

Australia 85c

South Africa 80c

New Zealand 85c

Malaysia \$2.25

PRACTICAL

ELECTRONICS

OCTOBER 1978

45p

Fuel Consumption Meter



From **PRACTICAL ELECTRONICS**
 in association with **Concept Electronics**
 8 Bayham Road
 Sevenoaks Kent

FREE STICKIES



Plus...
V.D.U. SYSTEM

FREE! in this issue
STICKIES worth 60p

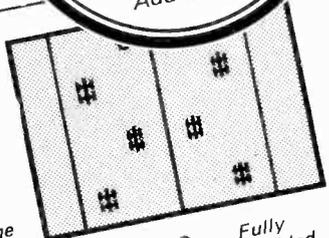
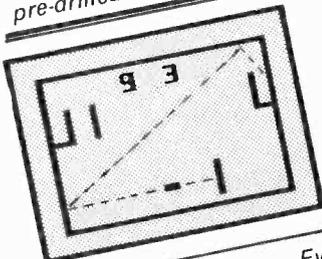
Teleplay now presents COLOURCARTS WITH FREE STAR OFFERS

A whole library of easy to assemble cartridge games for you and all the family to enjoy - all in full colour - works OK on Black and White TV - will save you pounds in the long run.



Our INTRODUCTORY OFFER consists of a bargain that cannot be snuffed at - a Kit consisting of a Professional Finished Inject Moulded Box - Joystick Hand Controls - one cartridge on which consists of 10 games - Football, Tennis, Solo Squash (1 & 2 players), Hockey, Basketball (1 & 2 players), Shoot etc. Mains Adaptor. All holes are pre-drilled - No Special equipment required. You'll be surprised how easy it is to assemble this superbly enjoyable kit!

We offer
all this to you
for ONLY
£28.90
inc. VAT and P&P.
Fully Assembled
Add £7.00



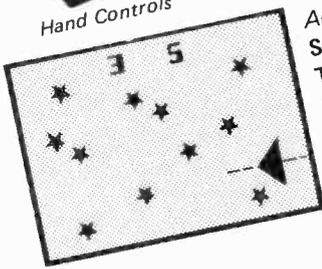
Every 3 months a NEW game will become available to you and those already under production include Submarines, Space War, Wipe Out and many more. The price of these will vary from £12 to £19 depending upon the complexity of the game.



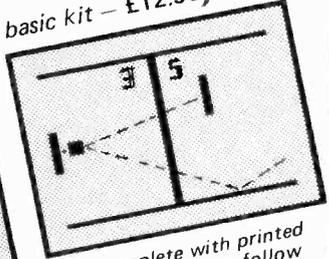
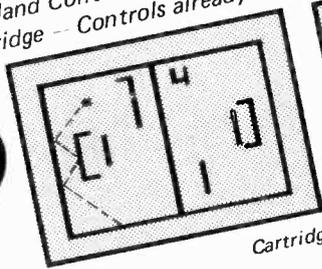
Hand Controls

- Additional Cartridges NOW available include:
- Stunt Cycle - 4 games - Cartridge and Hand Controls - £14.90
 - Tank Battle - Cartridge and Hand Controls - £18.90
 - Road Race - 2 games - Cartridge - Controls already with basic kit - £12.90

Fully Assembled
Add
£3.00



Watch this page each month for new cartridges, as they become available.



Cartridges come complete with printed case and easy to follow assembly instructions.

Electrical knowledge is not a necessity to assemble this project - just simple soldering.

Cheques and Postal Orders to be made payable to TELEPLAY: send your order (No Stamp Needed) to Teleplay, Freepost, Barnet, EN5 2BR or telephone your order quoting your Barclaycard or Access number. Queries and Technical Advice offered either by phone or by calling at our shop.



SHOP OPEN - 10am to 7pm - Monday to Saturday
CLOSE TO NEW BARNET BR STATION - MOORGATE LINE



All parts fully guaranteed.
EUROPE'S LARGEST STOCKIST OF TV GAME COMPONENTS.

14 Station Road, New Barnet, Herts EN5 1QW Tel: 01-440 7033/01-441 2922

PRACTICAL ELECTRONICS

VOLUME 14 No. 14 OCTOBER 1978

CONSTRUCTIONAL PROJECTS

- P.E. V.D.U. SYSTEM—1** *by A. A. Berk, B.Sc., Ph.D.*
Up to date "one chip" memory mapped system 1054
- FUEL CONSUMPTION METER** *By J. McCarthy*
An aid to economy, suitable for most cars 1060
- HIGH PERFORMANCE POWER SUPPLY UNIT** *by R. Lawrence, B.Sc.*
Voltage control down to zero, plus current limiting 1070
- ANALOGUE COMPUTER—2** *by P. J. Kronis, B.Sc.*
Construction details 1074
- TWO RANGE TIMER** *by J. D. Jardine*
A portable, inexpensive general purpose unit 1088

GENERAL FEATURES

- IMPEDANCE** *by Toby Bailey and Bob Whitaker*
Do you understand it? 1066
- MICROBUS** *by D.J.D.*
A bi-monthly focus on micro's for the home constructor 1098
- INGENUITY UNLIMITED**
Capacitor Continuity Tester—Synthesiser Repetitive Waveform Generator
Simple Fuzz—Accenting Metronome—Stereo Indicator
External Input Unit for Synthesisers 1080

NEWS AND COMMENT

- EDITORIAL** 1049
- MARKET PLACE**
New products 1050
- SPACEWATCH** *by Frank W. Hyde*
Pluto, More from the USSR, Copernicus discovers Black Hole 1053
- POINTS ARISING**
Linear Capacitance Meter, Dimwit, Kiln Controller 1058
- BOOK REVIEWS** 1084
- NEWS BRIEFS**
Strain Gauge—Big Brother Check—Micro Power Pack—Computers Galore Club 1087
Underground Cameras—Steam Advice—Here's To Progress 1090
Teletext Course 1094
Disc Full of Holes 1102
- HOW TO USE YOUR FREE STICKIES** 1093
- INDUSTRY NOTEBOOK** *by Nexus*
What's happening inside industry 1097
- PATENTS REVIEW**
Thought provoking ideas on file at the British Patents Office 1100
- READOUT**
A selection of readers' letters 1102

Our November issue will be on sale Friday, 13 October 1978, price 50p
(for details of contents see page 1059)

© IPC Magazines Limited 1978. Copyright in all drawings, photographs and articles published in PRACTICAL ELECTRONICS is fully protected, and reproduction or imitations in whole or part are expressly forbidden. All reasonable precautions are taken by PRACTICAL ELECTRONICS to ensure that the advice and data given to readers are reliable. We cannot, however, guarantee it, and we cannot accept legal responsibility for it. Prices quoted are those current as we go to press.



MINI CONSOLES

Ideal for small desk control panels and consoles. Moulded in orange, blue, black and grey ABS. Incorporates slots for holding 1.5mm thick pcb's. Aluminium panel sits recessed into front of console and held by screws running into integral brass bushes.

MC 161 x 96 x 58mm £2.12 (1-9) (Includes VAT)
MC 215 x 130 x 75mm £2.94 (1-9) (Includes VAT)
(Prices include VAT & P.P.)

ECONOMY QUALITY LED's

50 for only £5 - 100 for only £9
Mixed bags, all sizes, various colours



Full specification LED's also available
Red (specify size) 75p per pack
Green, Yellow, Orange (specify size) £1.20 per pack
Packs contain 5 LED's, mounting clips and data

TYPE A NEON INDICATORS

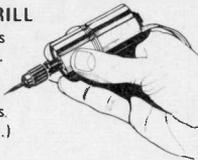
Supplied with resistor for 240 Volts operation
Held in 8mm hole by plastic bezel
150mm wire leads



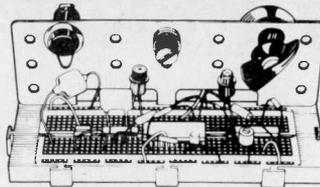
Red, Amber, Clear, Opal 19p each
Green 28p each

12 VOLTS MINI HAND DRILL

Ideal for drilling pcb, chassis etc as well as model making. Supplied with 2 collets that accept tools and drills with 3/32" and 0.50" dia shanks. £7.56 (Includes VAT & P.P.)



Stop wasting time soldering
The NEW MW BREADBOARD accepts
Transistors, LED's, Diodes, Resistors, Capacitors
and all DIL packages with 6 to 40 pins



Includes slot-in Component Support Bracket and has 470 individual sockets, plus Vcc and Ground Bus Strips
Price £9.72 (includes VAT & P.P.)

TYPE MP NEON INDICATOR

Supplied with resistor for 240 Volts operation
150mm leads, held in 6.4mm hole by nut



Red, Amber, Clear, Opal 20p each

SEVEN SEGMENT DISPLAYS

Economy quality
Red, yellow and green
Only 45p each
Common Anode - 0.3" Left Decimal
Full specification displays
also available as above
Red @ 98p each
Green and Yellow @ £1.35 each.
Data supplied with full spec.
displays only.



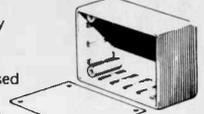
Quantity quotations on request

P.P. Note Unless included in price add 25p Post & Packing for orders totalling under £10. All prices include VAT and are valid in UK only for 2 months from journal issue date

Michael Williams Electronics
47 Vicarage Av. Cheadle Hulme, Cheshire SK8 7JP

SC BOXES

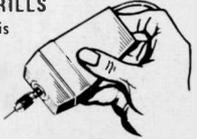
Easily drilled or punched, orange, blue, black and grey ABS. Incorporate slots for holding 1.5mm thick pcb's. Aluminium panel sits recessed into front of the box and held by screws running into integral brass bushes.



SC 85 x 56 x 35mm 97p (1-9) (Includes VAT)
SC 111 x 71 x 48mm £1.29 (1-9) (Includes VAT)
SC 161 x 96 x 59mm £1.81 (1-9) (Includes VAT)
Add 25p per £1 order value for Post & Packing

240 VOLTS MINI HAND DRILLS

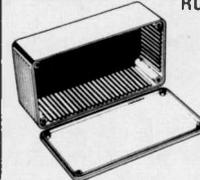
Ideal for drilling pcb's, chassis etc as well as model making. Supplied with 3 collets that accept tools and drills with 1mm, 2mm and 1/8" dia shanks.



£9.72 (includes VAT & P.P.)
Accessory tools... 5 Burs, 1mm, 2mm, 1/8th Drills, 3/32" Collet Price £1.75 (Includes VAT & P.P.)

RC BOXES ABS and DIECAST

1.5mm pcb slots and close fitting flanged lids. ABS in orange, blue, black or grey colours. Diecast in natural or grey hammertone colour. Lid held by screws running into integral brass bushes.



	ABS	Natural Diecast	Hammertone Diecast
RC 100x62x25mm	68p	70p	93p
RC 112x62x31mm	79p	94p	1.23
RC 120x65x40mm	88p	1.22	1.59
RC 150x80x50mm	1.03	1.64	2.11
RC 190x110x60mm	1.77	2.53	3.08

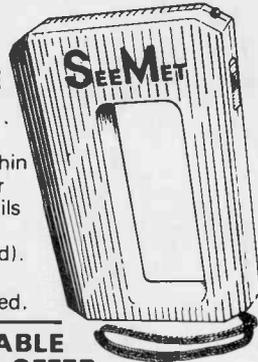
Polystyrene version

in grey only, no slots, no integral brass bushes
RC(P) 112 x 61 x 31mm 61p
All prices are 1-9 off, include VAT, but please add 25p per £1 order value for Post & Packing

AT LAST! SEEMET

THE FAMOUS POCKETSIZE METAL DETECTOR

Seemet readily detects concealed ferrous and non-ferrous metals within range of its detector field. Ideal for finding concealed pipes, wires, nails etc. One-handed operation, uses standard PP3 Battery (not supplied). **ONLY £3.25 plus p. & p. 25p.** (inc. VAT), full instructions supplied.

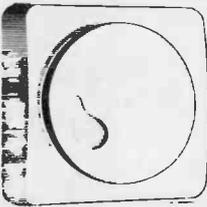


UNBEATABLE DIMMER OFFER

from Britain's largest Dimmer Makers.

Complete Kit of Parts for our VCL 500M, 500W Dimmer Switch. **Only £2.00, plus p. & p. 25p.** (inc. VAT) full instructions supplied.

Send coupon below with your remittance.



Please supply: - **PE3** NAME
 SEEMET KITS £3.50 incl. of p. & p. ADDRESS
 DIMMER KITS £2.25 inc. of p. & p.
 I enclose cheque/P.O. POSTCODE
 for £ BLOCK CAPS PLEASE

Fotherby, Willis Electronics Ltd.

GLADSTONE TERRACE, STANNINGLEY, LEEDS, LS28 6NE.
Telephone Leeds (STD 0532) 563373 Telex 557111 **GLYNWED**

ASTRA-PAK

92 GODSTONE ROAD
WHYTELEAF SURREY CR3 0EB

7400 and 74LS Series TTL		7486	74N	74LSN	74188	74N	74LSN	LINEARS		
7400	0.12	0.21	7486	0.26	0.30	74188	2.10	CA3045	-14	0.65
7401	0.12	0.21	7488	1.50		74189	2.10	CA3046	-14	0.70
7402	0.12	0.21	7489	0.35	0.85	74190	1.60	LM3800	-14	0.82
7403	0.12	0.21	7491	0.65		74172	4.00	LM3811	-14	1.20
7404	0.13	0.21	7492	0.44	0.82	74173	1.10	LM710N	-14	0.32
7405	0.13	0.21	7493	0.40	0.95	74174	0.80	LM711N	-14	0.32
7406	0.28		7494	0.80		74175	0.80	MC1310P	-14	1.50
7407	0.20		7495	0.54	1.05	745175	3.25	NE555N	-8	0.30
7408	0.14	0.21	7496	0.60	1.30	74176	0.80	NE556N	-14	0.50
7409	0.40		7497	2.00		74177	0.82	NE5510B	-14	2.00
7410	0.13	0.21	74100	0.94		74178	1.20	SN72702N	0.65	
7411	0.18	0.21	74104	0.40		74179	1.10	SN75110N	0.50	
7412	0.21	0.21	74105	0.40		74180	0.80	SN78003N	1.95	
7413	0.25	0.48	74107	0.28	0.40	74182	0.75	SN78013N	1.35	
7414	0.54	1.05	74108	0.45	0.40	745182	2.30	SN78023N	1.35	
7415	0.21		74110	0.48		74183	0.99	TAA5508	0.35	
7416	0.27		74111	0.70		74184	1.20	TAA5509	1.40	
7417	0.27		74112	0.30	0.40	74185A	1.20	TBA120S	0.84	
7418	0.13	0.21	74114	0.30	0.40	74188	2.70	TBA41A	1.88	
7421	0.28	0.21	74116	1.80		74189	3.00	TBA800	0.78	
7422	0.17	0.21	74118	0.82		74190	1.05	TDA2020	2.90	
7423	0.25	0.21	74119	1.25		74191	0.99	TDA270S	1.04	
7425	0.20		74120	0.82		74192	0.99	TDA2020	3.20	
7426	0.26	0.28	74121	0.25		74193	1.05	ZN414	1.00	
7427	0.25	0.30	74122	0.40		74194	0.90	OP AMPS		
7428	0.34	0.34	74123	0.50	0.50	74195	0.84	CA3130	-T099	1.00
7430	0.13	0.21	74124	1.25		74196	0.90	LM301A	-8	0.30
7430	0.30		74125	0.40	0.46	74197	0.90	LM301A	-T099	0.48
7432	0.24	0.31	74126	0.45	0.46	74198	1.40	LM3848N	-14	1.00
7437	0.24	0.28	74128	0.82		74199	1.45	LM709	-8	0.40
7438	0.26	0.36	74132	0.82	0.82	74247	1.50	LM709	-14	0.42
7440	0.13	0.22	74134	0.38		74247	0.90	LM709	-T099	0.50
7441	0.52		74135	0.68		74248	0.95	LM717	-14	0.22
7442	0.55	0.70	74138	0.55	0.40	74249	0.95	LM741	-14	0.25
7443	0.90		74137	0.94		74251	1.00	LM741	-T099	0.45
7444	0.90		74138	0.82		74253	1.10	LM747	-14	0.78
7445	0.70		74139	0.82		74257	1.12	LM3900N	0.58	
7446	0.70		74141	0.58		74258	1.15	MC1458P	-8	0.42
7447A	0.80	0.84	74142	0.80		74260	0.82	VOLTAGE REGULATORS		
7448	0.80	0.94	74143	2.00		74281	3.25	LM300	-T099	1.00
7449	0.80	0.94	74144	2.00		74288	0.43	LM309K	-T03	1.30
7450	0.13		74145	0.84	1.20	74273	2.15	uA723	-14	0.40
7451	0.13	0.21	74147	1.30		74278	1.25	7805	T0220	0.85
7453	0.13	0.21	74148	1.15		74283	1.70	7812	T0220	0.85
7454	0.13	0.21	74150	0.99		74284	0.85	7815	T0220	0.85
7455	0.13	0.26	74151	0.80	0.90	74289	3.02	7824	T0220	0.85
7460	0.13		74153	0.80	0.56	74290	0.85	7905	T0220	1.18
7470	0.13		74154	1.00	1.32	74293	1.35	7912	T0220	1.18
7472	0.22		74155	0.83	0.98	74298	1.92	7915	T0220	1.18
7473	0.28	0.36	74156	0.83	0.98	74352	1.80			
7474	0.28	0.36	74157	0.83	0.80	74353	1.05			
7537A	0.50		74158	0.58	0.62	74356	0.52			
7475	0.30	0.42	74159	1.70		74386	0.52			
7478	0.26	0.39	74160	0.80	1.30	74387	0.46			
7478	0.45	0.39	74161	0.80	0.80	74388	0.52			
7480	0.90		74162	0.80	1.30	74388	0.58			
7482	0.75		74163	0.80	0.82	74390	1.92			
7483	0.72	0.87	74164	0.89	1.20	74393	2.00			
7484	0.90		74165	0.89		73670	2.30			
7485	0.88	0.97	74167	2.70						

All prices include V.A.T. Add 25p for P.&P. (Extra for overseas). Discounts over £10 less 5%, over £20 less 10%, over £50 less 15%, over £100 less 20%. Send SAE for complete list of components.

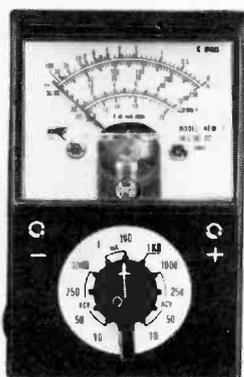
NOT EVERY CABLE HAS A LABEL

Everyone who works with electricity needs to know at some time or other what's going on inside the cable he's handling. What voltage. What current. What resistance. Not knowing the answers, or worse still having inaccurate answers, can make life difficult, even terminal.

Eagle Test Equipment gives the right answers

The range covers general multimeters, high voltage probes, clamp meters, insulation testers.

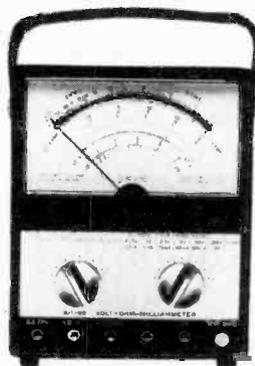
Here are just four. Send the coupon for details of all the rest.



KEW 7 Multimeter
1000 OPV. DC volts up to 1000, DC amps up to 100 mA. AC volts up to 1000. Resistance up to 150 Kohms. Pocket size. "Off" damping. Complete with leads & battery. R.R.P. £6.95 ex. VAT.



EM 1200 Multimeter
100,000 OPV. Taut band movement. Overload protection. Reversible DC polarity. AC amps: 15, AC volts to 1500. DC amps up to 15, DC volts to 1500. Resistance up to 200 megohms. R.R.P. £49.95 ex. VAT.

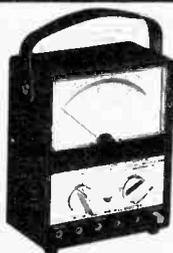


K1400 Multimeter
20,000 OPV. DC and AC volts up to 5000. DC and AC amps up to 10. Resistance up to 20 megohms. "Off" damping. Overload protection. R.R.P. £68.00 ex. VAT.



EM10, 20 & 30 Multimeters
10, 20 & 30,000 OPV. All with antiparallax mirror scale. DC volts to 1000 (1200 for EM30). DC amps to 250 mA (600 for EM30). AC volts to 1000 (1200 for EM30). Resistance up to 6, 5 and 60 megohms respectively. R.R.P.'s EM10 £12.40 EM20 £16.40 EM30 £18.95 ex. VAT.

Test Equipment: EAGLE



Please send me details of your complete range of Test Equipment.

Name _____ Company _____

Address _____

EAGLE INTERNATIONAL Precision Centre, Heather Park Drive,
Wembley, Middlesex HA0 1SU.

PE1

You'll learn a lot from Heathkit electronics courses.

Heathkit electronics courses are a most effective way to learn — with fast, reassuring results.

Each course is a complete self-instructional package with clear, concise instructions in everyday language. You follow at your own pace, using modern teaching aids and expert guidance.

Four basic courses to start with.

DC electronics, AC electronics, semi-conductors and electronic circuits. These courses give you a thorough and practical understanding — the key to all knowledge in the field of electronics.

Microprocessors and digital techniques.

The advanced Heathkit courses take you on to higher levels of computer technology and advanced circuit design, using the same easy-to-follow learning system.

Experimenter-Trainers.

With the benefit of increased practical guidance, these optional aids will help you through the courses with exceptional speed.

The finest way to learn.

Heathkit courses are used by home students, industrial concerns, technical colleges and schools. They're acknowledged as the finest way to learn. And the range of courses is complete from the earliest stages to the most advanced steps in specialist fields.

Send for the Heathkit Catalogue now.

As well as electronics courses, the Heathkit catalogue contains scores of electronics kits which you can build yourself. Burglar alarms, radios, digital clocks, car tune-up systems, test instruments, metal locators... and an exciting new range of personal computers!

Forty pages packed with exciting kits you'll be proud to make.

**Soldering
Iron offer
FREE**

When you receive your catalogue you will get details of this free offer worth approximately £4.75.



SPECIAL OFFER
10% off selected courses
until 15th October 1978



To Heath (Gloucester) Ltd., Dept: 10/78, Bristol Road, Gloucester, GL2 6EE.
Please tick the literature you want and enclose the appropriate amount in postage stamps.

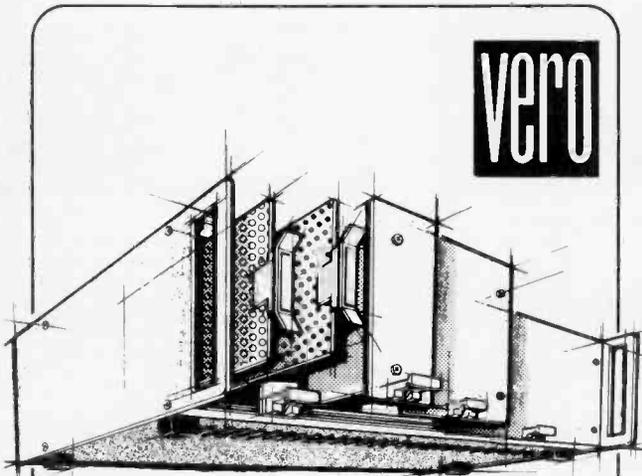
- Heathkit Catalogue only (enclose 20p).
- 16 page Computer Brochure only (enclose 20p).

Name _____
Address _____

Registered in England, number 606177

There are Heathkit Electronics Centres at 233 Tottenham Court Road, London (01-636 7349) and at Bristol Road, Gloucester (Gloucester 29451).

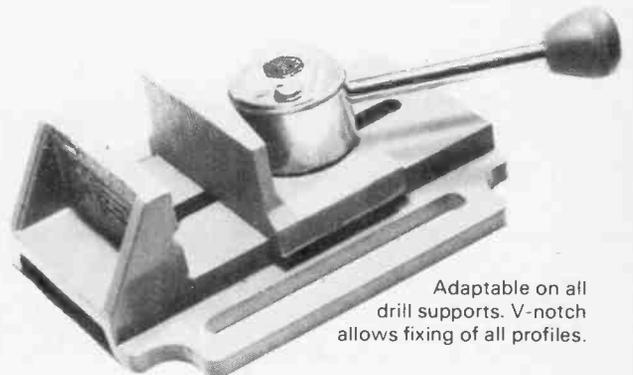
vero



Our new 1978 catalogue lists a card frame system that's ideal for all your module projects — they used it in the ETI System 68 Computer. And we've got circuit boards, accessories, cases and boxes — everything you need to give your equipment the quality you demand. Send 25p to cover post and packing, and the catalogue's yours.

VERO ELECTRONICS LTD. RETAIL DEPT.
Industrial Estate, Chandlers Ford, Hants. SO5 3ZR
Telephone Chandlers Ford (04215) 2956

Put a Clamp on those small jobs with **NODEX** quick-grip vice



Adaptable on all drill supports. V-notch allows fixing of all profiles.

Dimensions

Overall length	150mm
Overall width	130mm
Overall height	50mm
Jaw opening	70mm
Jaw height	35mm
Jaw width	70mm
Weight	850 grammes

The patented locking system of the Nodex vice allows for instantaneous locking or loosening for use as a vice or as a press. Usable horizontally or vertically on the bench top or on the bench edge.

Descriptive leaflet and general catalogue available from:

SPECIAL PRODUCTS DISTRIBUTORS LTD.
81 PICCADILLY, LONDON W1V 0HL
Tel: 01-629 9556 Cables: Speciproduct London W1

SAXON ENTERTAINMENTS

THE PIONEERS OF MODULAR DISCO/P.A. EQUIPMENT
NOW OFFER PACKAGE DEALS AT INCOMPARABLE PRICES

CENTAUR STEREO DISCOS

C/W LIGHT SHOW & DISPLAY,
TWIN SPEAKERS & LEADS

Standard 100W

£249 or Deposit **£57.12**
12 Months @ £21.75 or 24 Months @ £12.26
+ carr. £15

Super 200W

£299 or Deposit **£68.12**
12 Months @ £25.86 or 24 Months @ £14.56
+ carr. £15

GXL 200W (with twin 200 watt cabinets)

£389 or Deposit **£87.32**
12 Months @ £33.31 or 24 Months @ £18.76
+ carr. £15

BSR Decks - 17,000 Line Loudspeakers - Rugged Aluminium Trimmed Cabinets - Cue Light And Phones Output - Slave Output - Deck Lights/Motor Starts (GXL)

COMPLETE STEREO
ROADSHOWS - BUILT IN
SOUND TO LIGHT/SEQUENCER
& DISPLAY
TWO YEAR GUARANTEE

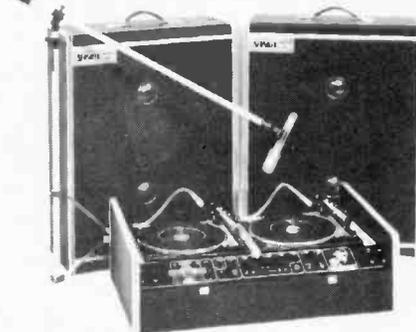


illustration shows GXL Centaur System

These systems feature full mixing for two decks tape & mic with monitoring facilities - override and are supplied complete with sound to light + sequencer, display, speaker leads etc.

JUST PLUG IN AND GO!

MINI DISCO 100 WATT MONO SYSTEM

£179.50 Deposit **£41.66**

12 Months @ £15.56
+ carr. £15

Similar in appearance to the Centaur and complete with loudspeakers and leads.

Headphones to suit any system **£7.50**
EM507 Electret Mic **£15.00**
ECM 81 Electret Mic **£19.95**
Boom Stand **£15.50**
Carriage on all disco and PA systems **£10.00**
(Included in H.P. Prices)

**20% Deposit Terms
On All Orders
Over £150 - 12 or 24
Months - Low Interest**

D.I.Y. MODULES FOR ALL DISCO/P.A. AMPLIFIERS

SA308 30W 8 ohms 45V	£9.95*	SUPPLY FOR TWO MODULES	£10.90*
SA604 60W 4 ohms 50V	£13.25	SUPPLY FOR TWO MODULES	£13.50
SA608 60W 8 ohms 65V	£14.25	SUPPLY FOR TWO MODULES	
SA1204 120W 4 ohms 75V	£15.95	SUPPLY FOR ONE MODULE	£22.50
SA1208 120W 8 ohms 95V	£21.00	SUPPLY FOR TWO MODULES	
SA2404 240W 4 ohms 95V	£29.50	SUPPLY FOR ONE MODULE	

0.2% Distortion, 30Hz-20, KHz + 2dB, Fully Short/Open Circuit proof input sensitivity 240 mV to suit most mixers - D.C. & Output Fuses fitted.

TOP QUALITY COMPONENTS THROUGHOUT



DISCO MIXERS - COMPLETE OR MODULAR



MONO OR STEREO
WITH AUTOFADE

Available complete and ready to plug in or as an easy to connect module with all controls except monitor switch already fitted - full instructions supplied.

FEATURES INCLUDE:

Twin Deck - Mic & Tape Inputs - Wide range bass & treble controls - Full headphone monitoring - Crossfade - Professional standard performance.

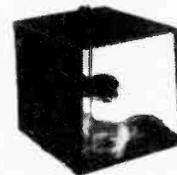
MODULES	£22.50
Mono module	£33.50
Stereo module	£39.95
Panel	£5.50
Kit of knobs/sockets etc	£5.50
COMPLETE MIXERS (with case)	
Mono 18V	£39.50
Stereo 18V	£57.50
Mono mains	£45.75
Stereo mains	£63.75

COMPLETE LIGHTING CONTROL AT YOUR FINGERTIPS!



Lighting Control Unit Mk II	£44.50
4kW Sequencer + Sound Light + Dimmers + Automatic Level Integrated Logic Circuitry	Module £32.50 Panel £2.95
Three Channel Sound to Light	£26.75
3kW 1-240W input - master Plus channel controls	Module £19.75 Panel £2.95

STROBE UNITS



Pro-Strobe 4-6 Joules **£37.50**
Super Strobe 2-3 Joules **£22.50**
(Pro-Strobe has external trigger facility).

SPARES & ACCESSORIES - LOUDSPEAKERS & CABINETS

Rope Lights - Red or Multicolour	£39.50 per 30ft.	Melos Echo Chamber	£59.00
Rope Light Controller for up to 120 ft	£30.00	Headphones	£7.50*
Fuzz Lights-Red/Blue/Yellow/Green	£22.80	Sirens: English Police, USA Police, Destroyer, Alien Voice Simulator	£7.50
Magnetic Cartridge Equalisers	£3.50*	Bulgin 8 way lighting plug/socket	£1.90

PROJECTORS - PLUTO - NEW LOW PRICES!!! CHOICE OF WHEEL/CASSETTE

P150 150W Tungsten	£37.50	Liquid wheels	£7.50
P500 100W Q.I.	£74.95	Cassettes	£8.00
P500 250W Q.I.	£84.95	Picture wheels from	£4.75
		(Wide choice available)	

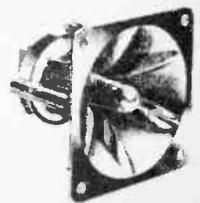
100 Watt Chassis Loudspeakers 12"	£23.50	18"	£47.50	(Add £1.50 carr.)
Empty Loudspeaker Cabinets: Small 12"	£15.50	Large 12"	£21.50	Small 2 x 12"
	£15.50	Large 2 x 12"	£28	1 x 18"
			£29.50	

PIEZO HORNS only £7.50 YES! - only £7.50

(As fitted to our package PA system)

Direct from Motorola Inc., USA at an UNBEATABLE PRICE

No crossover required 4kHz - 30kHz rated 75W/8 ohms 150W/4 ohms use two per 100W amplifier - Full instructions supplied.





PACKAGE P.A. SYSTEMS (2 Year Guarantee)

Complete with PIEZO horn columns fitted with 100 watt units (100 watt system illustrated)

100 Watt £159.90 + corr. £15

Deposit £38.46

12 Months @ £14.28

Includes 4 Channel 100 Watt Amplifier with Treble, Bass and Master Controls plus Leads and Twin Piezo Horn Columns (shown on right).

200 Watt £249.00 + corr. £15
Deposit £57.12

12 Months @ £19.11 or 24 Months @ £10.66

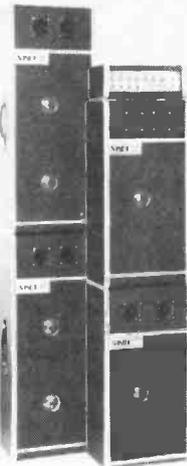
zix Mixed Inputs plus Three Sets of Bass and Treble Controls plus Slave Output and Master Control.

ACCESSORIES

Melos Echo Unit £59.00

A high quality Cassette Tape Echo Unit giving long tape life, infinitely variable echo depth and speed control. Suitable for all mics. and instruments.

High quality Boom Stand £15.50. Floor Stand £9.90. ECM81 Condenser Mic. - Removable Lead - Good Anti-Feedback £19.95.* EM507 Condenser Mic. - Good Value £15.00. Phasers £19.80.



D.I.Y. MODULES FOR P.A. SYSTEMS Mono or Stereo

Make your own mixer - Mono/Stereo - up to 20 channels with these, easy to wire modules - Available as PCB's or assembled on panels.



Input Stages Up to 20	Mono PCB	£5.95	Mono C/W panel etc.	£8.95
	Stereo PCB	£9.50	Stereo C/W panel etc.	£12.50
Mixer/Monitor (One only per system)	Mono PCB	£5.95	Mono C/W panel etc.	£8.95
	Stereo PCB	£9.50	Stereo C/W panel etc.	£12.50
Power supply for up to 20 channels		£9.50	Blank panel	£1.00

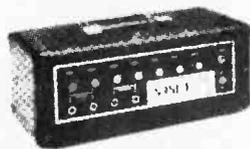
Send for free brochure for complete specification

Saxon AP100 Amplifier £45

Four mixing inputs - 100W into 4 ohms
Wide range bass & treble controls
+ master - Twin outputs

Saxon 150 Amplifier £59

Four mixing inputs - 100W into 8 ohms
150W into 4 ohms - wide range bass
& treble controls + master



All prices subject to 8% VAT except where asterisked (12½%)
Shop premises open Tues to Sat 9 am - 5 pm Lunch 12.30 - 1.30 pm
Mail order dept open Mon to Fri 10 am - 4 pm Ring 01-684 6385

TO ORDER

By Post Send your requirements with cheque crossed P.O. or 60p COD charge to address below or just send your Access or Barclay Card Number NOT THE CARD.

By Phone You may order COD, Access or Barclay Card.

Post & Packing 50p on all orders except where stated.

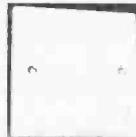
SAXON ENTERTAINMENTS

327 Whitehorse Road, Croydon, Surrey.
All Enquiries Large SAE Please Brochures on request.

BAD NEWS FOR KNOB TWIDDERS

A 300W Lightdimmer with NO knob. Dimming and on/off functions are controlled by touch. Features include:

- * No mains rewiring.
 - * Easy to build - uses one MOS IC.
 - * Switches on to preset brightness.
 - * Can be switched and dimmed from many locations using TDE/K kit making 2-way switching easy.
- *** PRICE **£9.67** TDE/K **£1.08**.



LIGHTING CONTROL KITS (300W) TSD300K TOUCH-SWITCH & DIMMER combined. One touchplate for on/off. Small knob controls brightness. **£5.62**
TS300K TOUCHSWITCH. Two touchplates. ON/OFF **£4.32**.
TSA300K AUTOMATIC. One touchplate. Preset time delay off. **£4.32**
LD300K LIGHTDIMMER. **£3.02**

DIGITAL VOLTMETER/THERMOMETER KIT



Based on the 7106 single IC 3½ digit D.V.M. the Kit contains a PCB, resistors, capacitors, pre-sets, I.C. and 0.5" liquid crystal display. Components are also included to enable the basic D.V.M. kit to be modified to a Digital Thermometer using a single transistor as the sensor.
ONLY £23.75

24HR CLOCK/APPLIANCE TIMER KIT



Switches any appliance of up to 1 KW on and off at preset times once a day. KIT contains: AY-5-1230 Clock/Appliance Timer IC, 0.5" LED display, mains supply, display drivers, switches, LEDs, triac, complete with PCBs and full instructions. **£14.85**
White box (56 x 131 x 71mm) - drilled **£2.70**
- undrilled **£2.38**

ABOVE PRICES INCLUDE V.A.T.

Quantity discounts on request. Add 25p postage and packing. Mail order only to:

T.K. ELECTRONICS (PE) 106 Studley Grange Road, London, W7 2LX.

TRIAC BARGAINS

400V Plastic Case	64p
3A	86p
6.5A with trigger	80p
8A	90p
12A	113p
16A	178p
20A	205p
25A	54p
SCR (C106D) 5A/400V	23p
Diac	

COMPONENTS

0.2" L.E.D.s	
Red	11p (86p/101)
Green	23p Yellow 27p
DL727 5" display	£1.62
LCD 5" digit	£9.72
LDR 5" dia.	45p
NE555 3p	(4 for £1.08)
741 27p	(5 for £1.08)
LM3911 temperature IC	£1.08
AY-5-1224	£3.51
AY-5-1230	£5.23
ZN1034E	£1.94
ICL7106 DVM IC	£9.99
IN4001	7p
IN4148	5p
BC182L	11p
2N3819	25p

MINI MAINS TRANSFORMERS

Standard 240V mains primary	
100mA secondary	
6-0-6V	92p
9-0-9V	97p
12-0-12V	102p

Motorola, 1 WATT AUDIO AMPLIFIER I.C.

9-16V 8-16Ω, 10-400MV sensitivity, S.C. proof, no heat sink required. Supplied with data and circuits, 90p. Data and circuits alone, 20p + SAE.

BARGAIN PACKS

Don't let your environment dehydrate you. Buy a Honeywell Humidity Controller membrane operated with 1" shaft, ideal for greenhouses, centrally heated homes, etc. Build your own humidity alarm, 3.75A. Contacts at 250V **£1.50** each, 3 for **£4.00**
4 aluminium boxes 128 x 44 x 38 mm ideal for signal injectors, etc. **£1.00**.
100 miniature reed switches ideal for burglar alarms, model railways, etc. **£3.30**.
6 x 6-pole 12 volt reed relays on board **£2.45**.

High quality computer panels smothered in top grade components: 5 lbs **£4.75**; 10 lbs **£8.95**.
Miniature edgewise panel mounting level meters 200 ua fsd **90p**.
Miniature transistorised f.m. front end with integral tuning gang 88-108MHz **£2.50**.
New U.H.F. transistor TV tuners

Rotary type with slow drive and AE. socket **£2.50**.

Aluminium TV coax plugs, 10 for **£1.00**.
Hardware Packs each containing 100's of items including: BA nuts and bolts, Nylon, Self-tapping, Posidrive, "P" clips, Cable clamps, Fuse holders, Spare nuts etc. **£1.00** per pound. Heavily insulated E.H.T. Discharging Probe with lead and earth connector **60p** each.
Ultrasonic transducers, transmitter and receiver 14mm diam. 40Kcs **£4.25** per pair.
Magnetic earpieces with plug and lead **25p** each, 5 for **£1.00**.
Crystal earpieces with lead **40p** each, 3 for **£1.00**.
12 assorted convergence pots **£1**
12 quil, low profile I.C. sockets, 14 pin **£1**

DE LUXE FIBRE GLASS PRINTED CIRCUIT ETCHING KITS

Includes 150 sq. ins. copper clad f/g board, 1 lb ferric chloride, 1 dolo etch resist pen, abrasive cleaner, 2 mini drill bits, etch tray and instructions - only **£5.30**.

150 sq. in. fibre glass board	£2.00
Dolo pen	90p
1 lb ferric chloride to mil spec	£1.25
5 lbs ferric chloride to mil spec	£5.00
Instruction sheet	20p

40p P & P ON ALL ABOVE ITEMS. SEND CHEQUE OR POSTAL ORDER WITH ORDER TO SENTINEL SUPPLY, DEPT PE, 149A BROOKMILL RD., DEPTFORD SE8

The latest kit innovation!

from Sparkrite

Sparkrite featured by Shaw Taylor in "DRIVE IN"

the quickest fitting
CLIP ON
capacitive discharge
electronic ignition
in KIT FORM



- Smoother running
- Instant all-weather starting
- Continual peak performance
- Longer coil/battery/plug life
- Improved acceleration/top speeds
- Optimum fuel consumption

Sparkrite X4 is a high performance, high quality capacitive discharge, electronic ignition system in kit form. Tried, tested, proven, reliable and complete. It can be assembled in two or three hours and fitted in 1/3 mins. Because of the superb design of the Sparkrite circuit it completely eliminates problems of the contact breaker. There is no misfire due to contact breaker bounce which is eliminated electronically by a pulse suppression circuit which prevents the unit firing if the points bounce open at high R.P.M. Contact breaker burn is eliminated by reducing the current to about 1/50th of the norm. It will perform equally well with new, old, or even badly pitted points and is not dependent upon the dwell time of the contact breakers for recharging the system. Sparkrite incorporates a short circuit protected inverter which eliminates the problems of SCR lock on and, therefore, eliminates the possibility of blowing the transistors or the SCR. (Most capacitive discharge ignitions are not completely foolproof in this respect). The circuit incorporates a voltage regulated output for greatly improved cold starting. The circuit includes built in static timing light, systems function light, and security changeover switch. All kits fit vehicles with coil/distributor ignition up to 8 cylinders.

THE KIT COMPRISES EVERYTHING NEEDED
Die pressed epoxy coated case. Ready drilled, aluminium extruded base and heat sink, coil mounting clips, and accessories. Top quality 5 year guaranteed transformer and components, cables, connectors, P.C.B., nuts, bolts and silicon grease. Full instructions to assemble kit neg. or pos. earth and fully illustrated installation instructions.

NOTE - Vehicles with current impulse tachometers (Smiths code on dial RV1) will require a tachometer pulse slave unit. Price £3.35 inc. VAT, post & packing.

Electronics Design Associates, Dept. PE10, 82 Bath Street, Walsall, WS1 3DE. Phone: (9) 614791

Electronics Design Associates, Dept. PE10
82 Bath Street, Walsall, WS1 3DE. Phone: (9) 614791

Name

Address

Phone your order with Access or Barclaycard

Inc. V.A.T. and P.P.

QUANTITY REQD.

Send SAE if brochure only required.

I enclose cheque/PO's for

X4 KIT £14.95

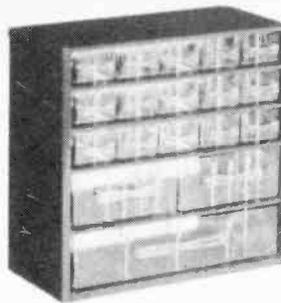
TACHS PULSE SLAVE UNIT £3.35

£

Cheque No.

Please state polarity pos or neg earth.
Access or Barclaycard No.

STORAGE CABINETS



Metal cabinets with transparent plastic drawers. Ideal for components, small parts, nuts, bolts etc. Many other uses in the home, workshop, laboratory etc.

Type 1118

Choose from the following range to suit your own needs:

Type	Height (ins.)	No. of Drawers			Price
		Total	Small	Medium Large	
1118	11	18	15	2 1	£8.65
1130	11	30	30	- -	£8.95
1633	16	33	30	2 1	£10.95
1150	18	50	50	- -	£12.95
1860	22	60	60	- -	£14.95

All cabinets are finished Blue, 12" wide x 5 3/4" deep. Prices include VAT and Post. Satisfaction or money refunded. Cheque/P.O. to:

MILLHILL SUPPLIES (TOOLS)

35 PRESTON CROWMARSH,
BENSON, OXON. OX9 6SL

Random FLASHER UNIT
Wired ready for use Complete with three 100 watt coloured lamps that flash independently at random
£19.95

TWIN BANK 6 LIGHT UNIT
(less lamps) LENGTH 14 1/2 inches
BC Fitting **£11.35** each
ES Fitting **£11.35** each

Sound to Light MASTER UNIT
600 WATTS PER CHANNEL
INCLUDING CHANNEL OUTPUT PLUGS AND MAINS INPUT SOCKET
£30.95

TYPE A SPOT
(less lamp)
BC Fitting **£2.30** each
ES Fitting **£2.30** each

TYPE B 3 BANK UNIT
(Less Lamps)
BC Fitting **£7.99** each
ES Fitting **£7.99** each

TWIN BANK 12 LIGHT UNIT
Length 31 1/2
(less lamps)
BC Fitting **£18.50** each
ES Fitting **£18.50** each

100 WATT SPOT LAMPS RED, YELLOW, GREEN, BLUE, CLEAR **£1.50** each
Maximum 3 lamps B.C. or E.S. Fitting **£4.50**

ALL PRICES INCLUDE V.A.T. AND POST & PACKING (these rates apply to the United Kingdom only)

Send 20p for illustrated leaflet & price list.

ALBEN ENGINEERING CO. LTD.
DEPT. PE THE CRESCENT, WORSTHORNE,
BURNLEY, LANCS. Tel: Burnley 20940

ELECTROVALUE Buying Guide

Section 2

If you have bought from Electrovalue, you will know just how large and varied our stocks are. For those who have yet to know, we are publishing a series of five ads. month by month to give up-to-date information and prices on the most important items we carry. These ads. will appear in stepped rotation in five journals - Pr. Electronics, Pr. Wireless, Everyday Electronics, Electronics Today Intnl. and Elektor so that the complete series will be available each month. In this way, no matter which journals you read, BY DETACHING AND SAVING THESE PAGES, YOU WILL HAVE A VALUABLE AND COMPREHENSIVE MONEY SAVING CATALOGUE. ALL MERCHANDISE IS BRAND NEW AND GUARANTEED.

Capacitors

Quantity prices available except for MDC.

Product	Value	Volts	Price	Product	Value	Volts	Price
CERAMIC DISC ●				ELECTROLYTIC, TANTALUM BEAD			
500V: 1.2, 5nF	3p	10, 25, 6.3	12p	R1524, 28.0 x 17.8mm	0.1	400	15p
50V: 0.02µF	3p	10, 40	12p	330	0.1	630	25p
50V: 0.05µF	4p	10, 63	14p	390, 470, 500	0.12	250	13p
CERAMIC FLAT TUBULAR B37448 ●				560, 680	0.15	250	14p
(2.5mm)				820, 1000	0.22	250	15p
0.01µF 63V	4p	10, 100	15p	2200	0.33	250	18p
0.022µF 40V #	3p	22, 100	12p	3300	0.47	250	27p
0.022µF 63V	5p	47, 3	12p	4700	0.68	250	31p
0.033µF 63V	5p	47, 10	12p	R2032, 35.6 x 23.0mm	1.0	250	46p
0.047µF 63V	5p	47, 25	14p	1500, 1800	1.0	400	46p
0.068µF 63V	6p	47, 40	15p	2200, 2700	2.2	250	51p
CERAMIC FLAT TUBULAR B37449 ●				3600, 3900	4.7	250	1.04
(5mm)				4700, 5000	10	250	1.81
0.047µF 63V	5p	100, 3	12p	6800			
0.068µF 63V	5p	100, 10	14p	8200, 10,000			
0.1µF 63V	6p	100, 16	15p	MIXED DIELECTRIC, M.D.C.			
0.22µF 63V	11p	100, 25	16p	600V			
CERAMIC PLATE (Mullard C333) ●				0.1 27p; 0.47 72p;			
E12 values				1000V			
1.8pF - 18pF	4p	220, 3	13p	0.001, 0.0022, 0.0047	18p		
CERAMIC PLATE ●				0.01 20p; 0.022 21p;			
E12 values				0.1 27p; 0.22 48p;			
22 - 33pF	3p	220, 10	15p	POLYESTER, Mullard C280, PC mtg.			
39 - 68pF	3p	220, 25	20p	0.01 0.015	6p		
82 - 220pF	3p	220, 40	24p	0.022	6p		
270 - 1000pF	3p	220, 100	30p	0.033, 0.047	6p		
E6 values				0.068	7p		
1500 - 4700pF	3p	470, 10	19p	0.1	7p		
6800pF	3p	470, 16	24p	0.15	8p		
CERAMIC FEED THROUGH ●				0.22	9p		
1000pF 350V	6p	470, 63	49p	0.33	13p		
ELECTROLYTIC, REVERSIBLE ●				0.47	15p		
EX50 series, 50V.				0.68, 1.0	24p		
2µF	25p	1000, 16	18p	1.5, 2.2	42p		
4, 6µF	27p	1000, 25	22p	POLYESTER, PC mounting			
8, 10, 16µF	30p	1000, 40	24p	Mullard 344- or Siemens			
25µF	35p	1000, 63	26p	B32234-series as available			
40, 60µF	56p	2200, 3	30p	100V			
100µF	65p	2200, 10	33p	0.047	9p		
ELECTROLYTIC, CANS ●				0.068	9p		
Siemens B41070, unsealed				0.1	10p		
1000µF 40V	.99p	4700, 16	85p	0.15	11p		
1000µF 63V	1.07	4700, 25	96p	0.22	12p		
1000µF 100V	1.50	10,000, 3	40p	0.33	16p		
2200µF 25V	1.08	ELECTROLYTIC, PLUGGABLE ●		0.47	18p		
2200µF 40V	1.21	Siemens B41316 series		0.68	22p		
2200µF 63V	1.50	µF volts		1.0	27p		
4700µF 25V	1.46	1.0 63	13p	1.5 63	30p		
4700µF 40V	1.50	2.2 63	13p	2.2 63	33p		
4700µF 63V	2.04	4.7 63	13p	3.3 63	37p		
ELECTROLYTIC, CANS ●				4.7 63	42p		
Daly, sleeved				6.8 63	49p		
1000/25	46p	10 63	13p	10 100	74p		
2200/50	94p	22 40	13p	1.0 250	76p		
5000/25	98p	47 63	14p	1.5 63	76p		
4700/100	3.61	100 63	13p	2.2 63	76p		
ELECTROLYTIC, axial lead ●				3.3 63	76p		
Siemens B41313/B41283/B41010				4.7 63	76p		
µF volts				6.8 63	76p		
0.47 63	21p	100 63	13p	10 100	76p		
0.47 100	12p	220 3	8p	1.0 250	76p		
1.0 40	21p	220 10	16p	1.5 63	76p		
1.0 100	12p	220 16	18p	2.2 63	76p		
2.2 25	12p	220 25	19p	3.3 63	76p		
2.2 63	12p	220 40	23p	4.7 63	76p		
2.2 100	12p	470 6.3	16p	6.8 63	76p		
4.7 16	21p	470 10	19p	10 63	76p		
4.7 40	12p	470 25	25p	10 100	76p		
4.7 63	12p	470 40	29p	1.0 100	76p		
4.7 100	14p	1000 16	26p	1.5 63	76p		
				2.2 63	76p		
				3.3 63	76p		
				4.7 63	76p		
				6.8 63	76p		
				10 63	76p		
				10 100	76p		
				1.0 250	76p		
				1.5 63	76p		
				2.2 63	76p		
				3.3 63	76p		
				4.7 63	76p		
				6.8 63	76p		
				10 63	76p		
				10 100	76p		
				1.0 250	76p		
				1.5 63	76p		
				2.2 63	76p		
				3.3 63	76p		
				4.7 63	76p		
				6.8 63	76p		
				10 63	76p		
				10 100	76p		
				1.0 250	76p		
				1.5 63	76p		
				2.2 63	76p		
				3.3 63	76p		
				4.7 63	76p		
				6.8 63	76p		
				10 63	76p		
				10 100	76p		
				1.0 250	76p		
				1.5 63	76p		
				2.2 63	76p		
				3.3 63	76p		
				4.7 63	76p		
				6.8 63	76p		
				10 63	76p		
				10 100	76p		
				1.0 250	76p		
				1.5 63	76p		
				2.2 63	76p		
				3.3 63	76p		
				4.7 63	76p		
				6.8 63	76p		
				10 63	76p		
				10 100	76p		
				1.0 250	76p		
				1.5 63	76p		
				2.2 63	76p		
				3.3 63	76p		
				4.7 63	76p		
				6.8 63	76p		
				10 63	76p		
				10 100	76p		
				1.0 250	76p		
				1.5 63	76p		
				2.2 63	76p		
				3.3 63	76p		
				4.7 63	76p		
				6.8 63	76p		
				10 63	76p		
				10 100	76p		
				1.0 250	76p		
				1.5 63	76p		
				2.2 63	76p		
				3.3 63	76p		
				4.7 63	76p		
				6.8 63	76p		
				10 63	76p		
				10 100	76p		
				1.0 250	76p		
				1.5 63	76p		
				2.2 63	76p		
				3.3 63	76p		
				4.7 63	76p		
				6.8 63	76p		
				10 63	76p		
				10 100	76p		
				1.0 250	76p		
				1.5 63	76p		
				2.2 63	76p		
				3.3 63	76p		
				4.7 63	76p		
				6.8 63	76p		
				10 63	76p		
				10 100	76p		
				1.0 250	76p		
				1.5 63	76p		
				2.2 63	76p		
				3.3 63	76p		
				4.7 63	76p		
				6.8 63	76p		
				10 63	76p		
				10 100	76p		
				1.0 250	76p		
				1.5 63	76p		
				2.2 63	76p		
				3.3 63	76p		
				4.7 63	76p		
				6.8 63	76p		
				10 63	76p		
				10 100	76p		
				1.0 250	76p		
				1.5 63	76p		
				2.2 63	76p		
				3.3 63	7		



TRAMPUS

ELECTRONICS LTD.

ELECTRONIC COMPONENT CENTRE
58-60 GROVE ROAD, WINDSOR, BERKS
SL4 1HS (TRADE AND EXPORT WELCOME)
HOTLINE FOR TELEPHONE CREDIT CARD ORDERS —
WINDSOR 54525



SEMICONDUCTOR DISTRIBUTORS

READERS OFFER: OVER £10 DISCOUNT 5% OFF. (THIS MONTH)
QUANTITY DISCOUNT FOR 100 OF ONE TYPE 10% OFF 1 UP PRICE

Cheque or cash orders over £5 Post Free. Other orders add 20p Post & Packing. Credit Card orders £5 min. by post or phone. + Post & Packing 20p. UK add 8% to prices marked. Add 12 1/2 % VAT to all other prices. Free price list send S.A.E.

All devices to makers specifications. Please quote ET1 as prices may change. E.&O.E. 1978. Callers welcome Tues to Sat (Lunch 1-2).



MICRO POWER SUPPORT

- All full spec Grade 1 displays
- DL704 CC or OL707 CA 0.3" £1.25
- FN5000 CC/161 0.6" £1.25
- MANKA Type/161A 0.6" £1.25
- OL747 CA or DL 750 CC £1.69
- Clock IC AY51224 £3
- Display PCB 6 Digit 0.6" £1
- LEDS. Bright full spec. 0.2" or 0.125" Red 10p
- TIL209 Red & Clp 12p
- 0.2" Dia Red & Clp 12p
- Yellow or Green LEDs 0.2" or 0.125" Dia. All 20p
- 12 volt Fluorescent Light £1
- Jackson Tuner 370pf £1
- Trimmer 0-8 or 5 to 40pf 25p
- Coil Former & Slug 0.3" Dia 25p
- Relay Mini 3 Pole 12 volt £1
- Coil £1
- RS Type Bleeder 9 to 12v £1.50
- Date PCB Pen 2 nibs 70p
- TUB Ferric CHL 1/4kg. £1
- Decon Board Cleaner Pad 50p
- 6x4" Nylon/Copper Board 60p
- Vero Stocked All 10% off i.e. 3"x5"x0.1" Board 56p

- 6"x4" DII Board £2.25
- PP3 or PP9 Clips. Pair 15p
- On Plugs. All 19p
- On Sockets. All 10p
- Disco Strobe Tube £5
- DEVELOPMENT PAR-CELS. All £5 each
- SET 1: 250x50 volt Ceramic Capacitors 5%. 10 each. From 22pf to 0.1uf £5
- SET 2: Tantalsms 1uf to 200uf 20v to 35v. Total 50 capacitors £5
- SET 3: Electrolytic 25 volt 10 each (80) 1/2/5/10/47/100/220/1000 £5
- SET 4: 1/2 watt Resistors 5% C.F. 10 each 10 ohm to 10 meg ohm. Total 500. Bulk packed in 1 bag £5
- SET 5: Zeners 400mw 5 each. 20 values 3 volt to 33 volt (Total 100) £5
- SET 6: -100 Presets £5
- SET 7: Heatsinks. 10 off. Each T018, T05, TV4 (T099) and small T03 £5
- PASSIVE GEAR
- Resistors 1/2 watt 5% CF 2p
- Presets Type PR Vert. 10p
- Type 45 Pots Log & Lin 25p
- CAPACITORS
- Ceramic 50v 5% Hi Stab 22pf to 0.1uf & 22/47 5p
- Tantalum Caps 12p
- ELECTROLYTICS 25 volt 1/10/47/100uf. All 10p
- (50 volt 20p) 220 or 470uf 30p
- 1000uf 25 volt 35p
- KNOBBS. 1" dia & trim 15p
- HEAT SINKS. T05 & 18 9p
- TV4 25p*. T03 small 25p*

- DISCO TRIAC 10A 400v £1
- 8R100 Diac 25p
- C1060 4A 400v SCR 55p
- TAG 1/400 lamp 55p*. 1/600 65p*
- Switches Mini SPST 55p
- Mini OPDT 69p*. Centre off 89p*
- Slide Switch 25p
- Push On 35p
- FULL SPEC PAKS ALL £1
- Pak A: 12 x Red LEDs £1
- Pak B: 6 x 741C 8 pin £1
- Pak C: 4x2 N13055. T03 £1
- Pak D: 12 x 8C109 £1
- Pak E: 13 x 8C182 £1
- Pak F: 13 x 2N3704 £1
- Pak G: 7 x 8FY FI £1
- Pak H: 7 x 2N3819 etel £1
- New Pak I: 10 x Metal Trim. Knob 1/2" dia (synthesiser etc.) £1
- Pak J: 6 x 2N3053 £1
- Pak K: 50xIN4148 £1
- Pak L: 50 x 33uf 10 volt electrolytic £1
- Pak M: 4 x Pairs Plastic Power 2amp 60 volt. NPN/PNP 80131/2 Type £1
- Pak N: 50 x 0A81/91 £1
- Pak P: 20 x Plastic 109 £1
- Pak Q: 50 x 220uf 6.3v Volt Electrolytic £1
- Pak R: 14 x 8C107 £1
- Pak S: 14 x 8C108 £1
- 10 x NPN Plastic Power 60 volt 2 amp 80BI Type £1

- TRANSISTORS
- Look at our Pak T. Ten Plastic Power £1
- Or Pak C: 4 x 2N3055 £1
- Matching 20p*. ins Kit 10p*
- AC127 17p* 8FY50 16p*
- AC176 10p* 8FY51 16p*
- AC187 20p* 8FX29 28p*
- AF162 40p* MJE2955 £1
- AF239 42p* MJE340 44p*
- BC107 8p* MJE2955 £1
- BC108 8p* MJE3055 80p*
- BC109 9p* MPU131 35p
- BC1096 15p* ORP12 55p*
- BC147 12p* TIP41A 60p*
- BC148 12p* TIP42A 65p*
- BC149 12p* TIP395 60p*
- BC157 15p* TIP305 50p*
- BC158 15p* TIS43 35p
- BC159 15p* 2N2646 39p*
- BC169 11p* 2N2926Y 10p*
- BC168 11p* 2N3053 16p*
- BC177 18p* 2N3055 45p
- BC178 18p* 2N3614 £1
- BC179 18p* 2N3702 9p
- BC181 10p* 2N3704 9p
- BC183 10p* 2N3706 9p
- BC184 10p* 2N3819 18p
- BC212 12p* 2N3820 38p
- BC213 12p* 2N3904 15p
- BC214 12p* 2N3906 15p
- BCV71 20p* 2N4347 50p*
- 80131 37p* 2N5457 32p
- 80132 37p* 2N5777 44p*
- 80695 69p* TL131 £2
- 80696 69p* TL63 £1
- DIODES & BRIDGE
- 1A 50V Bridge 22p*
- IN4148 or IN914 4p*
- 0A81 or 0A91 5p
- 0A200 & 202 10p
- IN4001 1A50v 5p*
- IN4004 7p*. IN4007 15p*

- 7400N SERIES TTL
- ALL FULL SPEC BRANDED
- 7400 8p* 7475 44p*
- 7401 9p* 7476 35p*
- 7402 10p* 7480 39p*
- 7403 10p* 7481 £1*
- 7404 17p* 7482 £1*
- 7405 9p* 7483 £1*
- 7406 28p* 7485 £1*
- 7407 28p* 7486 35p*
- 7408 12p* 7490 36p*
- 7409 12p* 7491 75p*
- 7410 10p* 7492 35p*
- 7411 22p* 7493 35p*
- 7412 22p* 7494 75p*
- 7413 28p* 7495 75p*
- 7416 28p* 7496 85p*
- 7417 28p* 74100 £1.15*
- 7420 10p* 74107 29p*
- 7423 26p* 74121 27p*
- 7425 26p* 74123 59p*
- 7426 26p* 74141 85p*
- 7430 10p* 74143 £3.14*
- 7432 20p* 74145 85p*
- 7440 14p* 74147 £1.69*
- 7441 79p* 74152 £2*
- 7442 87p* 74154 £2*
- 7445 69p* 74155 80p*
- 7446 88p* 74156 80p*
- 7447 82p* 74157 £1*
- 7448 11p* 74164 £1*
- 7450 15p* 74174 £1*
- 7451 15p* 74176 £1*
- 7453 15p* 74190 £2*
- 7454 15p* 74192 £2*
- 7456 15p* 74193 £2*
- 7470 29p* 74194 £2*
- 7472 26p* 74196 £1.30*
- 7473 25p* 74197 £1*
- 7474 29p* 74198 £2*

- CMOS TOP VALUE
- 4000 15p* 4066 58p*
- 4001 15p* 4067 £4*
- 4002 17p* 4069 22p*
- 4006 £1* 4070 32p*
- 4007 18p* 4071 21p*
- 4008 92p* 4072 21p*
- 4009 58p* 4073 21p*
- 4010 58p* 4075 23p*
- 4011 15p* 4076 £1.29*
- 4012 18p* 4077 40p*
- 4013 55p* 4078 21p*
- 4015 93p* 4081 22p*
- 4016 52p* 4082 21p*
- 4017 99p* 4089 £1.50*
- 4018 99p* 4093 85p*
- 4020 £1* 4507 53p*
- 4021 £1* 4508 £3*
- 4022 90p* 4510 £1.35*
- 4023 20p* 4511 £1.68*
- 4024 76p* 4512 98p*
- 4025 19p* 4514 £2.85*
- 4027 55p* 4516 £1.25*
- 4028 90p* 4518 £1.05*
- 4029 £1* 4520 £1.10*
- 4030 58p* 4521 £2.68*
- 4032 £1* 4522 £2.68*
- 4034 £2* 4528 99p*
- 4035 £1.20* 4534 £7.88*
- 4038 £1.08* 4536 £3.60*
- 4040 £1.05* 4541 £1.50*
- 4041 86p* 4543 £1.75*
- 4042 81p* 4553 £4.49*
- 4043 96p* 4556 78p*
- 4044 95p* 4558 £1.17*
- 4046 £1.30* 4566 £1.59*
- 4047 99p* 4569 £3.59*
- 4049 52p* 4583 £1.10*
- 4060 £1.15* 4585 £2.05*
- 4063 £1.10*

- TOP TWSOME!
- 555 8 Pin Timer 27p*
- 741C Full spec DIL 8. Branded Op Amp 19p*
- NEW LINEARS Data 10p
- TL170 Hall effect 69p*
- TL071 Lo noise 741 75p*
- TL081 FET 8p. 741 69p*
- TL083 FET 747 £1.49*
- TL080 FET 748/308 £1.15*
- IC SUPERMARKET
- 301 Op Amp 30p*
- 555 Timer (NE555) 27p*
- 556 Dual 555 70p*
- 710 Comparator 40p*
- 723 Regulator 45p*
- 741C 8 Pin DIL OPA 19p*
- 741C 1099 or DIL 14 39p*
- 748C Op Amp 33p*
- 3900 Quad Op Amp 55p*
- 7805 1 Amp 5 volt 95p*
- 7805 TO3/309K £1*
- 7808 or 7812 £1.25*
- 7815 1.5 volt plastic 69p*
- 7900 Negative Series £2.50*
- 8038 Sig Generator £3.55*
- 76013 & 76023 £1.35
- CA3130 & CA3140 94p*
- LM380 1 watt Amp 85p
- LM381 Dual Preamp £1.55
- LM387 Dual Preamp £1
- LM3900 Quad OPA 55p*
- MC1310 Decoder £1
- MC1460, 1461 & 1469 £3
- MC1460 1463, A/O £5*
- NE536 FET OPA £4*
- NE555 Timer 27p*
- NE556 Dual 555 70p*
- T8A810 7w AF £1
- ZN414 Radio 65p

Become a radio amateur.

Learn how to become a radio-amateur in contact with the whole world. We give skilled preparation for the G.P.O. licence.

Free!

Brochure, without obligation to:

BRITISH NATIONAL RADIO & ELECTRONICS SCHOOL,

P.O.Box 156, Jersey, Channel Islands.

NAME _____

ADDRESS _____ (Block caps please)

WAA PEK 10

PE SUSTAIN UNIT

(P.E. OCTOBER 1977)

BUILD A SUSTAIN UNIT EQUAL TO THE BEST COMMERCIAL MODELS.

COMPLETE KIT - £7.95

ALL HIGH QUALITY COMPONENTS AS SPECIFIED.

DESIGNER APPROVED.

ORION Complete set of semiconductors £4.99
tuner LP1186 Tuner Head £9.60
Glass fibre PCB, printed with component locations £2.45

ORION Complete set of semiconductors £9.40
amplifier Glass fibre PCB, printed with component locations £3.50

PE DIGITAL VOLTMETER (APRIL 1977)
SPECIAL CLEARANCE OFFERS (while stocks last)

Set of semiconductor devices including all I.C.'s, transistors, diodes, regulators etc. but without displays. £13.50*

Set of two professional grade printed circuit boards in glass fibre and printed with component locations. £1.95*

Complete set of resistors, including attenuator resistors. £1.00*

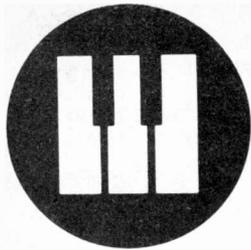
Complete set of capacitors, including 2200uF power supply ZN4116 £6.00* with circuits. ZN7447A £1.00*. 78M05 regulator 55p*. ZN423 £1.00*

PE TV SOUND SEPARATOR

Complete set of semiconductors £2.30. High quality glass fibre p.c.b. £1.00. Murata filters. SFE6.0MA 35p. CDA6.0MC 35p. P & P 15p per order. Orders over £5 post free.

All devices are top grade, brand new and to full manufacturer's spec. We do not sell seconds or rejects. Send S.A.E. for our data sheet and price list. Prices do not include VAT—add 8% to items marked*, and 12 1/2% to all others.

DAVIAN ELECTRONICS (Mail order, callers by appointment only).
13 Deepdale Avenue, Royton, Oldham OL2 6XD



WERSI

Tomorrow's Electronic Organ Kit is Here



GALAXY
The Flagship of the
WERSI range of
Organs

WERSI is the first kit producing company applying the latest achievements of the space age technology. This has decisive effects on the technical and musical quality of WERSI's electronic organs for the do-it-yourselfer. The application of modern integrated circuits, so-called IC's, simplifies the organ construction considerably. A single IC may replace up to 10,000 conventional electronic components. In addition, IC's save a lot of space and they are extremely reliable devices. WERSI, however, went a step farther yet. IC's which were not available on the open market were developed for specific purposes by WERSI engineering. They are being produced by the most highly reputed IC manufacturers in the world. The result: economical electronic organs with the most up-to-date techniques and unsurpassed musical capabilities.

POSSIBLY A NEW NAME TO YOU, BUT KNOWN IN OVER 25 COUNTRIES FOR THE SUPERIOR INSTRUMENTS WHICH THIS GERMAN COMPANY PRODUCE



USED BY WEST GERMAN BROADCASTING SERVICE



PLAYED BY KLAUS WUNDERLICH AND OTHER FAMOUS ORGANISTS

Without doubt, the most comprehensive kits and the most up-to-date designs available today. Just consider a few of the features

- Precision Master Generator, using MOS-LSI.
- Integrated electronic keying in I²L technology
- Unique—All switch functions are programmable.
- Even the smallest organ has drawbars in addition to fixed stops.
- Craftsman-made cabinets available in 5 veneers
- Ready-made wiring harnesses eliminate errors

Send now for the 104 page full colour catalogue and 16 page price list describing the 8 organs in the range, together with the complementary kits which WERSI produce.

To: AURA Sounds, P1., Copthorne Bank, Crawley, West Sussex.
Please telephone to arrange demonstration 0342 713338
I enclose £2.00, refundable against my first order to the value £25.00. Please send the Wersi catalogue and price list.

NAME

ADDRESS

SEMICONDUCTORS POTS & IRONS

SOCKETS

1611 8 pin DIL	£0 13
1612 14 pin DIL	£0 14
1613 16 pin DIL	£0 15
1614 24 pin DIL	£0 40
1615 28 pin DIL	£0 45
1616 TO18 Transistor	£0 12
1617 TU3 Transistor	£0 35
16117 TO5 Transistor	£0 12

VOLTAGE REGULATORS

Positive	
MVR7805 v.a. 7805 TO220	£1 00
MVR7812 v.a. 7812 TO220	£1 00
MVR7815 v.a. 7815 TO220	£1 00
MVR7824 v.a. 7824 TO220	£1 00
Negative	
MVR7905 v.a. 7905 TO220	£1 40
MVR7912 v.a. 7912 TO220	£1 40
MVR7915 v.a. 7915 TO220	£1 40
MVR7924 v.a. 7924 TO220	£1 40
v.a. 723C TO99	45p
72723 14 pin DN	45p
LM309K TO3	£1 50

ZENER DIODES

400mw (Bz88) DO7 Glass encapsulated Range of voltages available 1.3v, 2.2v, 2.7v, 3.3v, 3.9v, 4.3v, 4.7v, 5.1v, 5.6v, 6.2v, 6.8v, 7.5v, 8.2v, 9.1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 39v.

No. Z4 8p ea.

1w-1.6w Plastic and metal encapsulated Range of voltages available 1.3v, 2.2v, 2.7v, 3.3v, 3.9v, 4.3v, 4.7v, 5.1v, 5.6v, 6.2v, 6.8v, 7.5v, 8.2v, 9.1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 39v, 47v, 51v, 68v, 72v, 75v, 82v, 91v, 100v.

No. Z13 15p ea.

10w Metal stud type SO10 case. Range of voltages available: 1.3v, 2.2v, 2.7v, 3.3v, 3.9v, 4.3v, 4.7v, 5.1v, 5.6v, 6.2v, 6.8v, 7.5v, 8.2v, 9.1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 39v, 47v, 51v, 68v, 72v, 75v, 82v, 91v, 100v.

No. Z10 35p ea.

SILICON RECTIFIERS

200mA	
IS920 50v	£0 06
IS921 100v	£0 07
IS922 150v	£0 08
IS923 200v	£0 09
IS924 300v	£0 10
IN4001 50v	
IN4002 100v	£0 04
IN4003 200v	£0 05
IN4004 400v	£0 07
IN4005 600v	£0 08
IN4006 800v	£0 09
IN4007 1000v	£0 10
1.5 Amp	
IS015 50v	£0 09
IS020 100v	£0 10
IS021 200v	£0 11
IS023 400v	£0 13
IS025 600v	£0 14
IS027 800v	£0 16
IS029 1000v	£0 20
IS031 1200v	£0 25
3 Amp	
IN5100 50v	£0 14
IN5401 100v	£0 15
IN5102 200v	£0 16
IN5404 400v	£0 21
IN5405 600v	£0 21
IN5407 800v	£0 25
IN5408 1000v	£0 30
10 Amp	
IS10/50 50v	£0 19
IS10/100 100v	£0 21
IS10/200 200v	£0 23
IS10/400 400v	£0 35
IS10/600 600v	£0 42
IS10/800 800v	£0 51
IS10/1000 1000v	£0 60
IS10/1200 1200v	£0 69
30 Amp	
IS30/50 50v	£0 56
IS30/100 100v	£0 69
IS30/200 200v	£0 93
IS30/400 400v	£1 25
IS30/600 600v	£1 76
IS30/800 800v	£2 34
IS30/1000 1000v	£2 91
IS30/1200 1200v	£2 88
60 Amp	
IS70/50 50v	£0 75
IS70/100 100v	£0 84
IS70/200 200v	£1 20
IS70/400 400v	£1 75
IS70/600 600v	£2 25
IS70/800 800v	£2 50
IS70 1000 1000v	£3 00
BYX39/300 6A 300v	£0 45
BYX38/600 6A 600v	£0 40
BYX38/300 Rev 6A 300v	£0 45
BYX38/600 Rev 6A 600v	£0 40

POTENTIOMETERS

CARBON POTS (Linear Track)
Single gang with wire end terminations. 6mm 50mm plastic shaft 10mm bushes supplied with shake proof washer & nut. Tolerance $\pm 20\%$ of resistance.

1831 1k ohms £0 26* 1836 47kohms £0 26*
1832 2k ohms £0 26* 1837 100kohms £0 26*
1833 4kohms £0 26* 1838 22kohms £0 26*
1834 10kohms £0 26* 1839 47kohms £0 26*
1835 22kohms £0 26* 1840 1Meg £0 26*
1841 2M2 £0 26*

CARBON POTS (Log Track)
1842 4k ohms £0 26* 1846 100kohms £0 26*
1843 10kohms £0 26* 1847 22kohms £0 26*
1844 22kohms £0 26* 1848 47kohms £0 26*
1845 47kohms £0 26* 1849 1Meg £0 26*
1850 2M2 £0 26*

DUAL CARBON POTS (Lin Track)
These high quality dual gang pots are fitted with wire end terminations and 6mm 50mm plastic shaft 10mm bush and supplied with shake proof washer & nut track tolerance $\pm 20\%$ but matched to within 2db of each other. VC3

1851 4k7 £0 78* 1855 100kohms £0 78*
1.52 10kohms £0 78* 1856 220kohms £0 78*
1853 22kohms £0 78* 1857 47kohms £0 78*
1854 100kohms £0 78* 1858 1Meg £0 78*
1859 2M2 £0 78*

DUAL CARBON POTS (Log Law)
1861 4k7ohms £0 78* 1864 100kohms £0 78*
1861 10kohms £0 78* 1865 220kohms £0 78*
1862 22kohms £0 78* 1866 47kohms £0 78*
1863 47kohms £0 78* 1867 1Meg £0 78*
1868 2M2 £0 78*

SINGLE GANG SWITCHED (Lin Law)
These potentiometers are fitted with double pole on-off switches. The switch is incorporated within the rotary action of the pot. Specification of pot is as VC1. Switch rating 1 5amps at 250v AC.

1870 4k7ohms £0 60* 1874 100kohms £0 60*
1871 10kohms £0 60* 1875 220kohms £0 60*
1872 22kohms £0 60* 1876 47kohms £0 60*
1873 47kohms £0 60* 1877 1Meg £0 60*
1878 2M2 £0 60*

SWITCHED POT (Log Track)
Specification as VC2 but track having (log) law.

1879 4k7ohms £0 60* 1833 100kohms £0 60*
1880 10kohms £0 60* 1884 220kohms £0 60*
1881 22kohms £0 60* 1885 47kohms £0 60*
1882 47kohms £0 60* 1886 1Meg £0 60*
1887 2M2 £0 60*

ANTEX IRONS

O/No. 1943. 15 watt high quality soldering iron totally enclosed element in a ceramic shaft fitted with 3/32" bit £3 80

O/No. 1947. Replacement element for 1943 iron. £1 90

O/No. 1944. Iron coated bit 3/32" for 1943 iron. £0 46

O/No. 1945. Iron coated bit 1/8" for 1943 iron. £0 46

O/No. 1946. Iron coated bit 3/16" for 1943 iron. £0 46

O/No. 1948. General purpose 18 watt iron fitted with iron coated bit. £3 60

O/No. 1952. Replacement element for 1948 iron. £1 90

O/No. 1949. Iron coated bit 3/32" for 1948 iron. £0 46

O/No. 1950. Iron coated bit 1/8" for 1948 iron. £0 46

O/No. 1951. Iron coated bit 3/16" for 1948 iron. £0 46

DUAL GANG LOG-ANTI-LOG POT CONTROL
1888 Track specification as dual gang pots VC2 as above, but tracks mounted to log-anti log action. £0 75*

SPECIAL VOLUME CONTROLS
A miniature 16mm type replacement volume control incorporating single pole on-off switch. Resistance value 5kohms. Tolerance $\pm 20\%$ 1/8watt rating.

1899 £0 27* VC8

MINIATURE ROTARY VOL CONTROL
5kohms log law with on/off switch. 20mm grooved spindle. Tag connections 17mm dia. Supplied with fixing nut. Used mainly for replacement.

1890 £0 54* VC9

WIRE WOUND POTS
A range of wire wound single gang pots with linear tracks of 1 watt rating, fitted with 10mm bush and supplied with shake-proof washer and nut.

1891 10ohms £0 80 1895 220ohms £0 80
1892 22ohms £0 80 1896 470ohms £0 80
1893 47ohms £0 80 1897 1kohms £0 80
1894 2kohms £0 80 1898 2kohms £0 80
1899 4k7ohms £0 80

PRE-SET POTS HORIZONTAL MOUNTING
Miniature type for transistor circuits. The wiper of the preset is provided with a slot for screw driver adjustment. The tags of the preset will fit printed wiring boards with a pitch of 2.54mm. All tracks are linear law.

VC7

1801 100ohms £0 08* 1808 22kohms £0 08*
1802 220ohms £0 08* 1809 47kohms £0 08*
1803 47ohms £0 08* 1810 100kohms £0 08*
1804 1kohms £0 08* 1811 220kohms £0 08*
1805 2kohms £0 08* 1812 47kohms £0 08*
1806 4k7ohms £0 08* 1813 1Mohms £0 08*
1807 10kohms £0 08* 1814 2Mohms £0 08*
1815 4M7ohms £0 08*

PRE-SET POTS VERTICAL MOUNTING
Miniature type for transistor circuits. Wiper adjustment is made by a screw driver slot. Designed to fit 2.54mm pitch board. All tracks are linear law.

VC7

1816 100ohms £0 08* 1823 22kohms £0 08*
1817 220ohms £0 08* 1824 47kohms £0 08*
1818 47ohms £0 08* 1825 100kohms £0 08*
1819 1kohms £0 08* 1826 220kohms £0 08*
1820 2kohms £0 08* 1827 47kohms £0 08*
1821 4k7ohms £0 08* 1828 1Mohms £0 08*
1822 10kohms £0 08* 1829 2Mohms £0 08*
1830 4M7ohms £0 08*

PCB TRANSFERS

TR114 £1 65 TR312 £1 10



etch-resist pen. 11 different paks available each containing 10 sheets of transfers as illustration—approx. 1/2 size—Special Introductory Set, 1 pak each of above £12.00.

TR120 £1 19 TR101 £1 10 TR053 £1 10 TR203 £1 10 TR205 £1 10

TR115 £1 50 TR106 £1 65 TR113 £1 75

Draw your own boards with the new BI-PAK etch-resist transfers. Lay the symbols on the board, rub over with a soft pencil. The transfer will adhere to the board. Then complete the circuit with your BI-PAK

930 SERIES DTL

BP930	£0 30	BP948	£0 50
BP932	£0 30	BP951	£0 65
BP933	£0 30	BP962	£0 30
BP935	£0 30	BP9093	£0 42
BP936	£0 55	BP9094	£0 42
BP944	£0 30	BP9067	£0 42
BP945	£0 50	BP9099	£0 42
BP946	£0 30		

D.I.Y. P.C.B. ACCESSORIES

1609. Etch resistant pen	65p
1608. Paks of etchant, complete with instructions	80p
C26. 4 pieces 8 x 3 1/2" (approx.) boards. Single-sided fibre glass	80p
C27. 3 pieces 7 x 3 1/2" (approx.) boards. Double-sided fibre glass	80p

LEDs DISPLAYS & OPTOS

O/no.	Type	Size	Colour	Price
1501	TIL209 led	125	RED	£0 10
1502	TIL211 led	125	GREEN	£0 19
1503	TIL213 led	125	YELLOW	£0 19
1504	FLV115 led	2	RED	£0 19
1505	FLV310 led	2	GREEN	£0 19
1506	FLV410 led	2	YELLOW	£0 19
1510	BDL707 display	3	RED	£0 80
1511	BDL747 display	3	RED	£1 50
1512	BDL727 display	3	RED	£1 80
1514	ORP12 Light dependent resistor			£0 55
1520	OC71 Photo transistor			£0 35

LED CLIPS
1508/125 pack of 5 125 clips £0 15
1508/2 pack of 5 2 clips £0 18

2nd GRADE LEDs
A pack of 10 standard sizes and colours which fail to perform to their very rigid specification, but which are ideal for amateurs who do not require the full spec.

O/No. 1507 90p

NUMERICAL INDICATORS
Cold cathode ITT 50875T Side viewing indicator tubes. Displays 019 and decimal points. Wide viewing angle. Operates from 180v with 16kohms series anode resistor. Character height 10.5mm. Pin connectors and supply details on pack.

O/No. 1513. 5 for 60p

BRIDGE RECTIFIERS

SILICON 1 amp		Order No.	Price
Type	50V RMS	BR1/50	£0 20
	100V RMS	BR1/100	£0 22
	200V RMS	BR1/200	£0 25
	400V RMS	BR1/400	£0 36
SILICON 2 amp			
Type	50V RMS	BR2/50	£0 45
	100V RMS	BR2/100	£0 48
	200V RMS	BR2/200	£0 52
	400V RMS	BR2/400	£0 58
	1000V RMS	BR2/1000	£0 68
2 AMP METAL STUD MOUNTING			
No. KBS005	50 volt		£0 30
No. KBS01	100 volt		£0 35
No. KBS02	200 volt		£0 40

THYRISTORS

600ma	TO 18 Case	7 Amp	TO 48 Case
Volts No.	Price	Volts No.	Price
10 THY600/10	£0 15	50 THY7A/50	£0 48
20 THY600/20	£0 16	100 THY7A/100	£0 51
30 THY600/30	£0 20	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 44		
1 amp		TO 5 Case	
Volts No.	Price	Volts No.	Price
50 THY1A/50	£0 26	50 THY10A/50	£0 51
100 THY1A/100	£0 28	100 THY10A/100	£0 57
200 THY1A/200	£0 32	200 THY10A/200	£0 62
400 THY1A/400	£0 38	400 THY10A/400	£0 71
600 THY1A/600	£0 45	600 THY10A/600	£0 99
800 THY1A/800	£0 58	800 THY10A/800	£1 22
3 amp		TO 66 Case	
Volts No.	Price	Volts No.	Price
50 THY3A/50	£0 28	50 THY16A/50	£0 54
100 THY3A/100	£0 30	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		TO 66 Case	
Volts No.	Price	Volts No.	Price
50 THY5A/50	£0 36	50 THY30A/50	£1 18
100 THY5A/100	£0 45	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	£1 99
800 THY5A/800	£0 81	800 THY30A/800	£3 50
		No.	Price
		BT101/500R	£0 80
		BT102/500R	£0 80
		BT106	£1 25
		BT107	£0 93
		BT108	£0 98
		2N3228	£0 70
		2N3355	£0 77
		BTX30/50L	£0 33
		BTX30/400L	£0 46
		CI06.4	£0 66

ORDERING. Do not forget to state order number and your name and address.

V.A.T. Add 12 1/2% to prices marked*. 8% to those unmarked. Items marked are zero rated.

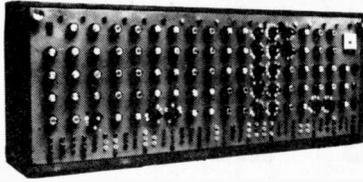
P&P 35p unless otherwise shown.

BI-PAK

DEPT. PE10, P.O. BOX 6, WARE, HERTS.

SHOP AT 18 BALDOCK ST., WARE, HERTS. OPEN 9 to 5.30 MON-SAT.

KITS FOR SYNTHESISERS, SOUND EFFECTS



PHONOSONICS

MAIL ORDER SUPPLIERS OF QUALITY PRINTED CIRCUIT BOARDS, KITS AND COMPONENTS TO A WORLD-WIDE MARKET

P. E. MINISONIC Mk. 2 SYNTHESIZER

A portable mains-operated Miniature Sound Synthesizer, 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. Consists of 2 log VCOs, VCF, 2 envelope shapers, 2 voltage controlled amps, keyboard hold and control circuits, HF oscillator and detector, ring modulator, noise generator, mixer, power supply.

Set of basic component kits from **£61-00**
Set of printed circuit boards **£8-99**

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

The well acclaimed and highly versatile large-scale mains-operated Sound Synthesiser complete with keyboard circuits. Other circuits in our lists may be used with the Synthesiser to good advantage.

The Main Synthesiser: PSU, 2 linear VCOs, 2 ramp generators, 2 input amps, sample hold, noise generator, reverb amp, ring modulator, peak level circuit, envelope shaper, voltage controlled amp.

Set of basic component kits **£79-09**
Set of printed circuit boards **£13-20**

The Synthesiser Keyboard Circuits (can be used without the Main Synthesiser to make an independent musical instrument): 2 logarithmic VCOs, divider, 2 hold circuits, 2 modulation amps, mixer, 2 envelope shapers and PSU.

Set of basic component kits **£47-34**
Set of printed circuit boards **£7-66**

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 **£7-69**
Alternative component set with panel switches **£5-05**
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) **£8-17**
Printed circuit board **£1-81**

Optional extra—additional Audio Modulator the use of which, in conjunction with the above component set, can produce jungle-drum rhythms.

Component set (incl. PCB) **£2-88**

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) **£3-20**

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) **£4-74**

SOPHISTICATED PHASING AND VIBRATO UNIT

A slightly modified version of the circuit published in "Elektron", December 1976, and includes manual and automatic control over the rate of phasing and vibrato.

Component set **£17-38**
Printed circuit board **£2-33**

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) **£3-63**

AUTOWAH UNIT (P. E. Mar. 77)

Automatically produces Wah-pedal and Swell-pedal sounds each time a new note is played.

Component set, PCB, special foot switches **£7-67**
Component set and PCB, with panel switches **£4-83**

COMPONENTS SETS include all necessary resistors, capacitors, semiconductors, potentiometers and transformers. Hardware such as cases, sockets, knobs, keyboards, etc. are not included but most of these may be bought separately. Fuller details of kits, PCBs and parts are shown in our lists.

CIRCUIT AND LAYOUT DIAGRAMS are supplied free with all PCBs unless "as published".

PHOTOCOPIES of P.E. texts for most of the kits are available—prices in our lists.

P. E. JOANNA PLUS ORGAN VOICING

The basic five octave electronic piano (P. E. May/Sept 75 and Sound Design) has switchable alternative voicings for Honky-Tonk, ordinary piano, and Harpsichord or a mixture of any of these three, together with facilities including fast and slow tremolo, loud and soft pedal switching, and sustain pedal switching. The modification retains all the circuitry associated with the piano but in addition provides an organ-voice envelope facility with 5 switchable pitches, variable attack and sustain, phasing and vibrato.

Set of components (excl switches) for PSU, Frequency generator, Pitch and Note Divider, Envelope Shapers, Voicings, and Control circuitries. (Order as KIT 71-5) **£99-25**
Set of PCBs (Order as PCB SET 71-6) **£29-18**

SYNTHESIZER TUNING INDICATOR (P. E. July 77)

A simple 4-octave frequency comparator for use with synthesizers and other instruments where the full versatility of the P. E. Tuning Fork is not required.

Component and PCB (but excl sw.) **£7-45**

GUITAR FREQUENCY DOUBLER (P. E. Aug. 77)

A modified and extended version of the circuit published.

Component set and PCB **£4-52**

GUITAR SUSTAIN (P. E. Oct. 77)

Maintains the natural attack whilst extending note duration.

Component set, PCB and foot switches **£5-13**
Component set, PCB and panel switches **£3-71**

WIND AND RAIN UNIT

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

Component set (incl. PCB) **£4-26**

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 **£7-58**
Component set using dual rotary pot **£6-89**
Printed circuit board **£1-82**

FUZZ UNIT

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

Component set (incl. PCB) **£2-05**

TREMOLO UNIT

Based upon P. E. Sound Design circuit.

Component set (incl. PCB) **£2-94**

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) **£2-51**

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

Produces 84 switch-selected frequency-accurate tones. A LED monitor clearly displays all beat note adjustments. Ideal for tuning acoustic or electronic musical instruments.

Main component set (incl. PCB) **£14-93**
Power supply set (incl. PCB) **£6-28**

**New Electronic Piano.
Elektron Aug. 1978
Details in our list.**

CONSTANT DISPLAY FREQUENCY METER (P. E. Aug. 78)

A 5-digit frequency counter for 1Hz to 999999Hz with a 1Hz sampling rate. Readout does not count visibly or flicker due to display blanking.

Component set **£24-05***
Printed circuit board **£3-03***
*This kit & PCB are at 8% VAT (all others are 12½%)

TAPE NOISE LIMITER

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

Standard tolerance set of components **£2-96**
Superior tolerance set of components **£3-76**
Regulated power supply (will drive 2 sets) **£4-69**

ENVELOPE SHAPER WITHOUT VCA (P. E. Oct. 75)

Provides full manual control over attack, decay, sustain and release functions, and is for use with an existing voltage controlled amplifier.

Component set (incl. PCB) **£4-77**

ENVELOPE SHAPER WITH VCA (P. E. Apr. 76)

This unit has its own voltage controlled amplifier and has full manual control over attack, decay, sustain and release functions.

Component set (incl. PCB) **£6-68**

TRANSIENT GENERATOR (P. E. Apr. 77)

An envelope shaper, without VCA, having the usual attack, decay, sustain and release functions, and in addition it also provides a Repeat Effect enabling a synthesiser to be programmed to imitate such instruments as a mandolin or banjo.

Component set **£4-87**
Printed circuit board **£1-82**

WAVEFORM CONVERTER

Slightly modified from a circuit published in "Elektron". Converts a saw-tooth waveform into four different waveforms: sine-wave, mark-space saw-tooth, regular triangle form, and squarewave with an externally variable mark-space ratio.

Component set (incl. PCB but excl. sw/s) **£8-40**

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

Part of the P. E. Minisonic now released as an independent kit for use with other synthesizers.

Component set (incl. PCB) (Order as Kit 65-1) **£7-17**

RING MODULATOR (P. E. Jan. 75)

Part of the P. E. Minisonic now released as an independent kit for use with other synthesizers.

Component set (incl. PCB) (Order as Kit 59-1) **£5-50**

NOISE GENERATOR (P. E. Jan. 75)

Part of the P. E. Minisonic now released as an independent kit for use with other synthesizers.

Component set (incl. PCB) (Order as Kit 60-1) **£3-64**

SOPHISTICATED POWER SUPPLIES

A wide range of highly stabilised low noise power supply kits is available—details in our lists.

MICROPHONE PRE-AMP (P. E. Apr. 77)

Component set (incl. PCB) **£3-82**

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) **£3-97**

DYNAMIC RANGE LIMITER (P. E. Apr. 77)

Automatically controls sound output to within a preset level.

Component set (incl. PCB) **£4-58**

POST AND HANDLING

U.K. orders—under £15 add 25p plus VAT, over £15 add 50p plus VAT. Keyboards £2.00 plus VAT.

Optional Insurance for compensation against loss or damage in post, add extra 50p for cover up to £50, £1.00 for £100 cover, £2.00 for £200 cover.

Ireland, C.I., B.F.P.O., and other countries are subject to Export postage rates.

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).

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 send 50p.

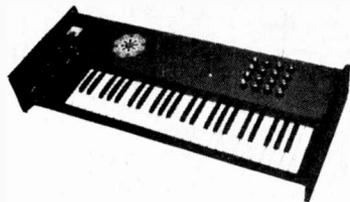
PHONOSONICS · DEPT. PE60 · 22 HIGH STREET · SIDCUP · KENT DA14 6EH MAIL ORDER AND C.W.O. ONLY
SORRY BUT NO CALLERS PLEASE

AND 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 50p.



KIMBER-ALLEN KEYBOARDS AND CONTACTS

Kimber-Allen Keyboards as required for many published circuits. The manufacturers claim that these are the finest moulded plastic keyboards available. All octaves are C to C, the keys are plastic, spring-loaded, fitted with actuators, and mounted on a robust aluminium frame.

3 Octave (37 notes)	£25.50
4 Octave (49 notes)	£32.25
5 Octave (61 notes)	£39.75

Contact Assemblies (gold-clad wire) for use with the above keyboards (1 required for each note):

Type GJ: Single-pole change-over	each 25½p
Type GB: 2 pairs of contacts, each pair normally open	each 28½p
Type GC: 3 pairs of contacts, each pair normally open	each 37½p
Type GE: 4 pairs of contacts, each pair normally open	each 46½p
Type GH: 5 pairs of contacts, each pair normally open	each 58½p
Type 4PS: 3 pairs of contacts plus single-pole changeover	each 57p

Printed Circuit Boards for use with GJ, GB and 4PS contacts (thus eliminating much interwiring) are available. Details in our lists.

RHYTHM GENERATOR

15-Rhythm Tempo, Timing and Logic control unit (excl. sw's but incl. PCB)	£9.75
10-Instrument Effects circuits	£14.23
PCB for Effects circuits	£4.25
Power Supply incl. PCB	£8.75

128-NOTE TUNE-PROGRAMMABLE SEQUENCER

(P.E. Nov/Dec 77)

Enables a voltage controlled synthesiser to automatically play pre-programmed tunes of up to 32 pitches and 128 notes long. Programs are keyboard initiated and note length and rhythmic pattern are externally variable. (Please use order codes quoted in brackets.)

Main Circuit (Nov) excl. sw's (KIT 76-1)	£18.03
Power Supply (KIT 76-3)	£4.72
Trigger Inverter and Alt. Output (KIT 76-2)	£1.15
LED Counter (KIT 76-4)	£2.10
PCB (as published) for KITS 76-1 & 3 (PCB 76A)	£2.61
PCB for KITS 76-2 & 4 (PCB 76B)	£2.54

P.E. STRING ENSEMBLE (PE Mar-July 78)

The new keyboard string-instrument synthesiser.

Basic component sets:

Power Supply (KIT 77-1)	£8.77
Tone Generator (KIT 77-2)	£14.66
Diode Gates (KIT 77-3)	£18.81
Chorus Generator (KIT 77-4)	£19.08
Voicing System (KIT 77-5)	£7.38

Printed Circuit Boards:

Double-sided PCB for Power Supply, Tone Generator & Diode Gates with most of the Matrix wiring as printed tracking (PCB 77L/R)	£18.40
PCB for Chorus Generator (PCB 77C)	£2.65
PCB for Voicing System (PCB 77D)	£2.62

Fuller details of kits & PCBs are in our lists.

FORMANT SYNTHESISER (Elektron 1977/78)

Very sophisticated music synthesiser for the advanced constructor who puts performance before price. Details in our lists.

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	£18.19
Printed circuit board	£3.45

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 Components set (incl. PCB)	£3.95
Basic Output Circuits—combined component set with PCBs, for alphaphone, cardiophone, frequency meter and visual feed-back lampdriver circuits.	£6.59
Audio Amplifier Module Type PC7	£7.75

10% DISCOUNT VOUCHER (PE68)

TERMS: Correctly costed, C.W.O., U.K. orders over £50 goods value. Valid until end of month on cover of P.E. This voucher must accompany order.

TRANSISTORS

AC128	32p
AC176	28p
BC107	13p
BC108	13p
BC109	15p
BC109C	16p
BC177	18p
BC184	11p
BC187	18p
BC204	10p
BC209C	13p
BF244A	11p
BC213	11p
BC262	18p
BC415	15p
BC478	15p
BD131	60p
BD132	44p
BF244A	32p
BF245A	38p
BSY95A	22p
MD8001	210p
OC71	20p
OC72	30p
RPY58A	82p
TIS43	50p
ZTX108	7½p
ZTX301	13p
ZTX384	12p
ZTX501	13p
2N2219	20p
2N2646	70p
2N2905	28p
2N2905A	29p
2N2906	22p
2N2907	24p
2N3054	52p
2N3055	76p
2N3702	12p
2N3704	12p
2N3819	24p
2N3820	61p
2N3823E	39p
2N5459	45p

INTEGRATED CIRCUITS

301	8-pin DIL	48p
318	8-pin DIL	220p
320-15	---	195p
324	14-pin DIL	87p
341-15	---	87p
709	8-pin DIL	48p
723	T05	87p
723	14-pin DIL	51p
726	T05	1005p
741	8-pin DIL	24p
748	8-pin DIL	57p
4007	14-pin DIL	173p
4011	14-pin DIL	171p
4024	14-pin DIL	46½p
4069	14-pin DIL	18p
4136	14-pin DIL	126p
AM2833	8-pin DIL	360p
AY10212	16-pin DIL	617p
AY16171/6	---	188p
CA3046	14-pin DIL	71p
CA3080	8-pin DIL	63p
CA3084	14-pin DIL	209p
FX209	16-pin DIL	729p
LM323	---	562p
M252	16-pin DIL	680p
MC3340	8-pin DIL	150p
MCM6810	24-pin DIL	670p
SG3402N	14-pin DIL	262p
STK025	---	595p
TDA1022	16-pin DIL	582p
XR2207	14-pin DIL	420p
ZN425E	16-pin DIL	375p

ENGINEERS

FREE



YOURSELF FOR A BETTER JOB WITH MORE PAY!

Do you want promotion, a better job, higher pay? "New opportunities" shows you how to get them through a low-cost, Home Study Course. There are no books to buy and you can pay as you learn.

This easy to follow GUIDE TO SUCCESS should be read by every ambitious engineer. Send for this helpful 44-page free book NOW! No obligation, nobody will call on you. It could be the best thing you ever did.

CHOOSE A BRAND NEW FUTURE HERE



Tick or state subject of interest.

Post to address below.

ELECTRICAL & ELECTRONICS

Practical Radio & Electronics (with KIT)

Electronic Engineering Certificate

General Elect. Eng. Certificate

C. & G. Elect. Installations

Elect. Install. & Work

C. & G. Elect. Technicians

RADIO & TELECOMMUNICATIONS

Colour TV Servicing

C. & G. Telecoms. Technician's Cert.

C. & G. Radio, TV & Electronics Mech. Cert.

Radio & TV Engineering Course

Radio, Servicing & Repairs

Radio Amateur's Exam.

AUTO & AERO Motor Mechanics

C. & G. Motor V. Mechanics

General Auto Engineering

A.M.I.M.I.

Air Registration Board Certs.

M.A.A./I.M.I. Dip.

CONSTRUCTIONAL

Heating, Ventilating & Air Conditioning

Architectural Draughtsmanship & Design

L.I.O.B.

Carpentry & Joinery

Plumbing Technology

General Building

Painting & Decorating

MECHANICAL

A.M.S.E. (Mech.)

General Mech. Eng.

Inst. Engineers & Technicians

Maintenance Engineering

Welding

MANAGEMENT & PRODUCTION

Computer Programming

Inst. of Cost & Managements Accts.

DRAUGHTSMANSHIP & DESIGN

General Draughtsmanship

A.M.I.E.D.

Electrical Draughtsmanship



G.C.E.
—58 'O' & 'A' Level Subjects
—over 10,000 Group Passes!

Aldermaston College

Dept. TPE 23, Reading RG7 4PF

also at our London Advisory Office, 4 Fore Street Avenue, London EC2Y 9DT. Tel. 628 2721.

NAME (Block Capitals)

ADDRESS

..... Postcode.....

Other subjects of interest..... Age.....

Accredited by C.A.C.C. Member of A.B.C.C.

HOME OF BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY

PRICES ARE CORRECT AT TIME OF PRESS.
E. & O. E. DELIVERY SUBJECT TO AVAILABILITY.

PHONOSONICS



WIRE WRAPPING CENTRE



HOBBY WRAP

Model BW 630



Battery Wire-Wrapping Tool Complete with Bit and SI Line

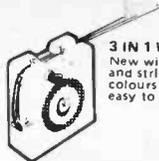
NEW

A £24.77 B £29.58 C £26.1 D £6.89

WIRE-WRAPPING TOOL

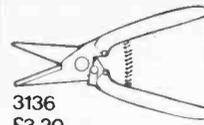
For .025" (0.63mm) sq. post "MODIFIED" wrap, positive indexing, anti-overwrapping device.

A	For AWG 30	BW-630
B	For AWG 26-28	BW-2628
C	Bit for AWG 30	BT-30
D	Bit for AWG 26-28	BT-2628



3 IN 1 WIRE DISPENSER
New wire dispenser cuts and strips three different colours of wire. Quick and easy to use pocket size.

£3.77



OK PLIERS AND CUTTERS
UNIVERSAL CUTTER
Cuts everything. Leather, wire, plastic, tin-plate, cardboard. Stainless steel blades.
Just one of the range of high quality pliers, cutters, tweezers and screwdrivers.

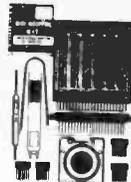
3136
£3.20

DIP/IC EXTRACTOR TOOL

£1.18
The EX-1 Extractor is ideally suited for hobby enthusiast or lab engineer. Featuring one piece spring steel construction. It will extract all LSI, MSI and SSI devices of from 8 to 24 pins.
Extractor Tool EX-1.

DIP/IC INSERTION TOOL WITH PIN STRAIGHTENER

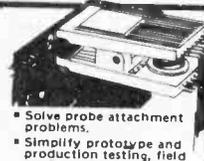
£2.58
INS-1416



WIRE-WRAPPING KIT

Contains: Hobby Wrap Tool WSU-30 M, Wire Dispenser WD-30-B, (2) 14 DIP's, (2) 16 DIP's, Hobby Board H-PCB-1, DIP/IC Insertion Tool INS-1416 and DIP/IC Extractor Tool EX-1.

Wire-Wrapping Kit WK-4B (Blue) £17.82



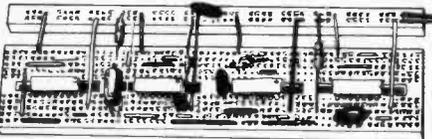
IC TEST CLIPS

£2.77
FOR DUAL-IN-LINE PACKAGES
• Provide full access to integrated circuit DIP leads.
• Remove DIP's damage free.
• Available in sizes to accommodate all DIP's. TC-14 fits 14-pin DIP's etc.



DIP SOCKET
Dual-in-line package, 3 level wire-wrapping, phosphor bronze contact, gold plated pins. .025 (0.63mm) sq., .100 (2.54mm) centre spacing.

14 Pin Dip Socket	14 Dip
16 Pin Dip Socket	16 Dip



FROM 75p TERMINAL AND DISTRIBUTION STRIPS

Bread boarding building blocks with universal matrices of solderless plug-in tiepoints.
• Facilitate quick, solderless circuit build-up and check-out on universal 1" x 1" matrix.

- Are offered in ten configurations.
- Accept all components with leads up to .032" diameter.
- Require no special patch cords.
- Includes integral non-shortening instant mounting backing.



HOBBY WRAP TOOL
Wire-wrapping, stripping, unwrapping tool for AWG 30 on .025 (0.63mm) Square Post.

A £4.39 B £4.69

Regular Wrap A	WSU-30
Modified Wrap B	WSU-30M

RIBBON CABLE ASSEMBLY

£2.40



With 14 Pin Dip Plug - 2" Long	DE 14.2
With 14 Pin Dip Plug - 4" Long	DE 14.4
With 14 Pin Dip Plug - 8" Long	DE 14.8
With 16 Pin Dip Plug - 2" Long	DE 16.2
With 16 Pin Dip Plug - 4" Long	DE 16.4
With 16 Pin Dip Plug - 8" Long	DE 16.8

DISTRIBUTORS WANTED***

OK Machine & Tool U.K. Limited

48a The Avenue Southampton SO12SY
Telephone Southampton (0703) 38966, 7 Telex 477222 Cablegram OKMAC

DISTRIBUTORS WANTED***



Wilmslow Audio

THE firm for speakers!

SEND 15p STAMP FOR THE WORLD'S BEST CATALOGUE OF SPEAKERS, DRIVE UNITS, KITS, CROSSOVERS, ETC. AND DISCOUNT PRICE LIST

- ACT ● AUDAX ● BAKER
BOWERS & WILKINS ● CASTLE ● CELESTION
CHARTWELL ● COLES ● DALESFORD
DECCA ● EMI ● EAGLE ● ELAC ● FANE
GAUSS ● GOODMAN'S ● HELME ● I.M.F.
ISOPHON ● JR ● JORDON WATTS
KEF ● LEAK ● LOWTHER ● MCKENZIE
MONITOR AUDIO ● PEERLESS ● RADFORD
RAM ● RICHARD ALLAN ● SEAS
TANNOY ● VIDEOTONE ● WHARFEDALE

WILMSLOW AUDIO (Dept. P.E. 8)
SWAN WORKS, BANK SQUARE, WILMSLOW,
CHESHIRE SK9 1HF

Discount Hi-Fi, etc. at 5 Swan Street and 10 Swan Street
Tel.: Wilmslow 29599 for Speakers Tel.: Wilmslow 26213 for Hi-Fi

NEW PRODUCTS · NEW PRODUCTS

POWER AMP KIT

The kit includes all metalwork, heatsinks and hardware to house any two of our power amp modules plus a power supply. It is contemporarily styled and its quality is consistent with that of our other products. Comprehensive instructions and full back-up service enables a novice to build it with confidence in a few hours.

ADVANCED PRE-AMP CPR1

This stereo module accomplishes pre-amplification of disc and other inputs to an impeccable standard. The disc input has no common mode distortion effects, thd of .001%, 40dB overload, 70dB s/n, and 6V/μS slew rate. Other inputs have 70mv sensitivity, thd of .001%, 90dB s/n, 12dB/octave subsonic filter, 4V/μS slew rate and active balance control. Output is delayed for 10 seconds. No controls are fitted.

MOVING COIL PRE-AMP MC1

This stereo module uses multiple input transistors to achieve 65dB s/n. Sensitivity is switched 70 or 160μV for 3.5mV output.

POWER SUPPLY

The regulator module, REG 1 provides 15.0-15v to power the CRP 1 and MC 1. It can be used with any of our power amp supplies or our small transformer TR 6. The power amp kit will accommodate a REG 1.

POWER AMPLIFIER MODULES

CE 608 60W/8 ohms 35-0-35v	£16.30
CE 1004 100W/4 ohms 35-0-35v	£19.22
CE 1008 100W/8 ohms 45-0-45v	£23.22
CE 1704 170W/4 ohms 45-0-45v	£29.12
CE 1708 170W/8 ohms 60-0-60v	£31.90

TOROIDAL POWER SUPPLIES

CPS1 for 2xCE 608 or 1xCE 1004	£14.47
CPS2 for 2xCE 1004 or 2/4xCE 608	£16.82
CPS3 for 2xCE 1008 or 1xCE 1704	£17.66
CPS4 for 1xCE 1008	£29.12
CPS5 for 1xCE 1708	£22.68
CPS6 for 2xCE 1704 or 2xCE 1708	£23.98

HEATSINKS

Light duty, 50mm, 2°C/W	£1.30
Medium power, 100mm, 1.4°C/W	£2.20
Disc/group, 150mm, 1.1°C/W	£2.85
Fan, 80mm, static 120 or 240v.	£18.50
Fan mounted on two drilled 100mm heatsinks.	
2x, 4°C/W, 65°C max with two 170W modules	£29.16
THERMAL CUT-OUT, 70°C	£1.90

POWER AMP KIT

£32.40

PRE-AMPS:

These are available in two versions - one uses standard components, and the other (the SI) uses M.O resistors where necessary and tantalum capacitors.

CPR1	£29.49	CPR1S	£39.98
MC1	£18.50	MC1S	£29.49

POWER SUPPLY:

REG 1 £6.75 TR6 £1.75

BRIDGE DRIVER, BD1

Obtain up to 340W using 2 x 170W amps and this module.

BD1 £5.40

CRIMSON ELEKTRIK

1A STAMFORD STREET
LEICESTER LE1 6NL
Tel. (0533) 537722

All prices shown are UK only and include VAT and post. COD 90p extra, £100 limit. Export is no problem, please write for specific quote. Send large SAE or 3 International Reply Coupons for detailed information.

SMUG

WE ALL like to feel a bit smug some times and we hope P.E. has a right to this month—though not for long! The *V.D.U. System* construction project which appears in this issue is believed to be the first design published in Britain, and makes use of an excellent Thomson CSF chip which has recently become available on the amateur market. The new chip incorporates most of the electronics required to produce a memory mapped system.

The unit provides, at a relatively low price, one of the most useful peripherals for the home computer man. All components, including the modulator, are on one "small" p.c.b. which includes 1K of user RAM mounted in a novel way.

The second item which we feel is worthwhile is the sheet of STICKIES, free with this issue. We have said they are worth 60p, which is true, but in fact with postage etc. you would have to spend 80p to get this product. Since they are so useful (see page 1093) we are sure most readers will consider them a very worthwhile gift. They are, of course, worth more than the cost of the issue!

VALUE

With the inclusion of more editorial pages per issue in recent copies of P.E.—and such items as the free STICKIES, 8-page supplement next month and some planned special offers etc., we have been doing our best to give good value for money and will, of course, continue in this way. However, as we said above, we won't be staying smug for too long as next month the price of P.E. will rise to 50p.

The last price increase was with the November 1977 issue—exactly a year ago and, as we all know, inflation has and no doubt will, continue. Our costs go up and reluctantly these must eventually be passed on. We hope you will still consider P.E. good value for money.

SAVING

Over the years we have presented a number of projects to help readers to save money in one way or another and our *Fuel Consumption Meter* in this issue is no exception. The price of oil regularly makes the headlines and no doubt it will not be long before this happens again. With the aid of our consumption meter better fuel economy can be achieved—something

we can all benefit from in one way or another.

If readers have devised other cost saving circuitry we would be pleased to hear from them. Even if you have an idea for some equipment a letter to us could set a few minds going and maybe a designer working?

To give an idea, a spontaneous invitation for suggestions from the office brought forth the following:

An independent timing device to display the cost of a telephone call (local or distant), and along similar lines, a meter for mains power consumption reading pence per hour.

PARTICIPATION

We try to keep *Readout* interesting each month and publish the "bad" with the "good" and sometimes even the "ugly"—see page 1102—but so much depends on you transmitting your views and thoughts! It is good to see some interesting and constructive submissions to *Microbus* this month and, as always we have plenty of I.U.'s, but please don't forget that *Readout* is your page so keep the letters coming and we will keep publishing the interesting and informative ones.

Mike Kenward

EDITOR

Mike Kenward

Gordon Godbold ASSISTANT EDITOR

Mike Abbott TECHNICAL EDITOR

Alan Turpin PRODUCTION EDITOR

David Shortland TECH. SUB EDITOR

Jack Pountney ART EDITOR

Keith Woodruff SENIOR ARTIST

John Pickering SEN. TECH. ILLUSTRATOR

Isabelle Greenaway TECH. ILLUSTRATOR

Judith Kerley SECRETARY

Editorial Offices:
Westover House,
West Quay Road, Poole,
Dorset BH15 1JG
Phone: *Editorial* Poole 71191

We regret that lengthy technical enquiries cannot be answered over the telephone.

Advertising Offices:
King's Reach Tower,
King's Reach, Stamford Street, SE1 9LS
Phone: *Advertisements* 01-261 5000
Telex: 915748 MAGDIV-G

ADVERTISEMENT MANAGER

D. W. B. Tilleard

P. J. Mew REPRESENTATIVE

C. R. Brown CLASSIFIED MANAGER

Make Up and Copy Dept.

Phone: 01-261 6601

Subscriptions

Copies of PE are available by post, inland or overseas, for £10.60 per 12 issues, from: Practical Electronics, Subscription Department, Oakfield House, Perry Mount Road, Haywards Heath, West Sussex RH16 3DH.

Back Numbers and Binders

Copies of most of our recent issues are available from: Post Sales Department, IPC

Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at 65p each including Inland/Overseas p & p.

Binders for PE are available from the same address at £2.85 each to UK addresses, £3.45 overseas, including postage and packing, and VAT where appropriate. Orders should state the year and volume required.

Cheques and postal orders should be

made payable to IPC Magazines Limited.

Letters

Queries regarding articles published in PE should be addressed to the Editor, at the Editorial Offices, and a stamped, addressed envelope enclosed. We cannot undertake to answer questions regarding other items, nor to answer technical queries over the telephone.

Market Place

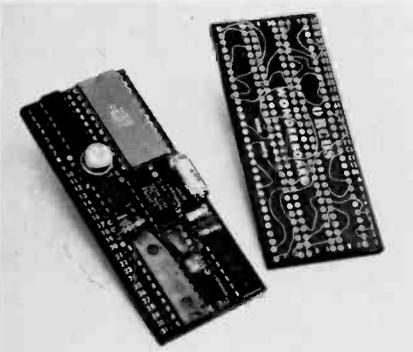
Items mentioned are usually available from electronic equipment and component retailers. However, where a full address is given, general enquiries may be made direct to the firm concerned. All quoted prices are correct at time of going to press.

by
Alan Turpin

and
David Shortland

WONDERBOARDS

Fresh in from across the big pond, Wonderboard is a solderless breadboard system using holes filled with a conductive elastomer (rubber) as the connecting points. The contact points are accessible from both sides of the board enabling components to be mounted one side and wire linking to be made on the other. Hole pitch is 0.1in and there are six rows of 31 holes allowing up to a dozen 14 d.i.l. devices to be mounted. Each contact point will hold up to six wires.



Specifications given are as follows:— contact resistance 10m Ω , current capacity 7A, breakdown voltage 9kV, insulation resistance 10,000M Ω , min/max wire diameters 0.2 to 0.8mm (32 to 20 gauge), contact life 150 insertions, useful temperature range -55 to +100°C. No noise/frequency figures were given but have been requested.

Wonderboards are available singly at £2.50 from Charcroft Electronics, and distributor enquiries are invited.

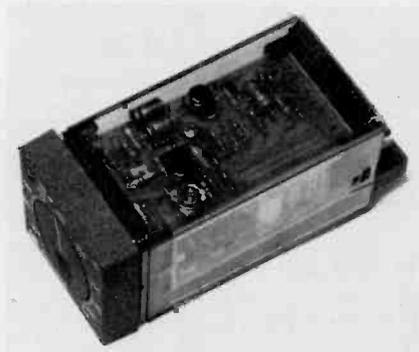
Charcroft Electronics, Charcroft House, Sturmer (Haverhill), Suffolk. Tel. 0440 5700.

COMPACT TEMP CONTROLLER

Capable of switching or controlling 3kW directly, the CAL 6103 high power, compact temperature controller is a panel mounted unit with a DIN standard 48mm² bezel, and a ± 1 per cent accuracy (typical) under steady load conditions.

The CAL 6103 is available to order in temperature ranges from 0°C to 1,600°C. Any specified thermocouple input, or PT100, can be supplied.

Its proportional control system avoids the



unnecessary "hunting" encountered in other compact on/off temperature controllers. Time cycling is set to a "standard" 20 secs which suits most applications. However, CAL will supply units with cycle times from 5 secs to 120 secs to order.

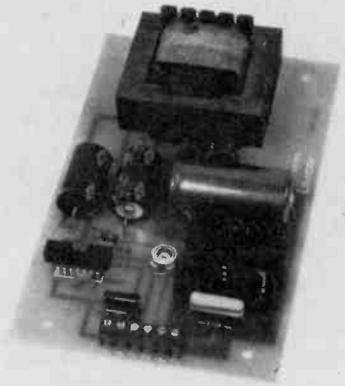
For resistive loads the output/control relay will switch 14A at a.c. mains voltages. A static output can also be provided to accommodate remote thyristor control systems.

For further information contact Controls & Automation Limited, Regal House, 55 Bancroft, Hitchin, Herts.

3-RAIL POWER SUPPLY

A three-rail Eurocard power supply announced by Lascar Electronics is suitable for most circuits where digital and linear devices are mixed.

The supply features one output of 5V 1A, and dual tracking outputs adjustable between $\pm 5V$ and 15V with a maximum of 100mA per

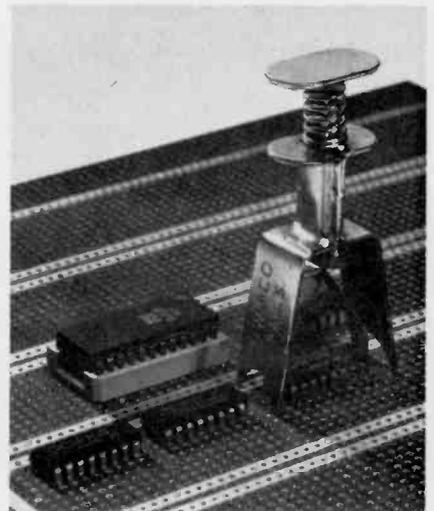


rail. The 5V and twin-rail supplies are isolated from each other and feature short-circuit, over-temperature and fold-back over-current protection. Input voltages 220V a.c. or 240V a.c. The supply is fitted with terminal blocks on the input and outputs, and is assembled on a p.c.b. measuring 160 x 100mm, with a maximum height of 47mm.

For details contact Lascar Electronics Limited, PO Box 12, Module House, Billericay, Essex.

EXTRACTOR TOOL

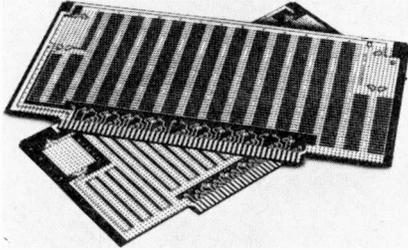
Designed for the specific task of automatically extracting i.c.s from p.c.b.s on completion of the desoldering operation, the DIP-OUT tool from Vero Electronics eliminates the danger of damage to i.c. legs by virtue of its "even pull" action. When used with a desoldering block it provides a fast and efficient method of removing i.c.s. The price of the tool is £5.67 plus VAT.



For further information contact Vero Electronics Limited, Industrial Estate, Chandler's Ford, Eastleigh, Hampshire.

MICRO-BOARD

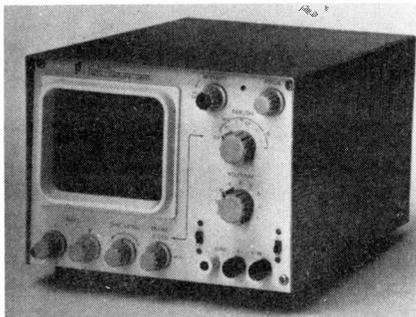
With the increasing use of S100 boards and bussing systems in microcomputers, Vero Electronics have released a universal S100 bus-compatible prototyping board. Designed for the manufacture or breadboarding of microprocessor, memory or interface assemblies the board will, without modification, mount directly into any equipment using the S100 bus system.



The board has an S100 edge connector configuration (100 gold-plated contact fingers on 3.175mm/0.125in pitch) and is fully pierced with 1.02mm/0.040in diameter holes on a 2.54mm/0.1in matrix. Provision is made for mounting up to four standard TO-220 plastic package regulators together with heat-sinks for on board regulation, and the voltage plane is capable of being divided to provide up to four separate positive or negative supply rails. The component side of the board carries a ground plane which can be used for terminations or screening and the wiring side carries both voltage and ground planes, thus providing for up to five planes.

A wide range of compatible standard accessories such as DIP sockets, pins, headers, ribbon cables, etc. is available, enabling the prototyping board to cope with virtually any microprocessor or microcomputer circuit requirement.

For further information contact **Vero Electronics Limited, Industrial Estate, Chandler's Ford, Eastleigh, Hampshire.**



£100 SCOPE

The Elmac 4810 single beam oscilloscope will interest many constructors because of its low cost (£99.00 plus VAT) and excellent specification which includes 4in CRT, d.c. to 5MHz bandwidth (vertical axis), 1MΩ input impedance and a maximum input voltage of 600V peak to peak.

For further information contact **Gemini Electronics, Newton Building, Newton Street, Manchester 1.**



PROGRAMMABLE TV GAMES

General Instrument Microelectronics have introduced a new set of MOS microcircuits for use in cartridge-based programmable TV games. Known as SYSTEM 8601, the circuits include a clock generator, colour encoder, modulator and a selection of cartridge microcircuits—enabling fully programmable games systems to be built at low cost.

Each games system will consist of a console into which individual game set cartridges are slotted. Each console will contain clock, encoder and modulator, as well as game controls, switches, power supplies, etc. Each cartridge contains individual games microcircuits,

plus interface circuitry, and all sets will feature realistic sound generation and on-screen scoring.

Some of the cartridge-mounted microcircuits are already available, including the 8610 "Supersport" (20 games), the 8765 "Motorcycle" (8 games) and the 8603 "Road Race" set (3 games). Three more circuits—the 8607 "Target" (12 games), the 8606 "Wipeout" (24 games) and 8605 "Warfare" (10 games)—will go into production within two months, with more to follow before the end of the year. For further information contact **General Instrument Microelectronics, Regency House, 1-4 Warwick Street, London, W1R 5WB.**

CRUSH PROOF DMM

A new series of true r.m.s. 4½-digit multimeters for bench and field use has been introduced by Systron-Donner Limited.

This new series consists of four models, available with a choice of d.c. accuracies of either 0.02 per cent or 0.05 per cent, and with a choice of current or dB measuring modes.

All models feature auto and manual range selection with a.c. and d.c. voltages from 10 microvolts to 750V and 1,000V respectively, measured in five ranges. A true r.m.s. a.c. converter permits accurate measurements of triangles, pulses, square waves or distorted sinewaves up to 20kHz.

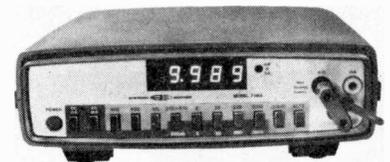
The resistance mode offers six ranges allowing measurements from 0.01Ω to 20MΩ. All ohms ranges are protected against input overloads of up to 350V r.m.s.

This multimeter will also measure dBs from -60 to +60 in five manual ranges. This capability is especially useful in checking long line voice communications. The dB mode is offered in place of the 5 d.c. and a.c. manual current modes which cover measurements from 1 microamp to 2 amps.

The cost of a DMM is directly related to the d.c. accuracy specification. Since applications can vary, Systron-Donner decided to offer its new Portable DMM with two different basic d.c. accuracies. The Model 7141A, which is the lowest priced has a d.c. accuracy of ±0.05 per cent of reading ±0.05 per cent of full-scale for a full 6 months. The Model 7141B offers a basic d.c. accuracy of

±0.02 per cent of reading ±0.01 per cent of full scale for a full 6 months. Care was taken in designing the circuit to choose components that minimised drift.

Two extra cost options can be specified: one adds an analogue meter to the front panel. This gives the user the ability to make nulling and/or peaking measurements and the other is a battery pack. An internally mounted set of



six nicad batteries provides approx. 2½ hours of continuous operation between charges.

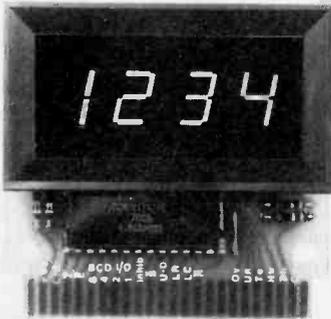
Portable DMMs need to be packaged to withstand frequent handling and accidental drops. To prevent damage, the unit is installed in a clamshell-shaped case made from Cycloy—the new ABS/Polycarbonate plastic alloy. The result is a case which is drop-proof and crush-proof.

For further information including price contact **Systron-Donner Limited, St Mary's Road, Sydenham Industrial Estate, Leamington Spa, Warwickshire.**

4-DIGIT PRESET COUNTER

A new 4-digit counter module claimed to be capable of almost all counting functions has been recently introduced by Lascar Electronics. Working from a +5V d.c. supply, the module incorporates 0.43in high efficiency l.e.d.s and is capable of counting at rates up to 2MHz. Besides normal counting from input pulses, the display can be set from external BCD sources.

The module also incorporates an internal register. When counter and register are level,



an "equals" output is produced giving many applications in batch counting, machine control etc. Thumbwheel switches can be used to set levels in both cases.

TTL/CMOS compatible, the module also features carry-borrow and zero outputs and count inhibit and store controls.

The count input has a Schmitt trigger making the module suitable for use in noisy environments.

For details contact **Lascar Electronics Limited, PO Box 12, Module House, Billericay, Essex.**

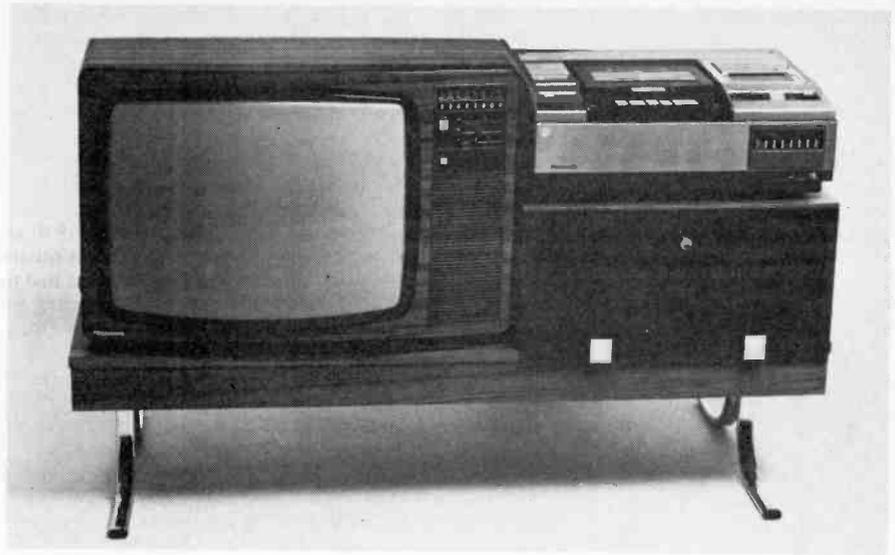
IRON CONTROLLER

Miniaturisation of components and increasingly complex printed circuit board design have brought in their turn the need for precise operator control of soldering irons. Apart from the likelihood of expensive damage caused by poorly earthed soldering instruments the operator now has to position the soldering bit more carefully, often in close proximity to heat or voltage sensitive components.



To provide maximum operator control, Adcola Products Ltd has designed a new Unit 101 TS model which features a far shorter and lighter soldering instrument.

The main circuit design is based on a thermocouple positioned at the rear of the solder-



VIDEO SYSTEM

The consumer's choice in video recorders is further extended this month with the arrival of National Panasonic's VHS (video home system) NV8600.

The unit, which is similar in operation to an audio cassette deck with controls for play, stop, rewind and fast forward also has a remote "pause" control to enable easy editing of unwanted material from a programme.

Three, two and one hour tapes are available at £13.50, £10.50 and £8.00 respectively and these tapes can run on any of the other VHS recorders on the market in this country. Lining up with National Panasonic to offer video home systems are Akai, Hitachi, JVC, Mitsubishi, Sharp and Thorn.

The NV8600 which is priced at £750 including VAT is available through High Street TV retailers.

ing bit feeding an operational amplifier which is switched via a zero crossing integrated circuit. This design avoids the need for moving parts which may wear and eliminates voltage transients in "Spiking", RF interference and the generation of magnetic fields. Proportional control also ensures a precise temperature to within ± 2 per cent of the indicated dial temperature—the dial may be locked onto any specific temperature within the range of 120–380°C.

The unit is earthed from the supply to the soldering bit to provide maximum safety against leakage currents, making the tool suitable for use with the majority of voltage sensitive components including FETs and CMOS.

For further details and a full specification on the unit contact **Adcola Products Ltd, Adcola House, Gauden Road, London SW4 6LH.**

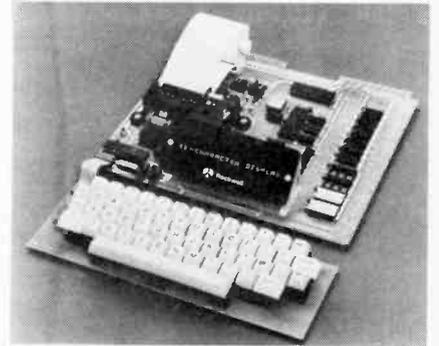
ROCKWELL'S AIM

Rockwell, who recently announced a single chip microcomputer called the R6500/1, have just introduced a single board microcomputer system which features an on-board 20 column printer and display with a full alphanumeric keyboard.

Designated the AIM 65 the system is intended as an educational aid for first time users and a general purpose microcomputer for engineers.

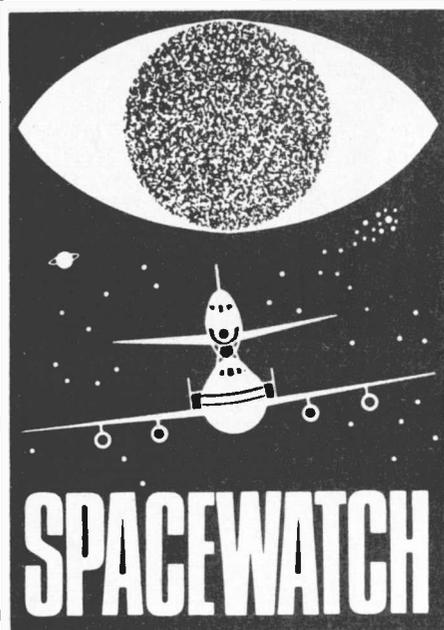
The AIM 65 is available in 1K and 4K byte RAM versions, is designed around the 6502 CPU which has 64K address capability with 13 addressing modes and is the microprocessor at the heart of other popular systems such as KIM 1, PET and

APPLE. An 8K ROM resident monitor programme provides all peripheral control and user programming functions. Spare sockets are included to further expand on-board program memory via user PROM-based programs or Rockwell's assembler, text editor and BASIC interpreter plug-in ROM options.



The AIM 65 board also has a connector that allows external access to the system bus for memory and I/O expansion. A separate application connector interfaces a teletype and two standard cassette recorders, and includes a user-dedicated Versatile Interface Adaptor. The VIA features three 8-bit bidirectional ports (two parallel, one serial) and two 16-bit interval timer/event counters, thus allowing the user to interface his own system, in many cases without the need for extra interface devices.

The system which is priced at under £250 is stocked by **Pelco (Electronics) Ltd., Enterprise House, 83/85 Western Road, Hove, Sussex.**



FRANK W. HYDE

PLUTO

Once again doubts about the most distant planet yet to be discovered in the solar system arise. It is a reminder that each new set of data which becomes available can seriously upset previous ideas. There have been many expressed doubts about Pluto, more perhaps than in regard to the other bodies revolving round the Sun.

Only a short while ago the size of Pluto was re-assessed. It demoted the planet from an estimated size of near to that of the Earth and of the same density, to the size of the Moon. Quite plausible reasons were given for this. The density was suggested to be about .01 of that of the Earth.

The acceptance of this meant that in no way could the perturbations of Uranus be linked with the effects of Pluto and its proximity. As previously reported in SPACEWATCH about three years ago the Soviet Union had calculated that there were possibly two planets beyond Pluto.

The two planets were shown to respond to a position from the Sun, but no celestial coordinates were offered. The suggested distances were: one at a distance of 54 astronomical units from the Sun which would imply a possible diameter of 12,000 miles; the second was set at 100 astronomical units from the Sun with a diameter of 18,000 miles. In that event the period of the first one could be of the order of 350-370 years and that of the second of the order of 1,000 years. It must be remembered that the whole of these data represent a computer mode. No visual identification has been made.

Now a new situation arises as the result of the discovery of a satellite associated with Pluto. This body has been named Charon, the name bestowed upon it by its discoverer. The present official designation is 1978-P1. Until the details are truly confirmed retains the number. However there seems to be little doubt that it is a satellite and in accordance with custom the discoverer has the choice of

name. The discoverer was James Christy from the Naval Observatory, Washington, DC. It was part of a study to refine the data regarding Pluto's orbit which is a nominal 248 years. The plates examined showed an elongation of the planet.

This set Christy the task of confirmation from other photographs that had been taken. He made an examination of the photographs taken from the same observatory in 1970 and in 1965. The telescope used was that situated in Arizona (Flagstaff). These pictures had the same evidence but the observers then had decided elongation was due to a plate fault.

A confirming plate was taken with a 4m telescope at Cerro Tololo Inter-American Observatory in Chile. Also a third confirmation has come from J. Derral Mulholland from photographs taken in 1977 at Macdonald Observatory in Texas. However as there has not been a plate so far that shows a division between the planet and the satellite, final confirmation cannot be assumed.

While resolution has not been attained the fact is that if it is not a satellite then it will have to be concluded that Pluto is several times longer than it is wide. In other words more like one of Mars' satellites. This would seem highly unlikely. The very existence of a satellite immediately provides astronomers with a tool to measure the parent body.

Robert Harrington, of the Naval Observatory, has given the centre to centre distance between the planet and the satellite as 17,000km. Its diameter is set at about 40 per cent of Pluto. If this is so, then the satellite is the largest, in proportion to its parent, such body in the solar system. The orbital period is 6.4 days. This means that it is stationary over one point on Pluto's surface, as Pluto's own period of rotation is calculated at 6.4 days. The estimate of density of the satellite indicates that Pluto has a density of 0.002 of Earth.

This alters entirely the current picture of the Planet. Now it confirms the model that Pluto (because its density is less than that of water) may well be nothing but a snowball. That is a snowball of frozen gases. The infra-red observations from Kitt Peak, showed that a plentiful covering of the gas methane (frozen) was apparent on the surface.

Brian Marsden of the Smithsonian Astrophysical Observatory who is responsible for the coordination of new discoveries has said that perhaps Pluto should be re-classified as a minor Planet.

Theories have been offered by Robert Harrington and T. Van Flandern of the Naval Observatory. The foremost hypothesis is that an unknown planet at some time in the past passed through the satellite system of Neptune. If it had a mass of four times that of the Earth it would have disrupted the system and Pluto ejected as a result. The new satellite of Pluto could have been created then. If this were the case then the intruding body would have been violently thrown about and could now be a tenth planet at a distance of 50 to 100 astronomical units from the Sun. It would be too faint to be easily seen and a long programme of searching might be necessary to locate it.

This agrees with a previous study in 1972 when Rawlins and Hammerton were searching for another planet. They suggested

that the motion of Neptune was consistent with a body of 2 to 5 Earth masses at a distance of between 50 and 100 astronomical units. The suggested longitude would be between 310° and 350°. At the same time they made it quite clear that they did not think that there was such a planet. The reason for this was that at the time of the search for Pluto the Lowell Observatory covered so much of the sky in their search that if there had been a body of reasonable brightness it would not have been overlooked. However a spherical coverage was not made.

Here is the point where present space activity meets with astronomy and this recent discovery. August SPACEWATCH gave details of the mission for the exploring of the areas around the Sun out of the plain of the ecliptic. This could very well reveal such a body or indeed the two bodies suggested by the Russian astronomers.

The classical theory of Pluto's origin is that it was once a satellite of Neptune. It was thought that it orbited Neptune every 6.4 days but came to near collision with Triton, another Neptunian satellite. The result of this encounter threw Triton into its present retrograde and ejected Pluto to become a planet of the Sun.

There is another matter to be considered and that is whether in fact Pluto and its satellite is a binary unit. With the present figures it would suggest that the two bodies revolve about a centre 6800km from the centre of Pluto. Thus there would be a system which behaved in the manner of a body 13,600km in diameter. This aspect well deserves some consideration.

A mission to investigate seems a must. Could it be that the Halley comet probe might do this after the cometary encounter. There seems to be a good case for knowing once and for all whether Pluto does have a significance in the Solar system.

MORE FROM THE USSR

The success of the Soyus-30 and the Progress-2 mission is already established. The space-walk also marks another satisfactory point in the progress of Soviet ventures.

The new furnace known as Kristall has been in use to produce pure monocrystals by the zone-melting technique. The furnace was used to form a monocrystal of gallium arsenide from a high temperature solution. The new furnace is installed in the transfer tunnel of Salyut-6. The crew have also been working on the Splav furnace to obtain new semiconductor materials and compounds of aluminium and tin and molybdenum.

COPERNICUS DISCOVERS BLACK HOLE

Among the instruments on the Orbiting Astronomical Observatory known as Copernicus there is an X-ray telescope from University College, London. It is this instrument which observed the X-rays of the super-giant double star in the constellation of Scorpio. Work which began in the 70's under Norman Walker of the Royal Greenwich observatory had shown that the super-giant had an unseen companion. The star is about 5,000 light years from Earth. The amount of X-rays received indicate that the unseen object must be a collapsed star.

PRACTICAL ELECTRONICS

VV	VV	DDDDDD	UU	UU
VV	VV	DDDDDDDD	UU	UU
VV	VV	DD DD	UU	UU
VV	VV	DD DD	UU	UU
VVVVVV		DDDDDDDD	UUUUUUUU	
VVV		DDDDDD	UUUUUU	

SYSTEM Part 1 T. BERK



LATEST DEVICE = LOWEST PRICE = SIMPLEST CONSTRUCTION = MEMORY MAPPED VDU

THIS project has been written to satisfy one of the most important needs of the home microcomputer constructor—an *inexpensive* output device for ASCII characters. The VDU shown here uses the very latest "one chip" VDU controller and provides, among other things:

- (a) 16 lines x 64 ASCII characters.
- (b) Full memory mapping, enabling random access to any part of the screen.
- (c) An extra 1K bytes of user RAM.
- (d) Full cursor control and screen scrolling in hardware.
- (e) High speed (limited only by MPU).
- (f) An inexpensive and easily constructed design.
- (g) An excellent addition to an evaluation kit.

The output from the unit is either in the form of video information suitable for a video monitor (or modified TV), or UHF modulated information to plug straight into a TV aerial socket.

The VDU shown in Fig. 1 is a complete output peripheral for a computer of any type. The details described below are orientated towards microcomputer based machines of 8 bit (one byte) word length, but apply almost unaltered to any type of system. The machine contains a 1 kilobyte block of user random access memory (RAM) which forms an addition to the MPU's addressable memory. The VDU should be thought of as a "window" to this area of RAM where each character position is a memory location in the micro-computer.

This type of VDU design has several advantages over the straightforward video writer system which acts very much like a teletype, all information being sent sequentially, thus preventing the random selection of any character slot.

The design is based around the new chip by Thomson-CSF which carefully controls the display timing with a minimum of extra chips. This i.c. also generates a flashing cursor with full position control, and allows the screen to be scrolled in the fashion of a roll of teletype paper in action (all hardware functions within the chip). This is described in detail later.

The VDU has ten address, eight data and seven control lines which interface to the standard bus systems of most MPU designs. The timing of the unit is generated using a 1MHz quartz crystal.

All character information is in standard ASCII character coding. It is advisable to keep, close at hand, a copy of the hexadecimal equivalents to each of the 64 characters in the 2513 character generator.

To interface a VDU to a computer system, some basic software is required. The VDU programme which suits your machine will depend upon its resident monitor. The basic elements, however, of a VDU programme will be common to most MPU systems. A general example is presented later to help with VDU utilisation.

OPERATION

The heart of the system is the Cathode Ray Tube Controller (CRTC). The clock requirements of this chip are supplied by a TTL oscillator circuit which is then divided by eight and fed to the clock input of the CRTC. To understand the working of this device, it is necessary to appreciate that the brightness of a TV line is proportional to the voltage level applied to its video input.

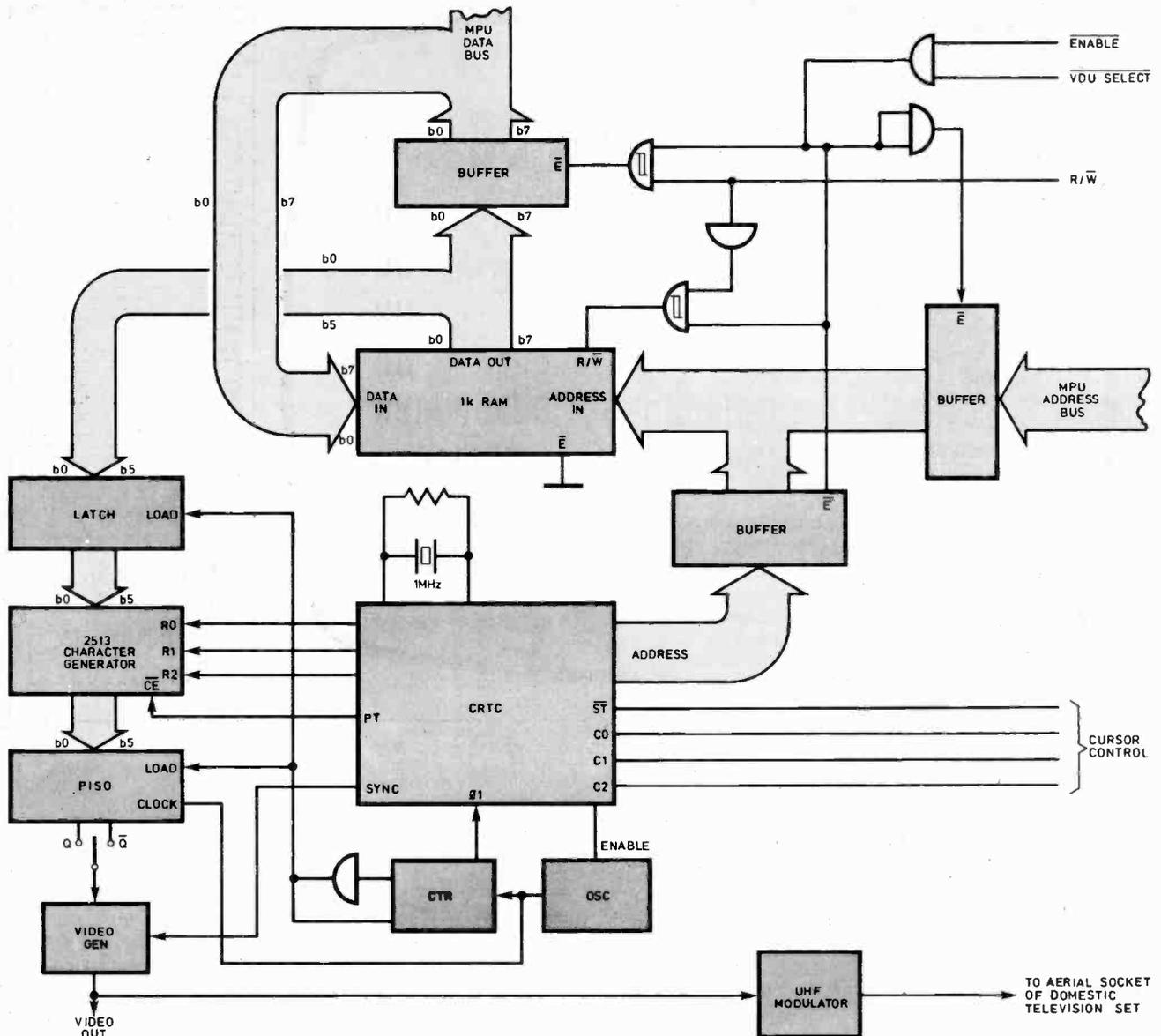


Fig. 1. Block diagram of VDU. Connection of the data bus, address bus, and some common control lines will allow this system to work with most microcomputer systems

As the line of a TV picture strobescross and down the screen, it must lighten and darken at exactly the right moment to build up a complete picture. Only two levels are used here: logical one, and logical zero, giving white and black. These ones and noughts are stored in the 2513 read-only memory employing it as a character generator, and it is the CRTC which controls the exact moment at which these are available to be displayed on the TV screen. A TV line is continuous and needs the ones and noughts in a sequential manner, hence the use of the "parallel-in serial-out" device, whose speed of transmission is determined by the TTL oscillator.

In order to send the correct character to any position on the screen, the CRTC generates the addresses for the RAM block which sends back the characters for display in the form of ones and noughts along its data lines. These are latched and form the address inputs for the 2513. The CRTC places white regions between characters by disabling the 2513 in those time slots.

In this mode of operation, the address buffers between the CRTC and the RAM are enabled (at zero level), and the data buffers into the RAM and the address buffers from the MPU are disabled. The RAM is also held in a "read" condition, being a one on the read-write (R/W) line. When the MPU wishes to address the RAM, the states of these buffer-enables are changed to allow the MPU to read or write to or from the RAM. The R/W line is controlled accordingly.

The final block of the system is a UHF modulator to allow the VDU to interface to an unmodified TV set. The definition of the display is always partly degraded by this technique. For those with a monitor or a modified TV set, a video output is provided which gives a highly stable and clear display.

CONTROL LINES

The VDU-select line is decoded from the upper address lines of the MPU system and is active-low. The enable line is a control generated by most MPU systems to enable only

when the address information is valid, thus preventing a false read or write. This line is fed from $\overline{VMA} \& \Phi_2$ in a 6800 system and is also active-low. R/\overline{W} is generated by MPU systems to distinguish between a read ($R/\overline{W} = 1$) and a write ($R/\overline{W} = 0$) operation.

This leaves only the CRTC control lines C_0, C_1, C_2 and \overline{ST} . They are specific to this chip and allow hardware control of the cursor (a flashing character permanently on display). The cursor may be moved up, down, left or right, by applying the appropriate ones and noughts on C_0, C_1 , and C_2 . \overline{ST} is used to inform the CRTC that a control word is present.

OPERATING SYSTEM

Displaying information on the screen is a very straightforward operation with this VDU. Characters are displayed by writing their ASCII codes to memory locations in the VDU. The exact addresses involved depends upon where in memory the VDU RAM has been placed.

It should be remembered that the display consists of 1024 ASCII characters arranged so that the top left position on the screen is the lowest address in the block. Thus, a user may decide to place this additional 1 kilobyte block of user RAM at address 0000 to 03FF (hex), for instance. These particular addresses are best used for other things in a 6800 system, however, and a better suggestion is to place it at, say, 1000 to 13FF. This means that the ten lower address lines, A_0 to A_9 are necessary to distinguish between each address on the screen. The upper six lines must be decoded to address this particular block of memory as opposed to any other. This occurs when A_{15} to A_{10} have values 000 100 respectively. That is, when the MPU places these six values on the respective address lines, the \overline{VDU} Select line must go low. The first 10 address lines of the MPU are fed to the VDU and take care of addressing within the VDU RAM automatically.

A typical display operation is illustrated by the following example. Suppose the word "hello" followed by spaces, is to be displayed on the top line. The letters of "hello" are first converted into their hexadecimal equivalents in ASCII:

- H = 48 (hex)
- E = 45 (hex)
- L = 4C (hex)
- O = 4F (hex)
- SPACE = 20 (hex)

A small program is now written to store 48, 45, 4C, 4C, 4F, in consecutive memory locations starting at 1000, in the above system. This displays the word at top left of the screen. Another program is then written to store 20 in locations 1005 through 103F. This fills the rest of the top line with blanks. In this way, any program, while running, simply stores the ASCII equivalents of its output somewhere in the VDU RAM.

Another important use of the VDU comes in program writing. Several ways may be used to check on what has just been written. The program may simply be input to the MPU system by a bootstrap loader. This is the type most commonly found in MPU monitors.

A "dump" of the contents of a block of memory containing this program may then be displayed on the screen for checking. Some monitors already contain a formatted dump, and it is then simply a question of ensuring that the VDU RAM is enabled at the correct addresses for this monitor. The writing of this sort of software is quite straightforward and well worthwhile. Another important method of checking during program development is to display the program one byte at a time as it is written.

Fig. 2. Cursor control flowchart

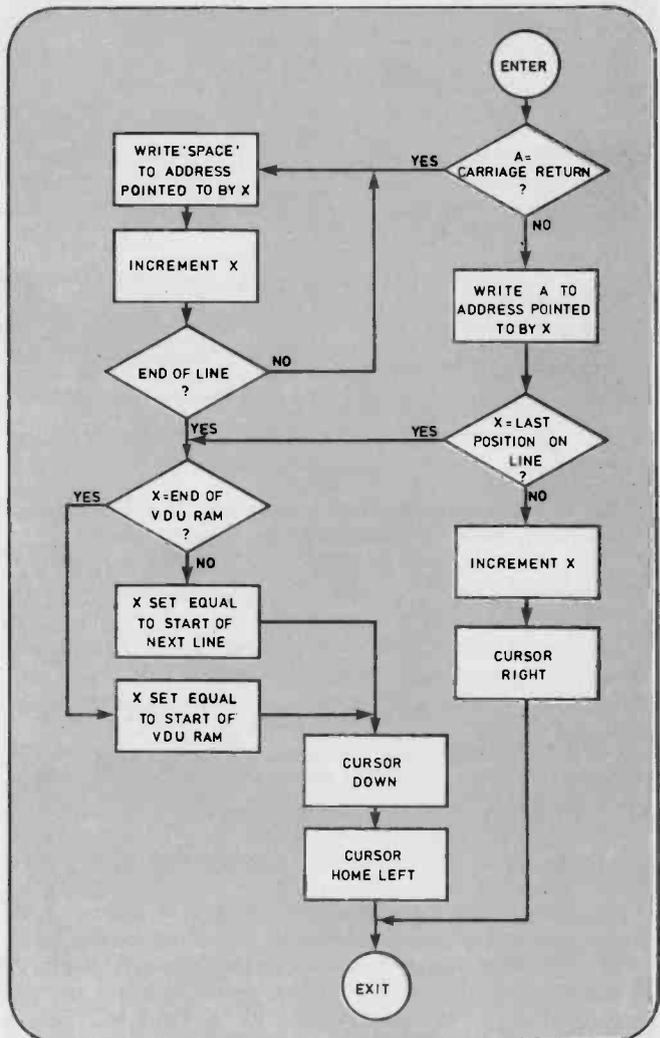
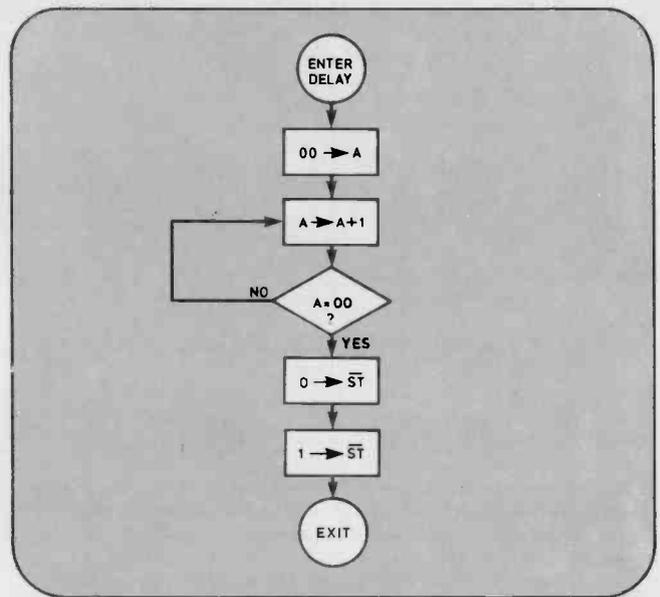
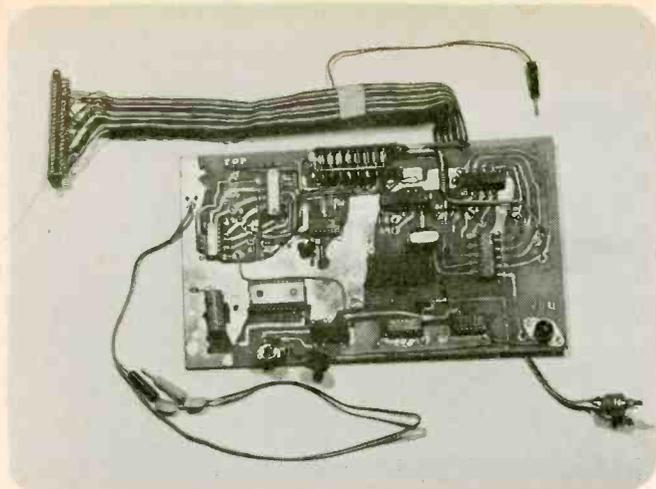
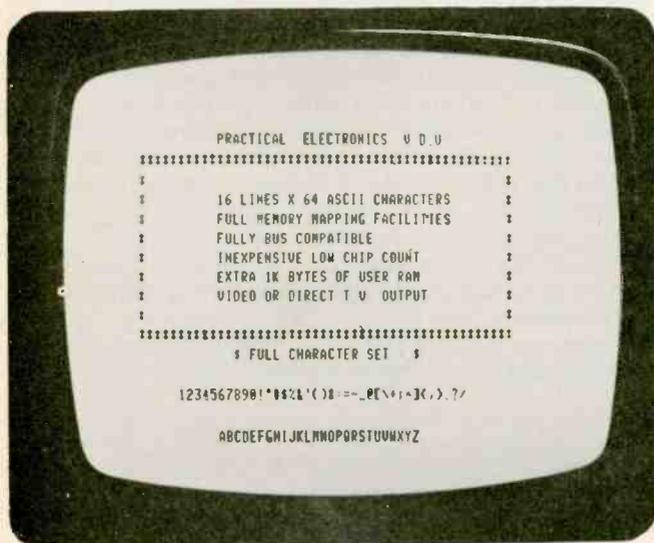


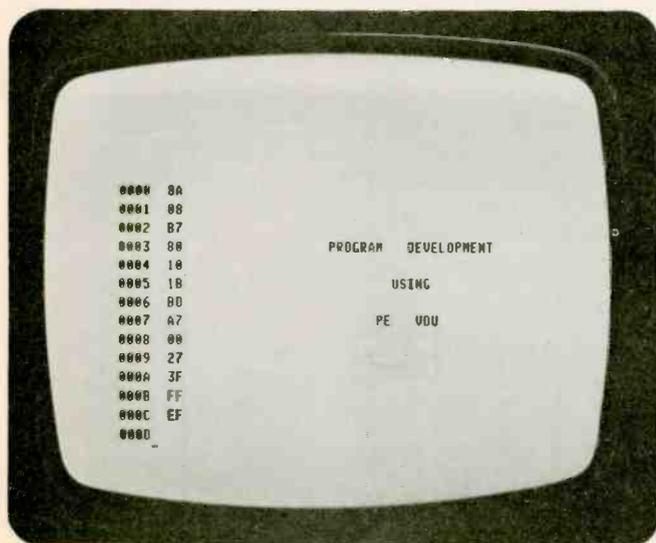
Fig. 3. Scrolling flowchart



The experimental prototype VDU board. Next month a double sided p.c.b. layout will be published which incorporates all refinements including the modulator



Two examples of the type of display attainable



COMPONENTS . . .

Resistors

R1	8.2M Ω
R2, R3	560 Ω (2 off)
R4	47k Ω
R5, R11	1k Ω (2 off)
R6	220 Ω
R7	3.3k Ω
R8	1.2k Ω
R9	2.7k Ω
R10	1k Ω
(all $\frac{1}{4}$ W 5% carbon film)	

Potentiometers

VR1	100k Ω min vert preset
VR2	100 Ω min vert preset

Capacitors

C1	0.22 μ F Disc ceramic
C2	100pF Sub min ceramic plate
C3	82pF Sub min ceramic plate
C4	33pF Sub min ceramic plate
C5	47pF Sub min ceramic plate
C6	10nF Disc ceramic
C7	33 μ F 10 volt Tantalum bead
C8	220 μ F 16 volt electrolytic
C9	47 μ F tant bead (10V)

Semiconductors

IC1	SFF96364 plus socket
IC2-IC9	2102LF (350nS) (8 off)
IC10	2513 (single supply type) plus socket
IC11	74174
IC12	74165
IC13-IC16	81LS97 (4 off)
IC17	74163
IC18	74LS132
IC19	7402
TR1	BC184
TR2	2N3663
XTAL 1	1MHz

Miscellaneous

SK1 chassis mounted coaxial TV socket plus nuts and bolts for fixing
 Two pieces of Veroboard (0.1in matrix)
 46 x 25mm each
 PP3 battery connector
 0.5 metre of 8-way ribbon cable
 Pins for through-board connection
 Switches: S1 s.p.d.t. S2 s.p.s.t.

Constructor's Note

A complete kit of parts including a drilled plated through p.c.b. will be obtainable from Technomatic (01-204 4333). Details next Month.

A limited number of assembled and tested boards will also be available exclusively from **Technomatic Ltd., 17 Burnley Road, London NW10.**

Normally this would be done as follows. A byte is loaded from the keyboard into some memory location. A jump to a display routine is then performed, which puts the address just loaded plus its old and new contents onto the screen. This is repeated until some control character tells the load routine to end.

The importance of a cursor, plus good screen management or formatting in this process cannot be over emphasised. Fortunately, the CTRC has a set of quite sophisticated cursor control commands, as previously mentioned.

A particularly effective and striking feature of the CTRC is its hardware scrolling function. If a Cursor Down (line-feed) command is given when the cursor is on the bottom line, the entire screen's contents jump up one line with the top line jumping to the bottom. This also occurs if Cursor Right operation is commanded with the cursor in the last position on the screen.

After such a scrolling function, the lowest address of the 1 kilobyte RAM is no longer displayed at the screen's top left. Instead, it is at the extreme left of the lowest line. A write operation to this address causes a character to appear in a position on the screen dependent upon the number of scrolls which has been performed. However, the Cursor Home operation forces the whole display to "de-scroll" and the display reverts to normal, with the cursor at top left.

The cursor operation required at any time is converted into a code of ones and noughts and applied to C_0 , C_1 , and C_2 according to Table 1.

The technical specifications of the CTRC demand that the \overline{ST} control line (normally in a high state) should complete a low pulse of at least $1\mu s$ a minimum of $8.3ms$ after any code is applied to C_0 , C_1 , and C_2 (apart from Cursor Home). This informs the CTRC of the presence of a cursor control word. The Cursor Home command requires at least $132ms$ between the control word and the \overline{ST} pulse. This is best done in software by the simple loop shown in Fig. 2.

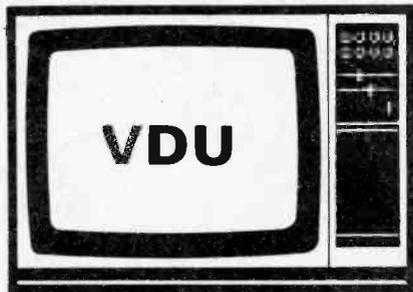


Table 1. Cursor control codes

OPERATION	C_0	C_1	C_2
cursor home	0	0	0
cursor home left	0	0	1
line feed	0	1	0
cursor left	1	0	0
cursor up	1	1	0
cursor right	1	1	1

The speed of operation of your MPU decides whether you should load A in the above with 00 (hex) initially or some higher number which will revert to 00 in fewer loop steps. A simple VDU routine is shown in Fig. 3. This routine assumes that a character to be displayed is stored in ASCII code in a register (called the A register here). The cursor position address is also assumed to be stored in a register (called the X register). Characters are written to the bottom of the display and a carriage return operation causes the screen to scroll upwards. Spaces are then written to the end of the current line, and the cursor is moved to the start of the line. Information thus enters on the bottom line, following the cursor, and then scrolls up the screen.

This completes the description of the system and in the next issue, constructional details and setting up procedures will be given.

The reader is urged to obtain a copy of the data sheet for the CTRC and 2513 chips for additional information.

NEXT MONTH: Assembly of p.c.b. and construction of high density RAM module.

POINTS ARISING

DIMWIT (July 1978)

Some constructors may find that during the period between the dim-out sequence and when the relay drops out, the lamp flickers. A cure for this is to shunt the l.d.r. (R13) with a 220k resistor.

LINEAR CAPACITANCE METER (June 1978)

Unfortunately another error in this article has come to light. IC4 and IC7 should be wired between +6V and -6V. In Fig. 4 they are shown connected to 0V.

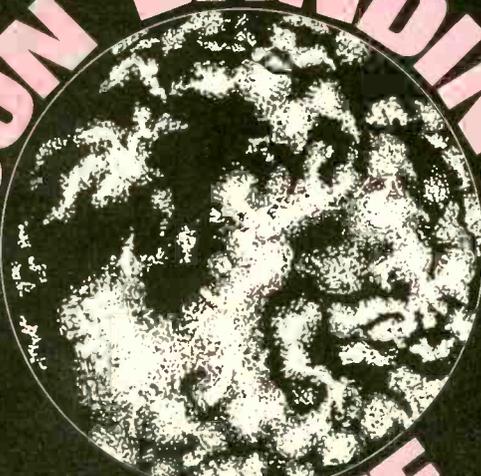
KILN CONTROLLER (June 1978)

In Fig. 2 page 733 the value of R8 should be $10k\Omega$ and the voltage rating of C2 in Fig. 4 should be 450V.

The setting up procedure on page 734 refers to the output of IC2 instead of IC3.

NEXT MONTH

MOON LANDING GAME



Be the first one down your street to land on the moon. Sixty seconds to make a gentle landing with only a limited amount of fuel. You have a readout of height, velocity and fuel remaining but if your efforts fail you can still push the panic button and run on medicinal whisky.

POWER FETS

A feature on the new semiconductor technology which is challenging the supremacy of the bipolar transistor in many power applications.

SPECIAL!

CAR DEVICES

8 Page Supplement

2 SOLDERING IRON OFFERS

PRACTICAL

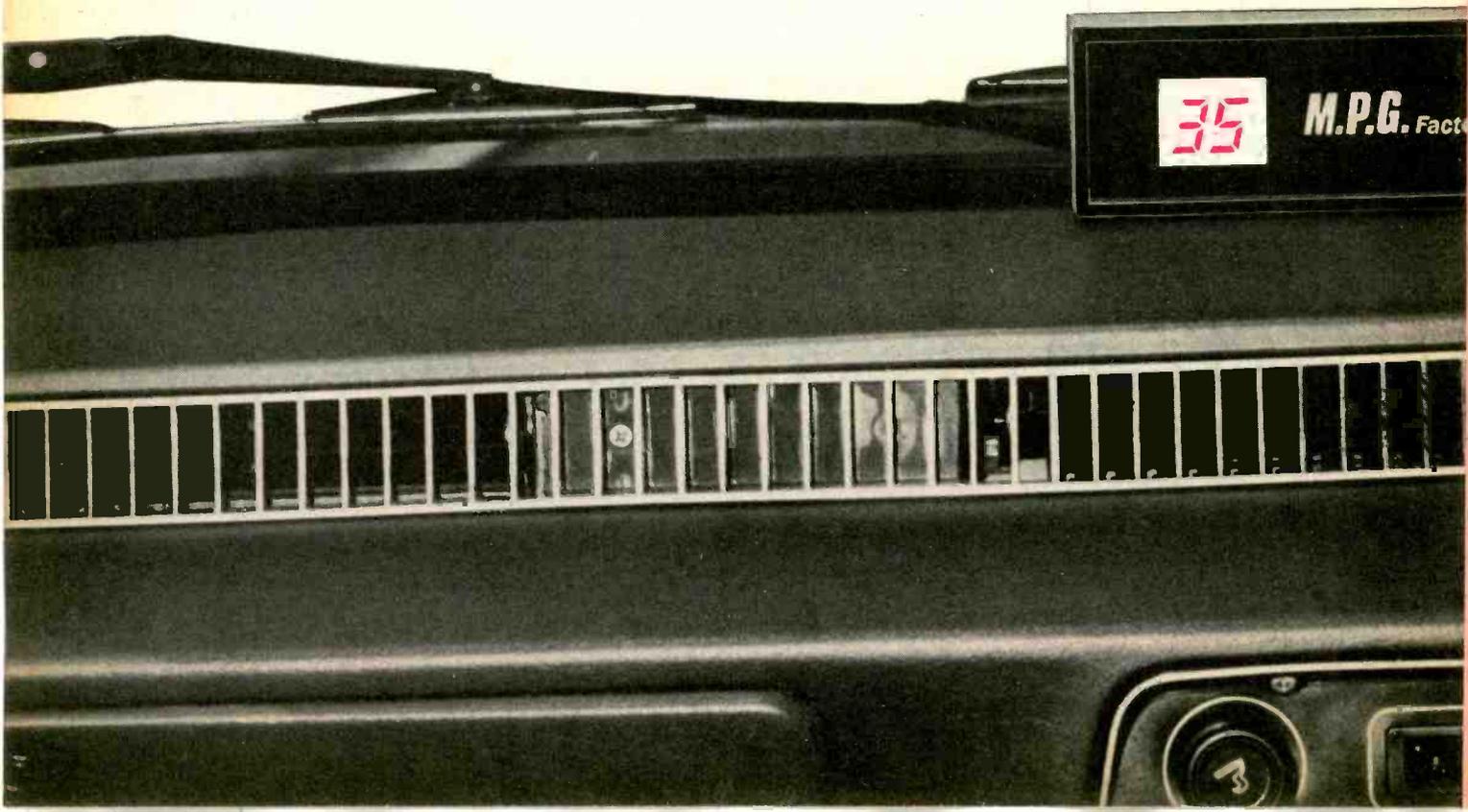
ELECTRONICS

OUR NOVEMBER ISSUE WILL BE ON SALE FRIDAY, 13 OCTOBER, 1978, PRICE 50p.

Fuel Consumption Meter

J. McCARTHY

This unit does not show the average m.p.g., but gives an instantaneous fuel consumption related factor. You can check your driving efficiency. As your foot goes down on the accelerator, down goes the m.p.g., and up it comes again when your foot does!



THIS article describes a fuel consumption meter which has been operating successfully for many months. The attributes of the system are:

- (a) Two digit digital display
- (b) Mainly low-price TTL
- (c) Interfaces to the car via a simple connection to the SU electric fuel pump, and an easy modification to the car's speedometer.

An SU electric fuel pump may be fitted to any car using a mechanical fuel pump, provided that the former can provide the fuel at a satisfactory rate. In the author's case, a 1725cc Hillman Hunter was fitted with a fuel pump borrowed from and aged side-valve Morris Minor. The Hunter never showed any signs of fuel starvation despite very hard driving. Fig. 2 shows a simplified diagram of such a pump. As the pump operates, the voltage at point "A" alternates between +12V and 0V (for -ve earth vehicles).

The measurement system may conveniently be considered as two interconnected sections, as depicted in Fig. 1. Referring to this diagram, the distance monitor counts pulses derived from the speedometer, whilst pulses at a slower repetition rate derived from the fuel pump cause the generation of a series of internal control pulses which halt the speedometer counting process, store and display the count to date, and reset the counter. This effectively generates a measure of distance covered per operation of fuel pump, which it may be noted is of the same dimensions as miles per gallon, or for that matter, kilometres per litre, although it is clearly not in these units. Fig. 3(a) shows the counter module circuit, which utilises a total of six TTL chips which drive a pair of 3015F seven-segment displays. Its function is as follows: Provided that the reset line is kept low, pulses into the gated speedo input, or to be more specific, negative going edges, will cause the two tandemed 7490s to count. Pulses to the strobe cause the 7475s to latch their outputs to the count generated at their inputs by the 7490s. The 7475s outputs are converted by a pair of 7447s into seven-segment display code.

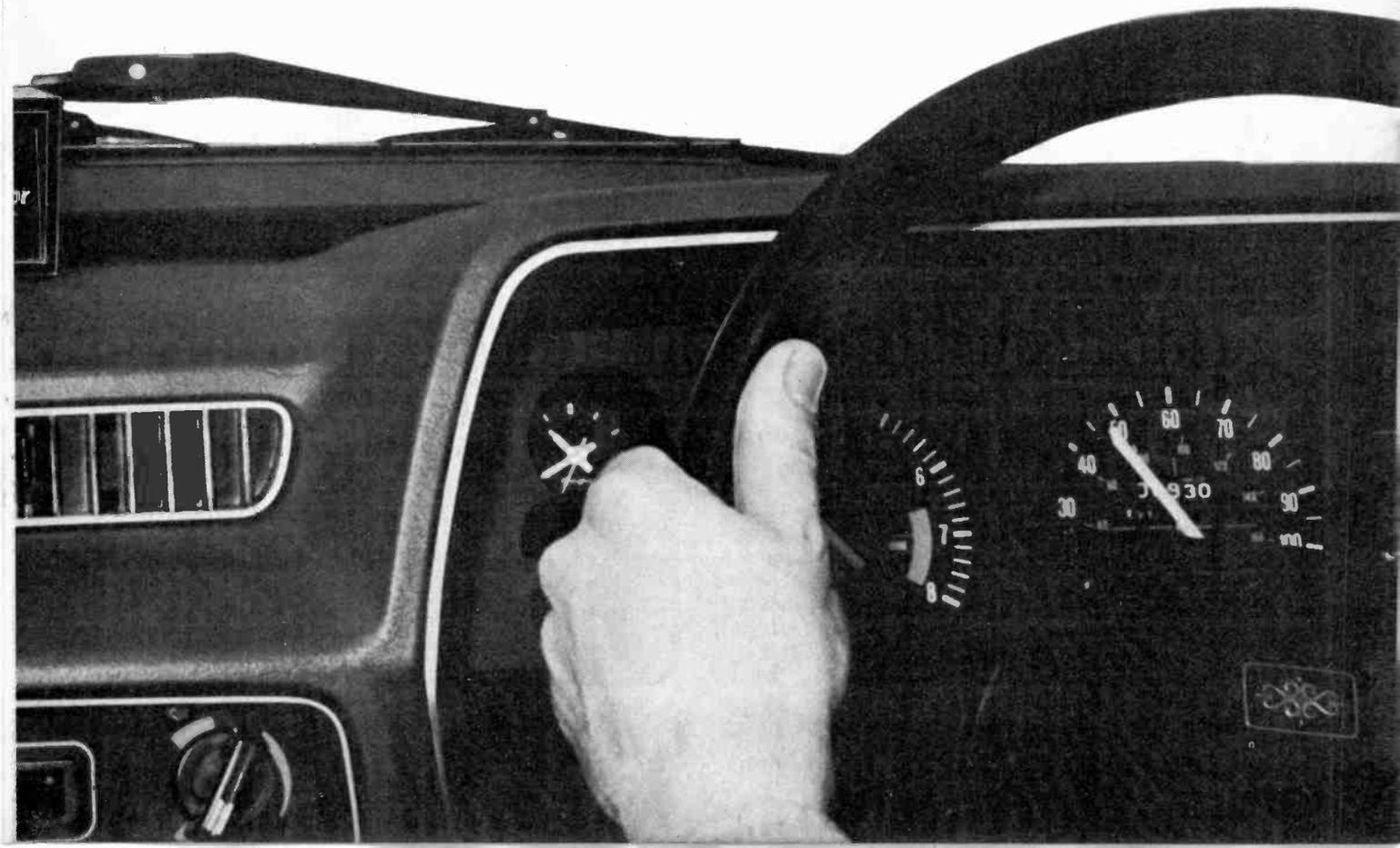
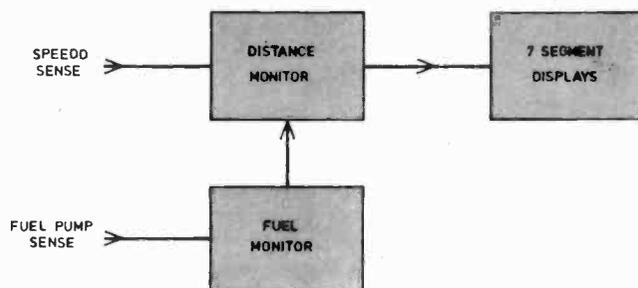
The signals applied to this module, in relation to the signal received from the vehicle sensors, relative to time, are in Fig. 4, which is not necessarily to scale. For each rotation of the speedometer cable, one pulse is applied to the gated speedo input, until the fuel pump operates, at which point the strobe and reset lines are sequentially pulsed in order to display the count since the last pump operation, and to reinitialise the counters.

Fig. 3(b) shows the second module; this circuit matches and converts the signals obtained from the speedometer and the fuel pump sensors into those suitable for TTL logic.

SPEEDOMETER SENSOR

At this point, it is necessary to describe the method of application to the speedometer of a sensor. The method used by the author, which should be applicable to the majority of cars, was to mount a photo-sensitive device in the rear of the speedo in such a way that light is reflected from the speedometer illuminating bulb via a part of the rotating mechanism, onto the photo-device. The point at

Fig. 1. Simplified block diagram of Fuel Consumption Meter



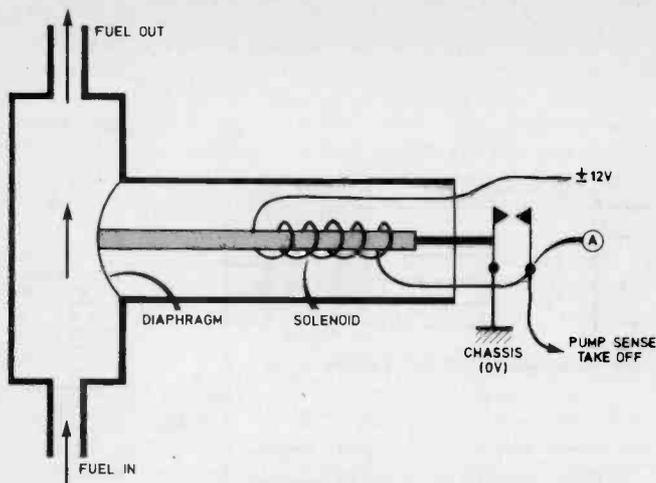


Fig. 2. Diagram shows the fundamental arrangement of an electric fuel pump, and how the sense signal is derived. One-way valves direct the flow of fuel as the diaphragm oscillates

which this is mounted has to be carefully selected, and it may be necessary to paint parts of the internal workings of the speedometer with matt-black paint. It is also necessary to make a minor change to the speedometer illumination system, entailing severing the wire connecting the speedometer bulb to the sidelight system, and connecting it instead to the ignition switch, such that it is on, whenever the ignition is on. The photo-device is then connected to the module of Fig. 3(b) via screened cable. This precaution has been found to be essential in view of the high impedance nature of the phototransistor, when no light is falling on it.

The current changes caused within the phototransistor due to changes in the incident light are then used to drive a p.n.p. Darlington pair, the output from which is taken to a variable Schmitt trigger comprising a 741 with adjustable positive feedback, a level-shifting n.p.n. transistor, and finally a 7413 to generate suitable TTL levels. The setting of the three variable resistors will be described later. The signals from this section of the unit are then sent to the counter module for processing.

FUEL PUMP

The pulses from the fuel pump which have additional unwanted spikes in both the positive and negative sense, are first clamped to TTL levels by a pair of diodes, one of which prevents negative pulses from entering the remainder of the circuitry, the other of which clamps the input level to less than 5V. The pulses then go to a pair of retriggerable monostables, held in one package, the 74123. The two monostable multivibrators have periods of T1 and T2 where T1 is very much greater than T2. The output of the monostable of period T2 is used to drive the subsequent circuitry, while the output of the other monostable is used to inhibit false triggering caused by contact bounce, ringing and so on.

The subsequent circuitry comprises a pulse sequence generator to generate the reset and latch strobe pulses, and to inhibit the input of speedometer derived pulses. The heart of this system comprises a divide-by-eight counter, part of a 7490 (IC8) and a clock oscillator, part of 7413 (IC9). A pulse from the monostable driver will force the counter to reset, which allows the oscillator to function. This causes the counter to count from zero to four, in so doing, generating the required control pulses. When the counter achieves a count of four, the rising of IC8 pin 9 output inhibits the function of the clock oscillator.

COMPONENTS . . .

Resistors

R1, R3	270Ω (2 off)
R2	2.2kΩ
R4	270kΩ
R5, R6	240kΩ 2% (2 off)
R7	6.2kΩ 2%
R8	27kΩ

All resistors ¼W 5% unless otherwise stated.

Potentiometers

VR1, VR3	100kΩ vertical preset (2 off)
VR2	1MΩ vertical preset

Capacitors

C1, C2, C8, C9, C10	1nF (5 off)
C3	0.01μF
C4	100μF/20V electrolytic
C5	10nF
C6	10nF
C7	22μF

Transistors and Diodes

TR1, TR2	OC200 (2 off)
TR3	2N3705
TR4	BP101, TDB7805T or equivalent
D1, D2, D3	OA202 (3 off)

Displays

X1, X2	3015F (2 off)
--------	---------------

Integrated Circuits

IC1, IC2, IC8	7490 (3 off)
IC3, IC4	7475 (2 off)
IC5, IC6	7447 (2 off)*
IC7	7413
IC9	7400
IC10	7404
IC11	74123
IC12	741
IC13	7805 regulator

Miscellaneous

Three way plug and socket for sensor inputs. Metal case (prototype housed in box 162 x 70 x 50mm). Plug and socket for 12V input. Veroboard. On/off switch. Integrated circuit holders if desired. Polarised display filter (for digital version).

* Not needed for meter display

Constructor's Note

The BP101 is available from **Electrovalue**. OC200 transistors are available from **Watford Electronics**, and **Semiconductors Supplies, Orchard Works, Church Lane, Wallington, Surrey, SM6 7NF**.

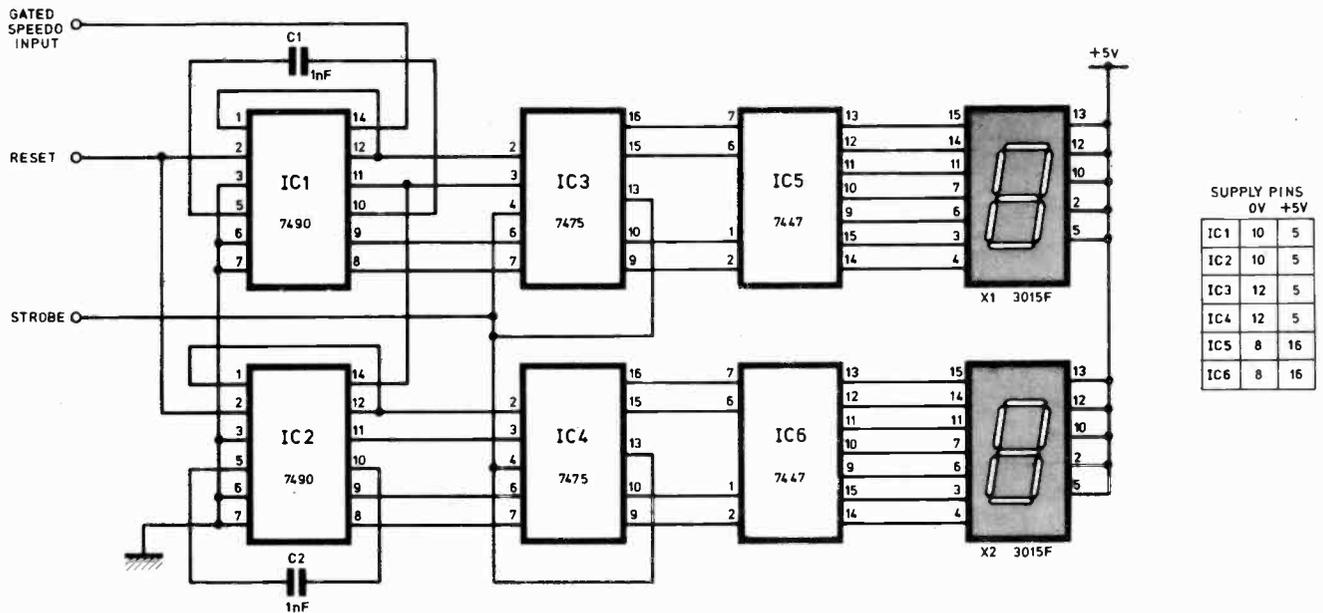


Fig. 3(a). Counter module circuit (built on separate board)

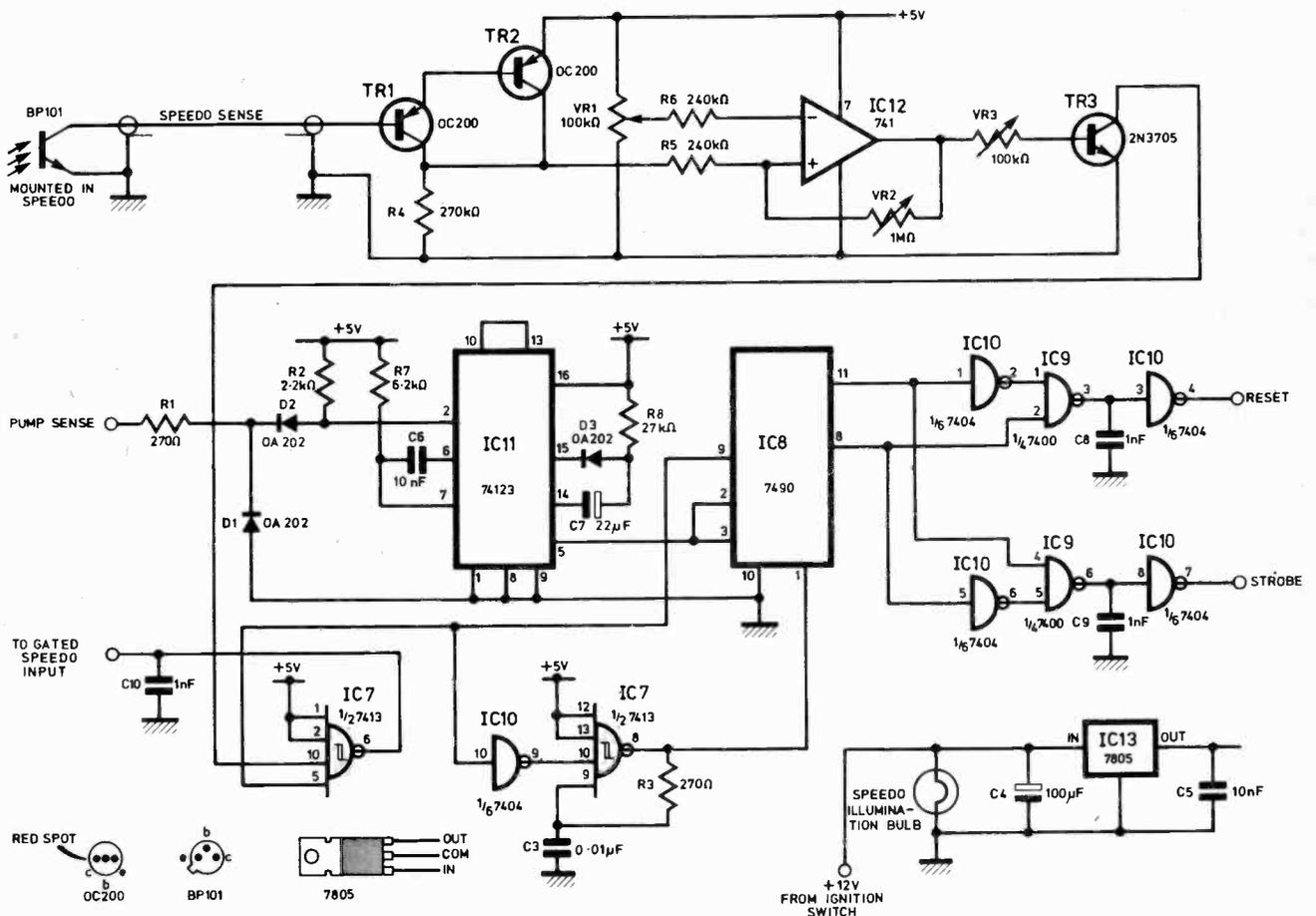


Fig. 3(b). Interfacing module circuit diagram. This part of the system matches the sense signals to the TTL

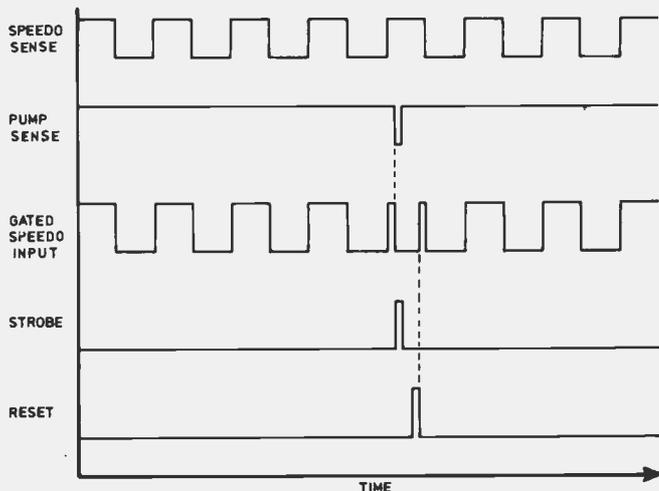


Fig. 4. Sensor and control signals relative to time. These are not to scale

ANALOGUE DISPLAY

The author's unit employs a pair of seven-segment displays, but it might be felt preferable by some constructors to use an analogue meter display. These may easily be done by replacing the displays and their associated 7447s with the circuit of Fig. 5. In this circuit, the inverted outputs of the two 7475s are used to drive a 6-bit resistive digital to analogue converter, the resulting current from which is amplified by TR4, and used to drive a 1mA meter movement. The emitter of TR4 is set to around 2.2V below V_{cc} by the effect of the three diodes D3, D4 and D5 and

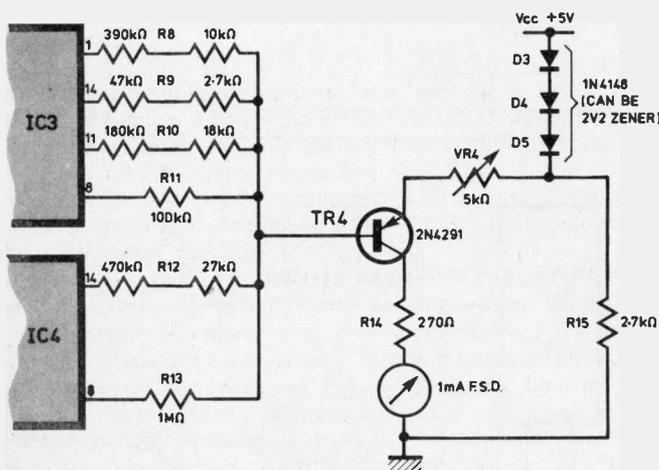


Fig. 5. Circuit diagram of meter display circuit. Devices marked with an asterisk in the main components list will not be necessary if this readout system is used

R15. This ensures minimum current flow when the outputs of the 7475s are high, thereby obviating the necessity of a set zero adjustment. VR4 is used to set the full-scale deflection value. This should be initially set to its maximum value, and when adjustment of the rest of the equipment has been made as next described, set to give the desired full-scale reading in use.



The use of a metal case is advisable for effective screening; the 5V regulator can then be mounted on the rear of the unit for excellent cooling. The driver will probably be most curious about the fuel consumption reading when accelerating hard; a time when increased concentration on the road is required, and so care should be taken in the use on this instrument.

COMPONENTS . . .

FOR METER DISPLAY

Resistors

R8	390kΩ + 10kΩ
R9	47kΩ + 2.7kΩ
R10	180kΩ + 18kΩ
R11	100kΩ
R12	470kΩ + 27kΩ
R13	1MΩ (2 off)
R14	270Ω
R15	2.7kΩ

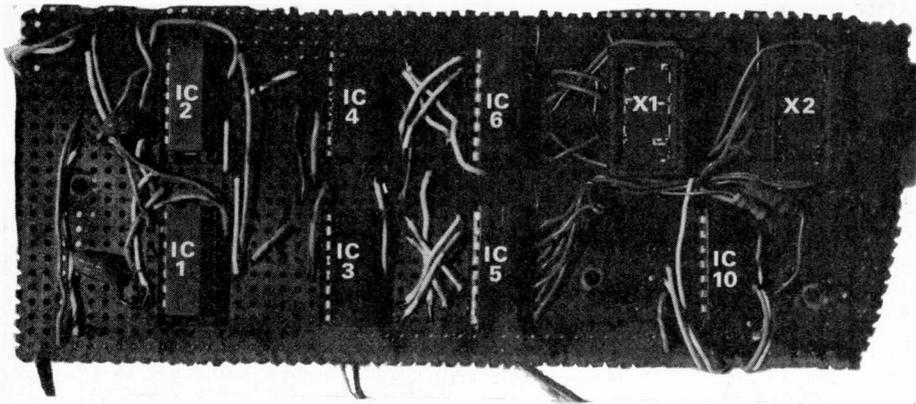
Potentiometers

VR4	5kΩ preset
D3, D4, D5	1N4148 (3 off) or 2VZ Zener (1 off)

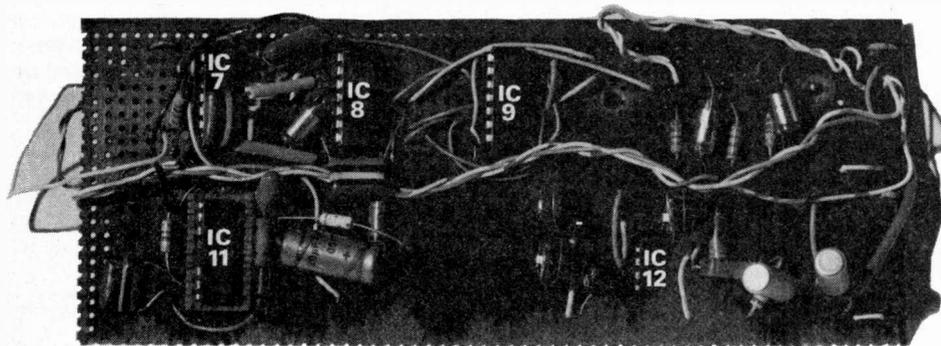
Meter	
M1	1mA f.s.d.

CONSTRUCTION

The circuit layout is in no way critical, and in the author's case, the equipment was built on two small sheets of Veroboard, with each board corresponding to one of the modules described previously. The above having been said, it is important to observe two important rules: The decoupling capacitors on the 7490s on the counter module board are essential to the counter chips' correct operation. They should be connected as closely as possible to the chip supply pins. In view of the electrically noisy environment within a car, due to ignition, and other radiation, the equipment should be constructed within an earthed metal box; failure to do so may result in spurious operation.



The author's Fuel Consumption Meter circuit was laid out on two pieces of Veroboard mounted one behind the other. Component layout is non-critical, and this photograph shows the basic arrangement of the counter section of the prototype unit.



Interfacing section circuit board. Use Fig. 3 for interwiring. This board should be mounted so that the displays show through the front panel directly

SETTING UP

The only specific adjustment required in the system is that relating to the circuitry interfacing the speedometer to the TTL, and three preset adjustments have been found necessary.

Adjustment may most easily be done with the equipment in the car, and *both* driving wheels *securely* jacked-up clear of the road. With the engine started and idling slightly faster than normal, gently engage first gear. The three preset potentiometers should be initially set as follows:

- VR1 mid-position.
- VR2 maximum resistance.
- VR3 maximum resistance.

A test meter should be set to around the 5V d.c. range, and connected to the output of the 741.

VR1 should be adjusted in either direction as necessary until the meter reading pulsates at a speed proportional to the speedometer reading. VR2 should then be adjusted until the pulsations just stop, and then increased by about 10 per cent. VR1 should be adjusted to the middle position of the range in which speedometer pulses are detected. So far, a centre point for the input pulses has now been determined, and by setting the positive feedback to the maximum acceptable, any rough tops to the waveform will be "ironed out". The number held by IC10 should now be checked; this should be the value 4. If this is not the case, momentarily trigger the 74123 by connecting the pump sense wire to earth for a brief period. If after a very short period of time,

the 7493 does not halt in the mentioned rest state, something in this area is not in order and the circuitry should be checked. If all is well, transfer the test meter probe to the input of the 7413, and reduce the value of VR3 until the pulsations appear from the output of the 741, and then at the *output* of the 7413. The equipment is now ready for use.

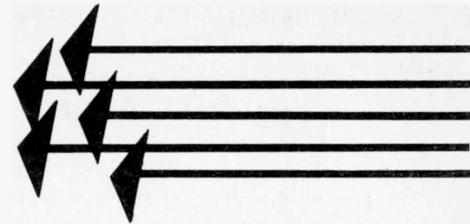
INTERPRETING THE RESULTS

During normal driving, the readings presented by the equipment will fluctuate with changes in fuel consumption. It should be noted that two sources of inaccuracy can occur.

The first of these occurs because the float-chamber systems of most carburettors are gravity operated, and any violent disturbance in the car's motion, such as violent braking or cornering will affect the amount of petrol allowed into the float-chamber by the needle-valve, causing a momentary upset in the readings obtained.

Secondly, as is well known by Morris Minor, and doubtless other drivers, a marked lowering of the level of fuel in the petrol tank causes the pump to operate very rapidly as air, rather than petrol is ingested. The settings of the timing components on the 74123 is such that a cycle during which air is ingested occurs before the 74123 pulse of time T1 has finished, thus ensuring that the pulses from the pump are ignored when air is being drawn in. Accuracy is still effected by this phenomenon however, and the fuel level should not be allowed to fall this low in normal running if accurate results are required from the equipment. ★

impedance



BY TOBY BAILEY & BOB WHITAKER

WHEN learning about electronics, one of the earliest things that we find is that for a resistor the voltage across it and the current driven through it are related by Ohm's Law

$$E = IR$$

where E is the voltage across a resistor with resistance R and I is the current. These three quantities are generally measured in volts, ohms and amps respectively. We then discover that capacitors and inductors produce a similar relationship, which is written as $E = IZ$ where Z is the impedance of the component and E and I are assumed to be sinusoidally varying a.c. voltage and current respectively.

The reason for this assumption is that non-sinusoidal waveforms are effectively a mixture of more than one frequency. Since the impedance of many components varies with frequency, the current flowing will not then be directly proportional to the driving voltage. It is worthwhile noting, as an aside, that the way that non-sinusoidal waveforms are dealt with is to break them up into the sum of sinusoidal parts, each of a different frequency. Each of these parts can then be dealt with using $E = IZ$, the current flowing can then be reconstructed by summing the currents of the individual parts.

In order to use the above formula we need to know the value of the impedance Z for the circuit. For a capacitor the impedance (often called the reactance) is given by $1/2\pi fC$, where f is the frequency of the signal in hertz, C is the capacitance of the capacitor in farads (a unit which we soon find out is about a million times larger than is useful), π is 3.1416. Similarly the impedance of an inductor is $2\pi fL$ where L is the inductance of the inductor in henrys.

Given this starting point it soon becomes apparent that there is much more to the impedance of capacitors and inductors than their simple numerical value. Consider, for example, the case when we have a

capacitor and an inductor which both have an impedance of, say, 10Ω at a particular frequency that we shall apply. If we connect these components in series and apply an a.c. voltage we might expect that the impedance of the combination would be 20Ω , but this is not the case. The total impedance is in fact zero! Furthermore if we connect the components in parallel the impedance is not 5Ω , it is infinitely large.

The above example demonstrates that we require rather more information if we want to calculate the impedance of a combination of elements.

COMPLEX NUMBERS

We now introduce the concept of a complex number which consists of two parts: called the real part and the imaginary part. A complex number is written like this

$$x + yi$$

Here x is the real part and consists of a real number, whilst y is the imaginary part. i is the important symbol (j is often used instead) which represents a number which when squared gives minus one

$$i \times i = -1$$

If that is a little difficult to conceive of it doesn't matter—just think of it as a symbol which labels the imaginary part of the complex number. Examples of complex numbers are: $3 + 4i$, $10 - 3i$, $-3.6 \times 10^4 + 6.7i$. Real numbers such as -7 and 43.6 may also be thought of as complex numbers whose imaginary part is zero. Similarly there are numbers such as $6i$, $-0.2i$ or even i (which is the same as $1i$) in which the real part is zero.

ARITHMETIC

Fig. 1 demonstrates a way in which complex numbers can be shown on a diagram. In the figure the complex number is $3 + 4i$. It is represented by a line which goes from the origin of co-ordinates (marked 0) to the point which lies on the lines; real part = 3

and imaginary part = 4. This line has a certain length "r", and makes a certain angle to the real axis " θ ". Note that the complex number can be specified in terms of r and θ , and these two numbers completely specify a particular complex number, just as x and y do.

Given the representation of a complex number as $x + yi$ or as an r and a θ , it is always possible to convert from one representation to the other.

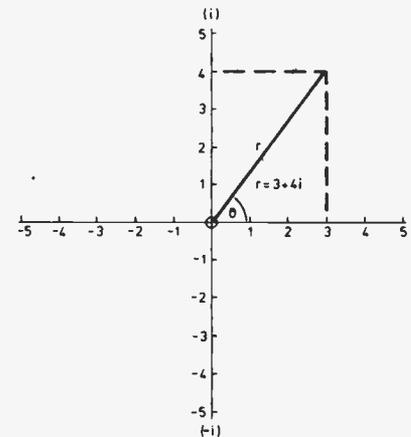


Fig. 1

Applying Pythagoras' Theorem to Fig. 1

$$r = \sqrt{x^2 + y^2}$$

This is by far the most often needed conversion. For the more mathematically minded we will give the other formulae

$$r \cos\theta = x$$

$$r \sin\theta = y$$

$$\tan\theta = y/x$$

Of these the last is the most important.

Addition of two complex numbers simply involves adding the real and the imaginary parts separately as shown below

$$(x + yi) + (a + bi) = (x + a) + (y + b)i$$

For subtraction you just subtract real and imaginary parts separately—be careful to get the signs right!

$$(x + yi) - (a + bi) = (x - a) + (y - b)i$$

Multiplication is a little more complicated

$$(x + yi) \cdot (a + bi) = (xa - yb) + (xb + ay)i$$

Unfortunately dividing complex numbers is more difficult than the preceding cases—hopefully the following steps should make the process clear. Assume we want to evaluate

$$\frac{x + yi}{a + bi}$$

First we multiply both the top and the bottom of this expression by $a - bi$. Since this is the same as multiplying the original expression by one, our division can now be written as

$$\frac{(x + yi) \cdot (a - bi)}{(a + bi) \cdot (a - bi)}$$

If we now multiply out $(a + bi) \cdot (a - bi)$ we get $a^2 + b^2$ which has no imaginary part at all, so our expression is the same as:

$$\frac{(x + yi) \cdot (a - bi)}{a^2 + b^2}$$

and we know how to multiply the top to get

$$\frac{(xa + yb) + (ya - xb)i}{a^2 + b^2}$$

and this is the same as

$$\frac{(xa + yb)}{a^2 + b^2} + \frac{(ya - xb)}{a^2 + b^2}i$$

There is just one more thing before we finish our maths lesson and that is how to multiply and divide complex numbers when they are in r and θ form. This is simpler than for numbers in $x + yi$ form: to multiply you multiply the "r"s and add the "θ"s; to divide you divide the "r"s and subtract the "θ"s.

In these examples the complex numbers are written as (r, θ) ; thus $(2, 36^\circ)$ stands for the complex number with $r = 2$ and $\theta = 36^\circ$.

$$(i) (3, 15^\circ) \cdot (4, -12^\circ) = (3 \cdot 4, 15^\circ - 12^\circ) = (12, 3^\circ)$$

$$(ii) (16, 186^\circ) \cdot (\frac{1}{2}, -26^\circ) = (16 \cdot \frac{1}{2}, 186^\circ - 26^\circ) = (8, 160^\circ)$$

$$(iii) \frac{2, 17^\circ}{5, 27^\circ} = \frac{2}{5}, -10^\circ$$

But remember that 360° is a full circle, so that -10° is the same as

$$+350^\circ \text{ so } \frac{2}{5}, -10^\circ = \frac{2}{5}, 350^\circ$$

It is now time to use these numbers.

COMPLEX IMPEDANCES

Any impedance which is a combination of resistances, capacitances and inductances can be represented as one complex number. Sinusoidally

oscillating voltages and currents are also represented by complex numbers. Using the arithmetic of complex numbers that we have described, it is now possible to use Ohm's law to give the correct answer and we can combine impedances in the same way as we used to combine resistances. Let's see how this works.

Resistors have no imaginary part to their impedance, it is just their resistance R .

Capacitors have no real part to their impedance, it is given by $-i/2\pi fC$. The symbols all have the same meanings as before.

Inductors too have no real part to their impedance, it is given by $2\pi fL$.

It is easiest to represent voltages and currents in r and θ notation. First it is essential that you know about the phase difference between two sinusoidal waveforms of the same frequency.

The phase difference is given by the distance between the peaks of the two waveforms and is specified by an angle which is worked out by defining the angle between two successive peaks of the same wave to be 360° . Reference to Fig. 2 should make this clearer.

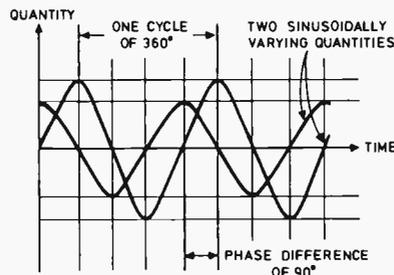


Fig. 2

To describe a voltage or current in terms of a complex number it is necessary to take one waveform in the circuit as a reference to which all the others will be referred. This reference value has no imaginary part, and its real part is just its peak value. All other voltages or currents are represented in r and θ notation by a complex number with r equal to the peak value and θ equal to the angle by which the waveform "leads" the reference waveform. By leads we mean that the angle is measured from a peak of the wave to the next peak in time of the reference wave. See Fig. 3 for an example of this.

With the set up we have just described, almost anything that you could have done with resistances and d.c. voltages can now be done for impedances and sinusoidal (i.e. one frequency) a.c. voltages.

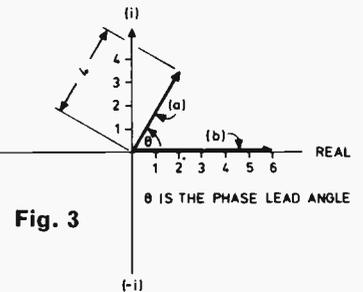
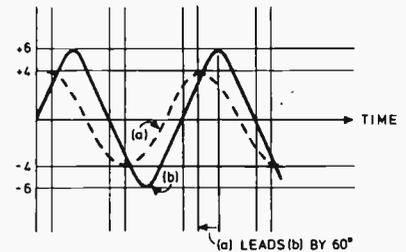


Fig. 3

TUNED CIRCUIT

The complex impedance of the series tuned circuit in Fig. 4 (a) is found simply by adding together the complex impedances of the capacitor and the inductor to get

$$\left(2\pi fL - \frac{1}{2\pi fC}\right) i$$

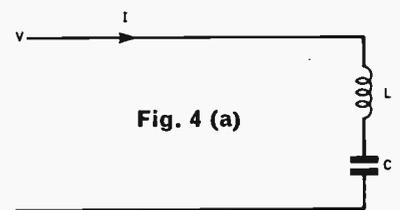


Fig. 4 (a)

Note that the impedance still has no real part. Hence in r and θ form it has

$$r = \left(2\pi fL - \frac{1}{2\pi fC}\right) \text{ and } \theta = 90^\circ.$$

You may notice that r might be negative in the above formula, in which case θ would be 270° —but negative r in the direction of 90° is the same as positive r in the direction of 270° . It isn't usually worth bothering about these things, they almost always work out alright in the end!

Now suppose that we want to know what current flows in the circuit. We know that $E = IZ$, so $I = E/Z$. Choose the input voltage to be the reference quantity for the circuit—it will then have $r = V$ (the peak value) and $\theta = 0^\circ$. To work out the current flowing we divide E by Z , remembering to divide the "r"s and subtract the "θ"s. So I has

$$r = \frac{V}{2\pi fL - \frac{1}{2\pi fC}} \text{ and } \theta = 0 - 90^\circ = -90^\circ.$$

So the current is 90° out of phase with the voltage, remembering that leading by -90° is the same as lagging by 90°. We have a rather peculiar expression for the peak value of the current (i). Notice how this expression is positive for high frequencies but negative for low ones. Thus the arrangement of the waveforms in

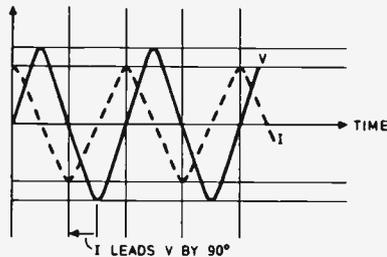


Fig. 4 (b)

Fig. 4 (b) is only valid for high frequencies. As f decreases, i suddenly becomes very large (when the bottom of the expression for r becomes zero) and then smaller again. However r is now negative so the phase changes by 180°—this is the same as saying that the waveform of the current becomes inverted.

In practical circuits of this nature there is always some resistance present so the change occurs gradually. Note that the impedance of this circuit goes to zero when

$$2\pi fL = \frac{1}{2\pi fC}$$

i.e. when

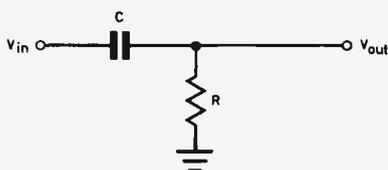
$$f = \frac{1}{2\pi\sqrt{LC}}$$

which is the well known resonant frequency.

SIMPLE R.C. CIRCUIT

The circuit shown in Fig. 5 is a very basic high pass filter. To find the current which flows we need to know the impedance of the combination, which is given by

$$Z = R + \left(\frac{-1}{2\pi fC}\right) i = R - \frac{1}{2\pi fC} i$$



Choosing V_{in} to be the reference quantity (which, you should remember means that $r = V_{in}$ and $\theta = 0^\circ$) we can then say that the current flowing

is given by

$$I = \frac{V}{Z} = \frac{V_{in}}{R - \frac{1}{2\pi fC} i}$$

Now the output voltage is produced by the current I flowing through the resistor R so, using Ohm's Law, we obtain

$$V_{out} = \frac{V_{in}R}{R - \frac{1}{2\pi fC} i}$$

To evaluate this we had better put it into r and θ form. $V_{in}R$ is simple—since it is just an ordinary number with no imaginary part it has $r = V_{in}R$ and $\theta = 0^\circ$. To convert the bottom half of the expression we need to use the formulae for r and θ in terms of x and y that we mentioned earlier: namely $r = \sqrt{x^2 + y^2}$ and $\tan\theta = y/x$ (this last part can be done by scale diagram). Putting the x and y values of

$$R + \frac{1}{2\pi fC} i$$

into these formulae gives the value of r to be

$$r = R^2 + \frac{1}{4\pi^2 f^2 C^2}$$

and θ is going to be the angle for which

$$\frac{y}{x} = \frac{-1}{2\pi fRC}$$

Using the rule for division in r and θ form we can now calculate the value of

$\frac{V_{out}}{V_{in}}$ — the r part is

$$r = \sqrt{R^2 + \frac{1}{4\pi^2 f^2 C^2}}$$

and the θ part is minus the angle for which

$$\frac{y}{x} = \frac{-1}{2\pi fRC}$$

—if you draw a diagram you can see that this is the same as the angle for which

$$\frac{y}{x} = \frac{1}{2\pi fRC}$$

The r value gives us the amount by which the amplitude of the voltage is decreased. When

$$R^2 = \frac{1}{4\pi^2 f^2 C^2}$$

this attenuation factor is about .707 (or, using the decibel scale, about -3dB). Rearranging this formula and getting rid of all the squares gives

$$f = \frac{1}{2\pi RC}$$

This is often called the break point for the filter.

What do all these complicated-looking formulae mean as regards the performance? Well, when the frequency is very high the

$$\frac{1}{4\pi^2 f^2 C^2}$$

term is very small and so $\frac{V_{out}}{V_{in}}$ becomes

very close to one. This indicates that high frequencies pass through the filter almost unobstructed. In contrast, when f is very small the

$$\frac{1}{4\pi^2 f^2 C^2}$$

term is going to be far larger than the R^2 term so we can ignore the R^2 term without too much loss of accuracy. We then have

$$\frac{V_{out}}{V_{in}} \sqrt{\frac{R}{\frac{1}{4\pi^2 f^2 C^2}}} = 2\pi fRC$$

Notice that the $\frac{V_{out}}{V_{in}}$ figure halves every

time the frequency halves. This sort of relationship is best shown on a decibels versus logarithmic frequency plot as shown in Fig. 6 (a).

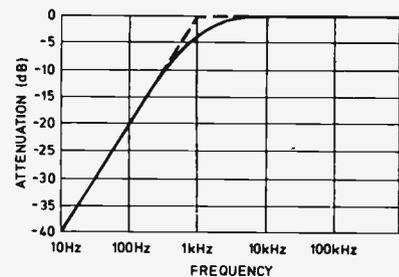


Fig. 6 (a)

Taking 0dB at the input level, the output level of the filter is fairly constant down to just above the break point; the output then curves down, finally falling off at about 6dB per octave (halving of frequency) which is 20dB per decade.

We have not yet used the information we have calculated about θ . For actual values of R, C and f , θ can be evaluated either by drawing a diagram or by working out

$$\theta = \arctan \frac{1}{2\pi fRC}$$

on a scientific calculator. We can see roughly what is going to happen: at very high frequencies when the filter is passing almost all of the input voltage, y/x is very small which means that the output voltage has almost the same phase as the input voltage. As the frequency decreases it will reach

the break point where

$$\frac{1}{2\pi fRC} = 1$$

—this means that the output will lead the input by 45°. As the frequency keeps on decreasing the phase lead will continue increasing, getting ever nearer to 90° but never quite getting there as shown in Fig. 6 (b).

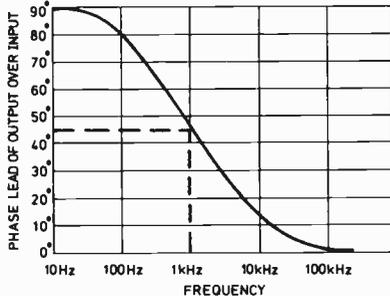


Fig. 6 (b)

When working with filters such as this one, it is generally true that the attenuation versus frequency graphs (on logarithmic scales) can be simplified considerably. To do this you just assume that the response is flat down to the break point, whereupon it falls off immediately at a rate of 6dB per octave = 20 dB per decade. This approximation is shown dotted in Fig. 6 (a)—the approximation is very accurate except for a decade or so around the break point when it can be up to 30 per cent out.

MORE COMPLICATED FILTERS

As a slightly more complicated example let us try to design a filter which passes high frequencies unattenuated and attenuates low frequencies by 10. We want the middle point to be at 1kHz (the full attenuation is 20dB so call the mid point the 10dB attenuation point). We would also like some idea of the phase performance.

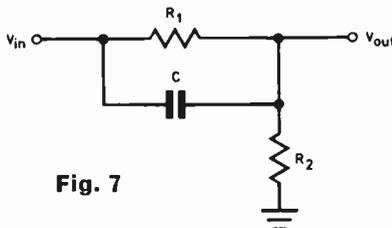


Fig. 7

The obvious way to do this is shown in Fig. 7. At very low frequencies the effect of the capacitor is insignificant so

$$\frac{V_{out}}{V_{in}} = \frac{R_2}{R_1 + R_2}$$

which we want to equal

$$\frac{1}{10}$$

Choose as fairly sensible values $R_1 = 9k\Omega$, $R_2 = 1k\Omega$. Whether these are sensible will, of course, depend on the impedance of the source we are using to drive the filter and the impedance that is being driven by the filter. Say for the sake of simplicity that the driving impedance is a few ohms and that the driven impedance is at least several tens of kilohms. Now down to work:

Using the symbol $R_1 \parallel C$ to mean the impedance of the parallel combination of R_1 and C we have

$$\frac{V_{out}}{V_{in}} = \frac{R_2}{R_2 + R_1 \parallel C}$$

But $R_2 = 1k\Omega$ and $R_1 = 9k\Omega$ so

$$R_1 \parallel C = \frac{9000 \left(\frac{-1}{2\pi fC} \right) i}{9000 - \frac{1}{2\pi fC} i}$$

and

$$\frac{V_{out}}{V_{in}} = \frac{90000 - \frac{5}{\pi fC} i}{90000 - \frac{50}{\pi fC} i}$$

The "r part" of this expression can be found by dividing the r part of the top by the r part of the bottom

$$r = \frac{\sqrt{(90000)^2 + \left(\frac{5}{\pi fC} \right)^2}}{\sqrt{90000^2 + \left(\frac{50}{\pi fC} \right)^2}} = \frac{1}{\sqrt{10}}$$

since we require this to be equivalent to an attenuation of 10dB when $f = 1kHz$ and 10dB is a voltage ratio of $\sqrt{10} : 1$.

Square both sides and multiply out which gives

$$9 \times 81 \times 10^8 = \frac{2500 - 250}{\pi^2 f^2 C^2}$$

this is for $f = 1kHz$ so

$$C^2 = \frac{2250}{9 \times 81 \times 10^8 \times \pi^2 \times 10^6} = 3.127 \times 10^{-15}$$

and finally we get to the value of the capacitance $C = 5.6 \times 10^{-8}$ farads = 0.056 μF . If we substitute this value into the original formula for the r part we get

$$\frac{\sqrt{(90000)^2 + \frac{8.1 + 10^{14}}{f^2}}}{\sqrt{(90000)^2 + \frac{8.1 \times 10^{16}}{f^2}}} = \frac{\sqrt{1 + \frac{10^5}{f^2}}}{\sqrt{1 + \frac{10^7}{f^2}}}$$

A graph of this is the attenuation of the filter, as shown in Fig. 8 (a).

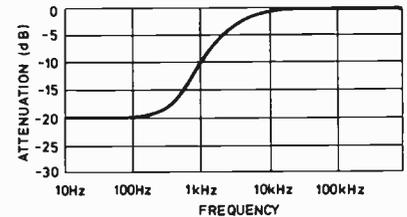


Fig. 8 (a)

PHASE PERFORMANCE

To get some idea of how the phase difference between the input and the output varies with frequency we see that at high frequencies the capacitor is going to have far more effect than R_1 and so the phase shift will go to zero, just as it did for the simple high-pass filter. Also at very low frequencies the effect of the capacitor will be negligible and the phase shift will go to zero again. What happens in between? If we substitute the value for the capacitance into

$$\frac{V_{out}}{V_{in}} = \frac{90000 - \frac{5}{\pi fC} i}{90000 - \frac{50}{\pi fC} i}$$

we end up with

$$\frac{V_{out}}{V_{in}} = \frac{1 - \frac{316}{f} i}{1 - \frac{3160}{f} i}$$

From this we can work out the phase shift for any frequency: for example at 1kHz we have

$$\frac{V_{out}}{V_{in}} = \frac{1 - 0.316 i}{1 - 3.16 i}$$

Now θ for $1 - 0.316i$ is about $-17\frac{1}{2}^\circ$ and θ for $1 - 3.16i$ is about $-72\frac{1}{2}^\circ$, so θ for

$$\frac{V_{out}}{V_{in}} = -17\frac{1}{2}^\circ - (-72\frac{1}{2}^\circ) = 55^\circ$$

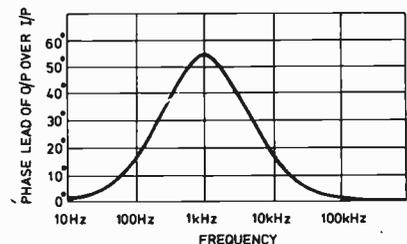


Fig. 8 (b)

In fact this is the maximum phase shift for any frequency. A graph of phase shift versus frequency is also shown on Fig. 8 (b).

High Performance POWER SUPPLY UNIT

R. Lawrence B.Sc.



THIS article describes a high performance power supply with voltage control down to zero (yes, zero, not two and a half volts or five and a quarter or, as in the case of many supplies, whatever the Zener voltage used in the system happens to be) and current limit from a few milliamps to several amps.

This ability to have current limit down to such low values allows one to, for example, work with low power circuitry knowing that even if something drastic happens nothing will be destroyed. One can even use this facility for measuring the values of larger electrolytic capacitors!

SPECIFICATION . . .

- **Voltage Control** 0–30V
- **Current Control** 2mA–2A
- **Output Resistance** Less than 0.001Ω
- **Ripple and Noise** Less than 1mV
- **Line Regulation** Less than 0.001%
- **L.e.d. indicator current limit mode**
- **Sharp voltage/current mode transition**
- **Instant switch off**

CIRCUIT ACTION

The reference voltage is generated in the circuitry around IC1 (see Fig. 1). D5 is a 5.6V Zener diode run at its zero temperature coefficient current. Values of most Zener series (BZY88 in particular) exhibit positive temperature coefficient below 5.6V and varying degrees of negative t.c. above this value.

R5 and R6 set the output of the reference generator at twice the Zener voltage and in addition a low output impedance feed to the rest of the p.s.u. is guaranteed by the high degree of feedback employed.

The circuit operates as follows; the output of the op amp IC1 increases until D8 conducts, whereupon the circuit stabilises with the Zener voltage appearing across R5. Negligible current flows into the non-inverting input of IC1 and therefore all the current in R5 flows into R6 yielding twice the Zener voltage at the output of IC1.

AMPLIFIER

Unlike most power supplies, instead of providing voltage control by means of varying the feedback factor in a control system, this design uses what is in effect a "uni-phase power amplifier" arrangement.

The reference section provides $2 \times 5.6 = 11.2V$, and we require 30V out, hence the gain of the amplifier is $30/11.2$.

The resistors R11 and R12 determine the gain, and this is given by:

$$\bar{A}_v = \frac{R11 + R12}{R11}$$

which can be re-written in terms of V_{ref} (11.2V), and the output voltage V_{out} (30V) as the ratio of the two resistors:

$$\frac{R11}{R12} = \frac{V_{ref}}{V_{out} - V_{ref}} = 0.59$$

PREFERRED VALUES

Two preferred values which give this ratio whilst at the same time approximately maintaining an equivalent impedance looking back from either the inverting or non-inverting inputs of the op amp (this keeps temperature drift effects in the input bias currents common-mode and therefore self-cancelling) are 33kΩ and 56kΩ.

ADVANTAGES

One of the advantages of using a "power amplifier"-type system in the voltage section is that the control of output voltage down to zero can be achieved easily. Other designs allow this to be performed but solutions sometimes can appear somewhat contrived. With the amplifier system zero input means zero output.

For perfectionists a preset has been provided which allows one to trim out any remaining millivolts which can be caused by offset in the 741 or possibly the voltage control potentiometer not yielding exactly zero output voltage when turned fully anti-clockwise.

CURRENT LIMIT SYSTEM

The current limit system sets the maximum output current available from the p.s.u. and also provides an indication that the unit has shifted from constant voltage mode to constant current mode.

Current limit comes into operation when the voltage across a sensing resistor (R7) reaches a predetermined value. This value is set by VR3 and is derived from the reference voltage line from IC1.

OPERATION

All the current that flows from the output terminals must also flow through R7. If we now consider the circuitry around IC3: the inverting input is biased at 0V via R21, whilst the non-inverting input can be adjusted to any voltage between 0 and 2V. Say it is set at 1V and the output voltage at several volts. If the load is increased the voltage output will be held at a constant value by the voltage amplifier section and the presence of R7 will have a negligible effect due

to its low value and because it is situated outside the feedback loop of the voltage control circuitry.

It is interesting to note that if the load is constant (a resistor for example) and the voltage output is constant, then the current through R7 is constant and substantially independent of any ripple in the incoming supply.

If the load is now increased to cause the voltage across R7 to reach 1V, IC3 comes into action.

COUPLING

The output of IC3 is coupled to the non-inverting input of IC2 (essentially the input to the voltage amplifier arrangement) with a diode. Thus the current control can "cut in" and override the voltage control, but at all other times is totally disconnected from it. Hence, when in our example the voltage across the sensing resistor reaches the predetermined 1V, IC3 adjusts the input to IC2 in such a fashion as to maintain this voltage across the resistor and thereby form a second dominant control system—except this time controlling output current and not voltage.

C8 provides compensation in this loop to maintain stability.

INSTANT "SHUT-DOWN"

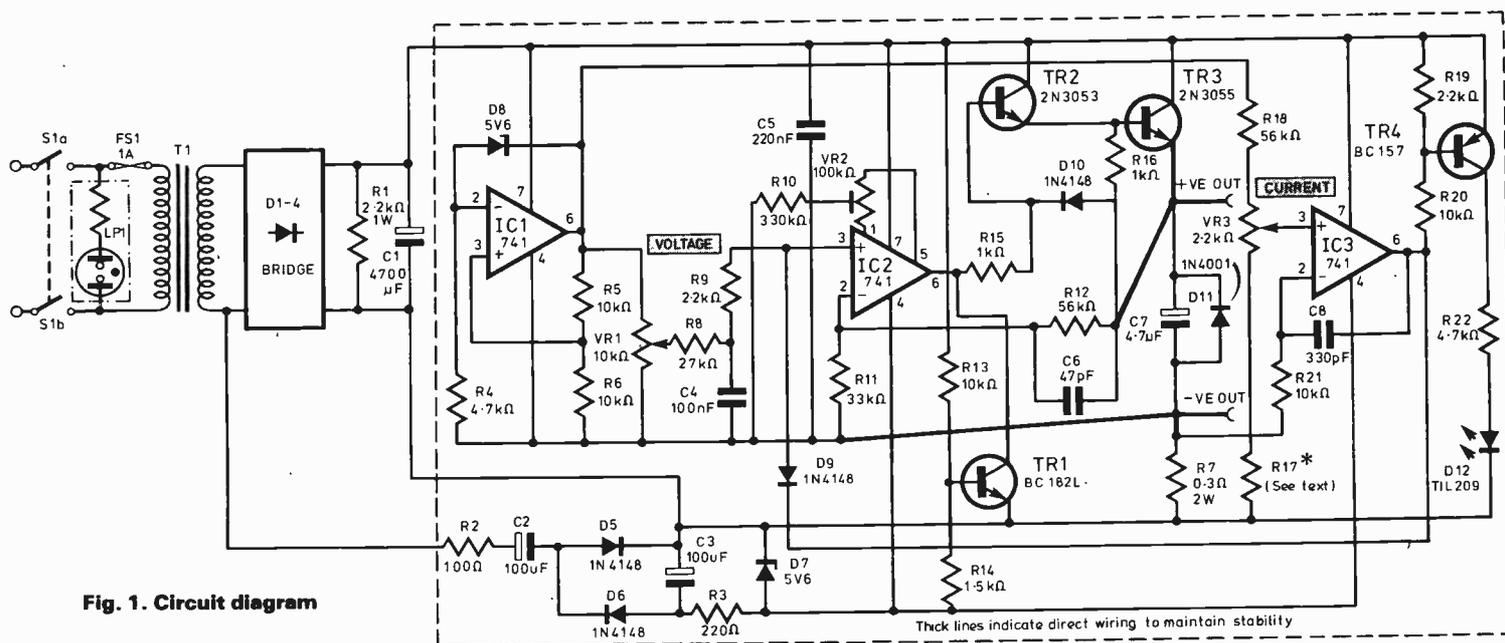
In order to prevent any spurious effects that may occur as the negative rail voltage decays away when power is removed from the unit, transistor TR1 removes drive to the output stage as soon as the rail collapses.

Under normal operation TR1 is held off by R14, but when the negative rail fades TR1 comes on and holds the output of IC2 low. This does no damage to the i.c. as the 741 has comprehensive internal output current limit circuitry built into it which limits its output current to a safe 15–20mA.

The fact that the output from the p.s.u. disappears virtually instantaneously can be an asset when doing test or experimental work. It allows one to kill the supply and perform circuit modifications without having to wait first for the power supply's internal capacitor to slowly discharge.

CONSTRUCTION

Construction should commence with the etching of the p.c.b. and then assembling components onto this as shown in Figs. 2 and 3. As this layout has been proven, it is wise to stick to it as much as possible to ensure stability. The remaining peripheral components should then be connected.



SUPPLY CURRENT

There is a small amount of current which flows through R7 which does not go to the load. This constitutes the negative supply current to IC1 and the Zener current. This is the reason for R17. It allows voltage appearing across R7 due to this current, and also any due to remanent resistance in VR3 (when fully anti-clockwise) to be offset. Normally it should lie in the range 0–100Ω (typically about 33Ω).

NEGATIVE RAIL GENERATOR

The circuitry around C2 and C3 forms the negative rail generator. This is required to enable IC2 to control the output voltage down to zero. Similarly since IC3 has to control the input of IC2 down to zero, it too requires a negative supply. IC1 is operating under fixed conditions, however, and therefore can be run between the positive unregulated input and earth.

The negative generator is simply a pump system with simple stabilisation on its output (R3 and D7).

TESTING

When building p.s.u.s, power amps. etc. initial switch-on can be a little nerve racking, as small mistakes can easily result in drastic burn-ups. Ideally a Variac should be used here, as then the input current to the system can be watched whilst the input voltage is slowly increased. If it is seen that the current has risen beyond a reasonable value then the circuit can be checked and the replacement of burnt, charred components is happily avoided.

However, in the absence of a Variac a low value resistor (20–50Ω) of a Watt or so rating can be used in series with the secondary of T1, together with a multimeter set to 1A a.c.

When power is applied the meter should just give an initial kick and then settle down to a low value (10–30mA). A fault condition exists if the resistor overheats and/or the current is substantially higher than the above readings.

Assuming the first switch on has been successfully accomplished and the unit is drawing the correct current,

short out the series resistor and make sure the current is still around 30mA.

Now check that the output of IC1 is between 11V and 12V with respect to the negative output terminal. Check that pin 3 of IC2 varies in voltage with the position of VR1, and that when VR1 is fully anticlockwise there is in fact zero volts at this point.

Next check that the negative supply pins of IC2 and IC3 are at between -5V and -6V with respect to the negative output. After this check the output of the supply can be varied from zero to 30V. With VR1 fully anticlockwise adjust VR2 to trim out any remaining millivolts.

CURRENT LIMIT

Once the voltage system is known to be satisfactory the current limit system can be checked. Diode D9 connects the output of IC3 to the non-inverting input of IC2 and it is worth noting that if IC3 output is staying low for some reason this will override VR2. If it is suspected that there is a fault in the current limit system, D3 can be removed and the two systems isolated. It should of course be replaced before the current limit system is examined.

To check the current limit system, first make sure that pin 3 of IC3 varies from 0V to about 2V when VR3 is adjusted. Turn VR3 to a minimum. If D12 lights it means R17 is too

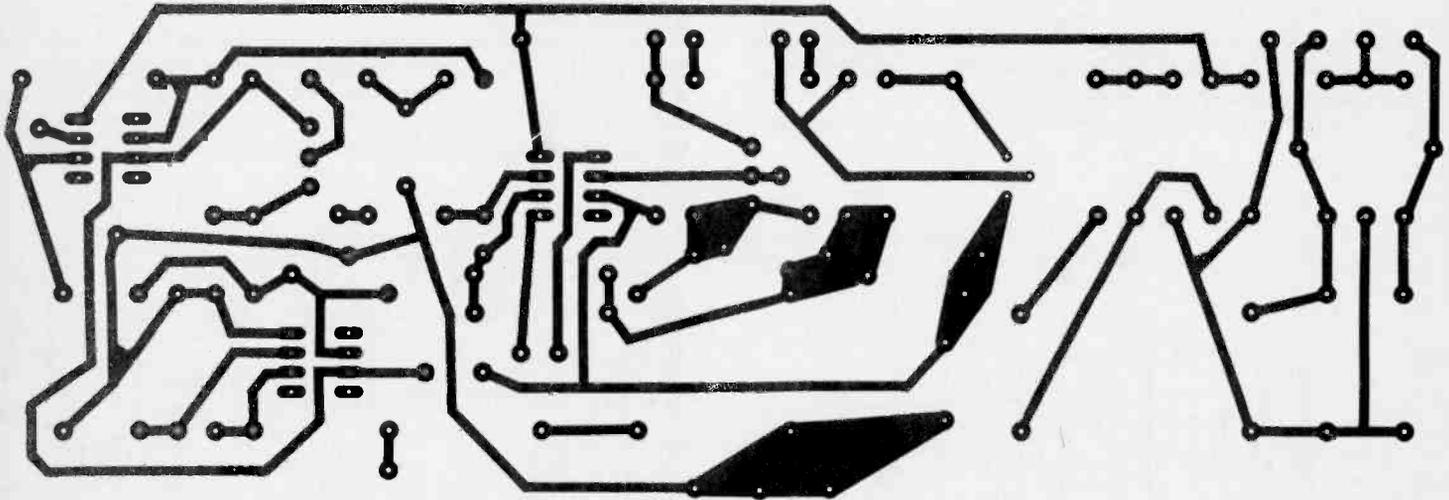


Fig. 2. P.c.b.

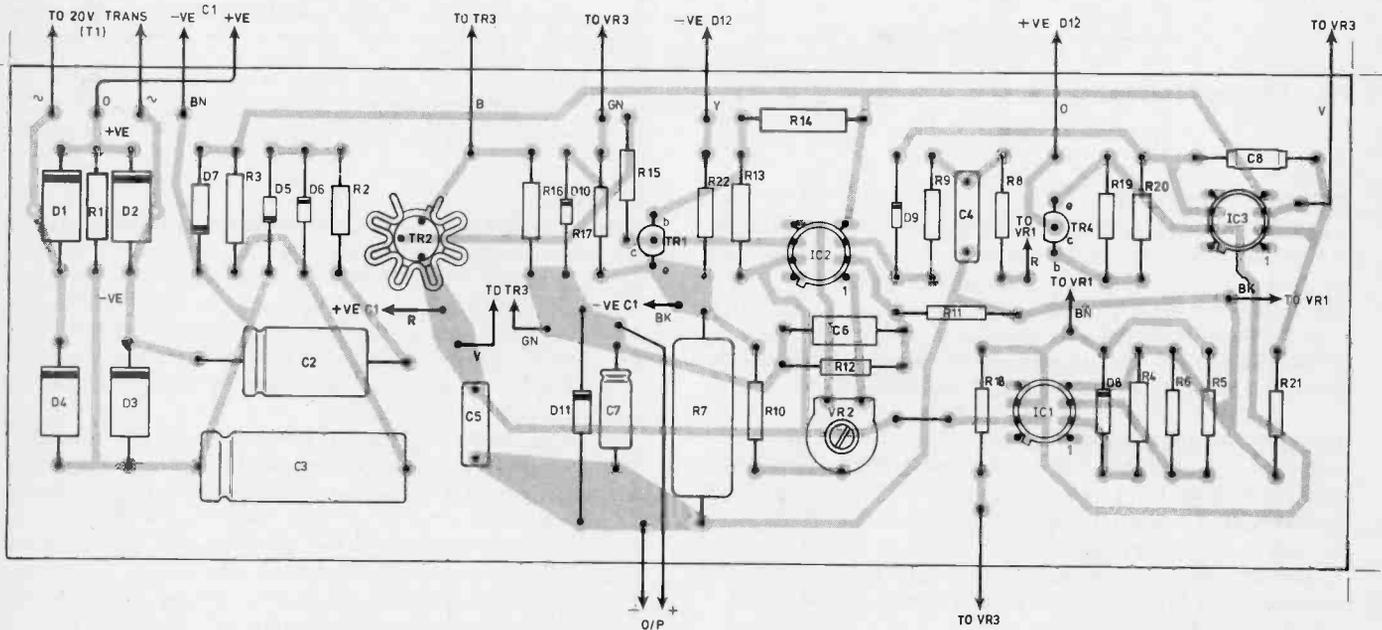


Fig. 3. Component layout. If bridge rectifier used R1 can be connected directly to C1

low. Ensure first though that it is not a fault condition.

Now turn VR1 to give zero output voltage (check this with a multimeter). Set the multimeter to about 100mA d.c. and slowly turn up the output voltage with VR1. If all is well, D12 should light and the current should limit at a low value (2-5mA). If this does not happen check D9 and IC3 and associated circuitry, with the usual attention being paid to such things as dry joints and solder splashes.

When this stage has been reached a value can be given to R17 if D12 still comes on at VR3 minimum setting. As mentioned above it should allow current control down to 3-5mA.

METERING

A meter is a very useful feature to have on a power supply. It is possible to do without one by having calibrated voltage and current controls but this does restrict the unit somewhat.

A circuit which allows switchable current/voltage monitoring is given in Fig. 4. Current is measured by monitoring the voltage across R7. This means the unit's very low output impedance is preserved.

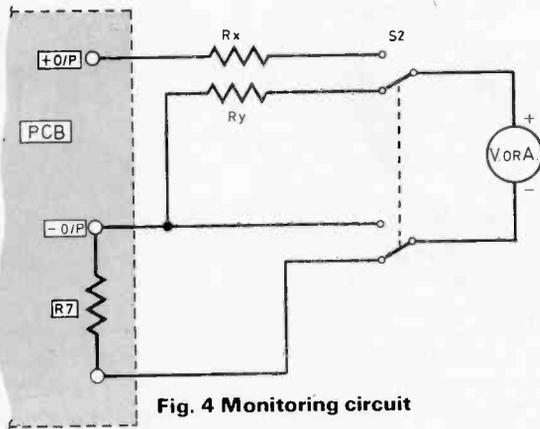


Fig. 4 Monitoring circuit

R_x and R_y are determined by the meter sensitivity and resistance. If the meter sensitivity is I_m for f.s.d. and it has a resistance of $R_m \Omega$, then R_x will be obtained from:

$$R_x = \left(\frac{30}{I} \times 1000 - R_m \right) \Omega$$

Similarly R_y is obtained from:

$$R_y = \left(\frac{1}{I} \times 1000 - R_m \right) \Omega$$

If two meters are available, of course, both voltage and current can be monitored simultaneously and S1 can be done away with.

HEATSINKING

Any linear power supply with a reasonable output should be equipped with generous heatsinks, and this is no exception. The worst-case condition for these "linear" type supplies is when they are supplying a high current at a low voltage. The dissipation in the series pass transistor can reach as high as 50W in this case and to keep the junction temperature of the series transistor down to a safe value a heatsink of around one degree C per Watt or better should be used.

The constructor's discretion can be resorted to here: if it is apparent that the unit is severely overheating and the transistor TR3 far too hot to touch (don't get misled however, they can take junction temperatures in excess of 150 degrees C) then greater heatsinking should be employed. ★

COMPONENTS . . .

Resistors

R1	2.2k Ω 1W
R2	100 Ω
R3	220 Ω
R4	4.7k Ω
R5	10k Ω
R6	10k Ω
R7	0.3 Ω 2W
R8	27k Ω
R9	2.2k Ω
R10	330k Ω
R11	33k Ω
R12	56k Ω
R13	10k Ω
R14	1.5k Ω
R15	1k Ω
R16	1k Ω
R17	0-100 Ω (33 Ω typ. see text)
R18	56k Ω
R19	2.2k Ω
R20	10k Ω
R21	10k Ω
R22	4.7k Ω

All $\frac{1}{2}$ W carbon except where otherwise stated

Potentiometers

VR1	3 good quality 10k Ω log.
VR2	100k Ω miniature carbon preset

Capacitors

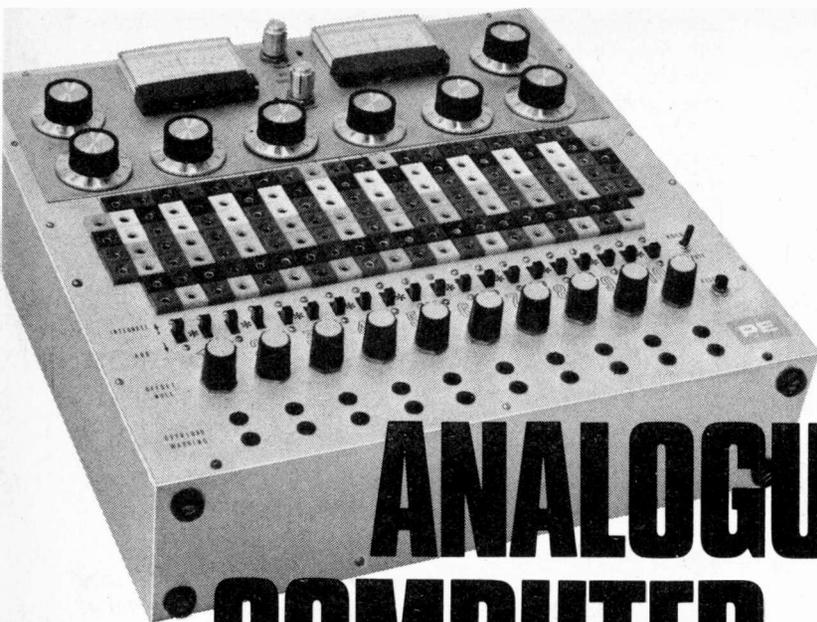
C1	4,700 μ F 40V elect.
C2	100 μ F 40V elect.
C3	100 μ F 40V elect.
C4	100nF polyester
C5	220nF 63V plastic or ceramic
C6	47pF plastic or ceramic
C7	4.7 μ F 35V tantalum (or elect.)
C8	330pF plastic or ceramic

Semiconductors

IC1-3	741 (any manufacturer as long as good quality, esp. for IC2)
TR1	BC182L
TR2	2N3053
TR3	2N3055
TR4	BC157
D1-4	Any 3A 50V bridge (or 4 discrete 3A diodes) e.g. RS type 261-457
D5-6	1N4148, 1N914
D7-8	BZY88-5V6
D9-10	1N4148, 1N914
D11	1N4001
D12	Any suitable l.e.d. (TIL 209 etc.)

Miscellaneous

Mains transformer 240V primary, 20 to 25V, 2A secondary. Heatsink for TR3, approx. 1 deg. C per Watt (plus mica insulation kit) RS type 401-807
Box to suit, on-off switch etc.
Meter (if required) see text
Switch (S1) if required (d.p.d.t.) + R_x & R_y values (see text)



ANALOGUE COMPUTER

P. J. KRONIS B.Sc.

PART 2

HAVING formed a general picture of the workings of the analogue computer, the complete circuit of a computing element can now be described. This is shown in Fig. 2.1. The basic circuits of input and feedback, components connected around the op-amp can be readily recognised. The input comprises four resistors, R₁ to R₄, which are connected to sockets in the patch panel and to the inverting input of the op-amp, via switches RLA2, S1c, and S1b. The feedback circuit consists of R5, C1 and C2, which can be selected by means of switch S1a and sockets (C7, B6 and C6) on the patch panel.

Consider switch S1a set so that R5 is selected in the feedback loop. The computing element now becomes a summer. By recalling the equation for the addition circuit that was described last month and by substituting the values for R5, R1, R2, R3, and R4 it can be seen that a voltage applied at inputs 1 and 2 will be multiplied by unity,

$$\left(\frac{R5}{R1 \text{ or } R2}\right) = \frac{1}{1} = 1.$$

whereas inputs 3 and 4 will multiply an input voltage by 10.

$$\left(\frac{R5}{R3 \text{ or } R4}\right) = \frac{1}{0.1} = 10.$$

With capacitor C1 selected in the feedback loop, the computing element is converted to an integrator and if values are substituted in the equation for the integrator, it can again be shown that inputs 1, 2 and 3, 4 give a gain of 1 and 10 respectively. The selection of C2 in the feedback loop increases the gain of all inputs by a factor of 10. This is usually referred to as a nose gain of 10. The symbols used to denote adders and integrators with the relevant gain values are shown in Fig. 2.2.

The "Initial Condition" resistors R6 and R7 are brought into the circuit by means of switches RLA2 and S1d. VR1 is a 10kΩ potentiometer, which provides the op-amp with external offset nulling. This is connected across pins 1 and 5,

with the pot slider taken to the negative supply rail. The non-inverting input of the op-amp is grounded via R8. The value of this resistor should be chosen for good thermal drift performance. The optimum resistance would be equal to the parallel value of the input and feedback resistances. Since in this case there are two values of input resistances, a compromise solution is necessary.

The circuit of Fig. 2.1 represents just one computing element and analogue computers may have many such elements. The prototype has ten computing amplifiers which is an adequate number for the solution of fairly complex problems.

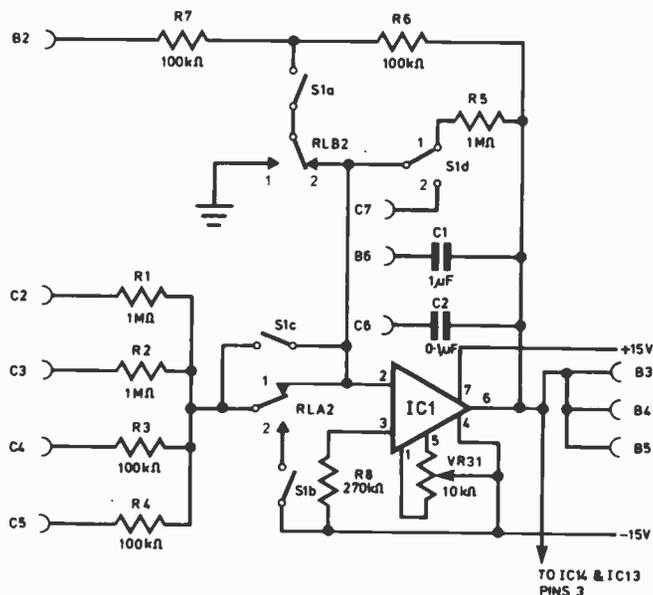


Fig. 2.1. Circuit diagram showing one of the ten computing elements of the Analogue Computer

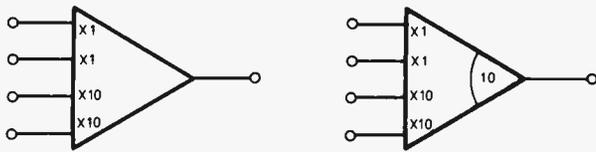


Fig. 2.2. Symbols used to denote adders and integrators

Mode Control is achieved by means of relay contacts RLA2 and RLB2. Relays are necessary because all ten amplifiers need to be controlled simultaneously. Table 1 shows the positions of relay and other switches for mode control of summers and integrators.

SWITCH	SUMMER			INTEGRATOR		
	COMPUTE	HOLD	RESET	COMPUTE	HOLD	RESET
RLA2	1	2	2	1	2	2
RLB2	1	1	2	1	1	2
S1a		OPEN			CLOSED	
S1b		OPEN			CLOSED	
S1c		CLOSED			OPEN	
S1d	1	1	1	2	2	2

TABLE 1

Fig. 2.5 shows how the ten computing amplifiers are arranged on a printed circuit board with the component overlay shown in Fig. 2.7. At the extreme ends of the board the two four-quadrant multiplier i.c.s are accommodated. This main p.c.b. is connected to other points in the computer by means of edge connectors.

The Four-Quadrant Multipliers

So far it has been shown how to multiply a variable voltage by a constant. This is easily done, using the coefficient multiplier, in conjunction with the amplifier gain. The formation of the product of two variables is much more difficult to obtain. Of the many methods that have been devised, most have involved the use of devices with certain characteristics, e.g. a diode function generator can be set up to provide a square law action, or a log-antilog action. Op-amps are usually employed with these circuits.

For the sake of simplicity and compactness it was decided to use two four-quadrant multiplier i.c.s in the prototype. As their name implies these can multiply in four quadrants,

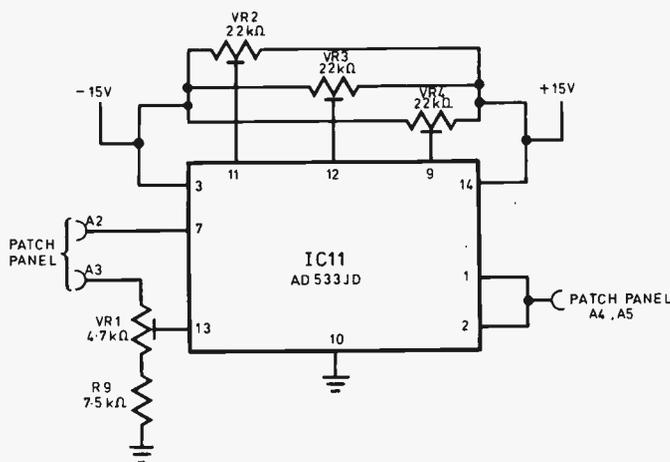


Fig. 2.3. Circuit diagram of the Four Quadrant Multiplier

which means that either or both voltages can be positive or negative. This dispenses with the need to have an absolute value circuit preceding the multiplier, as is the case with other methods.

The particular device chosen for the prototype was the AD533JD integrated circuit (shown in Fig. 2.3). This is not the cheapest four-quadrant multiplier on the market, but it has the advantage of being simple to operate, with the minimum of external components. The i.c. comprises a transconductance multiplying element, a stable reference, and an output operational amplifier on a single monolithic silicon chip.

The AD533JD multiplies with a transfer function of $\frac{XY}{10}$. The division by 10 should not worry the programmer but it should always be borne in mind when solving a problem. The op-amp output provides $\pm 10V$ at 5mA, and is fully protected against short circuits to ground or either supply voltage. The inputs are fully protected against overvoltage transients.

The Overload Warning Circuit

The operation of the overload warning circuit is very simple. The output of every computing amplifier is sampled and compared with a positive and a negative reference voltage. If the amplifier output goes higher than the positive reference voltage, an l.e.d. is switched on, to indicate that the amplifier is saturating in the positive sense. Similarly, if the amplifier output falls below the negative reference voltage another l.e.d. is switched on to indicate saturation in the negative sense. The prototype uses $\pm 11V$ as the reference voltages. An overload warning circuit is shown in Fig. 2.4. Only one pair of comparators and l.e.d.s are shown but ten pairs are necessary to serve the ten computing amplifiers. This circuit is arranged on a separate p.c.b. shown in Fig. 2.6 with the component overlay shown in Fig. 2.8.

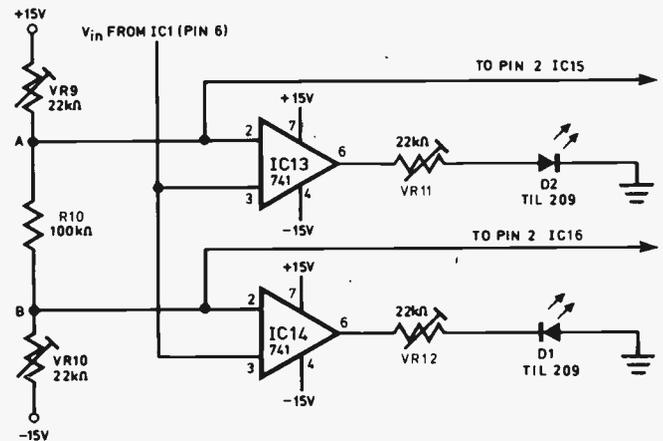


Fig. 2.4. Circuit diagram of the Overload Warning system required for each computing element

Resistor R9 and potentiometers VR11 and VR12 are connected across the positive and negative supply rails to form a potential divider that generates the positive and negative reference voltages of $+11V$ and $-11V$. These voltages are applied to the inverting inputs of the twenty comparators as shown. The output of each computing amplifier is applied to the non-inverting inputs of the corresponding pair of comparators. The comparators drive the warning l.e.d.s, the brightness of which is set by preset potentiometers. The 741 op-amp was also used here as a comparator. Experience with the prototype has shown that the 741 is capable of driving the l.e.d.s with reasonable brightness without overheating.

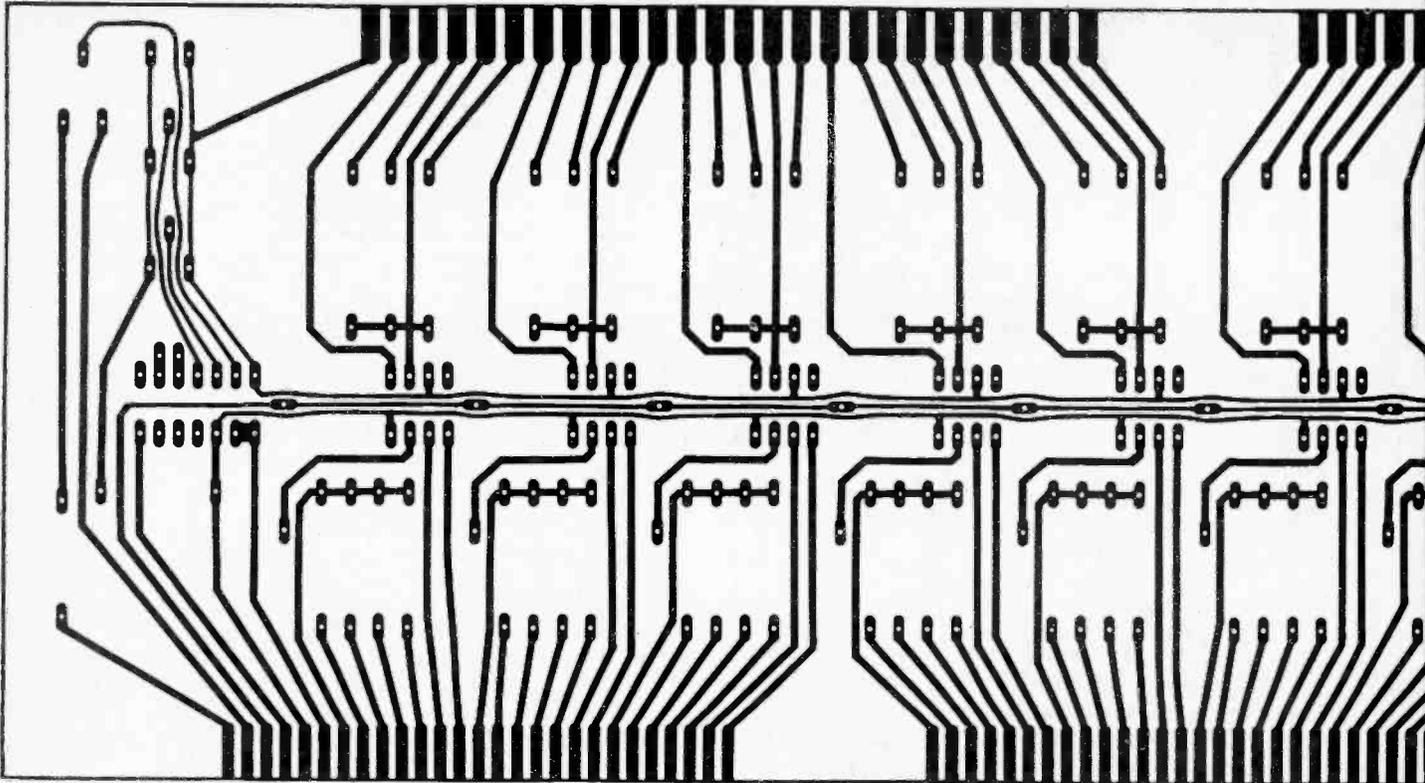


Fig. 2.5. Main p.c.b. containing the ten computing elements and the two Fo

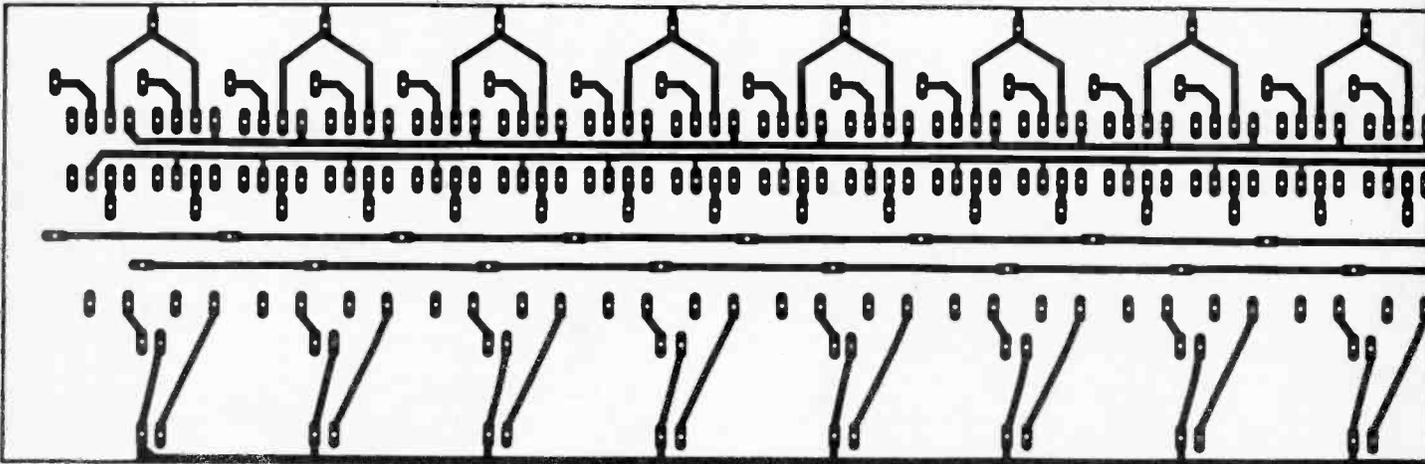


Fig. 2.6. The Overload Warning p.c.b.

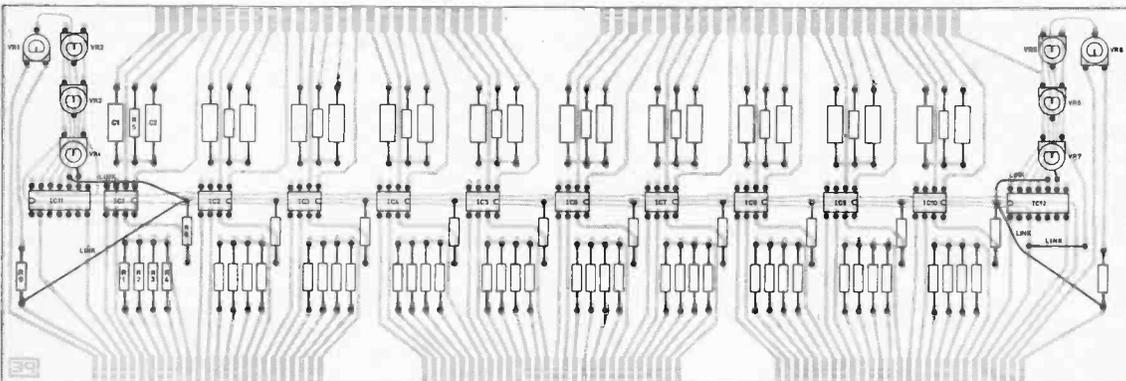
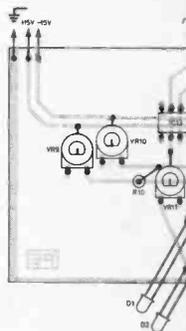
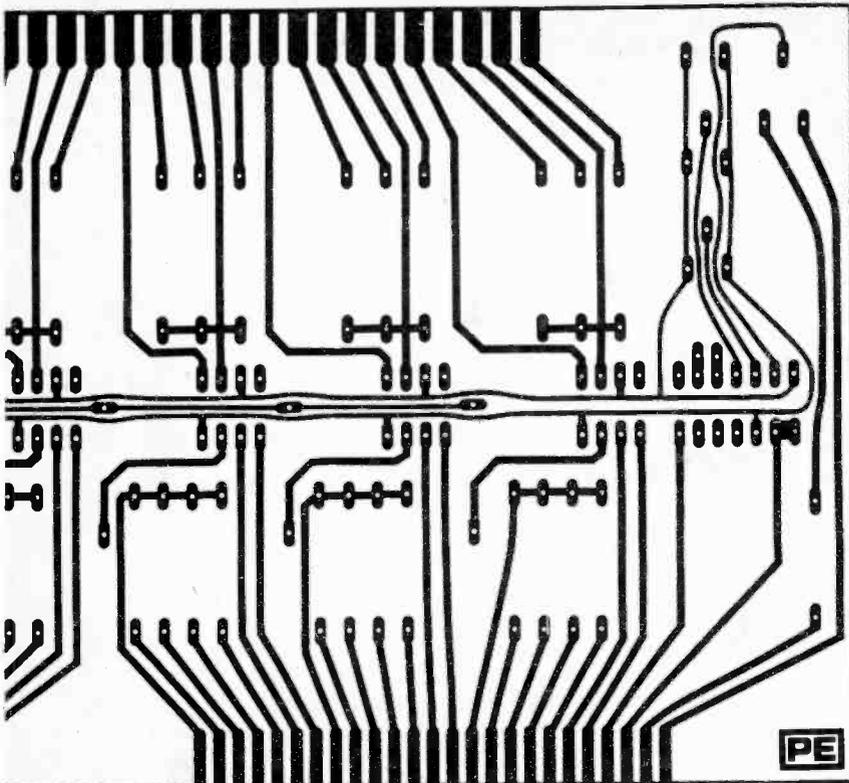


Fig. 2.7. Component layout for the main p.c.b.





quadrant Multipliers

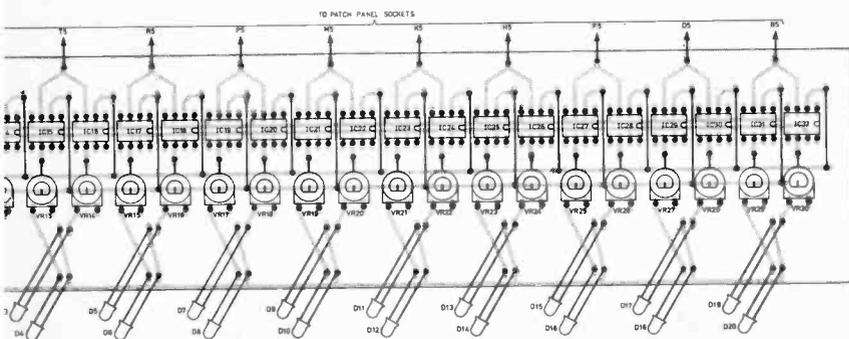
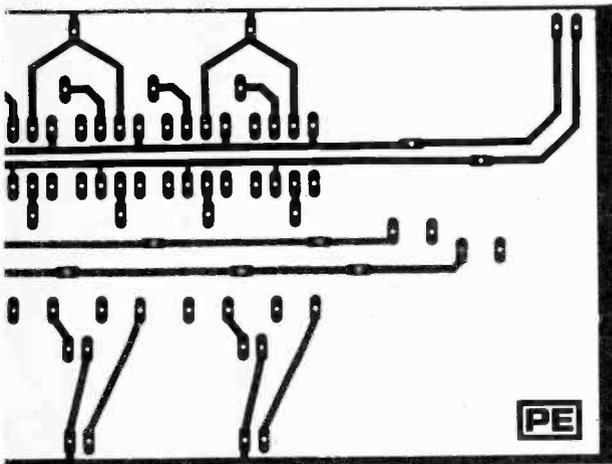


Fig. 2.8. Component layout for the Overload Warning Circuit

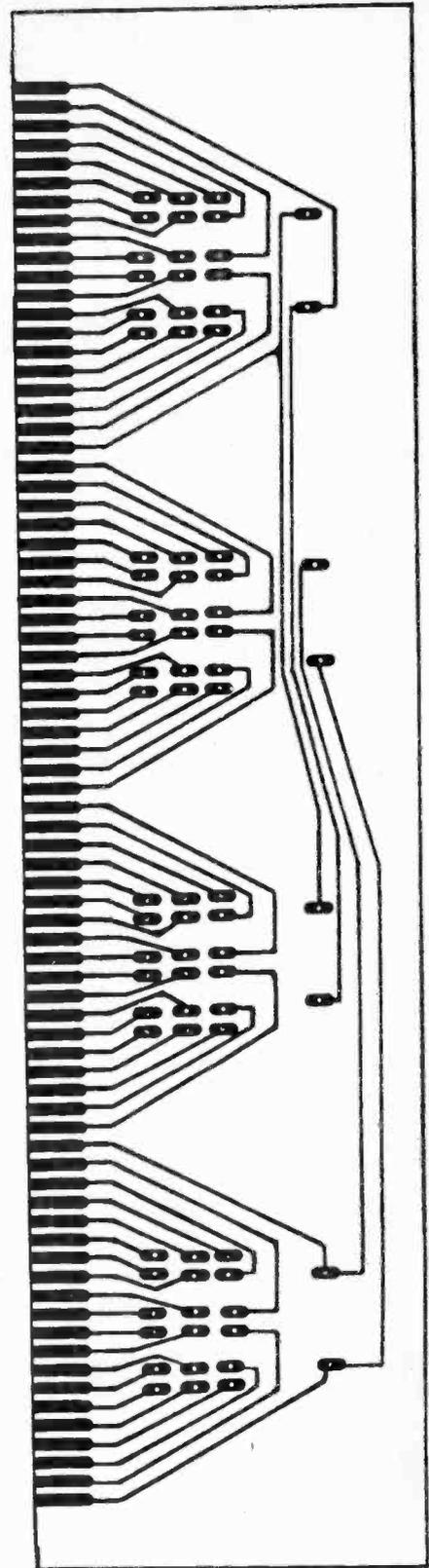
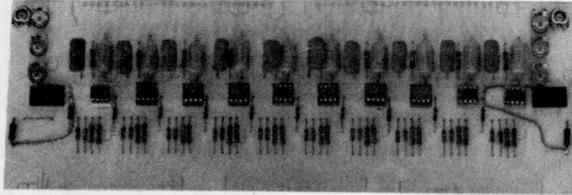
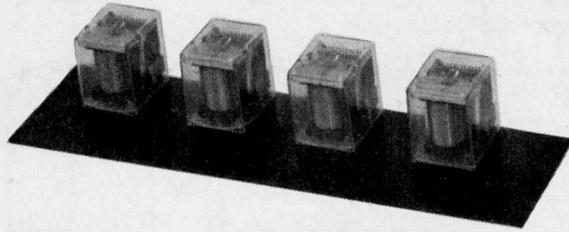


Fig. 2.9. P.c.b. design for the Relay Board



The Relay Mode Control P.C.B.

With ten amplifiers and two relay contacts per amplifier there is a need for twenty relay contacts. Complete mode control could be achieved with two ten-pole relays, one operating the RLA and C switches and the other the RLB and D switches. Ten-pole relays are difficult to find however and the prototype uses four six-pole relays operating in pairs. (The coil connections for the four relays are shown in Fig. 2.11.) This arrangement leaves four unused poles, which may become useful if it is decided to extend the computer.

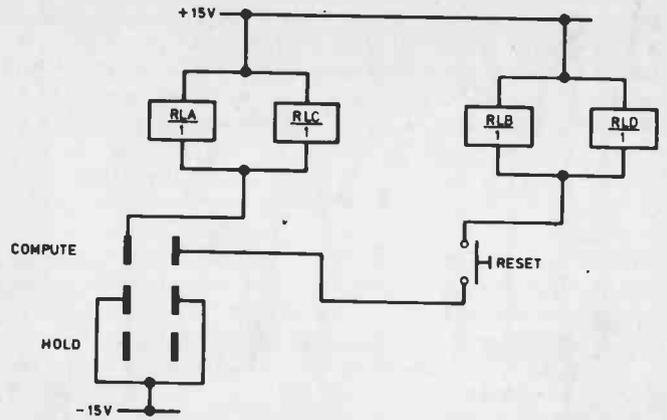


Fig. 2.11. Coil diagram for relays

The p.c.b. which accommodates the four relays is shown in Fig. 2.9. Connections to and from this board are also made via edge connectors.

Case Construction

The front panel requires a large surface area to accommodate the patch panel, potentiometers, switches, i.e.d.s etc. Because of this it will be difficult to obtain the right shaped case off the shelf. The prototype case was constructed from aluminium sheet. Two square panels form the front and the back of the case and the sides, top and bottom are cut and shaped as shown in Fig. 2.10, using the

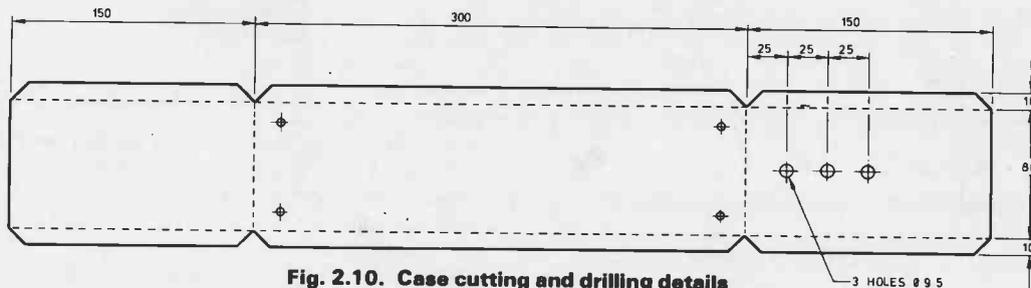
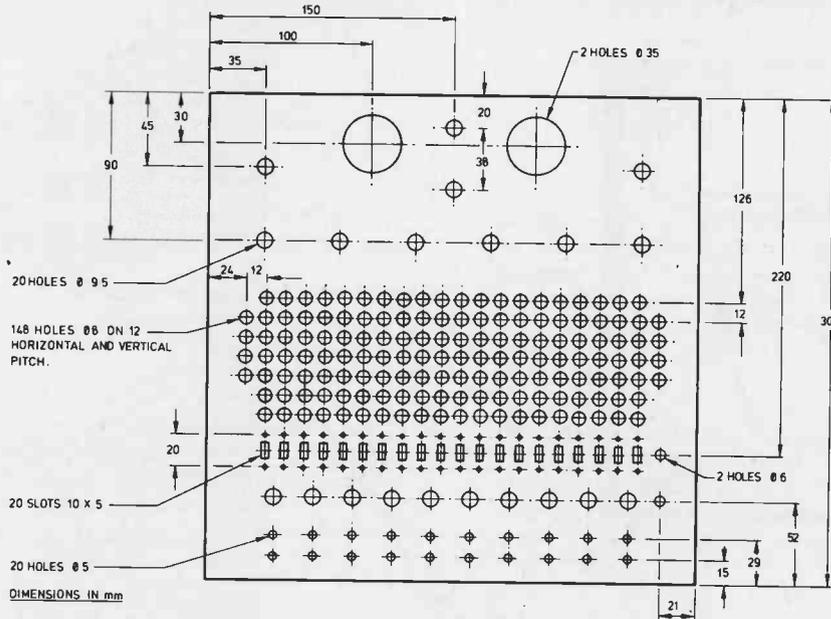
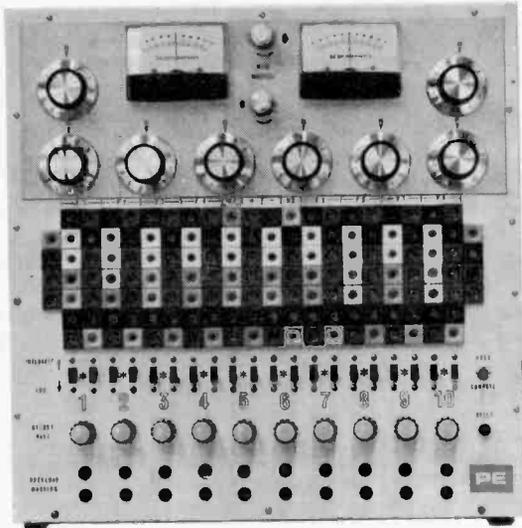


Fig. 2.10. Case cutting and drilling details

same gauge aluminium sheet. A bench vice, folding bar, and a sheet metal mallet are useful for this purpose. Fig. 2.10 shows the positions and dimensions of the holes required in the front panel. A lot of patience is required for the process of drilling, due to the large number of holes and the fact that a badly positioned hole will be detrimental to the appearance of the layout. This is particularly true in the case of the patch panel holes. A pitch of 12mm in both directions is enough to give a reasonable tolerance for positioning errors and at the same time avoid excessive gaps between the sockets. For the larger holes the use of sheet metal punches is recommended. Having drilled or punched all the holes, the front panel should then be labelled using dry letter transfers and sprayed with a clear lacquer fixative. The suggested labelling is shown in the photograph of the front panel.



The Patch Panel

The patch panel is constructed using 3.2mm sockets arranged in a matrix and packed together as closely as possible. There are 148 of these sockets and because identifying each one is difficult a colour coding system was used. Fig. 2.12 shows the arrangement of the sockets for one amplifier, one coefficient multiplier and one four-quadrant multiplier.

The pattern for the amplifier and coefficient multiplier shown in Fig. 2.12 is repeated ten times for the ten computing elements. The eight coefficient multipliers use 16 sockets on the top row. Two of the remaining four sockets are connected to the two panel meters and the other two are connected to batteries to provide reference voltages. Both positive and negative reference voltages will be needed for the solution of certain problems.

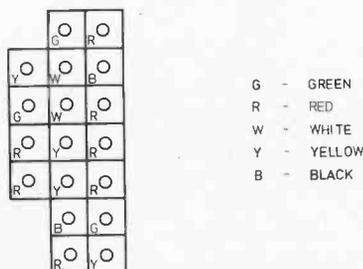


Fig. 2.12. Patch panel layout for one computing element (rows B and C) and one Four Quadrant Multiplier (row A)

For the four-quadrant multipliers four sockets are needed per multiplier and these are positioned on the extreme left and right of the patch panel.

COMPONENTS . . .

Resistors

R1, R2, R5	1M Ω $\frac{1}{2}$ W 2% metal oxide (30 off)
R3, R4	100k Ω $\frac{1}{2}$ W 2% metal oxide (20 off)
R8	270k Ω $\frac{1}{2}$ W 5% carbon (10 off)
R9	100k Ω $\frac{1}{2}$ W 5% carbon
R10	7.5k Ω $\frac{1}{2}$ W 5% carbon (2 off)

Potentiometers

VR1, VR8	4.7k Ω (2 off)
VR2-VR7	22k Ω (6 off)
VR9-VR30	22k Ω (22 off)
VR31-VR40	10k Ω 0.5W Lin (10 off)

All horizontal min. presets except where stated

Capacitors

C1	1 μ F 160V (10 off)
C2	0.1 μ F 160V (10 off)

Semiconductors

IC1-IC30	741 op amp (30 off)
IC31-IC32	AD533JD (2 off)
D1-D20	TIL 209 (20 off)

Miscellaneous

- 4 off 6 way changeover relays
- 4 off mounting sockets for relays holders for i.c.s (if req.)

CONSTRUCTOR'S NOTE: The AD533JD Four Quadrant Multiplier is available from **Analog Devices Ltd., Central Avenue, East Molesey, Surrey.**

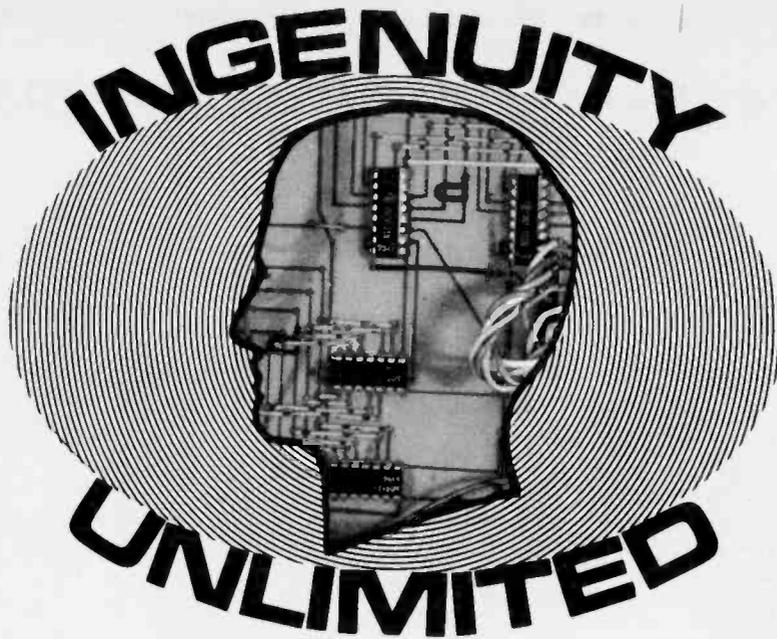
Stage by Stage Construction

The computer has been designed so that it can be built in stages. At this point in the construction, ie, with the aluminium case and the p.c.b.s constructed and drilled, the constructor has to take a decision, as to whether he wants to opt for a stage construction. His choice can be very flexible. For example, one may decide that initially, all ten computing amplifiers are not absolutely necessary for the solution of simple problems with which the inexperienced programmer will be involved. Four amplifiers are enough to carry out fairly interesting experiments. Later, when more experience is gained, more computing amplifiers can be added as necessary. The same applies to the coefficient multipliers and the panel meters.

It should be mentioned that if four 6-pole relays are used for the mode control, as is the case with the prototype, at least two of these will be necessary even if only one or two amplifiers are used initially. Two 6-pole relays can provide mode control for six amplifiers.

Another area in which stage by stage construction can be applied, concerns the overload warning circuit. Here, the comparators and the l.e.d.s can be added following the addition of more amplifiers. Alternatively it may be decided to leave the warning circuit out altogether initially. This will make life difficult for the programmer, but it will not affect the operation of the computer.

NEXT MONTH: WIRING AND TESTING



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.

CAPACITOR CONTINUITY TESTER

THE capacitor continuity tester is built around a 4011 i.c. using the basic oscillator circuit shown in Fig. 1. The frequency is approximately, $f = \frac{1}{1.7RC}$ Hz and this relationship was used to determine the values of R for a given value of C and a nominal frequency of 1kHz.

The working values of R and the corresponding ranges of C are given in the table and the actual tester circuit in Fig. 2.

Rather than leave the two unused gates idle, another oscillator was constructed and this formed the continuity tester, Fig. 3. The two testers were combined as shown in Fig. 4. The output was fed to the BC108/loudspeaker driver and the combined tester was powered by a PP3 battery.

This tester proved to be a very useful item especially when dealing with ex-computer type components etc.

A. W. Cunningham,
Strathblane,
Stirlingshire.

Capacitor Range	Resistor
0-1,000pF	R1 3.3M Ω
1,000pF-0.01 μ F	R2 430k Ω
0.01 μ F-0.1 μ F	R3 47k Ω
0.1 μ F-1 μ F	R4 4.7k Ω
1 μ F-10 μ F	R5 3.3k Ω
10 μ F	R6 —

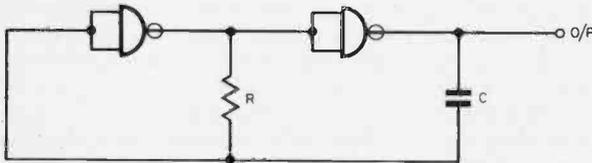


Fig. 1

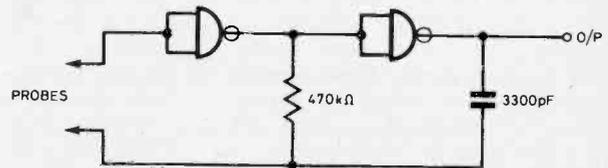


Fig. 3

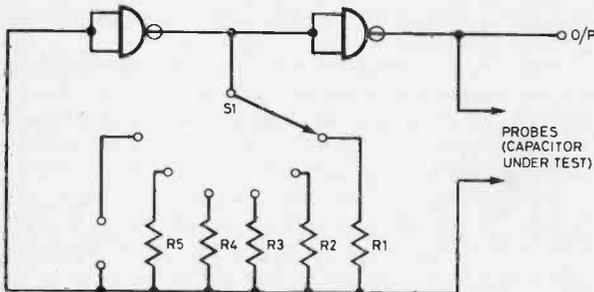


Fig. 2

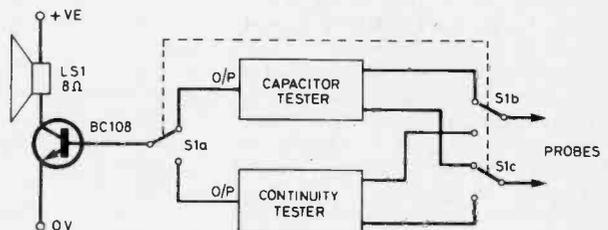
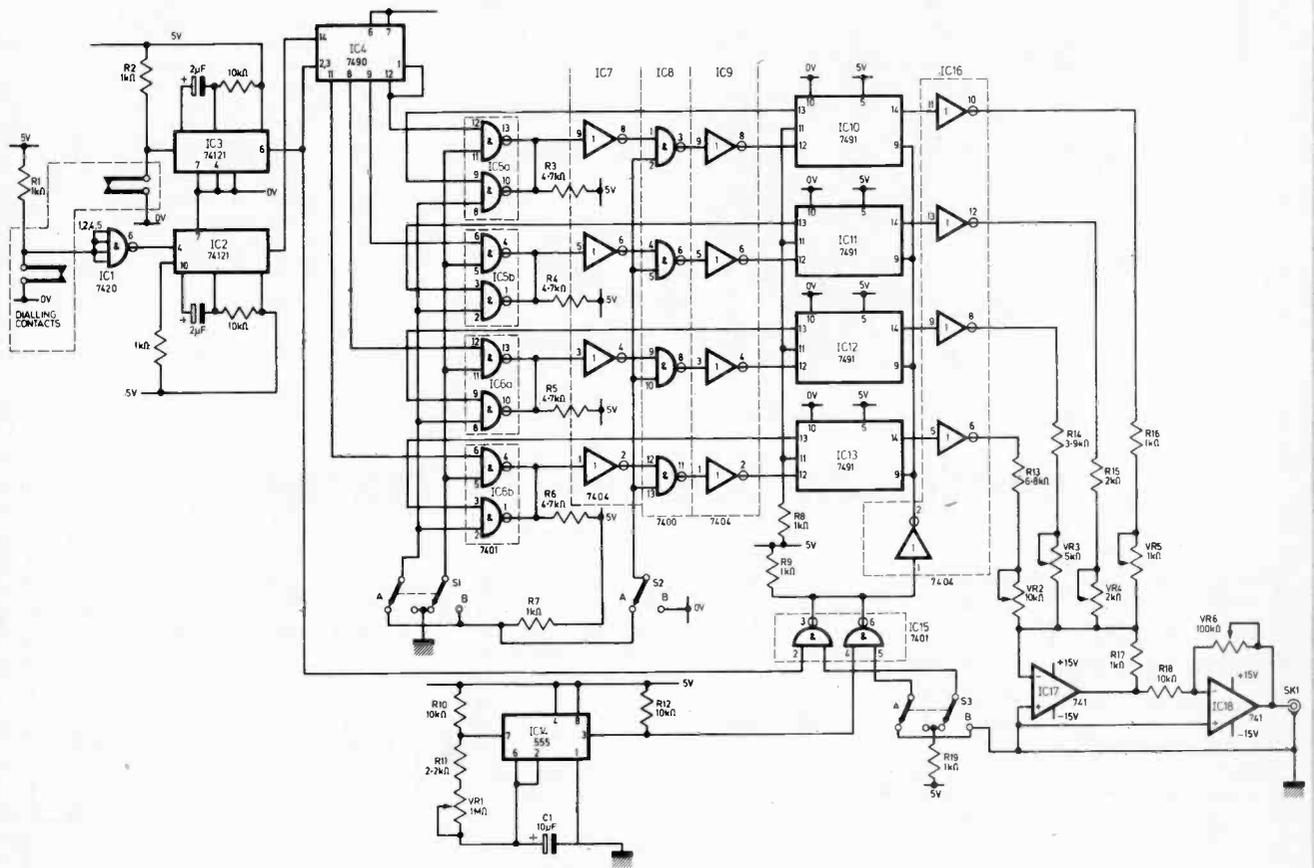


Fig. 4

SYNTHESIZER REPETITIVE WAVEFORM GENERATOR



THE circuit shown loads digital information into an 8-bit shift register when S1 is in position "B". In this version the information is supplied from a telephone dial. The dialling contacts generate a number of pulses which are used to clock a 7490 decade counter.

IC2 and 3 provide contact bounce suppression. The length of the output pulse may have to be varied slightly by adjusting the relevant timing components.

When the dial is released the second set of contacts open and this is used to reset the counter and advance the shift registers. During the loading of information S3 should be in position A. When the 8 bits of information are loaded, S1 is set to position A and S3 to position B. The shift registers are then advanced by the 555 astable at a rate dependent on VR1. The

output from the shift registers is then loaded into a digital-to-analogue converter, consisting of IC17 and 18 and associated components. The values assigned to each data bit can be varied by VR2-5. This enables the output to be "scaled" so that each word of digital information can be given the required value. The overall output level is controlled by VR6.

S2 is used to reset the shift registers to zero.

The circuit as shown lends itself readily to modification. The telephone dial circuitry could be replaced by any device producing digital information, as long as a means is provided for advancing the shift registers.

The 7490 counter could be replaced by a 7492 or -93, giving a greater range of output values. The D-A converter could be

replaced by a 4-10 line or 4-16 line decoder, and with due regard to loading of the outputs could provide totally independent control over the value of each data word.

There are many more variations which could be added to this list. The final version chosen would depend on the application and on the equipment available.

The device could be expanded to handle multiples of 8 words by adding further shift registers in series with those already in circuit.

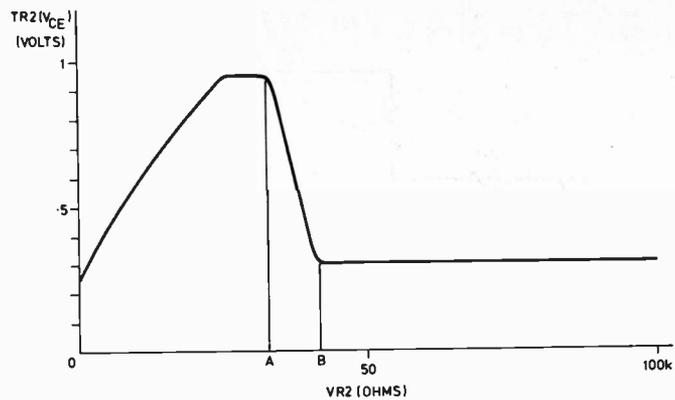
B. Hatton,
Southampton,
Hants.

REFERRING to the circuit diagram, TR1 is a simple variable-gain preamplifier. The amount of gain is controlled by VR1, and this in turn influences the sustain time produced.

TR2 and its associated components form the clipping stage which produces the fuzz effect. The coupling capacitors are kept small to prevent lower notes from the guitar overpowering the unit when chords are played. R3 and VR2 form a potential divider which provides bias for TR2. For the clipping stage to operate correctly, it is necessary for the bias to be set quite precisely (as described later).

The reason for this can be best understood by considering the graph. This shows the variation in the voltage at the collector of TR2 as VR2 is varied from zero resistance to 100k Ω . The limiting occurs if the resistance is set between the points A and B. If an a.c. voltage is then applied via C4, then positive half-cycles will cause the collector voltage to limit at about 0.3V, and negative half cycles will cause limiting at 0.8V. Between these two points, the gain is approximately linear and so the decay characteristic of the guitar note is preserved (after a period of sustain).

The simplest method of setting VR2 is to connect the unit to a guitar and am-



plifier and adjust VR2 until the note is audible. (The required position is approximately half-way). VR2 can then be finely adjusted so that the note decays without moving off or becoming distorted. Once set, the unit will only require adjusting occasionally, to compensate for falling battery voltage. Even so, it is advisable to have VR2 accessible from the outside of the cabinet.

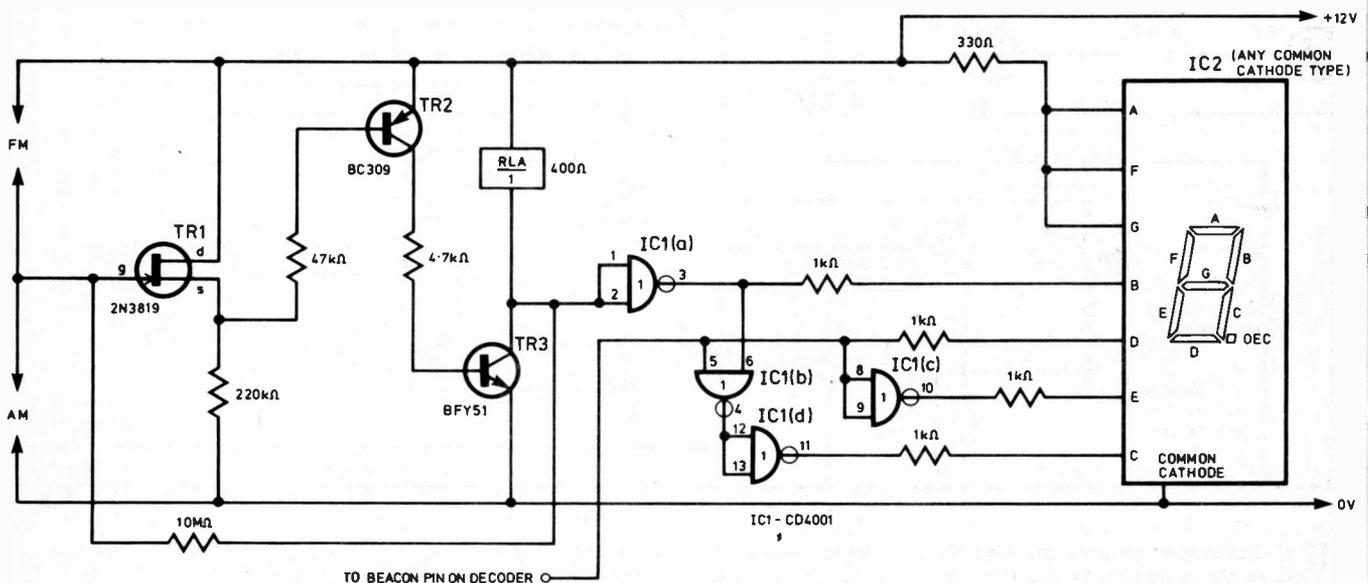
The values of C* and R* depend on the tone required. In the prototype 0.002 μ F

and 2.2k Ω were used to give a sharp, biting tone. A silicon diode can be substituted for the OA81 but with a consequent loss of sustain time.

The unit is very simple, has a very low movement consumption (0.5mA) and gives extremely good results, particularly when used with the Phasing Unit (PE 'Sound Design') or Treble Booster (PE April 1976).

D. McCabe,
Manchester.

STEREO INDICATOR



THE following is a description of an AM/FM Stereo Indicator for use with a stereo radio tuner. It is based on a seven segment l.e.d. display.

The segments are so connected that an "A" lights up for AM, an "F" for FM, and an "S" for FM stereo.

A touch switch, identical to that which appeared in the April 1975 issue of "Everyday Electronics", actuates a relay.

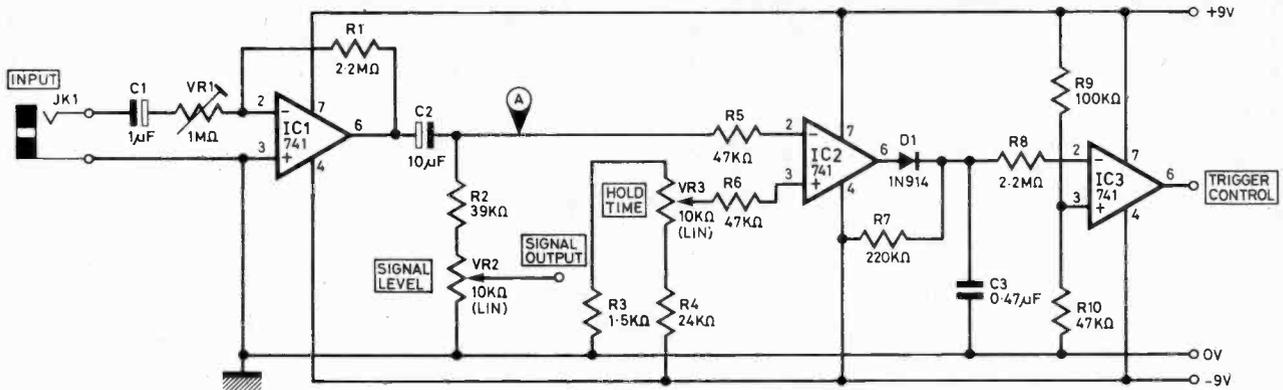
This is connected in place of the AM/FM switch in the tuner. The voltage at the collector of TR3 is taken to a NOR gate connected as an inverter. A further signal is taken from the stereo decoder which is removed. IC1 encodes these two signals into a form suitable to give the required display.

It will be noticed that segments A, F

and G are permanently connected to the positive supply line. This should be at no more than 15V, or else the i.c. will be damaged. The supply should be capable of supplying both the relay current and 60mA for the l.e.d. display. The remaining circuitry consumes little current.

D. P. Akerman,
Dagenham,
Essex.

EXTERNAL INPUT UNIT FOR SYNTHESISERS



THE unit shown will allow external inputs such as guitars, microphones etc. to be processed by the circuits within the synthesiser.

IC1 is an amplifier and VR1 should be adjusted to give 2V r.m.s. at A with the output of the input source at maximum amplitude. This will give about 400mV r.m.s. at the "signal output" which is adequate enough for most synthesisers.

IC1 also feeds a comparator IC2 whose reference level is variable and thus the length of time between the first and last positive pulses that will appear at the output is variable due to the nature of sound envelopes.

IC2 feeds another comparator IC3. The components D1, R7 and C3 make sure IC3 receives constant positive input level when a signal is inputted into the circuit. The time constant of R7 and C3 is about 100ms which is more than adequate to cope with the negative half of each cycle of

the input frequency but is not too large as to impair performance if two notes are played very quickly one after another.

Thus with no input signal the output of IC3 will be sitting at positive saturation but when an input signal is applied the output of IC3 will go to negative saturation for a length of time determined by the duration of the input signal and the setting of VR3 and will then go back into positive saturation.

If a synthesiser system is being used where a positive going trigger voltage is required for the envelope shapers the following changes should be made: R4 and R7 to +9V instead of -9V. R9 to -9V instead of +9V and D1 should be reversed. If the trigger output is to go from 0V to -8V or from 0V to +8V then diodes can be put on the output as required.

With a normal electric guitar envelope VR3 can adjust the trigger pulse length from about 10ms to about 3s.

Many interesting effects can be obtained using an electric guitar with the unit from envelope reshaping to triggered "Wah" and triggered "Phase" if the synthesiser has a voltage controlled phaser. Also white noise can be triggered and mixed to create strange rushing sounds with each note played.

The unit should work well with both the *P.E. Sound Synthesiser* and the *Minisonic I and II*.

P. G. Ludgate,
Wycombe Marsh,
Bucks.



BOOK REVIEWS

THE FIRST BOOK OF KIM-1

Edited by J. Butterfield, S. Ockers and E. Rehnke
Published in Europe by Human Electron GmbH
Available from Memec Ltd., The Firs, Whitchurch,
Nr. Aylesbury, Bucks.
210 x 145mm. Price £7.50

THIS is a book "Dedicated to the person who has just purchased a KIM-1 microprocessor system and doesn't know what to do with it" and as such, it undoubtedly fills a very large void! The KIM-1 system itself is a microprocessor board based on the 6502 chip. It features a hexadecimal keyboard, a cassette interface, a full IK of program RAM and a high standard of documentation. (A full review of KIM-1 was published in the Feb '78 issue.)

This new book makes the KIM-1 an even more attractive proposition because it takes the beginner by the hand with a chapter entitled "A beginner's guide to KIM programming" and then goes on to

discuss and document no fewer than twenty-nine different programs for "Games and diversions" and another thirteen "Utility" programs designed to expand KIM capabilities and aid system testing. After the programming section come further chapters on "Expanding your KIM", "Connecting to the world" and "Pot Pourri" which is a collection of useful information and tips.

The book is well written in an easy going style which does not assume that all readers already sport a degree or two in computer science and electronics, as do so many other microprocessor books! Despite its low-key approach and its accent on games and diversions though, this book is a mine of valuable knowledge which should prove both instructive and useful to all present or prospective KIM owners whether software or hardware orientated.

I feel that I can even recommend this book to readers who do not actually intend the purchase of a KIM system, but who thirst after this kind of knowledge for its own sake. All the programs in the book include a brief description and a full hexadecimal/mnemonic listing so that they can be easily understood and/or entered into a KIM system when required. Examples of the games programs listed are: Asteroid, Bandit, Black Jack, Clock, Farmer Brown, Lunar Lander, and Music Box. Utilities include: Directory, Hypertape, Relocate, Sort, and Verify Tape. Readers with a different microprocessor system should find these programs a source of inspiration and may even find it possible to convert some of them to run on a different system, with a little effort.

My last word comes from the *Pot Pourri* section of the book. Remember: Computers are dumber than humans but smarter than programmers!

R.C.

EASY BUILD SPEAKER DIY KITS

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 tweeters and a pair of matching crossovers.

Supplied complete with an easy-to-follow circuit diagram, and crossover components. Input 15 watts rms, 30 watts peak, each unit. + p & p £5.50 Cabinet size 20" x 11" x 9 1/2" (approx.)

SPEAKERS AVAILABLE WITHOUT CABINETS.

It's the units which we supply with the enclosures illustrated. Size 13" x 8" (approx.) woofer (EMI 2 1/2" spp. £17.00 per tweeter, and matching crossover components. stereo pair Power handling 15 watts rms, 30 watts peak + p & p £3.40

BUILT AND READY TO PLAY

SPEAKERS Two models - Duo IIb, teak veneer, 12 watts rms, 24 watts peak, 18 1/2" x 13 1/2" x 7 1/2" (approx.). Duo III, 20 watts rms, 40 watts peak, 27" x 13" x 11 1/2" approx. Duo IIb £17 PER PAIR p & p £6.50 Duo III £52 PER PAIR p & p £7.50

EASY TO BUILD



WITH SPEAKERS NOT TO SCALE

RECORD PLAYER KIT

for the D-I-Y man who requires a stereo unit at a budget price, comprising ready assembled stereo amp, module Garrard auto/manual deck with cueing device, pre-cut and finished cabinet work. Output 4 watts per channel, phono socket and record/replay socket including 2 SPHERICAL HIFI speakers £19.95 p & p £4.05

AM/FM STEREO TUNER AMPLIFIER CHASSIS COMPLETE

Ready built. Designed in a slim form for compact, modern installation. Rotary Controls Vol On/Off, Bass, Treble, Balance. Push Buttons for Gram, Tape VHF, MW, LW and 5 button rotary selection switch.

Power Supply Selenium Bridge—35V DC from 210-250V AC, 50Hz input.

Aerial Ferrite 8" x 1/2" built into chassis for LW and MW plus flying lead for FM aerial.

Power Output 5 watts per channel. Sine at 2% THD into 15 Ohm, 7 watts speech and music.

Tape Amplifier Playback 400mV/30K OHM for max. output. Record 200mV/50K output available from 25KHz (150mV/100K) deviation FM signal. Frequency Range (Audio) 50Hz to 17 KHz within ± 1dB.

Radio FM sensitivity for 3dB below limiting better than 10 uV. AM sensitivity for 20 dB S/N MW 350 uV/Metre LW 1mV/Metre. Size approx. length 16" x height 2 1/4" x depth 4 1/4" £19.95 p & p £2.50

VALUE FOR PERSONAL SHOPPERS

166 16 VOLT MAINS TRANSFORMER, 2 1/2 amp. £2.50

BSR Record auto deck on plinth with stereo cartridge ready wired. £11.95

LED 5 function men's digital watch stainless steel finish. £5.95

LCD 5 function men's digital watch stainless steel finish. £7.95

LCD 8 function CHRONOGRAPH men's digital watch stainless steel finish. £12.95

STEREO CASSETTE record/replay fully built P.C. board. Used, without guarantee. (Ex Equipment) £1.95

125 Watt Power Amp Module. £13.95

Mains power supply parts. £3.50

100K Multiturn Varicap tuning pots, 6 for MUSIC CENTRE CABINET with hinged smoke acrylic top, finished in natural teak veneers, size 30 1/4" x 14 1/2" x 7 1/4" approx. £5.95

MULLARD Built power supply. £1.50

OECCA DC 1000 Stereo Cassette P.C.B complete with switch oscillator coils and tape-heads. £2.95

IMF TLS 80 Monitor loudspeaker cabinet size approx. 43 1/2" x 15 1/2" x 15 1/2" £24.95

DECCA 20w Stereo speaker kit comprising 2 8" approx. bass units + 2 3 1/2" approx. tweeter inc. crossovers. £20.00

2 BAND CLOCK-RADIO. Mains operated with sleep control. £10.95

VIDEO MASTER Super Score TV Game with pistol mains operation. £14.95

VIDEO MASTER Door Tunes (24 different titles) £12.95

Micro cassette tape recorder. £13.95

7" TAPE TRANSPORT Mechanism—a selection of models from. £8.95

Opportunity!

AUDIO MODULES IN BARGAIN PACKS

CURRENT CATALOGUE

PRICE & AT OVER **25** PER PACK

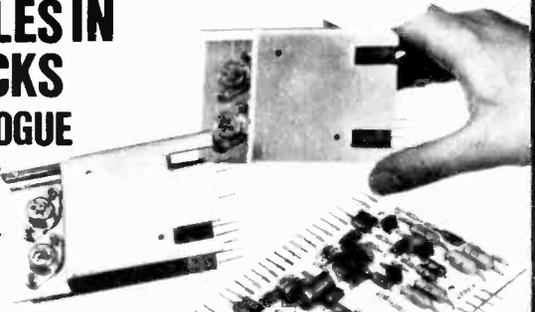
SEE OUR PRICES

1 PACK 1. 2 x LP1173 10w. RMS output power audio amp modules, + 1 LP1182/2 Stereo pre amp for ceramic and auxiliary input. OUR PRICE p+p £1.00 **£4.95**

2 PACK 2. 2 x LP1173 10w. RMS output power audio amp modules + 1 LP1184/2 Stereo pre amp for magnetic, ceramic and auxiliary inputs. OUR PRICE p+p £1.00 **£7.45**

3 PACK 3. 1 x LP1179/2 FM Tuning head with AM gang, 1 x LP1165/1 AM/FM IF module, 2 x LP1173/10w. RMS output power audio amp modules + 1 LP1182/2 Stereo pre amp for ceramic and auxiliary input. OUR PRICE p+p £1.00 **£9.95**

TRADE ENQUIRIES INVITED



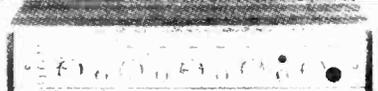
ACCESSORIES

Suitable power supply parts including mains transformer, rectifier, smoothing and output capacitors. £1.00 p+p **£1.95**

Recommended set of rotary stereo controls comprising BASS, TREBLE, VOLUME and BALANCE. p+p 50p **95p**

THIS MONTH'S OFFER

added to our bargain packs. When you buy Pack 3 at £9.95, together with a mains transformer at £1.95 and a set of controls for 95p you receive FREE a Mullard LP1400 Decoder to match. Listed at £11.90 p & p £2.50 **£12.85**



20 x 20 WATT STEREO AMPLIFIER £29.90
Superb Viscount IV unit in teak-finished cabinet. Silver fascia with aluminium rotary controls and p & p pushbuttons, red mains indicator and stereo jack £2.50 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.

30 x 30 WATT AMPLIFIER KIT £29.00
For the experienced constructor complete in every detail. Similar facilities as Viscount IV amplifier. p & p £2.50 60 + 60 peak.

AVAILABLE NOW built and fully tested with output 30 + 30 watts rms, 60 + 60 peak.

SPECIAL OFFER: PACKAGE PRICE WITH 30 x 30 KIT Mk. II version, operates into 4 to 15 OHMS speakers. Designed by R & TVC for the experienced constructor. Complete in every detail, facilities as Viscount IV amplifier 60 + 60 peak. Supplied with 2 Goodmans Compact 12" bass woofer with cropped 14,000 Gauss Magnet, 30 watt, rms, handling + 3 1/2" approx. tweeters and crossovers. £49.00 £4.00

ADD-ON STEREO CASSETTE TAPE DECK KIT
Designed for the experienced D.I.Y. man. This kit comprises of a tape transport mechanism, ready built and tested record/replay electronics with twin V.U. meters and level control for mating with mechanism. Specifications: Sensitivity - Mic, 0.85 mV; 20K OHMS, Din, 40mV; 400K OHMS; Output - 300mV RMS per channel; 1KHz from 2K OHMS source; Cross Talk - 30dB; Tape Counter 3 Digit; Re-settable; Frequency Response - 40Hz - 8KHz ± 6db; Deck Motor - 9 Volt DC with electronic speed regulations. Key Functions - Record, Rewind, £19.95 p & p £2.50 Opt. extras: Mains transformer to suite £2.50 + £1 p & p.



100K Multiturn Varicap tuning pots, 6 for MUSIC CENTRE CABINET with hinged smoke acrylic top, finished in natural teak veneers, size 30 1/4" x 14 1/2" x 7 1/4" approx. £5.95

MULLARD Built power supply. £1.50

OECCA DC 1000 Stereo Cassette P.C.B complete with switch oscillator coils and tape-heads. £2.95

IMF TLS 80 Monitor loudspeaker cabinet size approx. 43 1/2" x 15 1/2" x 15 1/2" £24.95

DECCA 20w Stereo speaker kit comprising 2 8" approx. bass units + 2 3 1/2" approx. tweeter inc. crossovers. £20.00

2 BAND CLOCK-RADIO. Mains operated with sleep control. £10.95

VIDEO MASTER Super Score TV Game with pistol mains operation. £14.95

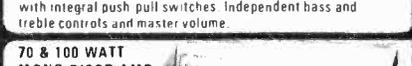
VIDEO MASTER Door Tunes (24 different titles) £12.95

Micro cassette tape recorder. £13.95

7" TAPE TRANSPORT Mechanism—a selection of models from. £8.95

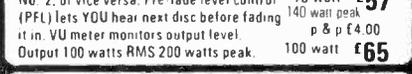


45 WATT MONO DISCO AMP £35.00 p & p £2.50 Size approx. 13 1/2" x 5 1/2" x 6 1/2" 45 watts rms, 90 watts peak output. Big features include two disc inputs, both for ceramic cartridges, tape input and microphone input. Level mixing controls fitted with integral push pull switches. Independent bass and treble controls and master volume.

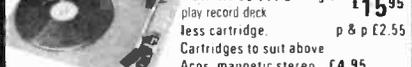


70 & 100 WATT MONO DISCO AMP £57.00 p & p £4.00 Size approx. 14" x 4" x 10 1/2" Brushed aluminium fascia and rotary controls. Five vertical slide controls - master volume, tape level, mic level, deck level, PLUS INTER DECK FADE for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre-fade level control. 70 watt (PFL) lets YOU hear next disc before fading. 100 watt peak it in. VU meter monitors output level. p & p £4.00 Output 100 watts RMS 200 watts peak. £65

CHASSIS RECORD PLAYER DECKS £7.95
Record changer with cue, stereo ceramic cartridge. p & p £2.00 BSR MP60 TYPE Single play record deck. £15.95 less cartridge. p & p £2.55 Cartridges to suit above. Acos, magnetic stereo £4.95 Ceramic stereo £1.95 BSR automatic record player deck cueing device and stereo ceramic head. p & p £2.55 £9.95 BSR MP 60 type, complete with magnetic cartridge. £29 diamond stylus, and de luxe plinth and cover. p & p £4.50 Home 8 Track cartridge player. This unit will match with the Viscount IV 9" x 8" x 3 1/2" p & p £2.50 **£16.50**



PORTABLE DISCO CONSOLE
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. Simple connects into your existing slave or external amplifier. p & p £8.50 **£64.00**



with built-in pre-amp

series record decks. Plus all the controls and features you need to give fabulous disco performances. Simple connects into your existing slave or external amplifier. p & p £8.50 £64.00

with built-in pre-amp

series record decks. Plus all the controls and features you need to give fabulous disco performances. Simple connects into your existing slave or external amplifier. p & p £8.50 £64.00

with built-in pre-amp

series record decks. Plus all the controls and features you need to give fabulous disco performances. Simple connects into your existing slave or external amplifier. p & p £8.50 £64.00

with built-in pre-amp

series record decks. Plus all the controls and features you need to give fabulous disco performances. Simple connects into your existing slave or external amplifier. p & p £8.50 £64.00

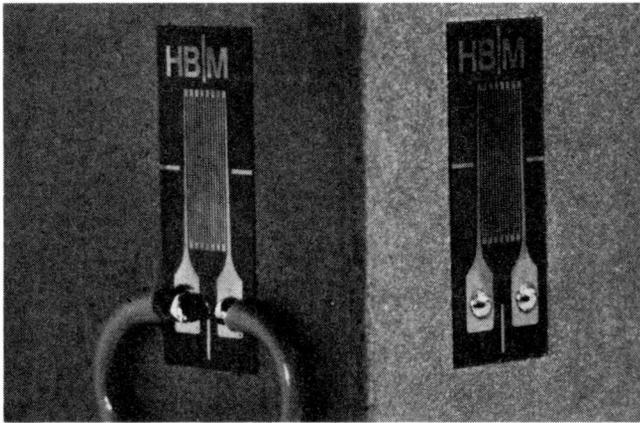
Personal Shoppers EDGWARE ROAD LONDON W2 Tel: 01-723 8432. 9.30am-5.30pm. Half day Thursday. ACTON: Mail Order only. No callers. GOODS NOT DESPATCHED OUTSIDE UK

News Briefs

by Mike Abbott

STRAIN GAUGE

It is certainly nice to know if a bridge is likely to collapse due to fatigue, or any other structure come to that! The most common method of analysing stress distribution and resultant strain is to employ strain gauges, and the photograph shows the latest from Hottinger Baldwin and Messtechnik (HBM for short), the LY41. The wires soldered to these gauges give an indication of their size, and this new range of low cost strain gauges have a unique integration of etched foil and tinned soldering terminals fully embedded in a 40µm thick polyimide carrier, specifically designed for ease of application in the field of static and dynamic stress analysis.



They combine good continuous vibration response, low hysteresis, excellent linearity and wide temperature range with a flexibility that allows the gauge to be bonded to a 0.3mm radius surface. Each of the types (LY41 with a temperature co-efficient that matches steel and LY43 that matches aluminium), are available in 9 different sizes in 120 ohm and 350 ohm nominal resistances.

BIG BROTHER CHECK

BEFORE it goes too far . . . Before what goes too far? Well, every organisation you deal with is, or will eventually have your details held by a computer. Banks, building societies, the taxman, your employer, vehicle licensing, police records, local authorities, hire purchase and finance companies, insurance companies . . . "all right, that's enough" I can hear you say. *It is enough* (or should be), but it will probably get worse. How? When these machines start conferring with each other. When judgements are made concerning your welfare, based on facts or past events, *perhaps even forgotten by yourself*, and through which doors are closed to you by nondescripts with your life history and status at their fingertips.

If this prospect frightens you (and it should do), you will be interested to learn of a new bimonthly journal from IPC Science and Technology Press, called "Information Privacy", and which sprung to life, guns at the ready, this September.

"Information Privacy" is an international journal which will cover the technical, legal and social issues of computer-based information systems and their use. Hardware, software and security considerations will be covered in detail as will the needs for and application of legal controls, codes of conduct and practice and social implications. The value and use of data information systems to individuals, organisations and the community will be important areas of discussion.

System analysts, designers, data processing managers and beneficial users now have to consider carefully the development and use of databases and databanks. Transnational dataflow poses worldwide problems of control.

Data has to be protected from unauthorised access and theft. Installations need to be protected from damage. Efficient measures are needed to ensure the smooth running of an organisation and to preserve competition. The type of information held may be subject to control. The effects of information systems on organisational structures and the consequent wider social implications will be significant.

Each issue of the journal will deal with a selection of the above topics and will contain five or six papers, industry news and international reviews of working groups, legislation and practice, conference reports, book reviews, calendar and literature reviews.

Topics covered will include: Techniques; Legislation; Information Systems; Working Group Activities; Case Studies; Computer Crime Casebook; Organisational Aspects; Current Interest Section.

Readership will be international and aimed at: Computer Engineers and Designers; Systems Analysts and Programmers; Data Processing Managers; Management services and top management; Legal Advisers; Beneficial users; All professionals who deal with computer based information systems.

Further details can be obtained from G. W. Jones, IPC Science and Technology Press Ltd., IPC House, 32 High Street, Guildford, Surrey GU1 3EW.

MICRO POWER PACK

DESIGNED especially for Series/80 microprocessor-boards but applicable to other microprocessor systems, is a new multi-level power supply from the Computer Products Group of National Semiconductor, which combines precise line and load regulation with current limiting, over-voltage protection and power-failure detection.

The BLC 635 power supply provides +12V at 2.0A, +5V at 14.0A, -5V at 0.9A and -12V at 0.8A. Incorporated are circuits to limit current at 1.2 times rated values at all levels, and over-voltage circuits which trip at 1.16 to 1.32 times rated voltage.

Load regulation is 0.1 per cent for a 50 per cent load change and line regulation is 0.1 per cent for a 10 per cent variation. Ripple is 10mV peak-to-peak, from d.c. to 500kHz, on all outputs. Stability is 0.05 per cent for 8 hours with constant line, load and temperature. Remote sensing is provided for the +5V level and all outputs may be trimmed ±5 per cent from nominal values.

An a.c. power failure detection circuit supplies a TTL compatible high-level signal when line voltage drops 10 per cent below normal. The signal returns low when line voltage reaches 8 per cent of normal value. For orderly shut-downs, all d.c. levels remain within specification for 2ms after low line conditions and 7.5ms after complete power loss.

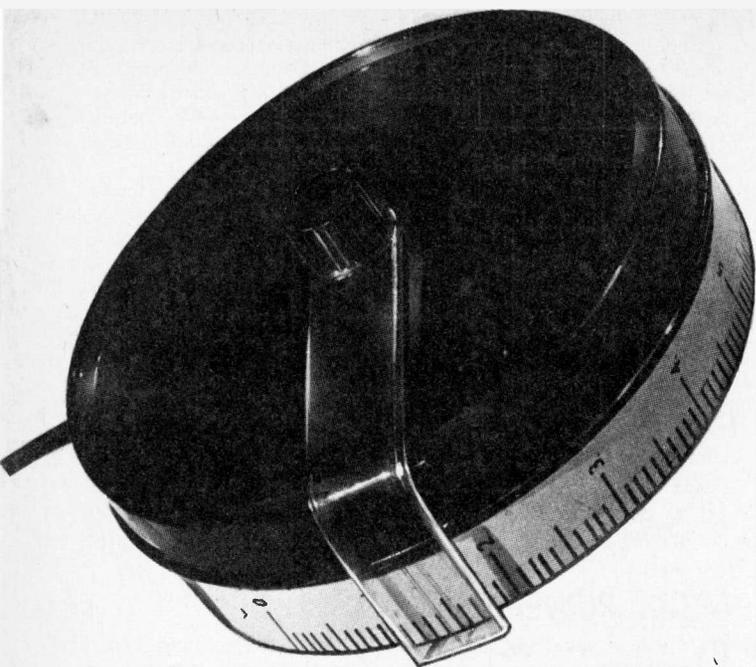
The line transformer is tapped for 100V, 115V, 200V and 230V a.c. The 100/115V and 200/300V lines are separately fused. Input frequency is 47Hz to 63Hz. The BLC635 measures 81 × 161 × 320mm and weighs 5.9kg (13lbs.).

COMPUTERS GALORE CLUB

THE NORTH London Hobby Computer Club will be opening on Wednesday, October 5. The Department of Electronic and Communications Engineering of the Polytechnic of North London will be making available much of their equipment for the club. They have two PETs, (third coming soon), four 6800 based computer systems, floppy disc, printers, VDUs, and some KIM and Motorola microcomputer systems. Can't be bad if you live in the area and are looking for some "hands on" experience, because the club is open to all, not just the students.

It is hoped that a few "home-brewed" activities get going before Christmas, and some meetings are expected to be centred around talks by manufacturers and discussions on programming. However, from the new year it is anticipated that three sets of activities will run concurrently (or sequentially depending upon membership numbers), and these are: short courses on programming in Basic, and at machine level, a home-brew section using the department facilities (up to 35 people can solder and test at the same time), and introductory talks and discussions for those intending to run their own systems.

The club is being organised by members of the Amateur Computer Club, as well as lecturers in digital electronics. If you are interested, hop on the Piccadilly Line to Holloway Road Station, and you'll find it all happening in Room 47 of the old polytechnic building opposite the tube station. The inaugural meeting starts at 6.30 p.m.



RANGE TIMER

J.D.JARDINE

THE unit to be described here is a two range timer which is capable of generating either 0–10 sec or 0–100 sec variable timing periods depending on the range selected.

The construction and calibration of the unit is straight forward with its output voltage capable of driving either an l.e.d. or small reed relay for the duration of the set time period.

The timer was originally constructed for photographic use where its good repeatability ensured consistent results when multiple print processing; but with it being portable and reasonably small, it has found many other general purpose applications.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Two Range Timer is shown in Fig. 1 with the range required being selected by S1.

If when S1 is in the position shown (0–100 second range) and S3 is pressed C1 is discharged and the timing period is initiated. After S3 has been released the output voltage of the comparator (IC1) is switched high and the relay energised.

IC2 which is connected as an integrator has its non-inverting input (pin 3) held positive by the potential divider

R2, VR3 and VR4 with respect to its inverting input (pin 2). This causes the output to IC2 to generate a positive going ramp waveform the slope of which is determined by C1, R1, VR3 and VR4. With IC2 acting as a constant current generator the slope of the ramp is linear.

This ramp voltage is applied to pin 2 of the voltage comparator (IC1) which compares it with a reference voltage set by VR1 and VR2. When the positive voltage on pin 2 reaches a level which is a few millivolts positive of pin 3 the output of IC2 is switched low and the relay de-energised.

TR1, R3 and D4 provide a stable 11.5V supply to the circuit and D1 eliminates the slight glow in the l.e.d. due to the saturation voltage of the i.c. when the unit has timed out.

CONSTRUCTION

In the prototype the components were soldered onto 0.1 in. Veroboard using the layout shown in Fig. 2. After soldering, the board and other components were fitted into 110mm dia. metal case which should be drilled or punched as shown in Fig. 3.

The layout of the components inside the case is shown in the photograph with the push button mounted on the lid.

The cursor which is made of Perspex can be bent by warming it over a hot soldering iron and gently bending it to

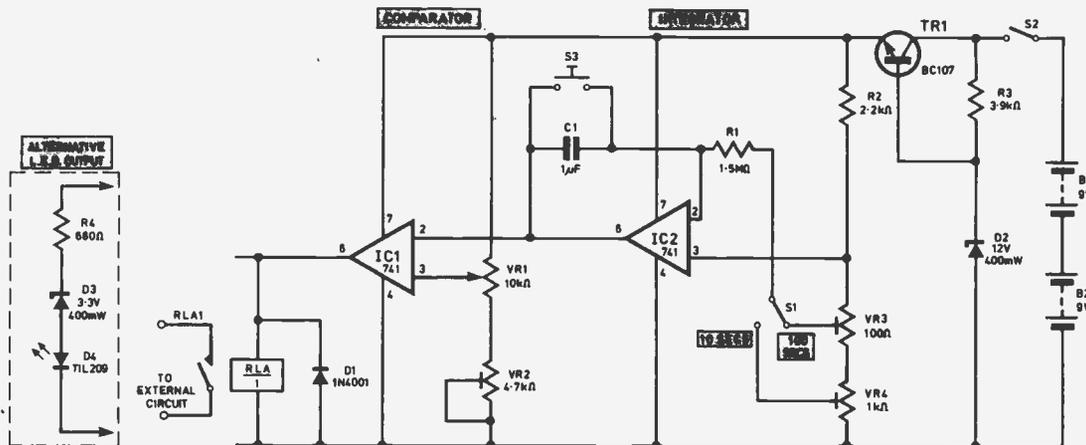


Fig. 1. Complete circuit diagram of the Two Range Timer

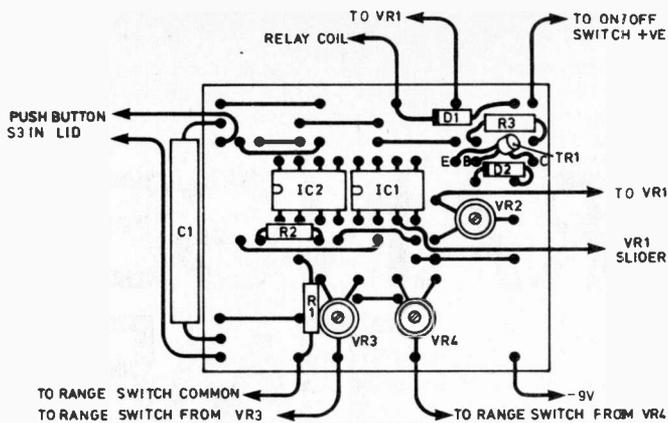


Fig. 2. Veroboard layout

shape. The index line should be scribed using a sharp knife and then the small knob should be fixed to the cursor using an epoxy adhesive.

The scale is thin white card, cut to the size shown and marked off with 100 two millimetre divisions and it is mounted on the case with its mid-way point opposite the centre

COMPONENTS . . .

Resistors

R1	1.5M Ω
R2	2.2k Ω
R3	3.9k Ω
*R4	680 Ω
All $\frac{1}{4}$ W 5% carbon	

Capacitors

C1	1 μ F polyester (C280 type)
----	---------------------------------

Potentiometers

VR1	10k Ω 0.25W linear
VR2	4.7k Ω
VR3	100 Ω
VR4	1k Ω

All horizontal sub-min presets except where stated

Semiconductors

D1	1N4001
D2	12V 400mW Zener
*D3	3.3V 400mW Zener
*D4	TIL 209 l.e.d.
TR1	BC107
IC1, IC2	741 op.amp. (2 off)

Switches

S1, S2	DPDT slide type (2 off)
S3	push to make (latching) switch

Miscellaneous

- *Reed relay R.S. type 348-986
- PP3 battery (2 off)
- 0.1" matrix Veroboard
- Clear Perspex
- Control knob
- Battery clips (2 off)
- 110mm dia. case
- *See Fig. 1.

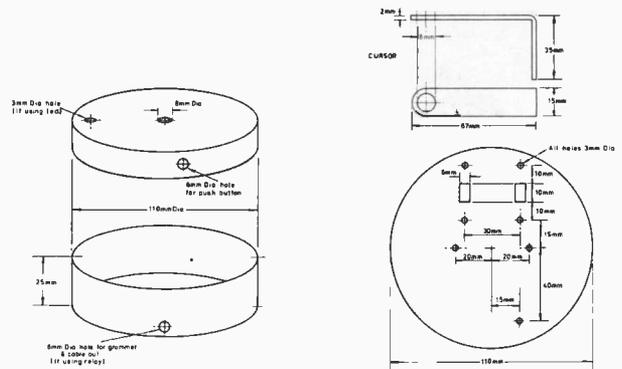


Fig. 3. Case drilling details

point of the potentiometers shaft rotation. Alternatively the scale can be left blank except for the 0 and 10 marks and calibrated as described in (b) (for more accurate time periods).

CALIBRATION

(a) Using a pre-marked scale.

- (1) Switch on and set the range switch to the 10 second range.
- (2) Set the cursor to 0 and push S3, and relay or l.e.d. should energise for a short while before dropping out; VR2 should then be adjusted so that when the button is pressed, the relay or l.e.d. is energised for as short a period as possible (less than 0.1 seconds).
- (3) Set the cursor to 10 and press the button; using a stop watch or clock, time the period before the relay or l.e.d. drops out.
- (4) Adjust VR4, press the button and re-time; adjust VR4 again if necessary. Repeat until a 10 second delay is obtained.
- (5) Switch to the 100 second range and repeat steps 3 and 4 using VR3.

(b) Using an unmarked scale.

Go through items 1, 2, 3, 4, 5 then select an intermediate time (on either range) and set the cursor somewhere near; push S3, time it through and thus adjust the cursor closer to the desired point. Repeat until the time period is exact and mark to scale, other times are obtained by the same method.



OTHER RANGES

The timing range generated by the unit is a function of the value of VR3, VR4, C1 and R1.

Therefore to double the ranges (0 to 20 seconds 0 to 200 seconds) C1 could simply be doubled in value; although due to the new components tolerance a small recalibration may be required. ★

News Briefs

UNDERGROUND CAMERAS

NEVER jump to the conclusion that because you are alone, you are not being watched. We are beginning to take for granted those rooftop cameras watching busy junctions and stretches of motorway. We have reported in this column, remote control cameras monitoring bus queues as part of public transport schemes. You see them at automatic railway crossings, department stores and public places.

Here is another news brief concerning those ever accumulating eyes. A closed-circuit-television transmission and switching system is to monitor the three stations on London Transport's new Piccadilly Line extension to Heathrow Airport. Designed by British Relay (Electronics) to a London Transport specification, the system provides video switching facilities at each of the three stations for local monitoring, and a transmission system to Earls Court (a distance of 13 miles), for remote monitoring of the station platforms by the line controller.

It has been provided as an operational aid to control passenger flows, particularly during emergencies or abnormal traffic conditions. It is intended to enable incidents to be detected and potential problems to be anticipated, thus allowing remedial action to be initiated quickly and station staff to be deployed more efficiently.

Cameras viewing strategic areas at each station can be selected by means of a new 12-input/8-output matrix designed and produced by British Relay. The matrix design also allows any one camera to be monitored by all outputs without deterioration of the composite video signal.



Local monitoring facilities are provided at Heathrow Central and platform-only monitoring of all three stations is provided for the line controller situated at Earls Court.

The transmission system comprises a wide-band 30-MHz 3-channel stacked carrier multiplex system over a single coaxial cable running the whole length of the line between Earls Court and Heathrow Central (a type of system particularly immune from electrical track interference). The carrier frequencies of the two existing channels employed are 4.43MHz and 13.30MHz but a third channel of 24.7MHz carrier frequency can be provided by the addition of an appropriate modulator at the required locations and a demodulator at Earls Court.

A feature of the system is that it can be easily extended by the addition of line repeater and directional coupler assemblies which would amplify and allow connection to other sites along the line without deterioration of the existing modulated composite video signal.

British Relay are also supplying London Transport with CCTV switching and transmission equipment for other important central area stations including the new ones being built under stage-1 of the Jubilee Line.

Perhaps it will eventually become a way of life to be visually "monitored" whilst out and about.

STEAM ADVICE

MOST people are by now aware that there are going to be some changes made in the ether on 23 November this year, when a new international frequency agreement comes into force. This provides for a considerable increase in the number, and power of transmitters used in Europe.

As a result of these new conditions, and to make best use of the frequencies available, the BBC is reorganising its arrangements for broadcasting Radios 1, 2, 3, and 4 on the medium- and long-wave bands.

Radio 1 will be transmitted on **1053** and **1089**kHz (285 and 275 metres) MF instead of 1214kHz (247 metres) MF. The low-power transmission on 1485kHz (202 metres) MF at Bournemouth will be retained.

Radio 2 will be transmitted on **693** and **909**kHz (433 and 330 metres) MF instead of 200kHz (1500 metres) LF and 1484kHz (202 metres) MF (Scotland).

Radio 3 will be transmitted on **1215**kHz (247 metres) MF instead of 647kHz (464 metres) MF.

Radio 4 will be transmitted on **200**kHz (1500 metres) LF instead of 692, 908 and 1052kHz (434, 330 and 285 metres) MF. There will be additional transmissions on 603kHz (498 metres) for Tyneside; 720kHz (417 metres) for Northern Ireland; 1449kHz (207 metres) for Aberdeen; and 1485kHz (202 metres) for Carlisle.

Services that are *unchanged* (except for a very small increase in frequency):

Radio Scotland (810kHz/371 metres)

Radio Wales (882kHz/341 metres)

Radio Ulster (1341kHz/224 metres)

Radio 1 Bournemouth (1485kHz/202 metres).

There are no changes to the BBC's VHF transmissions. Only the BBC's MF and LF radio services are affected by the changes.

Further details on the above changes and their effects can be obtained from: Radio Changes, BBC, Broadcasting House, London W1A 4WW.

A number of additional transmitters are being installed and listeners should not assume that their present reception of a particular frequency is necessarily any indication of the reception it will provide under the new plan. Maps are being prepared to show which frequencies are expected to provide the best service in each part of the country.

If you are considering purchasing a wireless and would like some free advice on three-band receivers, aerials, car radios, tuning scales etc, send a 9 by 6 in. S.A.E. to Engineering Information Department, BBC, Broadcasting House, London W1A 1AA.

The Beeb will send you a booklet with six pages of useful recommendations, the most important of which is to *get a three-band model*.

HERE'S TO PROGRESS

RAISE your glasses—but don't drink! Not if you're driving anyway, because technological progress might be waiting to nab you just down the road. A new portable instrument is out which makes instant analysis of breath alcohol giving accuracy to within 12mg/ml of actual blood alcohol level. There's no marching you down to the local "nick" for a blood test, and it wouldn't be much good pretending you were too weak to blow a bag up because your co-operation is not required, other than to continue breathing. Indeed, the device can be used on the unconscious.

The instrument, called the Alcolmeter type AE-M2, was invented by Dr T. P. Jones, and a small hand-held version designed for initial roadside screening purposes has been in production for nearly two years. The new Alcolmeter overcomes the limitations in precision of the pocket sized version while remaining small in size, completely portable and very simple to use. The instrument enables on-the-spot breath alcohol analysis to be carried out by passing an accurately metered volume of expired breath over a specially-sensitised fuel cell, housed in a hand-held unit linked to the equipment.

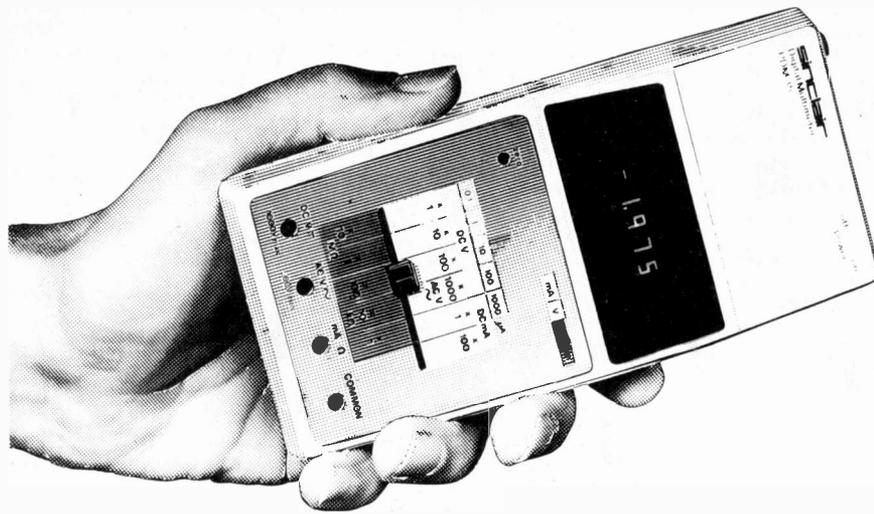
The cell is activated by alcohol vapour and generates an electrical signal proportional to the alcohol content of the sample. The electrical signal is amplified and displayed on a panel meter.

The Alcolmeter is currently in extensive use with the Spanish police authorities and has also been accepted for use in Nigeria, Switzerland and several American states. The instrument is also widely used in hospitals and alcohol clinics throughout the UK.

The Sinclair PDM35.

A personal digital multimeter for only £29.95

(+8% VAT)



Now everyone can afford to own a digital multimeter

A digital multimeter used to mean an expensive, bulky piece of equipment.

The Sinclair PDM35 changes that. It's got all the functions and features you want in a digital multimeter, yet they're neatly packaged in a rugged but light pocket-size case, ready to go anywhere.

The Sinclair PDM35 gives you all the benefits of an ordinary digital multimeter – quick clear readings, high accuracy and resolution, high input impedance. Yet at £29.95 (+8% VAT), it costs less than you'd expect to pay for an analogue meter!

The Sinclair PDM35 is tailor-made for anyone who needs to make rapid measurements. Development engineers, field service engineers, lab technicians, computer specialists, radio and electronic hobbyists will find it ideal.

With its rugged construction and battery operation, the PDM35 is perfectly suited for hand work in the field, while its angled display and optional AC power facility make it just as useful on the bench.

What you get with a PDM35

- 3½ digit resolution.
- Sharp, bright, easily read LED display, reading to ±1.999.
- Automatic polarity selection.
- Resolution of 1 mV and 0.1 nA (0.0001 µA).
- Direct reading of semiconductor forward voltages at 5 different currents.
- Resistance measured up to 20 MΩ.
- 1% of reading accuracy.

Operation from replaceable battery or AC adaptor.
Industry standard 10 MΩ input impedance.

Compare it with an analogue meter!

The PDM35's 1% of reading compares with 3% of full scale for a comparable analogue meter. That makes it around 5 times more accurate on average.

The PDM35 will resolve 1 mV against around 10 mV for a comparable analogue meter – and resolution on current is over 1000 times greater.

The PDM35's DC input impedance of 10 MΩ is 50 times higher than a 20 kΩ/volt analogue meter on the 10 V range.

The PDM35 gives precise digital readings. So there's no need to interpret ambiguous scales, no parallax errors. There's no need to reverse leads for negative readings. There's no delicate meter movement to damage. And you can resolve current as low as 0.1 nA and measure transistor and diode junctions over 5 decades of current.

Technical specification

DC Volts (4 ranges)

Range: 1 mV to 1000 V.
Accuracy of reading 1.0% ± 1 count.
Note: 10 MΩ input impedance.

AC Volts (40 Hz-5 kHz)

Range: 1 V to 500 V.
Accuracy of reading: 1.0% ± 2 counts.

DC Current (6 ranges)

Range: 1 nA to 200 mA.
Accuracy of reading: 1.0% ± 1 count.
Note: Max. resolution 0.1 nA.

Resistance (5 ranges)

Range: 1 Ω to 20 MΩ.
Accuracy of reading: 1.5% ± 1 count.
Also provides 5 junction-test ranges.

Dimensions: 6 in x 3 in x 1½ in.

Weight: 6½ oz.

Power supply: 9 V battery or Sinclair AC adaptor.

Sockets: Standard 4 mm for resilient plugs.

Options: AC adaptor for 240 V 50 Hz power. De-luxe padded carrying wallet. 30 kV probe.

The Sinclair credentials

Sinclair have pioneered a whole range of electronic world-firsts – from programmable pocket calculators to miniature TV's. The PDM35 embodies six years' experience in digital multimeter design, in which time Sinclair have become one of the world's largest producers.

Tried, tested, ready to go!

When you buy your PDM35 it comes complete with leads and test prods, carrying wallet and comprehensive operating instructions.

The PDM35 is a new concept in multimeters – but over 20,000 have already been sold! If you'd like to know more about the PDM35, and how to get one, complete the coupon and post it to us. We'll send you detailed information by return. Send the coupon today!

Sinclair Radionics Ltd, London Road, St Ives, Huntingdon, Cambs., PE17 4HJ, England.

To Sinclair Radionics Ltd, London Road, St Ives, Huntingdon, Cambs., PE17 4HJ.
Please send me more information on the Sinclair PDM35 personal digital multimeter.

Name

Occupation

Address

.....

.....

.....

PE 9



sinclair
World leaders in fingertip electronics

PROOPS BARGAIN PACKS

Useful selections of a wide range of components, materials, etc., in convenient packs. Just send £1 plus p&p.

£1 EA.
plus p+p

● **SAVE POSTAGE!** We pay UK postage & pkg. on orders for ANY 5 PACKS!

BARCLAYCARD AND ACCESS ACCEPTED - ORDER BY PHONE OR POST.

MAIL ORDERS TO PROOPS BROS. LIMITED, Dept. PE, The Hyde Industrial Estate, Edgware Road, Hendon, London, NW9 6JS. Tel. 01-205 8006.

PERSONAL SHOPPERS: 52 Tottenham Court Road, London, W1P 0BA. 9-6 Mon. to Sat.

SPADE & RING CONNECTORS

as used in cars and domestic appliances. Pack of approx. 100 connectors, balanced selection, insulated and plain, p&p 25p.



SPRINGS

generous and varied selection, compression and expansion springs, lengths from approx. 1/2 in. to 2 1/2 in. and diameters from 3/16 in. to 1 1/2 in. Pack of approx. 100, p&p 25p.

RUBBER GROMMETS

good selection, always useful for the motorist, radio enthusiast, etc. Varied assortment, 1/8 in., 3/16 in. and 1/4 in. Pack of approx. 200, p&p 20p.

SPACERS

Pack of approx. 100, good selection of useful sizes, various lengths and diam., p&p 25p.

CROC CLIPS

Pack of 16 1/2 in., p&p 15p.

VIDAFLEX SLEEVING

Pack of 4 x 25 yard lengths, 1.5mm bore, p&p 30p.

MAINS NEONS

in plastic holders, with leads and resistor. Pack of 5, p&p 15p.

MAINS NEONS

miniature type with leads and resistor. Pack of 20, p&p 15p.

Hair Trigger SWITCH MATS

6 or 12v. operation
Size: 29" x 16"
approx. **£1.95** Carr. & pkg. 40p
● Wafer thin - undetectable under door mat or carpet.

FRESNEL LENSES

2 for £1.70 carr. & pkg. 30p
Supplied as two separate lenses or mounted together as condenser assembly - state preference. Slightly imperfect but entirely suitable for IMAGE BRIGHTENERS, MAGNIFIERS, INTENSIFIERS, OVERHEAD AND BACK PROJECTION OPTICS, CREATIVE LIGHTING EFFECTS.

PLASTIC TERMINAL BLOCKS

5A, 2-way. Pack of 20, p&p 20p.

SLIDER POTS

47K Lin., 100K Lin.; 1 M Log.; 22 K Log. Pack of any 4, state choice, p&p 15p.

SELF TAPPING SCREWS

a generous 1lb mixture of about 500 screws in useful sizes and lengths from 1/4 in., various heads, p&p 50p.

STEEL WASHERS

about 500 in a useful 20oz. mixed pack that every tool box needs, p&p 50p.

SHAKEPROOF & STAR WASHERS

about 500 in a good, varied selection of sizes, weighing 6ozs., p&p 20p.

HOSECLIPS

pack of 25 in assorted sizes from 1/8 in., p&p 25p.

POP RIVETS

approx. 100 in balanced selection of 4 sizes, p&p 25p.

SOLENOIDS

1 1/2 volt. Small but relatively powerful solenoid with hundreds of uses for the modeller. Overall size approx. 25 x 26 x 10mm. Coil approx. 8mm diam. x 15mm long. Range of travel (0.5mm approx.) can be varied if desired. Pack of 4, p&p 20p.



MICROSWITCHES

useful pack of 8 switches, push to make/break or changeover, p&p 20p.

MODEL MOTORS

1 1/2v. 4 1/2v. powerful compact units suitable for wide variety of modelling applications. Pack of 6, p&p 25p.

TRANSFORMER

double wound 240v. input, 12v. 200mA. output. Size approx. 1 1/2 in. x 1 1/2 in. x 1 1/2 in. Pack of 2, p&p 55p.

REED SWITCHES

Ideal for burglar alarms, limit switches, position indicators. Introductory pack of 3 switches, rating 1A, 3 circular magnets and 1 reed switch coil, p&p 20p.



CIRCULAR MAGNETS

3/8 in. diam. with 1/8 in. square centre hole. Pack of 20, p&p 25p.

DIODES

low powered germanium diodes, forward current 85mA. Pack of 25, p&p 15p.

LIGHT GUIDES

yes, you can 'bend' light round corners with these high quality glass fibre optical 1mm active area, 2 metres, p&p 15p; OR 2mm active area 1 metre, p&p 15p.

JACK PLUGS & SOCKETS

2-way, pack of 4 plugs and 4 sockets, p&p 15p.

T.T.L. 74 I.C.'s By TEXAS, NATIONAL, I.T.T., FAIRCHILD etc

7400	14p	7426	25p	7473	30p	74121	30p	74151	65p	74179	140p
7401	14p	7427	25p	7474	30p	74122	40p	74153	65p	74180	100p
7402	14p	7428	40p	7475	30p	74123	60p	74154	120p	74181	200p
7403	14p	7430	15p	7476	30p	74125	50p	74155	70p	74182	75p
7404	14p	7432	25p	7483	85p	74126	50p	74156	70p	74184	150p
7405	14p	7437	25p	7485	100p	74130	130p	74157	70p	74185	150p
7406	40p	7438	25p	7486	30p	74131	100p	74160	90p	74188	350p
7407	40p	7440	15p	7489	250p	74132	65p	74161	90p	74189	350p
7408	20p	7441	65p	7490	35p	74135	100p	74162	90p	74190	140p
7409	20p	7442	65p	7491	75p	74136	80p	74163	90p	74191	140p
7410	15p	7445	80p	7492	45p	74137	100p	74164	125p	74192	120p
7411	20p	7446	85p	7493	40p	74138	125p	74165	125p	74193	120p
7412	20p	7447	75p	7495	60p	74139	100p	74166	125p	74194	100p
7413	30p	7448	70p	7496	70p	74141	60p	74167	325p	74195	100p
7414	60p	7450	15p	74100	95p	74142	270p	74170	200p	74196	100p
7416	30p	7451	15p	74104	40p	74143	270p	74173	150p	74197	100p
7417	30p	7453	15p	74105	40p	74144	270p	74174	100p	74198	185p
7420	15p	7454	15p	74107	30p	74145	75p	74175	75p	74199	185p
7422	20p	7460	15p	74109	50p	74147	230p	74176	100p		
7423	25p	7470	30p	74118	90p	74148	160p	74177	100p		
7425	25p	7472	25p	74120	90p	74150	120p	74178	140p		

C. MOS.

4000	14p	4030	55p
4001	14p	4032	95p
4002	14p	4033	120p
4006	90p	4047	100p
4007	16p	4048	55p
4009	55p	4049	40p
4011	14p	4050	40p
4012	14p	4054	120p
4013	50p	4055	140p
4015	90p	4056	135p
4016	40p	4060	120p
4017	90p	4066	55p
4018	90p	4069	20p
4020	100p	4071	16p
4022	90p	4072	16p
4023	16p	4081	16p
4024	65p	4082	16p
4025	16p	4510	120p
4026	160p	4511	150p
4027	50p	4516	110p
4028	90p	4518	130p
4029	110p	4528	100p

LEDS .125 OR .2 RED ONLY. 10 FOR £1.20, 100 FOR £9.00, 1000 FOR £60.00

IN4148 BY ITT/TEXAS 100 FOR £1.50.

UNENCODED

HEXADECIMAL 19 KEYBOARD. 1-10 A.B.C.D.E.F. 2 OPTIONAL KEYS. SHIFT KEY £12.50.

555 Timer, 10 for £2.50.

741 Op. amp. 10 for £2.00.

RCA SCR TO3 case 100V 12.5A £2.50.

MURATA ULTRASONIC TRANSDUCERS MA40LIR £2.50 each. £4.00 pair.

2102AN-2L 1024 x 1 BIT 250 NANO SEC. STATIC RAM. £2.20 each. 4/£8.40. 8/£16.00.

2102AN-4L 1024 x 1 BIT 450 NANO SEC. STATIC RAM. £1.60. 4/£6.00. 8/£11.60.

2112-4 256 x 4 BIT 450 NANO SEC. STATIC RAM. £2.95 each. 4/£11.60. 8/£22.80.

2513 CHARACTER GENERATOR. UPPER CASE £7.00.

2513 CHARACTER GENERATOR. LOWER CASE £7.00.

MM5204AQ PROM 4096 BIT READ ONLY MEMORY £8.00.

8212 8 BIT IN/OUT PORT £3.00.

8831 TRI-STATE QUAD LINE DRIVER £2.00.

8833 TRI-STATE TRANSCIEVER (TRUE) £2.00.

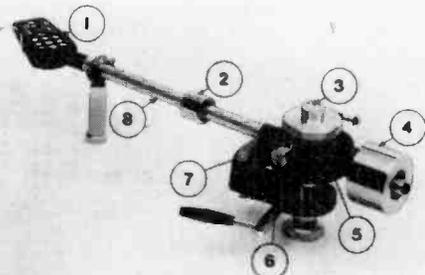
8835 TRI-STATE TRANSCIEVER (INVERTING) £2.00.

AYS-1013 UAR/T £6.00. LM309K/LM340K VOLTAGE REGULATOR £1.00 each.

Connoisseur's New and Exceptional SAU4 Pick Up Arm

Especially designed for modern high compliance cartridges and featuring...

1. Light weight metal headshell
2. Calibrated downforce pressure weight
3. Ball spirit level for visual indication of central balance.
4. De-coupled counter balance weight
5. Viscous damped unipivot
6. Lateral balance weights
7. Viscous damped raise/lower device
8. Light weight aluminium tube



Connoisseur

Write for further details to:

A. R. Sugden & Co. (Engineers) Ltd.
Manufacturers of Connoisseur Sound Equipment,
Connoisseur Works, Atlas Mill Road, Brighouse, West Yorkshire HD6 1ES
Telephone: Brighouse (0484) 712142, Telex: 517144 Sugden G
Telegrams & Cables: Connoisseur Brighouse.

HOW TO USE YOUR FREE

STICKIES

**A SHEET OF 120 STICKIES
WORTH 60p IS GIVEN
FREE INSIDE THIS ISSUE**

No doubt you will by now have found your free sheet of STICKIES. The ones you have are for the popular 7400 series of TTL i.c.s plus a few blank 14 and 16 pin ones that can be filled in as required. Sheets of CMOS (4000 series) are also available—details later.

FAULT FINDING

Our photograph shows one of the main uses of these labels. Having constructed a piece of equipment it helps with circuit checking and fault finding if each i.c. has its corresponding label attached. Each pin is then either labelled or its internal connection is shown in schematic form.

P.C.B. LAYOUT

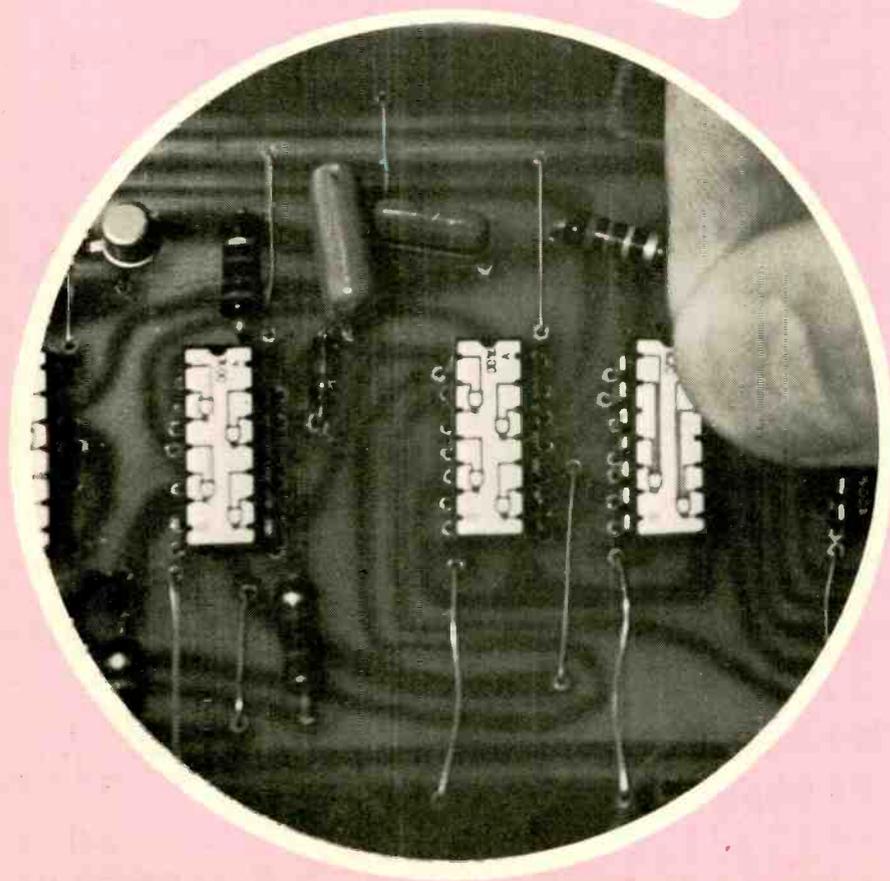
STICKIES are also very useful for designing p.c.b.s. Simply stick them down on a sheet of paper and join the pins down with pencil lines. They then provide immediate identification of each i.c. and its pins and form a reference for the i.c. size and pin positions.

PROTOTYPING

Many amateurs and professionals employ some type of plug in breadboard for prototyping. When using unfamiliar i.c.s STICKIES can provide an immediate pin reference, helping to speed up interwiring and eliminate mistakes. Of course once the i.c. is labelled it can be used later and the STICKIES will always provide pin identification without recourse to charts or reference books.

STORAGE

STICKIES should be stored away from direct sunlight avoiding extremes of tem-



perature and humidity. The adhesive used is a general purpose removable type which is suitable for use between -40 and +70 degrees C.

The data printed on STICKIES has been carefully checked and is believed to be entirely reliable; however, no responsibility can be assumed for inaccuracies.

ABBREVIATIONS

Some abbreviations have been used on STICKIES which may not be obvious to all readers. These are:

Car Out	—	Carry out
Clk	—	Clock
Clr	—	Clear
EN	—	Enable
ext	—	External
G	—	GND
Inh	—	Inhibit
(L)	—	Left
MOD	—	Mode
Pre	—	Preset
(R)	—	Right
Rst	—	Reset
Sel	—	Select
SER IN	—	Serial In
Sh	—	Shift

Str	—	Strobe	7439	—	7401
V	—	V _{CC}	7440	—	7420
Inverted functions are shown thus— \bar{A} ; for inputs this indicates active low, e.g. the circuit operates on the negative going transition.					
A broken division line is used on i.c.s which contain two circuits with identical functions. Thus each function is connected on one side of the line.					
			7443	—	7442
			7444	—	7442
			7445	—	7442
			7447	—	7446
			7451	—	7450
			7454	—	7453
			74132	—	7400
			74145	—	7442
			74161	—	74160
			74162	—	74160
			74163	—	74160

DIFFERENT I.C.s

The STICKIES given in this issue cover 61 different i.c.s, however, by the use of the "logically identical" table below this can be extended to 86 i.c.s.

FOR		USE
7403	—	7400
7405	—	7404
7406	—	7404
7409	—	7408
7412	—	7410
7413	—	7420
7416	—	7404
7417	—	7407
7422	—	7420
7426	—	7400
7437	—	7400
7438	—	7400

MORE!

We are sure you will find your 120 free ones very useful and will in due course need some more. Please don't write to P.E., be thankful for the 60p's worth we have given you and next time send your money to Concept Electronics, 8 Bayham Road, Sevenoaks, Kent. The cost, including an information sheet, plastic wallet, VAT and postage is 80p for a sheet of 120 (either 7400 or 4000 series—state which is required).

Alternatively, a 480 label pack is available for £2.80. Concept will also give discount for quantity orders, their phone number is 0293 514110.

News Briefs

by Mike Abbott

TELETEXT COURSE

YOU'VE probably seen Teletext by now, if not at an exhibition, then through a television dealer's window at least. Teletext could become the newspaper and magazine of the future, and if you're still not clear how this potentially revolutionising advancement works, there is still a chance to leap in on the course of lectures to be held at the main building of the South London College.

This short course of nine special lectures on receiver decoders will be held in the Lecturer Theatre on consecutive Tuesday evenings from 6.30 to 8.30, commencing 10th October 1978. Slides will be shown and demonstrations given.

The course is intended for television and telecommunications technicians and engineers, and will be presented by specialists from Industry and a member of the College staff, as follows:

C. J. Chapman of South London College, October 10 & 17: Introduction to digital terminology. Topics to be introduced will include: binary codes, gates, counters, decode-of-count and memories.

J. R. Chew of BBC Research Department, Tadworth, October 24: The Teletext signal; October 31: Character codes and generation. Technical facilities available.

J. R. Kinghorn of Mullard Central Applications Laboratories, Mitcham, November 7: Introduction to decoders—general requirements for reception of teletext; November 14: The decoder architecture; November 21: Data acquisition circuits; November 28: Memory circuits and character generation; December 5: Control of the system. Likely developments.

The course fee is £6.50, and early enrolment is advised. Contact: A. A. Rowlands, South London College, Knights Hill, London SE27 0TX.

PATENT VICTORY

THE JAPANESE Patent Office has issued a patent to Texas Instruments Inc. covering virtually all miniature electronic calculators.

The patent is for personal-sized, battery-operated calculators which have their main electronic circuitry in a single integrated-circuit chip. The Japanese patent is based on US Patent 3,819,921, which was granted to Texas Instruments on the 25th June, 1974.

The Japanese decision represents a significant milestone for Texas Instruments because its pocket calculator invention was subjected to stringent opposition by the patent system in Japan—where many electronic calculators are made, and was determined to be patentable over opposition arguments.

Official publication of the TI miniature calculator invention was made by Japan's Patent Office on the 24th August, 1974. Following this publication for opposition, 12 leading Japanese calculator companies objected. They cited a total of 25 references as a basis for their argument that the TI invention was not patentable. The Japanese Patent Office, on the 27th June, 1978, rejected the opposition arguments, awarding a patent to TI.

Under the Japanese patent, Texas Instruments will have the right to claim royalties retroactively to the date that the TI miniature calculator invention was officially published by the Japanese Patent Office. Texas Instruments will actively seek to licence this patent.

To date, 19 countries have issued patents to Texas Instruments for the calculator invention, among them the United Kingdom.

The miniature calculator described in the Texas Instruments patent was the result of work done at TI in the mid-1960s. The US patent was originally filed in 1967. This miniature calculator, the world's first, employed a large-scale integrated semiconductor array containing the equivalent of thousands of discrete semiconductor devices. Measuring only 108 x 155 x 44mm, it was the first miniature calculator to have the high degree of computational power, found at the time only in much larger machines.

Other elements of this early example of the miniature calculator included a small keyboard with 18 keys and a visual display in the form of a semiconductor thermal printer for printing out calculations of up to 12 decimal digits.

The Proto-Board®

Now circuit designing
is as easy as
pushing a lead
into a hole.

No soldering.
No de-soldering.
No heat-spilt components.
No manual labour.
No wasted time.



With a Proto-Board you can hook
your circuit together as quickly as you can
think.

And you can have second thoughts, and third
thoughts, equally quick and easy, till you've got the whole thing
right.

Then you can solder up if you want to, but most engineers don't because the
Proto-Board push-fit connectors are highly reliable.

And everything is visible: come back next week and you 'read' the circuit
immediately.

Contact terminals are arranged in sets of five, each
connected across the back, and in the Model 203A
illustrated you get 1770 contacts, in six rows of 59 x 5,
plus four double power rails, each with 100 contacts
connected lengthwise and two horizontal power units
with 40 contacts each. Many other models; see chart.
Proto-Board breadboards will accept transistors, ICs,
LSI packages, resistors, capacitors, LEDs, trimmers,
relays etc.; most plug straight in.

**Try one. You'll wonder how you ever
managed without it.**

Model Number	No. of Solderless Tie-points	IC Capacity (14-pin DIP's)	Unit Price	Postage & Package	VAT	Total Price	Other features
PB-6	630	6	£ 9.20	£1.00	£0.82	£11.01	Kit - 10 minute assembly
PB-100	760	10	11.80	1.00	1.02	13.82	Kit - with larger capacity
PB-101	940	10	17.20	1.25	1.48	19.93	8 distribution buses, higher capacity
PB-102	1240	12	22.95	1.25	1.94	26.14	Large capacity, moderate price
PB-103	2250	24	34.45	1.50	2.88	38.83	Even larger capacity; only 1.73 pence per tie-point
PB-104	3060	32	45.95	1.50	3.80	51.25	Largest capacity; lowest price per tie-point
PB-203	2250	24	55.15	1.50	4.53	61.18	Built-in 1%-regulated 5V, 1A low ripple power supply
PB-203A	2250	24	74.10	1.50	6.10	82.30	As above plus separate ½ Amp + 15V and - 15V internally adjustable regulated supplies

How to order. Telephone 01-890 0782 and give us your Access, Barclaycard or American Express number, and your order will be in the post that night. Or, write your order, enclosing cheque, postal order, or stating credit card number and expiry date. (Don't post the card!). Alternatively, ask for our latest catalogue, showing all CSC products for the engineer and the home hobbyist. (Prices are for UK only. For Europe add 10%, outside Europe add 12½% to total prices.)

CONTINENTAL SPECIALTIES CORPORATION (UK) LTD
SPUR ROAD NORTH FELTHAM TRADING ESTATE FELTHAM
MIDDLESEX TW1 40TJE TELEPHONE: 01-890 0782 TELEX: 881 3669.

CONTINENTAL SPECIALTIES CORPORATION



REGISTERED IN LONDON 303780 VAT No. 224470 7471
TRADE MARK APPLIED FOR 'CSC (UK) LTD 1977
DEALER ENQUIRIES WELCOME

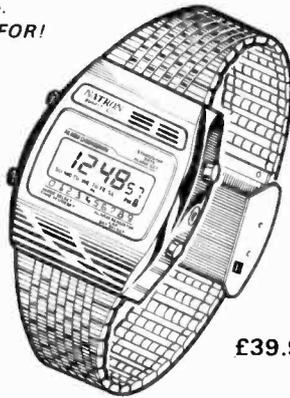
SPECIAL OFFER TO P.E. READERS

ALARM CHRONOGRAPH WITH DUAL TIME ZONE FACILITY

In a superb STAINLESS STEEL case with MINERAL GLASS face.
THIS MUST BE THE ONE YOU HAVE BEEN WAITING FOR!

If you could write the specification for your own ideal watch you would probably want everything this one has. As for styling, without a close inspection nobody is going to be able to tell the difference between this watch and that world famous James Bond classic selling for £145. However, this one goes one better and has 1/100 second measurement of net, lap and 1st & 2nd place times, with dual time facility.

- Constant LCD display of hours and minutes, plus optional seconds or date display, plus day of the week and am/pm indication.
- Perpetual calendar; day, date, month and year.
- 24 hour alarm with on/off indication.
- 1/100 second chronograph measuring net, lap and first and second place times.
- Dual time zone facility. Night light.
- Fully adjustable stainless steel bracelet.
- STAINLESS STEEL CASE. MINERAL GLASS.



£39.95

This watch is not to be confused with cheaper models with chrome plated cases and plastic lens. Manufactured by National Electronics, it runs a close second to Casio, Citizen and Seiko for quality and

reliability, with undeniable value for money. The first very limited quota will be available in mid-September with a few more due in October. Orders will be treated in strict rotation, so don't risk being disappointed.

OTHER LOW COST

NATIONAL WATCHES

PH-G1
4 digits
5 functions
all metal
£9.95



PH-Chronograph
6 digits
1/100 second
net, lap and
1st & 2nd place
£18.95



PH-Alarm
Hours, mins,
secs or date,
day, am/pm.
Calenda (perp.)
24 hour alarm
£29.95



PH-Analogue
Stepping motor
Day, date.
Sweep seconds
£24.95



AQ-1000 CALCULATING ALARM CLOCK PLUS 3-WAY STOPWATCH

Hours, minutes, seconds, am/pm. 24 hour Alarm with sign. Stopwatch: Net times, lap times, 1st & 2nd place times from 1/100 sec. to 10 hrs with ST & LAP signs. Calculator: 4 key memory, %, 1 year batteries. ±20 secs/month. 2 1/2 x 2 3/4 x 4 1/2 in.



RRP £26.95 Our price £21.95

NEW CASIO WATCHES

Experience has convinced us that for quality reliability and value for money, CASIO are unbeatable. CASIO have now increased their superb range.

All CASIO watches have a calendar display, night illumination, mineral glass and stainless steel cases, water resistant to 100 feet (except Sports Watches - 66 feet).

31QR-20B	Round, Stopwatch	(£31.95)	£26.95
51QR-19B	Round, 6 Digits, Selectable 12 or 24 hour display	(£35.95)	£29.95
54QS-16B	Square, as above	(£44.95)	£34.95
54QS-15B	Luxury version	(£49.95)	£39.95
45CS-22B	Chronograph, Net, lap and 1st & 2nd place times, 12 or 24 hour display, Dual time zone	(£64.95)	£49.95
53CS-18B	Square, stopwatch, dual time zone	(£69.95)	£54.95
53CS-19B	Barrel	(£69.95)	£54.95
53CGS-17L	Gold plated strap	(£84.95)	£69.95

All these models and full details should be available in early September.

Send 25p for our illustrated catalogue. Accurist, Casio, Citizen etc.
Prices include VAT P.&P. Send cheque, P.O. or phone your credit card No. to:

TEMPUS

Dept. P.E., 19/21 Fitzroy Street
Cambridge CB1 1EH, Tel. 0223 312866

THE SINCLAIR PDM35 digital Multimeter

Now a digital multimeter at an analogue price and look at the spec:
D.C. VOLTS 1 mV-1000V (1% - 1 count) 10mΩ input.
A.C. VOLTS 1V-500V, 40Hz-5kHz (1% + 2 counts).
D.C. CURRENT 1mA-200mA (1% count).
RESISTANCE 1Ω-20mΩ (1.5%+1 count).

£27.95 inc. VAT cash with order complete with test leads, prods & wallet, De-luxe padded case £3.25



SINCLAIR DM235



Portable 3 1/2 digit 6 function Multimeter.
DC volts 1mV to 1000V
AC volts 1mV to 750V
AC & DC current 1μA to 1A
Resistance 1Ω to 20MΩ
Diode test 0.3 1μA to 1 mA
10mΩ input, DC acc, 1.0% AC acc 1.5% 30Hz-10kHz

Cash with order

£52.80 inc VAT complete with test leads & prods

A full range of optional accessories. (Prices include VAT)
Eveready carrying case with lead storage compartment...£8.95
Rechargeable battery units £8.50. AC adaptor/charger 240V 50 Hz £3.50. 30kV voltage probe£18.04
All Prices include VAT. Add 50p. Postage and Packing To all Orders.

Also Available: The New Computer Chess Challenger with TEN levels of play £199.95. SAE
Sinclair Pocket Television. £199.95. SAE
Computer Backgammon £149.95. SAE
The NEW ELMAC 4" oscilloscope £109 inc. VAT + P.&P. SAE
Heavy duty prom eraser £56 + VAT. SAE.
Full range of support chips e.g. intel 8080 £8 inc. VAT. SAE.
Intel MCS/80(SDK) kit £190 + VAT. SAE.

Send cheque with order to:
GEMINI ELECTRONICS
Newton Buildings
Newton Street
Manchester. Tel: 061-236-3083
MAIL ORDER ONLY



CQ-81 CALCULATING ALARM CLOCK

PLUS 2 ALARM/TIMERS

Two AA batteries last for 10,000 hrs (1 year). LCD 6 digit clock, large angled display. 24 hr Alarm, also two 24 hr Alarm/timers with countdown (one self-clearing, one repeats). Full Memory. Constants, %, 1/8" x 2 3/4" x 5 in.



RRP £22.95 £17.95



ST-24 CARD TIME
24 hour stopwatch (or time display)
1/10 sec. to 10 hours
1 second to 24 hours
Two Alarm/Timers
Memory, %, 1/8" x 3 1/2" x 2 1/2 in.



RRP £24.95 £19.95



THE INCREDIBLE FX 8000

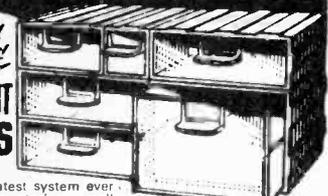


43 Scientific funct.
1/100 sec. Stopwatch.
Five Alarm-Timers, sequential (self-clearing) or repeat.
2 level parenthesis.
Memory, Deg, Rad, Gra.
Standard Deviations.
Fractions. Sexagesimal.
Rect/Polar convert.
LCD. 1300 hr batteries.
1/2 x 2 1/4 x 5 1/2 in. 2.7 oz.
RRP £35.95 £29.95

ALARM WATCHES. 25CR-16B (round) £49.95
25CS-14B (square) £59.95
WORLD TIME WATCH. 29CS-11B £59.95
SEIKO Calculator/Watch (£165) £135
CITIZEN Multi-Alarm (£135) £108
MAINS DIGITAL ALARM CLOCKS
Fairchild Timeband C500, Black or white £9.95
CASIO CALCULATORS
ST-1 Stopwatch (four way) £24.95
LCD LC822 £10.95. LC78 £16.95
AQ-1000 Clock, alarm, stopwatch £21.95
CASIO SCIENTIFICS
DIGITRON: FX-31 £11.95. FX-39 £15.95.
FX-140 £17.95. FX-120 £19.95. FX-360 £49.95.

INTERLOCKING PLASTIC STORAGE DRAWERS

NEAT!
HARDY!
TIDY!



DISCOUNT PRICES

Newest, neatest system ever devised for storing small parts and components: resistors, capacitors, diodes, transistors, etc. Rigid plastic units interlock together in vertical and horizontal combinations. Transparent plastic drawers have label slots. 1D and 2D have space dividers. Build up any size cabinet for wall, bench or table top.

5 SIZES ALL INTERLOCK

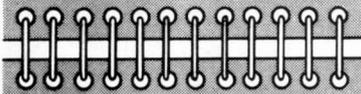
As supplied to Post Office, Industry and Government Depts.
SINGLE UNITS (1D) (5in x 2 1/2in x 2 1/2in) £3.50 DOZEN.
DOUBLE UNITS (2D) (5in x 4 1/2in x 2 1/2in) £5.50 DOZEN.
TREBLE (3D) £5.50 for 8.
DOUBLE TREBLE 2 drawers, in one outer case (6D2). £7.90 for 8.
EXTRA LARGE SIZE (6D1) £6.90 for 8.

PLUS QUANTITY DISCOUNTS
Orders over £20, less 5%. Orders over £60, less 7 1/2%. PACKING/POSTAGE/CARRIAGE: Add £1.00 to all orders under £10. Orders £10 and over, please add 10% carriage.
QUOTATIONS FOR LARGER QUANTITIES.
Please add 8% V.A.T. to total remittance.
All prices correct at time of going to press.



Modern, slim-line power panel, countless uses in home office, factory, showrooms. Perfectly safe, unbeatable. Can be mounted on wall or trailed anywhere in room. Neat rubber base. Smart PVC outer cover. Black £3.10, White £3.30. P.&P 60p each.

FLAIRLINE SUPPLIES (PE10)
124 Cricklewood Broadway, London N.W.2
Telephone 01-450 4844



INDUSTRY NOTEBOOK

By Nexus



The Great Debate (2)

Since my comments last month on VLSI and its probable impact on life-style in the 1980s and beyond, the Government have made a few announcements of intended aid to microelectronics producers and users. The Government's response, such as it is, is feeble in terms of financial aid and appears uncertain in intent. But can the Government be blamed when its input of information, not to mention advice, from well-meaning sources is itself confused and influenced, not by a master-plan carefully conceived for Britain, but largely by what other countries are doing?

Of course it is correct and prudent that we should keep an eye on what our competitors are doing but the level of government aid granted in Japan or France, West Germany or the United States is not necessarily the yardstick we need to adopt. A logical argument is that if VLSI is going to be a winner, then there should be plenty of private investment to support it without state aid. Unhappily there are other factors such as national self-sufficiency in the equation, and the high-risk element which deters private investment. Until some more clearly defined policy emerges it is reasonable that the few million pounds so far tentatively committed should be received with grateful thanks and in the hope that more is to come.

I remember ten or more years ago we all went through the same painful exercise in the early days of the integrated circuit. There was endless debate about what should be done and in the end the industry verdict was "too little and too late".

Today, we are going through even more agony because we have an even greater proliferation of official committees, working parties, think tanks, and other experts involved, not to mention powerful voices from non-experts like the unions and less-powerful but nonetheless influential TV and radio commentators.

And so the mistakes of the past are likely to be repeated with much talk and little or no action and in a technological situation in which hardly a day passes without advance. One rumoured plan for Britain is to set up and finance a mass-production unit for the 64K RAM market and site it in a depressed area. Even with technical assistance from Silicon Valley it is extremely doubtful whether production could be obtained in meaningful quantity by the time that others are working on the 256K RAM, expected to be on the market in a big way by 1982.

As far as MPUs are concerned the proposed government aid aimed at encouraging their application in new products should be well worth while. The MPU is just another chunk of silicon, worthless until it is programmed to a useful activity. The hardware costs are dropping dramatically while programming costs are relatively increasing. It will be the ingenuity in programming and application that could keep Britain ahead in world trade.

One positive step forward in the Great Debate is that the Government has now come to recognise that there is an electronics industry in Britain and, moreover, that it is important. And that can't be bad.

Postal Automation

The introduction of automation in the postal services is going at a snail-like pace according to a Mr J. Gombinski in a recent letter to *The Times*. Although a little out-of-date (being based on information disclosed in 1975) his statistics are worth repeating.

Nine years after the introduction of automation, writes Mr Gombinski, only six per cent of machinable mail was sorted automatically and at the then rate of progress it would take 150 years to automate entirely. But while the Post Office hardly ever uses the postal codes he calculates that in 1975, given 150,000 million machinable items a week and allowing only 3 seconds to write in each of the unused codes, 750,000 working days were lost on a useless exercise in that year alone.

Talking Computers

Racal-Milgo could be on to a good thing taking on the marketing of Wavetek voice response systems in Europe, the Middle East and Africa. The system allows you to dial up a central computer by ordinary telephone, use a low-cost key-pad to enter your enquiry and the computer supplies the answer, not in data form but in a simulated human voice. It is a fast-response system, especially useful for verifying whether a credit-card customer is in credit and for similar routine enquiries.

The Consumer Market

If market analysts Frost & Sullivan are right in their forecasts, the consumer electronics market in Western Europe is now due for a revival. Predictably the growth areas will be in the newer fields of videotape recorders, TV information services and TV games. Music centres are also tipped for big gains by 1985 and, perhaps

surprisingly, radio receivers will also do well. Table-top monochrome TV sets, however, will virtually become extinct except for the poorest homes in the poorest areas. The growth forecast is based on the assumption that Western Europe is not yet market-saturated in consumer electronics.

Meanwhile UK suppliers continue to have a rough time. Even well-managed GEC lost £4 million on TV last year and after drastic action to remedy over-capacity only a break-even situation is forecast for this year.

Encouragement

The Caroline Haslett Memorial Trust and the Institution of Electrical and Electronics Technician Engineers are putting up an annual award of £250 for "The Girl Technician Engineer of the Year". The idea is to draw attention to electrical and electronics engineering as a worthwhile career for young ladies.

Fibre-Optic TV

Following long experimental tests of TV signal distribution by fibre-optic link in the UK by Rediffusion, the first consumer household in the world to receive its TV signals by fibre-optics is in Arnhem, Holland. The local company, Delta Kabel, is using the Dial-A-Program system developed by Rediffusion and operated by Delta Kabel under licence.

The optical link into the house is about 800 feet long and is intended to demonstrate that the idea is not only workable but can be achieved with low-cost components. Signal distribution by light duct could prove cheaper than copper wire and, having a wider bandwidth, will accommodate many more TV channels as well as stereo radio.

Satellite News

Marconi Space and Defence Systems has won an order worth £12 million for two new transportable earth terminals for NATO and for updates on a dozen existing earth terminals. The contract also includes the supply of the same updating equipment for five terminals being built in the USA by Ford Aerospace.

Racal Electronics Group, better known for manpack military radios and h.f. receivers and transmitters, has broken through into mobile satellite ground terminals with a substantial order from the Ministry of Defence. The Racal design is a small terminal which can be accommodated in light field vehicles such as the Land Rover.

Transatlantic communications, shared amicably over the past few years by complementary submarine cables and Intelsat satellites, is now the subject of dispute. Intelsat want a larger share of the traffic and the FCC is objecting to further cables, such as TAT-7, which would increase cable capacity. Europe wants the new cable. So does the US Defence Department who see the transatlantic cable as a necessary back-up should the satellites be blown out of the sky by possible enemy action.

MICRO-BUS

Compiled by DJD.

Appearing every two months, Micro-Bus will present ideas, applications, and programs for the most popular microprocessors; ones that you are unlikely to find in the manufacturers' data books. The most original ideas will probably come from readers working on their own microcomputer systems, and payment will be made for any contribution featured here. This is also the place to air your views, in general, on this new technology, so let's be hearing from you!

THE THREE topics in this month's Micro-Bus are all concerned with minimization in some way or other, with a supremely simple cassette interface system, some improvements to the number-sorting routines given in April's Micro-Bus, and a diminutive program for finding prime numbers.

MINIMAL CASSETTE INTERFACE

The cassette interface system to be described was received from *Nick Toop of Cambridge*, and it overcomes one of the main drawbacks of the lower-cost microprocessor kits currently available; namely that they provide no way of permanently saving programs. The system described makes it possible to store and load programs and data using a standard domestic cassette or tape recorder, and although it is primarily designed for SC/MP, it should be possible to develop a similar system for use with any other microprocessor.

"The cassette interface and programs were originally designed for use with a SC/MP Introkitt with the Keyboard Kit, but they are currently being successfully used with a Science of Cambridge Mk14. The main objective in developing the system was to make the load-from-tape program as short as possible since this would have to be entered at the keyboard on powering up each time.

"On the other hand the length of the store-to-tape program is not so important since this can be loaded from tape each time it is needed,

and so on this side the hardware was made as simple as possible. The programs were written to be relocatable so they can be fitted anywhere in memory without modification."

RECORDING FORMAT

"Data is coded as a series of 1kHz tone bursts; a zero bit is represented as a 4ms burst followed by a 28ms gap, and a one bit is coded as a 16ms burst followed by a 16ms gap. The bytes are transmitted low-order bit first, and there is no extra gap between successive bytes. To load from tape the start address is first entered at OFF9 (high-order byte) and OFFA (low-order byte) so that the monitor will put the address in P1 on entering the program.

"In systems without a monitor some instructions will have to be added at the start of the program to set up P1 correctly. The tape is played until the blank interval in front of the data is reached, and then the LOAD program is executed. The tone bursts from the tape are processed by the circuit of Fig. 1 which uses a single 4001 (or 4011) CMOS gate package with the four gates wired as inverters.

"The first inverter is biased into its linear region to act as a simple amplifier, and two more inverters form a demodulator which gives at its output the squared-up envelope of the pulse bursts. This is fed to the SENSE-B and SERIAL-IN inputs of the SC/MP microprocessor, and to an indicator i.e.d. which flashes to indicate correct operation and

helps in setting up the best level at the input potentiometer."

LOAD PROGRAM

"The LOAD program in Fig. 3 operates as follows. It first waits in a loop for an input at SENSE-B. On receipt of an input it delays for 14msec. and then shifts whatever is present at SERIAL-IN into the extension register using the SIO instruction; this will be a 0 if the pulse was short and a 1 if the pulse was long. The program delays for a further 14msec. and then returns to the previous loop.

"When eight bits have been shifted into the extension register the byte just formed is stored to the location pointed to by P1 using auto-increment addressing so that P1 is then pointed to the next address. When the indicator i.e.d has stopped flashing the reset button on the microprocessor should be pressed to escape from the program, and loading is complete.

"Since the load program allows you to specify any arbitrary starting address for the data being loaded, the cassette system also serves as a means of relocating programs in memory."

STORE PROGRAM

"To store to tape the start address is put at OFF9 (high-order byte) and OFFA (low-order byte), and the number of bytes to be stored is put, in hex, at OFFB; the address and length

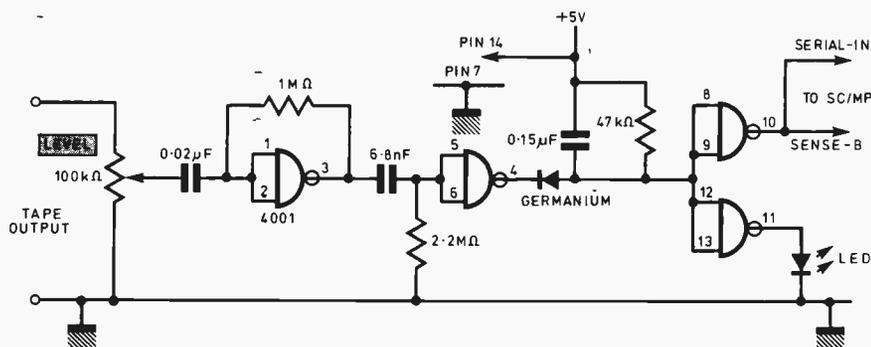


Fig. 1. Nick Toop's load-from-tape circuit, a demodulator using a single CMOS package

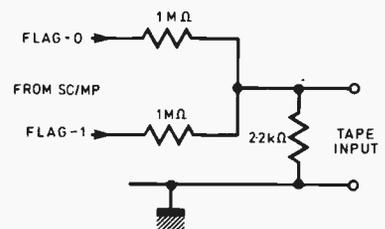


Fig. 2. The store-to-tape circuit, a simple adder which combines two signals from the microprocessor

are loaded into P1 and P2H respectively by the monitor program. The maximum length is 256 bytes, represented as X'00.

"The STORE program of Fig. 4 codes the data into a sequence of tone bursts at the FLAG-0 and FLAG-1 outputs on the SC/MP chip. FLAG-1 is set high between bursts so that when the two outputs are combined at the input of the tape-recorder using the simple adder circuit of Fig. 2 the gap between pulses is at a mean level; this avoids sharp transients due to the pulse onsets which would make an automatic volume control adopt an unduly low sensitivity.

"The program generates either four pulses for a zero or 16 pulses for a one, using the

together with the claim that they were believed to be the shortest programs possible. It now seems that this was a dangerous claim to make, and thanks are extended to all the readers, too numerous to mention, who sent in improvements.

The sort routines all used the exchange-sort method to order an array of up to 256 numbers, and the condition was made that the address and length of the array should be passed down to the routine in suitable registers. The routine for the Z80, which was taken from the Z80-CPU Technical Manual, received the greatest hammering and the shortest version, sent in by *Eric Baddiley of Cheshire*, reduces the number of program bytes from 38 to 23!

necessary to test them. This improvement can be incorporated in the program of Fig. 5 with no increase in size simply by changing the instruction at 0014 to "JR NZ, SORT-\$", and in the program of Fig. 5 by changing the position of the label AGAIN to the instruction "DEC A" in the previous line.

PRIME PROGRAM

Although the prime numbers are simple to define—they are numbers whose only divisors are 1 and the number itself—no explicit formula exists for generating them, and efficient programs to search for particular primes can be extremely complex. Note that 1 is not con-

Fig. 3. LOAD program for SC/MP which loads data into memory from a tape using the format described in the text

```

        .TITLE 'LOAD FROM TAPE'
        ; PUT IN MEMORY STARTING AT ADDRESS IN P1
        ;
        0000      .="OF7F"
        OF7F     COUNT:  .="+1"      ;BIT COUNTER
        ; BEGIN EXECUTION HERE
        ;
        OF80 C408 LOAD:  LDI  B      ;BIT COUNT
        OF82 C8FC      ST  COUNT
        OF84 06      LOOP:  CSA
        OF85 DA20     ANI  X'20  ;SENSE-B INPUT
        OF87 98FB     JZ    LOOP  ;NOTHING FOUND
        OF89 8F1C     DLY   X'1C  ;WAIT
        OF8B 19      DLY   X'1C  ;SHIFT INTO E-REG
        OF8C 8F1C     DLY   X'1C  ;WAIT FOR GAP
        OF8E 8F00     DLD   COUNT
        OF90 9CF2     JNZ   LOOP
        OF92 40      LDE   ;GET BYTE INPUT
        OF93 CD01     ST   @1(1) ;STORE IT
        OF95 90E9     JMP   LOAD
        ;
        0000      .END
    
```

Fig. 4. STORE program for SC/MP which encodes data from memory as a series of tone bursts

```

        .TITLE 'STORE TO TAPE'
        ; P1 CONTAINS START ADDRESS
        ; P2H CONTAINS LENGTH
        ;
        0000      .="OF9D"
        OF9D     PULSES:  .="+1" ;PULSE COUNTER
        OF9E     MASK:   .="+1"
        OF9F     LEN:    .="+1" ;LENGTH COUNTER
        ; BEGIN EXECUTION HERE
        ;
        OFA0 36     STORE: XPAH 2 ;GET LENGTH
        OFA1 C8FD   ST  LEN
        OFA3 02     CCL   ;
        OFA4 C501   SCAN:  LD   @1(1) ;PUT NEXT BYTE
        OFA6 01     MAE   ; IN E-REG.
        OFA7 C401   LDI   X'01 ;SET MASK
        OFA9 C8F4   NEXT:  ST  MASK
        OFAB 50     ANE   ;GET ONE BIT
        OFAC 9804   JZ    ZERO
        OFAE C410   LDI   X'10 ;STORE
        OFB0 9002   JMP   STORE ; APPROPRIATE
        OFB2 C404   ZERO:  LDI   X'04 ; NUMBER OF
        OFB4 C8E8   STORE: ST  PULSES ; PULSES.
        OFB6 C403   REP:   LDI   X'03 ;
        OFB8 07     CAS   ;FLAGS 0 AND 1
        OFB9 8F01   DLY   X'01
        OFBB C400   LDI   X'00
        OFBD 07     CAS   ;
        OFBE 8F01   DLY   X'01 ;FLAGS OFF
        OFC0 B8DC   DLD   PULSES
        OFC2 9CF2   JNZ   REP ;PULSE BURST
        OFC4 C401   LDI   X'01 ;MEAN LEVEL
        OFC6 07     CAS   ;
        OFC7 C0D6   LD   MASK ; BETWEEN BURSTS.
        OFC9 50     ANE   ;
        OFCA 9002   JNZ   ONE ; APPROPRIATE
        OFCC 8F18   DLY   X'18 ; TRAILING
        OFCE 8F20   ONE:  DLY   X'20 ; SPACE.
        OFD0 C0CD   LD   MASK
        OFD2 F0CB   ADD   MASK ;ADJUST MASK FOR
        OFD4 9C33   JNZ   NEXT ; NEXT BIT.
        OFD6 B8C8   DLD   LEN
        OFD8 9CCA   JNZ   SCAN ;READ NEXT BYTE?
        OFDA 3F     XPPC 3 ;GO TO MONITOR
        ;
        0000      .END
    
```

Fig. 5. Eric Baddiley's improved sort routine for the Z80 micro

```

        ; 2-80 SORT ROUTINE
        ; * ADDRESS OF DATA IN REGISTER HL
        ; * NUMBER OF BYTES IN REGISTER C
        ; * RELOCATABLE
        ;
        0000 0D     SORT  DEC C      ; ADJUST COUNT
        0001 E5     AGAIN PUSH HL   ; SAVE HL
        0002 41     LD  B,C        ; RESTORE COUNT
        0003 16FF   LD  D,OPFH    ; RESET THE FLAG
        0005 7E     NEXT  LD  A,(HL) ; GET FIRST ELEMENT
        0006 23     INC  HL        ; POINT TO NEXT
        0007 BE     CP  (HL)      ; IN THE RIGHT ORDER?
        0008 3006   JR  NC,NOEX-$ ; IF YES THEN JMP
        000A 5E     LD  A,E        ; ELSE SWAP THEM
        000B 77     INC  HL        ;
        000C 2B     DEC  HL        ;
        000D 73     LD  (HL),E    ;
        000E 23     INC  HL        ;
        000F 14     INC  D        ;
        0010 10F3   NOEX  DJNZ NEXT-$ ; AND SET THE FLAG
        0012 E1     POP  HL        ; RESTORE HL AND SP
        0013 11     INC  D        ; TEST THE FLAG
        0014 20EB   JR  NZ,AGAIN-$ ; DO AGAIN IF SWAPS
        0016 C9     RET           ; ELSE RETURN
        ;
        0000 0D     SORT  DEC C      ; ADJUST COUNT
        0001 E5     AGAIN PUSH HL   ; SAVE HL
        0002 41     LD  B,C        ; RESTORE COUNT
        0003 16FF   LD  D,OPFH    ; RESET THE FLAG
        0005 7E     NEXT  LD  A,(HL) ; GET FIRST ELEMENT
        0006 23     INC  HL        ; POINT TO NEXT
        0007 BE     CP  (HL)      ; IN THE RIGHT ORDER?
        0008 3006   JR  NC,NOEX-$ ; IF YES THEN JMP
        000A 5E     LD  A,E        ; ELSE SWAP THEM
        000B 77     INC  HL        ;
        000C 2B     DEC  HL        ;
        000D 73     LD  (HL),E    ;
        000E 23     INC  HL        ;
        000F 14     INC  D        ;
        0010 10F3   NOEX  DJNZ NEXT-$ ; AND SET THE FLAG
        0012 E1     POP  HL        ; RESTORE HL AND SP
        0013 11     INC  D        ; TEST THE FLAG
        0014 20EB   JR  NZ,AGAIN-$ ; DO AGAIN IF SWAPS
        0016 C9     RET           ; ELSE RETURN
    
```

Fig. 6. Andrew Yeomans' improved version of the M6800 sort routine

```

        NAM      SORT
        ; ENTRY: X CONTAINS START ADDRESS OF ARRAY
        ;          Y CONTAINS NUMBER OF ELEMENTS
        ;
        0000 0002  PTR      RMB 2
        ;
        0002 0F 00  SORT  STX  PTR  ;SAVE START ADDRESS
        0004 4A      AGAIN DEC  A  ;NUMBER OF PAIRS
        0005 36      AGAIN PSH  A  ;SAVE ON STACK
        0006 5F      AGAIN CLR  B  ;EXCHANGES FLAG
        0007 0E 00  AGAIN  LD   PTR ;GET START ADDRESS
        0009 36      NEXT  PSH  A  ;SAVE COUNT
        000A 46 00  AGAIN  LDA  A,0,X ;COMPARE TWO ITEMS
        000B A1 01  AGAIN  CMP  A,1,X
        000E 23 00  AGAIN  BLS  NOSWAP ;JUMP IF FIRST (<= SECOND)
        0010 37      AGAIN  PSH  B  ;SWAP ITEMS
        0011 E6 01  AGAIN  LDA  B,1,X
        0013 47 01  AGAIN  STA  A,1,X
        0015 E7 00  AGAIN  STA  B,0,X
        0017 33      AGAIN  PUL  B  ;RESTORE FLAG
        0018 5C      AGAIN  INC  B  ;EXCHANGE DONE
        0019 0B      AGAIN  INX  ;STEP POINTER
        001A 32      AGAIN  PUL  A  ;SET COUNT
        001B 4A      AGAIN  DEC  A  ;
        001C 26 EB  AGAIN  BNE  NEXT ;LOOP UNTIL END OF ARRAY
        001E 32      AGAIN  PUL  A  ;RESTORE COUNT
        001F 5D      AGAIN  TST  B  ;
        0020 26 E3  AGAIN  BNE  AGAIN ;LOOP IF EXCHANGES DONE
        0022 39      AGAIN  RTS     ;ELSE RETURN
        ;
        0000      .END
    
```

Fig. 7. Program for the MCS6502 which finds the nth prime number given n

```

        ; SUBROUTINE TO FIND X-TH PRIME
        ; RESULT RETURNED IN Y
        ; (ASSUMED LESS THAN 255)
        ;
        0000      .="+.1"
        ;
        0001 D8     START  CLD      ;CLEAR DECIMAL MODE
        0002 A0 01  LDY   #1
        0004 C8     CONT  INY
        0005 84 00  NEXT  TTY     ;NEXT CANDIDATE
        0007 98     NEXT  DEC  TRY  ;TEST DIVISOR
        0008 06 00  NEXT  SEC     ;SET UP DIVISOR
        000A 38     SEC
        000B 90 FA  SUB  BCC NEXT ;REMAINDER
        000D E5 90  SBC  TRY
        000F 06 FA  BNE  SUB
        0011 C6 00  EXACT  DEC  TRY ;WAS DIVISOR 1?
        0013 00 EF  BNE  CONT
        0015 CA     PRIME  DEX     ;MORE TO FIND?
        0016 D0 EC  BNE  CONT
        0018 60     RTS      ;RETURN - PRIME IN Y
        ;
        0000      .END
    
```

location PULSES as a counter; the pulses are followed by the appropriate trailing space, namely 28ms for a zero and 16ms for a one. Eight such bursts of pulses encode each byte of data.

"As you can see, the recording format is extremely simple, and this helps to make the software short and the hardware cheap. Nevertheless the system has proven extremely reliable even with a low-cost cassette recorder, and it is amply fast for most purposes, loading or storing 256 bytes in under a minute."

BETTER SORTS

In the April Micro-Bus number sorting routines were given for four different micros

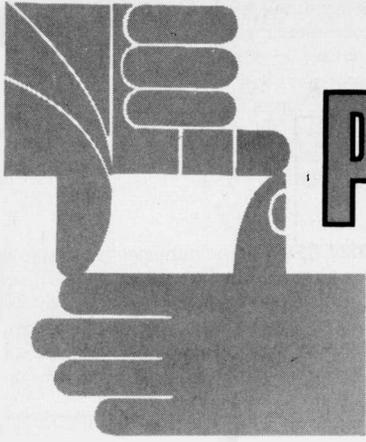
The new version, shown in Fig. 5, has the added advantage that it is relocatable because it makes no use of external store to hold data. A similar version was received from *D. Ritchie of Essex University*.

The shortest sort routine for the M6800 was submitted by *Andrew Yeomans of Surrey*, and this is shown in Fig. 6. It reduces the size of the program from 41 to 33 bytes by making use of the stack to store temporary variables.

Michael Blandford of Dorset pointed out that the sorts can be speeded up by decrementing the length of the block to be scanned after each pass; after one pass of the array the last element must be in its correct position, and after 20 passes the last 20 elements must be in order at the end, so it is un-

considered to be a prime, so the first eight primes are 2, 3, 5, 7, 11, 13, 17 and 19. Consider the task of writing a routine to find the n'th prime where n is passed down in a suitable register.

A surprisingly short program will achieve this if efficiency is not important, and Fig. 7 shows one for the MCS6502 which will find all the primes up to 251, the 54th prime. The number of the prime required is supplied in the X register and the prime is returned in the Y register. By altering the program to use double-byte variables it could easily be extended to find primes up to 65535. As it stands it is hard to see that the program could be shortened, but readers who find improvements are encouraged to send them in and some may be presented in a future issue.



PATENTS REVIEW...

Copies of Patents can be obtained from :
 the Patent Office Sales, St. Mary Cray, Orpington, Kent Price 95p each

IMPROVING "MUSICALITY"

In the hi-fi world there is currently considerable controversy over the "musicality" of amplifiers, that is to say the possibility that two amplifiers which measure the same on even the most sophisticated test equipment currently available may sound different when reproducing music. In BP 1 499 939 Tokyo Shibaura Electric Company Limited of Japan patented an amplification circuit that is claimed to give improved results, through a particular connection of capacitors, but with the admission by the inventor that it is unclear why the improvement is achieved.

Essentially the claim is that the connection of extra nonpolar capacitors parallel with the electrolytics "can effectively improve the fidelity of reproduction", although the reason why "is not theoretically clear".

The audio amplifier of Fig. 1 is based on FETS 12, 13 in a complementary pair. Electrolytic capacitors 20, 21 are used as filters for the d.c. source and also for decoupling. The capacitors are formed of an aluminium film and are of high value e.g. 5,000 to 20,000 μ F. To capacitor 20 is connected in parallel a pair of nonpolar capacitors 22, 23 and to capacitor 21 is likewise connected a pair of nonpolar capacitors 24, 25. The capacitors 22, 23, 24, 25 are each chosen to have a capacity which is sufficiently low to leave the capacity of the electrolytics 20, 21 largely unaffected but sufficiently large to allow a substantial proportion of the audio frequency range to pass through them.

Capacitors 22, 24 are of metallized paper in the value range 10 to 100 μ F and the

capacitors 23, 25 are of Mylar film type and similar value.

According to the inventor, "nothing is known about what effect is exerted on sound signals by the non-linearity of the inner loss of the capacitors relative to audio frequency" but he believes that electrolytics as used in audio amplifiers are non-linear in this respect.

He also believes that the connection of various given types of nonpolar capacitor in parallel with the electrolytics causes the collective inner loss-frequency characteristics of all the capacitors to be linear over the audio range. The number of nonpolar capacitors is not limited to two, and three or more may be used as necessary to provide linearity.

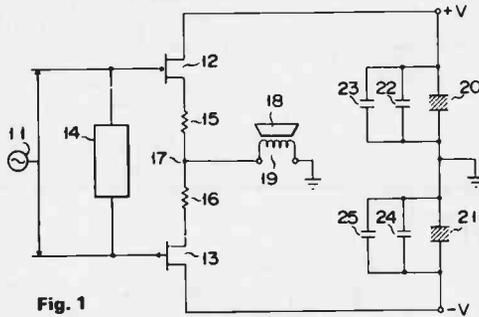


Fig. 1

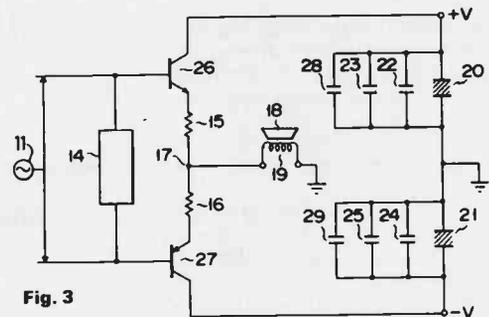


Fig. 3

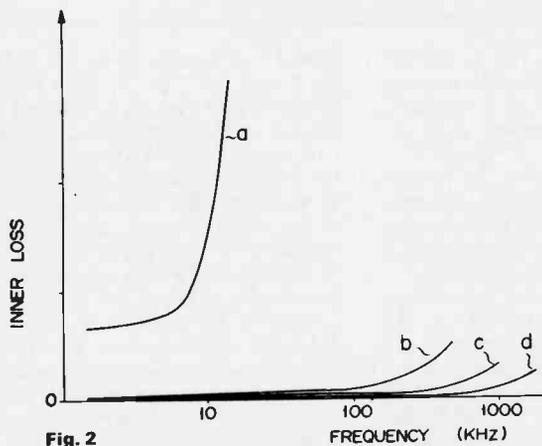


Fig. 2

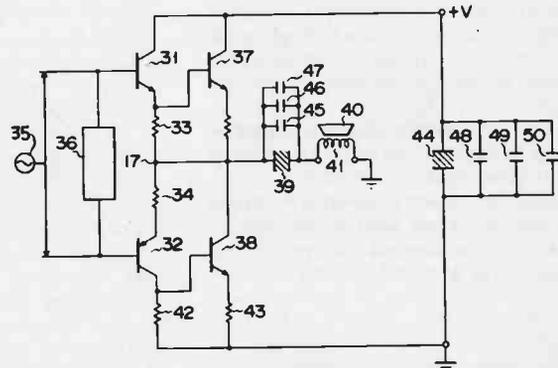


Fig. 4

EMI Ltd. in BP 1 497 394 describe an interesting approach to the eradication of low frequency noise or rumble from recorded or transmitted signals. The invention makes use of the fact that little or no directional information is derived from low frequency signals. EMI put the dividing line between high and low frequencies at 200Hz and although it is arguable that this figure is too high (i.e. that frequencies below 200Hz can carry directional information) this argument does not effect the basic theory of the invention.

As shown in Fig. 1 the recording or transmission system is fed with left and right channel signals L and R, each composed of high and low frequencies. Thus $L = L_h + L_l$ and $R = R_h + R_l$. The signals in the left channel ($L_h + L_l$) frequency modulate a carrier frequency, eg. at 300kHz, in modulator 3. The signals in the right channel are inverted at 4 and the inverted signals ($-R_h - R_l$) frequency modulate at 5 a carrier of the same (or different) frequency. The frequency modulated signals are recorded at 6, which may be an f.m. tape recorder or disc.

The reproduction circuit is shown in Fig. 2. The f.m. signal is first demodulated at 8, 9. The demodulated signals will inevitably now contain some unwanted low frequency noise which is represented by r. Because the two recorded channels have been derived from the same tape track, or record groove, the rumble components are virtually identical in magnitude and phase. Thus the signals in the left channel are, after demodulation, ($L_h + L_l + r$) and the signals in the right channel are ($-R_h - R_l + r$). The right channel signals are now inverted to produce ($R_h + R_l - r$) so that the rumble components r in the two channels are now in exact anti-phase. They can thus easily be removed by the matrixing circuit 11. The final output is thus free from all the low frequency noise introduced by the process.

RUMBLE ERADICATION

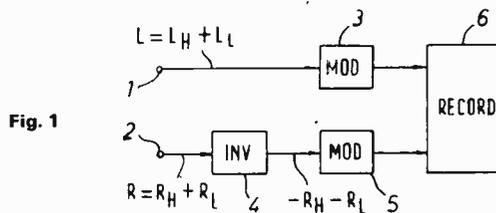


Fig. 1

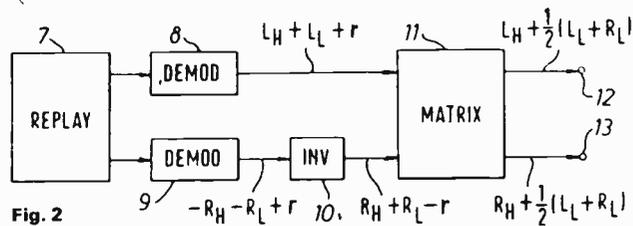


Fig. 2

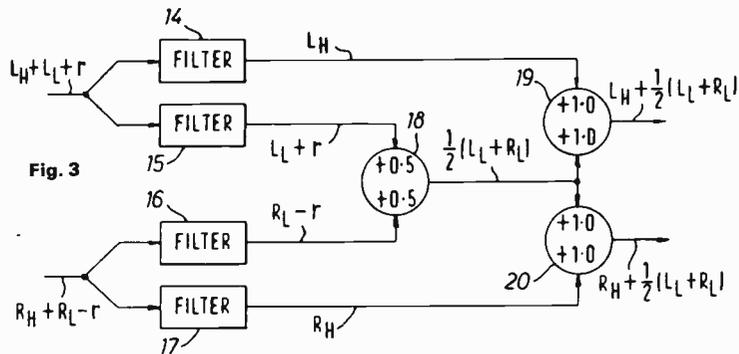


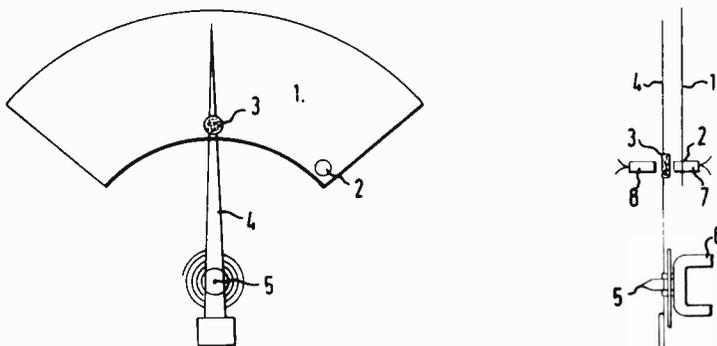
Fig. 3

An idea for a meter which automatically changes scale to avoid under and overload and provide the most accurate read out available, is patented by Lawrence Large of Sussex in BP 1 507 466. Although the idea is simple it could well prove valuable.

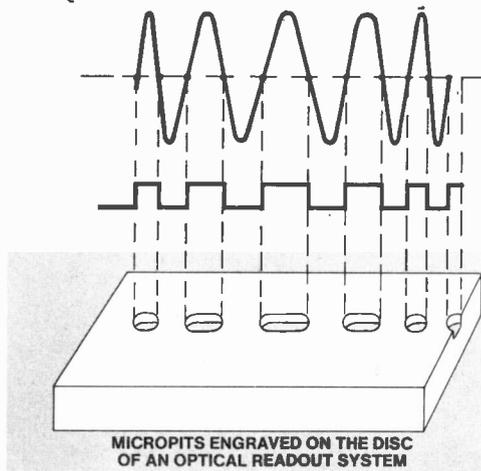
As shown the meter scale 1 has a perforation 2 at the "higher" end. A photoelectric cell 7 lies underneath this perforation and normally receives light from source 8. The meter pointer carries a blanking plate 3 which is dimensioned to obscure the perforation 2 as soon as the pointer is driven towards the dial stops. In this way light to the photo cell is blocked and this change of state is sensed to switch the meter scale to the next higher range.

A similar approach can be adopted at the low end of the scale with obstruction of another light path sensed to switch the meter down to a more sensitive scale. If successfully adopted such a system could prevent overload of a dial meter while at the same time optimising accuracy by selecting always the most sensitive, but safe, scale for the reading in hand.

RANGE CHANGING



News Briefs



DISC FULL OF HOLES

MANY developments have been made over the last few years on various picture recording and playback systems for television. In 1968, THOMSON-CSF considered that one of the best ways to solve this significant problem and offer new applications, was an optically scanned videodisc system. The disc is recorded as a continuous spiral track. This track consists of a succession of $0.6\mu\text{m}$ (approx.) wide micro-holes whose length and spacing varies in terms of modulation. The pitch between the spirals is about $1.6\mu\text{m}$. Upon reading, the light beam originating from a low power laser focused onto the spinning disc through a large aperture lens is modulated when passing through the holes (variable diffraction). A set of photo-electric sensors located underneath the transparent disc collects this modulation and changes it into an electric signal. After demodulation, the resulting signal reproduces the recorded video signal.

Each revolution of the disc corresponds exactly to one television frame which permits indefinite freeze-framing (videotape can only be held for two seconds) and, providing more than 50 copies are produced from any one master, discs are cheaper than tapes. In addition, there is speedy random access to any of the 45,000 frames on each disc (taking about two seconds from selection to presentation), and the disc can be played forwards or backwards at normal, fast or slow speeds without any wear. The recording is made, initially, on a polished glass disc covered with a $0.15\mu\text{m}$ -thick photo resist coating, the information being recorded on this photoresist by a modulated laser. The final, flexible PVC videodiscs, stamped by an electroformed die, give approximately 30 minutes continuous play, or access to 45,000 individual still pictures in full colour.

readout

... a selection from our postbag

Readers requiring a reply to any letter must include a stamped addressed envelope. Opinions expressed in Readout are not necessarily endorsed by the publishers of Practical Electronics.

Cheaper Ports

Sir—I wonder if I might, albeit somewhat belatedly, comment on the Semiconductor Update of the July '78 issue. The method suggested of obtaining eight 8-bit ports using eight 74251s is of course valid, but is rather expensive, as according to one advertiser these will cost a total of £12.00. A way of saving around a 'fiver' with no loss of elegance is to use 10 chips as follows:

8 × 74151 exactly as described	£6.48
2 × 4016 transmission gates	£1.08
	£7.56
saving	£4.44

All prices stated are from the same advertiser.

The two 4016s are connected between the outputs of the 74151s and the data bus and their eight control lines are connected to wherever the selects of the 74251 would have been connected.

A further advantage, over and above that of pure cost saving, is that, if a mishap should occur, and the databus drivers and the port controller should disagree as to who has the

bus, it is likely that it would be possible to get away with replacing £1.08 worth of CMOS rather than £12.00 worth of 74251s.

J. McCarthy,
Dulwich, London.

Well-er!

Sir—I read with interest Mr D. J. Bradbury's article in the August issue concerning Weller soldering irons. A few months ago I was faced with the same problem, namely running a 24V iron from a 12V source. My solution is, I think, far more elegant. It does away with D1, D2, D3, TR1, R1, C1 and C2 in Mr Bradbury's project. In fact the only component necessary is a 12V element part number HE60 (12) for the TCP1 or part number HE2 (12) for the TCP2 iron. You must surely agree that the best circuit is always the simplest one!

N. Goldring,
Reading.

We agree that the best circuit is the simplest—provided it does not have any drawbacks! The Weller element costs £4.80 and it is necessary to solder it in, so you must either purchase a complete 12V iron (at greater ex-

pense) or change the element every time—could be difficult if you only have the one iron!

Seriously though, we were not aware that 12V elements were available—nor was our contributor, who works for a large British equipment and component manufacturer! However, our unit can be built for approximately the same price as the element and is very much more convenient to use.

No oh!

Sir—A slip of the pen seems to have gone into print in Walter Hediger's neat little pH meter (August issue).

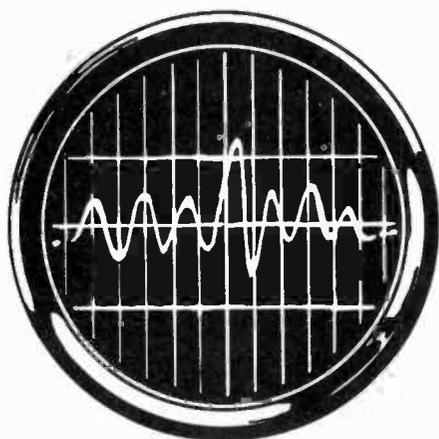
The scale is of course logarithmic in concept and so "0" should not appear on it. This may seem a small point but since all log. based scales can be divided ad infinitum it is a pity to spoil the effect by an error of principle.

Far better on log. scales to have a small space then start with "1". In the case of pH a value of "0" would imply some "absolute acid" capable of dissolving anything—including the meter probe.

R. E. Hurst,
Blackpool.

LOOK! Here's how you master electronics

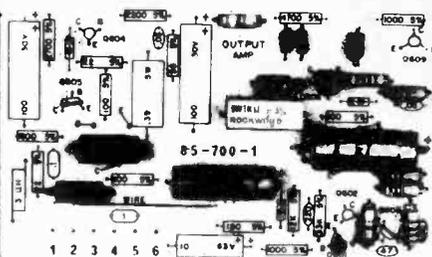
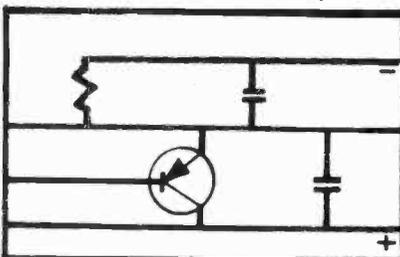
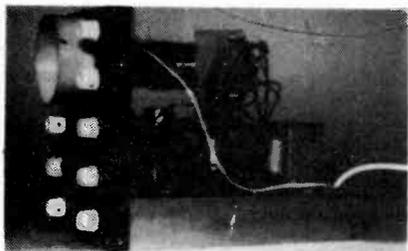
... the practical way



This new style course will enable anyone to have a real understanding of electronics by a modern, practical and visual method. No previous knowledge is required, no maths, and an absolute minimum of theory.

You learn the practical way in easy steps mastering all the essentials of your hobby or to further your career in electronics or as a self-employed electronics engineer.

All the training can be carried out in the comfort of your own home and at your own pace. A tutor is available to whom you can write, at any time, for advice or help during your work. A Certificate is given at the end of every course.



1 Build an oscilloscope

As the first stage of your training, you actually build your own Cathode ray oscilloscope! This is no toy, but a test instrument that you will need not only for the course's practical experiments, but also later if you decide to develop your knowledge and enter the profession. It remains your property and represents a very large saving over buying a similar piece of essential equipment.

2 Read, draw and understand circuit diagrams

In a short time you will be able to read and draw circuit diagrams, understand the very fundamentals of television, radio, computers and countless other electronic devices and their servicing procedures.

3 Carry out over 40 experiments on basic circuits

We show you how to conduct experiments on a wide variety of different circuits and turn the information gained into a working knowledge of testing, servicing and maintaining all types of electronic equipment, radio, t.v. etc.



All students enrolling in our courses receive a free circuit board originating from a computer and containing many different components that can be used in experiments and provide an excellent example of current electronic practice.

Free!

To find out more about how to learn electronics in a new, exciting and absorbing way, just clip the coupon for a free colour brochure and full details of enrolment.

British National Radio & Electronic School

P.O. Box 156, Jersey, Channel Islands.

NAME

ADDRESS

PEB10

Block caps please

CANON COMPONENTS

OFFER A FANTASTIC RANGE AT VERY COMPETITIVE PRICES including . . .

- | | | |
|-----------------|--------------------|-------------------|
| • R.F. | • SPEAKERS | • LEADS |
| • DIGITAL | • CABINETS | • PLUGS |
| • TRANSISTORS | • AMPLIFIERS | • JACKS |
| • LINEAR I.C.'s | • MICROPHONES | • POWER SUPPLIES |
| • DISPLAYS | • MIXERS | • METERS |
| • LED'S | • HEADPHONES | • SURPLUS ITEMS |
| • RESISTORS | • TURNTABLES | • TAPES |
| • CAPACITORS | • LIGHT MODULATORS | • RADIO'S |
| • HARDWARE | • LIGHT BOXES | • CALCULATORS |
| • CHASSIS | • SPOTS | • TEST EQUIPMENT |
| • BOXES | • BULBS | • KITS |
| • S-DEC | • JINGLE MACHINES | • VERO BOARD |
| • T-DEC | • PACKS | • SOLDERING IRONS |
| • TRANSFORMERS | • TWEETERS | • SOLDER |

PHONE OR SEND S.A.E. FOR LISTS ACCESS OR BARCLAYCARD ACCEPTED

322-324 WHITEHORSE ROAD CROYDON SURREY CRO 2LF

OPEN DAILY 9.30 A.M. - 6 P.M.

TEL. 01-684 9872

WORLD RADIO TV HANDBOOK 1978

by J. M. Frost

Price: £8.00

A PRACTICAL INTRO. TO ELECTRONIC CIRCUITS by M. H. Jones Price: £4.60

THE TTL DATA BOOK FOR DESIGN ENGINEERS by Texas Price: £5.65

THE OSCILLOSCOPE IN USE by I. R. Sinclair Price: £2.75

AUDIO AMPLIFIERS FOR THE HOME CONSTRUCTOR by I. R. Sinclair Price: £2.55

VIDEOTAPE RECORDING by J. F. Robinson Price: £7.60

IC OP-AMP COOKBOOK by W. G. Jung Price: £10.00

LINEAR INTEGRATED CIRCUIT APPLICATIONS by G. B. Clayton Price: £5.30

FOUNDATIONS OF WIRELESS & ELECTRONICS by M. G. Scroggie Price: £2.40

BEGINNER'S GUIDE TO ELECTRONICS by T. L. Squires Price: £2.55

THE RADIO AMATEUR'S HANDBOOK 1978 by A.R.R.L. Price: £7.60

* PRICES INCLUDE POSTAGE *

THE MODERN BOOK CO.

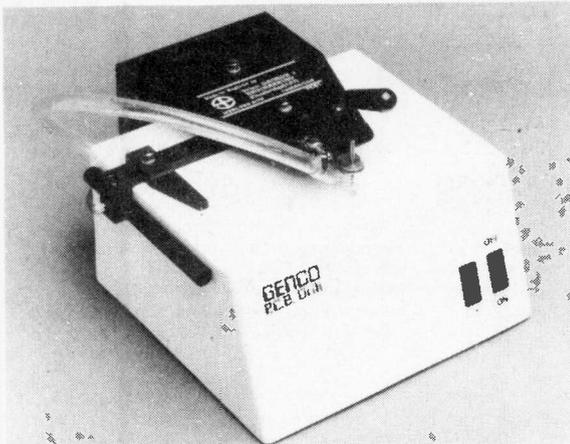
BRITAIN'S LARGEST STOCKIST of British and American Technical Books

19-21 PRAED STREET LONDON W2 1NP

Phone 01-723 4185

Closed Saturday 1 p.m.

A New PCB Drilling Machine



A Printed Circuit Board Drilling Machine, suitable for production or modification of circuit boards. The machine, by way of its kinetic design, is in fact a chuckless Drilling Machine, requiring no guide bushes for the turbo shank tungsten carbide drills.

The drills run in vee blocks at the drill arm end and, therefore, run perfectly accurately at speeds of 15,000 r.p.m.

- ★ FAST WORK THROUGHPUT
- ★ INTEGRAL VACUUM ATTACHMENT FOR SWarf DISPERSAL
- ★ FULLY ADJUSTABLE BACK STOP AND SIDE GAUGE
- ★ REAR OF MACHINE LIFTS FOR CIRCUIT MODIFICATIONS
- ★ ADJUSTING SCREW TO FACILITATE TRACKCUTTING
- ★ 0.2mm - 2mm DRILLS

Made in England by



brian GEORGE ENGINEERING (Cambridge) LTD

MERCERS ROW, CAMBRIDGE. 57744

Trade and Export Enquiries Welcome

Cash with Order add £2.00 P.P. and VAT



Barclaycard or Access. Quote Name, Address & Card Number.



SINCLAIR PRODUCTS*

Microvision TV now in stock £200. PDM35 digital multimeter £27-25. Mains adaptor £3-24. De-luxe padded case £3-25. 30kV probe £18-36. New DM235 digital multimeter £47-50. Cambridge programmable scientific calculator £13-15. Prog. library £2-95. Mains adaptor £3-20. Enterprise programmable calculator £20-95.

S-DECS AND T-DECS*

S-DeC £3-39. T-DeC £4-44. u-DeCa £4-52. u-DeC8 £6-73. 16 dill or 10T05 adaptors with sockets £2-14.

CONTINENTAL SPECIALITIES

PRODUCTS* EXP300 £6-21. EXP350 £3-40. EXP600 £6-80. EXP650 £3-89. EXP48 £2-48. P86 £9-94. P8100 £12-74. LM1 £30-99. LP1 £33-48. LP2 £19-44.

TV GAMES

Send sae for free data. New racing car TV games chip AY-3-8603 plus economy kit £20-60. Tank battle chip AY-3-8710 plus economy kit £13-95. Stunt motor cycle chip AY-3-8760-1 plus economy kit £12-50. 10 game paddle 2 chip AY-3-8600 plus economy kit £8-95. Modified shoot kit £4-95. Rifle kit £4-95. Colour generator kit £7-50. Attractively cased, assembled TV games- stunt cycle £25-95, tank war game £39-95, 4 game models (tennis, football, squash, pelota)- black and white £11-95, colour £14-50. De-luxe 6 game b/w model with pistol attachment £17-95.

MAINS TRANSFORMERS

6-0-6V 100ma 79p. 1½A £2-35. 6.3V 1½A £1-89. 9-0-9V 75ma 79p. 1A £1-99. 2A £2-60. 12-0-12V 50ma 79p. 100ma 90p. 1A £2-45. 13V 1A 95p. 15-0-15V 1A £2-79. 30-0-30V 1A £3-59.

JC12, JC20 AND JC40 AMPLIFIERS

A range of integrated circuit audio amplifiers supplied with free data and printed circuits JC12 6 watts £1-60. JC20 10 watts £2-95. JC40 20 watts £4-20. Send sae for free data on our range of matching power and preamp kits.

FERRANTI ZN414

IC radio chip £1-05. Extra parts and pcb for circuit £3-85. Case £1. Send sae for free data.

PRINTED CIRCUIT MATERIALS

PC etching kits- economy £1-70, standard £3-82. 50 sq ins pcb 40p. 1 lb FeCl £1-05. Etch resist pens- economy 45p, dalo 73p. Small drill bits ¼ ins or 1 mm 20p each. Etching dish 68p. Laminiate cutter 75p.

BATTERY ELIMINATORS

3-way models with switched output and 4 way multi-jack: 3/4/6V 100ma £2-92. 6/7/9V 300ma £3-30. 100ma radio models same size as a PP9 battery with press stud connectors. 9V £2-85. 6V £2-85. 4½V £2-85. 9Vx9V £4-50. 6Vx6V £4-50. 4½Vx4½V £4-50. cassette recorder mains unit 7½V 100ma with 5 pin din plug £2-85. car converters 12V dc input. Output 9V 300ma £1-50. Output 7½V 300ma £1-50.

BATTERY ELIMINATOR KITS

Send sae for free leaflet on range. 100ma radio types with press stud connectors. 4½V £1-80. 6V £1-80. 9V £1-80. 4½+4½V £2-50. 6+6V £2-50. 9x9V £2-50. cassette type 7½V 100ma with din plug £1-80. heavy-duty 13 way types 4½/6/7/8½/11/13/14/17/21/25/28/34/42V. 1 Amp £4-65. 2 Amp £7-25. translator stabilized 8-way types for low hum 3/4/6/7/9/12/15/18V 100ma £3-20. 1 Amp £6-40. variable voltage stabilized models. 2-18V 100ma £3-60. 2-30V 1A £6-95. 2-30V 2A £10-95. car converters 12V dc input. Output 9V 300ma £1-50. Output 7½V 300ma £1-50.

BI-PAK AUDIO MODULES

Send sae for data. S450 tuner £23-51. AL60 £4-86. PA100 £16-71. SPM80 £4-47. BMT80 £5-95. MK60 £38-74. Stereo 30 £20-12.

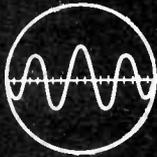
BULK BUY OFFERS

Minimum purchase £3 any mix from this section. IN4148 1.3p. IN4002 3.6p. 8C212 8p. 741 8 dill 15p. NE555 8 dill 29p. 723 14 dill 43p. Dalo pens 59p. AC76023N exact equiv. of SN76023N with improved heat sink 79p. Plastic equivs. of popular transistors- BC108 3.8p. BC109 4.4p. 8C7V1 4.7p. BCY22 4.4p. fuses 20 mm x 5 mm cartridge .25, .5, 1, 2, 3, 5 Amp. Quickblow type 0.7p. Antisurge type 3.4p. resistors 5% E12 10 ohm to 10M. ¼W 0.8p. 1W 1.9p. polyester capacitors 250V .01, .022, .033, .047mf 2.7p. .015mf 1.1p. .068mf 1.4p. 0.1mf 1.5p. 0.22mf 3p. 0.33mf 2.5p. 0.47mf 4.8p. polystyrene capacitors E12 63V 15 to 6800pf 21p. ceramic capacitors 50V E12 22pf to 1000pf 1.7p. E6 1500 to 33000pf 1.7p. 47000pf 2p. electrolytics 50V 47, 1, 2mf 5p. 25V 5mf 5p. 10mf 4p. 16V 22mf 5p. 33, 47, 100mf 6p. 220, 330mf 9p. 470mf 11p. 1000mf 12p. zeners 400mW E24 2V7 to 33V 6.1p. preset pots subminiature 0.1W horiz. or vert. 100 to 4M7 6.8p. potentiometers ¼W 4K7 to 2M2 log or lin. single 26p. dual 76p.

SWANLEY ELECTRONICS

DEPT. P.E., 32 Goldsel Rd., Swanley, Kent BR8 8EZ

Mail order only. Please add 30p to the total cost of order for postage. Prices include VAT. Overseas customers deduct 7% on items marked * and 11% on others. Official credit orders welcome.



TUAC

TRANSISTOR UNIVERSAL AMPLIFICATION CO. LTD.
 PHONE 01-672 3137/672 9080
 MANUFACTURERS OF QUALITY AMPLIFICATION AND LIGHTING
 CONTROL SYSTEMS

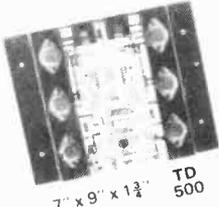
PRICES INCLUDE VAT. P & P FREE

correct at 1.8.78

TO ORDER BY POST

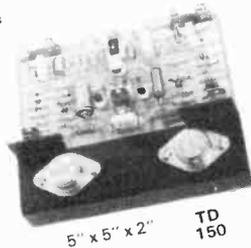
Make cheques/P.O.s payable to TUAC LTD. (PE108) or quote Access/Barclaycard No. and post to TUAC LTD. (PE108) 119 Charimont Road, London SW17 9AB. We accept phone orders from Access/Barclaycard Holders. Phone 01-672 9080.

NEW FROM TUAC ULTRA QUALITY HIGH POWER New D.C. Coupled Design AMPLIFIERS



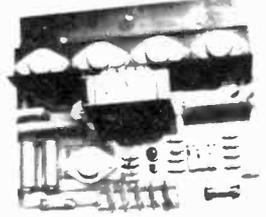
- T.H.D. at full power 0.1%
- T.D. 500 300W into 2 Ohms
- 220W into 4 Ohms
- 140W into 8 Ohms
- Power supply P.S. 300 **£45.00**
- T.D. 150 150W into 4 Ohms **£30.00**
- 100W into Ohms **£26.25**
- Power supply P.S. 150 **£18.50**
- T.D. 150. 60 Version 60W into 8 Ohms
- 40W into 15 Ohms **£17.75**
- Power supply P.S. 60 **£15.50**

Note P.S. 300 will drive 2 T.D. 150 amplifiers



All output ratings are R.M.S. continuous sine wave output.

AMPLIFIER MODULES



SPEC. INPUT SENSITIVITY 60 mV for full output
Frequency response 20 Hz-20 KHz
HUM & NOISE -70 dB

- TL30** 5" x 5" x 2"
 * 35 watt 10 amp output transistors **£13.25**
- TL60** 5" x 5" x 3"
 * 60 watt R.M.S. continuous sine wave output
 * 2 R.C.A. 110 watt 15 amp output transistors **£18.50**
- TL100** 5" x 5" x 3"
 * 100 watt R.M.S. continuous sine wave output
 * 2 R.C.A. 150 watt 15 amp output transistors **£21.50**
- TP125** 7" x 6 1/2" x 3"
 * 125 watt R.M.S. continuous sine wave output
 * 4 R.C.A. 150 watt 15 amp output transistors **£27.50**

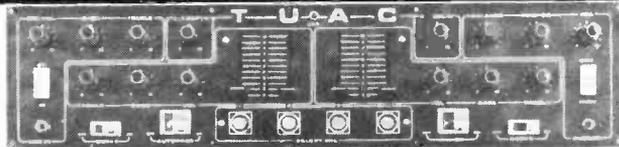
4 CHANNEL SOUND TO LIGHT SEQUENCE CHASER - 4LSM1

- Full wave control
- RCA 8A Triacs
- 1000W per channel
- Fully suppressed and fused
- Switched master control for sound operation from 1/2 W to 125W
- Speed control for fixed rate sequence from 8 per minute to 50 per second
- Full logic integrated circuitry with optical isolation for amplifier protection

£21.50

Model 501 500W per channel as above without sound triggering

£14.00



STEREO DISCO MIXER

With touch sensitive switching and auto fade

INPUTS: Four identical stereo inputs available with any equalisation. Two magnetic and two flat supplied as standard. High quality slider control on each channel. Volume, treble and bass controls for each pair of sliders. Sensitivity mag. 3mV (R.I.A.A. comp.) Flat 50mV at 1kHz. Bass controls ± 18 dB at 60Hz. Treble controls ± 18 dB at 15kHz.

OUTPUT: Up to 3 volts (+12dB) available. Attenuated output for TUAC Power Modules. Rotary master and balance controls. Band width 15Hz - 25kHz \pm dB.

P.F.L.: Output 250mV into 8 ohms. Rotary volume control. Monitoring facility for all 4 channels. Selection via touch sensitive illuminated switches. Switched visual cue indicator.

Miscellaneous Facilities: Two illuminated deck on/off switches. Mains illuminated on/off switches. Auto fade illuminated on/off switch. Mains powered with integral screen and back cover. Complete with full instructions.

Size: 25in long x 6in high x 3in deep

Mono Disco Mixer with autofade **£49.00**

£149.00

3 CHANNEL LIGHT MODULATOR SILMB

- RCA 8A Triacs
- 1000W per channel
- Each channel fully suppressed and fused
- Master control to operate from 1W to 125W
- Full wave control

£20.75

Single Channel Version 1500 Watts

£9.75



FRONT PANEL FOR LIGHTING EFFECT MODULES

(complete with switches, neons and knobs) as illustrated



For S1LMB **£7.25**
 Size 8" x 4 1/2"



4LSM1 **£6.00**
 Size 6 1/2" x 4 1/2"

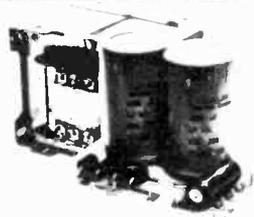


FUZZ LIGHTS
 Red, Green, Blue,
 Amber. **£24.50**



S1LMB **£8.25**
 Combined with 3SDM1
 Size 9" x 4 1/2"

POWER SUPPLIES



Vacuum varnish impregnated. Transformers with supply board incorporating pre-amp supply:

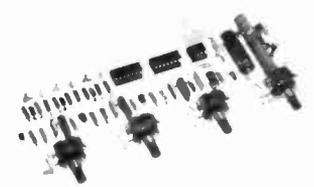
- PS250 for supplying 2 TP125s **£30.00**
- PS200 for supplying to TL100s **£30.00**
- PS60/60 for supplying 2 TL60s **£30.00**
- PS125 ± 45 volts for TP125 **£18.50**
- PS100 ± 43 volts for TL100 **£17.00**
- PS60 ± 38 volts for TL60 **£15.50**
- PS30 ± 25 volts for TL30 **£11.75**
- PSU 2 for supplying disco mixer **£7.50**

STOCKISTS - CALLERS ONLY

- A1 Music, 88, Oxford Street, Manchester (Tel 061-236 0340)
- Geo Mathews, 85/87, Hurst Street, Birmingham (Tel 021-622 1941)
- Soccodi, 9, The Friars (Tel Canterbury 60948)
- Cookies Disco Centre, 126/128, West Street (Tel Crewe 4739)
- Garland Bros. Ltd., Deptford Broadway, London 01-692 4412
- Luton Disco Centre, 88, Wellington Street, Luton (Tel Luton 411733)
- Session Music, 163, Mitcham Road, Tooting (Tel 01-672 3413).
- Mon-Sat 10am to 6pm. Closed Wed.

TRADE & EXPORT ENQUIRIES 01-672-3137

ADD SEQUENCE CHASING + DIMMING EFFECTS FOR TUAC 3 CHANNEL LIGHT MODULATOR



- Speed Control 3 per min. to 10 per sec.
- Full logic integrated circuitry
- Dimmer control to each channel

3SDM1 **£15.25**

SUPPLIERS TO H.M. GOVT. DEPTS. MANUFACTURED AND ASSEMBLED IN GT. BRITAIN FULLY TESTED AND GUARANTEED
 SEND NOW FOR OUR FREE 28 PAGE ILLUSTRATED CATALOGUE. SEND STAMP PLEASE

TRAIN FOR SUCCESS

in Radio, Television & Electronics

ICS have helped thousands of ambitious people to move up into higher paid more secure jobs in the field of electronics - now it can be your turn. Whether you are a newcomer to the field or already working in the industry, ICS provide you with the specialised training so essential to success.

Personal Tuition and Guaranteed Success

The expert and personal guidance by fully qualified tutors, backed by the ICS guarantee of tuition until successful, is the key to our outstanding record in the technical training field. You study at the time and pace that suits you best and in your own home. In the words of one of our many successful students: "Since starting my course, my salary has trebled and I am expecting a further increase when my course is completed."

City and Guilds Certificates

Excellent job prospects await those who hold one of these recognised certificates. ICS can coach you for:

- Telecommunications Technicians
- Radio, T.V. Electronics Technicians
- Technical Communications
- Radio Servicing Theory
- Radio Amateurs
- Electrical Installation Work
- Also MPT Radio Communications Certificate

Diploma Courses

Colour T.V. Servicing
Electronic Engineering & Maintenance
Computer Engineering and Programming
Radio, T.V. and Audio, Engineering & Servicing
Electrical Engineering, Installations & Contracting

Other Career Courses

A wide range of other technical and professional courses are available including GCE.

FREE BOOK

Post this coupon or 'phone today for free ICS careers guide.

Name _____

Address _____

Age _____

ICS

To ICS, Dept. 273Z, Intertext House, London SW8 4UJ or telephone 01-622 9911 (all hours)

100 PIV 25 Amp S.C.R.'s Branded for 40p.
100 PIV 10 Amp BRANDED DIODES @ 15p each.
3 PIN PLUG AND SOCKET like RS European type with 2 metres of Cable. 75p pr.
1uf 25v.w. ELECTROLYTIC CAPACITORS 6 for 25p.
MULLARD PRE-AMPLIFIER I.C. TYPE TAA 435 @ 40p.
SUB-MINIATURE TANTALUM CAPACITOR 4.7uf 10v.w. @ 6 for 25p.
6 WATT WIRE WOUND POTENTIOMETERS 1.2K @ 22p each.
0.2" LED's Red @ 15p, Green @ 18p.
ITT CAPACITORS TYPE PMT-2R Miniature .1uf 100v.w. @ 20p doz.
DISC CERAMICS - .1uf 18v.w. @ 25p doz.
5 TURN POTENTIOMETERS 5K @ £1, TEN TURN 1K, 5K, 100K @ £1.50.
400mW UNMARKED GOOD ZENERS 3.6v, 6.8v, 10v, 11v, 12v, 13v, 16v, 24v, 30v, 33v, 36v. All at 10 for 40p.
GENERAL PURPOSE FETS E111 @ 12p, 5 for 50p, E112 @ 10p, 5 for 45p, E113 @ 12p, 5 for 50p, E174 @ 22p, 5 for 85p, VHF J310 @ 20p.
200 ASSORTED 1/2 WATT RESISTORS for 75p.
50. 2 WATT ZENERS Assorted untested for 57p.
IS44 SILICON DIODES at 25p doz.
10 ASSORTED MULTI TURN PRE-SET POTENTIOMETERS @ 60p.
100 ASSORTED MULLARD C280 CAPACITORS for 57p.
TBA 120S FM I.C.'s Untested with data. 6 for 60p.
MULLARD ELECTROLYTICS 2240uf 40v.w. @ 40p, 4500uf 25v.w. @ 40p, 5000uf 10v.w. @ 15p, 6400uf 25v.w. @ 25p.
SUB-MINIATURE 8 OHM LOUDSPEAKERS 1 1/2" dia - @ 75p.
12 X BAND VARACTOR DIODES for £1.
X BAND GUNN DIODES with data @ £1.65 each.
ILLUMINATED EDGEWISE 200uA METERS at £1.25 each.
DIE CAST BOXES 4" x 2" x 1" @ 55p, 4 1/2" x 2 1/2" x 1 1/2" @ 65p, 4 1/2" x 2 1/2" x 1 1/2" @ 85p, 6" x 3 1/2" x 2" @ £1.15.
60 ASSORTED WIRE WOUND RESISTORS 1 to 10 watt @ 57p.
MINIATURE ROTARY SWITCHES 2 Pole 4 way @ 20p.
50. BC 107-8-9 TRANSISTORS Untested @ 57p.
50. AC 128 TRANSISTORS Branded but untested @ 57p.
ERIE RED CAP .01uf 100v.w. CAPACITORS @ 5p each.
1 Amp TRANSISTORS PNP BCX36 @ 12p, BCX37 @ 10p.
100 ASSORTED DISC CERAMICS for 57p.
30 10XAJ CRYSTALS Assorted between 5100 to 7900KHz @ £1.10.
5 WATT NPN DARLINGTON TRANSISTORS @ 20p, 3 for 50p.
CLOCK P. C. BOARDS with Buzzar, Mercury Switch, Bridge Rectifier, Transistors etc. No data £1.
MEDIUM POWER TRANSISTORS MP 8112 @ 15p, MP 8512 @ 15p.
MOS LEVEL SENSOR TAA 320A with data @ 35p.
20 PHOTO TRANSISTORS DARLINGTONS Untested for £1.
MCMURDO 8 PIN PLUGS @ 20p, 8 Pin Sockets @ 20p, Covers @ 15p.
NKT 214 TRANSISTORS equivalent to OC 71 @ 10p, 6 for 50p.
MAINS TRANSFORMERS 240 volt input Type 1. 22-0-22 volt 500mA @ £1.60 (P&P 25p), Type 2. 24 volt Tapped at 14 volt 1 amp @ £1.30 (P&P 25p), Type 3. 50 volt 10 amp @ £5.50 (P&P 95p), Type 4. 50 volt 2 amp, 45 volt 500mA @ £3.50 (P&P 85p), Type 5. 20 volt 1 amp Twice, 10 volt 1 amp twice @ £4.50 (P&P 95p).
2200uf 100v.w. @ 60p, 100uf 100v.w. @ 6 for 25p, 4700uf 63v.w. @ 50p.
3300uf 63v.w. @ 50p. ELECTROLYTICS.
2 GHz STRIPLINE NPN TRANSISTORS @ £1 each.

Please add 20p for post and packing, unless otherwise stated, on U.K. orders under £2. Overseas orders at cost.

J. BIRKETT
RADIO COMPONENT SUPPLIES
25 The Strait, Lincoln LN2 1JF Tel. 20767



TOPS THE PACK!

COMPONENTS - Now over 1,000 types in stock.
KITS - See the new range of low-cost 'ELEKITS'.
MODULES - New ready-built functions.
SERVICE - 1st Class same day despatch.
QUALITY - All guaranteed products.
PRICES - Many reductions!
MAGAZINE PROJECTS - Trouble-free!

LOOK

Our 2nd edition illustrated catalogue is now available. The much increased range shows many welcome reductions.

INTRODUCING

FABULOUS

ELEKITS

Easy build introduction to electronics. Many hours of enjoyment.

NOW AVAILABLE!

The new range of easy build kits complete with simple to follow instructions. Battery powered (not supplied). With case.

- * BURGLAR ALARM * ROULETTE
- * BICYCLE SOUND FLASHER
- * WATER LEVEL ALARM * SIREN
- * BLINKER * TIME SWITCH

Many others in preparation - included in full ACE catalogue - send S.A.E. for free brochure of kit range.



Mini ORGAN
only £7.95



MORSE TRAINER
only £4.95

PRICES Inc. VAT

I enclose 30p*, please send catalogue.

Name _____
Address _____

* Refundable with future orders over £5.00.

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 £6.27 + 78p VAT. P. & P. free

HY5 mounting board B.1. 48p + 6p VAT. P. & P. free



HY30 15W into 8 Ω

The HY30 is an exciting New kit from I.L.P. It features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of: I.C., heatsink, P.C. board, 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up to date technology available.

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 £6.27 + 78p VAT. P. & P. free

HY50 25W into 8 Ω

The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World.

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 £8.18 + £1.02 VAT. P. & P. free



HY120 60W into 8 Ω

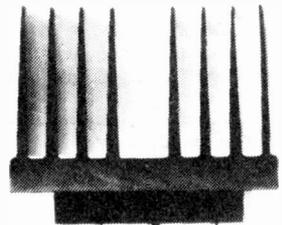
The HY120 is the baby of I.L.P.'s new high power range, designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design.

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 £19.01 + £1.52 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 50 x 85mm

Price £27.99 + £2.24 VAT. P. & P. free

HY400 240W into 4 Ω

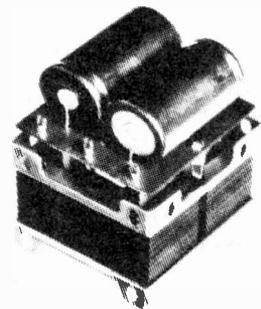
The HY400 is I.L.P.'s 'Big Daddy' of the range producing 240W into 4 Ω ! It has been designed for high power disco or public address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family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

Price £38.61 + £3.09 VAT. P. & P. free



POWER SUPPLIES: PSU36—suitable for two HY30s £6.44 + 81p VAT. P. & P. free. PSU50—suitable for two HY50s £8.18 + £1.02 VAT. P. & P. free. PSU70—suitable for two HY120s £14.58 + £1.17 VAT. P. & P. free. PSU90—suitable for one HY200 £15.19 + £1.21 VAT. P. & P. free. PSU180—suitable for two HY200s or one HY400 £25.42 + £2.03. VAT. P. & P. free.

Free post + packing applicable to U.K. only.

TWO YEARS' GUARANTEE ON ALL OUR PRODUCTS

I.L.P. Electronics Ltd.
Crossland House,
Nackington, Canterbury
Kent CT4 7AD
Tel (0227) 63218

Please supply

Total Purchase price

I Enclose: Cheque Postal Orders Money Order

Please debit my Access account Barclaycard account

Account number

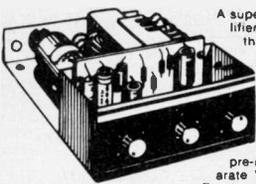
Name and Address

Signature

Registered office No 1032630

Signature

SUPERSOUND 13 HI-FI MONO AMPLIFIER



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 ± 3 db 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 3in high \times 6in wide \times 7in deep AC 200/250V PRICE £15.00 P & P £1.20

HARVERSONIC MODEL P.A. TWO ZERO

An advanced solid state general purpose mono amplifier suitable for Public Address system, Disco, Guitar, Gram, etc. Features 3 individually controlled inputs (each input has a separate 2 stage pre-amp). Input 1, 15mV into 47k. Input 2, 15mV into 47k (suitable for use with mic. or guitar etc.). Input 3, 200mV into 1 meg. suitable for gram, tuner, or tape etc. Full mixing facilities with full range bass & treble controls. All inputs plug into standard jack sockets on front panel. Output socket on rear of chassis for an 8 ohm or 16 ohm speaker. Output in excess of 20 watts R.M.S. Very attractively finished purpose built cabinet made from black vinyl covered steel, with a brushed anodised aluminium front escutcheon. For ac mains operation 200/240 volts. Size approx 12in wide \times 5in high \times 7in deep

Special introductory price £28.00 - £2.50 carriage and packing.

Mullard LP1159 RF-IF module 470 kHz £2.25 + P & P 20p. Full specification and connection details supplied. Pye VHF FM Tuner Head covering 88-108 MHz 10.7 MHz I.F. output, 7-SV + earth. Supplied pre-aligned, with full circuit diagram with precision-gear F.M. gang and 323PF + 323PF A.M. Tuning gang only £3.15 + P & P. 35p.

STILL AVAILABLE HA34 3 Valve Audio Amp. 4 $\frac{1}{2}$ W o/p. Ready built and tested £8.50 - £1.40 P & P.

Also HSL 'Four' Amp. Similar to above but in kit form. £8.00 - £1.40 P & P.



MAINS OPERATED SOLID STATE AM/FM STEREO TUNER



200/240V Mains operated Solid State F.M. A.M. Stereo Tuner. Covering M.W. A.M. 540-1605kHz V.H.F. F.M. 88-108MHz. Built-in Ferrite rod aerial for M.W. Full AFC and AGC on A.M. and F.M. Stereo Beacon Lamp Indicator. Built-in Pre-amps with variable output voltage adjustable by pre-set control. Max. o/p Voltage 600mV R.M.S. into 20K. Simulated Teak finish cabinet. Will match almost any amplifier. Size 8in wide \times 4in high \times 9in deep approx. Limited number only at £28.00 + £1.50 P & P.

MAINS TRANSFORMER, PRI. 0-110 and 240. SEC. 28V at 1.8 amps. Also tapped at 12V. 3 amp. Overall size 2 $\frac{1}{2}$ " x 3 $\frac{1}{2}$ " x 2 $\frac{1}{2}$ " d. £2.50 + P&P £1.00.

10/14 WATT HI-FI AMPLIFIER KIT

A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-150 speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up: 2 EL84s, ECC83, EF85 and EZ80 rectifier. Simple instruction booklet 25p + S.A.E. (Free with parts). All parts sold separately. ONLY £14.50 P & P. £1.40. Also available ready built and tested £19.00 P & P. £1.40.

"POLY PLANAR" WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER

Size 11 $\frac{1}{2}$ in \times 14 $\frac{1}{2}$ in \times 1 $\frac{1}{2}$ in deep. Weight 19oz. Power handling 20W R.M.S. (40W peak). Impedance 8 ohm only. Response 40Hz-20kHz. Can be mounted on ceilings, walls, doors, under tables, etc. and used with or without baffle. Send S.A.E. for full details. Only £8.40 each + P & P. (one 90p, two £1.10). Now available in either 8in round version or 4 $\frac{1}{2}$ \times 8 $\frac{1}{2}$ in rectangular. 10 watts R.M.S. 60Hz-20kHz £5.25 + P & P. (one 65p, two 75p.).

MAGNETIC PRE-AMP Lens. 3mV in for 100mV out. 15 to 35V neg. earth. Equ. ± 1 dB from 20Hz to 20kHz. Input impedance 47k. Size 1 $\frac{1}{2}$ in \times 2 $\frac{1}{2}$ in \times 5 $\frac{1}{2}$ in. £2.80 + 20p. P & P.

2in PLASTIC CONE HF TWEETER 4 ohm, £3.50 per matched pair + 50p. P & P.

HIGH POWER HI-FI 8 ohm Dome Tweeter. 1in voice coil. Magnet size 3in dia. Suitable for use in up to 50 watt systems. £4.50 each 60p. P & P.

HARVERSONIC SUPERSOUND 10 + 10 STEREO AMPLIFIER KIT

A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integral 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 metalwork, high quality ready drilled printed circuit board with component identification clearly marked. smart brushed anodised aluminium front panel with matching knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification. Power output 14 watts R.M.S. per channel into 5 ohms. Frequency response ± 3 dB 12-30,000Hz. Sensitivity better than 80mV into 1 M Ω . Full power bandwidth ± 3 dB 12-15,000Hz. Bass boost approx to ± 12 dB. Treble cut approx to ± 16 dB. Negative feedback 18dB over main amp. Power requirements 35V at 1A. Overall size 12in wide \times 8in deep \times 2 $\frac{1}{2}$ in high.

Fully detailed 7 page construction manual and parts list free with kit or send 25p plus large S.A.E.

AMPLIFIER KIT £13.50 P & P 80p (Magnetic input components 33p extra)

POWER PACK KIT £5.50 P & P. 95p

CABINET £5.50 P & P. 95p

SPECIAL OFFER—only £23.75 if all 3 items ordered at one time plus £1.25 P & P.

Full after sales service £31.25 P & P £1.50 Also available ready built and tested £31.25 P & P £1.50

HARVERSONIC STEREO 44

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 built in 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 rec play socket are mounted on the printed circuit panel. Size approx 9 $\frac{1}{2}$ in \times 2 $\frac{1}{2}$ in \times 1in 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 £9.00 + 50p. P & P. Mains transformer with an output of 17V a.c. at 500mA can be supplied at £1.50 - 40p. P & P. if required. Full connection details supplied.

STEREO DECOR SIZE 2" \times 3" \times 1" ready built. Pre-aligned and tested for 9-16V neg. earth operation. Can be fitted to almost any FM VHF radio or tuner. Stereo beacon light can be fitted if required. Full details and instructions (inclusive of hints and tips) supplied. £6.00 plus 20p P & P. Stereo beacon light if required 40p extra.

Open 9.30-5.30 Monday to Friday. 9.30-5 Saturday. Closed Wednesday. Prices and specifications correct at time of press. Subject to alteration without notice

HARVERSON SURPLUS CO. LTD.

(Dept. P.E.) 170 MERTON HIGH ST., MERTON, LONDON, S.W.19 Tel: 01-540 3985

A few minutes from South Wimbledon Tube Station

(Please write clearly)

PLEASE NOTE: P & P. CHARGES QUOTED APPLY TO U.K. ONLY P & P. ON OVERSEAS ORDERS CHARGED EXTRA.

NO DISCO SYSTEM IS COMPLETE WITHOUT...

ROPELIGHTS Rope light kits now available from Roger Squire's—22 feet long, 4 channel, including Tube, Bulbs and Multipin connectors. These ropelights are ex-demonstration stock and will require some bulb replacement—we will supply 20 spare bulbs free with your kit. Additional sets of 20 bulbs cost £4.88 each.

PIEZO HORNS FANTASTIC SPECIAL OFFER TO READERS OF PRACTICAL ELECTRONICS. Tweeters for your disco, PA system or Hi-Fi. Frequency range 5K-20K. No X-over required. They can be used in any PA system up to 100W. Why pay more? OUR PRICE ONLY £4.99 each (P&P 35p each)

BULGIN OCTAL PLUGS AND SOCKETS There's always hundreds of Bulgin Octal multiway plugs and sockets in stock at Roger Squire's. Each pin rated 6A. Perfect for your Sound to Light System. P552 SOCKET £0.65 (P&P 35p) P551 PLUG £1.84 (P&P 35p) Carriage on 10 or more nominal £1.00. Also available 6-way multicore cable 16 Amps per core; ex stock £0.65 per metre. Please phone for carriage quote.

PROJECTORS **SQUIRE MULTIFECT 150**—including rotator and effects wheel. A truly versatile projector which uses a powerful 150W Tungsten bulb, all effects attachments simply slot in ready for use. **A BARGAIN AT £40.50 (P&P £1.00)**

SOLAR 250 Utilising a 250W Quartz-Iodine bulb giving brilliant light output, this projector is fan-cooled and can be used free standing or ceiling mounted. Dual effect system for stunning versatility. Rotators are extra. Huge choice of special effects and attachments! **NOW ONLY £70.20 (P&P £2.00)**

PLUS MANY DISCO ACCESSORIES All Roger Squire's shops have a service department which carries large stocks of DISCO SPARES & ACCESSORIES. For example: Fane and H. H. Disco Speakers 12" and 15" BSR and Garrard decks at discount prices.

Plus sockets, Fuses, Plugs, etc.

Roger Squire's DISCO GEAR

Send Mail Orders to: Roger Squire's Mail Orders, Barnet Trading Estate, Park Road, Barnet, Herts EN5 5SA. 01-441 3527 (Hotline) 01-441 1919 (Switchboard) Open: Mon-Fri, 9.5-3.0

Personal callers: ROGER SQUIRE'S DISCO CENTRES
LONDON: 176 Junction Road, Tunfoll Park, N19 5QQ. 01-272 7474
BRISTOL: 125 Church Road, Redfield, Bristol BS5 9JR. 0272 550550
MANCHESTER: 251 Deansgate, Manchester M3 4EN. 061-831 7676
Open from 10-5 Tues-Sat 10-8 Weds. Closed Mondays.

Clef Products

P. E. JOANNA & 'STRING ENSEMBLE'

Send S.A.E. for details of Kits & P.C.B.s
Please indicate which instrument required.

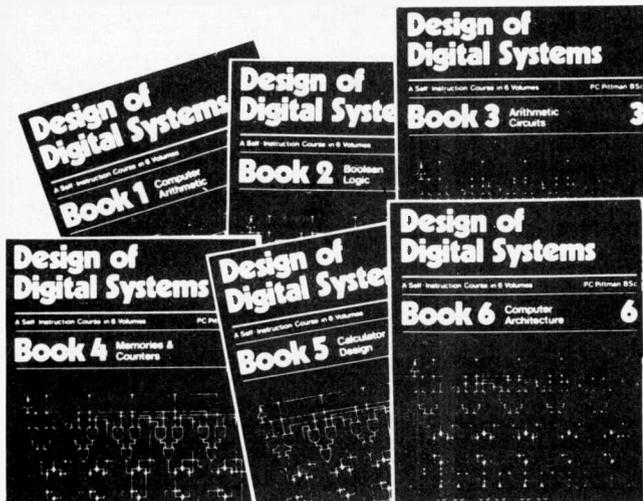
16 Mayfield Road, Bramhall, Cheshire SK7 1JU

TRANSISTORS		DIODES		DIGITAL I.C.'s		W/W RESISTORS			
Device	10	100	Device	10	100	Device	10		
ACY 20	3.20	27.00	AA 119	80	4.00	TEXAS	10		
ASV 66	90	65.00	BY 127	90	8.00	10 SW Radial	80		
BC 107	80	7.00	IS 44	45	3.00	10W Axial	80		
*BC 118	1.10	9.00	IS 940	40	2.50	15W Radial	85		
*BC 132	95	8.00	IS 941	40	2.50	74174	4.30		
*BC 147	80	6.50				74191	14.50		
*BC 149	80	6.50	LINEAR I.C.'s		1	10	FAIRCHILD		
*BC 204B	80	6.00	Device	1	10	Device	5.90	100 Gen. Purpose Transistors	
BC 348	1.00	8.00	741 8P DIL	18	1.70	9000	5.90	including BC 149, 2N 3703, etc. £5.80.	
BC 351	1.00	7.50	555 8P DIL	26	2.40	9002	3.00	PAK 2	
BD 131	3.30	29.00	HDRZ. PRESET		10	9016	3.60	20 Transistors including	
BD 895A	5.50	42.00	Device	60	3304	8.50	12.00	BD 131, BD 895A, etc. £5.50.	
BD 896A	5.50	42.00	*1 Megohm 0.25W.	60	9308	2.50	10.00	PAK 3	
BF 185	2.40	20.00	CAPACITORS		10	100	21.00	100 Mixed W/W Resistors including 2.5W, 5W, 10W, etc.	
BF 324	3.30	29.00	Device	10	100	9311	18.00	£3.50.	
BT 106	10.00	72.00	*BU 208	15.00	120.00	0.01/30 Disc	55	3322	
*BU 205	14.00	115.00	*ZX 212B	1.10	9.00	0.1/200 Radial	70	5.50	
*BU 208	15.00	120.00	*ZX 302	1.00	8.00	0.1/600 Axial	80	4.00	
			*ZX 502	1.10	9.00	0.59/100 Radial	70	5.50	
			2N 930	1.60	12.00	2.2/100 Radial	80	3.00	
			2N 2847	8.00	60.00	6.8/6 Tant	90	7.00	
			*2N 3703	80	6.50	100/250 Axial	3.20	24.00	
			*2N 3705	80	6.50	680/25 Axial	1.80	14.00	

Min. Order £2.00, P & P. 30p. VAT please add 8% except those marked * which are 12.5%.
Export, Wholesale and Manufacturers Enquiries Welcome.
K & A DISTRIBUTORS
52 Barkby Road, Syston, Leicester LE7 8AF. Tel: 0533 609391.

Understanding Digital Electronics

New teach-yourself courses



Design of Digital Systems is written for the engineer seeking to learn more about digital electronics. Its six volumes – each A4 size are packed with information, diagrams and questions designed to lead you step-by-step through number systems and Boolean algebra to memories, counters and simple arithmetic circuits, and finally to a complete understanding of the design and operation of calculators and computers.

The contents of Design of Digital Systems include:

- Book 1** Octal, hexadecimal and binary number systems; conversion between number systems; representation of negative numbers; complementary systems; binary multiplication and division.
- Book 2** OR and AND functions; logic gates; NOT, exclusive-OR, NAND, NOR and exclusive-NOR functions; multiple input gates; truth tables; De Morgans Laws; canonical forms; logic conventions; Karnaugh mapping; three-state and wired logic.
- Book 3** Half adders and full adders; subtractors; serial and parallel adders; processors and arithmetic logic units (ALUs); multiplication and division systems.
- Book 4** Flip flops; shift registers; asynchronous and synchronous counters; ring, Johnson and exclusive-OR feedback counters; random access memories (RAMs) and read only memories (ROMs).
- Book 5** Structure of calculators; keyboard encoding; decoding display data; register systems; control unit; program ROM; address decoding; instruction sets; instruction decoding; control program structure.
- Book 6** Central processing unit (CPU); memory organization; character representation; program storage; address modes; input/output systems; program interrupts; interrupt priorities; programming; assemblers; computers; executive programs; operating systems and time sharing.



Digital Computer Logic and Electronics is designed for the beginner. No mathematical knowledge other than simple arithmetic is assumed, though the student should have an aptitude for logical thought. It consists of four volumes – each A4 size – and serves as an introduction to the subject of digital electronics. Everyone can learn from it – designer, executive, scientist, student, engineer.

Contents include: Binary, octal and decimal number systems; conversion between number systems; AND, OR, NOR and NAND gates and inverters; Boolean algebra and truth tables; De Morgans Laws; design of logic circuits using NOR gates; R-S and J-K flip flops; binary counters, shift registers and half adders.

CAMBRIDGE LEARNING ENTERPRISES, Unit 21, Rivermill Site, FREEPOST, ST. IVES, HUNTINGDON, CAMBS. PE17 4BR, ENGLAND. TELEPHONE ST. IVES (0480) 67446. PROPRIETORS: DRAYRIDGE LTD. REG. OFFICE: RIVERMILL LODGE, ST. IVES. Giro Ac. No. 278 9159. REGD. IN ENGLAND NO. 1328762

In the years ahead the products of digital electronics technology will play an important part in your life. Calculators and digital watches are already commonplace. Tomorrow a digital display could show your vehicle speed and fuel consumption; you could be calling people by entering their name into a telephone which would automatically look up their number and dial it for you.

These courses were written by experts in electronics and learning systems so that you could teach yourself the theory and application of digital logic. Learning by self-instruction has the advantages of being faster and more thorough than classroom learning. You work at your own pace and must respond by answering questions on each new piece of information before proceeding.

After completing these courses you will have broadened your career prospects and increased your fundamental understanding of the rapidly changing technological world around you.

The six volumes of **Design of Digital Systems** cost only: **£8.10** +90p post & packing

And the four volumes of **Digital Computer Logic and Electronics** cost only: **£4.60** +90p post & packing

But if you buy both courses, the total cost is only: **£12** +£1 post & packing

Price includes surface mail anywhere in the world: Airmail extra.

Flow Charts & Algorithms

HELP YOU PRESENT:

safety procedures, government legislation, office procedures, teaching materials and computer programs by means of YES and NO answers to questions.

THE ALGORITHM WRITER'S GUIDE explains how to: define the questions, put them in the best order and draw the flow chart, with numerous examples shown. All that students require is an aptitude for logical thought. Size: A5, 130 pages. This book is a MUST for those with things to say.

£2.95 + 45p post and packing by surface mail anywhere in the world. Airmail extra.

GUARANTEE

If you are not entirely satisfied your money will be refunded.

Cambridge Learning Enterprises, Unit 21, Rivermill Site, FREEPOST, St. Ives, Huntingdon, Cambs. PE17 4BR, England.

Please send me the following books:

- sets Digital Computer Logic & Electronics @ £5.50, p & p included
- sets Design of Digital Systems @ £9.00, p & p included
- Combined sets @ £13.00, p & p included
- The Algorithm Writer's guide @ £3.40, p & p included

Name

Address

I enclose a *cheque/PO payable to Cambridge Learning Enterprises for £.....

Please charge my *Access / Barclaycard / Visa / Eurocard / Mastercharge / Interbank account number.....

Signature..... *delete as appropriate. Telephone orders from credit card holders accepted on 0480-67446 (Ansafone). Overseas customers should send a bank draft in sterling drawn on a London Bank, or quote credit card number. PE 21

RST

VALVE MAIL ORDER CO.

Climax House
Fallsbrook Road, London SW16 6ED

**SPECIAL EXPRESS
MAIL ORDER SERVICE**

Ep	Ep	Ep	Ep	Ep	Ep	Ep	
AA119	0-20	BCY71	0-22	*MPSU01	0-32	*ZTX550	1-67
AA30	0-13	BCY72	0-17	*MPSU06	0-40	1N914	0-07
AA32	0-15	BCZ11	1-50	*MPSU56	0-45	1N916	0-07
AAZ13	0-25	BD115	0-80	NKT401	2-00	1N4001	0-06
AAZ15	0-31	BD121	1-50	NKT403	1-73	1N4002	0-07
AAZ17	0-25	BD123	1-50	NKT404	1-73	1N4003	0-08
AC107	0-75	BD124		NE555	0-45	1N4004	0-09
AC125	0-30	BD131	0-51	OAS	0-75	1N4005	0-11
AC126	0-25	BD132	0-54	OA7	0-55	1N4006	0-15
AC127	0-25	*BD135	0-35	OA10	0-55	1N4007	0-15
AC128	0-25	*BD136	0-36	OA47	0-14	1N4009	0-15
AC141	0-20	*BD137	0-37	OA70	0-30	1N4148	0-07
AC141K	0-35	*BD138	0-40	OA79	0-30	1N5400	0-14
AC142	0-20	*BD139	0-43	OA81	0-30	1N5401	0-16
AC142K	0-30	*BD140	0-47	OA85	0-30	1S44	0-06
AC176	0-25	BD144	2-00	OA90	0-08	1S920	0-08
AC187	0-25	BD181	1-38	OA91	0-08	1S921	0-08
AC188	0-25	BD182	1-48	OA95	0-08	2G301	1-00
ACY17	0-65	BD237	0-80	OA200	0-10	2G302	1-00
ACY18	0-65	BD238	0-85	OA202	0-11	2G306	1-10
ACY19	0-65	BDX10	0-75	OA210	0-75	2N404	0-60
ACY20	0-65	BDX32	2-25	OA211	0-75	2N696	0-25
ACY21	0-65	BDY20	1-42	OAZ200	0-65	2N697	0-16
ACY39	1-25	BDY60	0-75	OAZ201	0-65	2N698	0-30
AD149	0-70	BF115	0-38	OAZ206	0-65	2N705	0-80
AD151	0-75	BF152	0-25	OAZ207	0-65	2N706	0-80
AD162	0-75	BF153	0-25	OC18	1-25	2N708	0-27
AF106	0-45	BF154	0-25	OC20	2-00	2N930	0-26
AF114	0-25	BF159	0-35	OC22	2-50	2N1131	0-26
AF115		BF180	0-30	OC23	2-75	2N1132	0-26
AF116	0-25	BF167	0-38	OC24	3-50	2N1302	0-37
AF117	0-25	BF173	0-38	OC25	0-90	2N1303	0-37
AF139	0-40	BF177	0-38	OC26	0-90	2N1304	0-45
AF186	1-50	BF178	0-45	OC28	2-00	2N1305	0-45
AF239	0-45	BF179	0-48	OC29	2-00	2N1306	0-50
AFZ11	2-75	BF180	0-45	OC35	1-50	2N1307	0-50
AFZ12	2-75	BF181	0-45	OC36	1-50	2N1308	0-60
AS226	0-65	BF182	0-45	OC139	0-50	2N1309	0-33
AS227	0-50	BF183	0-45	OC42	0-50	2N1613	0-33
ASZ15	1-25	BF184	0-38	OC43	1-50	2N1671	1-50
ASZ16	1-25	BF185	0-37	OC44	0-50	2N1893	0-33
ASZ17	1-25	*BF194	0-12	OC45	0-50	2N2147	1-00
ASZ20	0-75	*BF195	0-13	OC71	0-45	2N2148	1-65
ASZ21	1-75	*BF196	0-13	OC72	1-00	2N2149	0-42
AU113	1-70	*BF197	0-14	OC73	1-00	2N2219	0-42
AU110	1-70	BF200	0-32	OC74	0-75	2N2220	0-35
BA145	0-15	*BF224	0-20	OC75	0-80	2N2221	0-22
BA148	0-15	BF244	0-35	OC76	0-50	2N2222	0-25
BA154	0-10	BF251	0-37	OC77	1-00	2N2223	2-75
BA155	0-10	BF258	0-42	OC81	0-75	2N2368	0-17
BA156	0-13	BF259	0-45	OC81Z	1-00	2N2369A	0-21
BAW62	0-05	*BF336	0-50	OC82	0-75	2N2484	0-21
BAX13	0-07	*BF337	0-53	OC83	0-55	2N2646	0-50
BAX16	0-07	*BF338	0-55	OC84	0-80	2N2904	0-35
BC107	0-12	BF321	0-37	OC122	1-50	2N2905	0-35
BC108	0-12	BFS28	1-38	OC123	1-55	2N2906	0-25
BC109	0-13	*BFS61	0-25	OC139	2-25	2N2907	0-21
*BC113	0-15	*BFS98	0-25	OC140	1-95	*2N2924	0-15
*BC114	0-18	BFW10	0-80	OC141	2-25	*2N2925	0-17
*BC115	0-19	BFW11	0-80	OC170	0-75	*2N2926	0-13
*BC116	0-19	BFX84	0-38	OC171	0-75	*2N3053	0-25
*BC117	0-22	BFX85	0-41	OC200	1-00	2N3054	0-50
*BC118	0-16	BFX87	0-35	OC201	1-50	2N3055	0-85
*BC125	0-18	BFX88	0-32	OC202	2N3440	0-60	74125
*BC126	0-25	BFY90	0-28	OC203	2N3441	0-80	74126
*BC135	0-15	BFY51	0-26	OC204	1-25	2N3442	1-20
*BC136	0-18	BFY52	0-26	OC205	1-75	2N3525	0-30
*BC137	0-16	BFY64	0-30	OC206	1-75	2N3614	1-20
*BC147	0-10	BFY90	1-32	OC207	1-25	*2N3702	0-15
*BC148	0-10	BXS19	0-34	OC207	1-25	*2N3703	0-15
*BC149	0-13	BXS20	0-34	ORP12	0-83	*2N3704	0-15
*BC157	0-12	BXS21	0-32	*R2008B	2-25	*2N3705	0-15
*BC158	0-11	BT106	1-25	*R2009B	2-25	*2N3706	0-14
*BC159	0-13	BTY79/400R	3-19	*R2010B	2-25	*2N3707	0-18
*BC167	0-13	*BU205	2-25	T1C44	0-36	*2N3708	0-14
*BC170	0-16	*BU206	2-25	T1C226D	1-30	*2N3709	0-15
*BC171	0-14	*BU208	2-50	T1L209	0-25	*2N3710	0-14
*BC172	0-15	BY100	0-45	*TIP29A	0-50	*2N3711	0-15
*BC173	0-15	BY126	0-14	*TIP30A	0-80	2N3711	1-60
BC177	0-19	BY127	0-15	T1P31A	0-62	2N3712	1-70
BC178	0-18	BZX61	0-20	T1P32A	0-75	2N3713	2-65
BC179	0-20	Series		T1P33A	1-00	*2N3819	0-36
*BC182	0-11	BZY88	0-13	T1P34A	1-20	*2N3820	0-46
*BC183	0-11	Series		T1P41A	0-70	*2N3823	0-60
*BC184	0-12	CRS105	0-45	T1P42A	0-90	2N3856	1-00
*BC212	0-14	CRS140	0-60	T1P2955	1-00	*2N3904	0-21
*BC213	0-14	CRS305	0-45	T1P3055	0-50	*2N3905	0-22
*BC214	0-17	CRS340	0-75	*T1S43	0-35	*2N3906	0-22
*BC237	0-17	CRS350	0-90	*ZS140	0-25	*2N4058	0-20
*BC238	0-12	GEX86	1-50	*ZS170	0-12	*2N4059	0-15
BC301	0-45	GEX541	1-75	*ZS178	0-54	*2N4060	0-20
BC303	0-60	GJ3M	0-75	*ZS271	0-22	*2N4061	0-17
*BC307	0-20	GJ5M	0-75	*ZS278	0-56	*2N4062	0-18
*BC308	0-18	GMO378A	1-50	*ZTX107	0-11	*2N4124	0-17
*BC327	0-22	*KS100A	0-40	*ZTX108	0-10	*2N4126	0-17
*BC328	0-19	MJE340	0-58	*ZTX109	0-10	*2N4286	0-20
*BC337	0-19	MJE370	0-85	*ZTX300	0-12	*2N4288	0-25
*BC338	0-18	MJE371	0-81	*ZTX301	0-13	*2N4289	0-25
BCY30	1-00	MJE520	0-65	*ZTX302	0-17	*2N5457	0-35
BCY31	1-00	MJE521	0-75	*ZTX303	0-17	*2N5458	0-35
BCY32	1-00	MJE2955	0-75	*ZTX304	0-19	*2N5459	0-35
BCY33	0-90	MJE3055	0-75	*ZTX311	0-20	3N125	1-75
BCY34	0-90	*MPF102	0-30	*ZTX314	0-20		
BCY39	3-00	*MPF103	0-30	*ZTX500	0-13		
BCY40	1-25	*MPF104	0-30	*ZTX501	0-14		
BCY43	0-30	*MPF105	0-30	*ZTX502	0-16		
BCY58	0-32	*MPSA06	0-25	*ZTX503	0-17		
BCY58	0-32	*MPSA06	0-25	*ZTX504	0-20		
BCY70	0-18	*MPSA56	0-25	*ZTX531	0-20		

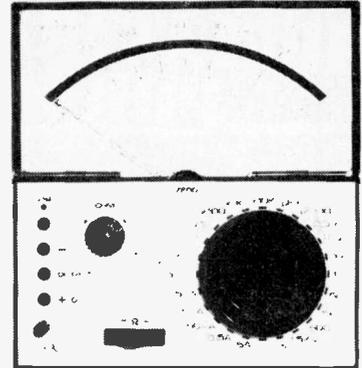
Open daily to callers: Mon.-Fri. 9 a.m.-5 p.m.
Valves, Tubes and Transistors - Closed Saturday
Terms C.W.O. only - Tel. 01-677 2424-7
Quotations for any types not listed S.A.E.
Post and Packing 25p per order + 8% V.A.T.
Items marked * 12½%

Plugs in socket
—low profile
8 pin DIL 0-15
14 pin DIL 0-15
16 pin DIL 0-17

INTEGRATED
CIRCUITS
7400 0-20
7401 0-20
7402 0-20

Prices correct
when going
to press

CHINAGLIA DINO—ELECTRICAL AND ELECTRONIC
TEST EQUIPMENT MANUFACTURERS



THE
DOLOMITI
20kV/V a.c. and d.c.

A NEW HIGH SENSITIVITY MULTIMETER WITH ALL THE FEATURES YOU WILL EVER NEED

Accuracy: D.C. ranges, ± 2.0%. A.C. & Ω ranges ± 2.5%.
39 ranges: d.c. V, 0-150mV, 500mV, 1-5V, 5V, 15V, 50V, 150V, 500V, 1-5kV; d.c.I, 0-50µA, 500µA, 5mA, 50mA, 0-5A, 5A; a.c. V, 5V, 15V, 50V, 150V, 500V, 1-5kV, a.c.I, 5mA, 50mA, 0-5A, 5A, dB - 10 to + 65 in 6 ranges; Ω 0-0.05kΩ, 5kΩ, 50kΩ, 500kΩ, 5MΩ, 50MΩ, pF 50kpf, 500kpf.

Automatic overload protection and high current range fusing.
Scale mirror and fine pointer for accuracy of reading. Single knob main range switching and all panel controls. C.E.I. Class 1 movement with sprung jewel bearings. Extended 92mm scale length for extra clarity. Compact ABS case 125 x 131 x 37mm. Weight 750g with batteries. Supplied complete with carrying case, fused leads, handbook and full 12-month guarantee. Optional 30kV d.c. probe available.

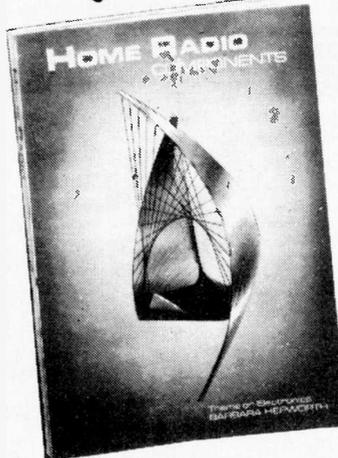
Meter £50.00 incl. VAT (£1 P. & P.)
30kV Probe £12.85 incl. VAT

For details of this and the many other exciting instruments in the Chinaglia range, including multi-meters, component measuring, automotive and electronic instruments please write or telephone.

ALCON Instruments Ltd.

19 MULBERRY WALK, LONDON SW3 6DZ TEL: 01-352 1897

THIS is the Catalogue you need to solve your component buying problems!



- The finest components catalogue yet published.
- 128 A-4-size pages.
- About 2,500 items clearly listed and indexed.
- Profusely illustrated.
- Bargain List sent free.
- At £1.00, incl. p. & p., the catalogue is a bargain.

Send the coupon below now.

POST THIS COUPON with cheque or P.O. for £1-00

HOME RADIO (Components) LTD., 234-240 London Road, Mitcham, Surrey CR4 3HD

Please write your Name and Address in block capitals

NAME _____

ADDRESS _____

HOME RADIO (Components) LTD Dept PE
234-240 London Road, Mitcham, Surrey CR4 3HD
Regd. No. 912966 London

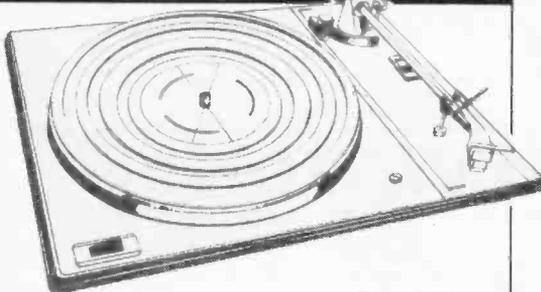


QUALITY HI-FI AT BUDGET PRICES

Fight inflation with these super Hi-Fi offers. Compare these prices with the recommended retail prices and you will see that you can save £££££—and what is more, you will be purchasing quality equipment—that is why we are happy to give these amazing guarantees.

TREMENDOUS SAVINGS FOR THE HOME ENTHUSIAST

GOLDRING CK2 BELT-DRIVE TURNTABLE CONSTRUCTION KIT



Complete with arm, template and easy-to-follow instructions. Ready for operation in a short time. Wow/Flutter 0.15% peak. Rumble 60 dB weighted. Removable headshell. Viscous damped cueing device. Easily adjusted tracking force and bias setting.

Two-speed, 16-pole synchronous motor. Dimensions: 37.8 x 28.3 cms. (Plinth, cover and cartridge available, prices on application.) R.R.P. £31.50

LION HOUSE PRICE £15.95
Postage and Packing £2.

MANY MORE EXCITING BARGAINS ARE AVAILABLE AT LION HOUSE—BRITAIN'S HI-FI SUPERSTORE WITH THE SUPERB DEMONSTRATION FACILITIES.

The MATSI TFS60 Tuner/Amplifier



AT LESS THAN HALF THE RECOMMENDED RETAIL PRICE

Due to a successful bulk purchase, we are happy to offer this really top quality receiver from one of Japan's leading manufacturers at less than half price. 15 watts per channel. FM/MW/LW. 12 MONTHS GUARANTEE. Recommended Retail Price £144. **OUR PRICE £65** (Securicor delivery £3.50)

GOLDRING TURNTABLE



Available to personal shoppers only, the Goldring belt-drive turntable comes complete with high quality attractive plinth and cover—12 MONTHS GUARANTEE.

TODAY'S VALUE £45
LION HOUSE PRICE £25

SANKYO STD-1610 STEREO CASSETTE DECK

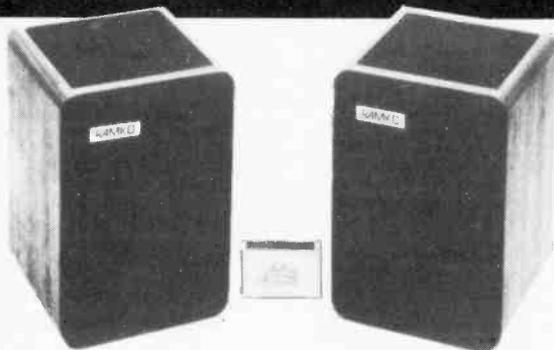


Features include Dolby noise reduction system, Autochrome, Input/Output Level Control, Peak Indicator, Auto-stop, Ferro heads, Tape-run Indicator, Hinged Dust Cover—

MORE FEATURES FOR LESS MONEY—12 MONTHS GUARANTEE—
A beautifully compact machine of highest quality. Another successful bulk purchase from Lion House at **ONLY £69.95** (Securicor delivery £3.50) (Recommended Retail Price £114.)

RAMKO GULLIVER SPEAKERS

GIANT PERFORMERS OF DWARF-LIKE DIMENSIONS



Two-way mini hi-fi studio quality loud speakers. Despite their mini size, their clean, solid bass range is equal to that of much bigger systems, and the use of a high density, high temperature metal voice coil system greatly enhances durability. In a room filled with excitingly realistic sound, they seem almost undetectable. 4-inch woofers have high power handling capability and are as efficient as 6-inch woofers. Extra light 1 inch soft dome tweeters weigh only 0.2 grams. A powerful

10-ounce precision ceramic magnet, coupled to the dome, creates immense flux providing excellent transient responses. Acoustically suspended and impregnated with finest damping fluid, protecting dome against distortion break-up or coloration even after prolonged heavy loading. Dome shape and construction produces extra-wide dispersion, smooth frequency response and high resolution of musical detail.

Highly precise crossover network, matched to component speakers, gives accurate separation of audio spectrum and stable frequency response. Specially designed cabinets made of high density chipboard with wood-welded joints and individually tested. Finished in the finest laminated rosewood veneer and crafted and oil finished by hand to a distinctive lustre.

We are the sole agents and offer them direct to you at **only £79.95** per pair. (Securicor delivery £3.50)

SPECIFICATIONS

Normal impedance	8 ohms
System components	4" woofer 1" dome tweeter
Frequency range	50-25,000 Hz
Sensitivity	1.5-3 watt
Nominal input	35 watt
Music power	50 watt
Dimensions	18 x 11.5 x 12.5 cm

WARRANTY

Every RAMKO loudspeaker model is guaranteed for a period of five years

Televisions, Radios, Tape Recorders, Music Centres, Cassette Recorders, Earphones, Quality Audio and Video Equipment, Hi-Fi Accessories, Export Televisions, In-Car Equipment, Watches, Binoculars, Cameras, Calculators, etc and an entire floor devoted to Musical Instruments—all at keen prices!



Lion House

LONDON'S HI-FI SUPERSTORE
227 TOTTENHAM COURT ROAD LONDON W1
Tel 01 580 7383 and 01 637 1601
Telex 28394 LION G

Open 9 am to 6 pm Monday to Saturday
(Thursday until 7 pm)

SAME DAY CREDIT FACILITIES TAX FREE EXPORT



Stockists for: A.D.C., Amstrad, Awa, B.S.R., Celestion, Empire, Fidelity, Goldring, Goodmans, Grundig, Harmon Kardon, Hitachi, J.B.L., Kef, K.L.H., Koss, Monitor Audio, Micro, Marantz, National, Panasonic, National Technics, NAD, Nakamichi, JVC, Autofon, Philips, Quad, Revox, Sansui, Sennheiser, Shure, S.M.E., Sony, Sharp, Superscope, Tannoy, Teac, Thorens, Transcriptor, Yamaha, etc.

GODDARD'S COMPONENTS MAIL ORDER DEPT.

110 LONDON ROAD, ST. ALBANS, HERTS. AL1 1NX

Callers Welcome MON-SAT: 9.30-5.30

THURS: Closed all day

Lunch: MON-FRI: 1.30-2.30, SAT: 1.00-2.00

STEREO



CASSETTE RECORDER DECK

- with + solenoid auto-stop
- + CrO2 switch
- + piano key operation
- + twin level meters
- + mic. sockets

Tech. Spec.:
Bias and erase freq. 88 kHz
4 ICs 8 Transistors
1 SCR 10 Diodes

Diagrams and top panel template supplied

£25.75 + £1.25 p&p

HIT-BOX



SHOCK-PROOF POLYSTYROL IN GREY

4mm thick walls
Larger sizes are pillar fixing
Smaller sizes are slotted

Inside Measurements:

Box No.	Breadth mm	Length mm	Height mm	Weight gm
1001	60	90	50	100
1002	75	130	61	175
1003	90	160	71	285
1004	93	193	95	340
1005	125	220	110	575

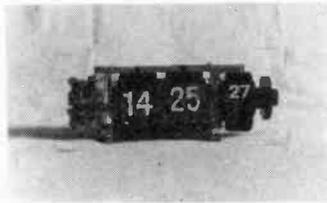
1001 - 90p 1004 - £2.00
1002 - £1.60 1005 - £3.00
1003 - £1.80 50p each p&p. £1.00 for 3 p&p

TRADE ENQUIRIES WELCOME!

DIGITAL CLOCK

BATTERY DROP LEAF CLOCK MOVEMENT

Hrs. Mins. Date
Easy-to-set regulator screw
Size: 140mm x 85mm x 60mm
Window size: 63mm x 28mm
No. height: 19mm
Date height: 10mm
Weight: 270gm



£4.95 + 50p p&p

LCD WATCHES

TOUCH GENTS CTG

£14.95



LADIES S/S C652

£16.95

UNISEX C551

6 Colours

£11.95



LARGE GENTS C165

£9.95



ALL WATCHES 5 FUNCTION... 1 YEAR GUARANTEE
P&P 50p per watch, Inc. Insurance

We can also supply components for 'ELECTRONIC SOUND MONITOR' P.E. Sept. 1978 • ALL PRICES INCLUDE VAT

DORAM

SEE THE RANGE OF BOOKS IN THE NEW DORAM HOBBIES CATALOGUE.



Doram Electronics Ltd
PO Box TR8, Leeds LS12 2UF

Please send my FREE Hobbies Catalogue.
I enclose 25p contribution to p. & p. (AVAILABLE LATE SEPT)

Name
Address

DORAM Doram Electronics Ltd
PO Box TR8, Leeds LS12 2UF

Overseas customers (except for N. Ireland) - 60p including despatch by Air (or all-up post).



LOW PROFILE DIL SOCKETS - TIN PLATED
PRICE PER 1 5 10 25
8 PIN 12p 65p £1.20 £2.50
14 PIN 14p 70p £1.30 £3.00
16 PIN 15p 85p £1.60 £3.40
28 PIN 28p £1.50 £2.80 £6.00
40 PIN 44p £2.10 £4.00 £9.00

STANDARD PROFILE DOUBLE-SIDED DIL - SOCKETS
14 PIN 14p 65p £1.25 £3.00
16 PIN 15p 70p £1.35 £3.25

MOUNTING PADS 10/PACK 50/PACK
TO 5 4 HOLE 9p 40p
TO 18 4 HOLE 9p 40p

CONVERTERS
TO 99 TO DIL 55p £2.50
TO 100 TO DIL 55p £2.50
TO 92, 98 TO TOS 9p 40p
TO 18 TO TOS 9p 40p
TO 98 TO TOS 9p 40p
DIODE CRADLES 10p 45p

READY DRILLED BLACK ANODISED HEAT SINKS
TO 3 1 @ 40p 5 @ £1.80
TO 66 1 @ 40p 5 @ £1.80
TO 3 x 2 1 @ 70p 5 @ £3.20

HEAT SINK COOLERS, FITTING TO 5.
NF 204 1 @ 14p 5 @ 65p
NF 205 1 @ 12p 5 @ 55p
NF 207 1 @ 13p 5 @ 60p
NF 209 1 @ 15p 5 @ 75p

INSULATING KITS, 5 WASHERS 10 BUSHES.
MELINEX MICA
TO 3 @ 28p/KIT @ 30p/KIT
TO 66 @ 28p/KIT @ 30p/KIT
BUSH SHANK LENGTH REQ: 205, 153, 125, 05, 025-125, 05, 025. For TO 3 only.

TRANSISTOR INSULATION COVERS
TO 3 5 @ 35p 10 @ 70p
TO 5 5 @ 15p 10 @ 25p
TO 66 5 @ 35p 10 @ 70p

POWER SOCKETS
TO 3 1 @ 14p 5 @ 65p
TO 66 1 @ 10p 5 @ 75p

TO 220 INSULATING KITS 5 Washer 5 Bushes
MELINEX 20p/KIT MICA 25p/KIT

LARGER RANGE OF TRANSISTOR PADS AND INSULATING BUSHES IN CATALOGUE. ALL PRICES INCLUDE V.A.T.

POST AND PACKING 15p KITS/PADS/sockets/coolers. 45p FOR ANODISED HEAT SINKS
Moulded Electronic Components Int. Ltd., Unit 3, Block 3, Vestry Estate, Otford Road, Sevenoaks, Kent

FULL ILLUSTRATED CATALOGUE - SEND 30p FOR POST AND PACKING.

FROM _____ MOULDED ELECTRONIC COMPONENTS
INT. LTD., Unit 3, Block 3, Vestry Estate,
Otford Road, Sevenoaks, Kent.
Telephone: 0732 59246/7
Registered No. 211169600.

U.K. RETURN OF POST MAIL ORDER SERVICE also WORLDWIDE EXPORT SERVICE

R.C.S. 10 WATT AMPLIFIER KIT



This kit is suitable for record players, tape play back, guitars, electronic instruments or small P.A. systems. Two versions are available. The mono kit uses 13 semiconductors. The stereo kit uses 22 semiconductors. Both kits have printed front panel and volume, bass and treble controls. Spec. 10W output into 8 ohms, 7W into 15 ohms. Response 20c/s to 30kc/s. Input 100M.V. high imp. Size 9 1/2 x 3 x 2in. A/C mains operated.

Mono kit **£12.50** Stereo kit **£20** post 45p
Easy to build Full instructions supplied.



ELAC SPEAKER 10 inch £4.50

Large ceramic magnet 50-16,000 c/s. Bass resonance 55 c/s. 10W. 8 ohm impedance.

RCS STEREO PRE-AMP KIT. All parts to build this pre-amp. Inputs for high, medium or low imp. per channel, with volume control and P.C. Board. Can be ganged to make multi-way mixers. **£2.95** Post 35p

MAINS TRANSFORMERS ALL POST 75p each

250-0-250V 70mA, 6.3, 2A	£3.45
250-0-250 80mA, 6.3V 3.5A, 6.3V 1A or 5V 2A	£4.60
350-0-350 80mA, 6.3V 3.5A, 6.3V 1A or 5V 2A	£5.80
300-0-300 120mA 2 x 6.3V 2A C.T., 6.3V 2A	£6.50
220V 45mA, 6.3V 2A	£1.75
HEATER TRANS. 6.3V 3A, £1.45, 1 amp. £1.00	
GENERAL PURPOSE LOW VOLTAGE Tapped outputs at 2A 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30V	£5.30
1A, 6.8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£5.30
2A, 6.8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£6.50
3A, 6.8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£11.00
5A, 6.8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£14.50
5, 8, 10, 16V 1A £2.12V 100mA £1.12V 300mA £1.	

12V 750mA £1.30, 40V 2A tapped 10V or 30V £2.95, 10-0-10V 2A £2.50, 40V 2A £2.95, 30V 5A 34V 2A ct. £3.75, 2 x 18V 6A £9.12, 0-12V 2 amp £2.95, 20-0-20V 1A £2.95, 30V 1A £2.75, 20V 1A £2.20, 9V 3 amp £2.75, 60V, 40V, 20V or 20-0-20V, 1A £3.50, 30-0-30 2A £7.9V 250mA £1.30, 30V 2 amp £3. AUTO TRANSFORMERS. 115V to 230V or 230V to 115V 150W £5; 250W £6; 400W £7; 500W £8. CHARGER TRANSFORMERS. Input 200/250V for 6 or 12V 1.5A £2.75; 4A £5.20. FULL WAVE BRIDGE CHARGER RECTIFIERS, 6 or 12V outputs 1 1/2A 55p; 4A £1.25. HALF WAVE 12V 1 1/2A 25p.

GOODMAN'S COMPACT 12in BASS WOOFER

Standard 12in diameter fixing with cut sides 12 x 10in 14,000 gauss magnet 20 watt r.m.s. 4 ohm impedance. Bass resonance 30 c.p.s. Frequency response 30-8,000 c.p.s. £9.95 each. Post £1.00.



10 WATT PER CHANNEL STEREO AMPLIFIER

In chassis form. A.C. mains operated. Volume, balance, treble and bass slider controls. Pick up and tape inputs. Recording output. Socket. Front panel size: 16 1/2 x 1 1/2in. Chassis size: 13 x 1 1/2in. Bargain **£18.50** Post 50p

HEATING ELEMENTS WAFER THIN

Size 10 1/2 x 8 1/2 x 1/4in Operating voltage 200/250V a.c. 250W approx. Suitable for Heating Pads, Food Warmers, Convector Heaters, etc. Must be clamped between two sheets of metal or asbestos. **ONLY 40p EACH (FOUR FOR £1.50)** ALL POST PAID—Discounts for quantity

E.M.I. 13 1/2 x 8in SPEAKER SALE!

With tweeter. And crossover.

10W Model	£7.95
State 4 or 8 ohm.	Post 45p
15W model	£10.50
8 ohms	Post 65p
20W model	£11.50
State 8 or 15 ohms.	Post 75p

TEAK VENEER HI-FI SPEAKER CABINETS

MODEL "A" 20 x 13 x 12in. For 12in. dia. or 10in. speaker. Illustrated **£14.50** Post £1.60
MODEL "B" BOOKSHELF For 13 x 8in. EMI Loudspeakers. **£8.50** Post £1

R.C.S. BOOKSHELF complete with speakers. Size 14 x 9 x 6in. approx. Response 50 to 14,000 cps

12 watt rms 8 ohms **£19 pair** Post £1.50
ACOUSTIC WADDING 18in. wide, 20ft.

MONO PRE-AMPLIFIER

A mains operated solid state pre-amplifier unit designed to compliment amplifiers without low level phono and tape input stages. This free standing cabinet incorporates circuitry for automatic R.I.A.A. equalisation on magnetic phono input and N.A.B. equalisation for tape heads. Power ON/OFF, PHONO/TAPE switches and pilot lamp are on the front panel; phono socket input and output are rear located. AC mains 240V. Size 6 x 3 1/2 x 2in. Post 50p

£4.50 ea. - 2 for £8.



BAKER MAJOR 12 INCH £16.88



30-14,500 c/s. 12in double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 40 c/s. Rated 25W. NOTE: 4 or 8 or 16 ohms available.

Module kit, 30-17,000 c/s with tweeter, crossover, baffle, 19 x 12in. instructions. As illustrated. **£20.52** Please state 4 or 8 or 16 ohms Post £1 60

"BIG SOUND" BAKER SPEAKERS

Robustly constructed to stand up to long periods of electronic power. As used by leading groups and discos Useful response 30-13,000 c/s Bass Resonance 55 c/s

GROUP "25"

12in 30W **£12.96** Post £1
4, 8 or 16 ohms.

GROUP "35"

12in 40W **£15.12** Post £1
4, 8 or 16 ohms.

GROUP 50/12in

12in 60W **£22.68** Post £1 60
4 or 8 or 16 ohms with aluminium presence dome

GROUP 50/15in

15in 75W **£28.08** Post £1 60
8 or 16 ohms.

Disco, Group - PA Cabinets in stock. Send for Leaflet. Cabinet Fittings, Handles, Corners, Feet, Covering Material all in stock.

BAKER 150 WATT ALL PURPOSE TRANSISTOR AMPLIFIER

Ideal for Groups, Disco, P.A. and Musical Instruments 4 inputs speech and music. 4 way mixing Output 4/8/16 ohm. a.c. Mains 240V. Separate treble and bass controls. **£85** Carr £1 50



NEW "DISCO 100 WATT" £59

ALL TRANSISTOR AMPLIFIER Carr £1
2 inputs, 4 outputs separate volume treble and bass controls. Ideal disco or slave amplifier chassis. Made by Jennings

R.C.S. SOUND TO LIGHT DISPLAY MK II Complete kit of parts with R.C.S. printed circuit. Three 1000W channels. Will operate from 20mV signal source. CABINET extra £4. **KIT = £17.00**

GOODMANS CONE TWEETER

18,000 c/s. 25W 8 ohm. Price **£3.25**
3 WAY CROSSOVER WITH TREBLE & MID RANGE CONTROLS. 50 WATT. £5 POST £1.

R.C.S. 100 WATT VALVE AMPLIFIER CHASSIS



Professional model. Four inputs. Treble, Bass, Master Volume Controls. Ideal disco, P.A. or group. S.A.E. for details. 5 speaker outputs, 3 or 8 or 15 ohm 100V line to order. Suitable carrying case **£16.50** plus £2.50 carr.

LOW VOLTAGE ELECTROLYTICS
1 2 4 5 8 16 25 30 50 100 200mF 15V 10p, 500mF 12V 15p; 25V 20p; 50V 30p, 1000mF 12V 17p; 25V 35p; 50V 47p; 100V 70p; 2000mF 6V 25p; 25V 42p; 2500mF 50V 82p; 3000mF 25V 47p; 50V 85p; 3900mF 100V £1.60, 4700mF 63V £1.20, 5000mF 6V 25p; 12V 42p; 25V 75p; 35V 85p; 5600mF 76V £1.60; 1200/76V 80p.

HIGH VOLTAGE ELECTROLYTICS

8/350V 22p	8+8/450V 50p	50+50/300V 50p
16/350V 30p	8+16/450V 50p	32+32/450V 75p
32/500V 75p	16+16/450V 50p	100+100/275V 65p
50/350V 50p	32+32/350V 50p	150+200/275V 70p

ROBUST BLACK PLASTIC BOX Size 6 1/2 x 3 1/2 x 2in with brushed aluminium fascia. Ideal for constructional projects. **£1.50** Post 30p

R.C.S. LOW VOLTAGE STABILISED POWER PACK KITS

All parts and instructions with Zener diode, printed circuit rectifiers and double wound mains transformer Input 200/240V a.c. Output voltages available 6 or 7.5 or 9 or 12V d.c. up to 100mA or less Size 3 x 2 1/2 x 1 1/2in. Please state voltage required **£2.95** Post 45p

ELECTRO MAGNETIC PENDULUM MECHANISM 95p

1.5V d.c. operation over 300 hours continuous on SP2 battery, fully adjustable swing and speed. Ideal displays, teaching electro magnetism or for metronome, strobe, etc.

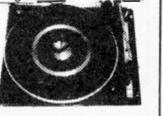
BSR AUTOCHANGER

Plays 12in, 10in or 7in records Auto or Manual. A high quality unit backed by BSR reliability with 12 months guarantee a.c. 200/250V. Size 13 1/2 x 11 1/2in. Above motor board 3 1/2in. Below motor board 2 1/2in. With STEREO/MONO CARTRIDGE **£12.95** All Post 75p
Single Player version **£17.50**
BSR P128 with Magnetic Cartridge **£24.50**
GARRARD AUTOCHANGER plays all records **£14.95**
BSR P163 BELT DRIVE DECK, less cartridge **£27.50**
GARRARD AP76 Single Player less cartridge **£27.50**



BSR DE LUXE AUTOCHANGER

Features balanced arm. Cueing device, stylus pressure gauge, 3 speed - plays all size records. Fitted with stereo ceramic cartridge. Size: 13 x 12ins. Post £1 **£17.50**
Or with Sonotone V100 magnetic cartridge **£21.50**



R.C.S. DISCO DECK SINGLE RECORD PLAYER

Fitted with auto stop, stereo compatible cartridge, Baseplate. Size 11 x 8in Turntable Size 7in diameter a.c. mains 220.250V 3 speeds plays all size records **£7.95** Post 45p
Two for £15. Post 75p.

HEAVY METAL PLINTHS

With P.V.C. Cover. Cut out for most B.S.R. or Garrard decks. Silver grey finish Model "A". Size 12 1/2 x 14 1/2 x 7 1/2in. Post £1 50
Model "B". Size 16 x 13 1/2 x 7in. £7.50.

Extra Large Plinth and Cover. For transcription decks. Size 20 x 17 1/2 x 9in. uncut board. Shop callers only **£18.50**.

TINTED PLASTIC COVERS ONLY

Sizes: 14 1/2 x 12 1/2 x 4 1/2in. £3, 16 1/2 x 14 x 4in. £4, 15 x 13 1/2 x 3in. £3.50, 17 1/2 x 9 1/2 x 3 1/2in. £3, 14 1/2 x 14 1/2 x 2 1/2in. Rosewood sides £4. Ideal for record decks, tape decks, etc. Post £1.

BAKER HI-FI SPEAKERS

HIGH QUALITY—BRITISH MADE

SUPERB £24.75

12in 25 watt Post £1 60

Quality loudspeaker, low cone resonance ensures clear reproduction of the deepest bass. Special copper drive and concentric tweeter cone full range reproduction with remarkable efficiency in the upper register. Bass Resonance 25 c/s Flux Density 16,500 gauss Useful response 20-17,000 c/s 8 or 16 ohms models



AUDITORIUM £22.68

12in 35 watt Post £1 60

A full range reproducer for high power Electric Guitars, public address, multi-speaker systems, electronic organs. Ideal for Hi-Fi and Discotheques. Bass Resonance 35 c/s Flux Density 15,000 gauss Useful response 25-16,000 c/s 8 or 16 ohms models



AUDITORIUM £28.08

15in 45 watt Post £1 60

BLANK ALUMINIUM CHASSIS, 18 s.w.g. 2 1/2in. sides, 6 x 4in. 95p; 8 x 6in. £1.40; 10 x 7in. £1.55; 14 x 9in. £1.90; 16 x 6in. £1.85; 12 x 3in. £1.20; 16 x 10in. £2.20; 12 x 8in. £1.70. ALUMINIUM PANELS, 18 s.w.g. 6 x 4in. 24p; 8 x 6in. 38p; 10 x 7in. 54p; 12 x 5in. 60p; 12 x 8in. 70p; 16 x 6in. 70p; 14 x 9in. 94p; 12 x 12in. £1.16; 16 x 10in. £1.16. ALUMINIUM ANGLE BRACKET, 6 x 3 x 1/2in. 15p. ALUMINIUM BOXES, MANY SIZES IN STOCK 4 x 2 x 2in. 86p; 3 x 2 x 1in. 65p; 6 x 4 x 2in. 95p; 8 x 6 x 3in. £1.50; 9 x 4 x 4in. £1.70; 12 x 4 x 4in. £1.95.

THE "INSTANT" BULK TAPE ERASER £4.95

Suitable for cassettes, and all sizes of tape reels a.c. mains 200/240V Post Leaflet S A E **50p**
Head demagnetiser **£4.75**



RADIO COMPONENT SPECIALISTS 337 WHITEHORSE ROAD, CROYDON, U.K. Tel. 01-684 1665

Minimum post 30p. Access/Eurocard and Barclaycard/Visa. Same day despatch. Radio Books and Components Lists 20p. Open 9-6 Wed. 9-1 Sat. 9-5 (Closed for lunch 1.15-2.30)

GREENWELD

443 Millbrook Road Southampton
SO1 0HX Tel: (0703) 772501

All prices quoted include VAT. Add 25p UK/BFPO Postage. Most orders despatched on day of receipt. SAE with enquiries please. **MINIMUM ORDER VALUE £1.** Official orders accepted from schools, etc. (Minimum invoice charge £5). Export/Wholesale enquiries welcome. Wholesale list now available for bona-fide traders. Surplus components always wanted.

BUY A COMPLETE RANGE OF COMPONENTS AND THESE PACKS WILL HELP YOU

★ **SAVE ON TIME**—No delays in waiting for parts to come or shops to open!

★ **SAVE ON MONEY**—Bulk buying means lowest prices—just compare with others!

★ **HAVE THE RIGHT PART**—No guesswork or substitution necessary!

ALL PACKS CONTAIN FULL SPEC. BRAND NEW, MARKED DEVICES—SENT BY RETURN OF POST. VAT INCLUSIVE PRICES.

K001 50V ceramic plate capacitors, 5%, 10 of each value 22pF to 1000pF. Total 210. **£3-35**

K002 Extended range, 22pF to 0.1µF. 330 values **£4-90**

K003 Polyester capacitors, 10 each of these values: 0.01, 0.015, 0.022, 0.033, 0.047, 0.068, 0.1, 0.15, 0.22, 0.33, 0.47µF. 110 altogether for **£4-75**

K004 Mylar capacitors, min 100V type, 10 each all values from 1000pF to 10,000pF. Total 130 for **£3-75**

K005 Polystyrene capacitors, 10 each value from 10pF to 10,000pF. E12 series 5% 160V. Total 370 for **£12-30**

K006 Tantalum bead capacitors, 10 each of the following: 0.1, 0.15, 0.22, 0.33, 0.47, 0.68, 1, 2.2, 3.3, 4.7, 6.8, all 35V; 10/25 15/16 22/16 33/10 47/6 100/3. Total 170 tants for **£14-20**

K007 Electrolytic capacitors 25V working, small physical size, 10 each of these popular values: 1, 2.2, 4.7, 10, 22, 47, 100µF. Total 70 for **£3-50**

K008 Extended range, as above, also including 220, 470 and 1000µF. Total 100 for **£5-90**

K021 Miniature carbon film 5% resistors, CR25 or similar, 10 of each value from 10R to 1M. E12 series. Total 610 resistors. **£6-00**

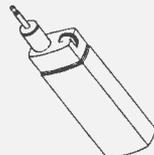
K022 Extended range, total 850 resistors from 1R to 10M **£8-30**

K041 Zener diodes, 400mW 5% BZY88, etc. 10 of each value from 2.7V to 36V. E24 series. Total 280 for **£15-30**

K042 As above but 5 of each value **£8-70**

DIODE SCOOP!!!

We have been fortunate to obtain a large quantity of untested, mostly unmarked glass silicon diodes. Testing a sample batch revealed about 70% useable devices—signal diodes, high voltage rects and zeners may all be included. These are being offered at the incredibly low price of £1.25/1000—or a bag of 2500 for £2.25. Bag of 10,000 £8. Box of 25,000 £17.50. Box of 100,000 £80.



SIGNAL INJECTOR

This handy, little instrument made to a very high standard at a very attractive price is just the job for fault finding on radios, amps, etc. Ready built and tested, just needs one HP 7 battery.

ONLY £2.00

74 SERIES PACK

Selection of boards containing many different 74 series IC's. 20 for £1; 50 for £2.20; 100 for £4.

DISC CERAMIC PACK

Amazing variety of values and voltages from a few pF to 2.2µF 3V to 3kV! 200 £1, 500 £2.25, 1000 £4.00

EXPERIMENTERS CALCULATOR

Based on the C500 chip, this pack of parts enables the more experienced constructor to make an 8 digit 4 function calculator. The comprehensive data supplied includes full size layout of PCB required, types of suitable display and keyboard that can be used etc. Components included in the pack are C500 calculator chip, driver IC, all components for inverter/clock circuits, R's C's etc. All for only **£3.50**.

TRANSFORMERS

All mains primary: 12-0-12V 50mA 85p; 100mA 95p; 1A £2.50. 6-0-6V 100mA 85p; 1½A £2.40. 9-0-9V 75mA 85p; 1A £2.10. Multitapped type 0-12-15-20-24-30V. 1A £3.95; 2A £5.35; 3A £6.90 20V; 3A £3.90; 25V 1A £2.25; 12V 8A £4; 24V 5A £7.50; 0-22-34-41V 4A £7.50; 20V @ 300mA twice £2.50; 12V @ 250mA twice £2.00

RELAYS

W847 Low profile PC mtng 10x33x20mm 6V coil, SPCO 3A contacts. **93p**
W852 Sub. min type, 10x19x10mm 12V coil DPCO 2A contacts **£1-15**
W701 6V SPCO 1A contacts 20x30x25mm Only **56p**
W817 11 pin plug in relay, rated 24V ac, but works well on 6V DC. Contacts 3 pole c/o rated 10A. **95p**
W819 12V 1250R DPCO 1A contacts. Size 29x22x18mm, min plug-in type **72p**
W839 50V ac (24V DC) coil, 11 pin plug in type, 3 pole c/o 10A contacts Only **85p**
W846 Open construction mains relay, 3 sets 10A c/o contacts. **£1-20**
Send SAE for our relay list — 84 types listed and illustrated.

STEREO AMPLIFIER CHASSIS £5-50

Complete and ready built. Controls: bass, treble, volume/on-off, balance. 8 transistor circuit gives 2 watts per channel output. Just needs transformer and speakers for low cost stereo amp. Suitable metal cabinet (W374) **£2-00** — or buy the amp, case and transformer for **£10-00** and get DIN speaker sockets and knobs free!

AMPLIFIER KIT £1-75

Mono gen. purpose amp with tone and Vol/on-off controls. Utilizes sim. circuitry to above amp. Output 2W into 8 ohms. Input matched for crystal cartridge, 4 transistor circuit. Simple to build on PCB provided. Can be either battery or mains operated. (For mains powered version add **£2-20** for suitable transformer.) Blue vinyl covered aluminium case to suit (W372) **£1-30**

TMS4030 RAM

4096 bit dynamic RAM with 300ns access time; 470ns cycle time; single low capacitance high level clock i/p; Fully TTL compatible; Low power dissipation. Supplied with data **£2-75**

MISCELLANEOUS IC'S

Supplied with data if required. MC3302 quad comp. 120p; 710 diff comp. (T099) 40p; ZN1034E precision timer **£2-25**; LM711 Dual diff comp 65p; LM1303 dual stereo pre-amp 75p; MC1469R voltage reg **£1-50**; UPC1025H audio **£3-50**; 575C2 audio **£2-88**; TDA2640 audio **£2-92**; SN75110 dual line driver 70p; MC8500 CRCC gen POA

HEAT SINK OFFER

Copper T05 sink 17mm dia x 20mm. 10 for 40p; 100 for £3; 1000 for £25

PC ETCHING KIT MK III

Now contains 200 sq. in. copper clad board, 1lb. Ferric Chloride, DALO etch-resist pen, abrasive cleaner, two miniature drill bits, etching dish and instructions. **£4-25**

VERO OFFCUTS

Pack A, All 0.1" Pack B, All 0.15" Pack C, Mixed Pack D, all 0.1" Plain Each pack contains 7 or 8 pieces with a total area of 100 sq. in. Each pack is **£1-30**. Also available by weight, 1lb **£4-20**, 10lb **£32-50**. 17 x 3½" Strips: 0.1" **£2-20**; 0.15" **£1-50**; 0.15" Plain **£1-83**

EDGE CONNECTORS

Special purchase of these 0.1" pitch double-sided gold-plated connectors enables us to offer them at less than one-third of their original list price! 18 way 41p; 32 way 72p; 40 way 90p.

CHROMASONIC electronics

56 FORTIS GREEN ROAD, MUSWELL HILL, N10 3HN
TELEPHONE: 01-883 3705

OUR LATEST CATALOGUE CONTAINS FREE 45 pence WORTH OF VOUCHERS



CONTAINS MICROPROCESSORS +BOARDS, MEMORIES, TTL, CMOS, ICs, PASSIVES, ETC., ETC.

SUPERSAVERS

ALL FULL SPEC DEVICES

TEXAS
741

5 for

£1.00

TIMER
555

4 for

£1.00

RED LED
TIL209

(INC CLIP)

10 for

£1.00

VAT INCLUSIVE PRICE + 25p P. & P.

A4 IC BOOKLET

SUPPLIED FREE WITH ORDERS OF ANY ICs WORTH £5.00 OR MORE, CONTAINS CIRCUITS, PIN CONNECTIONS AND DATA (35p + SAE IF SOLD ALONE).

CRESCENT RADIO LTD.

1 ST. MICHAELS TERRACE,
WOOD GREEN, LONDON,
N22 4SJ (MAIL ORDER DEPT.)

01-888 4474

TELESCOPIC AERIAL

8 Section Telescopic Aerial
Length, extended: 96 cm. (37½")
Length, closed: 16 cm. (6¼")
Nut and bolt fixing at base of aerial.
Only 70p each + 12½% VAT

3 KILOWATT PSYCHEDELIC LIGHT CONTROL UNIT

1000W lighting per channel, max. A 3 channel sound to light unit housed in a robust metal case, with a sensitivity control for each channel i.e. Bass, middle and treble. Full instructions make this unit easy to connect to your present amplifier. S.A.E. for spec. sheet.
Still only **£20.00 + 8% VAT.**

POWER SUPPLY UNIT

PP1 — switched 3, 4½, 6, 7½, 9 and 12 volts at 500mA, with on/off switch and pilot light. Size: 130 x 55 x 75mm approx.
Our Price: **£6.00 + 8% VAT**

SIX-PIECE MINIATURE SCREWDRIVER SET

Six precision screwdrivers in a hinged plastic box. Blade sizes: 0.8mm, 1.4mm, 2mm, 2.4mm, 2.9mm, 3.8mm.
Our Price: **£1.75 + 8% VAT**



PIEZO ELECTRIC HORN UNITS

High Quality, High Power Tweeter. No Xover reqd. Freq. Response: 3.8kHz-28kHz. Spec. sheet sent on receipt of S.A.E.
Our Price: **£6.50 + 8% VAT.**

BARGAIN TRANSFORMER

240V Primary 12—0—12V 500mA sec. Approx. size: 60 x 40 x 50mm. Fixing centres: 75mm.
Price: **£1.50 + 8% VAT.**

"FLIP" I

AN ELECTRONIC VERSION OF TWO-UP OR DODS AND EVENS.

We supply a complete kit of parts which includes a strong case and attractive front panel to give the finished game a long life and professional appearance.

Full assembly instructions are supplied. If you can solder you can make this great game. An ideal first project to introduce you to electronics. Not only will 'FLIP' start you on a great hobby but you will own a game which will amuse you and your friends for hours. Complete Kit: **£5.25 + 8% VAT**
Post Free!

BARGAIN LOUDSPEAKER

Goodmans 5" 8 ohm long throw heavy duty L/SPKR.
Mounting plate is integral with L/S chassis and has fixing holes with centres spaced at 5½" (diagonally)
Only **£6.00 + 12½% VAT.**

2 WAY 8 OHM HEAVY DUTY XOVER.

A 2 way 8 ohm H/D Xover suitable for L/S systems up to 100W. Input via screw terminals. Fitted with a 3 position 'HF LEVEL' switch which selects either Flat, -3dB or -6dB.
Buy now while stocks last!
Only **£3.00 + 8% VAT.**



'P&P' orders up to £5, Add 30p. Orders £5-£10, Add 50p. All orders over £10 post free! Please add V.A.T. as shown. S.A.E. with all enquiries please.



Personal callers welcome at: 21 GREEN LANES, PALMERS GREEN, N.13.

Marshall's

Come and get a great deal

Call in and see us 9-5.30 Mon-Fri 9-5.00 Sat
Express Mail Order Tel orders on credit cards £10 min.
Trade and export enquiries welcome

A. Marshall (London) Ltd, Dept. PE. Head Office mail order: Kingsgate House, Kingsgate Place, NW6 4TA. Tel: 01-624 0805. Retail Sales London: 40-42 Cricklewood Bdw, NW2 3ET. Tel: 01-461 0162. Telex: 21492. London: 325 Edgware Rd, W2. Tel: 01-723 4242. Glasgow: 85 West Regent St, G2 2QD. Tel: 041-332 4133. Bristol: 1 Straits Pde, Fishponds Rd, BS16 2LX. Tel: 0272 654201.

2N696 0.39	2N2219 0.38	2N3397 0.19	2N4062 0.20	2N5247 0.44	40410 0.82	BC2148 0.17	BC5498 0.14	BD2444 0.70	BF182 0.37	BF893 1.37	MJE520 0.50
2N697 0.31	2N2219A 0.39	2N3438 0.85	2N4064 1.35	2N5248 0.44	40411 0.30	BC2149 0.17	BC5499 0.15	BD2445 0.87	BF183 0.44	BF950 0.27	MJE521 0.70
2N698 0.49	2N2220 0.39	2N3440 0.75	2N4074 2.65	2N5294 0.44	40594 0.87	BC1747 0.13	BC2148 0.18	BC5557 0.14	BD2456 0.89	BF184 0.41	BF951 1.85
2N699 0.58	2N2221 0.25	2N3441 0.92	2N4121 0.27	2N5295 0.44	40595 0.98	BC1748 0.13	BC2149 0.18	BC5558 0.13	BD2457 0.85	BF185 0.37	BF952 1.05
2N706 0.30	2N2221A 0.25	2N3442 1.45	2N4122 0.27	2N5298 0.44	40673 0.80	BC1749 0.13	BC2149 0.18	BC5559 0.15	BD2464 0.72	BF184 0.16	BF950 1.35
2N706A 0.30	2N2222 0.25	2N3638 0.17	2N4123 0.19	2N5298 0.44	40699 1.30	BC1749 0.13	BC2149 0.18	BC5560 0.15	BD2465 0.93	BF185 0.16	BF951 1.85
2N708 0.30	2N2222A 0.25	2N3638A 0.17	2N4124 0.19	2N5447 0.16	40626 0.48	BC1749 0.13	BC2149 0.18	BC5561 0.15	BD2466 0.93	BF186 0.16	BF951 1.85
2N718 0.30	2N2269 0.27	2N3702 0.14	2N4125 0.19	2N5448 0.16	40627 0.48	BC1749 0.13	BC2149 0.18	BC5562 0.15	BD2467 0.93	BF187 0.16	BF951 1.85
2N718A 0.54	2N2369A 0.27	2N3703 0.14	2N4126 0.19	2N5449 0.20	40628 0.48	BC1749 0.13	BC2149 0.18	BC5563 0.15	BD2468 0.93	BF188 0.16	BF951 1.85
2N720A 0.85	2N2645 0.80	2N3704 0.14	2N4284 0.38	2N5457 0.38	40631 0.43	BC1749 0.13	BC2149 0.18	BC5564 0.15	BD2469 0.93	BF189 0.16	BF951 1.85
2N722 0.45	2N2647 1.55	2N3705 0.14	2N4286 0.22	2N5458 0.35	40632 0.54	BC1749 0.13	BC2149 0.18	BC5565 0.15	BD2470 0.93	BF190 0.16	BF951 1.85
2N727 0.50	2N2903 0.60	2N3706 0.14	2N4287 0.22	2N5459 0.32	40633 0.59	BC1749 0.13	BC2149 0.18	BC5566 0.15	BD2471 0.93	BF191 0.16	BF951 1.85
2N914 0.38	2N2904 0.31	2N3707 0.14	2N4288 0.22	2N5460 0.65	40634 0.59	BC1749 0.13	BC2149 0.18	BC5567 0.15	BD2472 0.93	BF192 0.16	BF951 1.85
2N916 0.33	2N2904A 0.31	2N3708 0.12	2N4289 0.22	2N5464 0.37	40637 0.70	BC1749 0.13	BC2149 0.18	BC5568 0.15	BD2473 0.93	BF193 0.16	BF951 1.85
2N917 0.38	2N2905 0.31	2N3709 0.12	2N4347 0.20	2N5485 0.40	40638 0.70	BC1749 0.13	BC2149 0.18	BC5569 0.15	BD2474 0.93	BF194 0.16	BF951 1.85
2N918 0.45	2N2905A 0.31	2N3711 0.16	2N4348 2.65	2N5486 0.40	40639 0.59	BC1749 0.13	BC2149 0.18	BC5570 0.15	BD2475 0.93	BF195 0.16	BF951 1.85
2N929 0.37	2N2906 0.25	2N3712 0.16	2N4318 0.65	2N5489 0.64	40640 0.59	BC1749 0.13	BC2149 0.18	BC5571 0.15	BD2476 0.93	BF196 0.16	BF951 1.85
2N929A 0.37	2N2906A 0.25	2N3713 0.15	2N4319 0.70	2N5492 0.64	40641 0.59	BC1749 0.13	BC2149 0.18	BC5572 0.15	BD2477 0.93	BF197 0.16	BF951 1.85
2N930 0.37	2N2907 0.25	2N3819 0.35	2N4320 0.83	2N5494 0.65	40642 0.59	BC1749 0.13	BC2149 0.18	BC5573 0.15	BD2478 0.93	BF198 0.16	BF951 1.85
2N930A 0.95	2N2907A 0.25	2N3820 0.39	2N4321 0.54	2N5496 0.67	40643 0.59	BC1749 0.13	BC2149 0.18	BC5574 0.15	BD2479 0.93	BF199 0.16	BF951 1.85
2N1171 0.30	2N2923 0.17	2N3822 0.96	2N4322 0.60	2N6027 0.64	40644 0.59	BC1749 0.13	BC2149 0.18	BC5575 0.15	BD2480 0.93	BF200 0.16	BF951 1.85
2N1889 0.30	2N2923 0.17	2N3900 0.28	2N4323 0.75	2N6107 0.45	40645 0.59	BC1749 0.13	BC2149 0.18	BC5576 0.15	BD2481 0.93	BF201 0.16	BF951 1.85
2N1890 0.30	2N2925 0.19	2N3901 0.30	2N4324 1.15	2N6124 0.55	40646 0.59	BC1749 0.13	BC2149 0.18	BC5577 0.15	BD2482 0.93	BF202 0.16	BF951 1.85
2N1893 0.30	2N2926 0.17	2N3902 0.25	2N4325 0.60	2N6109 0.55	40647 0.59	BC1749 0.13	BC2149 0.18	BC5578 0.15	BD2483 0.93	BF203 0.16	BF951 1.85
2N2102 0.50	2N3053 0.25	2N3904 0.18	2N5087 0.30	2N6111 0.49	40648 0.59	BC1749 0.13	BC2149 0.18	BC5579 0.15	BD2484 0.93	BF204 0.16	BF951 1.85
2N2192 0.58	2N3054 0.72	2N3905 0.18	2N5088 0.30	2N6121 0.41	40649 0.59	BC1749 0.13	BC2149 0.18	BC5580 0.15	BD2485 0.93	BF205 0.16	BF951 1.85
2N2193 0.50	2N3055 0.75	2N3906 0.18	2N5089 0.30	2N6122 0.44	40650 0.59	BC1749 0.13	BC2149 0.18	BC5581 0.15	BD2486 0.93	BF206 0.16	BF951 1.85
2N2193A 0.52	2N3056 0.50	2N4031 0.55	2N5190 0.65	2N6123 0.48	40651 0.59	BC1749 0.13	BC2149 0.18	BC5582 0.15	BD2487 0.93	BF207 0.16	BF951 1.85
2N2194 0.42	2N3057 0.40	2N4032 0.65	2N5191 0.75	2N6124 0.45	40652 0.59	BC1749 0.13	BC2149 0.18	BC5583 0.15	BD2488 0.93	BF208 0.16	BF951 1.85
2N2194A 0.45	2N3314 0.45	2N4036 0.72	2N5192 0.80	2N6125 0.47	40653 0.59	BC1749 0.13	BC2149 0.18	BC5584 0.15	BD2489 0.93	BF209 0.16	BF951 1.85
2N2195 0.40	2N3315 0.45	2N4037 0.60	2N5193 0.75	2N6126 0.45	40654 0.59	BC1749 0.13	BC2149 0.18	BC5585 0.15	BD2490 0.93	BF210 0.16	BF951 1.85
2N2195A 0.40	2N3317 0.17	2N4058 0.22	2N5194 0.90	2N6127 0.45	40655 0.59	BC1749 0.13	BC2149 0.18	BC5586 0.15	BD2491 0.93	BF211 0.16	BF951 1.85
2N2217 0.55	2N3384 0.17	2N4059 0.17	2N5195 0.97	2N6128 0.45	40656 0.59	BC1749 0.13	BC2149 0.18	BC5587 0.15	BD2492 0.93	BF212 0.16	BF951 1.85
2N2218 0.35	2N3395 0.19	2N4060 0.22	2N5245 0.37	2N6129 0.45	40657 0.59	BC1749 0.13	BC2149 0.18	BC5588 0.15	BD2493 0.93	BF213 0.16	BF951 1.85
2N2218A 0.38	2N3396 0.19	2N4061 0.19	2N5246 0.38	2N6130 0.45	40658 0.59	BC1749 0.13	BC2149 0.18	BC5589 0.15	BD2494 0.93	BF214 0.16	BF951 1.85

LINEAR CIRCUITS

CA3018 0.75	LM379S 4.25	LM324 0.75	TAAS808 1.45
CA3018A 1.10	LM3808N 0.96	LM7815K 1.75	TA0100 2.00
CA3020 2.20	LM3808N14	LM7824K 1.75	TA0120 0.80
CA3020A 2.50	1.08	LM78105CZ	TA6500 2.24
CA3028A 0.90	LM3814N 2.70	0.30	TA6500B 2.34
CA3028B 1.25	LM3814N 1.68	LM78L12CZ	TA6510 2.35
CA3030 1.50	LM3824N 1.35	0.30	TA65100 2.48
CA3030A 2.20	LM3845N 1.55	LM78L15CZ	TA6520 0.60
CA3038 2.90	LM3868N 0.88	0.30	TA65200 2.70
CA3038A 4.10	LM3874N 1.10	MM5314	4.60
CA3045 1.55	LM3888N 1.00	MM5316	4.60
CA3046 0.77	LM3898N 1.80	NE555	0.33
CA3048 2.45	LM703N 0.81	NE556	0.85
CA3052 1.78	LM709 0.70	NE558N	1.98
CA3080 0.85	LM7098 0.50	NE560	4.50
CA3080A 2.10	LM7091A 0.48	NE561	4.50
CA3086 0.50	LM710 0.67	NE562	4.50
CA3088B 1.87	LM710A 0.64	NE565	1.39
CA3089 2.90	LM711CN 0.72	NE566	1.75
CA3090 0.40	LM723C 0.75	NE567	1.90
CA3130 1.06	LM723C14 0.45	NE571N	4.95
CA3140 1.04	LM726 0.50	SAS560	2.70
LM301 0.30	LM741C 0.70	SAS570	2.70
LM307N 0.50	LM741C8 0.30	SAJ110	2.10
LM308N 0.95	LM741CN 0.70	SOP	1.35
LM309K 1.95	LM747CN 0.99	SOP2P	3.35
LM317K 3.35	LM7488 0.50	TA81800C	2.98
LM318N 2.45	LM7481A 0.90	1.30	TA8160B 2.55
LM320TS 2.15	LM1303N 1.15	SN76003N	TC2470 2.99
LM320T12 2.15	LM1304N 1.52	2.38	TC2470 4.50
LM320T15 2.15	LM1305N 1.10	SN76013N	TC2470 4.50
LM320T24 2.15	LM1307N 1.22	1.50	TC2470 3.00
LM320P5 1.15	LM1310M 2.10	SN76023N	TC2470 6.00
LM320P12 1.15	LM1315M 1.30	1.50	TC2470 1.49
LM320P15 1.15	LM1458N 0.45	SN76033N	TC2440 1.85
LM320P24 1.15	LM1458N 0.97	2.35	TD1022 5.70
LM322K 6.95	LM1809N 2.10	TA2623	3.50
LM339N 0.60	LM1812N 6.20	TA300 3.70	TD1034 4.75
LM340TS 0.88	LM1820N 1.16	TA320A 1.15	TD2020A 0.40
LM340TS15 0.88	LM1828N 1.90	TA350A 3.00	0.40
LM340T24 0.88	LM1830N 1.90	TA521 1.10	UAA170 2.15
LM341P5 0.80	LM1831N 1.90	TA522 2.10	UAA180 2.15
LM341P12 0.80	LM1845N 1.90	TA650 0.48	ULD02P 1.24
LM341P15 0.80	LM1848N 1.90	TA650 2.10	ULD02P 1.10
LM341P24 0.80	LM1850N 1.90	TA650 2.20	ULD02P 1.10
LM348N 0.95	LM1889N 4.90	TA670A 0.45	ULD03CN 1.40
LM358N 0.60	LM3301N 0.60	TA6630 2.40	ULD04CN 1.45
LM360N 3.00	LM3320N 0.55	TA696 3.30	LF355N 0.80
LM370N 3.30	LM3401N 0.55	TA670 4.20	LF355N 0.80
LM371N 2.35	LM3900N 0.68	TA651B 2.50	LF357N 0.80
LM350K 6.45	LM3905N 1.15	TA6621 2.50	LF13201N 3.00
LM373N 3.35	LM3909N 0.78	TA6616A 1.65	LF13331N 3.00
LM374N 3.36	LM3911N 1.10	TA6616B 1.45	LF13741N 0.80
LM377N 1.40	LM7805K 1.75	TA670 4.45	LF13741N 0.55
LM378N 2.80	LM7812K 1.75	TA930A 1.50	

MICROPROCESSOR SUPPORT

RAM STATIC
2101-1 £2.04
2102-2 £1.94
2111 £3.37
2112 £3.37

RAM DYNAMIC
4K TMS 4050 £7.43
16K TMS 4116 £36.55

COMPUTER ON A CHIP
The Texas 9980 - £29.89
Data 30p



National have 60 support devices for 8080 Intel have 30 - see our new catalogue for a large selection

CMOS ZINGERS
MM74C910 £6.79
MM74C914 £1.41
MM74C920 £11.83
MM74C929 £11.83
+ 30 others in stock

VAT INCLUDED IN PRICES

4000 0.22	4016 0.52
4001B 0.22	4017B 1.05
4002 0.22	4018 1.05
4006 1.25	4019 0.52
4007 0.22	4020 1.15
4008B 0.99	4021 1.05
4009 0.58	4022 1.00
4010 0.58	4023 0.22
4011B 0.22	4024 0.76
4012 0.22	4025 0.22
4013B 0.52	4027 0.55
4014 1.00	4028 0.92
4015 1.05	4029 1.10

CMOS



NOTICE TO READERS

When replying to Classified Advertisements please ensure:

- That you have clearly stated your requirements.
- That you have enclosed the right remittance.
- That your name and address is written in block capitals, and
- That your letter is correctly addressed to the advertiser.

This will assist advertisers in processing and despatching orders with the minimum of delay.

RECEIVERS AND COMPONENTS

BRAND NEW COMPONENTS BY RETURN

Electrolytic Capacitors 18V, 25V, 50V.
 0.47-1.0, 2.2, 4.7 & 10 mfd. — 5p.
 22, 47-5p, 150V-6p, 100-7p, 50V-8p.
 220-8p, 150V-10p, 470-11p, 50V-10p.
 1000/15V-15p, 1000/25V-18p, 1000/50V-22p.

Subminiature bead tantalum electrolytics.
 0.1-0.22, 0.47, 1.0 @ 35V, 4.7 @ 6.3V-8p.
 2.2/35V & 4.7/25V-9p, 10/25V, 15/16V-12p.
 22/16V, 33/10V, 47/6V, 68 & 100 @ 3V-14p.

Mullard Miniature Ceramic E12 Series 63V 2%.
 10 pf. to 47 pf.-3p, 56 pf. to 330 pf.-4p.

Vertical Mounting Ceramic Plate Caps. 50V.
 E12 22 pf.-1000 pf. E6 1500 pf.-47000 pf.-2p.

Polystyrene E12 Series 63V. Hor. Mounting.
 10 pf. to 1000 pf.-3p, 1200 pf. to 10000 pf.-4p.

Mullard Polyester 250V Vert. Mtg. E6 Series.
 .01 to .1-4p, .15, .22-5p, .33, .47-8p.
 .68-11p, 1.0-14p, 1.5-20p, 2.2-24p.

Mylar (Polyester) Film 100V. Vertical Mtg.
 .001, .002, .005-3p, .01, .02-4p, .04, .05-5p.

Miniature Film Resistors Highstab. E12 5%.
 0.125 watt 100 to 2M20.....1p.
 0.250 watt 10 to 10M0 (10% over 1M).....1p.
 0.500 watt 100 to 2M70.....1 1/2p.
 1.000 watt 100 to 10M0.....2p.
 1N4148-3p, 1N4002-5p, 1N4006-7p, 1N4007-8p.
 8C107/8/9, BC147/8/9, BC157/8/9, BF194 & 7-9p.
 20mm. fuses .15, .25, .5, 1.0, 2.0, 3.0 & 5A-3p.
 Printed Circuit Holders for 20mm. fuses-5p.
 Post 10p (Free over £4). Prices VAT inclusive.

THE C. R. SUPPLY CO.
 127, Chesterfield Road, Sheffield S8 0RN

VALVES. Radio - T.V. - Industrial - Transmitting and Projector Lamps. We dispatch Valves to all parts of the world by return of post, Air or Sea mail, 4000 Types in stock, 1930 to 1976. Obsolete types a speciality. List 20p. Quotation S.A.E. Open to callers Monday to Saturday 9.30 to 5.00 closed Wednesday 1.00. We wish to purchase all types of new and boxed Valves, Projector Lamps and Semiconductors. **COX RADIO (SUSSEX) LTD.**, Dept. P.W. The Parade, East Wittering, Sussex, PO20 8BN, West Wittering 2023 (STD Code) 024366.

RECHARGEABLE BATTERIES

EXTENDED RANGE

HP2 (size D) £3.56, HP11 (size C) £2.57, Sub C £1.64, Pencil (size AA) £1.32, 9 volt PP3 £4.98, 9 volt PP6 £11.86, 9 volt PP7 £9.14, 9 volt PP9 £14.30. All chargers £7.97 (except for PP3 - is £5.82 and pencil - is £8.90). 6 volt 8Ah sealed lead acid £11.88. New child's, 2.4 mile range.

ELECTRIC CAR

SAE for all details and lists plus £1.00 for rec. booklet "Nickel Cadmium Power". Add p.p.p. 10% (5% orders £25.00 and over). All prices include VAT. Dept. PE, Sandwell Plant Ltd., 201 Monmouth Drive, Sutton Coldfield, West Midlands. Callers to: TLC, 32 Craven Street, Charing Cross, or to 2 Union Drive, Boldmere, Sutton Coldfield. Tel: 021-354 9764.

SMALL ADS

The prepaid rate for classified advertisements is 20 pence per word (minimum 12 words), box number 60p extra. Semi-display setting £6.60 per single column centimetre (minimum 2.5 cms). All cheques, postal orders etc., to be made payable to Practical Electronics and crossed "Lloyds Bank Ltd". Treasury notes should always be sent registered post. Advertisements, together with remittance, should be sent to the Classified Advertisement Manager, Practical Electronics, Room 2337, IPC Magazines Limited, King's Reach Tower, Stamford St., London, SE1 9LS. (Telephone 01-261 5846).

MAINS TOUCH SWITCH KIT. 400 watt load capacity. Details free. I. G. BOWMAN, (Dept. PE), 59 Fowey Avenue, Torquay, S. Devon.

EVERYONE'S A WINNER WITH CODESPEED

Full Spec. Devices

Pack C1 5 x 12 pin Hybrid Circuits each containing 16 resistors/capacitors. Ideal for P.C.B. miniaturisation. With data. 5 for 50p

Pack DM1 5 x 14 pin dual in line chips each containing 23 quality matrixed signal diodes. With data. 50p

Pack E2 A calculator style 8 digit Liquid Crystal display 0.33in high. With data £2.95

Pack E3 Same as Pack E2 but 0.5in high digits. With data £4.25

Pack E4 A 1 1/2 digit 0.3in high 7 segment gas discharge display. Requires 180V Anode voltage. Makes an excellent replacement for LED's in your mains operated projects. With full data - fantastic value at only 90p

Pack E5 Same as Pack E4, but dual digit. 90p

Pack M1 Terrific value, two calculator keyboards. Only £1.00

Pack M2 1 x 2102, a 1024 bit static RAM. The most popular of all random access memories in professional and amateur electronics. With full data. £1.25

Pack T4 A 0.8in Giant red LED 12 hour clock display. Common cathode, 3 1/2 digit. An ideal size for your clock project. With data. £4.95

Pack T2 Back by popular demand. A high contrast 3 1/2 digit Liquid Crystal wristwatch display with data. £1.00

Pack P1 1 x MM5330 Digital Voltmeter I.C. With full instructions on how to build an extremely good digital multimeter or panel meter. £3.95

Pack M3 Build your own calculator! MM5725 calculator chip and data book £1.00

Full Spec. Series SN74, 36 60p SN74155 £1.00 SN74156 50p SN74164 75p SN74170 £1.60 SN74175 60p SN74167 £1.00

Satisfaction guaranteed or return complete pack for replacement or refund.

MAIL ORDER ONLY - NO CALLERS PLEASE
 Postage and Packing please add 25p

CODESPEED
 P.O. Box 23, 34 Seaford Road
 Copnor, Portsmouth, Hants., PO3 5BJ

TURN YOUR SURPLUS capacitors, transistors, etc., into cash. Contact **COLES-HARDING & CO.**, 103 South Brink, Wisbech, Cambs, 0945-4183. Immediate settlement.

PCBs Paxolin 10 1/2" x 4 1/2" 4 - £1.25. 12" x 9" 70p. 17 1/2" x 9 1/2" £1.15. Fibre Glass Double Sided 13" x 6" £1.30. 12" x 10 1/2" £2.10. Unit with 8 Silicon Diodes 600V 20 amp, 8 SCRs 400V 16 amp, 6 Vinkors w.w. resistors etc. £6.75. 300 Small Components Trans. Diodes £1.30. 7lbs. Assorted Components £2.95. List 15p Refundable. Post 20p under £1. Insurance add 15p.

J.W.B. RADIO

2 Barnfield Crescent, Sale, Cheshire M33 1NL

COMPONENTS. pots, resistors, capacitors, valves, transformers, relays - plus lots more. Give away prices. 10p + S.A.E. for list. Stephenson, Chimney Mill, Newcastle upon Tyne, NE9 4AL. (0632) 610210.

FULL SPECIFICATION COMPONENTS. Very competitive prices. 1448 50p, 7489 £1.50, 7493 35p. Send SAE for list. Deroytran, 37 Winstanley Road, Wellingborough, Northants.

ELECTRICAL

STYLI - illustrated equivalents (List 28) also cartridges, leads, etc. Superb quality and service at lowest prices: Fully guaranteed, Free for S.A.E. from **FELSTEAD ELECTRONICS (PE)**, Longley Lane, Gatley, Cheshire SK8 4EE.

CONDITIONS OF ACCEPTANCE OF CLASSIFIED ADVERTISEMENTS

- Advertisements are accepted subject to the conditions appearing on our current advertisement rate card and on the express understanding that the Advertiser warrants that the advertisement does not contravene any Act of Parliament nor is it an infringement of the British Code of Advertising Practice.
- The publishers reserve the right to refuse or withdraw any advertisement.
- Although every care is taken, the Publishers shall not be liable for clerical or printers' errors or their consequences.

SERVICE SHEETS

SERVICE SHEETS for Radio, Television, Tape Recorders, Stereo etc. With free Fault-finding guide, from 50p and S.A.E. Catalogue 25p and S.A.E. Hamilton Radio, 47 Bohemia Road, St. Leonards, Sussex.

BELL'S TELEVISION SERVICES for Service Sheets on Radio, TV, etc. 75p plus S.A.E. Colour TV Service Manuals on request. S.A.E. with enquiries to B.T.S. 190 Kings Road, Harrogate, N. Yorkshire. Tel: (0423) 55885.

FOR SALE

SYNTHESISER, Separate Keyboard, Based on P.E and E.T.I circuits £250. Riggs, 95 Pickwick Road, Corsham, Wilts. Phone Corsham 712414.

HARTLEY CT316 Oscilloscope and TE-20D Signal Generator together for £50. o.n.a. Phone 021-353 2346.

2 x 61 Note Organ Keyboards complete with contacts £30.00. Each. Selmar Clavoline £50.00. Lichfield 24870.

ELECTRONIC KITS-SAE for new catalogue, and clearance list of obsolete kits. AMTRON U.K. 7 Hughenden Road, Hastings, Sx.

RADIOSPARES MAINS TRANSFORMERS ex-equipment. Twin 12 volt 4 amp Secondary. Huge saving, only £5.95 post paid. J. Hansom, 12 Torquay Avenue, Hartlepool, Cleveland.

NEW BACK ISSUES of "PRACTICAL ELECTRONICS" available 65p each Post Free. Open P.O./Cheque returned if not in stock - Bell's Television Services, 190 Kings Road, Harrogate, N. Yorks. Tel: (0423) 55885.

DEWTRON SYNTHESISER modules 4 oscillators envelope shapers ring modulator 36 note keyboard £70. Also Eagle reverb unit £15. Tel: Jarrow 892417.

CORE MEMORY PLANES, ex-equip 4K (64x64) per plane. 99p each + 25p P & P. Eight for £7.50 post free. G. Langley, 31 Bakers Lane, Woodston, Peterborough.

"**RUN YOUR OWN BUSINESS AS AN EXTRA HOME ACTIVITY. LARGE PROFITS. A GENUINE OPPORTUNITY TO SUCCEED.**" Full details on receipt of s.a.e. Industrial Supplies, 102 Parrswood Road, Withington, Manchester 20.

SEEN MY CAT? 5000 Odds and ends. Mechanical Electrical. Cat free. Whiston, Dept. PRE, New Mills, Stockport.

DIGITAL HEATH KIT Self-instruction course/Tutor, Working. Basics to Microprocessors. £65. Bristol 027-52 8379.

BOOKS AND PUBLICATIONS

SIMPLIFIED TV REPAIRS. Full repair instructions individual British sets £4.50, request free circuit diagram. Stamp brings details unique. TV Publications, (AUSEPE) 76 Church Street, Larkhall, Lanarkshire.

THE END OF COMPUTER CONFUSION: what point have we reached - where are we going? Read Computer Lib/Dream Machine by Ted Nelson. £5.95 from your Local Computer Store, or send £6.45 to Computer Bookshop, Temple House (1), 43-48 New Street, Birmingham.

WANTED

WANTED: Clean new semiconductors, I.C.'s etc. Good prices paid. Hewitts, 52 Barkby Road, Syston, Leicester.

LADDERS

LADDERS. Varnished 25ft. Extd. £34.56. Carr. £2.70. Leaflet. Callers welcome. Open Sat. Ladder Centre, (PEE4) Halesfield (1) Telford, Salop. Tel: 586644.

Radio Technicians

Government Communications Headquarters has vacancies for Radio Technicians. Applicants should be 19 or over

STANDARDS required call for a sound knowledge of the principles of electricity and radio, together with appropriate experience of using and maintaining radio and electronic test gear.

DUTIES cover highly skilled telecommunications/electronic work, including the construction, installation, maintenance and testing of radio and radar telecommunications equipment and advanced computer and analytic machinery.

QUALIFICATIONS: Candidates must hold either the City and Guilds Telecommunications Part 1 (Intermediate) Certificate or equivalent HM Forces qualification.

SALARY (inc. supps.) from £2,927 at 19 to £3,700 at 25 (highest pay on entry) rising to £4,252 with opportunity for advancement to higher grades up to £4,706 with a few posts carrying still higher salaries.

Opportunities for service overseas.

Further particulars and application forms available from:

GCHQ

Recruitment Officer, (Ref PE/10)
GCHQ, Oakley,
Priors Road, Cheltenham, GL52 5AJ.
Cheltenham (0242) 21491 Ext 2270



EDUCATIONAL

COLOUR TV SERVICING

Learn the techniques of servicing Colour TV sets through new homestudy course approved by leading manufacturers. Covers principles, practice and alignment with numerous illustrations and diagrams. Other courses for radio and audio servicing. Full details from:

ICS SCHOOL OF ELECTRONICS
Dept. 272Z, Intertext House, London SW8 4UJ
Tel. 01-622 9911 (all hours)
State if under 18

TECHNICAL TRAINING

Get the training you need to move up into a higher paid job. Take the first step now—write or phone ICS for details of ICS specialist homestudy courses on Radio, TV, Audio Eng. and Servicing, Electronics, Computers: also self-build radio kits. Full details from:

ICS SCHOOL OF ELECTRONICS
Dept. 272Z, Intertext House, London SW8 4UJ
Tel. 01-622 9911 (all hours)
State if under 18

CITY & GUILDS EXAMS

Study for success with ICS. An ICS homestudy course will ensure that you pass your C. & G. exams. Special courses for: Telecoms. Technicians, Electrical Installations, Radio, TV & Electronics Technicians, Radio Amateurs. Full details from:

ICS SCHOOL OF ELECTRONICS
Dept. 272Z, Intertext House, London SW8 4UJ
Tel. 01-622 9911 (all hours)
State if under 18

MISCELLANEOUS

100 WATT GUITAR/PA/MUSIC AMPLIFIER

With superb treble, bass, Overdrive, slimline, 12 months guarantee. Unbeatable offer at £39. Also twin channel with separate treble/bass per channel £48. Money returned if not absolutely delighted within 7 days. Also fuzz boxes great sound robust construction £8.60. Also 100 watt 12 in. speakers £22.50.

All inclusive of P.P. Send cheque or P.O. to:
WILLIAMSON AMPLIFICATION
62, THORNCLIFFE AVENUE, DUKINFIELD,
CHESHIRE. TEL: 061-344 5007

CLEARING LABORATORY. Scopes, recorders, testmeters, bridges, audio, R.F. generators, turntables, tapeheads, stabilised P.S.U.s, sweep generators, test equipment, etc. Lower Beeding 236.

MORSE CODE TUITION AIDS

Cassette A: 1-12 w.p.m. for amateur radio examination.
Cassette B: 12-24 w.p.m. for professional examination preparation.
Morse by light system available. Morse Key and Buzzer unit for sending practice.
Prices each cassette (including booklets) £4.50. Morse Key and Buzzer £4.50.
Prices include postage etc., Overseas Airmail £1.50 extra.

MHEL ELECTRONICS (Dept. PE)
12 Longshore Way, Milton,
Portsmouth PO4 8LS.

PRINTED CIRCUITS and HARDWARE

Readily available supplies of Constructors' hardware. Printed circuit boards, top quality for individual designs. Prompt service. Send 25p for catalogue. From:

RAMAR CONSTRUCTOR SERVICES,
Masons Road, Stratford upon Avon, Warwick.
Tel. 4879.

ALFAC etch resist transfers and other p.c. board drawing materials available from stock, s.a.e. details. Ramar Constructor Services, Masons Rd, Stratford on Avon. CV37 9NF.

PRACTICAL ELECTRONICS P.C.B.'s

in glass fibre tinned and drilled
Dec. 77 Car Burglar Alarm 1412-1 88p.
May 78 Moving Light Display £2.96.
May 78 Workshop Power Supply £1.97.
May 78 Chorus Generator £2.55.
July 78 Dimwit £1.48.
Aug 78 Touch Switch 85p. C.W.O. Please.
For full list and current boards please send S.A.E.
P.C.B.'s also produced from customer's own master - please send for quote.

PROTO DESIGN

14 Downham Road, Ramsden Heath, Billericay, Essex

ELECTRONIC KITS. A company serving the amateur electronics market is interested in purchasing electronic kits to widen its range. Companies selling such kits are invited to contact: Box No. 75.

LOST THE TIME?

MSF 60 KHz RECEIVER, built-in antenna, £13.70, or with parts (no case or pcb) for sequential YEAR, MONTH, DATE, DAY, HOURS, MINUTES, SECONDS display £24.40.

MISSING LONG WAVE? NEW 200 KHz to Med. Wave Converter, built-in antenna, inductive (place near receiver) and coax outputs, £9.70.

PROGRAM YOUR OWN tunes on a MUSICAL DOORBELL, new jingle every day, just needs bell transformer and speaker, £19.50.

Each easy-assemble kit includes all parts, printed circuit, case, postage etc, instructions and money back assurance so SEND off NOW.

CAMBRIDGE KITS

45 (FK) Old School Lane, Milton, Cambridge

SUPERB INSTRUMENT CASES BY BAZELLI, manufactured from P.V.C. faced steel. Hundreds of people and industrial users are choosing the cases they require from our vast range. Competitive prices start at a low 90p, chassis punching facilities at very competitive prices, 400 models to choose from, free literature (stamp would be appreciated). BAZELLI, Dept: No. 23, St. Wilfred's, Foundry Lane, Halton, Lancaster. LA2 6LT.

MAKE YOUR OWN PRINTED CIRCUITS

Etch Resist Transfers - Starter pack (5 sheets, lines, pads, I.C. pads) £1.30. Large range of single sheets in stock at 27p per sheet.

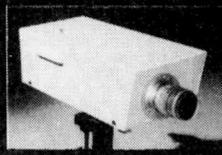
Ferric Chloride - 1lb bags 80p (P&P 40p)*
Master Positive Transparencies from P.C. layouts in magazines by simple photographic process. Full instructions supplied. 2 sheets (20 x 25cm) negative paper and 2 sheets (18 x 24cm) positive film £1.20. S.A.E. lists and information. P&P 20p/order except*

P.K.G. ELECTRONICS
OAK LODGE, TANSLEY, DERBYSHIRE

SINTEL FOR BOOKS, CMOS AND COMPONENTS

6800 Booklet 1.80, MOT CMOS Databk 3.50, 6800 Appl Man 12.95, 6800 Prog Man 5.35, SC/MP Introkit Man 0.75, NS TTL Databk 2.10, RCA CMOS Databk 5.45, 8085 User's Man 5.15, 280 Ass Long Prog Man 7.50, 280 CPU Man 5.60, 280 CTC Spec 0.80, 280 PIO Man 3.30. Also a full range of CMOS - send for free catalogue MPU's: MK6800D2 205.20, MC6802 7.50, 280 18.14, 280A 24.19, 280CTC 10.96, 280PI0 10.96, Memories: 2102-A 2.00, 2112A 3.13, Displays: Type FND500 C.C. 1.40, Type TL1321 CA. 1.40, 5LTO1 5.29, Crystals: 32.768KHz 3.19, Clock ICs: AY51202 3.35, AY51224 3.73, MK50253 5.83, Soldercon Pins: 100 0.54, 1000 4.32, 3000 11.34. Free catalogue by return. All items CWO. Prices inclusive of VAT. Add 35p p&P. SINTEL, P.O. Box 75B, 209 Cowley Road, Oxford. Tel. (0865) 49791.

BEST OFFER EVER £99-99 Total £110.64 inc p p & VAT TV CAMERA



Complete TV Camera Kit for under £100.00 (excluding P/P and VAT). Offer includes Lens, Tube and FREE Modulator. Plugs directly into AE socket of TV or VCR. Reliable high performance design. Suitable for Security, Education, Industry, etc. Fully compatible with other CCTV Equipment. Fully Guaranteed Parts. Buy it with your Credit Card.

CROFTON ELECTRONICS LIMITED

35 Grosvenor Road, Twickenham, Middlesex TW1 4AD. Tel: 01 891 1923

DEAD or ALIVE OR JUST MIXED UP?

5-FUNCTION 13 AMP SOCKET TESTER

SAFELY SHOWS YOU!



Safety fast! Shows: 1, If all wires correct. 2, Live wire faulty. 3, Live and Neutral wires reversed. 4, Earth faulty. 5, Neutral faulty. Shows exact fault instantly. British made. £3.95 post free. Save time. Be sure. Be safe.

PERSONAL SAFETY CO.,
Dept. PE1, P.O. BOX 1,
LLANRWST,
GWYNEDD, NORTH WALES

BUILD THE TREASURE TRACER

MK III Metal Locator



- Variable tuning
- Britain's best selling metal locator kit
- Fitted with Faraday shield
- Speaker and earphone operation
- 4,000 already sold
- Precut search coil assembly
- Five transistor circuit
- Thoroughly professional finish
- You only need soldering iron, screw-driver, pliers and snips
- As seen on BBC-1 and BBC-2 TV

Send stamped addressed envelope for leaflet

Complete Kit **£15.95** Post £1.20 - £1.37 VAT.
Built and tested **£20.95** Post £1.20 - £1.77 VAT.
MINIKITS ELECTRONICS, 6g CLEVELAND ROAD
LONDON E18 2AN (Mail Order Only)

TRANSFORMER PROBLEMS?

Send SAE with requirements for return of post quote.

TRENT TRANSFORMERS LTD
Chapel Street,
Long Eaton, Nottm. 06076 66716

NEW

ODIK MK 2 in-circuit junction tester. Tests all silicon and germanium transistors (inc. power types) without desoldering from the circuit. Also tests diodes, S.C.R.s and L.E.D.s.

- ★ Simple to use.
- ★ Go - No - Go indication.
- ★ Full instructions for use.
- ★ Robust.

Comes ready to use with battery fitted.

Price only **£7.95** inc. P. & P.



REVOLUTIONARY MULTI-PURPOSE TESTER

A MUST FOR EVERY HOME AND WORKSHOP.

Can be used to test all fuses, filament lamps and electrical appliances for continuity.

- ★ Tests High Resistance items (i.e. Low wattage appliances)
- ★ Simple to use.
- ★ Go - No - Go indication via Space Age L.E.D.
- ★ Battery supplied.
- ★ Absolutely invaluable to the handyman, amateur and professional.

Price only **£2.50** inc. P & P.

VERSATILE THE ODIK MULTIVOLT

A General purpose power supply providing 4 switchable output voltages from a mains input. Suitable for the majority of radios, cassette players and other battery powered appliances. May also be used as a step down transformer to power a model train etc.



- ★ Provides 12v, 9v, 7.5v, and 6v outputs.
- ★ Regulated output provides up to 400mA.
- ★ Attractive, Robust METAL enclosure.
- ★ Supplied with output lead together with 2.5mm and 3.5mm power plugs.

Price only **£6.95** inc. P&P.

DIRECT FROM THE MANUFACTURERS

ODIK ELECTRONICS
43, Meadowside, Nuneaton, Warwickshire

NO LICENCE EXAMS NEEDED

To operate this miniature, solid-state Transmitter-Receiver Kit. Only £9.75 plus 25p P. & P.

'Brain-Freeze' 'em with a MINI-STROBE Kit, pocket-sized 'lightning flashes', vari-speed, for discos and parties. A mere £4.30 plus 20p P. & P. Experiment with a psychedelic DREAM LAB, or pick up faint speech/sounds with the BIG EAR sound-catcher; ready-made multi-function modules. £5 each plus 20p P. & P.

LOTS MORE! Send 20p for lists. Prices include VAT. (Mail order U.K. only).

BOFFIN PROJECTS

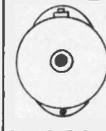
Cunliffe Road, Stoneleigh
Ewell, Surrey (P.E.)

PRINTED CIRCUIT BOARDS made to your requirements. Write for details and price list. Western Circuit Designs, 31 Great Hinton, Trowbridge, Wilts. BA14 6BY.

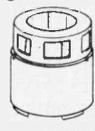
BELLS AND SIRENS

CARTERS SIREN £5.83
INDUSTRIAL SIX INCH
BELL £8.27

PRICES INCLUSIVE
Send Cheque, P.O. to:
CWAS ALARM
11 Denbrook Walk,
Bradford BD4 0QS.



6 to 12v D.C.



12v D.C.

SAE for full Price List of Professional Burglar Alarm Equipment

THE FABULOUS D2 MICROPROCESSOR EVALUATION KIT FROM MOTOROLA.

Featuring *24 key keyboard *Seven segment display *Cassette interface *Erom & Ram Expandable *Interface Capability *Full Documentation *5 Volt power supply Required *One years FREE membership of The Amateur Computer Club with every purchase*. £176 + £1.50 P & P + 8% VAT.

ENAMELLED COPPER WIRE

SWG	1 lb	8 oz	4 oz	2 oz
10-19	2.60	1.40	.66	.55
20-29	2.80	1.60	.85	.65
30-34	3.00	1.70	.95	.70
35-40	3.35	1.90	1.10	.79
40-43	4.50	2.50	1.90	1.25
44-46	5.00	3.00	2.10	1.65
47	8.00	5.00	3.00	1.76
48	15.00	9.00	6.00	3.30

Tinned Copper, Even Gauges 14-30 £3 per lb. Multicore 60/40 Solder 18SWG £3.24 per lb. Prices include P & P and VAT.

SAE brings list of copper and resistance Wires.

THE SCIENTIFIC WIRE COMPANY

PO Box 30 London E.4.
Reg. Office, 22 Coningsby Gdns.



RADIO CONTROL SPECIALISTS

Kits for multi channel systems. Special parts and accessories.

S.A.E. FOR LEAFLETS
Tel: 0602 395418

**MICRON R/C, Hayworth Road,
Sandiacre, Nottingham.**

CABINET FITTINGS

FOR

Stage Loudspeakers and Amplifier Cabs
Fretcloths, Coverings, Strap & Recess Handles, Feet, Castors, Jacks & Sockets, Cannons, Bulgin 8 ways, Reverb Trays, Locks & Hinges, Corners, Trim, Speaker Bolts etc.

Send 2 x 9p Stamps for samples and illustrated catalogue.

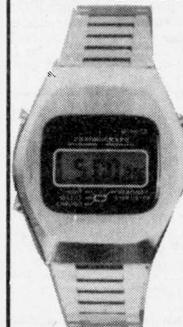
ADAM HALL (P.E. SUPPLIES)

Unit 3, Carlton Court, Granger Road
Southend-on-Sea, Essex.

NOTICE TO READERS

Whilst prices of goods shown in classified advertisements are correct at the time of closing for press, readers are advised to check with the advertiser both prices and availability of goods before ordering from non-current issues of the magazine

INCREDIBLE WATCH BARGAINS



ALARM LCD

six digit hours minutes optional seconds or date, month, day, 4 year calendar, alarm programmable for any minute in 24 hours with on/off indication, backlight.

ONLY
£24.95

12 FUNCTION CHRONOGRAPH LCD

hours, minutes, seconds, day, date, month, chrono time 1/10th sec, 2 event timing, 1st and 2nd place times, non interrupt between chrono and real time, backlight.

ONLY
£18.95



STOP PRESS

**FULL CHRONOGRAPH/ALARM LCD
ONLY £39.95**

All prices include presentation case, 12 month guarantee, instructions, P&P, Vat. Money back guarantee.

Send cheque of P.O. to

VIDEOTIME PRODUCTS

56 Queens Road, Basingstoke
Hants RG21 1RE. Tel. (0256) 56417
Telex 858747

Trade & Export Enquiries Welcome

TRANSFORMERS

ALL EX-STOCK—SAME DAY DESPATCH. VAT 8%

12 OR 24 VOLT OR 12-0-12V PRIMARY 220-240 VOLTS					
Ref	12V	24V	£	P & P	OA
111	0.5	0.25	2.20	0.45	
213	1.0	0.5	2.64	0.78	
71	2	1	3.51	0.78	
18	4	2	4.03	0.96	
70	6	3	5.35	0.96	
108	8	4	6.98	1.14	
72	10	5	7.67	1.14	
116	12	6	8.99	1.32	
17	16	8	10.39	1.32	
115	20	10	13.18	2.08	
187	30	15	17.05	2.08	
226	60	30	26.82	0A	

50 VOLT RANGE					
Ref	12V	24V	£	P & P	OA
102	0.5	3.41	0.78		
103	1.0	4.57	0.96		
104	2.0	6.98	1.14		
105	3.0	8.45	1.32		
106	4.0	10.70	1.50		
107	6.0	14.62	1.64		
118	8.0	17.05	2.08		
119	10.0	21.70	0A		

MAINS ISOLATING (SCREENED)					
Ref	VA (Watts)	£	P & P	OA	
07*	20	4.40	0.79		
149	60	6.20	0.96		
150	100	7.13	1.14		
211	150	11.14	1.64		
152	250	12.79	1.84		
153	350	16.28	1.84		
154	500	19.15	2.15		
155	750	29.06	0A		
156	1000	37.20	0A		
157	1500	45.60	0A		
158	2000	50.00	0A		
159	3000	79.05	0A		

HIGH VOLTAGE ISOLATORS					
Ref	VA (Watts)	£	P & P	OA	
60	243	5.89	1.32		
350	247	14.11	1.84		
1000	250	41.76	0A		
2000	252	54.25	0A		

30 VOLT RANGE					
Ref	12V	24V	£	P & P	OA
112	0.5	2.64	0.78		
79	1.0	3.57	0.96		
3	2.0	5.27	0.96		
20	3.0	6.20	1.14		
21	4.0	7.44	1.14		
51	5.0	8.37	1.32		
117	6.0	9.92	1.45		
88	8.0	11.73	1.64		
89	10.0	13.33	1.84		

60 VOLT RANGE					
Ref	12V	24V	£	P & P	OA
124	0.5	3.88	0.96		
126	1.0	5.58	0.96		
127	2.0	7.60	1.14		
125	3.0	10.54	1.32		
123	4.0	12.23	1.84		
120	5.0	13.95	1.64		
121	6.0	15.66	1.84		
122	10.0	20.15	0A		
122	10.0	24.03	0A		
189	12.0	27.13	0A		

AUTO TRANSFORMERS					
Ref	VA (Watts)	£	P & P	OA	
113	15	0-115-210-240	2.48	0.71	
64	75	0-115-210-240	3.95	0.96	
4	150	0-115-220-240	5.35	0.96	
67	500	0-115-200-220-240	10.99	1.64	
84	1000	0-115-200-220-240	18.76	2.08	
93	1500	0-115-200-220-240	23.36	0A	
95	2000	0-115-200-220-240	34.82	0A	
73	3000	0-115-200-220-240	46.00	0A	
805	4000	0-115-200-220-240	67.50	0A	

CASED AUTO TRANSFORMERS					
Ref	VA (Watts)	£	P & P	OA	
15	4	9.96	0.96	113W	
150	8	8.48	1.14	4W	
200	9	9.92	1.45	65W	
250	10	10.49	1.45	69W	
500	15	15.73	1.64	67W	
750	18	18.55	1.76	83W	
1000	23	23.50	0A	84W	
1500	26	26.02	0A	93W	
2000	37	37.65	0A	95W	

SCREENED MINIATURES					
Ref	mA	Volts	£	P & P	
238	200	3-0-3	1.99	0.55	
212	1A, 1A	0-6-0-6	2.85	0.78	
13	100	0-8-0-8	1.99	0.38	
235	300	0-9-0-9	1.99	0.38	
207	500	0-8-9-0-8-9	2.59	0.71	
208	1A, 1A	0-8-9-0-8-9	3.53	0.78	
236	200	0-15-0-15	1.99	0.38	
214	300	0-25-0-25	2.56	0.78	
211	700 (DC)	20-12-0-12-20	3.41	0.78	
206	1A, 1A	0-15-20-0-15-20	4.63	0.96	
203	500	0-15-27-0-15-27	3.99	0.96	
214	1A, 1A	0-15-27-0-15-27	5.39	0.96	
S112500		12-15-20-24-30	2.64	0.78	
239	50	12-0-12	1.99	0.38	

MINI-MULTIMETER					
DC-1000V AC-1000V DC-100mA Res-150kΩ					
1000Ω/V Bargain E586 P & P 62p					
VAT 8%					

20,000 ohm/V Multimeter, mirror scale. Ranges AC/DC to 1000V, DC currents to 250mA. Resistance to 3 Megs. 5" x 3 1/2" x 1 1/2"					
£11.34 P & P £1.05 VAT 8%					

TEST METERS					
U4315 Budget Meter 20KΩ/V DC 2KΩ/V AC 1000V AC/DC 2.5A AC/DC 500K res. in robust steel case and leads £15.85					
BX505 Sanwa £33.68 TT169 circuit transistor AV08 £77.10 tester £32.50					
AVO71 £31.10 DA116 digital £100.00					
AVO73 £42.50 Megger 8M7					
EM272 £50.70 Battery £42.50					
MM5 £26.10 Wee Megger £64.00					

Special Offer AVO Meter (107)					
Ranges DC volts 2.5, 10, 50, 100, 500, 1000V - current 1mA, 2.5, 10, 50, 100, 500, 1 amp, AC 10V, 100, 1000, 3 ohmic ranges to 10M ohms, 10,000Ω/V, DC, 1000 AC Safety cut out £40.00 P & P £1.15 VAT 8%					

ISOLATOR 1KVA 240V to 240V enclosed. Special Offer @ £18.70. Carriage £2.75.					
--	--	--	--	--	--

ELECTRONIC CONSTRUCTION KIT					
10 projects (including electronic organ). No soldering needed £7.29. VAT 8% P & 70p					

PANEL METERS					
2" 0-50µA 5.50 4" 0-50µA 6.70					
0-500µA 5.50 0-500µA 6.70 Carriage					
0-1mA 5.50 0-1mA 8.40					
0-50V 5.50 0-50V 8.40					
0-100µA 5.50 0-100µA 6.70 VAT 8%					
VU Indicator Panel 48 x 45 250µA FSD £2.60					
VU Indicator Edge 54 x 14 250µA FSD £2.60					

COMPONENT PACKS					
50 High Quality Metal Oxide 2.5% 1W Resistors.					
150 Mixed Value Capacitors					
10 Read Switch					
30 Wire Wound Resistors.					
25 assorted Presets.					
50 3 Tag Terminal Strips					
Hardware pk. bolts, nuts, washers, Insulators. All 70p each + 12 1/2 p P & P 40p.					

Fuse holder 1 1/2" completely enclosed 25p P & P 15p.					
2x Fuse boards - 2 with open 1 1/2 fuse holders 2 1/2" x 3" 30p P & P 15p.					

NEW RANGE TRANSFORMERS					
45-36-0-36-45 2A 9.89 1.38					
to give 3A 11.47 1.48					
36-0-36 4A 13.90 1.84					
45-0-45 5A 16.74 2.15					
72V or 90V. 6A 20.77 2.30					
VAT 8%					

PLUG IN SAVE BATTERIES					
MVA 30 - fits into 13A Skt. 6 7.5.					
9V 300mA multiplug outlet £3.30.					
MVA 36 - 13A Skt. 3 4.5, 6V @ 100mA multiplug outlet £3.30.					
A122 3, 4.5, 6, 7.5, 9, 12V 500mA multi plug outlet £9.21					
VAT 12 1/2 p P & P 55p.					

DECS SOLDERLESS BREAD-BOARDING					
S Dec 70 contacts £1.98					
T Dec 208 contacts £3.63					
U Dec "A" for I.C.s etc £3.99					
U Dec "B" for I.C.s etc £6.99					
VAT 8% P & P 40p					

ANTEX SOLDERING IRONS					
15W £3.75 ST3 - Iron safety					
25W £3.95 stand £1.40					
P & P 46p VAT 8%					

BRIDGE RECTIFIERS					
50V 50A £2.00					
200V 2A £0.45					
400V 4A £0.85					
400V 6A £1.05					
*VAT 8% 15p P & P					

AMPLIFIER MODULES					
10W (AL30) £3.75					
25W (AL60) £4.57					
35W (AL80) £7.15					
125W (AL250) £17.25					
Power Supply PS12 £1.30					
Power Supply SP80 £4.25					
Pre-amp PA12 £6.70					
PA100 £13.88					
VAT 12 1/2 p P & P 35p					

Magnetic to Ceramic. Cartridge Converter operating voltages 20-45V only £3.50. VAT 12 1/2 p P & P 35p.					
--	--	--	--	--	--

TRANSFORMERS Special Offer					
BE1 Prim 0-120, 0-120V (120 or 240V) Sec 24V 10A £5.50 P & P £1.66					
PW Scope 250-0-250V. 6.3V. 12 9-0-12-9V. £6.50 P & P 90p.					
BE3 100V line to 4.5 7/10W £2.05 P & P 66p					
BE4 0-120V x 2 (120V or 240V) Screen sec 9-0-9V 1A £2.40 P & P 71p					
BE5 15W matching trans sec 150 suit £1.89 £1.50 P & P 30p					
BE6 PR1 0-220V sec 4500V 10 MA £4.50 P & P £1.00					
BE7 0-110-120 220V Pri 240V Sec 20V 1A £1.50 30p P & P.					
Ref 30 240-240 Isolator 200VA £4.20 P & P 96p					
Ref 62 240-240 Isolator 250VA £5.20 P & P 96p					

Barrie Electronics Ltd.
 3, THE MINORIES, LONDON EC3N 1BJ
 TELEPHONE: 01-488 3316/7/8
 NEAREST TUBE STATIONS: ALDGATE & LIVERPOOL ST

Our wide range of transformers are too numerous to list. Please call (open 9am-5pm Mon-Fri) or send your requirements. Electrofil & semiconductor stockists. Audio accessories.

PROGRESSIVE RADIO

93 DALE STREET, LIVERPOOL L2 2JD. Tel: 051-236-0982

SEMICONDUCTORS ALL FULL SPEC. BC212, BC182, BC237, BF197, BC159 all 8p each. LM380 80p. LM381 95p. 741 8 PIN 23p. 741S (wide bandwidth) 8 pin 35p. TIL305 Alpha numerical display (with data) £2.50p. BX504 opto isolators infra red led to photo cell 4 lead 25p. BFY50 plastic 14p. STC 3 volt 1 watt zener diodes 7p each. BD533 33p. MRD3051 photo transistors 35p. FETS similar to 2N3819 18p. MOSFET similar 40673 35p. Intel C1103 1024 bit mos rams 95p. CD4051 45p. 723 14 pin I.C.s 35p.

DIODES. BY127 9p. IN4002 4p. IN4005 7p. 600v 3 amp 17p. Lucas bridge recs. 400v 1.5 amp 30p. SPECIAL OFFER. TBA800 10 for £5.00. NE555 10 for £3.00.

MAN3A 3mm led displays 50p. Min. Nixie 587 OST 75p. Pot core unit, has six pot cores including one FX2243 (45mm) and two FX2242 (35mm) 3 TO3 sil power transistors on heat sink, 3-20mm panel fuseholders and panel with various transistors, diodes and a 5 amp plastic SCR, £1.75p plus 75p postage.

MOTORS. Model type 1-5-6 volts 20p. 'BIG INCH' sub min motor 115 vac. 3 r.p.m. 25p. 24 OVAC SYNCH. MOTORS WITH GEARBOX, 1/5 r.p.m. 75p. 1/24th r.p.m. 75p. 15 r.p.m. £1.20p. Croutet 115 VAC 4 r.p.m. 95p. 12v dc 5 pole 35p.

HI-SPEED MORSE KEY. ALL METAL £2.25p. PLASTIC MORSE KEYS 95p.

PLESSEY WINKLER SWITCHES. 1 pole 30 way, 2 bank adj; stop 75p.

Crystal microphone inserts 37mm 45p. Ground electret condenser inserts with built in FET preamp £1.50p. ELECTRET PENCIL HAND MICROPHONES 1K IMP WITH STANDARD JACK PLUG £2.85p. TIE CLIP CONDENSER MIKES OMNI, 1K IMP. (uses deaf aid battery, supplied) £4.95p.

SOLDER SUCKER. high suction, eye protection shield £4.95p.

PROJECT BOXES. BLACK ABS PLASTIC WITH BRASS INSERTS AND LID. 75 x 56 x 35 44p. 95 x 71 x 35 52p. 115 x 95 x 36 60p.

BUZZERS. GPO open type 3-6v 30p. Large plastic domed type loud note 6 or 12 volts 50p. Solid State buzzers, miniature, 6-9-12-24 volt 15ma 75p each.

TAPE HEADS. Mono Cassette £1.30p. Stereo cassette £3.00. BSR MNI330 half track dual in-line. heads £1.75p. TD10 Dual head assemblies 2 heads both 1/2 track R/P with built in erase. mounted on bracket. £1.20p.

Relays. Min. sealed 12v dc type 4 pole changeover 55p. Min. 24v dc 2 pole c/o 3 amp contacts 55p. Min sealed 220v ac 2 pole c/o 40p. Open type 12v dc 4 pole c/o 50p. 4 pole reed relays N/O 20p.

CRYSTALS. 300khz 40p. Aerosol 'Touch up' paint one colour yellow/grey. 6oz can 35p. 50v ac cam units, motor switching ten c/o micro switches, supplied with capacitor for 240v ac use £1.95p plus 35p postage.

Belling Lee L4305 masthead amplifiers and mains power unit, new but only for group A UHF £7.50p.

TRANSFORMERS. 6-0-6v 100ma, 9-0

TLAs BY TEXAS			LINEAR ICs			TRANSISTORS			DIODES			BRIDGE RECTIFIERS														
7410	13p	74116	200p	74368	150p	9302	175p	4015	84p	*AY1-0212	600p	*MC1495	400p	TRANSISTORS	8Y5/172	22p	TIP41C	78p	*2N3823	70p	DIODES	*BY127	12p	BRIDGE	*1A 50V	21p
7401	14p	74118	130p	74390	200p	9308	316p	4016	45p	*AY1-1313	668p	*MC1496	100p	AC127/8	20p	8Y5/30	33p	TIP42C	70p	*2N3886	90p	*0A47	9p	*1A 100V	22p	
7402	14p	74119	210p	74393	200p	9310	275p	4017	80p	*AY1-5050	212p	*MC1497	120p	AD149	70p	8Y5/90	30p	TIP42Z	82p	*2N3903/4	18p	*0A81	15p	*1A 400V	30p	
7403	14p	74121	110p	74430	225p	9311	275p	4018	85p	*AY1-3115	600p	*MC1498	100p	AD167/2	45p	8Y5/183	700p	TIP42Z	82p	*2N3905/6	20p	*0A85	15p	*2A 500V	30p	
7404	17p	74121	28p	74430	225p	9312	160p	4019	45p	*AY5-1317	635p	*MKS5098	750p	BC109	11p	8X519/20	20p	TIP505	75p	*2N4058/9	12p	*0A90	9p	*2A 100V	35p	
7405	18p	74122	48p	74430	225p	9314	155p	4020	110p	*AY5-1320	320p	*NE531	130p	BC147/8	10p	8U105	190p	*2X108	12p	*2N4060	12p	*0A91	9p	*2A 400V	45p	
7406	32p	74123	55p	74430	225p	9316	225p	4021	110p	*CA3019	80p	*NE541	200p	BC148	10p	8U108	250p	*2X108	12p	*2N4060/1/2	12p	*0A95	9p	*2A 400V	65p	
7407	32p	74125	55p	74430	225p	9317	225p	4022	110p	*CA3046	80p	*NE543K	225p	BC149	10p	MJ431	200p	*2X108	12p	*2N4123/4	22p	*0A200	9p	*3A 200V	60p	
7408	19p	74128	60p	74430	225p	9318	200p	4023	60p	74450	225p	*NE555	30p	BC158	11p	8U208	200p	*2X108	12p	*2N4125/26	22p	*0A202	10p	*3A 800V	72p	
7409	19p	74128	75p	74430	225p	9319	200p	4024	60p	74450	225p	*NE568	70p	BC169C	12p	8U208	200p	*2X108	12p	*2N4125/26	22p	*0A202	10p	*4A 100V	95p	
7410	19p	74132	75p	74430	225p	9320	200p	4025	20p	74450	225p	*NE568	70p	BC172	12p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 400V	100p	
7411	24p	74136	75p	74430	225p	9321	200p	4026	30p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7412	24p	74136	75p	74430	225p	9322	150p	4027	30p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7413	30p	74142	20p	74430	225p	9323	150p	4028	84p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7414	60p	74145	90p	74430	225p	9324	150p	4029	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7416	27p	74147	190p	74430	225p	9325	150p	4030	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7417	27p	74147	190p	74430	225p	9326	150p	4031	200p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7420	17p	74150	100p	74430	225p	9327	150p	4032	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7421	40p	74151A	70p	74430	225p	9328	150p	4033	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7422	22p	74153	70p	74430	225p	9329	150p	4034	200p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7423	34p	74154	100p	74430	225p	9330	150p	4035	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7425	30p	74155	90p	74430	225p	9331	150p	4036	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7426	40p	74156	90p	74430	225p	9332	150p	4037	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7427	34p	74157	70p	74430	225p	9333	150p	4038	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7428	35p	74159	100p	74430	225p	9334	150p	4039	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7430	17p	74160	100p	74430	225p	9335	150p	4040	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7432	30p	74161	100p	74430	225p	9336	150p	4041	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7433	40p	74162	100p	74430	225p	9337	150p	4042	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7437	35p	74167	100p	74430	225p	9338	150p	4043	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7438	35p	74168	100p	74430	225p	9339	150p	4044	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7440	17p	74165	100p	74430	225p	9340	150p	4045	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7441	70p	74166	100p	74430	225p	9341	150p	4046	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7442A	60p	74167	200p	74430	225p	9342	150p	4047	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7443	112p	74170	240p	74430	225p	9343	150p	4048	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7444	112p	74172	220p	74430	225p	9344	150p	4049	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7445	102p	74173	120p	74430	225p	9345	150p	4050	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7446A	93p	74174	93p	74430	225p	9346	150p	4051	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7447A	70p	74175	85p	74430	225p	9347	150p	4052	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7448	80p	74176	90p	74430	225p	9348	150p	4053	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7450	17p	74177	90p	74430	225p	9349	150p	4054	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7451	17p	74178	160p	74430	225p	9350	150p	4055	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7453	17p	74180	90p	74430	225p	9351	150p	4056	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7454	17p	74181	200p	74430	225p	9352	150p	4057	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7460	17p	74182	90p	74430	225p	9353	150p	4058	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7470	35p	74188A	500p	74430	225p	9354	150p	4059	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7472	30p	74189	100p	74430	225p	9355	150p	4060	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7473	34p	74186	700p	74430	225p	9356	150p	4061	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7474	30p	74190	100p	74430	225p	9357	150p	4062	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7475	36p	74191	100p	74430	225p	9358	150p	4063	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427	90p	*1N918	7p	*4A 500V	90p	
7476	35p	74192	100p	74430	225p	9359	150p	4064	100p	74450	225p	*NE568	70p	BC177/8	11p	MJ481	175p	*2X108	12p	*2N4427						

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

FT3 NEON FLASH TUBE

High intensity multi turn high voltage neon glow discharge flash tube. Design for ignition timing. etc. £1.50. P & P 25p (£1.89 inc VAT) 3 for £3. P & P 50p (£3.78 inc VAT & P)

NI-CAD BATTERY

35AH 1 2V Metal £7.56
Height (mm) 219 Width (mm) 75 Length (mm) 29
Post 50p per unit

WHY PAY MORE?

MULTI RANGE METER TYPE MF15A a.c. d.c. volts 10 - 50, 250, 500, 1000 Ma 0.5, 0.10, 0-100. Sensitivity 2000V. 24 range, diameter 133 by 93 by 46mm including test leads. Price £7.00 plus 50p P & P (£8.10 inc VAT & P)

METERS (New) - 90 mm DIAMETER

A.C. Amp. Type 62T2 0-1A, 0-5A, 0-15A, 0-20A
A.C. Volt. 0-15V, 0-300V
£4.00 P & P 60p (£4.96 inc VAT & P). Similar in appearance to illustration.
D.C. Amp. Type 65C5 0-2A, 0-10A, 0-20A, 0-100A
D.C. Volt. 0-15V, 0-30V
All types £3.50 ea. + P & P 50p (£4.32 incl VAT), except 0-100A D.C. price £5.00 + 50p P & P (£5.94 incl VAT).

NEW HEAVY DUTY SOLENOID

by Magnetic Devices. 240V a.c. operation approx. 10lbs pull at 1.25in. Price £4.00 P & P 60p (£4.96 inc VAT & P). Similar in appearance to illustration. Approx. 1 1/2lb pull. Size of feet 1 1/2 x 1 1/2in. Price £1.00 P & P 25p.
EXLT.

MINIATURE UNISELECTOR

12 volt 11-way, 4 bank (3 non-bridging, 1 homing). £2.50.
P & P 35p (£3.08 inc VAT & P).

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 £3.95, post 25p (£4.53 inc VAT & P). 1000 watt model £5.60, post 25p (£6.32 inc VAT & P). 2000 watt model £9.75, post 40p (£10.96 inc VAT & P).

MICRO SWITCHES

Sub min Honeywell roller m/s type 3115m 906t. 10 for £2.50 post paid.
LEVER OPERATED 20 amp C/O. Mfg. by Unimax USA. 10 for £4. P & P 50p (min. order 10) (£4.86 inc VAT & P).
D.P. C/O lever m/switch mfg. by Cherry Co. USA. Precious metal low resistance contacts. 10 for £2.25 P & P 30p. Total inc. VAT £3.02 (min 10).
Sub min lever m/switch type MM1. 46 for 10 for £2.50. N.M.S.

24 VOLT DC SOLENOIDS

UNIT containing 1 heavy duty solenoid approx. 25lb pull 1 inch travel. Two approx 1lb pull 1/2 inch travel. 6 approx 4oz pull 1/4 inch travel. One 24V d.c. 1 heavy duty single make relay. Price £3. Post £1 (£4.32 inc VAT & P). ABSOLUTE BARGAIN.

VORTEX BLOWER AND VACUUM UNIT

Dynamically balanced totally enclosed 9in rotor with max air delivery of 1.5 cubic metres per min. Max static pressure 600mm W.G. Suction or blow from 2 side by-side 37mm ID circular apertures fitted to base of unit. Powerful continuously rated 115V a.c. motor mounted on alloy base with fixing facilities. Dimensions length 32cm, width 25cm, height 25cm. These units are ex equipment but have had minimum use. Fully tested prior to despatch. Price £12. £1.50 P & P (£14.58 inc VAT & P). Suitable transformer for 230/240V a.c. £6. £1 P & P (£7.56 inc VAT & P).

CENTRIFUGAL BLOWER

Smith type FFB
1906 022 220/240V A.C. Aperture 10 x 4 1/2cm overall size 16 x 14cm. Price £3.75 P & P 75p (£4.86).
Other types available on request. N.M.S.

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. £49. Post 80p (£53.78 inc VAT & P). 1,000V, 1,000MΩ, £55. Post 80p (£60.26 inc VAT & P). SAE for leaflet.

VARIABLE VOLTAGE TRANSFORMERS

INPUT 230/240V a.c. 50/60 OUTPUT VARIABLE 0-260V All Types SHROUDED TYPE

200 watt (1 amp) inc. a.c. voltmeter £14.50
0.5 KVA (2 1/2 amp) (MAX) £17.00
1 KVA (5 amp) (MAX) £22.50
2 KVA (10 amp) (MAX) £37.00
3 KVA (15 amp) (MAX) £45.50
5 KVA (25 amp) (MAX) £74.00
10 KVA (50 amp) (MAX) £168.00
15 KVA (75 amp) (MAX) £260.00
CARRIAGE AND PACKING EXTRA

LT TRANSFORMERS

0-15V at 3 amp (ex new equip) £2.50 P & P 50p (£3.24 inc VAT)
13-0 13V at 1 amp £2.50 P & P 50p (£3.24 inc VAT)
25-0-25V at 2 1/2 amp £4.50 P & P 75p (£5.67 inc VAT & P.)
0-4V/6V/24V/32V at 12 amp £15.00 P & P £1.50 (£17.82 inc VAT & P.)
0-6V/12V at 20 amp £13.50 P & P £1.50 (inc VAT £16.20)
0-12V at 20 amp or 0-24V at 10 amp £12.00 P & P £1.50 (£14.58 inc VAT & P.)
0-6V/12V at 10 amp £8.25 P & P £1.25 (inc VAT £10.26)
0-6V/12V/17V/18V/20V at 20 amp £16.50 P & P £1.50 (£19.44 inc VAT & P.)
0-10V/17V/18V at 10 amp £10.00 P & P £1.40 (inc VAT £12.31)
Other types in stock, phone for enquiries or send sae for leaflet.

STROBE! STROBE! STROBE!

HY-LIGHT STROBE KIT MK IV

Latest type Xenon white light flash tube. Solid state timing and triggering circuit 230/240V a.c. operation. Designed for larger rooms, halls, etc. Speed adjustable 1-20 f.p.s. Light output greater than many so called 4 Joule strobes. Price £19.00. Post £1 (£21.60 inc VAT & P). Specially designed case and reflector for Hy-Light £8.80. Post £1 (£10.58 inc VAT & P).

XENON FLASHGUN TUBES

Range available from stock. SAE for details.

WIDE RANGE OF DISCO LIGHTING EQUIPMENT

SAE (foolscap) for details.

Superior Quality Precision Made NEW POWER RHEOSTATS

New ceramic construction, vitreous enamel embedded winding heavy duty brush assembly continuously rated.
25 WATT 10/25 50/100/150/250/500/1kΩ
1-5kΩ £2.40. Post 20p (£2.81 inc VAT & P.)
50 WATT 100/250/500 £2.90. Post 25p (£3.40 inc VAT & P.)
100 WATT 1/5/10/25 50/100/250/500/1kΩ 1-5kΩ 2-5kΩ 3-5kΩ £5.90 p & p 35p (£6.75 inc VAT)
Black, Silver, Skirted knob calibrated in Nos. 1-9 1 1/2in. dia. brass bush. Ideal for above Rheostats 24p each.

RESET CENTER

230V a.c., 3 digits mfg. Veeder Root Type LL 1441 £1.75. P & P 25p (£2.16 inc VAT & P.). 7 Fig 24V d.c. non set £1.50. P & P 25p (£1.89 inc VAT & P.). 6 fig 24V d.c. resettable £3. P & P 25p (£3.51 inc VAT & P.). N.M.S.

230V a.c. FAN ASSEMBLY

Powerful continuously rated a.c. motor complete with 5 blade 6in Aluminium fan. Price £3.00. P & P 65p (£3.94). N.M.S.

ULTRA VIOLET BLACK LIGHT FLUORESCENT TUBES

4ft. 40 watt £7.75 (callers only). 2ft. 20 watt £8.50. Post 60p (Variable in stock by arrangement). Mini 12in. 4 watt £2.50. Post 25p (£2.87 inc VAT & P.). 9in. Swan £2.00 Post 25p (£2.43 inc VAT & P.). 6in. 4 watt £1.75 Post 25p (£2.18 inc VAT & P.). Complete battery unit. Either 6" or 12" tube 230V A.C. op. £3.50 plus P&P 40p (£4.21 inc VAT & P.). Also available for 12V D.C. op. £3.50 plus P&P 40p (£4.21 inc VAT & P.).

SQUAD LIGHT

A new conception in light control. Four channels each capable of handling 750 watts of spotlights, floodlights 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 £60.00
Post 75p. SAE (foolscap) for further details.

VAT

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

SERVICE TRADING CO.

ACCOUNT CUSTOMERS MIN. ORDER £10.00

GEARED MOTORS

100 r.p.m. 115lb in. 110V 50Hz 2 BA single phase split capacitor motor. Immense power. Continuously rated. Totally enclosed. Fan cooled in-line gearbox. Length 250mm Dia 135mm Spindle dia 15.5mm Length 145mm. Ex-equipment tested £12. Post £1.50 (£14.58 inc VAT & P.). Suitable transformer 230/240V operation £8. Post 75p (£9.45 inc VAT & P.).



GEARED MOTORS

28 r.p.m. 20 lbs inch
115v a.c. Reversible motor.
71 r.p.m. 10 lbs inch
115v a.c. Reversible motor.



Both types similar to above drawing. Price either type £4.75 p&p 75p (£5.94 inc VAT + p&p). Supplied complete with transformer for 240v a.c. operation £7.25 p&p £1.00 (£8.91 inc VAT + p&p).

Crouzet 230/240V AC 2RPM synchronous geared motor. Brand new £2.90 p&p 30p (£3.45 incl VAT) (quantity discount available).

FRACMO GEARED MOTOR

56 r.p.m. 50lb in. 240V a.c. 50Hz 0.7 amp shaft length 35mm dia 16mm weight 6 kilos 600 grammes. Price £15.00 P & P £1.50 (£17.82). N.M.S.



PARVALUX GEARED MOTOR

230/240V A.C. 30 rpm 50lbs inch. Price £15.00 P & P £1.00 (£17.82 inc VAT). N.M.S.



PARVALUX 230/250V a.c. MOTOR

500 rpm 3 1/2 lbs inch 2 right angled spindles £11.00 P & P £1.00 (£12.96 inc VAT & P.). N.M.S.

CITENCO 19 RPM

FHP motor type C 7333 15 220/240V a.c. 19 r.p.m. reversible motor. torque 14.5 kg gear ratio 144:1 Brand new incl capacitors our price £14.25 P & P £1.25 (£16.20 inc VAT & P.). N.M.S.



PROGRAMME TIMERS

12 cam model £7.50. Post 60p (£8.75 inc VAT & P.). Also available for 50V operation. Price as above. N.M.S.



Time Switch

Yenner Time ERD Time switch 200/250V a.c. 30 amp contact 2 on/2 off every 24 hrs. at any manually pre-set time. 36 hour Spring Reserve and day omitting device. Built to highest electrically Board specification. Price £7.75. P & P 75p (£9.18). R & T.



SANGAMO WESTON TIME SWITCH

Type S251 200/250V a.c. 2 on/2 off every 24 hours. 20 amps contacts with override switch dia 4 x 3 price £6.50 P & P 50p inc. VAT £7.56. Also available with Solar dial. R & T.

FRACMO MOTOR

1400 rpm H.P. 1/30 continuously rated 115V a.c. supplied complete with transformer for 230/240V a.c. op. Complete with anti vibration cradle mounting £10.00 P & P £1.00 (£11.88 inc VAT & P.). N.M.S.

ROTARY VACUUM AIR COMPRESSOR & PUMP

Carbon vane oil free vacuum pump and compressor. Approx. 20 inch vacuum 10 PSI at 79 CFM. Powered by 110V a.c. 1.8 amp Parvalux motor fitted with additional shaft at rear suitable light loads. Inc. capacitor £14.00 p&p £1.50 (£16.74 inc VAT + p&p). Suitable transformer for 230/240V a.c. operation £5.00 p&p £1.00 (£6.48 inc VAT + p&p). N.M.S.



Yet another outstanding offer.

New IMFD 600V Dubilier wire ended capacitors. 10 for £1.50 p&p 50p (£2.16 inc VAT + p&p) (Min 10).

RELAY

Diamond H heavy duty A.C. relay 230/240V a.c. two C/O contacts 25 amps res at 250 a.c. £2.50 p&p 50p (£3.24 inc VAT + p&p). Special base 50p. N.M.S.

KEY
N.M.S. New Manufacturers Surplus
R & T Reconditioned and Tested
EXLT. Ex-London Transport

Personal callers only Open Saturdays

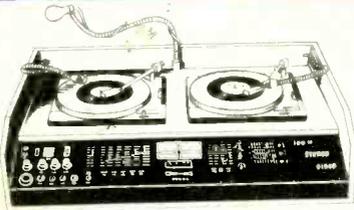
9 LITTLE NEWPORT STREET
LONDON WC2H 7JJ
Phone 01-437 0576

All Mail Orders—Callers—Ample Parking
Dept. PE, 57 BRIDGMAN ROAD
CHISWICK, LONDON W4 5BB
Phone 01-995 1560

Showroom open Mon-Fri.

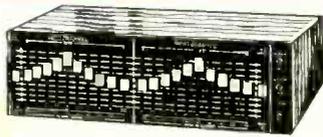
MAPLIN

everything for the modern D.I.Y. electronics enthusiast and more.



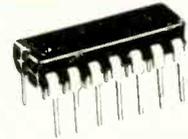
100W RMS STEREO DISCO

A genuine 100W RMS per channel (both channels driven) stereo disco with auto fade on microphone, VU meters, full monitoring and cueing facilities and a very high quality light show. Complete construction booklet MES41, price 25p. Cabinet comes complete with lid and carrying handles.



10 CHANNEL STEREO GRAPHIC EQUALISER

A new design with no difficult coils to wind, but a specification that puts it in the top-flight hi-fi class. All this for around £70 including fully punched and printed metalwork and woodwork. Send for our component schedule now. Full construction details price 25p. (All prices include V.A.T. and p & p)



INTEGRATED CIRCUITS

Over 35 pages in our catalogue devoted to hundreds of useful I.C.s. All with data, pin connections and many with applications circuits and projects to build. Post the coupon now!



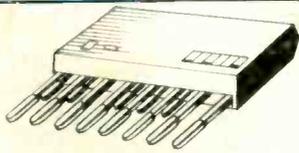
VERY LOW-DISTORTION AUDIO OSCILLATOR

The very low distortion sine wave (<0.01% output is suitable for testing very high quality hi-fi audio equipment. Also includes square wave output. Range 20Hz to 20kHz. Output 0V to 1V in three continuously variable steps. Total cost around £21. Full construction details in our catalogue. Send the coupon below, now (All prices include V.A.T. and p & p)



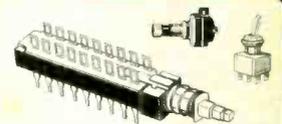
TOUCH-SENSITIVE PIANO

The revolutionary new IC AY-1320 first seen on 'Tomorrow's World' is now available. Complete kit of IC's to build a 60-note piano (18 x IC's) order as HQ53H price £36.86. Preliminary circuit details in our October newsletter. Complete design, pcb's attractive veneered wooden cabinet available soon. It's the most realistic-sounding electronic piano we've ever heard and includes simulated damping, loud and soft pedals. Full details in our newsletters. (All prices include V.A.T. and p & p)



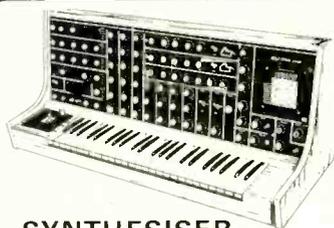
PEDAL UNIT

A completely self-contained pedal unit. 13-note, 2-Octave range, 4 organ stops. It can be added to any organ. A really unusual extra is the bass guitar stop which uses four envelope shapers to give a real bass guitar sound. A must for the solo guitarist. Full construction details in our catalogue - post the coupon below, now!



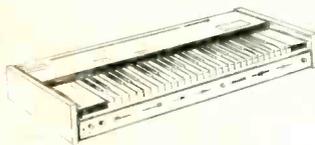
SWITCHES

We stock a wide range of switches including a really low-priced high quality interlocking push-button switch system which is extremely versatile. We've got toggle switches, slide switches, push switches, rotary switches - there are dozens to choose from, but it's only a tiny part of our fantastic range.



SYNTHESISER

The International 4600 Synthesiser. A very comprehensive unit. Over 400 sold. We stock all the parts costing less than £500 including fully punched and printed metalwork and a smart teak cabinet. Far less than half what you'd pay for a ready made synthesiser of equal quality. Specification on request. Full construction details in our construction book £1.50. (All prices include V.A.T. and p & p)



'PE' STRING ENSEMBLE

Unbeatable prices and finest quality components only when you buy from Maplin. All parts available to build this fascinating project. Component schedule available shortly (s.a.e. appreciated). Demonstration model in our shop soon. Phone now and compare our prices.



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



POST THIS COUPON NOW FOR YOUR COPY OF OUR 1977 CATALOGUE PRICE 60p

Please rush me a copy of your 216 page catalogue I enclose 60p, but understand that if I am not completely satisfied I may return the catalogue to you within 14 days and have my 60p refunded immediately.

NAME _____

ADDRESS _____

★ Look inside for our
★ 4 page special pull out
★ featuring the New
★ 79-80 catalogue