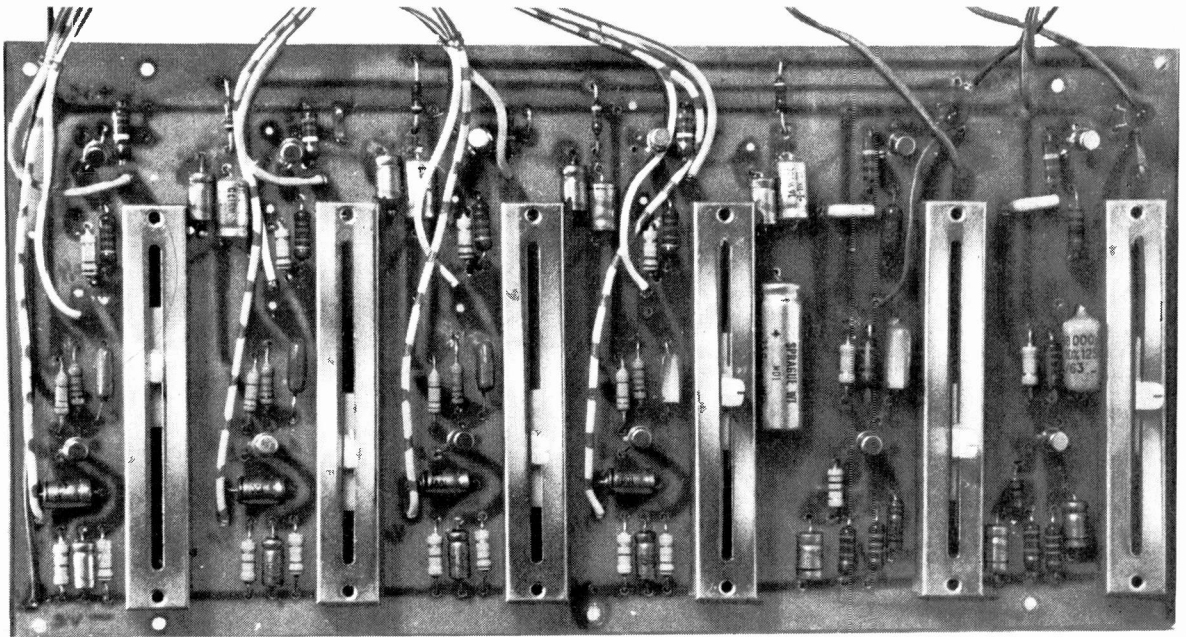
The signal is transferred to the next stage by way of breakjack JK1, at which point a high impedance input can be inserted. VR1 is the channel fade control which feeds the base of TR2 via isolating capacitor C5. Resistors R3 and R6 provide base



NOTE VOLTAGE MEASUREMENTS ARE SHOWN THUS:- 18

TR1 TO TR12 - BC 109

Fig. 2. Circuit diagram of the mixer. All four input channels are identical, as are the two output channels and overload indicators. Voltage readings are referenced to chassis, and were taken on a 20kΩ/V meter. The value of R11 can be reduced to make D2 brighter, but this will increase the battery drain. Italic letters indicate off-board connection points



The completed printed circuit board from the prototype mixer. There are a few minor differences in component layout from the final version shown in Fig. 5

bias for TR2, R7 is the emitter load resistor and the collector is connected directly to the positive supply. The low impedance output from TR2 is taken from the emitter via isolating capacitor C6 and resistor R8 at which point it is commoned with the other channels, either as stereo or mono depending on the setting of S1.

OUTPUT AMPLIFIER

The combination of signals is then fed to the base of TR6 through the coupling capacitor C13. R15 and R22 are the base bias resistors for TR6, and R16 is the collector load resistor. R23 and R24 in series form the emitter resistor, partially decoupled by C16. R23 being undecoupled introduces a small amount of negative feedback in this stage, but can be altered to give extra gain if needed by making it smaller and thus reducing the feedback. The output from TR6 is applied to the top of potentiometer VR3 via the coupling capacitor C15. The slider of the potentiometer is fed out of the mixer to the next equipment by way of the phono socket SK5. SK8 is an alternative output connection using a 5 pin DIN socket for both channels for ease of connecting the mixer to a stereo tape recorder.

The capacitor C14 and resistor R9 connect the output to transistor TR3. D1 connects the collector to the positive supply, and R10 is an emitter resistor. The transistor is normally biased to cut off. When a signal current is present at the collector of TR6 a small proportion is applied to the base of TR3. When this is large enough the positive peaks cause TR3 to begin to conduct, the transistor passes current and the l.e.d. begins to glow.

Power is supplied from two PP6, 9 volt batteries connected in series. D2 is in series with R11 across the supply, the current through the l.e.d. being about 5mA. C17 is used to decouple the supply.

CONSTRUCTION

All of the electronics of the mixer is accommodated on a single circuit board which greatly simplifies construction. Fig. 4 is a full sized drawing of the printed circuit. When the board has been etched and cleaned up it can be drilled from the copper side. Use a fine drill (about 1mm) for the component holes, except for the four holes which are used to mount each slide potentiometer, which need to be a little larger (about 2.5mm) to take the slider terminals and allow room for physical alignment of the sliders with the panel. There are also five mounting holes which should be drilled 6BA clearance.

The six slider potentiometers can now be fitted to the circuit board. On the potentiometers as supplied there were two wiper terminals, the bottom one of each is not used. When soldering the sliders into position make sure that each one sits flush on the circuit board, and that they are all square with the bottom of the board and parallel to each other. Before proceeding any further with the circuit board it is a good idea to make the top panel and match this to the circuit board.

In the prototype the case and front panel (see photographs) were made of thin gauge sheet tinfoil, which enabled the parts of the case to be soldered together. They could equally well be made from aluminium sheet, though the case would then have to be bolted or riveted together. Metal should be used to provide adequate screening. The front panel cut outs for the slider controls allow some leeway as they will be covered later with bezels, but take care not to distort the edges of the slots. Make neat holes for the switches and l.e.d.s since these will not be covered. Do not add the bezels at this time, but wait until the mixer is completely assembled to prevent damaging them.

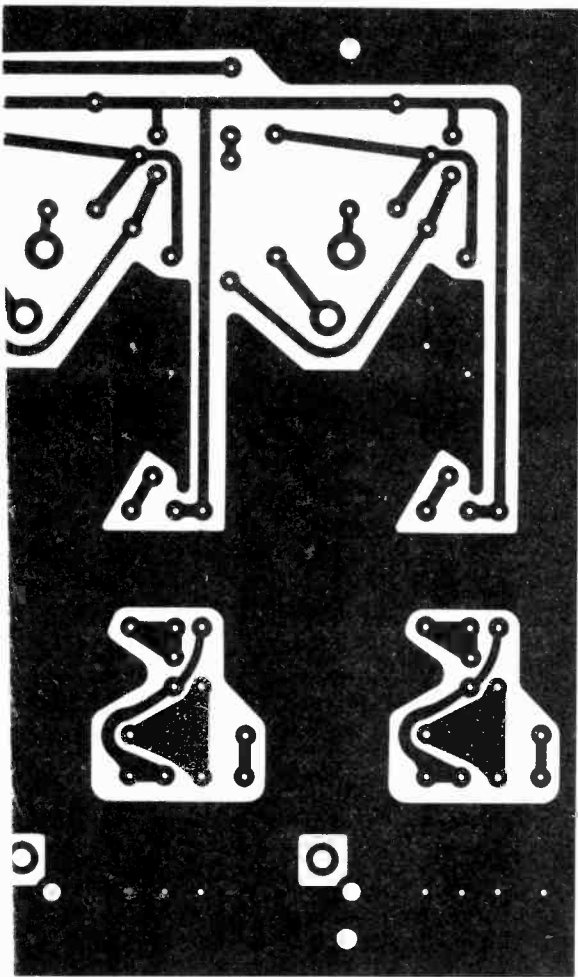


Fig. 4. Track layout for the printed circuit board, drawn full size

Fig. 5. Printed circuit board component layout with off-board connection points identified

The front panel and circuit board are separated by 15mm spacers drilled and tapped 6BA at one end. Mount the five spacers on the circuit board on the same side as the slider controls using short 6BA bolts. Note that one bolt contacts the negative supply rail to earth the front panel. The front panel is now supported face down on suitable pieces of wood and the circuit board laid on top of it with the spacers contacting the rear of the front panel and the slider controls protruding through it. Line the two up very carefully. If the front panel has been made from tinfoil it can be soldered to the five spacers with a large hot iron. Alternatively, with an aluminium front panel, the spacers can be attached with an epoxy resin glue. When this is completed the two can be separated by removing the bolts from the spacers. The front panel can be cleaned up and painted while work continues on the circuit board.

The circuit board can now be completed by adding the resistors, capacitors and transistors. Fig. 5 shows the location of all the components. The two board mounted l.e.d.s can be placed in position but

COMPONENTS . . .

Resistors

R1, R12, R25, R36	150k Ω *
R4, R17, R28, R41	22k Ω *
R2, R13, R26, R37	15k Ω *
R5, R18, R29, R42	3.3k Ω *
R3, R14, R27, R38	150k Ω
R6, R19, R30, R43	180k Ω
R7, R20, R31, R44	8.2k Ω
R8, R21, R32, R45	4.7k Ω
R15, R39	330k Ω
R22, R46	33k Ω
R16, R40	8.2k Ω
R23, R47	100 Ω
R24, R48	820 Ω
R10, R35	33 Ω
R9, R34	22k Ω
R11	4.7k Ω

Components marked * are $\frac{1}{2}$ W metal oxide, remainder are $\frac{1}{2}$ W 5% carbon film type

Potentiometers

VR1-VR6 500k Ω log law sliders (Maplin Electronics, 60mm travel) with knobs and bezels

Capacitors

C1, C7, C18, C24	0.1 μ F disc ceramic
C2, C8, C19, C25	10 μ F 10V elect.
C4, C10, C21, C27	100 μ F 10V elect.
C3, C9, C20, C26	0.1 μ F polyester
C5, C11, C22, C28	1 μ F 25V elect.
C6, C12, C23, C29	1 μ F 25V elect.
C13, C30	1 μ F 10V elect.
C16, C33	47 μ F 10V elect.
C15, C32	0.22 μ F polyester
C14, C31	0.047 μ F polyester
C17	330 μ F 25V elect.

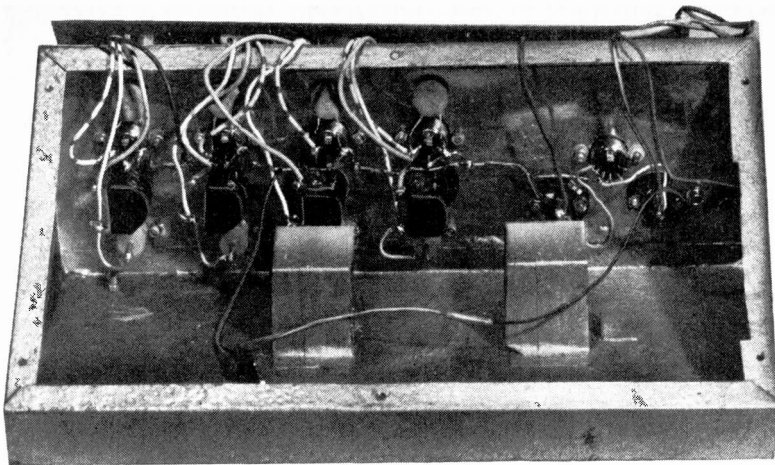
Semiconductors

TR1-TR12 BC109
D1-D3 0.2in l.e.d.s with mounting clips

Miscellaneous

SK1, SK3, SK6, SK9	3-pin DIN sockets
SK2, SK4, SK7, SK10	Coaxial sockets
JK1-JK4	$\frac{1}{4}$ in Jacks with break contacts
SK5, SK11	Phono sockets
SK8	5-pin DIN socket
S1, S2	S.p.d.t. sub-min slide switch

Printed circuit board; case; PP6 batteries (2 off); spacers (15mm); battery clips.



Internal view of the case, showing battery retaining clips, etc.

should not be soldered yet since their position has to be adjusted later. The i.e.d.s must be forward biased which means that the cathode goes to the collector of the transistor. Connect pieces of flexible insulated wire to the holes *X*, *Y*, *Z*, *P* and *S* as follows: *X*, *Y*, approximately 180mm, *Z*, *P* and *S*, approximately 120mm. Wires approximately 180mm long should also be soldered to the positive and negative rails.

When the board is completed it can be checked to make sure it works correctly. Temporarily connect together wires *Y* and *Z* for each channel, and temporarily connect together the wires *S*. Connect the positive and negative wires to two nine volt batteries in series, and check the voltages on the transistors which should be more or less as shown on the circuit diagram. If you have test gear you can connect an audio signal generator to the input, between wires *X* and the negative supply, and an oscilloscope or a.c. voltmeter to the output, i.e. between wires *P* and the negative supply. If you do not have test gear you can try connecting a microphone to the input and tape recorder to the output. The mixer should meet the specification for gain, noise, etc., as detailed in the table. When all is in order proceed with construction of the case.

The front panel is completed by mounting the switches and D2 in the appropriate places and wiring them up. Reassemble the front panel to the circuit board after snapping the mounting clips for i.e.d.s D1 and D3 into their holes. Make sure that the i.e.d.s engage in their clips when the board and panel are brought together. The i.e.d.s can then be soldered into position. Connect the two wires from point *S* to switch S1, and the wire from the positive to S2.

The arrangement of the case used in the prototype can be seen from the photographs. The battery holders must be positioned carefully so as not to foul either the underneath of the circuit board nor the sockets on the rear of the case.

Wiring of the input and output sockets should commence with the earth connections. Run a single busbar of bare copper wire between the earthy (sleeve) terminals of jacks JK1-JK4, and then on to the earths of the output sockets SK5 and SK11. The earths of the input sockets SK1, SK3, SK6 and SK9, and the DIN output socket SK8 can also be wired to this busbar. Sockets SK2, SK4, SK7 and SK10 are earthed through the case if coaxial sockets are used.

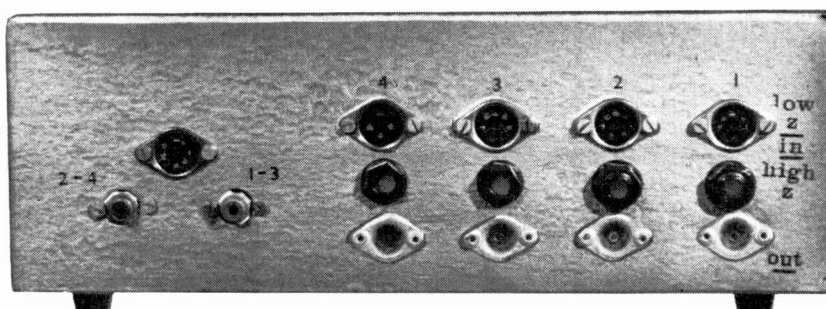
SUPPRESSION

The r.f. suppression capacitors C1, C7, C18 and C24 should be wired directly across pins 1 and 3 of the input sockets. The wires from points *X* are connected to pin 1 of the respective input sockets. The wires from points *Y* and *Z* are connected to the appropriate terminals of jacks JK1-JK4 and wires *Y* are extended to the coaxial sockets.

The wire from the negative rail on the p.c.b. should be connected to the busbar, and the two battery clips wired in series with the positive going to S2 and the negative to the busbar.

USING THE MIXER

The method of using the mixer is fairly obvious from the block diagram description given above. The warning given earlier about ensuring that the mixer is operated below the point at which the i.e.d.s light should be carefully noted. ★



Rear view of the mixer, showing arrangement of input and output connectors

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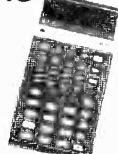
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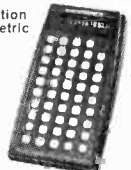
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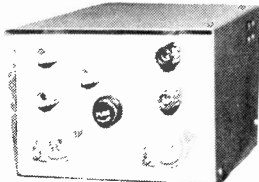
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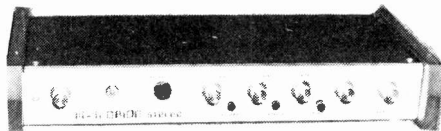
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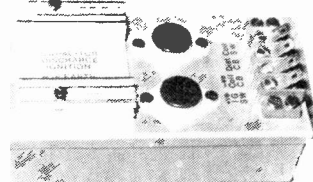
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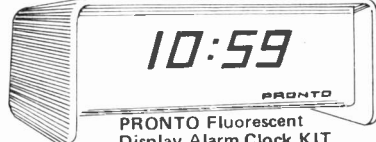
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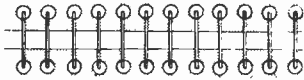
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INDUSTRY NOTEBOOK

By *Nexus*



WHY SO GLUM?

At the risk of being branded an incurable optimist I still question the forecasts of doom for British electronics put about by so many of my fellow commentators. One electronics trade journal despairingly went on record with, "What we may be seeing, therefore, is the start of the decline of a great industry which has given the world much of value in both basic technology and sound engineering."

That comment was soon after the minimum lending rate had been jacked up to 15 per cent. We can all agree that the increased rate imposed a new burden in financing further growth, a new challenge which will have to be met. But I don't see the electronics industry declining in any way. My colleague's gloomy remarks were more likely to have been influenced by his publication date (the 13th of the month), his house mortgage having gone up, and an industrial dispute in his publishing company, than a sober examination of the facts.

Of course, we could always do better but taken in relation to most other industries in Britain, electronics is doing rather well and in some product areas and in some world markets the performance is exceptional.

Who would ever have imagined that Plessey Semiconductors, not usually regarded as being in the major league of world suppliers in the most abrasive business area in electronics, would land a single order for three million i.c. devices. Or that such an order should, of all places, have come from Japan. But such is the case. The product is for Citizens' Band radio and Plessey is optimistic that more big Japanese orders are on the way.

A prime example of the simple policy of offering the right goods at the right price at the right time.

Remember the EMI-Scanner? This product is still good news and has built up EMI's medical electronics division from zero to 2,600 people and it's still growing. Latest score at my copy date was 655 systems sold worth £125 million. Not bad for an idea thought up on a country ramble and then vigorously pursued in the market place. The Scanner has helped push EMI world-wide sales up 33 per cent to £671 million and boosted profits from electronics products to 40 per cent of EMI's total.

SCRAMBLE

Remember the scramble for the aerospace "sale of the century", the successor to the ageing Starfighter? Winner was General Dynamics with the F-16 which will be built on a consortium basis in Belgium, Denmark, the Netherlands and Norway. The initial order is for 348 aircraft for the air forces of the four governments and the electronics in these aircraft are going to be worth at least 950 million U.S. dollars, say £600 million.

What a pity Britain hasn't a share. But wait a minute, Britain is still there. Marconi-Elliott head-up displays have been specified for the lot. And not only for 348 F-16's for the European consortium but also the 650 American-built F-16's on order for the United States Air Force. Altogether about £30 million worth of business although some of it will be farmed out to participating nations. There could be more business to follow because by the end of its useful life it is expected that 3,000 F-16's will have been sold. Marconi-Elliott is the world's leading suppliers of HUD's with 3,000 delivered for 25 aircraft programmes, half in the USA, which isn't bad going for a private venture development.

Remember Decca Radar? Still the world's biggest seller of shipborne marine radars and the company that has designed and installed more harbour radar schemes than the rest of the competition added together. And remember Racal Electronics Group? Still No. 1 suppliers of military manpacks and mobiles, regular purveyor to 130 different countries.

WILL TO SUCCEED

Let's go down the scale in size and into the Dorset countryside. In sleepy Wimborne you'll find a modest little company called Membrain making automatic test equipment. In a single month earlier this year Membrain pulled in another

£400,000 worth of business from tough buyers like the Japanese and the Yugoslavs not to mention the toughest of all, the German Post Office, who might be expected to favour the local product but preferred the British buy.

Ever heard of Omega? It's the world-wide navigation system working on v.l.f. and it gives you a fix within one mile anywhere in the world in daylight, two miles after dark. World's largest supplier of Omega receivers is Redifon with over 800 systems sold. And Redifon is now hoping to repeat this success story with the Redifon Satellite Navigator.

Not, I should have thought, a British electronics industry in decline. Of course, there are companies doing less well and if you attend electronics exhibitions you will still find plenty of companies who are having a rough ride but few who are in a state of absolute despair.

Even in the hard-pressed consumer sector, struggling against Far East imports, there is hope of improvement. Jack Akerman, managing director of Mullard, has been conducting a vigorous campaign along with other top men in consumer electronics to warn industry of what might happen if we lose out to foreign competition. Akerman is the new chairman of the Electronic Components Board which will give him an even stronger voice. One of his themes is that the electronics industry should be regarded as a single industry instead of two industries (i.e. professional and consumer) because elimination or even further weakening of the consumer business will have a disastrous effect on the whole.

On the general economic scene I am not so optimistic. The will to succeed is evident throughout the electronics industry. I don't see the same will or the same spirit elsewhere.

CALCULATING WATCH

The U.S. company Hughes is producing a solid-state module which combines a digital wrist watch and a calculator with 8-digit i.e.d. display. The calculator keys in a standard layout, are tiny but can be operated with a pencil point.

Britain's Sinclair Radionics has moved up-market in pocket calculators with a nicely designed prestige package for the jet-set credit card user and the nouveau-riche. Satin chrome finish costs £30.00, hard gold-plate £60.00. The advertisement copy writer missed out on one point by describing the i.e.d. display as red. Perhaps ruby would have been more appropriate.

POWER OUTPUT METER

By H.T. KITCHEN

THE measurement of a.c. power developed in a load resistance requires that the voltage applied across the resistance, or the current flowing through it, is measured, the power then being computed by taking E^2/R or I^2R where E and I represent the voltage and current, R being the load resistance.

Where many power measurements are involved, the calculations can become tedious and time-consuming and errors can very easily be made. It was to circumvent such errors that the power output meter to be described was developed and built.

DESIGN REQUIREMENTS

Amplifiers with power outputs exceeding 50 watts average are as yet relatively uncommon on the domestic scene, and so a maximum power measurement capability of 50 watts was considered adequate.

The distortion levels of some class B and AB amplifiers tend to increase at lower levels, sometimes significantly, and so the capability of measuring lower power outputs accurately, in conjunction with a distortion meter, was considered essential. The lowest range is 50mW f.s.d., enabling low powers to be measured, albeit at reducing accuracy.

The bandwidth over which an amplifier should deliver its full rated output should ideally cover the full audible frequency range of 15Hz to 20kHz without significant peaks or troughs. The power output meter used for testing amplifiers to proper hi-fi standards must possess a bandwidth at least comparable to the amplifier's, but preferably much wider, with an amplitude response significantly superior to that of the amplifier under test. The amplitude

response of the unit to be described is within 0.5dB from 20Hz to 50kHz, and within 0.2dB between 30Hz and 25kHz.

Loudspeaker impedances seemed to have settled down very nicely to nominal—sometimes very nominal—values of 4Ω, 8Ω and 15Ω, with 8Ω the norm for most transistor amplifiers, though there were signs that 4Ω was finding favour, particularly on the Continent. Recently, for reasons best known to themselves, some manufacturers introduced models with nominal impedances of 6Ω. For simplicity the power output meter was designed to cater for the established impedances of 4Ω, 8Ω and 15Ω, plus 600Ω usable only on the 50mW and 500mW ranges for headphones and professional 600Ω lines.

METER CIRCUIT

With so much voltage available—27.386 volts on the 15Ω/50W ranges, reducing to 447mV on the 4Ω/50mW ranges—it was tempting to explore the use of simple rectifier circuits. The diode pump, particularly, looked most promising but its extreme non-linearity proved unacceptable and so an operational amplifier was used as a simple voltage follower. The op amp adopted is the well known and highly satisfactory 741.

The complete meter circuit is shown in Fig. 1. The voltage to be measured is applied, suitably attenuated, to the non-inverting input of the op amp. A feedback loop containing the meter and rectifier diodes D1-D4 is connected from the output to the inverting input. The high level of negative feedback provides a very linear scale—voltage-wise—although



when calibrated in terms of wattage the scale displays the well known square-law look. The feedback also enables the a.c. gain of the op amp to be set within precisely defined limits, and maintains that gain substantially constant over a wide bandwidth. The feedback and hence the gain is set by R8. This can be a preset resistor, or a fixed resistor if the gain required is known. On the prototype a value of $1.5k\Omega$ gave meter f.s.d. for an input of $95mV$.

The low frequency gain is dependent on the values of two capacitors, C1 and C3. The reactance of each must be very low compared to their associated resistors R7 and R8. The values shown ensure that

not really warranted, besides, when measuring very low powers the isolation afforded by battery operation is invaluable in eliminating the much dreaded hum loop.

INPUT CIRCUITS

Changeover switch S1 allows either of two inputs to be selected. This greatly facilitates work on stereo amplifiers, enabling channel power balance to be quickly checked. The output from S1 goes to the load resistors and also to a coaxial socket, providing for the connection of an oscilloscope or distortion meter.

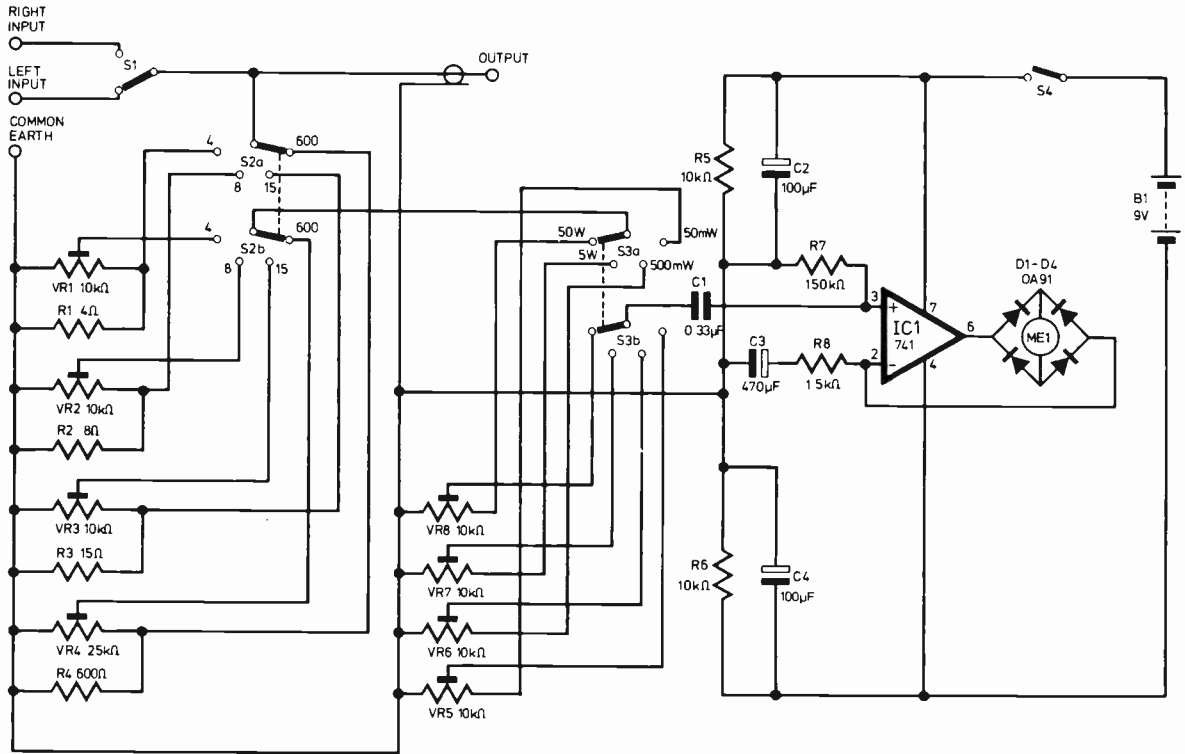


Fig. 1. Circuit diagram of the complete power output meter

the i.f. gain is well maintained with respect to that at $1kHz$. The high frequency response of the amplifier is dependent on the a.c. gain; the higher the gain, the lower the frequency at which the $-3dB$ point occurs. The a.c. gain of the prototype is very low, and the $-3dB$ point lies at $100kHz$.

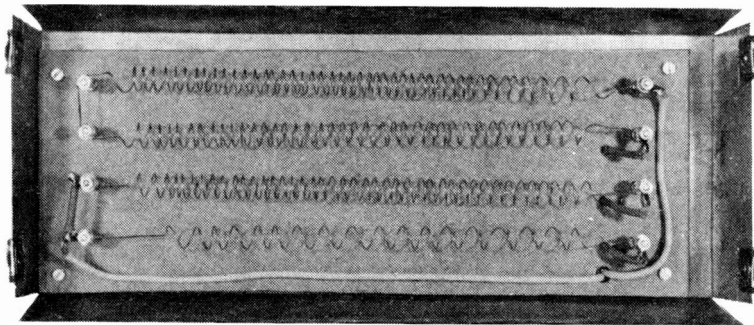
POWER SUPPLIES

The 741 is a differential amplifier and requires a dual polarity supply of up to ± 18 volts. However, a satisfactory performance can be obtained by using a potential divider to provide dual-polarity supplies from a single 9 volt battery. This function is performed by R5 and R6, decoupled by C2 and C4. The inverting and non-inverting inputs of IC1 are returned to the junction of this potential divider via R8/C3 and R7 respectively.

The current consumption is very low at $1mA$, and a 9 volt battery of the PP6 type should give a very useful life even if the power output meter is regularly used. A mains operated power supply is

The voltage required by the meter amplifier is only $95mV$, but as mentioned previously the maximum input voltage will vary from $27.386V$ to $447mV$. Some means of attenuating these voltages is therefore required. The original intention was to use resistive ladder attenuators using fixed resistors for the two attenuators in cascade, one for the load resistance ranges, the other for the wattage ranges. However, a little mathematical juggling soon revealed that attenuators to the required degree of accuracy could not be constructed using resistors of the easily obtained 2% E12 or E24 types. Instead, it was decided to use preset potentiometers for the attenuators. Each pot can be individually set up, so that given an accurate reference voltmeter and careful workmanship a degree of accuracy superior to that obtainable with fixed resistor ladder type attenuators should be easily obtained.

The load resistors, R1-R4, are selected by S2. The attenuator pots, VR1-VR3, are connected directly across the load resistors, the value of $10k\Omega$ having minimal effect on the overall resistance on the 4Ω ,



The load resistor assembly for the 4, 8 and 16 ohm loads

8 Ω and 15 Ω load ranges. On the 600 Ω range, however, the parallel connection of a 10k Ω pot would reduce the total resistance to 566 Ω , an error of some 5 $\frac{1}{2}$ %. Increasing the value of the pot to 25k Ω reduces this to about 2 $\frac{1}{2}$ %, an error acceptable for all but the most stringent applications.

The voltage change corresponding to a power change by a factor of 10 is equal to $\sqrt{10}:1$, due to the square function involved in power calculations. Therefore, each time the wattage range switch S3 is operated the input to the meter amplifier must alter by a ratio of $\sqrt{10}:1$ or 3.162:1.

COMPONENTS

In any measuring instrument only one type of component should be used, the best available. The 741 operational amplifier should be a new component and carry the manufacturer's markings and guarantee.

Of the static components, the preset pots and switches call for special mention. The presets used in the prototype were multi-turn types, more expensive than the normal skeleton type but giving greatly superior resolution. Switches S1 and S2 must be capable of carrying the full signal current to the loads. This will be around 3.5 amps on the 4 Ω range, decreasing as the load resistance increases, to around 1.8 amps on the 15 Ω range. Both values are of course at the maximum rating of 50 watts. On the prototype, S1 was a mains type double-pole changeover switch with poles connected in parallel to reduce contact resistance and also to improve reliability. Avoid the smaller type of switch, which often has non-wiping contacts unsuitable for low-power operation. S2 was a three-pole, four-way switch with two poles connected in parallel for S2a, again to reduce contact resistance and improve reliability. The importance of reliable low contact resistance in these two switches cannot be over-emphasised.

The meter used in the prototype was a BPL type S31V, but any 1mA f.s.d. movement should be suitable, providing the front can be easily removed for access to the scale for recalibration.

LOAD RESISTORS

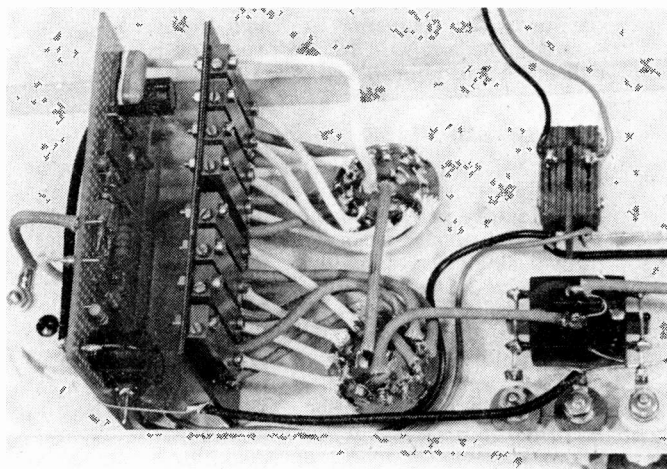
The load resistors should be as accurate as possible in value, should be non-reactive, and should possess low coefficients of temperature. Proprietary components meeting these requirements are not easily obtained in small quantities; some alternative approach is therefore needed. The simplest way

is to build your own from resistance wire, a ready source being replacement electric fire elements obtainable at most electrical shops. The load resistors comprise the resistance wire, recoiled and of the appropriate lengths, supported on a hardboard frame.

The element wire when unwound was found to have a resistance of approximately 6.5 Ω per metre. The 15 Ω resistor was constructed first, and to do this a length was cut 2.5m long. A loop was formed at one end, of the right size to be clamped between a pair of 6BA nuts on a 25mm long 6BA bolt, for the wire is not amenable to soldering by any easy and reliable means. This bolt was connected to one terminal of an accurate bridge, the other bridge terminal being slowly slid along the wire, and in firm contact with it. When precisely 15 Ω was indicated, the point was marked and the wire cut just 25mm longer, another loop being formed and clamped in similar fashion. The bridge terminals were then applied to the two 6BA bolts. The resistance was, happily, just 15 Ω . The 8 Ω and 4 Ω resistors were constructed in precisely the same way.

The ohms ranges of even the best multimeters are simply not accurate enough for this measurement, unless one is content to accept degraded accuracy. In the absence of a bridge, the ohmmeter must of necessity prevail. However, a cross check is possible by passing a known current through each resistor, the resulting volts drop being measured on

Inside view of the front panel, showing the amplifier board and board carrying the multi-turn presets on the left



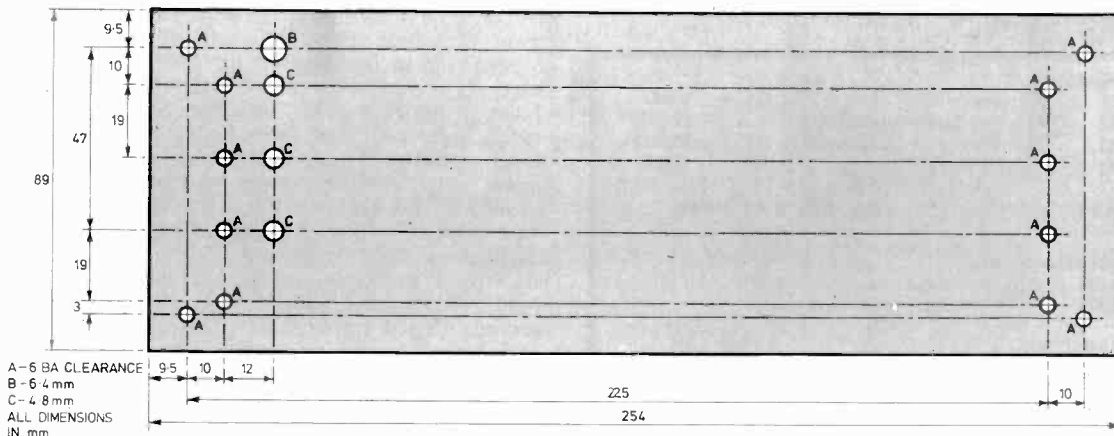


Fig. 2. Drilling details for the load resistance mounting frame

an accurate voltmeter. The voltage and current ranges of all multimeters are appreciably more accurate than the resistance measuring section.

Once the lengths are accurately determined, the individual lengths can be removed from the temporary bolts and coiled upon any suitable mandrel of about 6mm diameter, taking care that the wire is not stretched for that will increase the resistance. When released, the coils should be considerably shorter than the distance between the supporting screws, so that when they are stretched out they will be taut with adjacent turns equally spaced. The arrangement of the load resistors is shown in the photographs; drilling arrangements for the hardboard frame used in the prototype are shown in Fig. 2.

Countersunk 6BA bolts 30mm long are used to mount the load resistors, with lock-nuts to space the coils about 12mm clear of the hardboard. Washers should be fitted both sides of the resistance wire loop, plus a solder tag for the connecting wire. The

nuts must be very firmly tightened down, almost to shearing point, to ensure a near-zero resistance contact between the wire and the solder tag.

CONSTRUCTION

The completed prototype power output meter was built into a West Hyde Developments size C Mod-2 instrument case. The load resistors require adequate air flow for cooling purposes and this implies open-air mounting. Consequently, the rear panel was omitted and replaced by a 22 s.w.g. aluminium panel to the dimensions shown in Fig. 3. The front panel layout is shown in the photographs, holes being drilled to suit the components that will actually be used, or to suit individual ideas.

The amplifier is built on plain 0.1in Veroboard measuring 95 × 57mm, Fig. 4. The multi-turn presets are mounted on a piece of s.r.b.p. measuring 89 × 57mm. Both boards are secured to a small U-shaped bracket, fixed to the rear of the front panel by one of the meter fastening studs.

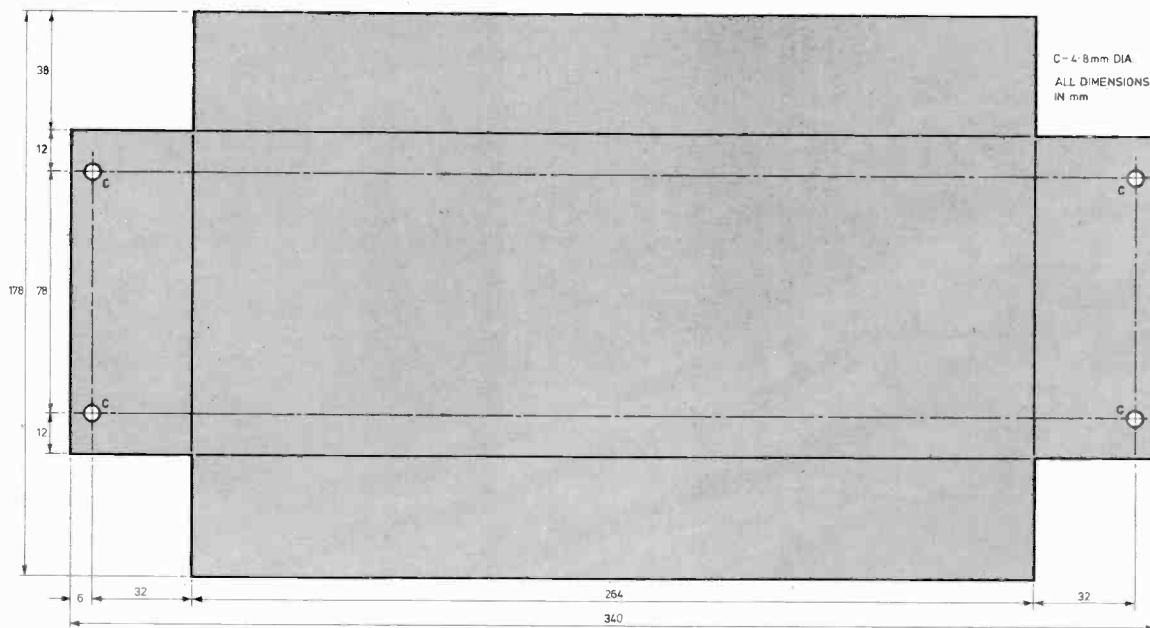


Fig. 3. Cutting and drilling dimensions for the new rear panel

COMPONENTS . . .

Resistors

R1	4Ω wire-wound (see text)	R5-6	10kΩ
R2	8Ω wire-wound (see text)		(2 off)
R3	15Ω wire-wound (see text)	R7	150kΩ
R4	600Ω 1W 1%	R8	1.5kΩ
			(see text)

All resistors $\frac{1}{2}$ W 5% unless otherwise stated

Potentiometers

VR1-3, VR5-8	10kΩ multi-turn (7 off)
VR4	25kΩ multi-turn

Capacitors

C1	0.33μF polyester
C2, 4	100μF 15V elect. (2 off)
C3	470μF 6V elect.

Semiconductors

IC1	741 8 pin d.i.l.
D1-4	OA91 or OA95 (4 off)

Switches

S1	D.P.D.T. mains toggle switch (see text)
S2, 3	3- pole, 4- way rotary switch (2 off)
S4	S.P.S.T. toggle switch

Miscellaneous

1mA moving coil meter (see text).
 Instrument case, West Hyde Developments Size C Mod-2.
 Battery, 9V PP6.
 Plain Veroboard, 0.1in matrix, 95 × 57mm.
 S.R.B.P., 89 × 57mm.
 Sundry materials and hardware.

The load panel is screwed to the new rear panel using 6BA nuts and screws, with spacers about 6mm long. Prior to building up the load panel, it can be used as a template for drilling the corresponding holes in the rear panel, ensuring accurate alignment of all holes. All lead holes in the rear panel should have grommets fitted. Connections between the load panel and the front panel switches and terminals should be of heavy gauge wire, the prototype was wired up with 16 s.w.g. The 4Ω and 8Ω resistors are earthed by means of two 16 s.w.g. wires in parallel to ensure minimum additional resistance. All the load resistor earth connections should be returned directly to the front panel earth terminal, so ensuring that all heavy circulating currents are kept out of the meter amplifier circuit.

CALIBRATION

Prior to calibration, all the attenuator presets should be set so that their wipers are at the earthy end of the tracks and the link between S2b and S3a should be broken. A variable a.c. voltage of at least 28V r.m.s. is required for calibration. A mains transformer with a good-quality wirewound potentiometer connected across its secondary is a suitable source (see Fig. 5). The value of the pot should be such that it draws an appreciable current in comparison with the calibrating voltmeter. The use of an accurate millivoltmeter is desirable for this purpose as it will enable the low wattage/low resistance ranges to be checked.

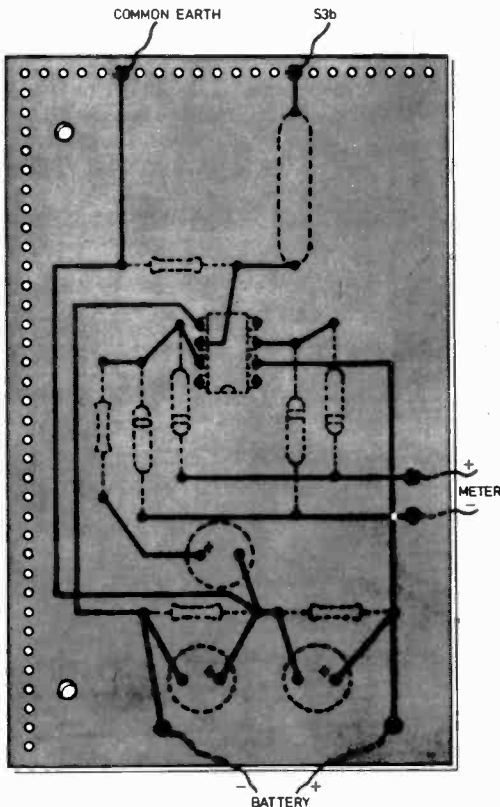
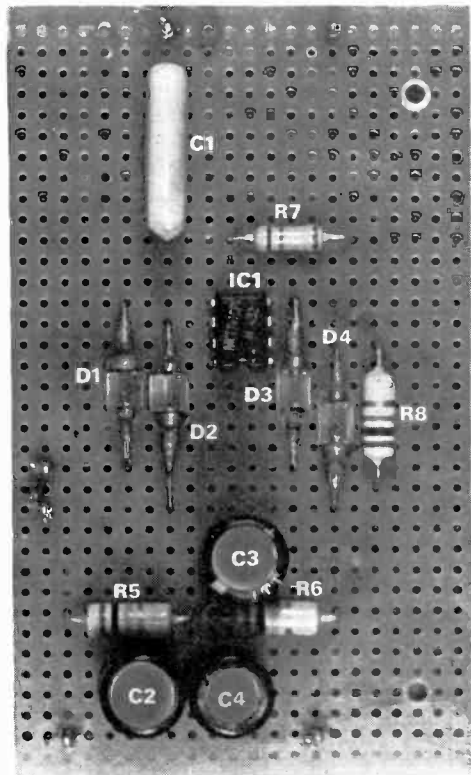


Fig. 4. Amplifier board wiring, viewed from the underside



Amplifier board component layout

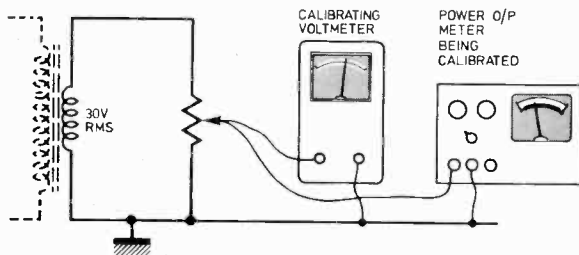


Fig. 5. Calibration source arrangements

The wattage range attenuators are set first. To do this, connect the calibrating voltage source, set to zero volts, to the wiper of S3a. Follow the procedure detailed in Table 1, line by line. If the mains voltage fluctuates considerable patience is required at this task. Accuracy depends on the care taken, so persevere. Recheck all settings of the pots until quite satisfied that all is well.

The load attenuator pots can be set next, but first of all the loads must be disconnected from circuit to prevent overloading the calibrating voltage source. Also, the link between S2b and S3a must be restored and the power level switch set to 50 watts. Then follow the procedure detailed in Table 2.

After calibration, all the ranges should be rechecked; the best way of doing this is to feed in various voltages using Table 3 as a guide, to see if meter f.s.d. is still obtained.

CALIBRATING THE METER DIAL

Dial recalibration can be a somewhat tricky task if one has not done it before, but it can be safely performed with care and patience. The completed power output meter should be placed on a clean, dust-free sheet of newspaper and the front cover removed from the meter movement. The BPL meter used in the prototype has the advantage of being supplied with a spare blank scale-plate which can be used for the new scale. With any other movement the scale-plate must be carefully removed and covered with thin white paper or plastic before being refitted.

Table 3 gives a range of voltages for each resistance range, the 600Ω range excepted, and from this one range can be selected for dial calibration purposes. The figures are quoted to three decimal places for the benefit of owners of DVMs.

Assuming the 15Ω range is chosen, an input of 27.386 volts is applied whereupon the pointer should come to rest at its normal maximum position. Being careful not to breathe on the pointer, and carefully avoiding nudging it with the pencil, a faint mark should be made as precisely under the pointer as possible. This is the 50 watt mark. Reduce the input voltage, then increase it again to the original reading and check that the meter pointer returns to the mark.

Similarly, very lightly pencil in the marks for the remaining wattages, taking very great care not to displace the pointer by heavy breathing, sneezing, or by the pencil. The latter can damage the delicate suspension so be ultra careful. Recheck by feeding in various voltages corresponding to given power levels and load impedances and seeing if the meter reading corresponds. It is worth feeding in a voltage on each range in turn, commencing with the

Table 1
LOAD RANGE ATTENUATOR CALIBRATION

Step	Input level to S3a	S3 range	Adjust for f.s.d.
1	10V	50W	VR8
2	3.162V	5W	VR7
3	1V	500mW	VR6
4	316mV	50mW	VR5

Table 2
WATTAGE RANGE ATTENUATOR CALIBRATION

Step	Input level to S1	S2 range	Adjust for f.s.d.
1	Set S3 to 50W		
2	27.4V	15	VR3
3	20V	8	VR2
4	14.14V	4	VR1
5	Set S3 to 500mW		
6	17.32V	600	VR4

Table 3
POWER-VOLTAGE CONVERSION

Watts	4 Ω	8 Ω	15 Ω
50	14.142	20.000	27.386
45	13.416	18.973	25.980
40	12.649	17.888	24.494
35	11.832	16.733	22.912
30	10.954	15.491	21.213
25	10.000	14.142	19.364
20	8.944	12.649	17.320
15	7.745	10.954	15.000
10	6.324	8.944	12.247
5	4.472	6.324	8.660
1	2.000	2.828	3.872
0.5	1.414	2.000	2.738
0.4	1.264	1.788	2.449
0.3	1.095	1.549	2.121
0.2	0.894	1.264	1.732
0.1	0.632	0.894	1.224
0.05	0.447	0.632	0.866
0.01	0.200	0.282	0.387

50mW range, such that f.s.d. is obtained. The power level switch should be set to the next range up, where the reading should be one tenth of the previous reading.

The cross checks being satisfactory, the meter dial can now be removed from the meter and firmly taped by its corners to a piece of stiff card. The centre of arc, i.e. the pointer's pivot, should be marked on the card and two arcs drawn in very lightly in pencil so that they overlap the tip of the pointer by equal amounts, say 1.5mm; i.e. the radii differ by 3mm. Using the previously established datum points for power levels, and the centre of arc, mark the final calibration lines in Indian ink using the two arcs as guide lines. When the ink is thoroughly dry the two pencil arcs can be carefully erased and the power levels marked with stencil or transfers at intervals of every five or ten watts, though the actual calibration lines can be at very much closer intervals if desired.



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NEWS BRIEFS

The Obedient Car

PROGRAMMED to obey only his voice, Mr Neil Vickery, an electronics enthusiast in Australia, has developed a computer controlled car which responds to spoken commands.

At a cost of some ten times the value of the car, he has added about SA50,000 worth of electronic equipment to his Australian made Holden Monaro GTS and to foil would-be car thieves it is programmed to respond to only his voice.

Using a walkie talkie transmitter enables him to issue commands to his car from distances up to 19km (12 miles) away. The car will obey oral instructions such as "start", "accelerate", "slow down" and "stop". It will also obey such commands as "lights on" or "off", "sound horn", and "activate windscreen wipers". All these commands are relayed to the relevant part of the vehicle by the on-board computer, based on a microprocessor.

Infra red sensors cause the car to brake automatically as it approaches a red traffic light and a radar system monitors the distance to the car in front and adjusts the speed accordingly. Another sensor applies the brakes if it comes too close to any object, including pedestrians. There is an elaborate security system including a homing device which enables the car to be traced up to 180km (112 miles) away if stolen.

The car has a closed circuit television system using two rear mounted cameras which enables the driver to see what is behind by glancing at a small dashboard-mounted monitor screen. Also installed in the car is a radio telephone.

Mr Vickery demonstrates his car at charity functions.

Summer School

THE Department of Electrical Engineering Science at Essex University will be holding its annual Electronics Summer School for teachers during the week July 11 to 15, 1977. Two courses, *Linear Circuit Design* and *Digital Circuit Design* will be run simultaneously.

The Linear Circuit Design course is concerned with the use of transistors and operational amplifiers in analogue applications and the basic circuits of a hi-fi amplifier are investigated in detail.

The Digital Circuit Design course concentrates on the use of the transistor as a switch and develops design using integrated logic circuits; a digital patchboard is used to introduce the concepts of combinational and sequential logic design.

Further information on the Summer School can be obtained from R. J. Mack at the Department of Electrical Engineering Science, University of Essex, Wivenhoe Park, Colchester CO4 3SQ.

Audio Fair '77

PLANS are now ready for the 1977 International Audio Festival and Fair, to be held at Olympia from September 12 to 18. While retaining its appeal to the specialist audio and hi-fi enthusiast, the 1977 Audio Fair will take account of the greatly increased family demand for sound and visual home entertainment.

Next Month

ELECTRONIC CONTROL UNIT for SOLAR HEATING SYSTEMS

Rising fuel costs are focusing attention on natural power sources such as solar energy. Next month we describe a simple unit to control the circulating pump on a domestic solar water-heating system.

RADIO CONTROL Part 2

The decoder, plus final setting up details for the complete system.

SEVEN-SEGMENT DISPLAY

An inexpensive unit allowing the display of numerals 0-9 on an oscilloscope screen. Intensity (Z) modulation facilities are not required.

I.C. SNAP

An electronic version of the traditional card game, based on three 7400 integrated circuits.

PRACTICAL ELECTRONICS

FEBRUARY ISSUE ON SALE JANUARY 7, 1977

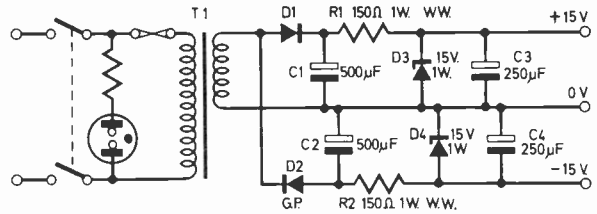
ONE of the disadvantages of operational amplifiers is the need for a split power supply. This normally requires a mains transformer with a double secondary winding. The circuit shown in Fig. 1 overcomes this problem, allowing the use of a transformer with a single output winding.

The arrangement is that of a standard voltage doubler, but with the difference that the centre point of the output, rather than one side of it, is taken to be the 0V or earth rail. The circuit can be considered to be two half-wave rectifiers, operating on alternate half cycles of the supply. The series resistors and



Fig. 1

DUAL POWER SUPPLY

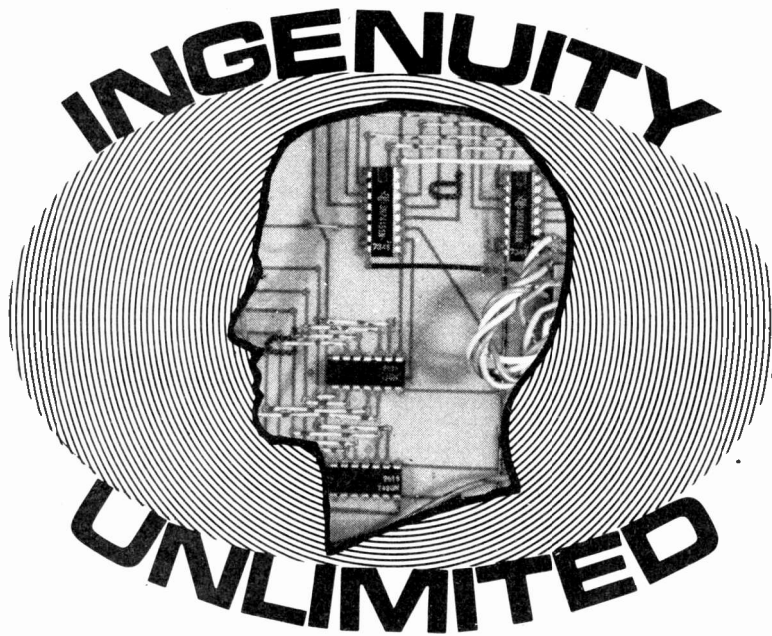


Zener diodes stabilise the outputs at a nominal $\pm 15V$.

Using the values shown, a maximum stabilised output of about 50mA can be obtained. A high current balanced power supply, such

as is required by some direct coupled Hi-Fi power amplifiers, can be produced by omitting all components to the right of C1/C2.

N. Croucher,
Hull.



A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

Why not submit your idea? Any idea published will be awarded payment according to its merits.

Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not inserted in the text.

Each idea submitted must be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been accepted for publication elsewhere.

THIS circuit (Fig. 1) monitors the level of ambient light at some position, and sounds an alarm if that level alters due, for instance, to the presence of an intruder.

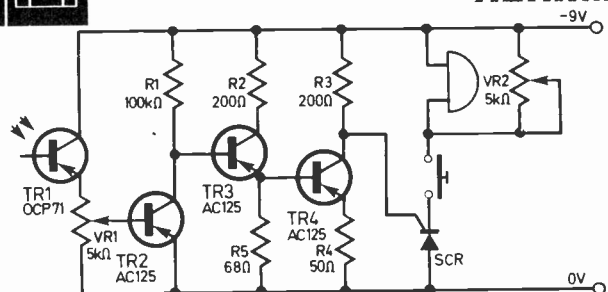
Photo-transistor TR1, which is operated with its base open circuit, can be mounted at some considerable distance from the remainder of the unit. VR1 sets the sensitivity, and is adjusted so that TR4 is just cut off at normal lighting levels. When the light level falls TR2 collector current is reduced and TR3 collector current rises. Base current flows in TR4 and the fall in collector voltage triggers the SCR.

Having fired, the SCR will remain in conduction even if the intruder moves away from the vicinity of TR1, and the bell will continue to



SENSITIVE BURGLAR ALARM

Fig. 1



ring. VR2 ensures that enough current is bypassed to keep the SCR on when the bell trembler contacts are in the open condition. Its setting will depend upon the particular SCR

used. The circuit is reset by breaking the ringing circuit momentarily with the Reset switch.

I. Musa,
Lagos, Nigeria.

The Experimenter

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That's 550 contacts in all! (See diagram).

All terminal strips are recessed into the bottom of the plastic body, and covered with a stick-on vinyl backing, so you have no insulation problems.

The contact rows are numbered 1-5-10 etc. and A-B-C--J lengthways, so each position is clearly defined. The bus-strips are labelled X-Y, each end.

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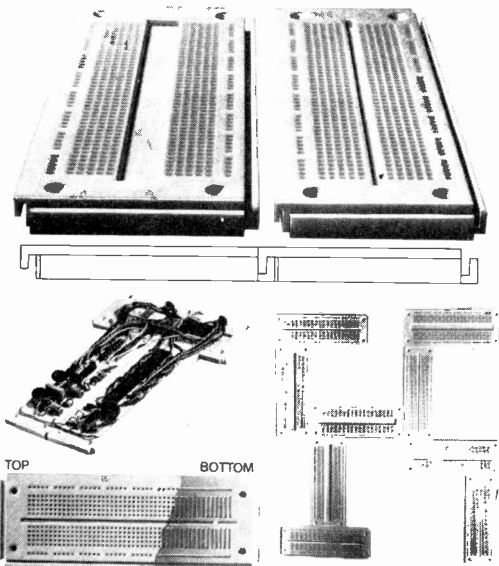
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GRAPHIC LEVEL DISPLAY

THE following device was designed to display the relative signal levels of audio inputs to a mixer unit, in a graphical form, and thus allowing all the levels to be seen simultaneously. On a conventional audio mixer there may be at least 20 VU meters, and these need to be looked at in quick succession to judge the relative signal levels.

An arbitrary number of i.e.d. indicator lamps are mounted in a vertical line on a panel, and one column is used for each input. A low level signal will trigger the lowest lamp, a slightly higher level will trigger the next lamp, and so on, until all the lamps are triggered and all light up. The lamps could be colour coded according to the intensity.

As Fig. 1 shows, the signal levels can be seen in one glance, the higher up the bar the lamps are lit, the greater the level. This type of display could perhaps be used to greatest benefit in a sound mixer for concert work.

The audio signal is amplified and the resulting signal is rectified to produce a signal that is used as a control voltage for a CMOS switch, the quad analogue switch 4061. In this i.c. when a certain pre-fixed

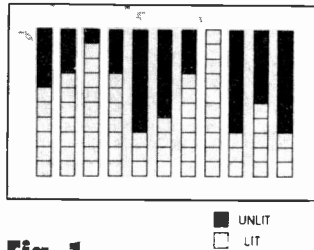
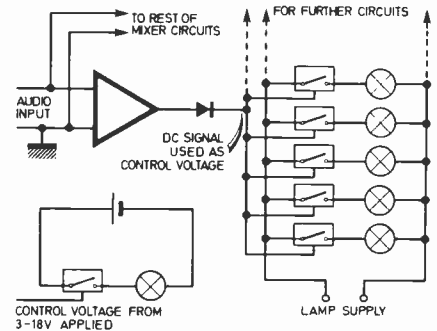


Fig. 1

voltage is applied to the control input of the device, it causes an electrostatic switch to close circuit and conduct, and in this circuit, it causes the lamps to light.

A separate CMOS device is needed for each pre-set level but each i.c. can be used for three other level controls of the same magnitude on other input sections.

As an example, an amplified level of 3V (actually the lowest level that will trigger the 4061) is used as one control voltage for the i.c. This 3V level corresponds to an instrument input level of 30mV before amplifying; this is used to trigger the first lamp of the series, and using separate CMOS devices with higher trigger levels will trigger the next lamps



in the series, if the instrument level increases. (Figures based on a gain of 100 for a 741.)

The power taken by each switch in the CMOS is very low, so a large number of indicator lamps could be triggered by the control voltage from the same source (i.e. high fan-out). There is no interference from the switching procedure, so there will be no pick-up on the audio signal, also the switching is very fast so no audio peaks will be missed.

PRACTICAL ELECTRONICS, February 1976 (not available), explains the 4061 and gives the layout.

Miss L. Robinson,
Wilmslow,
Cheshire.

SOUND OPERATED FLASH TRIGGER

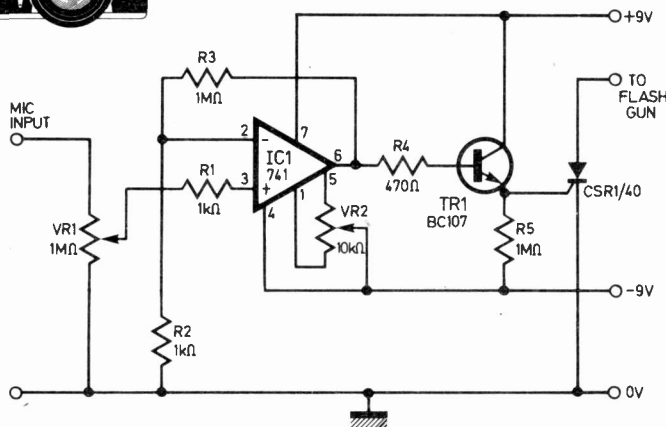


Fig. 1

THIS circuit is built around the versatile 741 operational amplifier, resistors R1, R2 and R3 are in a standard biasing pattern for a gain of approximately 10³. A sound hitting the microphone creates an electrical signal which is developed across VR1, which provides control of the operating level. This signal is then amplified by IC1 and fed to the base of TR1. When TR1 conducts, a voltage appears on the gate of the thyristor, causing it to fire and thus discharge the flash. Resistor R5 holds the gate at or near earth potential until the trigger pulse arrives, so preventing the thyristor drifting into a random firing condition.

Preset potentiometer VR2 can be set to give an output from IC1 of about +600mV under no signal conditions, so that TR1 is on the point of conduction. Two small nine volt batteries provide an adequate power supply and allow the unit to be housed in a very small container.

R. A. Dix,
Newcastle,
Staffs.



ACTIVE CROSSOVER

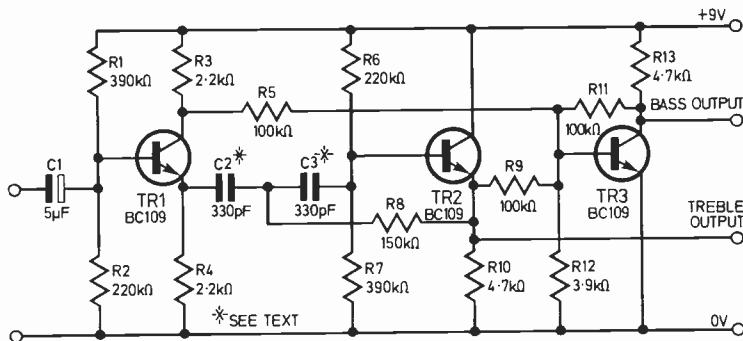


Fig. 1

This circuit will divide a flat audio output into bass and treble components for driving a woofer and a tweeter via separate amplifiers.

Transistor TR1 operates as a unity gain phase splitter, antiphase outputs appearing across R3 and R4. The non-inverted signal across R4 is fed to the second stage TR2. This transistor in conjunction with R8, C2 and C3 forms a second order high pass Butterworth filter with a

turnover of 3kHz and a slope of 12dB per octave.

The output of the filter is the high frequency audio component. This signal is also subtracted from the flat input signal by the virtual earth amplifier formed by TR3 and its associated components. Since these signals are mixed out of phase, and their amplitudes are equal, the output at the collector of TR3 contains only the bass frequencies of the original signal.

With the values shown for C2 and C3 the crossover has a turnover frequency of 3kHz. This can easily be changed by choosing new values for these components from the formula

$$C2 = C3 = \frac{1.06 \times 10^6}{f_n} \text{ pF}$$

where f_n is the required turnover frequency.

J. Macauley,
Crawley, Sussex.

LADDER OSCILLATOR WITH CMOS

The circuit in Fig. 1 shows a ladder network oscillator constructed round one gate of a CD4011. Four oscillators can thus be constructed around the one i.c.—useful perhaps for electronic music or sound effects.

The gate output (Fig. 2) is a distinctly rounded square wave (less so at low supply voltages) whilst a good sine wave is available at input A. Input B is free for switching the oscillator on and off. Second harmonics can be induced at the gate output by R1 or R2 (dotted).

As far as values of K are concerned K values down to 1.5 are usable, but $K \geq 10$ and/or four-stage ladders are possible with CMOS gates with their high input/output impedance ratios.

A second oscillator can be used to produce an interrupted tone. Frequencies of a few Hz are easily obtainable.

Two precautions should be noted. When using large value capacitors it would be prudent to protect the A input from switch-on damage with a 5kΩ or greater resistor. The other factor to be watched is dissipation, which should be limited to 200mW per chip (since the gate is not driven hard into high or low states). Experience has shown that at a supply voltage of 12V the overall dissipation

Fig. 1

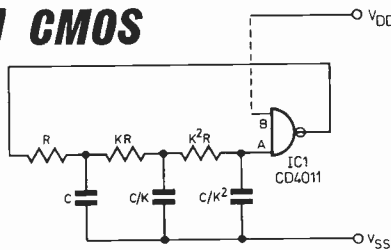


Fig. 2

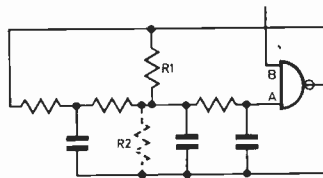
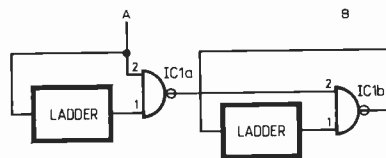


Fig. 3



is acceptable. According to the chip used, the minimum supply voltage for oscillation is around 3-4V.

Note: an improved waveform (but a little different in sound) is obtained by connecting input 2 of gate IC1a to gate IC1b output, if

input 2 is not required for control purposes, i.e. with input 2 high an interrupted tone is obtained, and with 2 low, a continuous tone.

C. J. Collins,
Letchworth.



15-240 WATTS!

HY5 Preamplifier

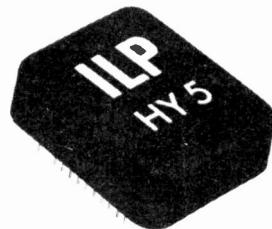
The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc.) are catered for internally, the desired function is achieved either by a multi-way switch or direct connection to the appropriate pins. The internal volume and tone circuits merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.

FEATURES: complete pre-amplifier in single pack; multi-function equalisation, low noise, low distortion, high overload; two simply combined for stereo.

APPLICATIONS: hi-fi; mixers, disco; guitar and organ, public address.

SPECIFICATION: Inputs—magnetic pick-up 3mV; ceramic pick-up 30mV; tuner 100mV; microphone 10mV; auxiliary 3-100mV, input impedance 47k Ω at 1kHz. Outputs—tape 100mV, main output 500mV R.M.S. Active Tone Controls—treble \pm 12dB at 10kHz; bass \pm 12dB at 100Hz. Distortion—0.1% at 1kHz, signal/noise ratio 68dB. Overload—38dB on magnetic pick-up. Supply Voltage— \pm 16-50V.

Price \pounds 4.75 + 59p VAT. P. & P. free
HY5 mounting board B.1. 48p + 6p VAT. P. & P. free



HY30 15W into 8 Ω

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FEATURES: complete kit; low distortion, short, open and thermal protection, easy to build
APPLICATIONS: updating audio equipment, guitar practice amplifier, test amplifier, audio oscillator
SPECIFICATION: Output Power—15W R.M.S. into 8 Ω . Distortion—0.1% at 15W. Input Sensitivity—500mV. Frequency Response—10Hz-16kHz -3dB

Price \pounds 4.75 + 59p VAT. P. & P. free

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FEATURES: low distortion, integral heatsink; only five connections; 7 amp output transistors no external components.

APPLICATIONS: medium power hi-fi systems, low power disco, guitar amplifier.
SPECIFICATION: Input Sensitivity—500mV. Output Power—25W R.M.S. into 8 Ω . Load Impedance—4-16 Ω . Distortion—0.04% at 25W at 1kHz. Signal/Noise Ratio—75dB. Frequency Response—10Hz-45kHz -3dB. Supply Voltage— \pm 25V. Size—105 x 50 x 25mm

Price \pounds 6.20 + 77p VAT. P. & P. free



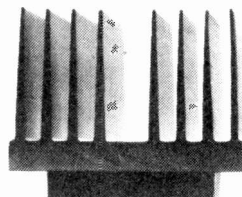
HY120 60W into 8 Ω

The HY120 is the baby of I.L.P.'s new high power range, designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design.

FEATURES: very low distortion, integral heatsink, load line protection, thermal protection; five connections; no external components.

APPLICATIONS: hi-fi; high quality disco, public address, monitor amplifier, guitar and organ
SPECIFICATION: Input Sensitivity—500mV. Output Power—60W R.M.S. into 8 Ω . Load Impedance—4-16 Ω . Distortion—0.04% at 60W at 1kHz. Signal/Noise Ratio—90dB. Frequency Response—10Hz-45kHz -3dB. Supply Voltage— \pm 35V. Size—114 x 50 x 85mm

Price \pounds 14.40 + \pounds 1.16 VAT. P. & P. free



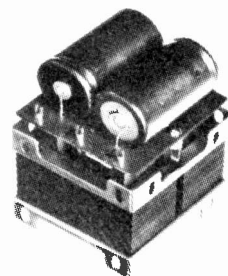
HY200 120W into 8 Ω

The HY200 (now improved to give an output of 120 watts) has been designed to stand the most rugged conditions such as disco or group while still retaining true hi-fi performance.

FEATURES: thermal shutdown, very low distortion, load line protection, integral heatsink, no external components.

APPLICATIONS: hi-fi, disco, monitor; power slave, industrial, public address
SPECIFICATION: Input Sensitivity—500mV. Output Power—120W R.M.S. into 8 Ω . Load Impedance—4-16 Ω . Distortion—0.05% at 100W at 1kHz. Signal/Noise Ratio—96dB. Frequency Response—10Hz-45kHz -3dB. Supply Voltage— \pm 45V. Size—114 x 100 x 85mm

Price \pounds 21.20 + \pounds 1.70 VAT. P. & P. free



HY400 240W into 4 Ω

The HY400 is I.L.P.'s 'Big Daddy' of the range producing 240W into 4 Ω ! It has been designed for high power disco or public address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.

FEATURES: thermal shutdown, very low distortion, load line protection, no external components.

APPLICATIONS: public address, disco, power slave, industrial
SPECIFICATION: Output Power—240W R.M.S. into 4 Ω . Load Impedance—4-16 Ω . Distortion—0.1% at 240W at 1kHz. Signal/Noise Ratio—94dB. Frequency Response—10Hz-45kHz -3dB. Supply Voltage— \pm 45V. Input Sensitivity—500mV. Size—114 x 100 x 85mm.

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Although the unit uses a 741 the need for a dual supply is avoided by the biasing resistors R1, R2

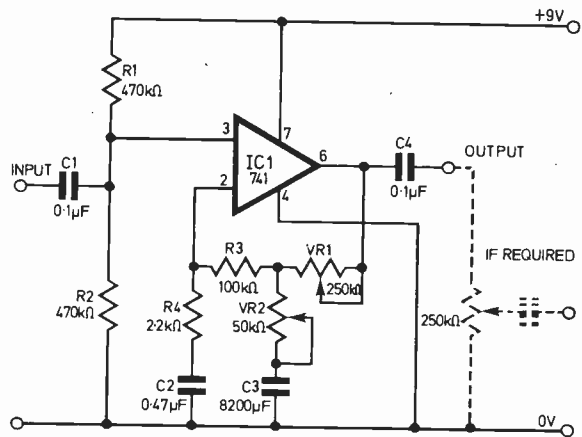


Fig. 1

enabling it to be powered from a PP3 type battery, and making it small enough to be built into an existing amplifier, or guitar. If the output level is found to be too high a volume control or small preset

could be fitted as shown dotted in the diagram.

J. White,
Huddersfield,
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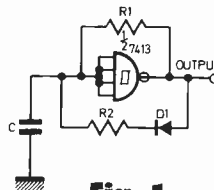


Fig. 1

value. The capacitor charges up via D1/R2 with R1 in parallel, and discharges through R1 as normal. The minimum pulse width is obtained when R2 is omitted, the charge resistance then being equal to the forward resistance of the diode.

A. Glover,
Braunston,
Northants.

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A DYNAMO is the most economical form of cycle lighting, but is dangerous at low speed or when stationary as little or no light is produced. The circuit shown in Fig. 1 overcomes this problem.

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One side of the dynamo was originally earthed and so had to be insulated; with a hub dynamo this

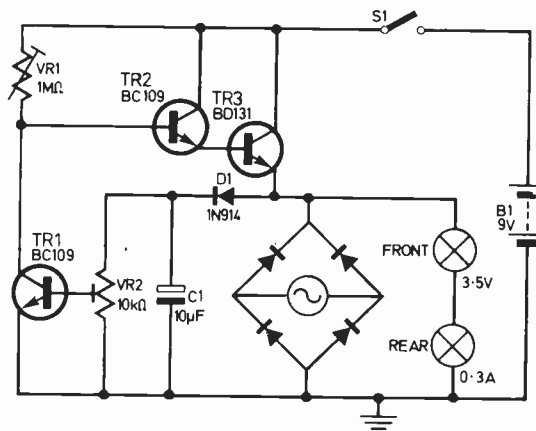


Fig. 1

would not be necessary. Two 4.5V flat batteries were used, secured in a plastics case beneath the saddle. Current drawn from the batteries drops to virtually zero at a fast walking pace, and so they should have a long life.

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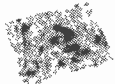
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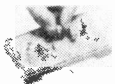
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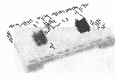
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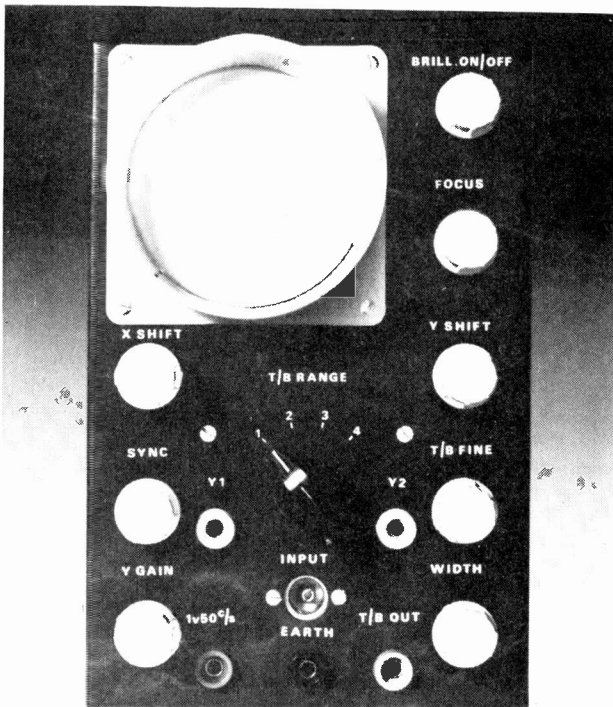
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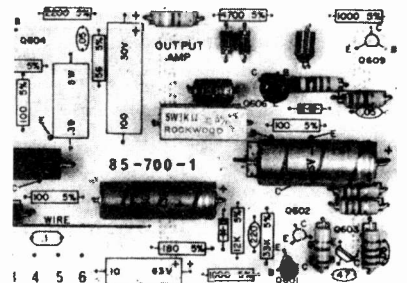
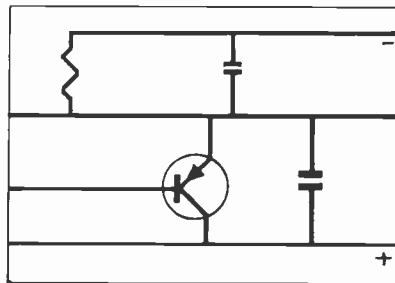
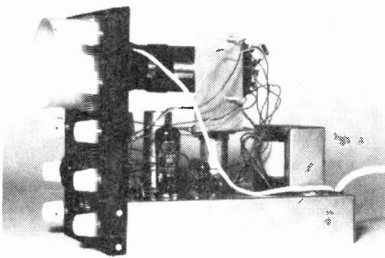


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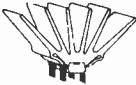
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The audio signals from the microphone and amplifier capsule create a varying magnetic field throughout the coil, which produces an electromotor effect on the magnet and vibrates the stapes. The stapes then functions in its normal manner, like a piston, causing vibration of the inner ear fluids, to produce an inner ear vibratory sensation of the sound picked up by the external microphone.

The aid could thus be of value to any patient with a defect in the

natural mechanical chain between the outer ear and stapes. Particularly valuable is the obviation of positive feedback or "howlround" risk as may be encountered with conventional acoustic aids.

STEAM TRAIN SOUND BP 1 436 814

A simple system for controlling a white noise generator on board a toy train, to simulate the puffing sound of a steam locomotive, is described by Louis Marx & Co Inc, of Connecticut, USA, in BP 1 436 814.

The noise generator, of any suitable form, is concealed in the engine chassis together with an audio amplifier and small loudspeaker. One of the engine wheels is mounted on a conductive axle and comprises two semicircular conductors separated by an insulator.

The conductors are bridged by a resistor and as the train moves under d.c. power supplies to the rails, the conductors alternately contact the live rail. In this way the white noise generator receives first unimpeded d.c., via one half of the wheel, and then impeded d.c. through the other half of the wheel and resistor.

The voltage supplied to the noise circuits thus alternately drops and rises producing the characteristic high and low hissing sounds associated with the puffing of a steam train. The sound produced is always proportional to the speed the train travels.

OIL LEVEL ALARM BP 1 431 230

In BP 1 431 230, the British Petroleum Co. Ltd. patents a mechanical gadget that poses an interesting electronic problem. The object of the patented invention is to provide an automatic dashboard alarm when the level of oil in a car sump falls below a safety level.

The part solution to the problem as patented by BP is a dipstick, formed of plastics material (such as PTFE) with very high insulation resistance and tolerance to temperatures. This dipstick has a central core of mild steel with a spade connector at the upper end, a bared metal portion at the lower end, and a bung for securing it to any car dipstick orifice halfway along its length.

The dipstick is sold in one size and trimmed to just the right length for a specific car to locate the metal tip at the level below which the oil should not fall.

What the patent refers to simply as "an indicating means" is provided on the dashboard, to register "the very small current that is made to flow from the detecting tip of the probe into the oil" when a reference voltage is applied between the sump casing and the probe tip. Current flow, of course, indicates the presence of oil and safe conditions in the sump. However, having in mind the fact that oil is conventionally used as an insulating material, the "indicating means" claimed by BP will need to be highly sensitive to minute current flows.

No clue is given as to possible circuitry for such a means, and readers may care to consider the practicability or otherwise of adapting currently available circuitry for the task.

IN BRIEF

BP 1 446 421/2—Royce Thompson Electric Ltd: *Electrical Switching System*. A photosensitive solid-state switching circuit for a.c. power, which switches sharply from full-off to full-on and back to full-off again depending on ambient light levels and with a minimum of r.f. interference. Intended for use, for instance, in street lights as an alternative to time-switching.

BP 1 440 724



Fig. 1

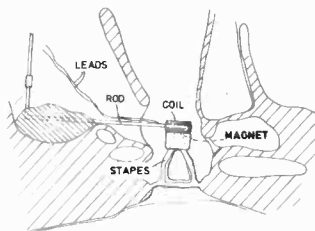


Fig. 2

Copies of Patents can be obtained from the Patent Office Sales, St. Mary Cray, Orpington, Kent Price 75p each

Readout —

A SELECTION FROM OUR POSTBAG

Readers requiring a reply to any letter must include a stamped addressed envelope. We regret that we cannot answer any technical queries on the telephone.

Time Check

Sir.—Many electronic digital watches are now advertised in PRACTICAL ELECTRONICS and elsewhere, yet none seems to offer a 24-hour display. The 12-hour display which necessitates the distinction between a.m. and p.m. is one of the main disadvantages of analogue watches which are in general easier to read and more convenient to use. The other disadvantage is that accuracy depends on high precision engineering which is costly.

The majority of digital clocks, whether mechanical or electronic, provide 24-hour displays which greatly simplify reference to virtually all public transport timetables, and it cannot be long before the BBC and P.O. adopt this format. I suspect they already use it for internal purposes and the sooner we all standardise on a single international system of weights and measures, including time, the better.

Electronic watches are often advertised with such phrases as "state of the art" or "space age technology" and it is surprising that they do not use an up-to-date display format, especially when it must be presumed that potential buyers are in favour of innovation.

I should be very grateful if any of your readers could tell me of any suppliers of 24-hour digital watches—at a reasonable price.

R. A. Porter,
Redcar.

We understand that only one digital watch with a 24-hour display is currently available in this country. This is the solar-powered Ragen Synchronar, retailing at £325.00!—Ed.

Lamp Lens

Sir.—Some of your readers may be interested in my idea for making indicator lamp lenses using a Dymo tape machine and one of the liquid plastic resins, such as Plasticraft, available from hobby shops.

The required motif is first stamped out on the tape machine. The tape is then stuck on the inside of a shallow

metal tray or tin lid of the desired shape and size of the finished lens. The inside of the tray is now coated with release agent and carefully polished.

The liquid plastic resin is then mixed and poured into the tray. When set, the plastic may be removed from the tray and the tape peeled from the back of the casting. The net result is that the motif will now be cast in reverse.

The next stage is to file the lens to shape and polish it. The motif, which now looks similar to the engraving, is filled with soft wax, any excess being sanded off, and the whole of the back of the lens sprayed matt black.

When the paint is dry the wax can be carefully picked out of the motif with a pin. The result is that when the lens is illuminated from behind the motif will stand out against the black background. With a red filter behind the lens or by tinting the plastic with translucent dye the effect is similar to l.e.d.s.

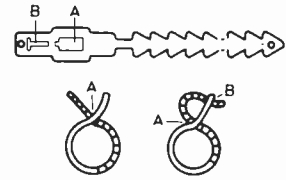
M. J. Hourican,
Portsmouth,
Hants.

Substitute Cable Clips

Sir—A project involving large amounts of interconnecting wiring between units requires cable ties or lacing cord to organise them. Purpose designed polythene ties retail at about £2.16 per 100. However, polythene "Plasti-Ties" for gardeners, for plant stems at 36p per 100, are available.

The tie consists of a serrated tail on the end of which are two slots for engaging the serrations, after encircling the plant, which, in this case, can also be used for retaining bunches of wires, see Fig. 1. One slot "A" will permit the tying of bunches of wires from 6–28mm in 2mm steps. The second alternate, slot "B", will enable wires from 10–32mm diameter to be secured.

Use of both retaining slots simultaneously will result in a figure "8" configuration, thus securing two bunches of wires alongside each other, their maximum diameter being 10 and



16mm. A hole which will accept an 8BA bolt is present at both ends of the tie and can be used for securing. The ties are reusable.

M. B. Wignall,
Portsmouth

A strong wind

Sir—I feel it hard to believe that Mr Gray has made his "Simple Anemometer" (*Ingenuity Unlimited*), October issue, work.

It would need a very strong wind to turn half "ping-pong" balls on 6in dowels unless the bearing was frictionless. I have seen half of ball valve floats used this way with three being used with arms in the region of two feet with a good bearing.

As for the use of a car, there is the very great difficulty of elevating the device above the car enough to clear currents brought about by the car moving through even still air. The speed of the airflow round a car is far higher than the road speed resulting from the displacement of the air by the car.

E. Radd,
York.

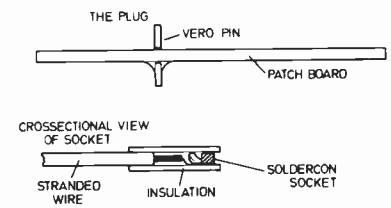
Good Connection

Sir.—Patch-board plugs and sockets, whatever their application, tend to be rather costly, particularly if a large number are required. Fig. 1 shows a way of producing a connector system which will not break the bank!

The plugs are made simply by soldering Veropins onto the patch-board. The sockets are made from Soldercon sockets, individual i.e. sockets purchased by the 100. The Soldercon socket is soldered to the end of a stranded wire lead and covered with insulation. Heat-shrink sleeving is ideal for this purpose, giving a neat and durable finish. Connections are made simply by pushing the socket onto the Veropin.

At current prices, the cost works out at about £1 per 100 plugs and sockets.

T. I. Mason,
Evington,
Leicester.



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2N457A	1-70	Yellow	0-13	AF106	0-45	BC207	0-11	BF160	0-30	LM308N	1-32	OC28	2-00
2N490	4-60	Orange	0-13	AF114	0-65	BC208	0-10	BF161	0-60	LM309K	1-80	OC35	1-50
2N491	5-00	2N3053	0-25	AF115	0-65	BC212	0-14	BF166	0-40	LM381AN	2-07	OC42	0-50
2N492	5-75	2N3054	0-50	AF116	0-65	BC212L	0-17	BF167	0-33	LM702C	0-75	OC45	0-75
2N493	5-98	2N3055	0-65	AF117	0-65	BC214L	0-17	BF173	0-33	LM709	0-83	OC71	0-45
2N496	0-25	2N3390	0-37	AF118	0-65	BC237	0-17	BF177	0-38	TO99	0-40	OC72	0-45
2N697	0-16	2N3391	0-34	AF125	0-65	BC238	0-12	BF178	0-45	8DIL	0-40	OC74	0-45
2N698	0-82	2N3392	0-14	AF126	0-65	BC239	0-16	BF179	0-48	14DIL	0-40	OC81	0-75
2N699	0-55	2N3393	0-15	AF127	0-65	BC251	0-15	BF180	0-45	LM723C	0-60	OC83	0-50
2N706	0-12	2N3394	0-15	AF128	0-65	BC253	0-22	BF181	0-45	LM741	0-45	ORP12	0-70
2N706A	0-12	2N3402	0-30	AF139	0-69	BC257	0-17	BF182	0-45	TO99	0-38	RS3	1-80
2N708	0-21	2N3414	0-15	AF186	0-50	BC258	0-17	BF183	0-45	8DIL	0-40	SL414A	2-35
2N709	0-50	2N3415	0-17	AF200	0-70	BC259	0-18	BF184	0-45	14DIL	0-40	SL610C	2-35
2N711	0-55	2N3416	0-23	AF239	0-74	BC261	0-21	BF185	0-30	LM747CN	0-78	SL623C	2-35
2N718	0-22	2N3418	0-27	AF240	0-90	BC262	0-19	BF194	0-12	LM748	0-45	SL611C	2-35
2N718A	0-20	2N3440	0-57	AF279	0-80	BC263	0-30	BF195	0-11	TO99	0-38	SL612C	2-35
2N720	0-69	2N3441	0-78	AF280	0-85	BC300	0-45	BF196	0-13	8DIL	0-44	SL620C	3-50
2N914	0-22	2N3442	1-20	AL102	1-50	BC301	0-45	BF197	0-14	14DIL	0-41	SL621C	3-50
2N915	0-43	2N3443	0-18	AL103	1-50	BC302	0-40	BF198	0-15	LM76033N	2-36	SL623C	5-75
2N918	0-34	2N3638A	0-30	BC107	0-14	BC303	0-20	BF200	0-31	LM76033N	2-36	SL640C	4-00
2N929	0-25	2N3639	0-30	BC108	0-12	BC307	0-20	BF225J	0-25	LM7805P	1-39	SL610C	4-00
2N930	0-26	2N3641	0-20	BC109	0-15	BC308	0-18	BF244	0-35	LM7812P	1-39	SL620C	3-50
2N1302	0-37	2N3702	0-17	BC113	0-17	BC309C	0-25	BF245	0-34	LM7815P	1-39	TA263	1-25
2N1303	0-37	2N3703	0-15	BC115	0-19	BC317	0-14	BF246	0-75	LM7824P	1-39	TA305	2-67
2N1304	0-40	2N3704	0-15	BC116	0-19	BC318	0-13	BF254	0-20	LM7826P	1-39	TA350	2-67
2N1305	0-40	2N3705	0-15	BC116A	0-20	BC337	0-19	BF255	0-20	LM7828P	1-39	TA455	2-67
2N1306	0-45	2N3706	0-14	BC117	0-22	BC338	0-21	BF257	0-37	LM7830P	1-39	TA550	2-67
2N1307	0-45	2N3707	0-18	BC118	0-16	BC347	0-12	BF258	0-49	MC1466L	3-95	TA651	1-80
2N1308	0-80	2N3708	0-14	BC119	0-30	BC548	0-10	BF259	0-49	MC1469R	2-50	TB800	1-20
2N1309	0-60	2N3709	0-15	BC121	0-45	BC549	0-13	BF259	0-24	ME0402	0-20	TB810	1-16
2N1671	1-80	2N3710	0-14	BC125	0-18	BCY30	1-03	BF279	0-24	ME0404	0-15	TB820	1-03
2N1671A	1-92	2N3711	0-15	BC126	0-25	BCY31	1-06	BFS21A	2-80	ME0412	0-20	TB820	1-79
2N1671B	2-12	2N3712	0-20	BC132	0-30	BCY32	1-18	BFS28	1-04	ME4102	0-10	TIL209	0-30
2N1711	0-57	2N3713	0-20	BC134	0-15	BCY33	0-90	BFS51	0-30	ME4104	0-10	TIP29A	0-50
2N1907	5-20	2N3714	2-45	BC135	0-15	BCY34	0-68	BFS98	0-27	MJ480	1-05	TIP29C	0-75
2N2102	0-60	2N3715	2-45	BC136	0-19	BCY38	2-00	BFX29	0-36	MJ481	1-10	TIP30A	0-60
2N2147	1-40	2N3716	2-60	BC137	0-14	BCY42	0-60	BFX30	0-38	MJ490	1-05	TIP30C	0-85
2N2148	1-65	2N3717	1-60	BC140	0-60	BCY58	0-55	BFX84	0-38	MJ491	1-55	TIP31A	0-82
2N160	1-10	2N3772	1-70	BC141	0-65	BCY59	0-32	BFX85	0-41	MJ2955	1-21	TIP31C	0-85
2N2218A	0-47	2N3773	2-65	BC142	0-30	BCY70	0-25	BFX87	0-35	MJE340	0-58	TIP32A	0-75
2N2219	0-42	2N3789	2-60	BC143	0-60	BCY71	0-26	BFX88	0-32	MJE355	1-25	TIP32C	1-00
2N2219A	0-52	2N3790	2-75	BC147	0-10	CV72	2-44	BFX89	0-95	MJE3055	0-75	TIP33A	0-85
2N2220	0-35	2N3791	2-75	BC148	0-10	BD115	1-20	BFY50	0-30	MJE370	0-68	TIP33C	1-45
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2N2221A	0-26	2N3794	0-20	BC153	0-27	BD121	2-00	BFY52	0-36	MJE520	0-85	TIP34C	1-70
2N2222	0-25	2N3819	0-36	BC154	0-27	BD123	2-00	BFY53	0-34	MJE521	0-75	TIP35A	2-30
2N2222A	0-25	2N3820	0-29	AC152V	0-50	BC157	0-50	BFY54	0-32	MJE2955	1-25	TIP35B	2-30
2N2368	0-17	2N3823	0-61	AC153	0-40	BC158	0-11	BRV39	0-50	MP8112	0-40	TIP41A	0-70
2N2369	0-25	2N3904	0-21	AC153K	0-42	BC160	0-78	BSX20	0-31	MP8113	0-45	TIP41C	1-00
2N2369A	0-21	2N3906	0-22	AC154	0-45	BC167	0-12	BSX21	0-32	MPF102	0-30	TIP42A	0-90
2N2646	0-55	2N4036	0-67	AC176	0-40	BC176	0-12	BU05	3-05	MPSA05	0-20	TIP42C	1-20
2N2647	1-10	2N4037	0-55	AC176K	0-45	BC168	0-12	BU025	2-40	MPSA06	0-20	TIP2955	1-00
2N2904	0-36	2N4038	0-50	AC180	0-46	BC169	0-12	BU205	2-40	MPSA07	0-20	TIP2955	0-50
2N2904A	0-37	2N4059	0-15	AC188K	0-45	BC169	0-12	BU206	2-40	MPSA08	0-20	TIP2955	0-50
2N2905	0-37	2N4060	0-20	AC187	0-45	BC170	0-16	BU207	2-40	MPSA09	0-20	TIP2955	0-50
2N2905A	0-38	2N4061	0-17	AC188	0-42	BC171	0-14	BU208	2-40	MPSA10	0-20	TIP2955	0-50
2N2906	0-28	2N4062	0-18	AD142	0-85	BC172	0-12	CA3046	0-73	MPSU06	0-40	ZTX300	0-15
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2N2907	0-59	2N4289	0-30	AD148	0-74	BC178	0-18	CA3052	1-62	MPSU06	0-45	ZTX501	0-15
2N2907A	0-22	2N4919	0-85	AD150	0-21	BF117	0-21	CA3080A	1-10	NE555V	0-48	ZTX502A	2-28
2N2924	0-15	2N4920	0-90	AD161	0-75	BC182	0-11	CA3089E	0-60	NE561	0-40	ZTX530	0-23
2N2925	0-17	2N4921	0-60	AD162	0-75	BC182L	0-14	CA309AQ	4-25	NE560D	4-48	ZTX531	0-22

CA3130	0-68	NE561	4-48
LM301A	0-47	NE565A	1-30
LM308N	1-32	OC28	2-00
LM309K	1-80	OC35	1-50
LM381AN	2-07	OC42	0-50
LM702C	0-75	OC45	0-75
LM709	0-83	OC71	0-45
TO99	0-40	OC72	0-45
8DIL	0-40	OC81	0-75
14DIL	0-40	OC83	0-50
LM723C	0-60	ORP12	0-70
LM741	0-45	RS3	1-80
TO99	0-38	SL414A	2-35
8DIL	0-35	SL610C	2-35
14DIL	0-40	SL611C	2-35
LM747CN	0-78	SL612C	2-35
LM748	0-45	SL620C	3-50
LM7805P	1-39	SL621C	3-50
LM7812P	1-39	SL623C	5-75
LM7815P	1-39	SL640C	4-00
LM7824P	1-39	SN76033N	2-36
LM7826P	1-39	SN76033N	2-36
LM7828P	1-39	SN76033N	2-36
LM7830P	1-39	SN76033N	2-36
MC1466L	3-95	SN76033N	2-36
MC1469R	2-50	SN76033N	2-36
ME0402	0-20	SN76033N	2-36
ME0404	0-15	SN76033N	2-36
ME0412	0-20	SN76033N	2-36
ME4102	0-10	TIL209	0-30
ME4104	0-10	TIP29A	0-50
MJ480	1-05	TIP29C	0-75
MJ481	1-10	TIP30A	0-60
MJ490	1-05	TIP30C	0-85
MJ491	1-55	TIP31A	0-82
MJ2955	1-21	TIP31C	0-85
MJE340	0-58	TIP32A	0-75
MJE355	1-25	TIP32C	1-00
MJE3055	0-75	TIP33A	0-85
MJE370	0-68	TIP33C	1-45
MJE371	0-81	TIP34A	1-20
MJE520	0-85	TIP34C	1-70
MJE521	0-75	TIP35A	2-30
MJE2955	1-25	TIP35B	2-30
MP8112	0-40	TIP41A	0-70
MP8113	0-45	TIP41C	1-00
MPF102	0-30	TIP42A	0-90
MPSA05	0-20	TIP42C	1-20
MPSA06	0-20	TIP2955	1-00
MPSA07	0-20	TIP2955	0-50
MPSA08	0-20	TIP2955	0-50
MPSA09	0-20	TIP2955	0-50
MPSA10	0-20	TIP2955	0-50
MPSU06	0-40	ZTX300	0-15
MPSU05	0-45	ZTX500	0-15
MPSU06	0-45	ZTX501	0-15
NE555V	0-48	ZTX502A	2-28
NE561	0-40	ZTX530	0-23
NE560D	4-48	ZTX531	0-22

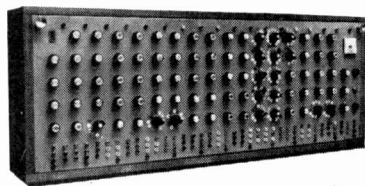
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(P.E. Feb. 73 to Feb. 74)

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 - Keyboard Stabilised Power Supply £7-61
 - Printed Circuit Board £1-04

GUITAR EFFECTS PEDAL (P.E. July 75)

Modulates the attack, decay and filter characteristics of an audio signal not only from a guitar but from any audio source, producing 8 different switchable effects that can be further modified by manual controls. Possibly the most interesting of all the low-priced sound effects units in our range. Circuit does not duplicate effects from the Guitar Overdrive Unit.

- Component Set with special foot operated switches £6-79
- Alternative component set with panel mounting switches £4-90
- Printed Circuit Board £1-43

SOUND BENDER (P.E. May 74)

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

- Component Set for above functions (excl. SWs) £7-24
- Printed circuit board £1-74
- Optional extra—additional Audio Modulator, the use of which, in conjunction with the above component set, can produce "jungle-drum" rhythms. £2-76
- Component Set (incl. PCB)

PHASING UNIT (P.E. Sept. 73)

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

- Component Set (incl. PCB) £2-85

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

For use with the above Phasing Unit to automatically control the rate of phasing.

- Component Set (incl. PCB) £4-25

WAH-WAH UNIT (P.E. Apr. 76)

The Wah-wah effect produced by this unit can be controlled manually or by the integral automatic controller.

- Component Set incl. PCB £3-20

POST AND HANDLING

U.K. orders under £15 add 25p plus VAT, over £15 add 50p plus VAT. Keyboards £1-50 plus VAT. Optional Insurance for compensation against loss or damage in post, add 35p in addition to above post and handling. Eire, C.I., B.F.P.O., and other countries are subject to Export postage rates.

P.E. JOANNA (P.E. May/Sept. 75)

A five-octave electronic piano that has switchable alternative voicing of Honky-Tonk piano, ordinary piano, harpsichord, or a mixture of any of the three, together with facilities including fast and slow tremolo, loud and soft pedal switching, and sustain pedal switching. The power amplifier typically delivers 24 watts into 8 ohms. The PCBs have been redesigned by ourselves making improved use of the space available.

- Main Power Supply £10-09
- Tone Generator and Top C Envelope Shaper £10-61
- PCB for Main PSU, Tone Gen & Top C E.S. £2-31
- Envelope Shapers for all notes (except Top C) £37-68
- Set of PCBs for Envelope Shapers (except Top C) £11-88
- Voicing and Pre-Amp Circuits £2-80
- PCB for Voicing and Pre-amp £2-80
- Power Amplifier (incl. separate Power Supply) £15-06
- PCB for Power Amp and PSU 95p

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

Programmable for 64,000 rhythm patterns from 8 effects circuits (high and low bongos, bass and snare drums, long and short brushes, blocks and soft cymbal), and with variable time signatures and rhythm rates. Really fascinating and useful.

- Tempo, Timing and Logic circuits £12-68
- PCB for above circuits (double-sided) £3-24
- Component set for all 8 effects circuits £12-72
- PCB for all 8 effects £3-74
- Simple mixer (our design) incl. PCB £3-95
- Alternative mixer with external volume controls, incl. PCB £10-94
- Power Supply for T, T and L, and Effects, incl. PCB £7-10
- (See our list for Power Supplies for Mixers)

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

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

- Component Set (excl. spring unit) £8-79
- Printed Circuit Board £1-93
- 9 in. Spring Unit £5-50
- Panel Meter (50µA) (optional) £4-99

WIND AND RAIN UNIT

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

- Component set incl. PCB £3-37

GUITAR OVERDRIVE UNIT (P.E. Aug. 76)

Sophisticated, versatile Fuzz unit, including variable and switchable controls affecting the fuzz quality whilst retaining the attack and decay, and also providing filtering. Does not duplicate the effects from the Guitar Effects Pedal and can be used with it and with other electronic instruments.

- Component set using dual slider pot £6-57
- Component set using dual rotary pot £5-80
- Printed circuit board £1-37

FUZZ UNIT

Simple Fuzz unit based upon P.E. 'Sound Design' circuit.

- Component set incl. PCB £1-98

TREMOLO UNIT

Based upon P.E. 'Sound Design' circuit.

- Component set incl. PCB £3-19

TREBLE BOOST UNIT (P.E. Apr. 76)

Gives a much shriller quality to audio signals fed through it. The depth of boost is manually adjustable.

- Component Set incl. PCB £2-31

25 WATT MONO AMPLIFIER (P.E. Sept. 75)

A good general purpose integrated circuit power amplifier typically delivering 25 watts into 8 ohms. Power bandwidth 20Hz to 20kHz, 3dB. Input impedance 20kΩ. Distortion 0.2%. Suitable for use with any of our sound producing kits.

- Component Set incl. power supply £15-06
- Printed Circuit Board 95p
- For stereo use two sets and PCBs are required.

DON'T FORGET VAT!

Add 12½% (or current rate if changed) to full total of goods, post and handling. (Does not apply to export orders).

P.E. MINISONIC MK I

(P.E. Nov. 1974 to March 1975)

A portable, battery or mains operated, miniature sound synthesiser, with keyboard circuits. Although having slightly fewer facilities than the large P.E. Synthesiser, the functions offered by this design give it great scope and versatility. Like the large Synthesiser it too may be advantageously used with other circuits in our lists.

- Basic component set £41-58
- Set of PCBs £7-71
- Full details in our list.

P.E. MINISONIC MK 2

More sophisticated version of the MK I.

- Basic component set £52-15
- Set of PCBs £9-10
- Full details in our list.

DISCOSTROBE (P.E. Nov. 76)

4-channel light-show controller giving a choice of sequential, random, or full strobe mode of operation.

- Basic component set £19-43
- Printed circuit board £2-85

ENVELOPE SHAPERS

Both of the kits below have manual control over their Attack, Decay, Sustain and Release functions. Both kits include PCB (VCA means Voltage Controlled Amplifier)

- Envelope Shaper and VCA (P.E. Apr. 76) £6-50
- Envelope Shaper (without VCA) (P.E. Oct. 75) £4-62

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

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

- Component Set incl. PCB £3-74

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

An independently designed VCF that can be used with the P.E. Synthesiser.

- Component Set £3-67
- Printed Circuit Board £1-38

P.E. TUNING FORK (P.E. Nov. 75)

84 switch-selected frequency-accurate tones. An LED monitor clearly displays all beat note adjustments. Ideal for tuning acoustic and electronic musical instruments alike.

- Main Component Set incl. PCB £14-77
- Power Supply set incl. PCB £6-95

P.E. SYNCHRONOME (P.E. Mar. 76)

An accented-beat electronic metronome, providing duple, triple and quadruple times with full control over the beat rate. Can also be used as a simple drum-beat rhythm generator. Includes power supply.

- Component Set incl. loudspeaker £10-68
- Printed Circuit Board £1-70

PEAK LEVEL INDICATOR (P.E. Mar. 76)

A twin-channel visual display unit for monitoring the peak level of audio signals. Well suited for use when inter-coupling our many sound producing kits to help avoid signal over-loading.

- Component Set incl. PCB (as published) £3-84

EXPORT ORDERS are welcome, though we advise that a current copy of our list should be obtained before ordering as it also shows Export postage rates. All payments must be cash-with-order, in Sterling and preferably by International Money Order or through an English Bank. To obtain list for Europe send 20p, for other countries send 40p.

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OTHER PROJECTS

PHOTOGRAPHS in this advertisement show two of our units containing some of the P.E. projects built from our kits and PCBs. The cases were built by ourselves and are not for sale, though a small selection of other cases is available.



LIST—Send Stamped Addressed Envelope with all U.K. requests for free list giving fuller details of PCBs, kits, and other components.

OVERSEAS enquiries for list: Europe—send 20p; Other Countries—send 40p.

KEYBOARDS AND CONTACTS

Kimber-Allen Keyboards as required for many published circuits, including the **P.E. Joanna, P.E. Minisonic, and P.E. Synthesiser**. The manufacturers claim that these are the finest moulded plastic keyboards available. All octaves are C to C. The keys are plastic, spring-loaded and mounted on a robust aluminium frame.

Contact Assemblies for use with above keyboards: Single-pole change-over (type SP) as for P.E. Joanna and P.E. Minisonic. Two-pole normally open-make-break (type DP) as for P.E. Synthesiser. Special contact assembly (type 4PS) having 4 poles, 3 of which are normally-open make-break contacts and the fourth is a change-over contact—this special assembly enables **THE SAME KEYBOARD** to be used with the P.E. Synthesiser, P.E. Minisonic and the P.E. Joanna simultaneously thus avoiding the cost of more than one keyboard.

Contact	Each	3 Octave Set	4 Octave Set	5 Octave Set
SP	24p	£8.88	£11.76	£14.64
2P	27p	£9.99	£13.23	£16.47
4PS	53p	£19.61	£25.97	£32.33

PRINTED CIRCUIT BOARDS for use with the above contacts and thus eliminating most of the inter-wiring required, are available. Details in our lists.

SOUND-TO-LIGHT (P.E. Apr./Aug. 71)

The ever-popular **Aurora**—4 or 8 channels each responding to a different sound frequency and controlling its own light. Can be used with most audio systems and lamp intensities. A MUST for any Disco, and a fascinating visual display for the home.

4 Channel Component Set (excl. thyristors)	£14.42
8 Channel Component Set (excl. thyristors)	£25.75
Power Supply Component Set	£5.35
PCB for 4 frequency channels	£3.65
PCB for power supply and 8 lamp drivers	£1.70
IA 400V thyristors (1 per chan. req.) each	75p
Panel meter (1µA) (optional)	£4.99

3-CHANNEL SOUND-TO-LIGHT (P.E. Apr. 76)

A simple but effective sound-to-light controller capable of operating 3 lamps each of approximately 700 watts. Includes power supply, thyristors, and by-pass switches.

Component Set incl. PCB £11.18

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

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

Pre-Amp Module Component Set incl. PCB £4.11

Basic Output Circuits—combined component set with PCBs, for alphaphone, cardiophone, frequency meter and visual feed-back lamp-driver circuits £5.95

Audio Amplifier Module Type PC7 £6.75

TAPE NOISE LIMITER

Very effective circuit for reducing the hiss found in most tape recordings. All kits include PCBs.

Standard Tolerance Set of Components £2.85

Superior Tolerance Set of Components £3.30

Regulated Power Supply (will drive 2 sets) £4.69

SINE AND SQUARE WAVE GENERATOR (P.E. July 75)

Suitable for audio, digital, or general purpose. Controllable through 4 decade ranges 10Hz to 100kHz, switched attenuation through 10 ranges from 10V to 1mV peak-to-peak.

Component Set. While stocks last £9.83

PCB for above components £1.76

Power Supply £6.21

PCB for Power Supply £1.06

SEMI CONDUCTOR TESTER (P.E. Oct. 73)

Essential test equipment for the enterprising home constructor. While stocks last.

Set of resistors, capacitors, semiconductors, potentiometers, makaswitches and PCB £8.86

Panel meter (500µA) £4.99

P.E. MINIMIX 6 (P.E. Nov./Dec. 75)

Each of the 6 input channels has its own gain, volume and panning controls. The volume of the twin channel outputs are fully manually controllable, as are the head-phone and pre-fade monitoring facilities. Twin VU meters provide visual display of channel audio levels. Ideal for use with effects and synthesiser kits. For details see our list. While stocks last.

8-INPUT MIXER

A simple mixer having 8 inputs each of which has a preset level control and which are combined into one output channel having a preset over-all level control and a master output volume control. Designed for inter-coupling our various sound effects and synthesiser kits. £3.95

Component set incl. PCB £3.95

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BC149	12p
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BC159	13p
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BC184	12p
BC187	25p
BC204	14p
BC209C	14p
BC212L	15p
BC213	15p
BC478	28p
BCY71	22p
BD131	44p
BD132	54p
BFY50	22p
BFY51	22p
BFY52	24p
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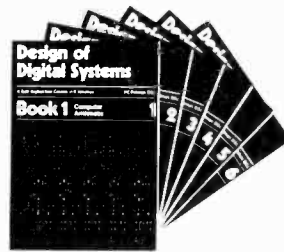
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NEW EDU-KIT MAJOR

**COMPLETELY SOLDERLESS
ELECTRONIC CONSTRUCTION KIT**

BUILD THESE PROJECTS WITHOUT SOLDERING IRON OR SOLDER



- 4 Transistor Earpiece Radio
- Signal Tracer
- Signal Injector
- Transistor Tester NPN-PNP
- 4 Transistor Push Pull Amplifier
- 5 Transistor Push Pull Amplifier
- 7 Transistor Loudspeaker Radio MW/LW
- 5 Transistor Short Wave Radio
- Electronic Metronome
- Electronic Noise Generator
- 24 Resistors
- 21 Capacitors
- 10 Transistors
- 3 1/2" Loudspeaker
- 3 12-way Connectors
- 2 Volume Controls
- 2 Slider Switches
- Ready Wound MW/LW/SW Coils
- Ferrite Rod
- 6 1/2 yards of wire
- 1 yard of sleeving, etc.
- Batteryless Crystal Radio
- One Transistor Radio
- 2 Transistor Regenerative Radio
- 3 Transistor Regenerative Radio
- Audible Continuity Tester
- Sensitive Pre-Amplifier
- Earpiece
- Mica Baseboard
- Tuning Condenser
- 3 Knobs

Complete kit of parts including construction plans
Total building costs £9.00 P.P. and Ins. 85p

V.H.F. AIR CONVERTER KIT

Build this converter kit and receive the aircraft band by placing it by the side of a radio tuned to medium wave or the long wave band and operating as shown in the instructions supplied free will all parts.

Uses a retractable chrome plated telescopic aerial, gain control, V.H.F. tuning capacitor, transistor, etc. All parts including case and plans
£3.95 P.P. & Ins. 45p



POCKET FIVE

Now with 3in Loudspeaker 3 tunable wavebands. MW, LW and trawler band. 7 stages, 5 transistors and 2 diodes, supersensitive ferrite rod aerial, attractive black and gold case. Size 5in x 1 1/2in x 3 1/2in approx.

Complete kit of parts including construction plans.
 Total Building Costs: **£3.60 P.P. and Ins. 60p**



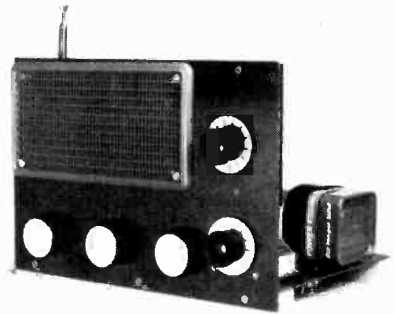
NEW ROAMER TEN MODEL R.K. 3

MULTIBAND V.H.F. AND A.M. RECEIVER.

13 TRANSISTORS AND FIVE DIODES. QUALITY 5" 3" LOUDSPEAKERS.

WITH Multiband V.H.F. section covering Mobiles, Aircraft, T.V. Sound, Public Service Band, Local V.H.F. Stations, etc. and Multiband A.M. section with Airspaced Slow Motion Drive Tuning Capacitor for easier and accurate tuning, covering M.W.1, M.W.2, L.W. Three Short Wave Bands S.W.1, S.W.2, S.W.3 and Trawler Band. Built-in Ferrite Rod Aerial for Medium Wave, Long Wave and Trawler Band, etc. Chrome Plated 7 section Telescopic Aerial, angled and rotatable for peak Short Wave and V.H.F. reception. Push-Pull output using 600mW Transistors. Gain, Wave-Change and Tone Controls. Plus two Slider Switches. Negative Feedback circuit and SPECIAL POWER BOOSTER SOCKET AND RESISTOR, to virtually double gain if required. Powered by P.P.9—9 volt Battery.

Complete kit of parts including carrying strap, Building Instructions and operating Manuals. **£13.99 Inc. P. & P.**
 Case enclosure kit (if required), **£1.80 inc. P. P. and Ins.**



NEW Everyday Series



Build this exciting new series of designs.

E.V.5. 5 Transistors and 2 diodes. MW/LW. Powered by 41V battery. Ferrite rod aerial, tuning condenser, volume control, and now with 3in. loudspeaker. Attractive case with red speaker grille. Size 9in. x 5 1/2in. x 2 1/2in. approx. All parts including Case and Plans.

Total Building costs **£4.30 P. & P. + Ins. 60p**

E.V.6. Case and looks as above. 6 Transistors 3 diodes. Powered by 9V battery. Ferrite rod aerial, 3in. loudspeaker, etc. MW/LW coverage. Push/Pull output. All parts including Case and Plans.

Total Building costs **£4.95 P. & P. + Ins. 65p**

E.V.7. Case and looks as above. 7 Transistors and 3 diodes. Six wavebands, MW/LW, Trawler Band SW1, SW2, SW3, powered by 9V battery. Push pull output. Telescopic aerial for short waves. 3in. Loudspeaker. All parts including Case and Plans.

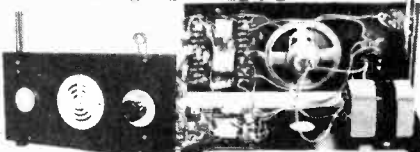
Total Building Costs **£6.95 P. & P. + Ins. 70p**

ELECTRONIC CONSTRUCTION KITS

E.C.K. 2 Sell Contained Multi-Band V.H.F. Receiver Kit.

8 transistors and 3 diodes. Push pull output. 3in loudspeaker, gain control, superb 9 section swivel ratchet and retractable chrome plated telescopic aerial, V.H.F. tuning capacitor, resistors, capacitors, transistors, etc. Will receive T.V. sound, public service band, aircraft, V.H.F. local stations, etc. Operates from a 9 volt P.P. 7 battery (not supplied with kit).

Complete kit of parts **£7.95 P.P. and Ins. 70p**



including Construction Plans

E.C.K. 4

7 Transistors, 6 tunable wavebands, MW, LW, Trawler Band, 3 Short Wave Bands. Receiver Kit. With 3in. x 3in loudspeaker. Push pull output stage, gain control, and rotary switch. 7 transistors and 4 diodes. 6 section chrome-plated telescopic aerial. 8in sensitive ready wound ferrite rod aerial, tuning capacitor, resistors, capacitors, etc. Operates from a 9 volt P.P. 7 battery (not supplied with kit).

Complete kit of parts **£7.25 P.P. and Ins. 70p**



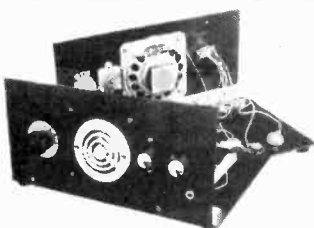
including Construction Plans

EDU-KIT JUNIOR

Completely Solderless Electronic Construction Kit. Build these projects without Soldering Iron or Solder.

- ★ Crystal Radio Medium Wave Coverage—No Battery necessary
- ★ One Transistor Radio
- ★ 2 Transistor Regenerative Radio
- ★ 3 Transistor Earpiece Radio Medium Wave Coverage
- ★ 4 Transistor Medium Wave Loudspeaker Radio
- ★ Electronic Noise Generator
- ★ Electronic Metronome
- ★ 4 Transistor Push/Pull Amplifier

All parts including loudspeaker, earpiece, MW ferrite rod aerial, capacitors, resistors, transistors, etc.
 Complete kit of parts including construction plans **£6.55 P. & P. + Ins. 60p**



**To: RADIO EXCHANGE LTD.
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Bedford MK40 1SA**

Tel.: 0234 52387, REG NO. 788372

- Callers side entrance "Lavelle's" Shop.
- Open 10-1, 2.30-4.30 Mon.-Fri. 9-12 Sat.

I enclose £..... for.....

Name.....

Address.....

PE1/77



Build yourself this high quality touch-sensitive piano. The design also features the new transpose control which is an external tuning control—this tunes the entire keyboard higher or lower than the concert pitch by one whole octave. Two models are available: TS50 which is a straight piano and TS53 has piano, honky tonk, harpsichord, and fast and slow tremolo effects. These professional pianos can be built in just 12 hours.

Parts List
Constructional details

Price
£11.50

- ESU/5 Divider and Touch-Sensitive Keyer Unit**
- 1 x AY-1-5051 i.c. divider
 - 25 x diodes low noise high resistance (5p each)
 - 5 x transistors 2N3703 (12p each)
 - 10 x elect. caps 3-3uF 25V (5p each)
 - 48 x resistors watt 5% (1p each)
 - 12 x terminal pins (4p each)
 - 1 x p.c. board, drilled
 - 2 x 0-01 (4p each)
 - 3 x 0-02 (4p each)

£11.20
£11.25
60p
50p
48p
5p
£11.00
8p
12p

Total Price per unit (11 units required)

£5.29

- ESU/6 Divider and Touch-Sensitive Keyer Unit**
- 1 x AY-1-6721/5
 - 30 x diodes low noise high resistance (5p each)
 - 6 x transistors 2N3703 (12p each)
 - 12 x elect. caps 3-3uF 25V (5p each)
 - 58 x resistors watt 5% (1p each)
 - 14 x terminal pins (4p each)
 - 1 x P.C. board, drilled
 - 2 x 0-01 (4p each)
 - 4 x 0-02 (4p each)

£11.30
£11.50
72p
60p
58p
7p
£11.00
8p
16p

Total Price (only 1 unit required)

£6.01

Power Supply

- 3 x yards main cable (10p yard)
- 1 x mains transformer 20-0-20 1A
- 1 x mains plug and socket
- 2 x fuse holders (20p each)
- 2 x fuses 1A (5p each)
- 4 x rectifier diodes (5p each)
- 2 x elect. caps 2,200uF 40V (95p each)
- 1 x elect. caps 1,000uF 35V
- 2 x resistors 5W (12p each)
- 1 x neon lamp
- 1 x pot with switch
- 1 x metal knob
- 2 x capacitor clamps (5p each)
- 1 x chassis

30p
£2.45
75p
40p
12p
20p
12p
40p
24p
25p
54p
55p
10p
60p

Total Price (only 1 unit required)

£8.81

- 1 x voltage regulator
- 1 x 5-Octave keyboard C-C or F-F
- 1 x cabinet, front plate and fittings
- 1 x jack socket
- 1 x switched jack socket
- 1 x stereo jack socket
- 1 x stereo jack plug
- 4 x rocker switches (29p each)
- 1 x headphone amp. built and tested
- 1 x loud and soft pedal
- 1 x tremolo unit for TS53 only
- 1 x toneforming unit for TS53 only
- 1 x variable capacitor, 10 turns
- 1 x GU500 built and tested. M.T.G.
- 3 x yards gold wire (59p yard)
- 2 x yards rhodium bar (£1.50 yard)
- 3 x yards 25 core cable (58p yard)
- 61 x terminal pins (4p each)
- 1 x pre amp for TS50 only

£1.75
£22.00
£26.00
15p
50p
25p
25p
£1.16
£2.89
£6.00
£3.68
£5.50
£3.72
£14.05
£1.77
£3.00
£1.74
301p
£1.95

- ★ **TS50 Complete Kit** £168.81 + £21.10 VAT
- ★ **TS53 Complete Kit** £172.72 + £21.59 VAT

Carriage on Complete Kit £6 (U.K. only).
★ Wide range of Electronic Organ Kits available, i.e. Mayfair Mk. II Portable Organ—4 octave keyboard, 4 pitches, 10 voices, sustain, vibrato, split keyboard, transpose control. Price £166 inc. VAT, carriage £6 (U.K. only). Overseas customers C.I.F. at cost.
★ Also available from stock, a huge quantity of specialised I.C.s and components. Send 60p for catalogue. Data Sheets for organ I.C.s 25p.



★ **Showroom:** 12 Brett Road, Hackney, London E8 1JP. Tel. 01-986 8455
★ **Component Shop:** 40a Dalston Lane, Dalston Junction, London E8 2AZ. Tel. 01-249 5624

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“DELTA”

GENUINE TEAK OR PERSPEX CASE

prompt order despatch

NON-ALARM

£10.65

+ 85p VAT

ALARM

£13.43

+ £1.07 VAT

(Prices include P. & P.)

DELTA DATA: 4 Radiant Red 1/4in high LEDs. 12hr display with a.m./p.m. indication. Beautiful Burma Teak Case or Pretty Perspex in white, black, blue, red, green. Power failure is indicated by flashing display.

MODULES: Kits can be bought without case—Non-Alarm £9; Alarm £12.50 inclusive.

READY BUILT: Buy a working tested module and fit your own case—Non-Alarm £9.50; Alarm £13; or put it with our case parts (£4.32) and save on complete clock price. Complete clock ready built. 2yr guarantee—Non-Alarm £13.50; Alarm £16.50.

ALARM FEATURES: Pulsed tone. Tilt operated 10 minute “Snooze” period. Single switch setting. Optional extra mercury switch (45p) allows alarm reset by tilting clock. Digit brightness is automatically controlled to suit lighting level.

“ALPHA” CHRISTMAS OFFER

4 Glowing Green
1in high digits
12 or 24 hour. Non-Alarm

Built and Tested
Module plus
Perspex Case

£11
incl.

NOVUS CALCULATORS

650 £5.40
850 £6.75

4510 £16.20
6030 £21.60

Send payment with order. S.A.E. for complete range of clocks, calculators and components



Pulse Electronics Ltd

Dept. PE7, 202 Shefford Road,
Clifton Shefford, Beds.
Telephone: Hitchin (0462) 814477

WELBROOK STEREO

This new hi-fi amplifier from Welbrook is the result of painstaking design incorporating 5 I.C.s 22 transistors plus 10 diodes and offers outstanding value for money to the discerning enthusiast.

30W RMS per channel into 8 ohms load. Total harmonic distortion less than 0.1% at all power levels.

Hum/Noise:

– 80dB Tape/Tuner

– 65dB Disc (Magnetic Input)

Complete unit comprising power supply, pre-amplifier with filter networks, two power amplifiers and loudness control all in teak finished cabinet only £88 plus VAT.

As above but without filters and loudness control only £79 plus VAT.

Also available in module form complete with front panel but without cabinet—easily assembled by the average enthusiast.

Send for details and price list to:

Welbrook Engineering & Electronics Ltd

Brooks Street, Hillgate
Stockport SK1 3HT

RELAYS SIEMENS, PLESSEY, Etc. MINIATURE RELAYS

RELAYS. WIDE RANGE OF A.C. and D.C. RELAYS AVAILABLE from stock, phone or write in your enquiries.

GENTS' 4in ALARM BELL.

3-4 1/2 V d.c.
Price £4.50. P. & P. 50p.



HONEYWELL PUSH BUTTON PANEL MOUNTING MICRO SWITCH ASSEMBLY.

Each bank comprises of a changeover rated at 10 Amp. 250V a.c. Black knob lin dia. fixing hole lin. Prices: One bank 40p. Two bank 50p. Three bank 60p. Min. order 5 pieces. P. & P. 50p.

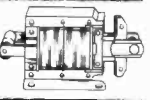


21 WAY SELECTOR SWITCH WITH RESET COIL.

The ingenious electro mechanical device can be switched up to 21 positions and can be reset from any position, energising the reset coil. 230/240V a.c. operation. Unit is mounted on strong chassis, complete with cover. Price £5.50. P. & P. 75p.

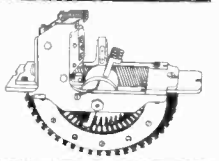
NEW HEAVY DUTY SOLENOID.

mfg. by Magnetics Devices. 240V a.c. operation approx. 20lb pull at 1.25in. Price £7. P. & P. 75p.



UNISELECTOR SWITCHES

4 bank, 25 way 75 ohm. Coil. 36-48V d.c. operation. Ex. New equipment £4.25. P. & P. 75p. Total price inc. VAT £5.40.



MINIATURE C/O ROLLER MICRO SWITCH

OMRON Type V15 FL22/IC. 10 for £2. Post 50p. (Min. order 10).

Sub miniature Burgess Type V.4.T.1. 10 for £2.50. 50 for £10. Post paid.



MINIATURE UNISELECTOR

12 volt 11-way, 4 bank (3 non-bridging, 1 homing). £2.50, p.p. 35p.

24 VOLT DC SOLENOIDS

UNIT containing 1 heavy duty solenoid approx. 25lb pull 1 inch travel. Two x approx. 1lb pull 1/2 inch travel. 6 x approx. 4oz. pull 1/2 inch travel. One 24 volt d.c., 1 heavy duty single make relay. Price £3.00. Post £1. ABSOLUTE BARGAIN.

600 WATT DIMMER SWITCH

Easily fitted. Fully guaranteed by makers. Will control up to 600W of lighting except fluorescent at mains voltage. Complete with simple instructions. £3.65. Post 25p.

1,000 watt model, £5.60. Post 25p.
2,000 watt model, £9.75. Post 40p.

CENTRIFUGAL BLOWER

Mfg. by Smiths Industries. 230/240V a.c. Miniature Model. Series SE/200. Size 95mm x 82mm x 82mm. Aperture 38mm x 31mm. 12 c.f.m., £2.75. Post 50p.

Mfg. by Sracmo 115/230V a.c. 2800/3400 r.p.m. Fan type aperture 3" x 2 1/2" VBL4 25/L. Mfg. Aircontrol Installations Ltd. Price £12. Post £1.



INSULATION TESTERS NEW!

Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L.8in. W.4in. H.6in. Weight 6lb. 500V, 500 megohms, £40. Post 80p. 1,000V, 1,000MΩ, £46. Post 80p.



BLOWER UNIT

200/240V a.c. precision German built. Dynamically balanced, quiet, con rated, reversible. Consumption 60mA. Size 120mm dia. x 60mm deep. Price £3.50. Post 50p.



VARIABLE VOLTAGE TRANSFORMERS

INPUT 230/240V a.c. 50/60 OUTPUT

VARIABLE 0-260V All Types

SHROUDED TYPE

200 watt (1 amp) inc. AC voltmeter

£11.50

1 KVA (5 amp) (MAX) £18.00

2 KVA (10 amp) (MAX) £30.00

3 KVA (15 amp) (MAX) £38.00

4 KVA (20 amp) (MAX) £60.00

CARRIAGE AND PACKING EXTRA



L.T. TRANSFORMERS

0, 10, 17, 18 Volt at 10 amp. £10.45. Post £1.00

0, 4, 6, 24, 32 Volt at 12 amp. £13.00. Post £1.00

0, 6, 12 Volt at 20 amp. £11.85. Post £1.00

0, 12, 24 Volt at 10 amp. £12.35. Post £1.00

0, 6, 12, 17, 18, 20 Volt at 20 amp. £14.15. Post £1.00

Other types to order at short notice—Phone your enquiries.

AUTO TRANSFORMERS

Step up, step down, 0-115/200/220/240 volts at 75 watt £3.60. Post 40p. 150 watt £5.15. Post 50p. 300 watt £7.45. Post 60p. 500 watt £11.00. Post 75p. 1000 watt £16.20. Post 90p.

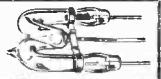
STROBE! STROBE! STROBE!

HY-LIGHT STROBE MK IV

Build a Strobe Unit, using the latest type Xenon white light flash tube. Solid state timing and triggering circuit. 230/250V a.c. operation. For use in large rooms, halls and utilises a silica tube, printed circuit. Speed adjustable 0-20 f.p.s. Light output greater than many (so called 4 Joule) strobes £15.40. Post 75p. Specially designed case and reflector £8.25. P. & P. £1. Super high light approx. 4 times more output. S.A.E. for leaflet.

XENON FLASHGUN TUBES

Range available from stock. S.A.E. for details.



ULTRA VIOLET BLACK LIGHT FLUORESCENT TUBES

4ft 40 watt, £6.00 (callers only).
2ft 20 watt, £4.60. Post 60p. (For use in standard bi-pin). MINI. 12in 8 watt, £1.75. Post 25p. 9in 6 watt, £1.40. Post 25p. 6in 4 watt, £1.40. Post 25p. Complete ballast unit and holders for 9in and 12in tube, £2.50. Post 30p. (9in and 12in measures approx.)

SQUAD LIGHT

A new conception in light control. Four channels each capable of handling 750 watts of spot lights, flood lights or dozens of small mains lamps. Seven programs all speed controlled plus flash modulation, effectively giving 14 different displays. Makes sound-to-light obsolete. Completely electrically and mechanically noise free. Price only £60. Post 75p. S.A.E. (Foolscap) for further details.

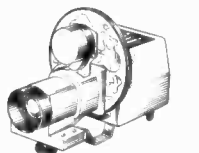


WIDE RANGE OF DISCO LIGHTING EQUIPMENT

S.A.E. (Foolscap) for details.

COLOUR WHEEL PROJECTOR TYPE P150 INTANCHAGE

200/240V a.c. 50Hz 150W lamp, complete with oil filled colour wheel and motor plate. Takes interchange accessories and full range of lenses. £29.95. Post £1.35. (Total inc. VAT & Post, £33.70.)



BIG BLACK LIGHT

400W Mercury Vapor Ultra Violet Lamp. Powerful source of UV P.F. ballast unit is essential with this lamp. Price of bulb and matched ballast unit. £28. Post £2. Spare bulb only £10. Post 80p.

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AT CURRENT RATE MUST BE ADDED TO ALL ORDERS FOR THE TOTAL VALUE OF GOODS INCLUDING POSTAGE UNLESS OTHERWISE STATED.

SERVICE TRADING CO.

GEARED MOTORS

100 r.p.m. 115 lb. in. 110V, 50Hz. 2-BA, single phase, split capacitor motor. Immense power. Continuously Fated. Totally enclosed. Fan cooled in-line gearbox. Length 250 mm. Dia. 135 mm. Spindle dia. 15.5 mm. Length 145 mm. Ex-equipment tested £12. Post £1.50. Suitable transformer 230/240V operation £8. Post 75p.



DRAYTON MOTOR

Type RQR

230/250V 50c. Continuously rated 1 r.p.m. 90 lb. in. Reversible Motor. Twin spindle size 100mm by 140mm by 125mm. Shaft 50mm by 8mm. Weight 2 kg.



New Price £16.50. P. & P. £1.

BODINE TYPE N.C.I.

(Type JJ) 71 r.p.m. torque 10 lb. in. Reversible 1/70th h.p. 50Hz.

The above precision made U.S.A. motor is offered in 'as new' condition. Input voltage of motor 115V A.C. Supplied complete with transformer for 230/240V A.C. input. Price, either type £6.25. Post 75p or less transformer £3.75. Post 65p. (Type 3) 71 r.p.m. 4 lb. ins. 230V a.c. Continuously rated. Non-reversible. £6.50. Post 75p.



15 R.P.M.

Type SD48 80 lb. in. Input 100/200 volt A.C. Length incl. gearbox 270 mm. Height 135 mm. Width 150 mm. Drive shaft 16 mm. Weight 8.5 Kilos. BRAND NEW. Price £10. Carr. £1. Suitable transformer for use on 220/240 volt A.C. £3.85. Post 50p.

24 R.P.M. 230V a.c. Continuously rated. Mfg. Mycalex. Ex-equip. Fully tested. £3.85. Post 75p.

1 R.P.M. 230/240V A.C. SYNCHRONOUS!

Ex-equipment. Thoroughly tested and guaranteed. ONLY £1.50. Post 20p.

20 R.P.M. 230/240 volt a.c. miniature motor. Price £1. Post 20p.

PROGRAMME TIMERS

230v operation a.c. 15 or 20 r.p.m. 6 cam model £5. Post 60p.
9 cam model £6.50. Post 60p.
12 cam model £7.50. Post 60p.
Also available for 50V operation. Prices as above.



METERS NEW—90 mm Diameter

Type: 65CS D.C. M/C 2, 5, 10, 20, 50 amp. £2.75. Post 20p. 100 amp £3.25. Post 20p.

Type: 62T2 A.C. M I, 1, 20, 50 amp. £2.50. Post 20p. 0-300 volt. A.C. M I £2.75 and 300 volt A.C. R/M/C. £3. Post 30p.



WHY PAY MORE?!

MULTI RANGE METER. A.C. volts 2.5-500. D.C. volts 2.5-500 (Sensitivity 2000Ω/V D.C. and A.C.) D.C. current 0.1/1/10/100 mA. Ohms range. Sturdy compact moving coil instrument with 21 ranges, dimensions 120 x 80 x 44 mm. Weight 0.32 kg. SERVICE TRADING CO. Price £5.50, incl. leads and battery. Post 50p. (Total price incl. VAT and Post £6'48).



TIME SWITCH

'Horstmann' Type V Mk. II Time switch. 200/250 volt A.C. Two on/two off every 24 hours, at any manually pre-set time. 30 amp contacts. 36 hour spring reserve in case of power failure. Day omitting device. Fitted in heavy high impact case, with glass observation window. Built to highest Electricity Board Spec. individually tested. Price £7.75. Post 50p. (Total inc. VAT £8'91)



Superior Quality Precision Made

NEW POWER RHEOSTATS

New ceramic construction, vitreous enamel embedded winding, heavy duty brush assembly, continuously rated.
25 WATT 10/25/50/100/150/250/500/1k/1-5k ohm. £1.90. Post 20p.
50 WATT 1/5/10/25/50/100/250/500/1k ohm. £2.40. Post 25p.
100 WATT 1/5/10/25/50/100/250/500/1k/1-5k/2-5k/3-5k/5k ohm £3.70. Post 35p.
Black Silver, Skirted knob calibrated in Nos. 1-9 1 1/2 in. dia. brass bush. Ideal for above 22p each.



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TAMBA ELECTRONICS

QUALITY PRODUCTS
FOR HI-FI, DISCO,
P.A. GROUP AND CLUB USE

AMPLIFIER AND MIXER MODULES

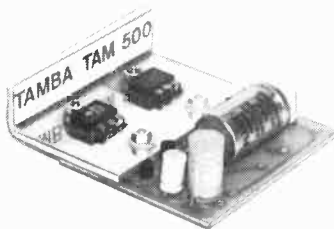
25 WATTS-100 WATTS RMS

TAM1000 100W 4 ohms 65V	£9.80
TAM500 50W 4 ohms 45V	£7.50
TAM250 25W 8 ohms 45V	£4.75

POWER SUPPLIES	
For 1 or 2 TAM250/500	£7.50
For 1 or 2 TAM1000	£9.80
(Carriage 50p on supplies)	

- Suits loads 4-16 ohms
- 20-20,000 Hz \pm 1dB
- Silicon circuitry throughout
- Glass fibre P.C.B.
- High sensitivity (100mV 10k)

High grade components used throughout: Texas, Mullard, R.C.A., Plessey, etc.



- Low distortion (0.1%)
- Low profile (1in high 3½in x 3in)
- 75% efficient
- Accepts most mixer/pre-amplifiers
- Four simple connections

NEW

ALL PURPOSE MIXER/PRE-AMP.

(with 60mm slider volume)

- Suitable for multiple input systems
 - High and low impedance inputs
 - High sensitivity
 - Built-in supply smoothing
 - 20-20,000 Hz \pm 1dB
 - -80dB noise level
 - Accepts a wide variety of inputs
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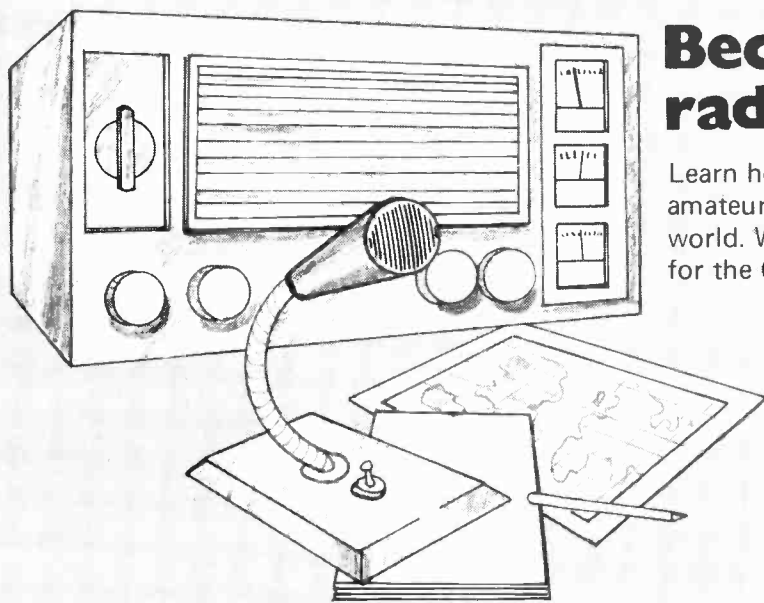
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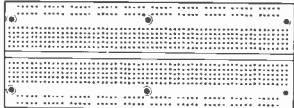
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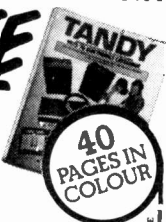
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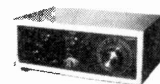
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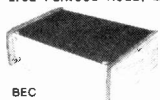
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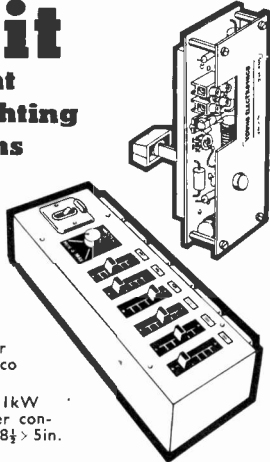
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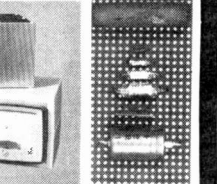
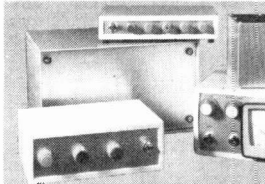
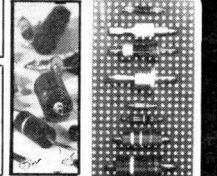
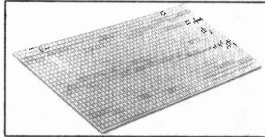
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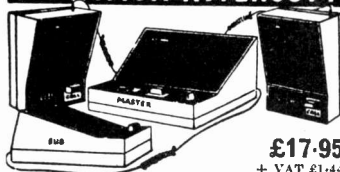
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74LS00	32p	7496	84p	4002	21p	3140	104p	BF257/B	36p	ZTX300	16p	2N4425/6	32p	12V 7812	130p
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7401	18p	74100	118p	4007	22p	536T	300p	AC176	18p	2N897	25p	2N4471	97p	30V 7818	150p
7402	18p	74104	80p	4009	67p	709	30p	AC187/8	20p	2N698	40p	2N4526	85p	24V 7824	150p
7403	18p	74105	97p	4011	21p	741	70p	AC187B	25p	2N706/8	22p	2N5296	85p	LM309K (TO3)	5V 1A, 150p; LM323K (TO3)
7404	24p	74107	35p	4012	21p	747	70p	AC188K	25p	2N918	43p	2N5457/8	40p	5V 3A, 700p; TA625B (TO5)	12V 0.5A 99p;
74H04	40p	74109	70p	4013	55p	748	40p	AD149	58p	2N930	19p	2N5457	40p	7805 (TO3)	150p; 1468 Dual preset = 15V
7405	25p	74110	55p	4014	110p	776	153p	AD161/2	39p	2N930	19p	2N6027	60p	16 pin DIL	300p
7406	45p	74111	86p	4015	120p			AF114/5	20p	2N1131/2	25p	2N6027	60p	VARIABLE: 723	14 pin DIL, 44p.
7407	45p	74112	220p	4016	120p			AF116/7	20p	2N1304/5	45p	2N6107	20p		
7408	25p	74118	90p	4017	110p			AF124	36p	2N1306/7	45p	2N6247	20p		
7409	27p	74120	85p	4018	120p			AF127	36p	2N1813	22p	2N6254	140p		
7410	18p	74121	32p	4019	54p			AF139	43p	2N1711	22p	2N6292	70p		
74H10	30p	74122	30p	4020	120p			AF239	48p	2N1893	32p	3N128	97p		
7411	28p	74123	73p	4022	100p			BC107/B	10p	2N2160	99p	3N140	105p		
7412	28p	74125	70p	4023	21p			BC108/B	10p	2N2219	97p	3N141	97p		
7413	36p	74126	76p	4024	75p			BC109/C	11p	2N2222	22p	3N187	200p		
7414	96p	74128	90p	4025	18p			BC147/8	9p	2N2369	15p	40361/2	45p		
7416	35p	74132	78p	4026	220p			BC149/C	9p	2N2484	32p	40409/10	85p		
7417	40p	74136	81p	4027	81p			BC157	11p	2N2646	48p	40411	325p		
7420	18p	74141	85p	4028	152p			BC158/9	12p	2N2905/4	22p	40594	90p		
7421	43p	74142	300p	4029	120p			BC169/B	16p	2N2905A	22p	40595	97p		
7422	27p	74145	90p	4030	58p			BC172/B	12p	2N2906A	24p	40673	70p		
7423	36p	74148	173p	4042	90p			BC177/8	20p	2N2926OYG					
7425	33p	74150	135p	4043	100p			BC182/3	12p	2N3053	20p				
7427	40p	74151	77p	4048	150p			BC187	32p	2N3054	54p				
7430	18p	74153	82p	4047	110p			BC212	14p	2N3055	54p				
7432	34p	74154	184p	4049	88p			BC213	12p	2N3442	151p				
7437	37p	74155	97p	4050	54p			BC214	16p	2N3702/3	14p				
7438	37p	74156	97p	4055	150p			BC248	32p	2N3704/5	14p				
7440	18p	74157	96p	4055	140p			BC270	20p	2N3706/7	14p				
7441	85p	74158	180p	4056	145p			BC311	40p	2N3708/9	14p				
7442	75p	74159	220p	4060	120p			BD131	24p	2N3773	320p				
7443	130p	74160	100p	4069	40p			BD132	43p	2N3819	27p				
7444	130p	74161	100p	4071	29p			BD135	54p	2N3820	50p				
7445	108p	74162	100p	4072	29p			BD136	55p	2N3823	54p				
7446	108p	74163	100p	4081	25p			BD140	60p	2N3866	95p				
7447	90p	74164	300p	4082	29p			BD156	225p	2N3904/5	22p				
7448	90p	74165	150p	4083	85p			BF115	24p						
7450	18p	74166	136p	4510	142p			BF167	25p						
7451	18p	74167	340p	4511	160p			BF173	27p						
7453	18p	74170	250p	4516	140p			BF180	40p						
7454	18p	74173	100p	4518	140p			BF184	30p						
7460	20p	74174	130p	4528	130p			BF194/5	12p						
7470	32p	74175	82p	4533	575p										
7472	32p	74176	130p												
7473	36p	74177	130p												
7474	37p	74180	118p												
7475	48p	74181	324p												
7476	37p	74182	68p												
7480	54p	74185	144p												
7481	108p	74186	995p												
7482	85p	74190	155p												
7483	85p	74191	160p												
7484	103p	74192	130p												
7485	130p	74193	130p												
7486	36p	74194	130p												
7489	340p	74195	160p												
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A superb solid state audio amplifier. Brand new components throughout. 5 Silicon transistors plus 2 power output transistors in push-pull. Full wave rectification. Output approx. 13 watts r.m.s. into 8 ohms. Frequency response 12Hz-30KHz $\pm 3db$. Fully integrated pre-amplifier stage with separate Volume, Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3" high x 6" wide x 7 1/2" deep. AC 200/240V. PRICE £13.75. P. & P. £1.00.

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A solid state stereo amplifier chassis, with an output of 3-4 watts per channel into 8 ohm speakers. Using the latest high technology integrated circuit amplifiers with short term thermal overload protection. All components including rectifier smoothing capacitor, fuse, tone control, volume controls, 2 pin din speaker sockets and 5 pin din tape reel/play socket are mounted on the printed circuit panel, size approx. 9 1/2" x 2 1/2" x 1" max. depth. Supplied brand new and tested, with knobs, brushed anodised aluminium 2 way escutcheon (to allow the amplifier to be mounted horizontally or vertically), at only £7.50 plus 50p P. & P. Mains transformer with an output of 17.5 v a/c at 500 ma, can be supplied at £1.50 plus 40p P. & P. if required. Full connection details supplied.

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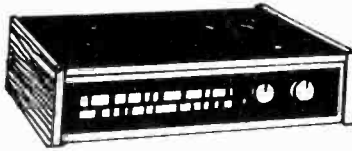
A top quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, and rectifier. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in wide x 3in deep x 6in high. Ready built and tested. PRICE £6.20. P. & P. 90p.

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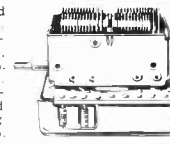
Designed and styled to match our 10 + 10 amplifier but will suit any other standard stereo amplifier. The design incorporates the very latest circuitry techniques with high-grain, low noise IF stages. Automatic frequency control to 'lock on' station and prevent drift. IC stereo decoder for maximum stereo separation. I.L.D. for stereo beacon indicator. Nominal output of tuner 100mV. Approximate size 12 1/2in wide x 8in deep by 2 1/2in high. Supplied ready built, fully tested and fully guaranteed. AC mains 200/240V (not available in kit form).

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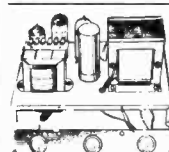


A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume controls. Suitable for use with Ceramic or Crystal cartridges. Very simple to modify to suit magnetic cartridge—instructions included. Output stage for any speakers from 8 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled printed circuit board with component identification clearly marked, smooth brushed anodised aluminium front panel with matching knobs, screws, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specifications: Power output: 14 watts r.m.s. per channel into 5 ohms. Frequency response: 3dB 12-30,000 Hz Sensitivity: better than 80mV into 1M Ω . Full power bandwidth: $\pm 3dB$ 12-15,000 Hz. Bass, boost approx. to $\pm 12dB$. Treble cut approx. to $-16dB$. Negative feedback, 18dB over main amp. Power requirements 35v. at 1.0 amp. Overall Size 12" w x 8" d x 2 1/2" h. Fully detailed 7 page construction manual and parts list free with kit or send 25p plus large S.A.E.

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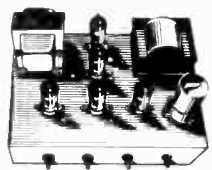
Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7 1/2" w x 4" d x 4 1/2" h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4 1/2 watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only £7.80. P. & P. £1.00.

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Just a tiny part of the component section is an extended range of capacitors and resistors. Our capacitor range includes non-polarised electrolytics! Our resistor range includes even 1% tolerance types!



Another fascinating new addition is the disco section - including a very high quality sound-operated light show to build - high power speaker and suitable cabinet - specifications of our build it yourself 100W stereo disco-lighting effects projector and accessories.

Projects section includes full construction details of a really low-cost, easy to build, highly effective electronic ignition system. Extremely reliable yet takes less than 10 seconds to switch to normal running if fault should occur.

Catalogue includes a very wide range of components: hundreds of different capacitors; resistors; transistors; I.C.'s; diodes; wires and cables; discotheque equipment; organ components; musical effects units; microphones; turntables; cartridges; styli; test equipment; boxes and instrument cases; knobs, plugs and sockets; audio leads; switches; loudspeakers; books; tools - AND MANY MANY MORE.



* Our bi-monthly newsletter keeps you up to date with latest guaranteed prices - our latest special offers (they save you pounds) - details of new projects and new lines. Send 30p for the next six issues (5p discount voucher with each copy).

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Owing to delay in completion of larger warehouse, catalogue will be delayed by up to four weeks - so there's still time to order before publication and get your pack of ten super special offer coupons, giving big discounts on ten different popular items. YOU COULD SAVE POUNDS! - SO DON'T DELAY - FILL IN AND POST COUPON NOW!

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